AUSTRALIAN MEAT PROCESSOR CORPORATION

CASE STUDY

A Staged Waste Heat Recovery and Heat Pump as a System

Gundagai Meat Processors
Gundagai, NSW

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Contents

Executive summary

Gundagai Meat Processors (GMP) has implemented a staged heat recovery system that reduces natural gas consumption, improves refrigeration efficiency, and removes the need for a major boiler upgrade.

The system recovers waste heat from refrigeration condensers and compressor oil coolers through a closed-loop network that preheats boiler feed water from approximately 15°C to 50°C.

Measured results show average gas savings of approximately 30 GJ per day, together with more stable boiler operation, reduced condenser loading, and significant operating cost reductions — while also avoiding the capital cost of a boiler upgrade.

A future industrial heat pump will lift the water temperature further to approximately 88°C, pushing gas displacement toward 100% and creating one of Australia's most advanced integrated industrial heat recovery systems.

This project offers a practical, scalable and commercially attractive model for the Australian red meat industry's transition to lower emissions and improved energy efficiency.

GMP
Est. 1974

Purpose

This case study documents the design and measured performance of the staged heat recovery system installed at GMP.

It demonstrates how low-grade waste heat from an existing refrigeration system can be recovered and upgraded to substantially reduce gas consumption while improving refrigeration performance.

The project supports AMPC's Decarbonisation Pathway by combining passive heat recovery with future industrial heat pump integration — maximising the recovery of available waste heat before any active, energy-intensive temperature lifting is introduced.

Key benefits demonstrated by the project include:

- Significant, lasting reduction in natural gas consumption and operating cost
- Deferred or avoided capital expenditure on boiler and condenser upgrades
- Improved refrigeration condenser capacity and reduced refrigeration energy use
- Lower carbon emissions
- A commercially practical, replicable pathway toward industrial electrification

Heat recovery should be considered an integrated energy system rather than a single piece of equipment — the staged approach here offers a model that can be replicated across other meat processing facilities.

Background

Energy costs are one of the most significant operational challenges facing Australian meat processors. Refrigeration remains the largest electrical load, while natural gas continues to supply the majority of process heating.

Hot water is essential for sterilization, sanitation and cleaning, so boiler performance directly affects production reliability, food safety and operating cost. Historically, the considerable heat rejected by refrigeration systems through evaporative condensers has simply been discharged to atmosphere.

At the same time, processors face rapidly rising gas prices, growing pressure to cut emissions, ageing boiler infrastructure, and rising expectations around energy efficiency and sustainability — all of which have increased interest in waste heat recovery.

Industrial heat pumps can achieve large temperature lifts but often carry high capital cost and electrical demand. GMP's staged approach instead extracts as much useful energy as possible from existing refrigeration equipment first, before introducing active heat pumping — improving overall efficiency and reducing lifecycle cost.

1

Industry Problem

Natural gas remains the dominant source of thermal energy within Australia's red meat processing sector. However, the long-term outlook for gas presents both economic and environmental challenges.

Feedback from Australian Alliance for Energy Productivity (A2EP) members indicates that delivered gas prices typically sit around $15/GJ for larger users consuming approximately 100 TJ per annum or more, rising to over $20/GJ for smaller users consuming less than 20 TJ per annum. The AER reference price is generally understood to exclude transmission and distribution costs, which typically add $2–3/GJ for large gas users but can be significantly higher, in the order of $10–15/GJ, for smaller gas users (<20 TJ per annum). On this basis, a delivered gas price of $18/GJ has been adopted as a representative and reasonable figure for the purposes of this case study.

With regard to the future outlook for gas prices, the Federal Government's 20% gas reservation policy applies only to new gas fields. As most of the fields supplying Queensland's LNG export terminals are already developed, this policy is not expected to place significant downward pressure on domestic gas prices. Measures of this nature would need to be implemented ahead of major field development in order to meaningfully influence prices, rather than after development has already occurred.

For many processing plants, boilers installed more than twenty years ago are now operating near maximum capacity. Expanding production often requires installation of larger boilers together with associated infrastructure upgrades involving substantial capital expenditure.

