Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Economic impact assessment of a sample of 10 projects completed in 2020/21

AMPC Impact Assessment Program – FY20-24

Project Code
2021-1044

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Abbreviations

ACCC	Australian Competition and Consumer Commission
AEMIS	Australian Export Meat Inspection System
AMPC	Australian Meat Processor Corporation
AMIC	Australian Meat Industry Council
BCR	Benefit Cost Ratio
CRRDC	Council of Rural Research and Development Corporations
DAWR	Federal Department of Agriculture and Water Resources
EoP	End-of-Pipe
EU	European Union
IRR	Internal Rate of Return
LCA	Life-Cycle Assessment
LCOE	Levelised Cost of Energy
MBR	Membrane Bioreactor
MILA	Meat Industry Labour Agreement
MIRR	Modified Internal Rate of Return
MLA	Meat & Livestock Australia
NPV	Net Present Value
O&M	Operation and Maintenance
OH&S	Occupational Health and Safety
PV	Present Value
R&D	Research and Development
R&M	Repairs and Maintenance
RD&E	Research, Development and Extension
RDC	Research and Development Corporation
RO	Reverse Osmosis
RMI	Red Meat Industry
US	United States
W2E	Waste to Energy
WHS	Workplace Health and Safety

1.0 Executive Summary

The Australian Meat Processor Corporation (AMPC) is the Rural Research and Development Corporation (Rural RDC) that supports the Australian red meat processing industry through targeted investments in research, development and extension (R,D&E).

AMPC engaged GHD to complete a series of ex-post economic impact assessments on a representative sample of ten (10) projects completed during the 2020/2021 financial year. Evaluations were completed in line with the Council of Rural Research and Development Corporations (CRRDC) *Impact Assessment Program: Guidelines* (2018). They were informed by a review of project outputs, and consultation with researchers, industry representatives and other relevant stakeholders.

Broadly, the assessments were completed by modelling the marginal costs and benefits from a project over a 30 year period, then discounted to present day amounts (applying a 5% discount rate) to determine key measures of economic impact: Net Present Value of Benefits (NPV); Benefit Cost Ratio (BCR); Internal Rate of Return (IRR); Modified Internal Rate of Return (MIRR).

The results for the ten individual projects assessed are summarised in Table 1.

Table 1 Results from impact evaluations (Economic Impact over 30 years)

Project Code	Project Name	Present Value of Costs ($m)	Present Value of Benefits ($m)	NPV ($m)	BCR (ratio)
2021-1146	Remote Operations – Shadow Robots	$0.21	$0.58	$0.37	2.8
2020-1006	Aggregated Waste to Energy (W2E)	$0.09	$0.39	$0.31	4.6
2020-1065	Working towards an ideal RMI Visa Program - Stage 2	$0.25	$1.97	$1.72	7.9
2020-1010	Export Certification Framework Project	$0.21	$1.43	$1.22	6.9
2021-1086	Development of a COVID Marshall training package	$0.08	$1.13	$1.06	14.4
2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2	$0.45	$4.07	$3.62	9.0
2018-1030	Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs	$0.26	$1.64	$1.38	6.4
2020-1054	Solar PV with Storage & Biomass Boilers – LCOE calculator	$0.10	$0.47	$0.37	4.9
2020-1012	Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator	$0.07	$0.36	$0.29	5.4
2019-1039	US Pilot for pallet labels as an alternate system of shipping mark	$0.20	$4.49	$4.29	22.5

The aggregated results from the ten projects modelled over 30 years from the last year of investment (2020/21) is presented in Table 2 below.

Table 2 Summary of overall results from evaluated projects

Years from project investment (2021/22)	0	5	10	15	20	25	30
Present value of benefits ($m)	$0.43	$6.31	$11.75	$15.50	$16.25	$16.51	$16.53
Present value of costs ($m)	$1.90	$1.90	$1.90	$1.90	$1.90	$1.90	$1.90
Net present value ($m)	-$1.47	$4.41	$9.85	$13.60	$14.36	$14.61	$14.63
BCR (weighted average)	0.22	3.32	6.19	8.17	8.56	8.70	8.71

The overall estimated economic return from the ten evaluated projects (weighted average BCR 8.71 over 30 years) is slightly above the typical assessed returns from RDC investments.[1] The expected economic return is also somewhat higher than the assessed returns from previous assessments of AMPC projects completed by GHD in 2020 (weighted average BCR of 5.11 across 10 projects) and 2019 (weighted average BCR of 6.05 across 17 projects). The higher result is largely attributable to significant returns from the following projects:

- 2019-1039 *US Pilot for pallet labels as an alternate system of shipping mark*. Significant potential savings in unpacking/inspection costs and reduced rejections (NPV $ $4.29m, BCR 22.5)
- 2021-1086 *Development of a COVID Marshall training package* . Reduced risk of expensive plant closures due to Covid-19 outbreaks (NPV $1.06m, BCR 14.4)
- 2018-1045 *First prototype automation for deboning lamb Shoulder - Stage 2*. Potential for significant labour savings (NPV $3.62, BCR 9.0)

Overall, the results from the sample of evaluated projects suggests that AMPC R&D projects concluding in the 2021 financial year, are likely to yield substantial economic benefits to processors over the coming years, realised primarily through reduced costs (labour, energy, food waste, business disruption and regulatory compliance costs).

[1] An assessment of 111 RDC project cluster evaluations, between 2014 and 2019, found a comparable weighted average BCR of 5.5, with annual weighted average BCRs from 3.3 to 9.1 (Agtrans Research 2019).

2.0 Introduction

This report presents the results of ex-post impact assessments on a representative sample of AMPC projects completed during the 2020/2021 financial year.

Evaluations were completed in line with the Council of Rural Research and Development Corporations (CRRDC) *Impact Assessment Program: Guidelines* (2018). They were informed by a desktop review of project outputs, and consultation with researchers, industry representatives and other relevant stakeholders.

The results provide an objective and independent assessment of the qualitative and quantitative outcomes likely to be realised from the evaluated projects. Where necessary, the evaluations rely on informed estimates of unknown parameters, such as economic benefits from practice change, potential rates of adoption and attribution of benefits.

3.0 Project Objectives

Specific objectives of this impact assessment were:

1. To provide an assessment, in line with the CRRDC Impact Assessment Guidelines, of a representative sample of AMPC investments completed between 1 July 2020 and 30 June 2021.
2. To collect, on behalf of AMPC, relevant industry data to support an understanding of industry issues, and the delivery of future investments.
3. To identify and analyse key drivers of investment success, including investment outputs, industry awareness, industry adoption, cost of adoption, adoption benefit, benefit attribution.
4. To identify and analyse key lessons learned, for future investments.
5. To identify and outline key messages relevant for service providers, AMPC members and key stakeholder groups (including MLA, AMIC, RMAC and the Commonwealth Government).

4.0 Methodology

Economic impact evaluation

As per the *CRRDC Impact Assessment Program: Guidelines* (2018) GHD considered and modelled the project case (with project scenario) against the counterfactual (without project scenario) to determine the likely change in net economic benefit and, therefore, return on investment.

GHD reviewed project reports and outputs, and consulted with key stakeholders, to determine reasonable assumptions for the following:

- Potential impact if/when project outputs and findings are utilised by industry;
- Likely rates of adoption over the coming years (adoption profile); and
- Attribution of benefits, i.e. the extent realised benefits are attributable to the project investment, as separate from previous related research, future implementation costs and other factors.

Impacts were modelled over a 30 year timeline and discounted to present day amounts (applying a 5% discount rate) to determine the:

- Net Present Value of Benefits (NPV): Net benefits minus net costs;
- Benefit Cost Ratio (BCR): Net benefits divided by net costs;
- Internal Rate of Return (IRR): Interest rate at which the NPV of all the impacts from a project (both costs and benefits) from a project or investment equal zero; and
- Modified Internal Rate of Return (MIRR): Similar to the above IRR, but assuming more realistic returns from reinvested benefits and financing of initial outlays (5% applied for both, as per CRRDC guidelines).

All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs. All costs and benefits after 2021/22 were discounted to 2021/22 dollars using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a high level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

Sensitivity analysis was used to test results against changes to key assumptions and discount rates, for both individual projects and aggregate results. For each evaluation GHD also specified confidence ratings in terms of coverage of benefits and accuracy of assumptions.

Selection of projects for evaluation

Ten projects were selected for evaluation to provide a representative sample across the main research areas within AMPC. Some projects were removed from the sample based on being too small or with benefits too difficult to quantify. Table 3 below shows the evaluated projects from the broader sample of projects completed during 2020/21. The evaluated projects represented a combined budget of $1.69m or approximately 37% of the total investment.

Table 3 Projects completed and selected for evaluation

Project Code	Project Title	AMPC Budget ($)[2]	Evaluated
1. Advanced Manufacturing: 1.1 Hands-Off Processing			
2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2	$393,300	✓
2018-1048	Naked Primal Cut Recognition Vision System Trial in Plant	$141,800	
2021-1128	Bovine IMF Measurement Production Prototype (Stage 1)	$85,000	
2021-1137	Remote Operations (Gamification) – Stage 1	$143,195	
2021-1146	Remote Operations – Shadow Robots	$190,876	✓
1. Advanced Manufacturing: 1.2 Technology Adoption			
2021-1177	High Level Business Case Analysis of Innovation Themes	$56,010	
1. Advanced Manufacturing: 1.3 Digitisation			
2021-1120	Primal Proof of Load RFID On- Site (Stage 2) Trials - Improved Traceability and Quality Control for Meat Products	$165,000	
2. Sustainability: 2.2 Energy			
2018-1027	Energy and Materials Recovery from Paunch Waste Using Novel Hydrothermal and Supercritical Water Gasification Processes - Phase 1	$172,165	
2020-1006	Aggregated Waste to Energy (W2E)	$80,340	✓
2020-1054	Solar PV with Storage & Biomass Boilers – LCOE calculator	$86,500	✓
2. Sustainability: 2.3 Water			
2018-1030	Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs	$230,000	✓
2. Sustainability: 2.4 Waste			
2019-1060	Megasonic demulsification of oil and grease from meat processing wastewater	$224,115	

[2] Nominal, excluding AMPC overheads

Project Code	Project Title	AMPC Budget ($)[2]	Evaluated
3. People & Culture: 3.1 Attraction			
2020-1002	2020-21 Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry	$45,455	
2020-1065	Working towards an ideal RMI Visa Program - Stage 2	$222,090	✓
3. People & Culture: 3.3 Development			
2016-1019	Red Meat Processing Upskilling Scholarship Program	$235,700	
2016-1368	An Integrated Scholarship Program in Process Engineering - Year 4	$55,000	
2016-1439	Educational Pathways: Creating a Highly Skilled Meat Industry - Year 3 & 4	$360,667	
2017-1078	Australian Agribusiness Leadership Program	$144,000	
2018-1007	Diploma of Meat Processing Scholarship Program	$240,000	
2019-1037	Diploma of Meat Processing (Technical Program)	$72,000	
2019-1056	Facilitation of the QCMPA Network FY18-FY20	$66,500	
4. Markets & Market Access: 4.3 Market Access			
2020-1012	Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator	$57,662	✓
4. Markets & Market Access: 4.4 Global Competitiveness			
2019-1064	Creating Visibility in the Supply Chain utilising Intelligent Inspection and Data Technologies	$235,000	
2020-1010	Export Certification Framework Project	$184,800	✓
2020-1067	Evaluating the socio-economic benefit of the red meat processing industry in regional Australia 2020	$88,200	
2021-1043	Digital Transformation Road Map for Meat Export Reforms	$171,732	
5. Product & Process Integrity: 5.1 Traceability			
2019-1039	US Pilot for pallet labels as an alternate system of shipping mark	$180,000	✓
2020-1013	Exotic Disease Preparedness Review	$62,400	
5. Product & Process Integrity: 5.2 Animal Welfare			
2018-1021	Review and compare Australian animal welfare systems throughout the supply chain to major trading partners (whole of life animal welfare)	$70,000	

Project Code	Project Title	AMPC Budget ($)[2]	Evaluated
2020-1020	Revision of the Industry Animal Welfare Standard for livestock processing establishments	$106,800	
5. Product & Process Integrity: 5.3 Food Safety			
2021-1086	Development of a COVID Marshall training package	$71,500	✓
Total Budget		**$4,637,807**	
Total Budget (evaluated projects)		**$1,693,182**	
% of Total Budget Evaluated		**37%**	

Evaluation assumptions

Impact evaluations relied on assumptions adopted from:

- Industry data: e.g., plant numbers, throughput volumes, operating costs, prices and profitability;
- Targeted consultation with relevant researchers and project leaders; and
- The consultants informed judgement.

All results are subject to rounding error.

All assumptions and sources are referenced in the individual project evaluations (in 8.0 Appendices).

5.0 Results

Alignment with Australian Government Research Priorities

Table 4 below shows how the evaluated projects align with The Australian Government's Rural Research, Development and Extension (RD&E) priorities, as well as the Science and Research Priorities.

Table 4 Australian Government Research Priorities

	Rural RD&E Priorities	Science and Research Priorities
Stated Priorities	1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	5. Food 6. Soil and water 7. Transport 8. Cybersecurity 9. Energy 10. Resources 11. Advanced Manufacturing 12. Environmental Change 13. Health

Project	Alignment with priorities	
2021-1146 Remote Operations – Shadow Robots	1, 2, 4	1, 7, 9
2020-1006 Aggregated Waste to Energy (W2E)	1, 3, 4	1, 5, 7, 8
2020-1065 Working towards an ideal RMI Visa Program - Stage 2	4	1, 7, 9
2020-1010 Export Certification Framework Project	2, 4	1, 7, 9
2021-1086 Development of a COVID Marshall training package	2	1, 7, 9
2018-1045 First prototype automation for deboning lamb Shoulder - Stage 2	1	1, 7
2018-1030 Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs	1, 3, 4	2, 5, 6, 8
2020-1054 Solar PV with Storage & Biomass Boilers – LCOE calculator	1, 3, 4	5, 8
2020-1012 Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator	1, 2	1, 7, 9
2019-1039 US Pilot for pallet labels as an alternate system of shipping mark	1, 2, 3, 4	1, 3, 7, 9

Source: Commonwealth of Australia (2016) and Office of the Chief Scientist (2015).

Economic impact by project

The results for the ten individual projects assessed are presented in Table 5.

Table 5 Results from impact evaluations (Total Project Investment, 30 years)

Project Code	Project Name	PV Costs ($m)	PV Benefits ($m)	NPV ($m)	BCR
2021-1146	Remote Operations – Shadow Robots	$0.21	$0.58	$0.37	2.8
2020-1006	Aggregated Waste to Energy (W2E)	$0.09	$0.39	$0.31	4.6
2020-1065	Working towards an ideal RMI Visa Program - Stage 2	$0.25	$1.97	$1.72	7.9
2020-1010	Export Certification Framework Project	$0.21	$1.43	$1.22	6.9
2021-1086	Development of a COVID Marshall training package	$0.08	$1.13	$1.06	14.4
2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2	$0.45	$4.07	$3.62	9.0
2018-1030	Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs	$0.26	$1.64	$1.38	6.4
2020-1054	Solar PV with Storage & Biomass Boilers – LCOE calculator	$0.10	$0.47	$0.37	4.9
2020-1012	Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator	$0.07	$0.36	$0.29	5.4
2019-1039	US Pilot for pallet labels as an alternate system of shipping mark	$0.20	$4.49	$4.29	22.5

Overall economic impact

The aggregated results from the ten projects modelled over 30 years from the last year of investment (2020/21) is presented in Table 6 below. The results suggest most of the net benefits will be realised in five to ten years' time. This is typical of rural R,D&E as innovations often take up to five years to become fully developed and adopted. After 10 years many innovations are likely to be superseded, or similar outcomes achieved, under the counterfactual scenario.

Table 6 Summary of overall results from evaluated projects

Years from project investment (2021/22)	0	5	10	15	20	25	30
Present value of benefits ($m)	$0.43	$6.31	$11.75	$15.50	$16.25	$16.51	$16.53
Present value of costs ($m)	$1.90	$1.90	$1.90	$1.90	$1.90	$1.90	$1.90
Net present value ($m)	-$1.47	$4.41	$9.85	$13.60	$14.36	$14.61	$14.63
BCR (weighted average)	0.22	3.32	6.19	8.17	8.56	8.70	8.71

Sensitivity Analysis

Table 7 shows how the overall economic impact results would change based on changes in the discount rate. The results show that even applying a discount rate of 9%, the projects would still deliver a positive NPV ($10.56M) and favourable BCR (6.56).

Sensitivity analysis was also undertaken for individual projects, adjusting both discount rates and assumed benefits once innovations are adopted. These results are detailed in the report appendices.

Table 7 Aggregated economic impact (total project investment, after 30 years) applying different discount rates

Discount rate	NPV ($M)	BCR
1%	20.59	11.85
3%	17.31	10.12
5%	**14.63**	**8.71**
7%	12.41	7.54
9%	10.56	6.56

6.0 Discussion

The overall estimated economic return from the ten evaluated projects (weighted average BCR 8.71 over 30 years) is slightly above the typical assessed returns from RDC investments. An assessment of 111 RDC project cluster evaluations, between 2014 and 2019, found a comparable weighted average BCR of 5.5, with annual weighted average BCRs from 3.3 to 9.1 (Agtrans Research 2019).

The weighted average BCR of 8.71 is also somewhat higher than the assessed returns from previous assessments of AMPC projects completed by GHD in 2020 (weighted average BCR of 5.11 across 10 projects) and 2019 (weighted average BCR of 6.05 across 17 projects). The higher result is largely attributable to significant returns from the following projects:

- 2019-1039 *US Pilot for pallet labels as an alternate system of shipping mark*. Significant potential savings in unpacking/inspection costs and reduced rejections (NPV $ $4.29m, BCR 22.5)
- 2021-1086 *Development of a COVID Marshall training package* . Reduced risk of expensive plant closures due to Covid-19 outbreaks (NPV $1.06m, BCR 14.4)
- 2018-1045 *First prototype automation for deboning lamb Shoulder - Stage 2*. Potential for significant labour savings (NPV $3.62, BCR 9.0)

Overall, the results from the sample of evaluated projects suggests that AMPC R&D projects concluding in the 2021 financial year, are likely to yield substantial economic benefits to processors over the coming years, realised primarily through reduced costs (labour, energy, food waste, business disruption and regulatory compliance costs).

7.0 References

Agtrans Research (2019) *Cross-RDC Impact Assessment 2019*. Prepared for The Council of Rural Research and Development Corporations.

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Additional references for each project assessment are outlined in appendices.

8.0 Appendices

Appendix	Project Code	Project Name
A	2021-1146	Remote Operations – Shadow Robots
B	2020-1006	Aggregated Waste to Energy (W2E)
C	2020-1065	Working towards an ideal RMI Visa Program - Stage 2
D	2020-1010	Export Certification Framework Project
E	2021-1086	Development of a COVID Marshall training package
F	2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2
G	2018-1030	Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs
H	2020-1054	Solar PV with Storage & Biomass Boilers – LCOE calculator
I	2020-1012	Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator
J	2019-1039	US Pilot for pallet labels as an alternate system of shipping mark

8.1 Appendix A: 2021-1146 Remote Operations – Shadow Robots

Background

An imperative of red meat industry is to reduce work health safety (WHS) incidents from meat processing operations. Two potential pathways identified to address this challenge are (1) to automate high risks tasks to reduce exposing staff to danger, and (2) to remove operators from dangerous tasks that are not cost-effective to automate through the introduction of safety techniques. Shadow robotics and tele-remote operated robots present an opportunity to remove the risks of injuries from processing lines. Operators having the capability to control robots to complete these tasks reducing the likelihood of injuries caused by sharp equipment, such as knives and saws, and reducing the stress and fatigue caused by heavy duty tasks. The technology is still in the early development stage with considerable work required to refine and tailor uses for commercial meat processing. The standard tele-remote robot currently lacks a haptic feedback device, which allows operators to interact with and have control over the robot.