Simultaneously, the Australian meat industry is working toward ambitious decarbonisation objectives. Reducing fossil fuel consumption is therefore becoming essential not only for operational cost control but also for maintaining long-term competitiveness and meeting customer sustainability expectations.

Although industrial heat pumps represent an emerging solution, many facilities struggle to justify the investment required for complete replacement of conventional boiler systems.

A practical intermediate solution is therefore required:

- ✓ reduces gas consumption immediately
- ✓ improves existing plant performance
- ✓ minimizes capital expenditure
- ✓ integrates with existing refrigeration systems
- ✓ provides a pathway toward future electrification.

The GMP Staged Heat Recovery Project was developed specifically to address these industry challenges.

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Introduction to Gundagai Meat Processors (GMP)

GMP is one of Australia's leading lamb processing companies, operating from Gundagai, New South Wales. Established in 1974 by the Barton family, it has grown from a small regional abattoir into a modern, export-certified facility processing approximately one million lambs annually.

As a family-owned business, GMP has built its reputation on innovation, quality and long-term partnerships with producers and customers in Australia and overseas.

The plant operates a medium-sized ammonia refrigeration system alongside hot water generation for production, sterilisation and cleaning. Prior to this project, GMP's 2 MW hot water boiler was struggling to keep pace with growing production, particularly in winter when incoming water temperatures were lowest and demand highest — occasionally causing steriliser temperatures to fall below required operating conditions.

Rather than simply replacing the boiler, GMP partnered with Hoctor Refrigeration to investigate recovering waste heat already generated by the refrigeration plant. The result was a staged heat recovery system designed to reduce gas consumption, improve refrigeration efficiency, increase condenser capacity, and establish a scalable platform for future industrial heat pump integration — combining GMP's operational experience with Hoctor's refrigeration engineering expertise.

3

The Challenge

3.1 Operational Challenges

Prior to implementation, GMP faced operational and financial challenges common throughout the Australian meat processing industry.

Its 2 MW hot water boiler supplying sterilisation, carcass processing, wash-down and sanitation was regularly operating over its maximum capacity as production increased, especially in winter when incoming water temperatures averaged approximately 15°C.

During peak demand, maintaining the required 82°C steriliser temperature across the plant became increasingly difficult, occasionally interrupting production. Engineering assessments concluded that continued expansion would require replacing the existing boiler with a new 2.5 MW unit, at an estimated capital cost of approximately $400,000 and around the same time GMP experienced a roughly 50% increase in gas pricing on contract renewal. This combination of rising fuel costs and looming capital expenditure prompted GMP to look for an alternative to simply increasing boiler capacity.

3.2 Opportunity for Heat Recovery

Ammonia refrigeration systems continuously reject significant heat during normal operation where they traditionally discharged to atmosphere through evaporative condensers, compressor oil cooling and compressed air systems without performing any useful work.

A detailed review of the refrigeration plant identified the evaporative condensers and compressor lubricating oil as the two largest near-term recovery opportunities, with compressed air heat recovery and industrial heat pump integration identified as further stages for the future (see Section 4). Collectively, these represented a significant untapped energy resource capable of substantially reducing boiler fuel consumption while improving refrigeration performance.

4

The Heat Recovery Solution

4.1 Design Philosophy

Safety was a primary design consideration, with a risk assessment carried out at the design stage.

Unlike open-loop arrangements, the system uses a completely isolated closed-loop water circuit between the refrigeration system and the plant's hot water supply, so this provides additional layer of protection for process water to be in contact with ammonia, compressor oil or other refrigeration fluids. This is reinforced by high-integrity plate heat exchangers, continuous pH monitoring, automated control and alarms, independent isolation valves, and temperature monitoring throughout; providing confidence that a refrigeration-circuit failure cannot contaminate process water, while simplifying maintenance.

The system is fully integrated into the plant's SCADA platform for automatic control and continuous monitoring (instrumentation is detailed in Section 5.1), with a PLC continuously adjusting operation based on process conditions.

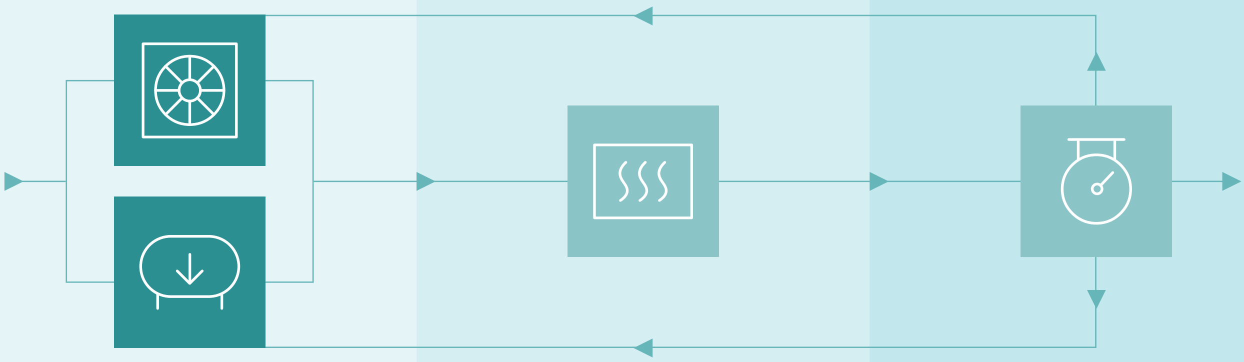
Rather than relying on one large heat pump to achieve the full temperature lift, Hoctor Refrigeration developed a staged philosophy: every degree gained through passive heat recovery reduces the energy required at each subsequent stage.

The three stages are

Stage 1A
Passive heat recovery from the refrigeration condenser, with further uplift from compressor oil cooling.

Stage 1B (future)
Additional passive heat recovery from the compressed air system.

Stage 2 (future)
An industrial heat pump providing the final temperature lift for high-temperature process water.



This progressive approach allows the overall system to achieve significantly higher efficiency than a conventional single-stage system, while letting the facility invest in each stage as business needs evolve.

4.2 Stage 1A — Condenser and Oil Cooling Heat Recovery

The first stage captures waste heat from the ammonia refrigeration condensers.

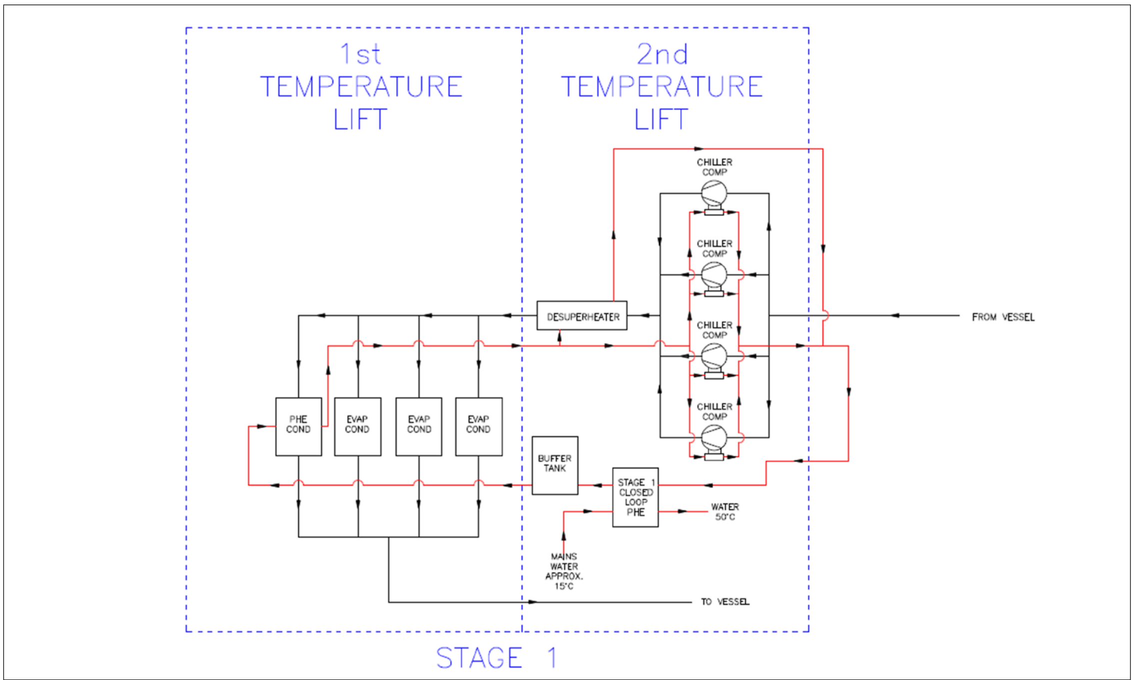
Under conventional operation, hot ammonia gas leaving the compressors is condensed by rejecting heat to atmosphere through evaporative condensers; the new system instead diverts part of this energy into the closed-loop water circuit via a high-efficiency plate heat exchanger before final heat rejection occurs, raising process water temperature without any additional fuel.