Description of the project

The purpose of the project was to develop and showcase a solution to allow staff to tele-remotely operate high-risk processing operations. The technology involved the procurement and programming of a haptic controller to enable the remote control of a robot. This robot was presented to the industry at Beef Week 2021 for demonstration purposes and to receive feedback related to the weaknesses and strengths of the technology.

Figure 1 Shadow Robotics Exhibit at Beef Week 2021

Table 8 Project description and logic

2021-1146	Remote Operations – Shadow Robots
Project Details	Organisation: Intelligent Robotics Date: 2021 Principle Investigator: Todd Enfield
Rationale	To investigate the potential use of a haptic feedback device to tele-remotely operate a robot, and to demonstrate this technology to the industry at Beef Week in 2021
Objectives	The objectives of the project were to: / Identify and procure a haptic controller and robot / Program and commission a haptic controller to move robot / Presentation and exhibition of the technology at Beef Week 2021 / Analyse technology and plan for next step of evaluation and development of the technology
Activities and Outputs	/ Commissioned the Shadow Robotic System / Developed and created a Trade-Show suitable display / Attended Beef Week 2021 to demonstrate and discuss technology
Potential Outcomes	/ Work health safety benefits for staff with higher risk, heavy duty operations completed through technologies / Potential for yield gain with assisted technologies / Widening of labour pool with the requirement of strength in tasks reduced. This could include older people, people with disabilities and people who are not able to carry out heavy duties and day
Potential Impacts	/ Reduced operating costs due to reduced staff costs, increased staff retention, reduced injury time and costs and increased yield (reduced waste). / Improved Workplace Health and Safety

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 9 Annual Investment in Project 2021-1146

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$0	$190,876	$190,876
Co-investment			
Total			**$190,876**

Summary of impacts

Table 10 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 10 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced operating costs due to reduced staff costs, increased staff retention, reduced injury time and costs and increased yield (reduced waste).**
Environmental	/	
Social	/	Improved Workplace Health and Safety

Quantification of impacts

Estimated benefits

Shadow robotics is a concept which is expected to be further developed over the coming years and potentially adopted for a range of uses within meat processing. The trade stand exhibition represented an opportunity for processors to be introduced to the concept and observe an example of the technology in operation. The trade stand exhibition was an initial step in what will likely be a longer-term R&D process bringing this technology to Australian meat processors. This process will involve AMPC working with a range of technology developers to develop and pilot various use cases. Development of this technology will also be driven by external investments (outside AMPC) including from processors and technology developers, both in Australia and abroad.

Estimating the economic benefits from such a small component of a larger R&D pipeline is very challenging, particularly when the future applications and benefits are not yet known. In order to evaluate these outcomes, it was assumed that in the future, the technology will deliver cost savings to processors, realised through reduced labour costs, increased staff retention, increased yield, improved quality control, biosecurity and food safety.

Table 11 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Potential future cost savings from adopting shadow robotics	5%	GHD high level estimate based on a range of potential benefits including reduced labour costs, increased staff retention, yield, quality control, biosecurity and food safety.
b) Total potential industry wide potential annual benefits from adopting shadow robotics	$105m	Applying the potential cost savings above (a) to the estimated total processing costs estimated by S.G. Heilbron Economic & Policy Consulting (2018)

Adoption costs

The above potential benefits will be offset by the costs incurred by processors adopting the technology, including capital costs as well as potential disruption to existing activities.

Table 12 Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs	25% of the potential cost savings outlined in Table 11 are assumed to be offset by adoption costs, including capital costs, financing and costs associated with changing practices.	GHD assumption based on typical payback periods for technology investment.

Counterfactual

Under the counterfactual scenario shadow robotics technology is not developed and adopted by the Australian meat processing sector.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development and extension. In the case of shadow robotics significant levels of investment have been made and will be required to develop the technology to a point where it can be implemented into Australian processing plants, therefore the AMPC project investment represents a very small percentage of overall investment.

Table 13 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	9.14%	Based on an indicative estimate of $10m already invested into R&D directly related to shadow robotic applications suitable for Australian processing plants.
b) Future Development	67.91%	Based on an estimated future investment of $3m annually into R&D for shadow robotic applications suitable for Australian processing plants.
c) Promotion and extension	22.64%	Based on an estimated future investment of $1m annually into promotion and extension for shadow robotic applications suitable for Australian processing plants.
d) Attribution of remaining benefits to project	0.31%	= 100% - a – b – c

Adoption

It is inherently difficult to predict future adoption levels of emerging technologies. Many seemingly promising technologies can fail to achieve expected adoption rates, while other technology can emerge to be become the new standard, achieving almost 100% adoption. Furthermore, technology applications can change significantly from what was originally envisaged.

Based on the balance of probabilities the analysis assumed that adoption of shadow robotics will not begin until 2025/26 before steadily increasing until 2035/36, peaking at 50% of production (Figure 2). After this point it is assumed the original technology will evolve and become superseded by alternative technologies. Adoption of the technology will be driven by ongoing developments and refinements in use cases, improved reliability and reduction in capital costs. However, the technology may not be suitable for all processors for various reasons, therefore adoption has been capped at 50%.

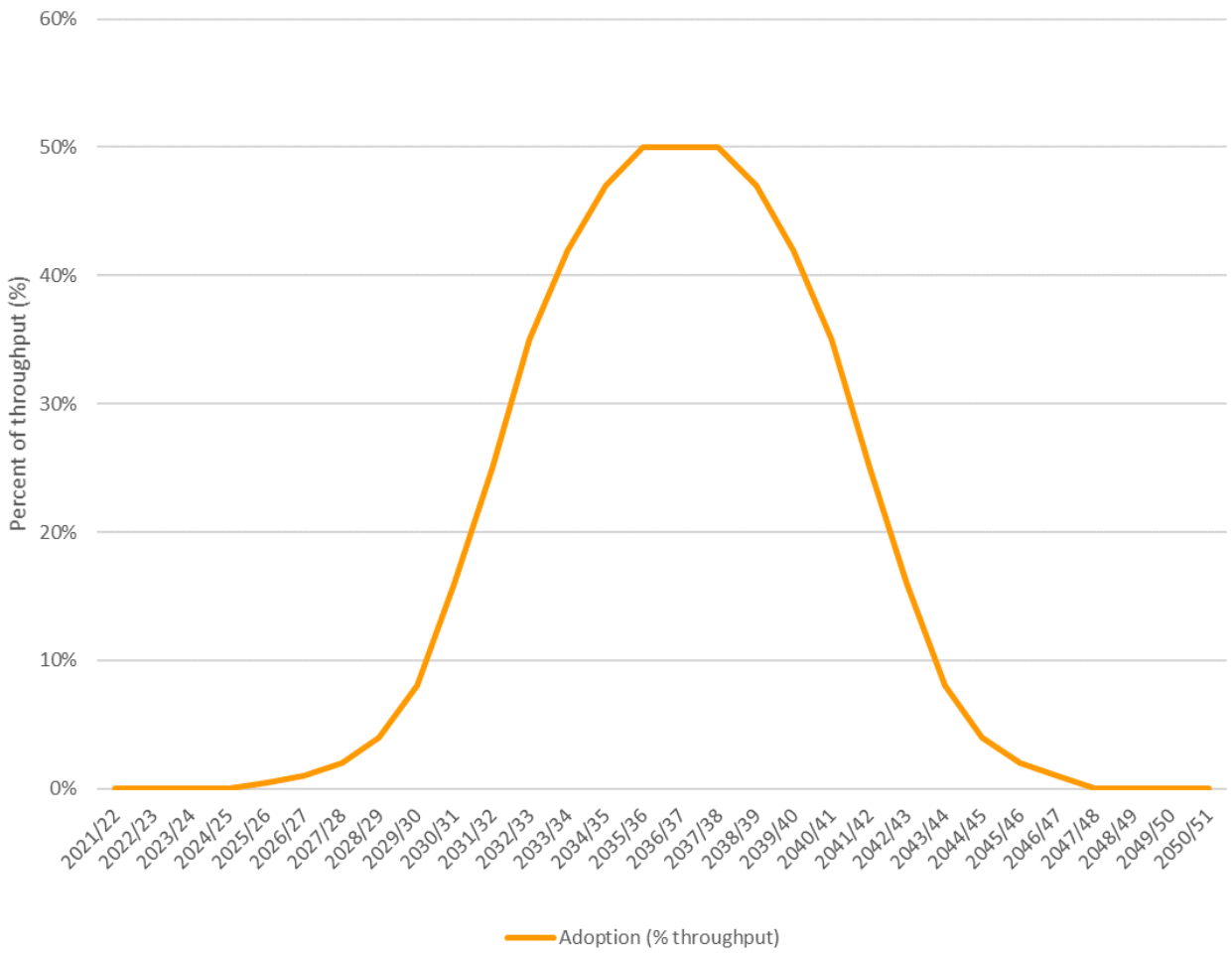

Figure 2 Projected adoption rate of shadow robotics

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $0.37 and a positive Benefit Cost Ratio of 2.8.

Table 14 Investment criteria for total investment in Project 2020-1146 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	$0.00	$0.05	$0.30	$0.53	$0.58	$0.58
PV Costs	$0.21	$0.21	$0.21	$0.21	$0.21	$0.21	$0.21
NPV	-$0.21	-$0.21	-$0.16	$0.09	$0.32	$0.37	$0.37
BCR	-	0.0	0.2	1.4	2.5	2.8	2.8
IRR	NA	NA	-10%	8%	12%	12%	12%
MIRR	-100%	-42%	-5%	7%	9%	9%	8%

The flow of total undiscounted costs and benefits from the project is presented below.

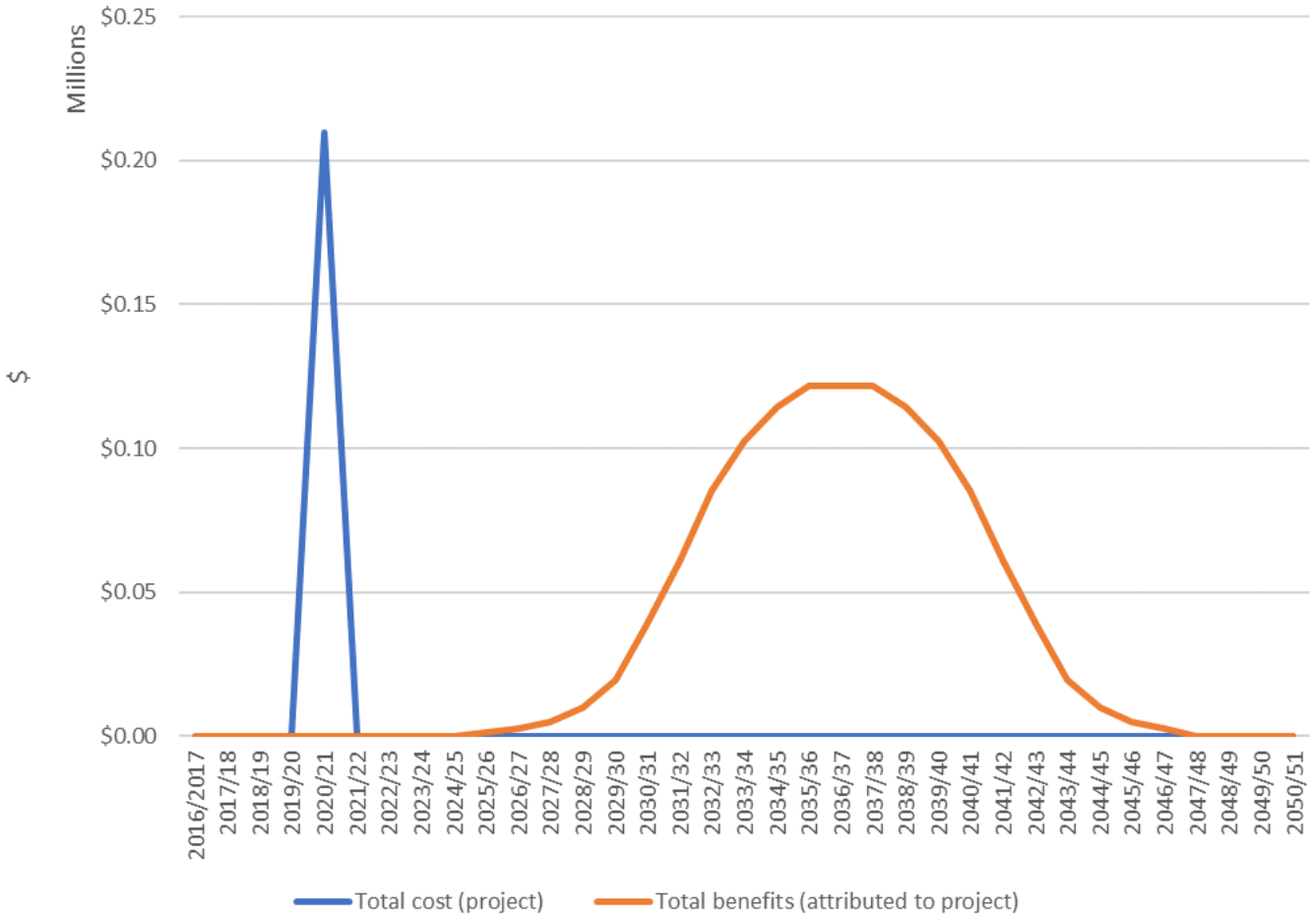

Figure 3 Flow of undiscounted costs and benefits from project 2021-1146

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented below in Table 15 below. The investment remained positive under all scenarios modelled.

Table 15 Sensitivity analysis

Changes to Key Variables	NPV ($M)	BCR	MIRR
Standard assumption	0.37	2.76	8%
Adjusted discount rate			
0%	$0.46	3.18	3%
10%	$0.23	2.11	12%
Adjusted potential cost savings from technology use			
+40% (from 5% to 7%)	$0.60	3.86	9%
-40% (from 5% to 3%)	$0.14	1.66	7%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 16 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis covers the primary expected benefits from the trade exhibition, being introduction of shadow robotics leading to cost savings for processors. However, the full nature of future benefits remains unclear and for example may include social outcomes from increased employment opportunities for disabled people.
Confidence in assumptions	Very low	Shadow robotics is considered “blue sky” technology, therefore the applications, expected benefits, costs and timeline for adoption remain very unclear. In the absence of more certainty, very high-level assumptions were used.

Conclusions

The trade show exhibition represented an opportunity to introduce Australian meat processors to the concept of shadow robotics and to begin to envision the future uses and benefits for their businesses. The nature of these uses and magnitude of benefits is not yet known, therefore this impact assessment relied on high level estimates of potential cost savings (5%). Based on this and other assumptions of future development costs and adoption rates, the analysis concluded that the trade show exhibition was likely to deliver a positive economic benefit (BCR 2.8). This outcome was highly sensitive to changes in assumptions, however the investment returns remained positive under all scenarios modelled.

References

Enfield, T. (2021), *2021-1146 Shadow robotics remote operations-shadow robots final report*, Australian Meat Processor Corporation.

S.G. Heilbron Economic & Policy Consulting (2018) *Analysis of Regulatory and Related Costs in Red Meat Processing*, Australian Meat Processor Corporation.

Acknowledgements

Stuart Shaw (AMPC)

Jonathan Cook (Intelligent Robotics)

8.2 Appendix B: 2020-1006 Aggregated Waste to Energy (W2E)

Background

Waste to Energy (W2E) technologies provide opportunities for processing plants to convert a wide range of organic waste materials (manure, paunch, blood, guts, saveall overflow etc) into thermal (biogas) and electrical energy. The key potential benefits from this technology include reduced power and thermal energy costs, reduced waste disposal costs and improved environmental outcomes.

A limiting factor of waste to energy (W2E) facilities in the meat processing industry, is processors' ability to only utilise their own waste. The small amounts of organic wastes generated and the difficulty in handling dam sludges impedes the ability of the facilities to operate viably. An opportunity presented to assist W2E facilities in reaching a minimum scale for viability is the aggregation of suitable wastes from third parties.

Description of the project

The purpose of the project was to assess the economic and technical viability of waste to energy (W2E) investments for processors, feedlots, and other streams. Based upon industry surveys and preliminary economic modelling, two specific waste to energy technologies were considered in detail:

- Anaerobic digestion of red meat process (RMP), pig processing wastes, food organics and green organics from municipal wastes in continuous stirred tank reactors (CSTRs) to generate biogas used to fuel reciprocating cogeneration engine, and
- Aggregation of different biomass fuels from within RMP operations and adjacent to operations for combustion in boilers for creating steam.

Table 17 Project description and logic

2020-1006	Aggregated Waste to Energy (W2E)
Project Details	Organisation: All Energy Pty Ltd Date: 2020 Principle Investigator: Max Barnes and Dr. Gareth Forde
Rationale	To explore ways for red meat processors to aggregate localised biowastes to assist in making distributed Waste to Energy (W2E) facilities more feasible in regional locations
Objectives	The objectives of the project were to: / Develop tools to assess the economic viability of W2E that aggregate wastes from processors, feedlots and other streams / Develop tools to assess the thermal energy and power generation potential from processing plant wastes and other waste streams / Provide processors on the key parameters impacting the economic and technical viability of W2E facilities / Explore current interest and activity in W2E throughout Australian RMI processors / Map out options and collaborations for aggregated W2E facilities

2020-1006	Aggregated Waste to Energy (W2E)
	/ Develop feasibility studies for two specific case studies considering the impact of waste type, tonnages, composition and technology selection on CAPEX and economic viability of aggregated W2E projects / Communicate findings through reports, articles, snapshots, workshops and other suitable avenues
Activities and Outputs	/ Analysed and evaluated energy usage of the current available beef processing and piggery pork processing wastes, and the financial opportunity of digesting these wastes anaerobically to offset power usage and costs of NSW red meat processors / Lab testing confirmed piggery blood, guts and paunch are all high value streams. Yard manure / cattle wash water was confirmed to be highly diluted and low energy content and not of value / Consideration of two specific W2E technologies in detail: (1) anaerobic digestion in continuous stirred tank reactors (CSTR), (2) aggregation of different biomass fuels / Consideration of other technologies: pyrolysis and gasification / Feasibility study for co-combusting a range of biomass fuels within red meat processing operations
Potential Outcomes	/ Anaerobic digestion appeared to be an attractive option to offset electrical and thermal energy cost, reduce emissions, improve energy security, and provide a sustainable approach to waste management. The CSTR was able to handle higher fats, oils, greases and solid concentration in comparison to covered anaerobic systems. The CTSR had a smaller footprint and higher conversion efficiency of substrates into biogas / Multi-fuel biomass boilers able to provide a 2 to 3 year payback compared to LPG fired boiler, and 6 to 7 years paybacks compared to coal fired boilers
Potential Impacts	/ Reduced power costs, thermal energy costs and waste disposal costs of W2E plants / Improved environmental outcomes and social license to operate / Reduced reliance on fuel hauled / reticulated to site / Improved energy security and reduced reliance on fuels from third parties and / or energy utilities / Reduction in greenhouse gas emissions / Additional saleable produces such as soil conditioner at a retail standard

Project investment

Table 18 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 18 Annual Investment in Project 2020-1006

Contributor	2020/21	2021/22	Total

AMPC investment (including overheads)	$40,428	$43,671	$84,099
Co-investment			
Total			**$84,099**

Summary of impacts

Table 19 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project

*Table 19 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced power costs, thermal energy costs and waste disposal costs of W2E plants**
Environmental	/	Improved environmental outcomes and social license to operate
	/	Reduction in greenhouse gas emissions
Social	/	Improved energy security and reduced reliance on fuels from third parties and / or energy utilities

Quantification of impacts

Estimated benefits

Anaerobic digestion appeared to be the most attractive option to offset electrical and thermal energy cost, reduce emissions, improve energy security, and provide a sustainable approach to waste management. Therefore, modelling of benefits was focussed on this technology.

The study assessed the economic costs and returns from installing an anaerobic digestor at a typical processing plant, with quotes from three commercial suppliers obtained. Table 20 below shows the average of the two suppliers considered the most viable.

Table 20 Investment returns

Investment criteria	Average from two most viable anaerobic digestion options
Capex ($M)	$6.1m
Annual Operating Costs ($M)	$0.4m
Gross annual Cost Savings ($M)	$1.45
Net annual Cost Savings ($M)	$1.05
Simple payback period (years)	5.8
NPV ($M)[3]	$20.1
IRR (%)	21%

Source: All Energy Pty Ltd 2020

The completion of the study has highlighted to processors the opportunity to adopt this technology, including potential financial gains and risks. As a result of the project more processors will be likely to make sound investments in W2E technology.

Table 21 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Net annual cost savings for plant	$1.05m	Table 20 above
b) Chance of success	80%	Actual investment returns may fail to reach the estimated figures in the study due to mis-estimation of cost and benefits, technical challenges and other factors.
c) Net annual cost savings for plant (probability adjusted)	$0.84m	= a x b

Adoption costs

The capital cost for a typical processor to adopt the technology is outlined below.

[3] The project applied a discount rate of 3.63% reflecting financing costs

Table 22 Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs	$6.1m	Table 20 above

Counterfactual

Under the counterfactual scenario W2E technologies will still be available and promoted to processors, however they will not have access to an independent assessment of the relative benefits and suitability of the options to help guide investment decisions. As a result processors will be more likely to avoid or delay investment, or may invest in less suitable options, reducing the return on investment or increasing the risk of failure.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development, promotion and extension.

Table 23 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	48.4%	The value of past research into W2E options for the Australian meat processing sector was estimated at $5m. This includes the global research which underpins the technologies presented in the project report. Researchers also cited a number of past AMPC projects which helped inform the outcomes from the research, in particular P.Pip0477 and P.Pip0739. This estimate of past research value was based on the consultant's judgement through consultation with researchers.
b) Future Development	29.1%	It was estimated that technology developers and retailers will spend an additional $4m on further development of the technology and $4m on promotion and extension over the four years following the report from 2020/21 to 2023/24.
c) Promotion and extension	29.1%	
d) Attribution of remaining benefits to project	0.7%	= 100% - a – b – c

Adoption

The results of the study suggest that anaerobic digestion of aggregated organic waste to biogas represents a very sound investment for meat processing plants, with payback periods of around 6 years. Sensitivity analysis completed as part of the project found the investment returns remained strong when key variable were adjusted (e.g. current baseline power costs and waste disposal costs reduced by 50%, and costs for delivery of piggery wastes to site increased by 50%).

Increasing pressure on meat processing companies to reduce carbon emissions will further enhance the attractiveness of the investment.

Based on the strength of the results, researchers suggest that the technology is likely to be economically beneficial for almost all processors. However, adoption will likely be limited by a range of factors:

- Some processors may have more attractive alternative arrangements for waste disposal and energy supply
- Some processors may not have access to sufficient external waste sources (piggeries, feedlots etc.)
- Some processors may not be willing to invest due to having a shortage of capital, different investment priorities or a shorter-term investment horizon.

This analysis has assumed that anaerobic digestion will steadily increase to peak at 40% of Australian plants (71 plants) in 2029/30. Adoption is assumed to steadily decline after 2033/34 as alternative waste disposal and energy supply options (e.g. plug flow anerobic digesters) supersede the technology described in this project.

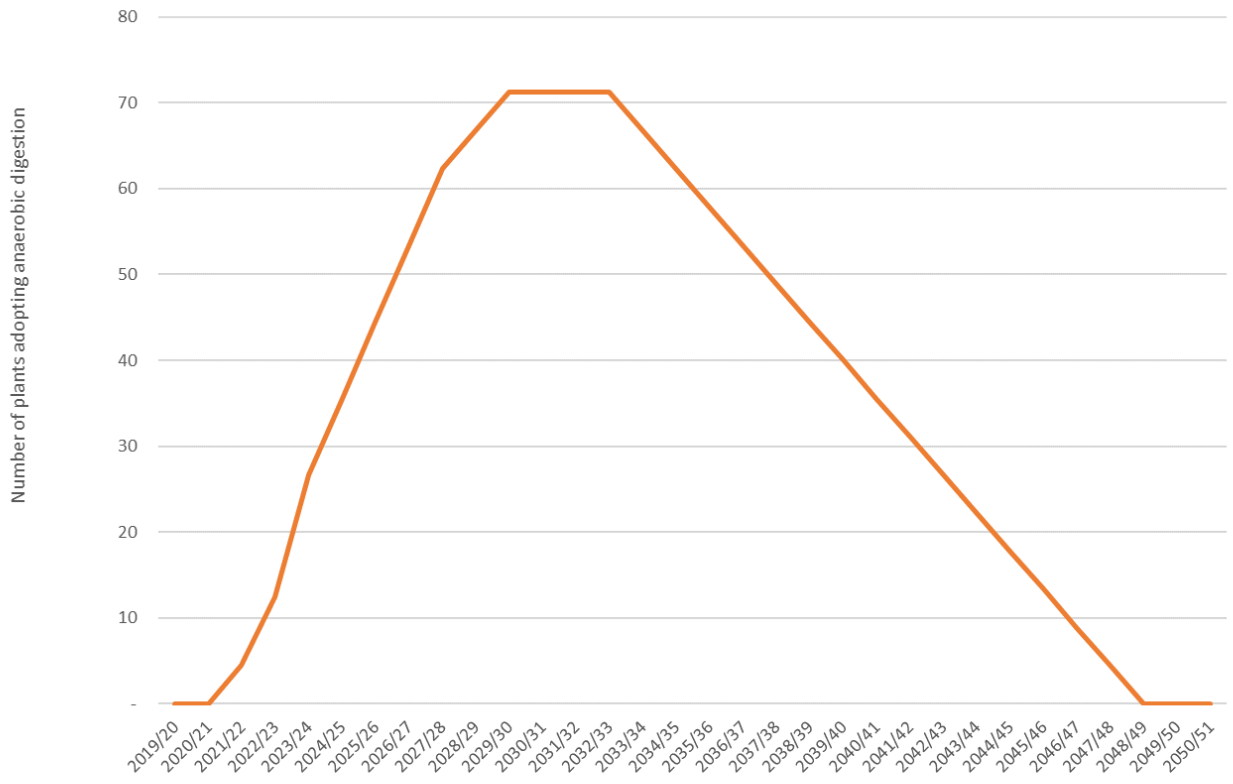

Figure 4 Projected adoption rate of anaerobic digestion in Australian processing plants

Results

Table 24 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $0.31m and a positive Benefit Cost Ratio of 4.6.

Table 24 Investment criteria for Project 2020-1006 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	-$1.39	-$1.35	-$0.36	$0.16	$0.37	$0.39
PV Costs	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09
NPV	-$0.09	-$1.48	-$1.43	-$0.45	$0.08	$0.29	$0.31
BCR	-	-16.3	-15.8	-4.2	1.9	4.3	4.6
IRR	NA	NA	-7%	9%	11%	12%	12%
MIRR	-100%	-100%	-1%	7%	8%	8%	7%

The flow of total undiscounted costs and benefits from the project is presented below.

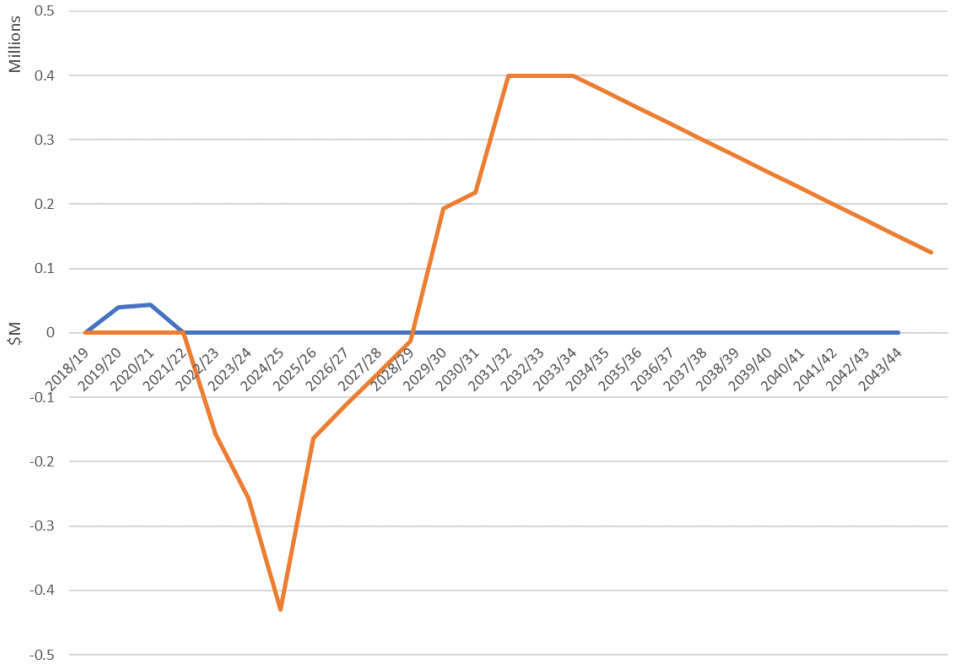

Figure 5 Flow of undiscounted costs and benefits from project 2020-1006

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented below in Table 25 below.

Table 25 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		0.31	4.6	12%
Discount rate				
	0%	$2.94	35.4	12%
	10%	-$1.09	-11.7	12%
Annual cost savings for processing plants installing anaerobic digestion				
	+20%	$1.02	12.9	16%
	-20%	-$0.40	-3.7	8%

The accuracy of the assessment results are highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 26 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis covers the primary expected benefits from adopting W2E technology being cost savings in waste disposal and energy supply. The analysis does not account for potential future cost savings in greenhouse emission abatement.
Confidence in assumptions	Medium	The analysis relied on the estimated financial returns from implementing W2E as stated within the study report. Higher level assumptions were needed to estimate adoption levels and attribution of benefits to the study.

Conclusions

The study helped to confirm the economic viability of processing plants installing anaerobic digestors to convert a range of organic waste streams (both internal and external) to generate biogas and electricity. The pay-pack period from this technology was estimated at 5-6 years with potential benefits including reduced power and thermal energy costs, reduced waste disposal costs and improved environmental outcomes.

The project represented a small but important investment to help demonstrate investment opportunities to drive technology adoption within industry. Based on the assumptions applied, the analysis concluded that the project is likely to deliver a positive economic benefit (BCR 4.6). This outcome was sensitive to changes in assumptions (discount rate and annual cost savings for processing plants installing anaerobic digestion).

References

Barnes, M and Forde, G. (2020), *2020-1006 aggregated waste to energy (W2E) final report*, Australian Meat Processor Corporation.

Acknowledgements

Gareth Forde (All Energy)

8.3 Appendix C: 2020-1065 Working towards an ideal RMI Visa Program - Stage 2

Background

The red meat processing sector is reliant on visa workers to fill skill shortages. A 2018 survey completed by the Australian Meat Industry Council (AMIC) found that 62% of processors were operating at less than 90% volume capacity due to labour shortages. In order to fill this labour shortage, it was estimated that an additional 3,784 workers would be required, a gap representing 21% of the overall workforce. AMIC estimate that 23% of the vacant positions could be filled by visa workers, therefore improving arrangements for the use of visa workers could have a direct and immediate impact on productivity.

In 2020, AMPC commissioned Stage 1 of the *Working Towards an Ideal RMI Visa Program (2019-1047)*, which involved a review of the use of visa labour by the Australian red meat processing sector to understand the efficiency and efficacy on the workforce and businesses. Through data collection, literature review and stakeholder consultation, the project established a suite of 11 recommendations aimed at developing an 'ideal' policy for visa use in the red meat sector. These recommendations seek to:

- Amend the existing Meat Industry Labour Agreement (MILA) program to continue to improve the meat industry's access to, and use of, overseas workers; and
- Creating an appropriate meat processing sector pathway to permanent residency (PR).

The policy recommendations were made available for the consideration of industry and government.

In 2020/21 GHD evaluated the expected impact from the Stage 1 project, finding the initiative could lead to policy improvements reducing the cost of visa use for processors. Over a 30 year period the project was estimated to have benefit cost ratio of 7.66.

Description of the project

The Stage 1 review was followed by a Stage 2 project (2020-1065) aimed at progressing the most critical strategic policy recommendations through the implementation of four phases:

- Market Research
- Government Extension
- Government Submissions
- Industry Extension.

Table 27 Project description and logic

2020-1065	Working towards an ideal RMI Visa Program - Stage 2
Project Details	Organisation: KPMG Australia Date: 2021 Principle Investigator: Georgie Aley
Rationale	To progress the strategic recommendations outlined in Stage 1 of the project through market research, government extension and submission, and industry extension.
Objectives	The objectives of the project were to: / Undertake a processor-wide market research project to quantify the use and cost of visas to the Red Meat Industry (RMI) processing sector / Implement a strategic and tactical extension process with Government. The compilation of two Government submissions including (1) to the Senate Select Committee on *Temporary Migration,* and (2) to the National Agricultural Labour Advisory Committee on a *National Agricultural Workforce Strategy Inquiry* / Undertake industry education by developing materials and hosting forums
Activities and Outputs	1. **Market research** / Developed processor-wide survey to accurately quantify the impact, cost and extent of visa use for the industry / Developed baseline information for government and industry extension stage 2. **Government extension** / Kick-off session with AMPC and AMIC was conducted to confirm and agree mutual project understanding was established / Hosted collaborative industry workshop and received input from key RMI stakeholders on current industry visa use and issues / One-on-one consultation held with processors with known engagement with State and Federal Government Departments and Ministers / Government Extension Plan and briefing materials developed and implemented using information collated from the industry workshop and processor survey / Eleven key engagement sessions conducted at both Federal Ministerial (strategic) and Departmental (tactical) level 3. **Government submission** / Developed two key submissions to Government for the Senate Select Committee on *Temporary Migration,* and National Agricultural Labour Advisory Committee on a *National Agricultural Workforce Strategy Inquiry* 4. **Industry extension**

2020-1065	Working towards an ideal RMI Visa Program - Stage 2
	/ Attended and facilitated update sessions at AMPC processor network meetings across the country to support AMPC in the delivery of educational updates on the Visa Project
Potential Outcomes	/ Industry and Government has improved understanding of visa program use, their benefits and shortfalls, and the impacts that they have on the day-to-day operations of processing businesses. / Significant policy reform in visa use has generally been delayed due to the COVID-19 outbreak, however the establishment of the Horticulture Industry Labour Agreement and Proposed Agricultural Visa offers hope that the meat processing sector can achieve similar reforms. / Industry was given assurances from a number of Government stakeholders that they would seek to work on the industry's behalf to progress changes to the visa system. / The Select Committee on Temporary Migration has received and reviewed the industry's submission and is due to present its final report on 2 September 2021. / The *National Agricultural Workforce Strategy* was released in December 2020 and includes a number of references to AMIC submission aligned to policy recommendations (12, 21).
Potential Impacts	/ Reduced costs associated with accessing visa workers to fill skill shortages. / Improved access to employment and reduced uncertainty for visa workers.

Project investment

Table 28 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 28 Annual Investment in Project 2020-1065

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$128,080	$94,010	$222,090
Co-investment			
Total			**$222,090**

Summary of impacts

Table 29 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 29 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced costs associated with accessing visa workers to fill skill shortages.**
Environmental	/	
Social	/	Improved access to employment and reduced uncertainty for visa workers.

Quantification of impacts

Estimated benefits

Stage 1 of the study used extrapolated data from consultation with processors to estimate the total industrywide cost of visa use at approximately $30m annually (excluding any costs relating to transition to permanent residency, sourcing visa users, soft-landing visa users, or any other administrative costs e.g. HR staff time opportunity costs). A break-down of costs is provided below in Table 30.

Table 30 Estimated direct cost of visa use in the Australian red meat processing sector

VISA	Application & Processing costs	Average Number Used (from consults)	Processors	Total cost ($m)
403	$310	10	130	$0.40m
417	$485	118	130	$7.44m
482	$3,910	11.75	130	$5.97m
482	$7,200	11.75	130	$11.00m
491	$4,045	10	130	$5.26m
Total				**~$30m**

GHD completed a previous evaluation of the Stage 1 project (2019-10470), which estimated that the suite of recommended changes could reduce annual costs by around 25% ($7.5m) primarily through fewer applications being required and reduced fees and costs per application. At the time it was estimated there was a 50% chance of these savings being realised (reducing the annual benefits to $3.75m), however as Stage 2 of the project has progressed GHD consider the likelihood has increased to 70% ($5.25m).

Table 31 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Reduced costs associated with accessing visa workers to fill skill shortages		
b) Estimated total annual industrywide cost of visa use	$30m	Estimated cost based on research from Stage 1 report (Table 30).
c) Potential reduction in the cost of visa use if recommendations are implemented	25%	GHD estimate based on consultation with researcher and consideration of the value from recommended changes.
d) Annual benefit from reduced cost of visa use	$7.5m per annum	a x b
e) Probability of impact	70%	GHD assumption based on consultation with researcher and consideration of broader influences on government policy.
f) Probability adjusted annual benefits from reduced cost of visa use	$5.25	= c x d

Adoption Costs

Processors will incur costs associated with learning about the new arrangements and implementing changes to their current arrangements. Adoption costs were deducted from benefits as per CRRDC guidelines.

Table 32 Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs	$1.78m spread over 5 years from 2021/22 ($10K per processor)	GHD and consultation with researchers

Counterfactual

Under the counterfactual scenario, industry would continue to pursue policy change and improvement to visa programs, however, without an established and agreed set of recommendation, informed by industry consultation, progress would likely be slower and with more risk of ad-hoc or less strategic policy responses.

Attribution

If policy changes are implemented, the project will have provided a relatively small, but important input into the process. Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research (The stage 1 project), future development and extension efforts (Government and industry development and implementation of policy changes).

Table 33 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	14%	The cost of the Stage 1 Project estimated at $250,000 including contract value, project management and stakeholder input.
b) Future Development	58%	Government and industry will incur costs to consider and implement policy changes, including (where necessary) changes to legislation, program compliance and communications. These costs have been estimated at $1.2m ($200K over 6 years from 2020/21 to 2025/26)
c) Promotion and extension	14%	Government and industry will incur costs to communicate changes to industry. These costs have been estimated at $300K ($50K over 6 years from 2020/21 to 2025/26)
d) Attribution of remaining benefits to project	14%	= 100% - a – b – c

Adoption

The first policy changes are assumed to occur in 2022 (quick wins) with other policy changes progressively implemented over the following years until 2026. Under the counterfactual scenario an equivalent system is assumed to be progressively implemented from 2026 to 2031 (5 years behind the project case).

Table 34 Adoption assumptions

Variable	Assumption	Source/ Explanation
Year of first impact	2022	GHD assumptions based on consultation with researchers.
Year when maximum adoption/impact is reached	2026	
Year when adoption/impact ceases	2026	

Results

Table 35 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $1.72 and a positive Benefit Cost Ratio of 7.9.

Table 35 Investment criteria for total investment in Project 2020-1065 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	$0.96	$1.97	$1.97	$1.97	$1.97	$1.97
PV Costs	$0.25	$0.25	$0.25	$0.25	$0.25	$0.25	$0.25
NPV	-$0.25	$0.71	$1.72	$1.72	$1.72	$1.72	$1.72
BCR	-	3.9	7.9	7.9	7.9	7.9	7.9
IRR	-	39%	50%	50%	50%	50%	50%
MIRR	-100%	20%	20%	16%	14%	12%	11%

The flow of total undiscounted costs and benefits from the project is presented in Figure 6 below.