A second temperature increase is then achieved by recovering heat from compressor lubricating oil.

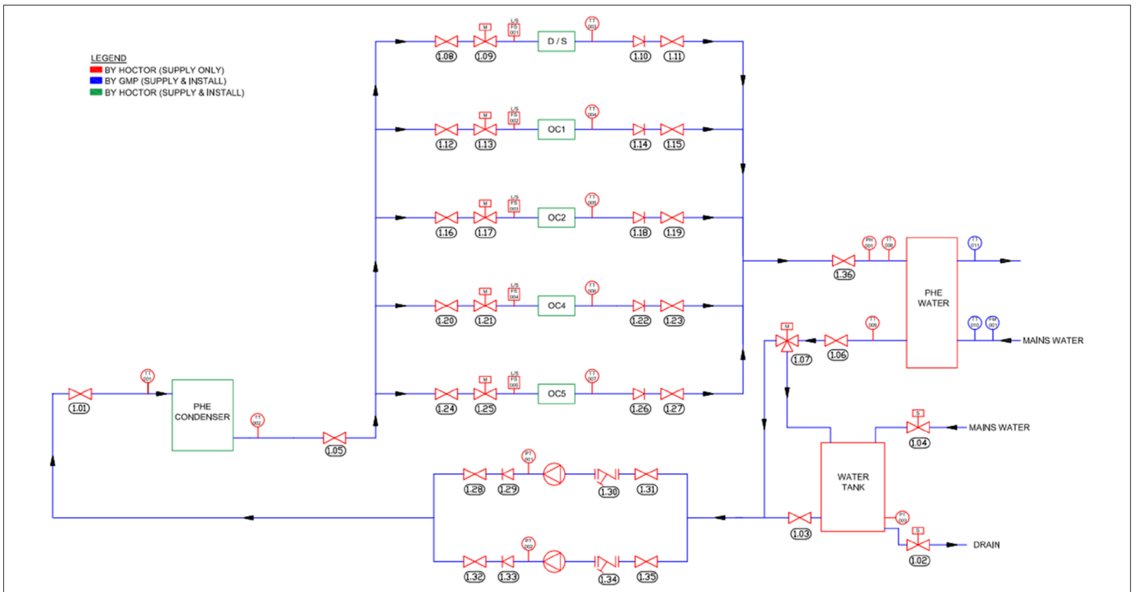
Dedicated heat exchangers on each compressor package transfer this heat into the same closed loop, adding further boiler-gas saving and useful redundancy for compressor oil cooling.

The Process Flow Diagram (PFD) and Piping and Instrumentation Diagram (P&ID) illustrate the two-step temperature lift for Stage 1A. Following commissioning, the system has operated reliably and automatically with minimal maintenance requirements.

The Process Flow Diagram (PFD)



Piping and Instrumentation Diagram (P&ID)



4.3 Future Stage 1B — Compressed Air Heat Recovery

A further opportunity has been identified in the site's compressed air system, which supports production equipment, pneumatic controls, packaging and cleaning.