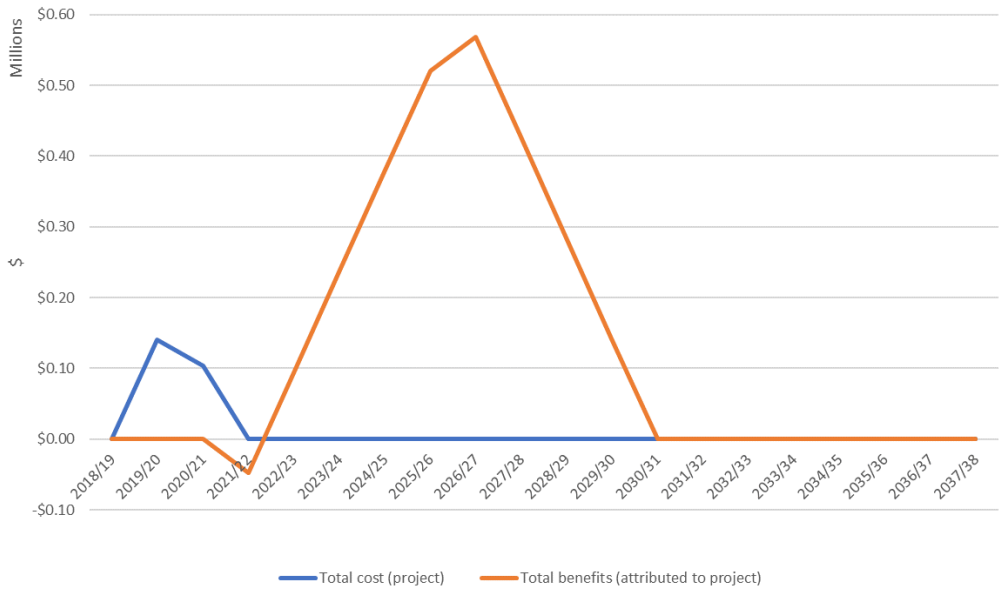

Figure 6 Flow of undiscounted costs and benefits from Project 2019-1047

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented below in Table 36 below.

Table 36 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		1.72	7.92	11%
Discount rate				
	0%	$2.14	9.57	6%
	10%	$1.40	6.61	16%
Cost savings from implementing recommendations		$2.16	9.68	12%
	20%	$1.29	6.17	10%
	-20%	$2.14	9.57	6%

The accuracy of the assessment results are highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 37 Coverage and Confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis captures the benefit from reduced costs for the meat processing sector, however the broader implications to labour markets, visa worker employment opportunities and immigration have not been quantified.
Confidence in assumptions	Medium	The analysis required significant assumptions about the likelihood of government implementing recommendations and the resulting cost savings.

Conclusions

Stage 2 of the *Working towards an ideal RMI Visa Program* aimed to progress the most critical strategic policy recommendations from the Stage 1 project through market research, government extension and submissions, and industry extension. Industry has now presented a well-researched case to Government for reform, which if even partially implemented should reduce the annual cost of visa (estimated at $30m).

Based on the adopted assumptions this analysis has estimated the Stage 2 project investment will likely deliver a positive economic benefit (BCR 7.92), which is broadly consistent with the Stage 1 project investment. This investment return remained positive under all scenarios modelled.

References

KPMG (2020), 2019-1047 *Working towards an Ideal RMI visa program,* Australian Meat Processor Corporation.

KPMG (2021), *2020-1065 Working towards an ideal RMI visa program - stage 2 final report*, Australian Meat Processor Corporation.

Acknowledgements

Georgie Aley (KPMG)

Evie Murdoch (KPMG)

8.4 Appendix D: 2020-1010 Export Certification Framework Project

Background

The red meat processing sector identified an opportunity to work more collaboratively with government to deliver efficient export services and achieve more cost-effective export inspection fees, charges and associated costs.

In 2019 AMPC commissioned a review of the Australian Export Meat Inspection Service (AEMIS) (2018-1131) which included a series of 12 recommendations to make the AEMIS more effective, efficient and fit-for-purpose into the future. However, in order to prioritise and pursue these recommendations, the industry first needed to establish a process to reach agreement before engagement with the government to ensure all industry stakeholder groups are broadly represented in government consultation processes.

Description of the project

The purpose of the project was to provide a process to enhance relationships and engagement between the industry and government. The project aim was to reset and reform engagement between both parties to achieve sustaining outcomes within the Australian meat industry through shared knowledge, uncovered interests and defined policy options. The project outlined observations and priority actions to reframing the industry's engagement with the government to enable the meat industry the opportunity to shape export service delivery, cost recovery arrangements and broader reform agendas. Three focal areas identified as critical steps in the early stages of the process included:

1. Establishing a new engagement environment
2. Engagement on the design of service delivery and the cost recovery model
3. Engagement to enhance performance of service delivery and the cost recovery model

Table 38 Project description and logic

2020-1010	Export Certification Framework Project
Project Details	Organisation: Brickfielder Government Engagement Date: 2020 Principle Investigator: Dr Vanessa Findlay
Rationale	To enhance the competitiveness of Australian meat exporters by resetting and reframing stakeholder (industry and government) engagement with a 'knowledge framework' that achieves sustaining outcomes through mutual understanding.
Objectives	The objectives of the project were to: / Enhance the competitiveness of Australian meat exporters / Enhance stakeholder engagement and co-design / Reset and reframe industry and government engagement with a framework to achieve enduring outcomes through mutual understandings
Activities and Outputs	1. **Establish new environment for engagement** / Observed barriers to enhanced engagement / Recommendations made to establishing an Industry Engagement Steering Committee for outcomes-focused engagement by the industry

2020-1010	Export Certification Framework Project
	/ Recommendations made for key inputs to the Industry Engagement Steering Committee. The basis of structuring the industry's working relationship with the government on cost recovery arrangements was recommended to use principles and processes established under the Australian Cost Recovery Guidelines (CRGs) 2. **Engagement on the design of service delivery and the cost recovery model** / Observed barriers to effective cost recovery design / Recommendations made on key areas of focus for stakeholder engagement and steps to engage 3. **Engagement to enhance performance of service delivery and the cost recovery model** / Recommendations made for government entities to develop performance frameworks that is connected to government policy outcomes. The framework should determine operational outputs that can be used to measure progress in achieving these outcomes.
Potential Outcomes	/ New engagement environment established / Industry better positioned to meet opportunities and challenges / Baseline source of knowledge established for industry to engage with the government / Opportunity for industry and government to co-design a consistent and transparent service delivery and cost recovery scheme
Potential Impacts	/ Efficient export services / Cost-effective inspection fees, charges and associated cost / Increased trust between industry and the government / Improved Australian meat industry competitiveness

Project investment

Table 39 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 39 Annual Investment in Project 2020-1010

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$126,000	$58,800	$184,800
Co-investment			
Total			**$184,800**

Summary of impacts

Table 40 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 40 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced regulatory costs for processors and regulators**
	/	Improved market access
Environmental	/	
Social	/	

Quantification of impacts

Estimated benefits

Following the AEMIS review industry had 12 recommendations to make the AEMIS more effective, efficient and fitness-for-purpose into the future. Some of the recommendations, if implemented, are likely to deliver immediate cost savings and efficiency gains, while other recommendations are likely to yield longer term benefits in terms of both cost savings and improved market access.

Following the review and during the course of the Export Certification Framework Project (2020-1010) the Federal Government released the 2020/21 Federal Government, which included the *'Busting Congestion for Agricultural Exporters'* package, worth around $328.4M over four years.

Table 41 2020 Federal Budget Announcements broadly attributable to the AEMIS Review.

2020 Budget Announcements	Relevance to AEMIC Review Recommendations
a) $10.9m for Building a More Competitive Export Meat Industry to reform the export meat regulatory system by targeting higher-risk export processes and/or exporters and introducing flexible assurance methods aimed at reducing costs.	1,3,4,8
b) $71.1m to improve the financial sustainability of export certification services by returning to full cost recovery of these services over time, while minimising the impost on industry as it recovers from the effects of the drought, bushfires and COVID-19. Agriculture and food exporters and producers will also be assisted through the reform process with a freeze in fees and charges in 2020-21, and stepped increases spread through to 2023-24. Due to the reforms, fees and charges are expected to realise $21.4M in efficiencies through to 2023-24.	9
c) $222.2m over 4 years for 'Digital Services to Take Farmers to Markets' which aims to reduce red-tape, improve regulation and service delivery for producers and exporters. This measure will establish a single online portal for transactions between exporters and government, streamlining processes for exporters and helping them experience faster and more cost-effective services.	4,5

GHD consider the three items within this package are broadly in response to recommendations in the AEMIS Review, and also partly attributable to the initial work of the Export Certification Framework Project in establishing industry agreement and a process for engaging government. Following the budget announcement, the Export Certification Framework Project likely helped to ensure the red meat processing sector benefited as the implementation details from the budget announcements were negotiated.

The Government's decision to fund these items was also influenced by a range of other factors, as discussed within the attribution section below.

Table 42 below outlines the assumptions used to estimate the economic benefit delivered to red meat processors from each of the three budget items.

Table 42 Benefit assumptions

Budget measure	Building a more competitive meat industry	Reform of fees and charges for export certification	Digital Services to Take Farmers to Markets	Total	Notes/Source
a) Budget Cost over 4 years ($m)	10.9	21.4	222.2	254.5	2020 Budget
b) Relevance to red meat processing (%)	100%	65%[4]	25%		GHD estimate
c) Expected Industry benefit (% of Budget cost)	90%	90%[5]	50%		GHD estimate noting that some measures will deliver efficiencies for Government (taxpayers) rather than industry[6]
d) Red meat sector benefit over 4 years ($M)	9.8	12.5	27.8	50.1	a x b x c
e) Probability of impact	90%	90%	90%		Budget measures have been announced, however minor risk that some details may change, or implementation could be delayed.
f) Benefits over 4 years ($M)	8.8	11.3	25.0	45.1	= d x e
g) Benefits per year ($M)	2.2	2.8	6.2	11.3	= f /4 years

[4] The red meat sector's approximate proportion of overall export certification fees and levies
[5] $21.4m relates to industry efficiencies through reduced fees and charges
[6] Treasury estimates suggest the overall 'Busting Congestion for Agricultural Exporters' package will cost Government $328.4m over 4 years and generate $236m in industry benefits over 10 years.

Adoption Costs

Processors will incur costs associated with learning about the new arrangements and implementing changes to their current arrangements. Adoption costs were deducted from benefits as per CRRDC guidelines.

Table 43Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs	$1.78m spread over 3 years from 2021/22 ($10K per processor)	GHD and consultation with researchers

Counterfactual

This analysis has assumed that under the counterfactual scenario (without the project), the implementation of improvements to the AEMIS would be delayed by 3 years on account of industry not having a united and coordinated industry position to communicate to government. Ongoing improvements may have likely been implemented on an ad-hock basis.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past developments (i.e. the AEMIS review and other initiatives which influenced the changes), future development, promotion and extension (i.e. industry and government efforts to develop and implement the changes).

Table 44 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	77%	The outcome was heavily influenced by previous groundwork, in particular: / The AEMIS review (AMPC project 2018-1131) and the subsequent efforts by AMIC, EMIAC and the Meat Modernisation Working Group in advocating for the implementation of recommendations: / An Auditor General Report into cost recovery for export certification activities (The Australian National Audit Office 2019) / An independent review of the cost of its export certification activities, commissioned by the Department. / Departmental upgrade of export documentation systems from EXDOC to NEXTDOC [7] The combined cost of these outcomes is estimated at $3m.

[7] Department of Agriculture, Next Export Documentation System (NEXDOC), http://www.agriculture.gov.au/export/certification/nexdoc, 2019

Variable	Assumption	Source/ Explanation
b) Future Development	9%	Government and industry are likely to incur additional costs to develop and implement policy and program changes, including (where necessary) changes to legislation and program compliance. These costs have been estimated at $400K ($100K over 4 years from 2020/21 to 2023/24).
c) Extension and promotion	9%	Government and industry will incur costs to communicate and promote policy and program changes. These costs have been estimated at $400K ($100K over 4 years from 2020/21 to 2023/24).
d) Attribution of remaining benefits to project	5%	= 100% - a – b – c

Adoption

The proposed changes to the AEMIS are expected to be adopted on as industry wide basis over the coming years, and delayed for 3 years under the counterfactual scenario.

Table 45 Adoption assumptions

Variable	Assumption		Source/ Explanation
a) Adoption of benefits (with project)	2021/22	50%	It is assumed that the benefits from the 2020 Budget measures will be first realised in 2021, and spread evenly across the 2021, 2022 and 2023. Under the counterfactual scenario it is assumed that the AEMIS would have eventually been reviewed, and/or improvements made however delayed by three years.
	2022/23	100%	
	2023/24	100%	
	2024/25	100%	
	2025/26	100%	
	2026/27	100%	
	2027/28	100%	
b) Adoption of benefits (without project)	2021/22	0%	
	2022/23	0%	
	2023/24	0%	
	2024/25	50%	
	2025/26	100%	
	2026/27	100%	
	2027/28	100%	

Results

Table 46 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $1.22m and a positive Benefit Cost Ratio of 6.9.

Table 46 Investment criteria for total investment in Project 2020-1010 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	$1.43	$1.43	$1.43	$1.43	$1.43	$1.43
PV Costs	$0.21	$0.21	$0.21	$0.21	$0.21	$0.21	$0.21
NPV	-$0.21	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22
BCR	-	6.9	6.9	6.9	6.9	6.9	6.9
IRR	-	103%	103%	103%	103%	103%	103%
MIRR	-100%	30%	20%	16%	14%	12%	11%

The flow of total undiscounted costs and benefits from the project is presented in Figure 7 below.

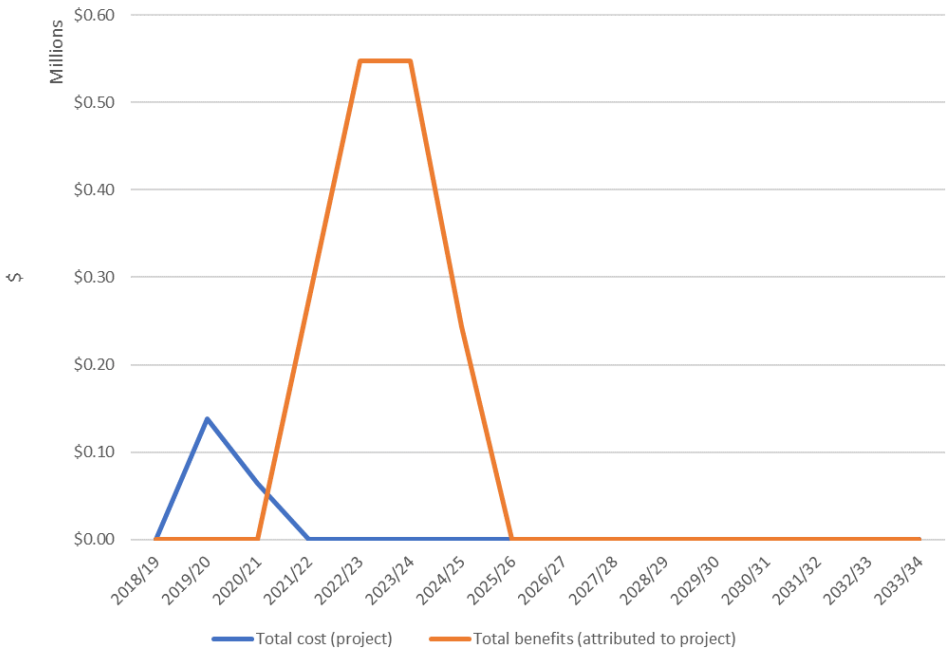

Figure 7 Flow of undiscounted costs and benefits from Project 2020-1010

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented below in Table 47 below.

Table 47 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		1.22	6.88	103%
Discount rate				
	0%	$1.38	7.65	102%
	10%	$1.09	6.22	104%
Annual benefit derived from the 'Busting Congestion for Agricultural Exporters' package				
	+20%	$1.53	8.36	119%
	-20%	$0.92	5.40	86%

The accuracy of the assessment results are highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 48 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The assessment evaluated the immediate benefits from cost savings and efficiency gains via announcements in the 2020 Federal Budget. However, the project sought to make broader and longer-term improvements to the AEMIS through increased use of technology, improved recruitment and training of inspectors, improved financial management and tailoring of the program to market access needs. If these recommendations are implemented additional, longer term benefits will be yielded.
Confidence in assumptions	Medium	Some high level assumptions were required to estimate the economic benefit delivered to red meat processors from Federal Government Budget announcements.

Conclusions

The development of the Export Certification Framework Project (2020-1010) helped to establish a process for industry to reach agreement on proposed changes to the AEMIS before engagement with the government to ensure all industry stakeholder groups are broadly represented in government consultation processes.

While it is challenging to quantify the economic benefits from such industry engagement, the project helped to establish a coherent and agreed industry position on the AEMIS which will likely ensure the sector achieve maximum benefits from the Federal Government's 'Busting Congestion for Agricultural Exporters' package, worth around $328.4M over four years.

The analysis concluded that the project was likely to deliver a positive economic benefit (BCR 6.9). This outcome was highly sensitive to changes in assumptions, however the investment returns remained positive under all scenarios modelled.

References

Australian Government (2020), *2020/21 Budget Paper No. 2*. https://budget.gov.au/2020-21/content/bp2/download/bp2_02_payment.pdf

Brickfielder Government Engagement Pty Ltd (2020), *2020-1010 Effective relationships to improve the competitiveness of the Australian meat export industry*, Australian Meat Processor Corporation.

Department of Agriculture, Water and the Environment (2020), *Budget 2020-21: Busting Congestion for Agricultural Exporters* https://www.awe.gov.au/sites/default/files/2020-10/budget_2020-21_busting-congestion-for-agricultural-exporters.pdf

Palladium International Pty Ltd (2019), *2018-1131 AEMIS review recommendations report*, Australian Meat Processor Corporation.

The Australian National Audit Office, Auditor-General Report No.38 of 2018–19 Performance Audit Report

Acknowledgements

Dr Vanessa Findlay (Brickfielder Government Engagement)

8.5 Appendix E: 2021-1086 Development of a Covid Marshal training package

Background

The COVID -19 pandemic is having significant impacts on the Australian meat processing industry, with state governments nation-wide mandating policy frameworks to control COVID-19 within workplaces. The Australian Health Protection Principal Committee (AHPPC) notes that meat processing facilities carry particular risks of COVID -19 transmission due to:

- Environmental conditions (e.g. cold and damp environment), and
- Tasks that require workers to be in close proximity (e.g. at workstations and on processing lines).

In Victoria, the meat processing industry was identified as a High-Risk Industry, and therefore all facilities were required to have a delegated Covid Marshal on each shift, whose role is to monitor compliance with health directions (e.g. social distancing, personal protective equipment etc.).[8] In other states the Covid Marshal role is recommended, however not mandatory (at the time of writing).

In Victoria Covid Marshals are required to undertake an appropriate training, however the course developed by the Victorian Department of Health Services was mainly tailored to healthcare professions and was difficult for the identified potential Covid Marshals to navigate and complete. As a result, AMIC and AMPC engaged a Registered Training Organisation (RTO) to develop a Covid Marshal online course tailored to the specific needs of the meat processing sector. The course materials were designed to satisfy the requirements of the Victorian Government, while also being applicable for processors in other states (New South Wales, Queensland, South Australia, Tasmania and Western Australia).

Description of the project

The purpose of the project was to design a short course suitable for the meat industry that matches the requirements for the Victorian Government and is applicable to other states. The project reviewed state and federal government websites to develop course materials. Consultations were held with key stakeholders to ensure conformance of the course materials to government requirements and industry needs.

8 Workplace-(Additional-Industry-Obligations)-Direction-(No-27)-10-June-2021.pdf (dhhs.vic.gov.au)

Table 49 Project description and logic

2021-1086	Development of a Covid Marshal training package
Project Details	Organisation: Response Research Pty Ltd Date: 2021 Principle Investigator: Roderick Glass, Paul Eldridge, Christine MacMillian and Chris Bartlett
Rationale	To develop a Covid Marshal training course specific for the meat processing industry that meets the requirements of both government and industry.
Objectives	The objectives of the project were to: / Develop course materials based on the Victorian requirements, also consider the Covid Marshal requirements in other states / Ensure the instructional design and scaffolding of the course meets the needs of participants and requirements of all state governments, with a focus on Victoria / Deliver design and build interactions, including courses and quizzes that are multilingual / Set up of online course on the Learning Management System (LMS) / LMS access and licensing fee for up to 150 users for 12 months
Activities and Outputs	/ Developed course materials by reviewing state and federal government websites / Confirmed conformance of course materials with government requirements and industry needs through consultation with AMPC, AMIC and meat processing professionals / Designed, developed, tested and delivered an online eLearning course / Ongoing phone and email support for approximately 12 months provided to participants / Issues encountered by participants on learning platformed monitored / Online payment framework developed for AMPC to recoup a nominal charge from non-AMPC members
Potential Outcomes	/ At the time of writing approximately 50 individuals had completed the Covid Marshall Course with uptake expected to continue in the coming years / The industry has course material specific to meat processing that meets the requirements of individual state governments is made available to the industry / The industry has an improved understanding of COVID-19 and human transmissible diseases, as well as an understanding of the COVID-19 Management plan and its development and implementation
Potential Impacts	/ Improved work health safety (reduced risk of COVID-19 outbreaks) / Reduced financial losses due to COVID-19 outbreaks in processing plants

Project investment

Table 50 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 50 Annual Investment in Project 2021-1086

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$0	$71,500	$71,500
Co-investment			
Total			**$71,500**

Summary of impacts

Table 51 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 51 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced financial losses due to COVID-19 outbreaks in processing plants.**
Environmental	/	Reduced wasted resources due to COVID-19 outbreaks in processing plants.
Social	/	Reduced risk of COVID-19 health impacts within staff and other contacts.
	/	Reduced risk of employment loss due to due to COVID-19 outbreaks in processing plants.

Quantification of impacts

Estimated benefits

Globally, COVID-19 has had a significant impact on the meat processing sector. In the US an estimated 58,913 meat processing workers have contracted the virus (or around 45% of the total workforce), resulting in an estimated 297 deaths (Food and Environment Reporting Network). In many countries processing plants have been required to operate at reduced capacity, for example in New Zealand capacity has decreased by approximately 30% for cattle and 50% for sheep (Beef & Lamb NZ), creating supply chain challenges for livestock turnoff and filling export orders.

For Australian meat processors COVID-19 protocols and responses have largely been determined by the various State and Territory Governments. Victorian processors were required to appoint trained covid marshals, adhere to a range of risk reduction protocols (e.g. social distancing) and also operate at 2/3 of peak capacity during that states local outbreak.

At the time of writing an estimated 14 meat processing and handling premises had temporarily closed due to COVID-19 since the beginning of the pandemic;

- Cedar Meats, Brooklyn Vic
- JBS, Brooklyn Vic
- Somerville Retail Services, Tottenham Vic
- Bertocchi Smallgoods, Thomastown, Vic
- Don KR, Castlemaine, Vic
- Ingham's Foodservice, Thomastown, Vic
- Pacific Meats, Thomastown, Vic
- Australian Lamb, Colac, Vic
- Greenham, Tongala, Vic
- Greenham, Moe, Vic
- Teys, Wagga, NSW
- Teys, Tamworth, NSW
- Thomas Food International, Tamworth, NSW
- Fletchers, Dubbo, NSW[9]

Typically, a positive detection has resulted in the premises being closed for a period of time, while all staff and close contacts isolate and undergo testing during the minimum 14 day incubation period.[10] During this time processing businesses suffer from a loss of revenue, while typically still incurring labour costs and other overheads. Processors are also concerned that COVID-19 outbreaks could result in temporary loss of market access to key markets (e.g. China) for up to 6 months.

Table 52 estimates the economic cost of a temporary closure for a typical Australian meat processing plant due to COVID-19 outbreak, as well as the likely risk of such an outbreak occurring (based on cases to date). Modelling is completed for plants with and without a Covid Marshall being present. The analysis suggests that appointing a Covid Marshall to enforce health regulations can reduce the risk based cost of a COVID-19 related plant closure by $102,940.

[9] Voluntary closure without COVID-19 cases detected.
[10] Cedar Meats in Melbourne was closed for six weeks following a 2020 outbreak.

Table 52 Benefit assumptions

	Without Covid Marshal	Without Covid Marshal	Source/Explanation
Average plant daily turnover	$321,687	$321,687	The total annual turnover of the industry is estimated at $20.9 billion,[11] averaged across an estimated 178 plants.
% of turnover lost during COVID-19 plant closure	40%	40%	GHD estimate based on loss of sales revenue and on-going costs (e.g. staff), offset by some ability to recover throughput once plant re-opens.
Average daily cost of plant closure	$128,675	$128,675	= a x b
Typical length of plant closure (days)	14	10	Covid Marshalls and associated health regulations have some ability to increase separation of staff between and within shifts (e.g. avoiding car pooling) therefore the length of lockdowns may be reduced.
Typical cost of plant closure	$1,801,447	$1,286,748	= c x d
Annual risk of closure due to COVID-19 (per annum)	15%	13%	To date an estimated 8% of Australian plants have experienced a COVID-19 outbreak and subsequent closure. At the time of writing the more infectious delta strain of the virus was circulating in NSW, Victoria and QLD, therefore additional detections are expected in processing plants before the pandemic ends. This analysis has assumed the presence of a Covid Marshall, enforcing health regulations (e.g. social distancing, PPE, temperature checks etc.) is expected to reduce the risk of outbreak by 2% (from 15% to 13%)
Annual risk based cost of plant closure	$270,217	$167,277	The analysis suggests that appointing a Covid Marshall to enforce health regulations can reduce the risk based cost of a COVID-19 related plant closure by **$102,940**

[11] MLA state of industry report https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/trends--analysis/soti-report/mla-state-of-industry-report-2020.pdf

Adoption costs

Processors will incur costs associated with training and appointing Covid Marshalls as well as costs associated with complying with the associated health regulations.

Table 53 Adoption cost assumptions

Variable	Assumption	Source/ Explanation
a) Additional hours per week for Covid Marshall	20	1-2 hours per day to undertake temperature testing and ensure compliance with health regulations. Covid Marshalls will typically be appointed from existing safety officers (or similar).
b) Cost of labour (including on-costs)	$40 per hour	GHD estimate
c) Annual cost of additional labour	$41,600 per annum	= a x b
d) Other compliance costs	$40,000 per annum	Consultation suggests some processing plants are installing Perspex sheeting and larger break rooms to ensure social distancing.
e) Adoption cost per plant	$81,600 per annum	= c + d

Counterfactual

Under the counterfactual scenario processing plants in Victoria will still be required to install trained Covid Marshalls, however they would be reliant on the generic government course, which does not account for the unique risks and operating environment within meat processing plants. As a result Covid Marshalls are likely to be less well equipped to ensure staff compliance with COVID-19 rules and the risk of an outbreak occurring will be marginally higher.

Outside of Victoria, where Covid Marshalls are not mandatory, meat processors would focus on adhering to their own State Government's health directions to minimise risk of outbreaks occurring. Processors would not have access to a tailored course to assist staff appointed to overseeing COVID-19 protocols and risk reduction activities. As a result the risk of an outbreak occurring in these plants will be marginally higher.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development, promotion and extension.

Table 54 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	35%	The course drew on established research and best practice materials, which were nominally valued at $100,00 for the purpose of this analysis.
b) Future development	19%	The course may require minor updates over the coming years to ensure it remains compliant with changing COVID-19 regulations and best practices protocols (estimated cost of $20,000 per annum over 3 years).
c) Extension and promotion	19%	The course will need to be administered and promoted to industry (estimated cost of $20,000 per annum over 3 years).
d) Attribution of remaining benefits to project	27%	= 100% - a – b - c

Adoption

It was assumed that adoption of Covid Marshalls (or similar positions) will steadily increase to 60% of processing plants by 2022/23 after which time vaccinations will largely eliminate the risk of the virus causing plant closure.

Table 55 Adoption assumptions

Variable	Assumption	Source/ Explanation
2020/21	20% of processors with Covid Marshalls	GHD assumptions based on consultation with researchers.
2021/22	40% of processors with Covid Marshalls	
2022/23	60% of processors with Covid Marshalls	

Results

Table 56 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/23 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $1.06 and a positive Benefit Cost Ratio of 14.4. Note that it was not possible to calculate IRR of MIRR because the value of benefits exceeded the costs during the years of investment.

Table 56 Investment criteria for total investment in Project 2021-1086 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$0.20	$1.13	$1.13	$1.13	$1.13	$1.13	$1.13
PV Costs	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08
NPV	$0.12	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06
BCR	2.6	14.4	14.4	14.4	14.4	14.4	14.4
IRR	NA	NA	NA	NA	NA	NA	NA
MIRR	NA	NA	NA	NA	NA	NA	NA

The flow of total undiscounted costs and benefits from the project is presented below.

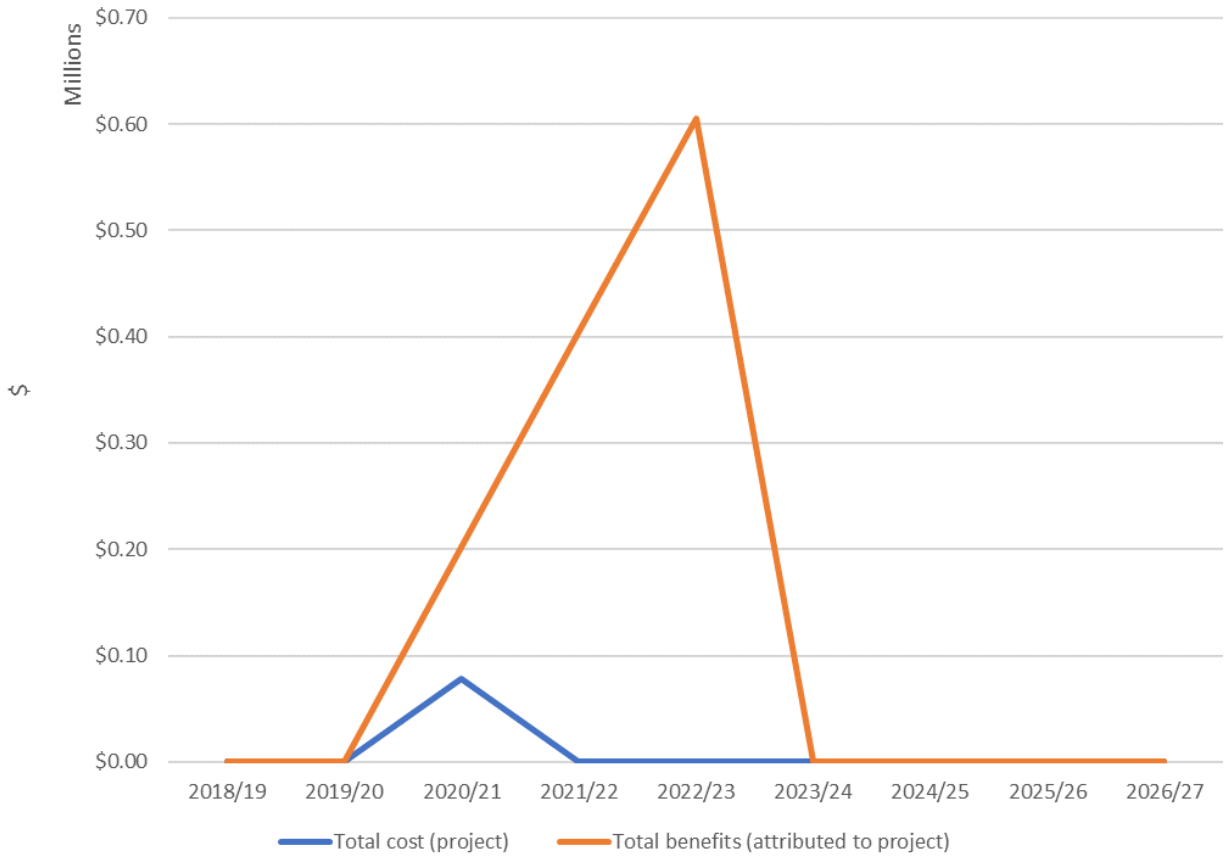

Figure 8 Flow of undiscounted costs and benefits from Project 2021-1086

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV and BCR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented below in Table 57 below.

Table 57 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR
Standard assumption		1.06	14.42
Discount rate			
	0%	$1.11	15.09
	10%	$1.01	13.81
Estimated annual benefits from plants appointing Covid Marshalls			
	+20%	$2.15	28.33
	-20%	-$0.04	0.51

The accuracy of the assessment results are highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 58 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis covered the cost savings from reduced risk of plant closures due to COVID-19, however did not quantify the health benefits for staff and the broader community from reduced COVID-19 risk.
Confidence in assumptions	Medium	The analysis drew on relatively robust data to estimate the likely probability and cost of temporary closures of processing plants due to COVID-19. However higher level assumptions were needed to estimate the impact of the Covid Marshall course in reducing this risk.

Conclusions

The development of a meat industry Covid Marshall short course has helped to ensure processing plants adhere to health directions and therefore has likely reduced the risk of expensive plant closures occurring due to outbreaks within staff and other contacts. By reducing contact between shift workers, the Covid Marshall may also reduce the length of enforced plant closures.

Based on the assumptions applied, the analysis concluded that the development of the online Covid Marshall short course was likely to deliver a substantial economic benefit (BCR 14.4). This outcome was highly sensitive to changes in assumptions, however the investment returns remained positive under all scenarios modelled.

References

Food and Environment Reporting Network. https://thefern.org/2020/04/mapping-covid-19-in-meat-and-food-processing-plants

Glass, R., Eldridge, P., MacMillian, C. and Bartlett, C. (2021), *2021-1086 COVID marshal: development of a COVID marshal training package final report*, Australian Meat Processor Corporation.

Acknowledgements

Roderick Glass (Response Research)

Paul Eldridge (Response Research)

Stacey McKenna (AMIC)

8.6 Appendix F: 2018-1045 First prototype automation for deboning lamb Shoulder - Stage 2

Background

Significant labour shortages are projected in the meat sector with increasing food demand. The development of efficient and cost-effective automation capabilities has been identified as a key opportunity in sustaining the meat industry to meet future demanded volumes. Automating meat processing increases the efficient use of the operator time and reduces handling and complexity on production lines.

In 2016, AMPC commissioned Stage 1 of the feasibility study, which assessed the viability of automating the de-boning process of lamb shoulder. The study involved evaluating the separation of the rib cage and also to develop a solution for implementing a first robot prototype. The approach of the original solution was based on the ATTEC Shoulder Machine. However, new solutions have been examined due to complexities in the separation process, given the wide variability in shoulder primal pieces.

Description of the project

Stage 2 project involved developing a prototype to automate the processes of lamb shoulder deboning. The project assessed shoulder primal variability in relation to de-boning intended for the automation solution and examined the manual process and its automation possibilities. The project integrated the solutions developed in Stage 1 into the prototype to undertake practical trials.

Table 59 Project description and logic

2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2
Project Details	Organisation: Business and Manufacturing Consultancy UK Date: 2020 Principle Investigator: Koorosh Khodabandehloo
Rationale	To implement the first robotic deboning prototype with the capability to perform the deboning of the rib cage from a lamb forequarter.
Objectives	The objectives of the project were to: / Review developments to date and document requirement specifications for an automated lamb shoulder deboning machine / Produce a functional specification for the automated system and plan its pilot preparation / Implement a first prototype machine in a workshop environment and test its capability using lab shoulders of varying size / Improve on the design based on near production trials / Implement a final production prototype and test functionality prior to shipment to a location in Australia for testing / Conduct structured testing with shoulder primal pieces and consider installation requirements for production / Document test results, machine improvements and final report
Activities and Outputs	/ Reviewed the measurements defining the lamb forequarter primal variability and the defined process steps through video recordings of the current practices

2018-1045	First prototype automation for deboning lamb Shoulder - Stage 2
	/ Examined the meat separation processes from shoulder primal pieces using information and observations from plant visits / Implemented and tested early experimental modules / Implemented and tested the first complete robotic system / Refined and further developed the automatic process of primal piece loading, which considered improving speed and operator safety / Final testing with forequarter primal pieces
Potential Outcomes	/ Reduced labour requirements / Work health safety benefits for operator, particularly with the integrated interlock switch on the robotic fixture which provides safe grasping and fixation during thee loading of primal pieces / Increased processing capacity to meet projected increased meat demand / Reduced handling of primal pieces and minimising complex separation processes for operator
Potential Impacts	/ Labour savings / Reduced worker injuries

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 60 Annual Investment in Project 2018-1045

Contributor	2019/20	2020/21	2021/22	Total
AMPC investment (including overheads)	$183,700	$217,030	$31,900	$248,930
Co-investment				
Total				**$248,930**

Summary of impacts

Table 10 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 61 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Labour savings**
Environmental	/	
Social	/	Reduced worker injuries

Quantification of impacts

Estimated benefits

The primary benefit from an automated system for deboning lamb shoulder would be potential cost savings for plant operators through reduced labour requirements. The final project report estimated that an automated system processing 300 pieces per hour would deliver savings equivalent to 2 units of labour. Elsewhere in the report it is suggested that "the approach to using automation would remove 30%-40% of the whole manual processing time, when focusing on the separation of the shoulder rib cage". However these results were not validated as part of the project, as the COVID-19 pandemic prevented in-plant testing from being undertaken. The report concluded that the performance (e.g. accuracy) of the prototype machine was comparable with what may be achieved manually, whilst the speed and consistency for operation in a plant are to be validated with large number of primal pieces. Consultation with the developer suggests the payback period for the system is likely to be around 18 months.

Table 62 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Estimated labour savings per head processed	$0.47	The study suggests that an automated system processing 300 shoulders (i.e. 150 head) per hour would require 2 less labour units, valued at $35 per hour including on costs.
b) Typical annual throughput of plants adopting technology	$500,000	The technology appears more suited to larger plants with faster throughput and which are more likely to make the required capital investment.
c) Estimated labour savings per plant per annum	$233,333	= a x b
d) Chance of success	60%	The technology appears promising at the prototype stage, however still needs to be proven viable under in-plant testing, and a feasible investment for plants. The previous design attempt had to be revised and this prototype may also need to undergo multiple revisions. Consultation with the researcher suggested that stage 3 of the project will bring the chance of success up to 90%.
e) Probability adjusted labour savings per plant per annum	$140,000	= c x d

Adoption costs

The above potential benefits will be offset by the costs incurred by processors adopting the technology, including capital costs as well as potential disruption to existing activities.

Table 63Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs	$400,000	GHD estimate based on consultation with researcher.

Counterfactual

Under the counterfactual scenario the prototype automation machine would not be developed and adopted by the Australian meat processing sector therefore the industry will continue to be reliant on the current manual process. However under the counterfactual scenario, it was assumed that an automated solution would eventually be imported into the Australian market.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development and extension. In the case an automated system for deboning lamb shoulder of significant levels of investment have been made and will be required to develop the technology to a point where it can be implemented into Australian processing plants, therefore the AMPC project investment represents a smaller percentage of overall investment.

Table 64 Attribution assumptions

Variable	Assumption	Source/ Explanation
a) Past research	29%	Based on an indicative estimate of $0.3m already invested into R&D directly related to this automation function, including the phase 1 project.
b) Future Development	32%	Based on an estimated future investment of $0.4m to test the prototype in plants, refine the concept and validate benefits.
c) Promotion and extension	0%	Promotion and extension is considered to be factored into the capital cost of adoption.
d) Attribution of remaining benefits to project	39%	= 100% - a – b – c

Adoption

It is inherently difficult to predict future adoption levels of emerging technologies. Many seemingly promising technologies can fail to achieve expected adoption rates, while other technology can emerge to be become the new standard, achieving almost 100% adoption. Furthermore, technology applications can change significantly from what was originally envisaged.

Based on the balance of probabilities the analysis assumed that adoption will begin in 2022/23 when the technology is expected to be tested in pilot plants. Adoption is predicted to peak in 2028/29 when 25 larger sheepmeat processing plants are estimated to adopt the technology (Figure 2). Under the counterfactual scenario it is assumed that the technology would be delayed by 8 years, however eventually ‘off the shelf’ solutions developed overseas, would likely be made available in the Australian market.

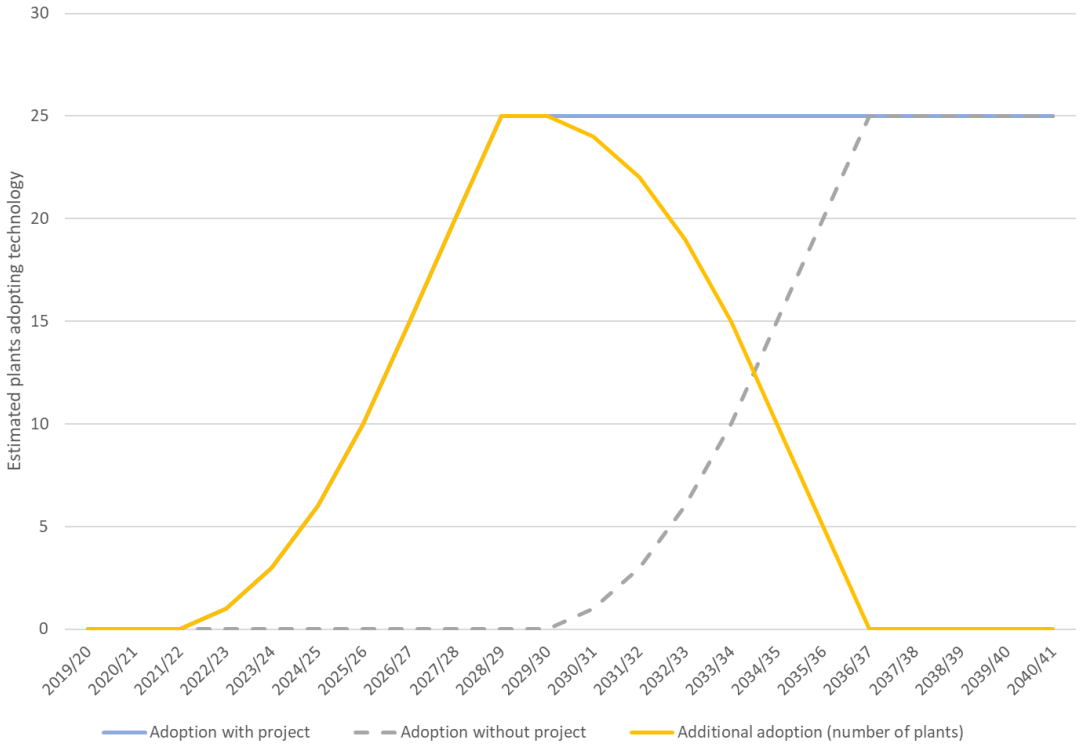

Figure 9 Projected adoption rate of 2018-1045

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $3.6m and a positive Benefit Cost Ratio of 9.05.

Table 65 Investment criteria for total investment in Project 2018-1045 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	-$0.4	$1.9	$4.1	$4.1	$4.1	$4.1
PV Costs	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4	$0.4
NPV	-$0.4	-$0.8	$1.5	$3.6	$3.6	$3.6	$3.6
BCR	-	-0.88	4.31	9.05	9.05	9.05	9.05
IRR	negative	negative	18%	24%	24%	24%	24%
MIRR	-100%	-100%	13%	15%	12%	11%	10%

The flow of total undiscounted costs and benefits from the project is presented below.

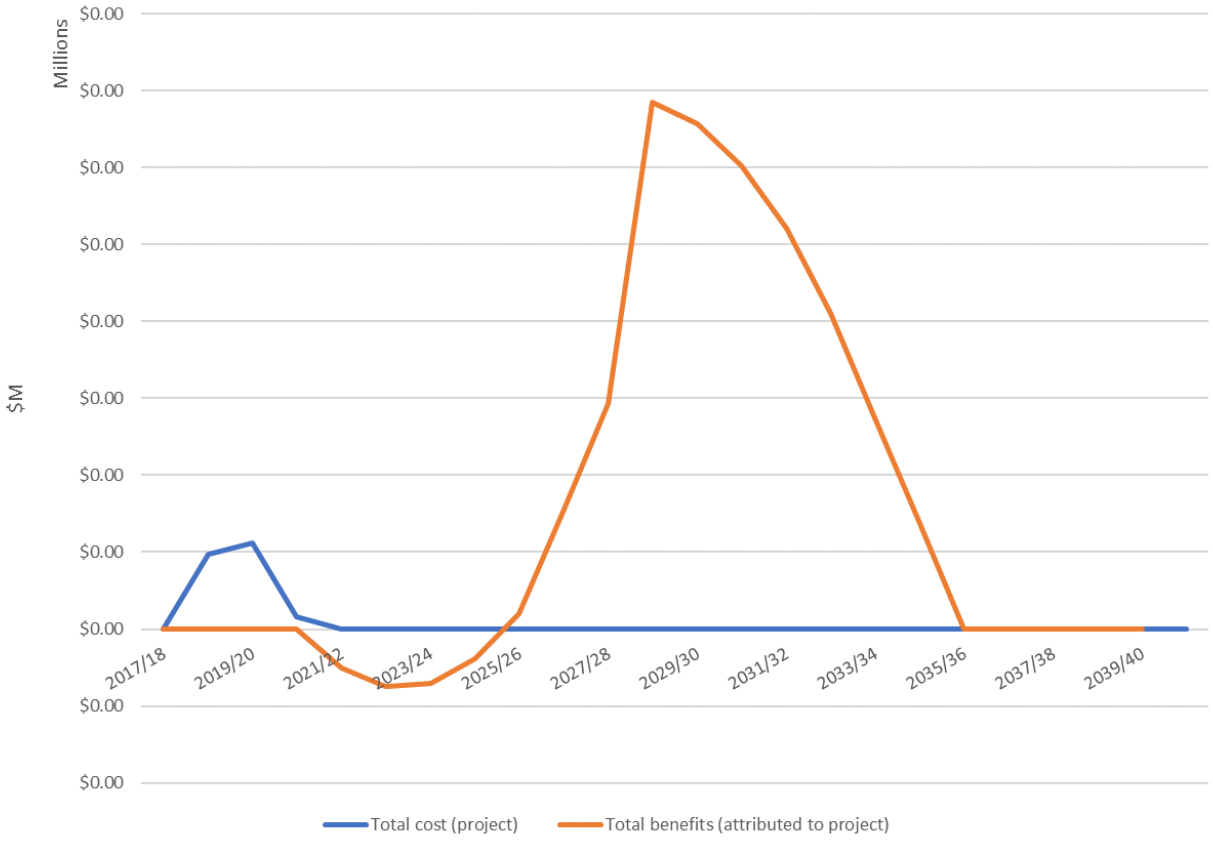

Figure 10 Flow of undiscounted costs and benefits from Project 2018-1045

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 66 below. The investment remained positive under all scenarios modelled.

Table 66 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		$3.62	9.05	10%
Adjusted discount rate				
	0%	$6.43	15.28	6%
	10%	$2.01	5.47	14%
Adjusted cost savings from technology use				
	+20%	$5.03	12.17	12%
	-20%	$2.21	5.92	8%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 67 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis covers the primary expected benefits from the technology, through labour cost savings. However other benefits including improved workplace health and safety were not able to be accurately quantified.
Confidence in assumptions	Medium	The technology remains at the prototype stage, therefore expected benefits, costs and timeline for adoption remain unclear. In the absence of more certainty, very high-level assumptions were used.

Conclusions

The project developed a prototype robotic system for deboning lamb shoulder, which is expected to be further developed and tested before being adopted by Australian processing plants. This analysis suggests that once developed this system will reduce labour costs by around $0.47 per head and is likely will be adopted by around 25 plants by 2028/29. Based on these and other assumptions, the analysis concluded that the project is likely to deliver a positive economic benefit (BCR 9.05). This outcome was highly sensitive to changes in assumptions, however the investment returns remained positive under all scenarios modelled.

References

Khodabandehloo, K. (2020), *2018-1045 First prototype automation for deboning lamb shoulder – Stage 2*, Australian Meat Processor Corporation.

Acknowledgements

Koorosh Khodabandehloo

8.7 Appendix G: 2018-1030 Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs

Background

Large volumes of water and energy is used by Australian red meat processors to meet food safety requirements. There is a perception that abattoirs in rural areas are over-users of water, which has led to increased tension in water consumption between red meat processors and the local community, particularly during periods of water shortage. With increasing water scarcity, it is becoming increasingly important to achieve further efficiency in water usage.

The 2015 AMPC environmental performance review highlighted that it was clear the red meat processing industry had achieved improvements in reducing energy consumption. However, it was identified that the industry had only achieved a modest improvement in water use efficiency, therefore emphasising the need for the industry to explore solutions in water re-use or recycling.

Description of the project

The purpose of the project was to conduct a technical and economic feasibility study to identify waste streams and technology to reduce water consumption of modern abattoirs through reuse or recycling. The project studies viable techno-economic strategies for water recovery that have the potential for implementation in the red meat processing industry.

Table 68 Project description and logic

2018-1030 Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs	
Project Details	Organisation: University of New South Wales Date: 2021 Principle Investigator: Keng Han Tng, Rui Zhang, Pierre Le-Clech and Francisco Trujillo
Rationale	To provide engineering solutions and technical recommendations to reduce water consumption of modern abattoirs.
Objectives	The objectives of the project were to: / Identify sources of wastewater in meat processing, as well as water quality and quantity through operational data collection / Select wastewater streams and pair with treatment technologies for reuse or recycling / Evaluate and optimise operating conditions of the proposed water reuse or recycling options' treatment process / Evaluate the environmental impact of adoption of treatment trains and assess the economic feasibility through NPV and ROI calculations
Activities and Outputs	/ Collected abattoir operational data to identify the source of meat processing wastewaters, and its respective water quality and quantity / Current legislations and perceived risks were identified as a barrier to the adoption of direct planned potable recycled water, limiting the red meat processing industry to only AQIS approved reuse options

2018-1030	Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs
	/ Paired selected wastewater streams with the appropriate treatment technologies to produce treated water that meets the required quality standards for identified reuse or recycling applications / Evaluated and optimised the operating conditions of treatment process trains for the proposed water reuse and recycling options / Undertook a Life-Cycle Assessment (LCA) and economic cost-benefit assessment for the adoption of treatment trains
Potential Outcomes	/ Recycling abattoir wastewater to potable standards was the most ideal method to achieve significant water savings / Selection of wastewater stream identified that the most feasible for reuse or recycling was wastewater sourced from the cattle yard wash, boning room, kill floor, sider chiller wash, boiler ash wash and rendering condensates.
Potential Impacts	/ Plant cost savings from reduced need to purchase fresh water / Plant cost savings from reduced need to treat wastewater / Environmental benefits through reduced mineral resource scarcity and freshwater consumption / Reduced environmental impacts from freshwater eutrophication, freshwater ecotoxicity and fossil resource scarcity / Improved social licence and water availability for regional uses

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 69 Annual Investment in Project 2018-1030

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$110,000	$143,000	$230,000
Co-investment			
Total			**$230,000**

Summary of impacts

Table 70 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 70 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Plant cost savings from reduced need to purchase fresh water**

	/	Plant cost savings from reduced need to treat wastewater
Environmental	/	Environmental benefits through reduced mineral resource scarcity and freshwater consumption
	/	Reduced environmental impacts from freshwater eutrophication, freshwater ecotoxicity and fossil resource scarcity
Social	/	Improved social licence and water availability for regional uses

Quantification of impacts

Estimated benefits

The project report included an analysis of projected financial returns to processing plants from installing two types of water recycling options:

1. Internal recycling utilising a Membrane Bioreactor (MBR) and a Reverse Osmosis (RO) unit to treat six selected waste streams
2. End-of-Pipe (EoP) recycling which involves using an Ultrafiltration (UF) membrane unit and a RO unit to treat effluent from a conventional water treatment plant.

This analysis found that the internal recycling option was potentially a financially viable option, returning a 10.2% return on investment and recovering the capital investment after 8 years. The end of pipe recycling option was not financially viable based on these assumptions (however was viable in situations where water prices were higher).

Table 71 Summary of assumptions and results from 2018-1030 financial analysis

	1. Internal Recycling (MBR-RO)	2. End-of-Pipe Recycling (UF-RO)
Upfront Fixed Capital Investment	/ $2,533,401	/ $1,438,793
Opex	/ $380,010	/ $818,459
Volume of potable water recovered (kL/day)	/ 1023	/ 1023
Cost of water (AUD/kL)	/ $2.98	/ $2.98
Total Annual Revenue	/ $914,562	/ $914,562
Annual net benefits (Revenue minus Opex)	/ $534,552	/ $96,103
NPV (AUD)	/ $2.9M	/ $363,182
ROI (%)	/ 10.2%	/ 0.07%
Capital recovery point	/ 8 years	/ Not reached

From the above results it can be assumed that there is a potential economic benefit for plants implementing an internal recycling system utilising a Membrane Bioreactor and a Reverse Osmosis.

Table 72 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Annual net benefit from implementing technology	$534,552	Table 71
b) Chance of success	70%	Accounting for possibility that once implemented the technology may not perform as expected in the modelled analysis. Operating costs may be higher than assumed and water recovered may be lower.
c) Probability adjusted annual net benefit from implementing technology	$374,186	= a x b

Adoption costs

The above potential benefits will be offset by the costs incurred by processors adopting the technology, including capital costs as well as potential disruption to existing activities.

Table 73Adoption cost assumptions

Variable	Assumption	Source/ Explanation
Processor adoption costs per plant	$2,533,401	Table 71

Counterfactual

Under the counterfactual scenario wastewater recycling technology options would be available to Australian meat processors, however they would not have been independently reviewed therefore their relative feasibility for implementation will be less clear. As a result, processors would be reliant on information from commercial providers and their own research in order to make investment decisions. Processors would be more likely to delay investment decisions (or select less suitable technology options).

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development and extension. In the case of water recycling and energy recovery options, significant levels of investment have already been made to develop and commercialise the technology. Further investment will likely be required to continue to develop and adapt the technology for meat processors.

The study identified the following recommended actions for allowing the technology to be broadly adopted:

- current abattoirs would need to retrofit plumbing for waste segregation.
- greenfield abattoirs would need to conduct hydraulic planning to allow for access to individual waste streams and minimise cross-contamination between streams.
- validation guidelines need to be developed for direct planned potable recycled water, to avoid impacts on food safety and market access.
- pilot testing of the proposed potable water recycling treatment trains could be completed to allow for technical validation of treatment processes and final product water quality compliance monitoring.

As a result of the above, the AMPC project investment is likely to represent a very small percentage of overall investment.

Table 74 Attribution assumptions

Variable	Assumption	Source/ Explanation
e) Past research	34%	Based on an indicative estimate of $2m already invested into directly related R&D (i.e. internal recycling utilising a membrane bioreactor and a reverse osmosis for water Australian processing plants.
f) Future Development	46%	Based on an estimated future R&D investment of $3m required to further develop, refine and pilot the technology (in line with the recommended actions above).
g) Promotion and extension	15%	Based on an estimated future investment of $1m annually into promotion and extension of feasible applications suitable for Australian processing plants.
h) Attribution of remaining benefits to project	4%	= 100% - a – b – c

Adoption

Based on the projected financial returns from Internal Recycling (MBR-RO) systems this analysis has assumed around 20 plants will adopt the technology over the coming 6-7 years, after this point the technology is likely to change and develop to a point where it can no longer be attributed to the 2018-1030 project. Outlined below is the assumed adoption rate, with and without the project, used in this evaluation.

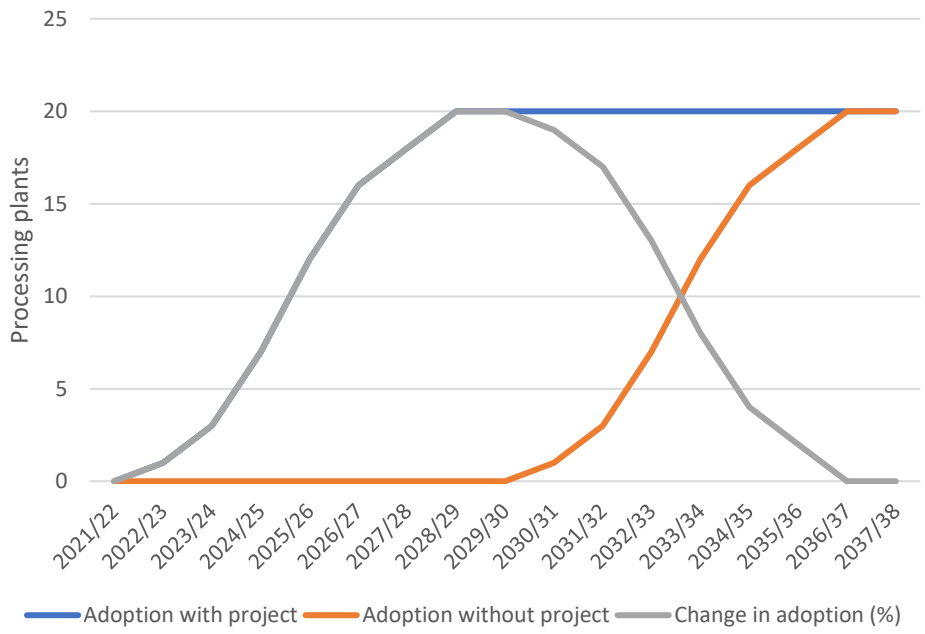

Figure 11 Projected adoption rate of Internal Recycling (MBR-RO)

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $1.38 and a positive Benefit Cost Ratio of 6.4.

Table 75 Investment criteria for total investment in Project 2018-1030 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	$0.29	$1.26	$1.64	$1.64	$1.64	$1.64
PV Costs	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26
NPV	-$0.26	$0.03	$1.00	$1.38	$1.38	$1.38	$1.38
BCR	-	1.1	4.9	6.4	6.4	6.4	6.4
IRR	NA	8%	31%	33%	33%	33%	33%
MIRR	-100%	6%	18%	16%	13%	12%	11%

The flow of total undiscounted costs and benefits from the project is presented below.

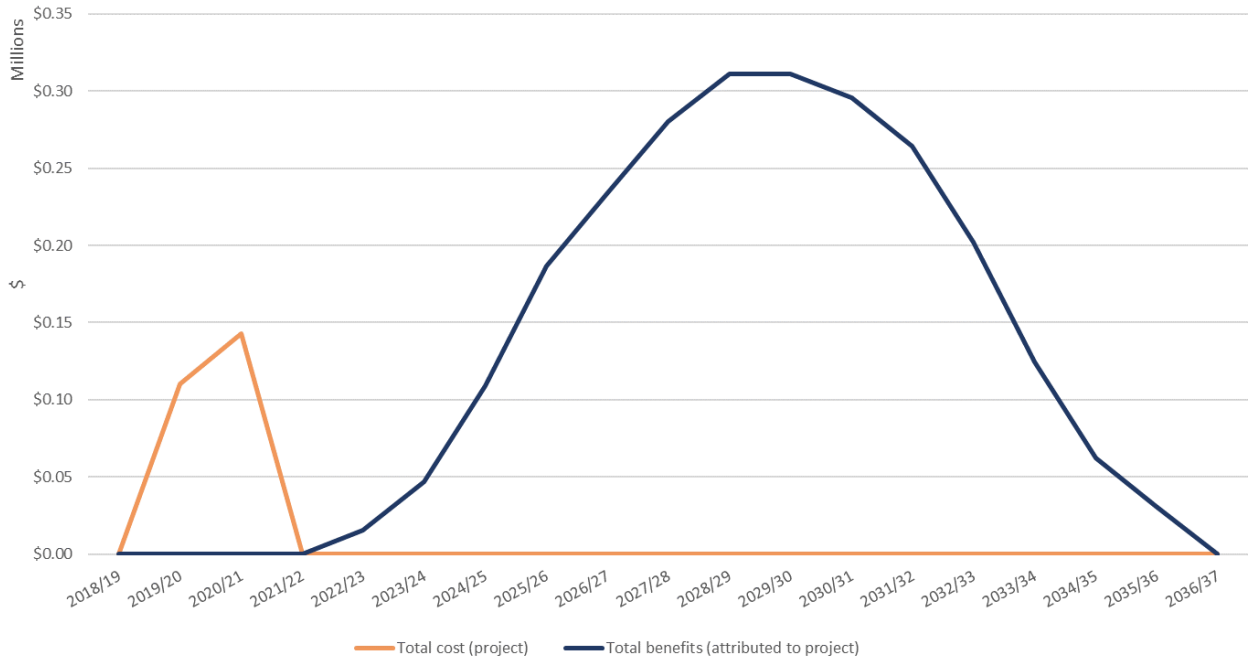

Figure 12 Flow of undiscounted costs and benefits from Project 2018-1030

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 76 below. The investment remained positive under all scenarios modelled.

Table 76 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		$1.38	6.37	11%
Adjusted discount rate				
	0%	$2.14	9.35	7%
	10%	$0.90	4.50	15%
Adjusted cost savings from technology use				
	+20%	$1.71	7.65	11%
	-20%	$1.05	5.10	10%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 77 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis covers the primary expected benefits from the technology being reduced external water use and costs.
Confidence in assumptions	Medium	The analysis relied on independently verified cost and benefit figures within the project report. Assumptions around adoption rate and attribution are less certain.

Conclusions

The project demonstrated that membrane bioreactor and a reverse osmosis system for water recycling may be financially viable for Australian processing plants. The analysis modelled a ROI of 10.2% and return on capital after 8 years, however financial returns may be higher where water supply and/or disposal costs are high. The project is likely to help processors make more informed investment decisions around this technology.

Based on these and other assumptions of future development costs and adoption rates, the analysis concluded that the project was likely to deliver a positive economic benefit (BCR 6.4). This outcome was sensitive to changes in assumptions, however the investment returns remained positive under all scenarios modelled.

References

Tng, K. H., Zhang, R., Le-Clech, P. and Trujillo, F. (2021), *2018-1030 Technical and economic feasibility of water recycling and energy recovery for red meat processing operations in abattoirs*, Australian Meat Processor Corporation.

8.8 Appendix H: 2020-1054 Solar PV with Storage & Biomass Boilers – LCOE calculator

Background

Australian Meat Processing Corporation (AMPC) members are receiving both solicited and unsolicited offers for the provision of alternative energy supply systems such as solar PV systems and biomass boilers. The offers are developed using broad assumptions for energy prices and escalation rates (e.g. CPI) and the equipment quality and functionality can be highly variable as well. Without a detailed knowledge of alternative energy supply systems, it is difficult to assess these offers on a consistent basis (AMPC 2021).

Description of the project

The purpose of the project was to assist AMPC members in making informed decisions on renewable project investments by providing advice for the provision of alternative energy supply systems. The project developed Levelized Cost of Energy (LCOE) tools to assess solar PV systems and biomass boilers to provide members with a comprehensive financial analysis of renewable project offers.

Table 78 Project description and logic

2020-1054	Solar PV with Storage & Biomass Boilers – LCOE calculator
Project Details	Organisation: Energetics Pty Ltd Date: 2021 Principle Investigator: Roger Horwood
Rationale	To develop a tool to provide members with advice on the financial feasibility of solar PV and biomass boiler offers.
Objectives	The objectives of the project were to: / Assist AMPC members in evaluating solar PV and battery and biomass boiler projects through providing insights / Reduced time used to evaluate projects and assist senior management in making informed decisions / Encourage innovation and development in the renewable energy industry
Activities and Outputs	/ Development of two separate LCOE tools for the assessment of PV systems and biomass boilers / Provision of a comprehensive financial analysis of renewable project offers / Development of a user manual for each tool to assist in personnel training and presentation for AMPC members
Potential Outcomes	/ Processing plants make better investment decisions in energy infrastructure options / Processing plants save time and effort in evaluating and comparing offers, and justifying investment
Potential Impacts	/ Cost savings for processing plants implementing solar PV with storage and/or biomass boilers / Reduced carbon emissions through increased uptake of renewable energy options

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 79 Annual Investment in Project 2020-1054

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$10,450	$84,700	$95,150
Co-investment			
Total			**$95,150**

Summary of impacts

Table 10 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 80 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Cost savings for processing plants implementing solar PV with storage and/or biomass boilers**
Environmental	/	Reduced carbon emissions through increased uptake of renewable energy options
Social	/	NA

Quantification of impacts

Estimated benefits

Since being developed the calculators have been used to evaluate a range of infrastructure offers across multiple plants. The results have shown that supplier ROI and payback calculations vary significantly and are on average 10-15% higher than actual ROI estimates as determined by the calculator. Consultation suggests the use of the calculators can deliver potential savings in the upfront capital cost, through better choice of options and increased bargaining power (estimated 5% saving from a typical investment of $100K). The calculator can also save time for staff attempting to evaluate and compare alternative offers with benefits and payback periods calculated in different ways. Having an independent tool, developed by engineers, also helps to justify investment to senior management, the board or financiers.

Table 81 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Average capital cost of solar/biomass boiler energy investment	$100,000	Average solar system is 100kw (pers. Consult. Energetics), with a capital cost of approximately $100,000 (excluding small-scale technology certificates).
b) Average savings for processing plant in selecting the best energy infrastructure offer and/or being able to bargain with	5%	Conservatively, using the calculator to select/negotiate should deliver a 5% saving in capital cost.

Variable		Assumption	Source/ Explanation
	suppliers based on the results of the calculator		
c)	Capital cost saving per plant	$5,000	= a x b
d)	Additional savings in time and effort for plants evaluating/comparing offers and justifying investment	$5,000	Time savings for senior management and board to review, compare and approve investment (or engage outside advice).
e)	Total benefit per plant using the calculator	$10,000	= c + e

Adoption costs

The calculator is free to adopt for AMPC members.

Counterfactual

Under the counterfactual scenario processors will be fielding offers from energy infrastructure suppliers and attempting to make informed judgements about the expected return on investment (ROI).

Attribution

All benefits have been attributed to the project, as the calculator did not draw significantly on past research and did not require any future development or extension.

Table 82 Attribution assumptions

Variable		Assumption	Source/ Explanation
i)	Past research	0%	The calculator did draw significantly on past research.
j)	Future Development	0%	The calculator is ready to use and will not require future development.
k)	Promotion and extension	0%	The calculator is being promoted via AMPC, however these costs are accounted for in project overheads.
l)	Attribution of remaining benefits to project	100%	= 100% - a – b – c

Adoption

Consultation suggests that all Australian processors are fielding offers by energy suppliers, and most will be actively considering installing solar/battery and/or biomass boiler systems. At the time when the calculators were produced a proportion of processors had likely already made investments. On balance, GHD assumed the calculators would likely be used by 50 processors over the coming years, as per figures below.

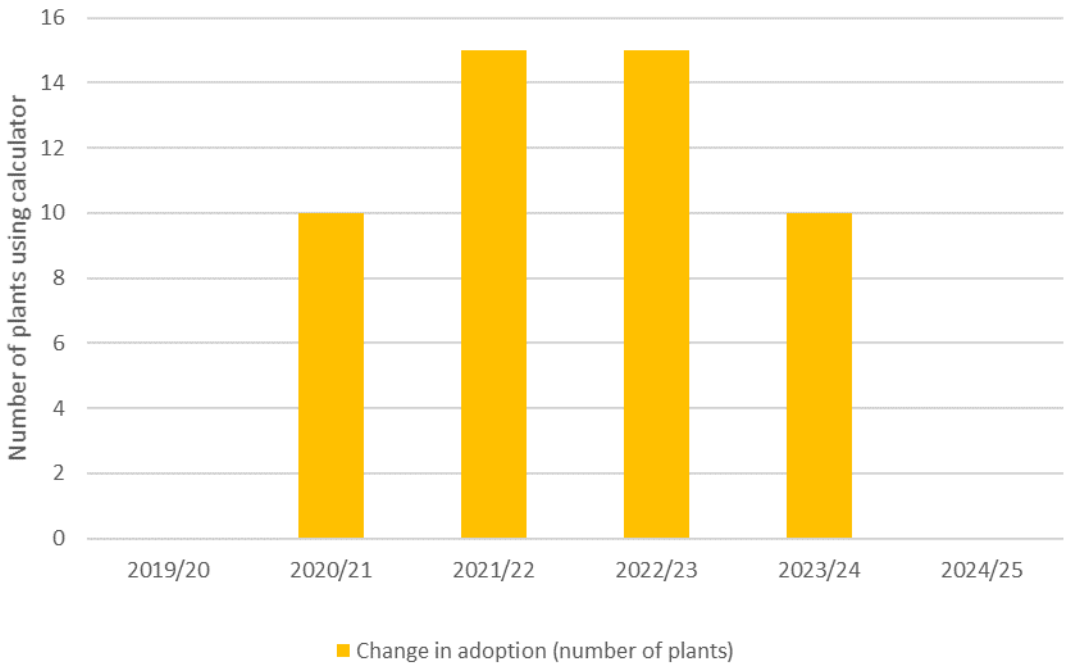

Figure 13 Projected adoption rate of Project 2020-1054

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $0.37m and a positive Benefit Cost Ratio of 4.87.

Table 83 Investment criteria for total investment in Project 2020-1054 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$100,000	$465,295	$465,295	$465,295	$465,295	$465,295	$465,295
PV Costs	$95,507	$95,507	$95,507	$95,507	$95,507	$95,507	$95,507
NPV	$4,493	$369,789	$369,789	$369,789	$369,789	$369,789	$369,789
BCR	1.05	4.87	4.87	4.87	4.87	4.87	4.87
IRR	46%	399%	399%	399%	399%	399%	399%
MIRR	14%	56%	35%	27%	22%	19%	17%

The flow of total undiscounted costs and benefits from the project is presented below.

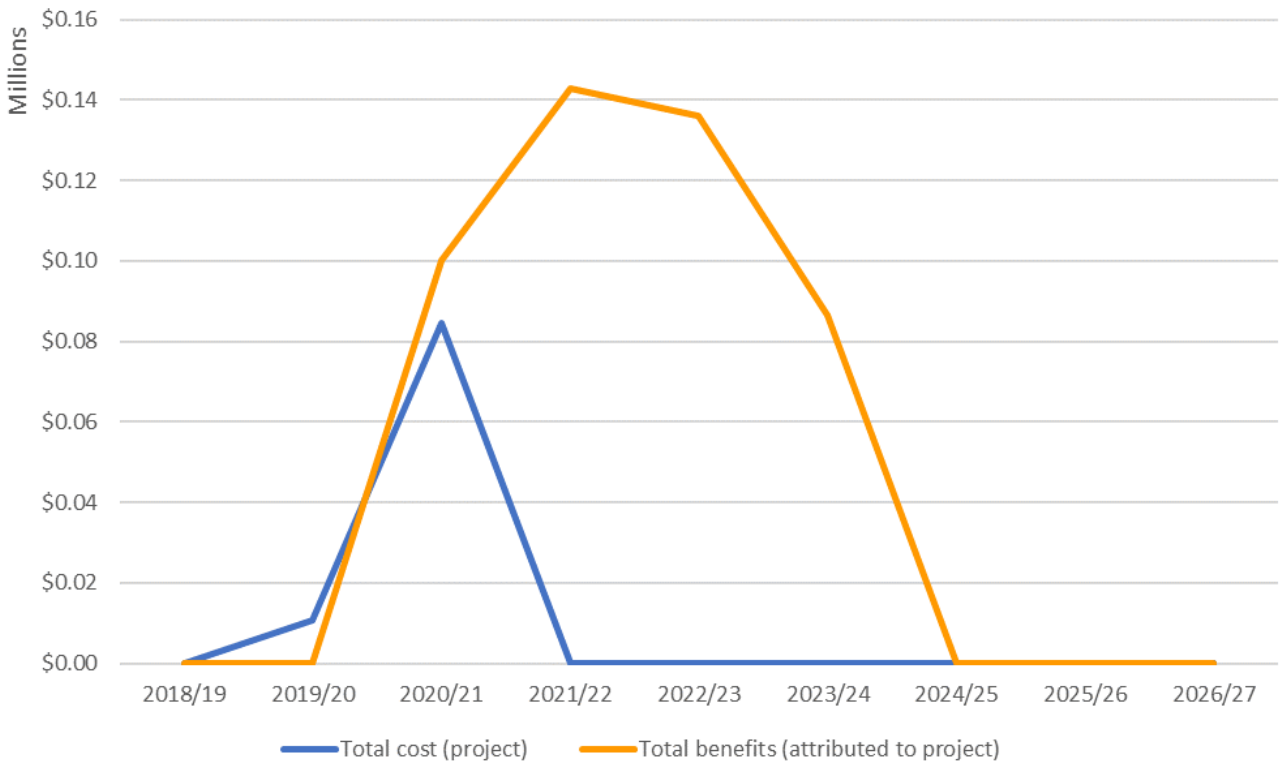

Figure 14 Flow of undiscounted costs and benefits from Project 2020-1054

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 84 below. The investment remained positive under all scenarios modelled.

Table 84 Sensitivity analysis

Changes to Key Variables	NPV ($M)	BCR	MIRR

Standard assumption		$0.37	4.87	17%
Adjusted discount rate				
	0%	$0.40	5.24	11%
	10%	$0.34	4.56	22%
Adjusted cost savings from calculator use				
	+20%	$0.46	5.85	17%
	-20%	$0.28	3.90	14%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 85 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	High	The analysis covers the primary expected benefits from the calculator, being improved investment decisions and time savings for processors evaluating solar and bioenergy options.
Confidence in assumptions	Medium	The assumed savings in capital costs and time were based on anecdotal findings from real-world situations where the calculator was used to evaluate energy investment options for processing plants.

Conclusions

The project developed Levelized Cost of Energy calculators for evaluating solar PV with storage and biomass boilers investment options. These calculators are being used by processing plants to independently and accurately evaluate and compare commercial offers and make better investment decisions. Through reduced cost of capital investments and time savings in comparing options this analysis assumed the average plant using the calculator would save $10,000. This equates to the project returning a net present value (NPV) of $0.37m and a positive Benefit Cost Ratio of 4.87.

References

AMPC (2021) *Snapshot: Solar PV Plus Battery and Biomass Boiler LCOE Assessment Tools*, 22 November 2021

Acknowledgements

Roger Horewood (Energetics)

8.9 Appendix I: 2020-1012 Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator

Background

Quality indicators for freshness is critical for the marketing of red meat products, particularly for 'fresh-chilled' products that are sent to export markets. Total volatile basic nitrogen (TVB-N), which is a term used to describe a range of chemical compounds that commonly comprise of nitrogen in their structure, are often used as a method to evaluate the freshness and quality of meat for consumption. These nitrogen compounds are formed mainly post-slaughter from the degradation of proteins and amines, and accumulate in amount during meat storage. Extensive studies have been conducted in the use of TVB-N determination and the formation of nitrogen compounds in seafood, however, information for red meat is not readily available or established.

Description of the project

The purpose of the project was to undertake a scientific literature review on the use and application of TVB-N in meat products. The project aims to develop recommendations for a research plan to outline robust indicators of freshness in red meat for Australian beef exports.

Table 86 Project description and logic

2020-1012 Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator	
Project Details	Organisation: Department of Primary Industries (NSW) Date: 2020 Principle Investigator: Prof David Hopkins, Dr Benjamin Holman, A/Prof Alaa El-Din Bekhit and Dr Stephen Giteru
Rationale	To understand the use and application of TVB-N in red meat and develop recommendations that consider robust indicators of freshness for Australian beef exports.
Objectives	The objectives of the project were to: / Review scientific literature on the use and application of TVB-N, particularly for use in red meat / Better understand the usefulness and suitability of TVB-N in indicating freshness in red meat / Develop recommendations of a research plan to underpin Australian beef exports, with respect to robust indicators of freshness
Activities and Outputs	/ Undertook a literature review of TVB-N application for red meat / Reviewed literature outlining the different threshold limits of TVB-N acceptability / Identified knowledge gaps, enabling the industry an opportunity to better prepare for potential risks to market access related to TVB-N
Potential Outcomes	/ TVB-N accumulation increases with meat storage, in line with other biomarkers of food spoilage. Lower levels of TVB-N were detected when preservation techniques were applied / No specific threshold to interpret TVB-N results against for red meat and results are not often consistent

2020-1012	Total volatile basic nitrogen in meat products: occurrence, method of determination and use as a freshness indicator
	/ The method for TVB-N determination is often destructive. However, most systems reported are non-destructive and are able to differentiate between spoiled and non-spoiled samples / A range of TVB-N guidelines have been proposed to differentiate between fresh or spoilt meat products, however very few are readily available for red meat. Therefore, the project recommended investigations specific to red meat for the application of TVB-N as a freshness biomarker / Knowledge gaps were identified related to market-access based on TVB-N, providing the industry with an opportunity to understand and be better prepared to respond to potential challenges
Potential Impacts	/ More targeted future research into demonstrating freshness and extending shelf-life / Reduced food waste / Improved food security

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 87 Annual Investment in Project 2020-1021

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$51,328	$12,100	$63,428
Co-investment			
Total			**$63,428**

Summary of impacts

Table 10 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 88 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**More targeted future research into demonstrating freshness and extending shelf-life.**
Environmental	/	Reduced food waste
Social	/	Improved food security

Quantification of impacts

Estimated benefits

As a result of the project the Australian red meat industry has a stronger understanding of potential application of TVB-N and the knowledge gaps that exist within the scientific literature. Industry also has a scientifically informed recommendations for a research plan to underpin Australian exports of beef meat with respect to robust indicators of freshness.

The output from this project (final literature review report) is very technical in nature and unlikely to be directly utilised by processors. However, it is expected to be used by researchers and industry research planners when developing future research strategies. In this sense the project will help ensure that future R&D investments in this area are more targeted to filling knowledge gaps and less likely to duplicate past research efforts. Therefore, the benefits from this project have been calculated based on an efficiency dividend from future R&D investments within the Market Access Science sub-program which is jointly managed by MLA and AMPC. This research sub-program is focussed on building consumer trust in red meat products and reducing non-tariff (technical) trade barriers.

Table 89 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Average annual R&D investment into Market Access Science sub-program (jointly managed by MLA/AMPC)	$4,140,500	Average annual investment from 2020/21 and 2021/22 Annual Investment Plans
b) Estimated proportion of Market Access Science sub-program typically directed towards demonstrating freshness and extended shelf-life	30%	GHD estimate based on a review of Market Access Science activities and KPIs.
c) Estimated annual R&D investment into demonstrating freshness and extended shelf-life	$1,242,150	=a x b
d) Efficiency dividend from project ensuring R&D investments are more targeted to filling knowledge gaps and less likely to duplicate past research efforts	10%	GHD estimate based on the findings within the project report
e) Annual efficiency dividend from project	$124,215	= c x d

Adoption costs

The costs for industry researchers and research planners to adopt the recommendations within the project report are generally incorporated into AMPC overheads, which are factored into the project costs.

Counterfactual

Under the counterfactual scenario future industry investments into demonstrating freshness and extended shelf-life will be less targeted and more likely to duplicate existing research.

Attribution

The benefits from the project (more targeted future research with less duplication) are wholly attributable to the Project.

Table 90 Attribution assumptions

Variable	Assumption	Source/ Explanation
m) Past research	0%	NA

Variable	Assumption	Source/ Explanation
n) Future Development	0%	NA
o) Promotion and extension	0%	NA
p) Attribution of remaining benefits to project	100%	= 100% - a – b – c

Adoption

The analysis has assumed that the findings from the literature review will remain relevant and useful for informing industry R&D into freshness indicators for a period of 3 years (2020/21 to 2022/23). After this time the research is likely be superseded.

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $0.29m and a positive Benefit Cost Ratio of 5.45.

Table 91 Investment criteria for total investment in Project 2020-1012 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$0.12	$0.36	$0.36	$0.36	$0.36	$0.36	$0.36
PV Costs	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07
NPV	$0.06	$0.29	$0.29	$0.29	$0.29	$0.29	$0.29
BCR	1.91	5.45	5.45	5.45	5.45	5.45	5.45
IRR	118%	218%	218%	218%	218%	218%	218%
MIRR	26%	29%	20%	16%	13%	12%	11%

The flow of total undiscounted costs and benefits from the project is presented below.

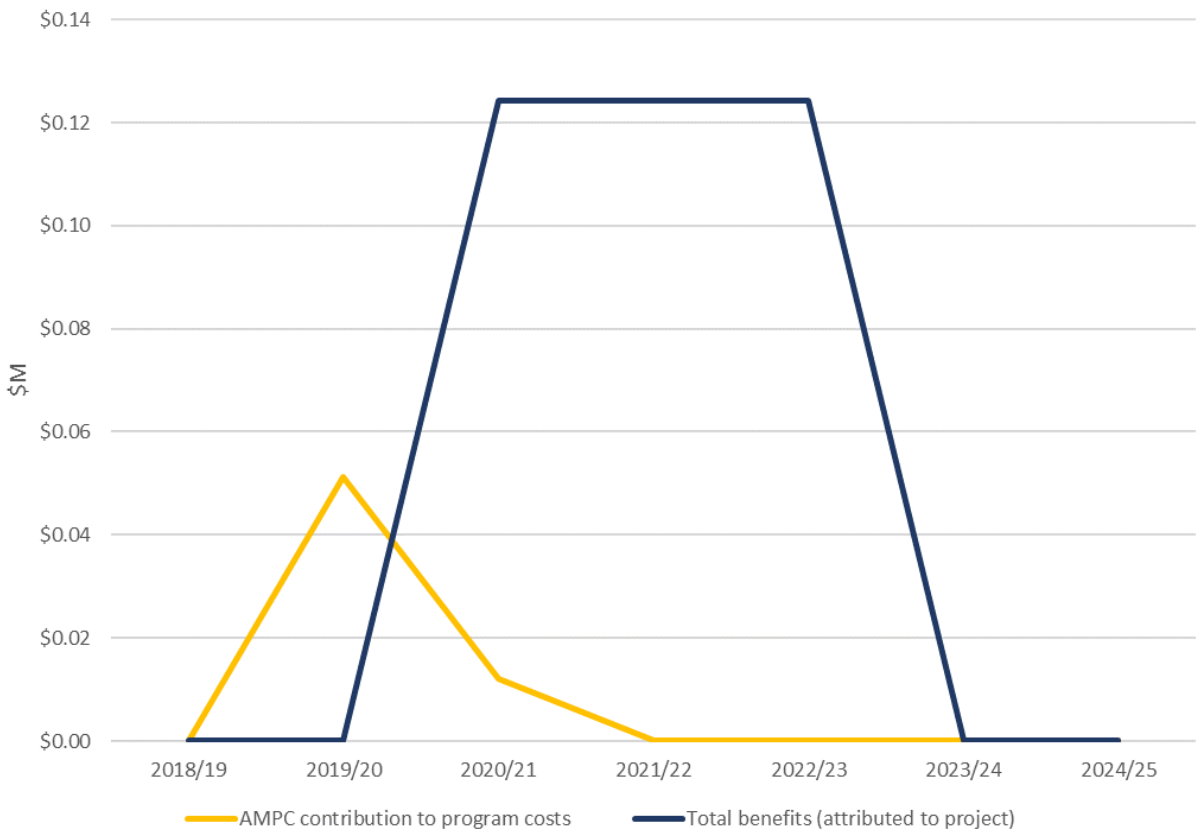

*Figure 15 Flow of undiscounted costs and benefits from Project 2020*1012*

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 92 below. The investment remained positive under all scenarios modelled.

Table 92 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		0.29	5.45	11%
Adjusted discount rate				
	0%	$0.31	5.72	6%
	10%	$0.27	5.21	16%
Adjusted cost savings from technology use				
	+20%	$0.36	6.54	11%
	-20%	$0.22	4.36	10%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 93 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	Medium	The analysis assessed benefits in terms of an efficiency dividend on future R&D investments into freshness indicators and extended shelf-life. Additional benefits may be derived from the findings in the literature review triggering future innovations.
Confidence in assumptions	Medium	The analysis relies on relatively high level estimates of efficiency dividends in future research investments.

Conclusions

As a result of the project the Australian red meat industry has a stronger understanding of potential application of TVB-N and the knowledge gaps that exist within the scientific literature. Industry also has a scientifically informed recommendations for a research plan to underpin Australian exports of beef meat with respect to robust indicators of freshness.

The output from this project is expected to be used by researchers and industry research planners when developing future research strategies. In this sense the project will help ensure that future R&D investments in this area are more targeted to filling knowledge gaps and less likely to duplicate past research efforts.

Based on an estimated efficiency dividend on future research, the analysis estimated the project investment would return a net present value (NPV) of $0.29m and a positive Benefit Cost Ratio of 5.45.

References

Hopkins, D., Holman, B., Bekhit, A.E.D. and Giteru, S. (2020), *2020-1012 Total volatile basic nitrogen in meat productions: occurrence, method of determination and use as a freshness indicator*, Australian Meat Processor Corporation.

8.10 Appendix J: 2019-1039 US Pilot for pallet labels as an alternate system of shipping mark

Background

There is a significant amount of Australian red meat exported into the US that is wasted due to label or shipping mark non-compliance. There were protocols in place that allowed for remarking services by Government officials designed to resolve these issues, but these are scheduled to be discontinued by November 2021.

The US pallet pilot project was formed to develop a protocol through which Australian Exporters can have their red meat consignments accepted by US import establishments by use of the pallet labels, without an Australian Government official being present.

Description of the project

The purpose of the project was to develop a pilot protocol that could minimise the amount of Australian red meat wasted during export into the US due to non-compliance in label or shipping mark. The protocol uses pallet labels for Australian exporters to have their red meat consignments accepted by US import establishments without having the need for an Australian Government official to be present.

Table 94 Project description and logic

2019-1039	US Pilot for pallet labels as an alternate system of shipping mark
Project Details	Organisation: Management for Technology Pty Ltd Date: 2021 Principle Investigator: Des Bowler
Rationale	Unpacking and inspecting cartons of red meat is labour intensive and often results in product rejection due to damaged packaging and missing labels.
Objectives	The objectives of the project were to: / Respond to issues of Australian red meat wastage during export to the US due to labelling or shipping non-compliance / Enable US inspection agents to verify consignments through a pallet label rather than a shipping mark
Activities and Outputs	/ Developed a pilot protocol to use a pallet label instead of a label or shipping mark during Australian red meat export into the US. / Engaged two US inspection facilities, three customers and one Australian exporter as participants for the pilot. / Monitored the compliance of the participants to identify operational issues to the pilot project. / Resolve issues identified during the monitoring phase. / Delivered information sessions and training materials to help fill knowledge gaps amongst participants.
Potential Outcomes	/ New pallet label system is more likely to be adopted.
Potential Impacts	/ Reduced unpacking and inspection time required to read individual carton labels. / Reduced wasted product exported to the US because of packaging damage and non-compliant shipping marks.

2019-1039	US Pilot for pallet labels as an alternate system of shipping mark
	/ Environmental benefits from reduced waste (food, packing, production, transport and supply chain resources).

Project investment

Table 9 below outlines the total project investments. The AMPC components of project investment costs were all multiplied by a factor of 1.1 to accommodate program management costs.

Table 95 Annual Investment in Project 2019 - 1039

Contributor	2020/21	2021/22	Total
AMPC investment (including overheads)	$47,300	$150,700	$198,000
Co-investment			
Total	**$47,300**	**$150,700**	**$198,000**

Summary of impacts

Table 10 below provides a summary of the expected triple bottom line impacts (economic, environmental and social) from the project.

*Table 96 Triple bottom line impacts, including those valued as part of this evaluation (**bold**)*

Economic	/	**Reduced unpacking and inspection time required to read individual carton labels.**
	/	**Reduced wasted product exported to the US because of packaging damage and non-compliant shipping marks.**
Environmental	/	Environmental benefits from reduced waste (food, packing, production, transport and supply chain resources).
Social	/	NA

Quantification of impacts

Estimated benefits

The pilot project found that for an average container consisting of 700 cartons, across 24 pallets, unloading and inspection time was reduced to 1 person for 15 minutes, compared previously 5 people for up to 4 hours. This time saving was attributed to not having to scan and restack cartons.

The system is also expected to significantly reduce product rejections by reducing the instance of lost or missing shipping marks and carton damage during handling. Previous estimates suggest that over half of the rejections of Australian meat arriving in the United States was due to carton damage.[12]

[12] Update April 03 (csiro.au)

Table 97 Benefit assumptions

Variable	Assumption	Source/ Explanation
a) Estimated number of cartons of red meat exported from Australia to the US per annum	15.15 million	Average 327,788 tonnes SWT per annum (average past 3 years according to FSIS). Average carton weight was 21.64kg (MeatMessaging usage reports)
b) Time saving per carton from using the system	0.02857h (1.7 minutes)	Based on the results of the trail
c) Cost of labour and facilities	$40 per hour	Indicative cost including labour (packers/inspectors), on-costs and facilities.
d) Labour saving per carton	$1.14	= b x c
e) Current rate of rejection	0.16%	FSIS rejection data from past 4 years[13] / total export volume (a)
f) Likely reduction in rejection rate for shipments using the system	40%	Conservative estimate based on trail results, consultation and past rejection reasons.
g) Reduced rate of rejection	0.064%	= e x f
h) Value of rejected carton	$173/kg	$8 per kg (indicative of lower grade product more likely to use the system) x average carton weight of 21.64kg
i) Average benefit per carton from reduced rejection risk	$0.11	= g x h
j) Total benefit per carton from using the system	$1.254	= d + i

Adoption costs

The analysis has assumed that the system will be adopted primarily by processors with packing and certification systems that are already largely compatible therefore adoption costs are negligible. Also, the adoption benefits represent a net difference in packing and inspection costs, therefore adoption costs are incorporated.

Counterfactual

Under the counterfactual scenario pallet labels will not be developed as an alternative system of shipping marks for Australian red meat exported to the US.

Attribution

Attribution of benefits was based on the estimated costs incurred by all parties in delivering the outcomes, including past research, future development and extension. The US pallet labelling system was made possible by past investments to develop the Meat Messaging portal. Further costs are likely to be incurred to fully implement the system, in particular training of packing and inspection staff.

[13] https://plumber.initmedia.com.au/meatmsg-rejection-chart

Table 98 Attribution assumptions

Variable	Assumption	Source/ Explanation
q) Past research	44%	Based on an indicative estimate of $1.5m already invested in developing and refining the meat messaging system over many years.
r) Future Development	0%	
s) Promotion and extension	40%	Based on an estimated future investment of $0.5m to promote and train staff in using the system.
t) Attribution of remaining benefits to project	17%	= 100% - a – b – c

Adoption

Consultation suggests that the pallet labelling system will be suitable for use on approximately 50% of Australian red meat exports to the US. The remaining volume is generally exported in smaller, higher value consignments with more than one product type per pallet. Adoption is likely to be driven by large customers (e.g. food service chains) making the system mandatory across all consignments.

The analysis has assumed that adoption will peak at 35% of overall Australian red meat exports to the US (or approximately 5 million cartons per annum). In the absence of the project it is assumed that the development of the system would be delayed by 5 years, after which time the efficiency issues would likely be resolved.

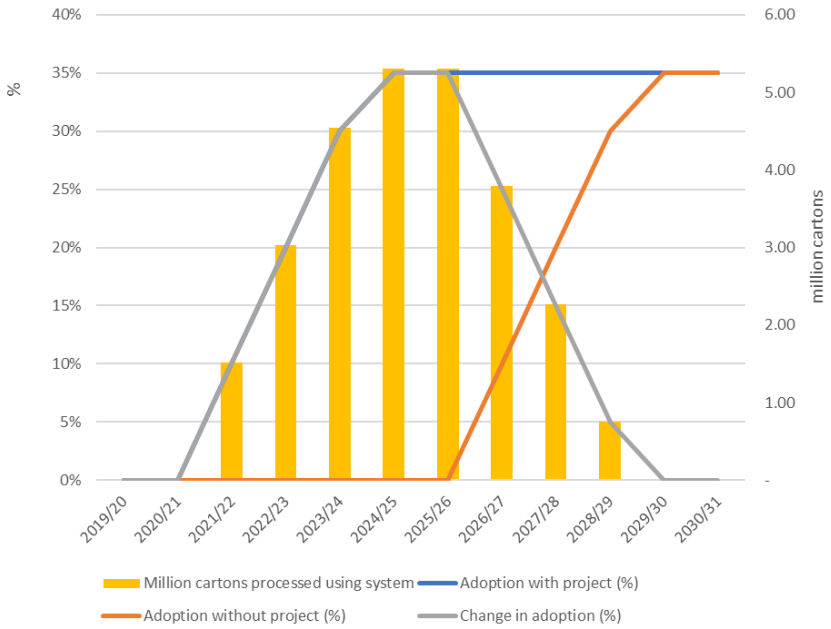

Figure 16 Projected adoption rate of Project 2019-1039 (proportion of total Australian-US red meat exports using the pallet labelling system)

Results

Table 14 below presents the modelled investment performance from the project. All past costs and benefits were expressed in 2021/22 dollar terms using the Implicit Price Deflator for GDP, while all future costs and benefits were discounted to 2021/22 valued using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The analysis used the best available estimates for each variable,

notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22) to the final year of benefits assumed.

The results show the investment returning a net present value (NPV) of $4.29m and a positive Benefit Cost Ratio of 22.5.

Table 99 Investment criteria for total investment in Project 2019-1039 ($m)

Year	0	5	10	15	20	25	30
Total Project/AMPC Contribution							
PV Benefits	$-	$3.46	$4.49	$4.49	$4.49	$4.49	$4.49
PV Costs	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20
NPV	-$0.20	$3.26	$4.29	$4.29	$4.29	$4.29	$4.29
BCR	-	17.3	22.5	22.5	22.5	22.5	22.5
IRR	negative	171%	172%	172%	172%	172%	172%
MIRR	-100%	44%	31%	24%	20%	17%	15%

The flow of total undiscounted costs and benefits from the project is presented below.

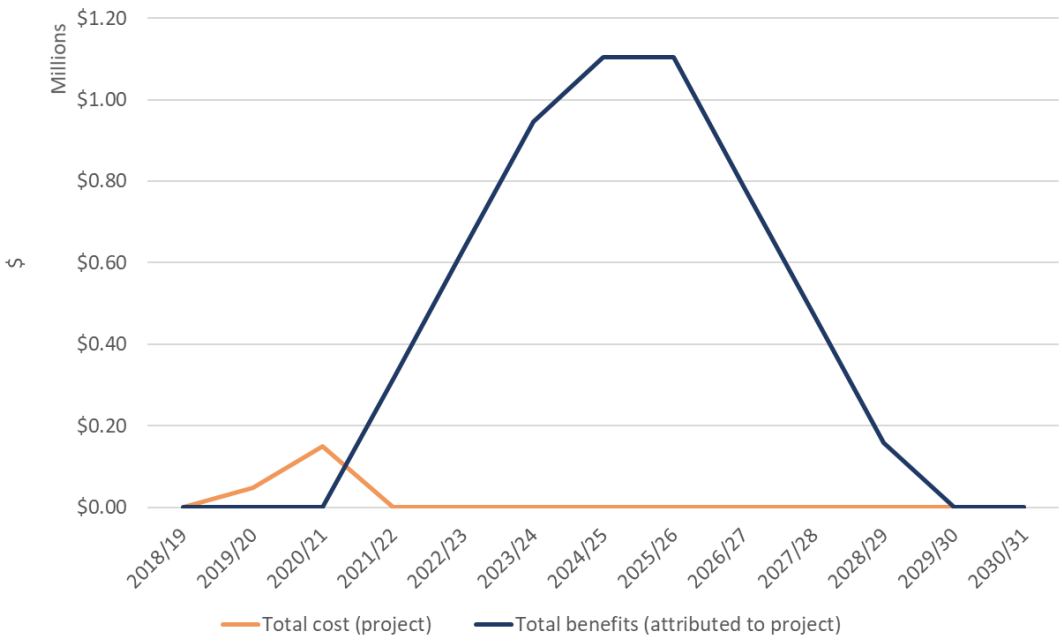

Figure 17 Flow of undiscounted costs and benefits from Project 2019-1039

Sensitivity analysis and confidence

A sensitivity analysis was carried out to determine how the investment performance (NPV, BCR and MIRR after 30 years) would change based on changes to the discount rate and other key variables. The results are presented in Table 100 below. The investment remained positive under all scenarios modelled.

Table 100 Sensitivity analysis

Changes to Key Variables		NPV ($M)	BCR	MIRR
Standard assumption		$4.29	22.50	15%
Adjusted discount rate				
	0%	$5.21	27.10	10%
	10%	$3.59	18.97	20%
Adjusted cost savings from system use				
	+20%	$5.19	27.00	16%
	-20%	$3.39	18.00	14%

The accuracy of the assessment is highly dependent on both the extent to which the analysis captures and quantifies the various benefits from the project, including non-market benefits (i.e. coverage of benefits), and the level of confidence in the accuracy of assumptions used (i.e. confidence in assumptions). Presented below is an assessment of coverage and confidence ratings for this project.

Table 101 Coverage and confidence ratings

Factor	Rating	Comment
Coverage of benefits	High	The analysis covers the primary expected benefits from the system, including labour savings during unpacking and inspection as well as reduced product rejections.
Confidence in assumptions	Medium	The analysis relied on sound data from the trial, combined with export volume and rejection data. However the expected rate of adoption is somewhat uncertain, as is the proportion of benefits which can be attributed to the project.

Conclusions

The piloting of the US pallet system demonstrated substantial benefits in reduced time and labour required for unpacking and inspection, as well as potential to significantly reduce product rejections due to damaged packaging and lost labels.

Overall the analysis found that the pilot project is likely to return a net present value (NPV) of $4.29m and a positive Benefit Cost Ratio of 22.5. This outcome was sensitive to changes in assumptions, however the investment returns remained very strong under all scenarios modelled.

References

Management for Technology (2021) *2019-1039 US pallet label pilot: US Pilot for pallet labels as an alternate system of shipping mark.* Australian Meat Processing Corporation.

Acknowledgements

Des Bowler (Management for Technology Pty Ltd.)

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Revision	**Author**	**Reviewer**		**Approved for Issue**		
		Name	**Signature**	**Name**	**Signature**	**Date**
1.0	Seamus Hoban Fiona Yu	Michael White		Michael White		20/08/2021
2.0	Seamus Hoban	Susan Madden		Susan Madden		26/11/2021
3.0	Seamus Hoban	Susan Madden	Susan Madden	Susan Madden	Susan Madden	21/02/2022