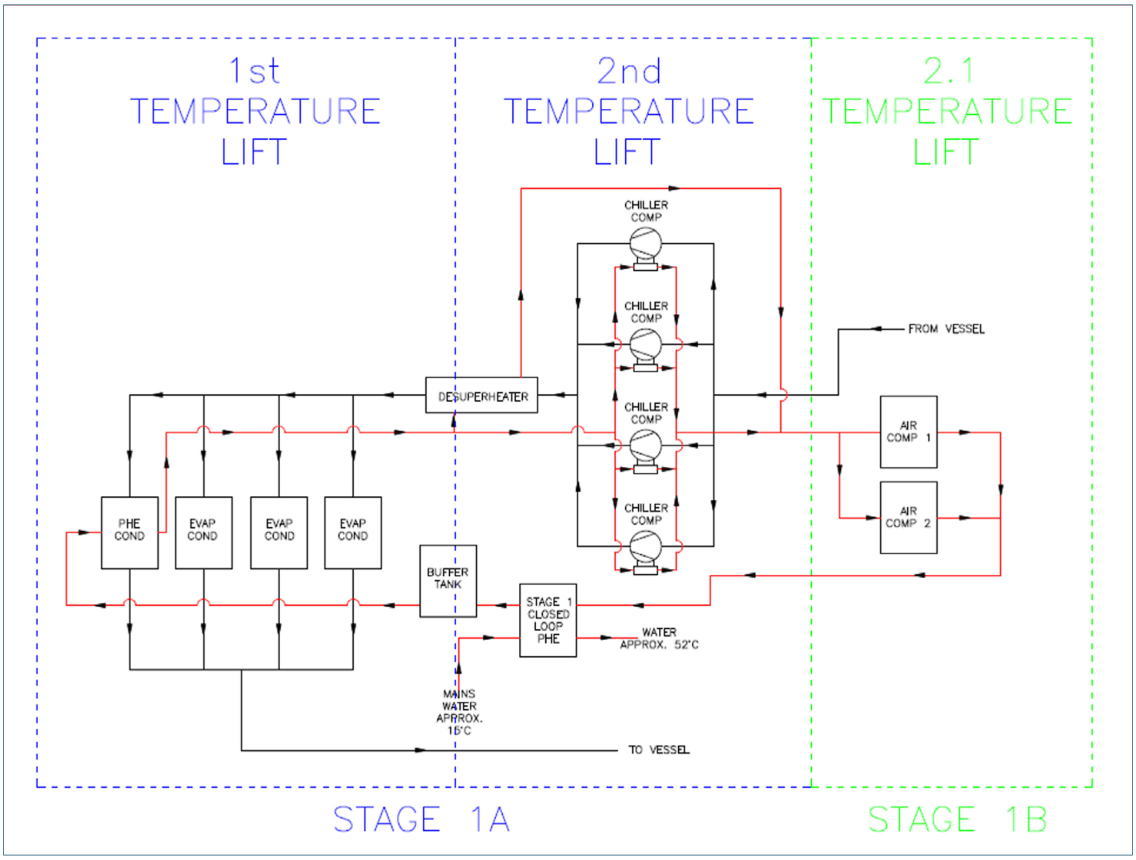
GMP's compressed air plant comprises a 90 kW production compressor and a 45 kW compressor supporting sanitation, together operating around 21 hours a day. Almost all of the electrical energy supplied to these compressors is ultimately converted to heat, currently rejected to atmosphere via air-cooled oil radiators.

Stage 1B proposes replacing or supplementing these air-cooled oil coolers with liquid-cooled heat exchangers connected to the existing heat recovery circuit, adding a further temperature lift downstream of Stage 1A before the water reaches the boiler.

Beyond the additional gas savings, this stage would lower compressor oil operating temperatures (improving equipment reliability and lubricant life), reduce heat discharged into plant rooms, and increase the overall system's Coefficient of Performance (CoP) by raising the proportion of passive heat recovery.

Because the pipework, control philosophy and monitoring infrastructure are already in place from Stage 1A, integrating the compressed air system is expected to require only modest additional capital investment relative to the energy savings achieved.

The Process Flow Diagram (PFD)



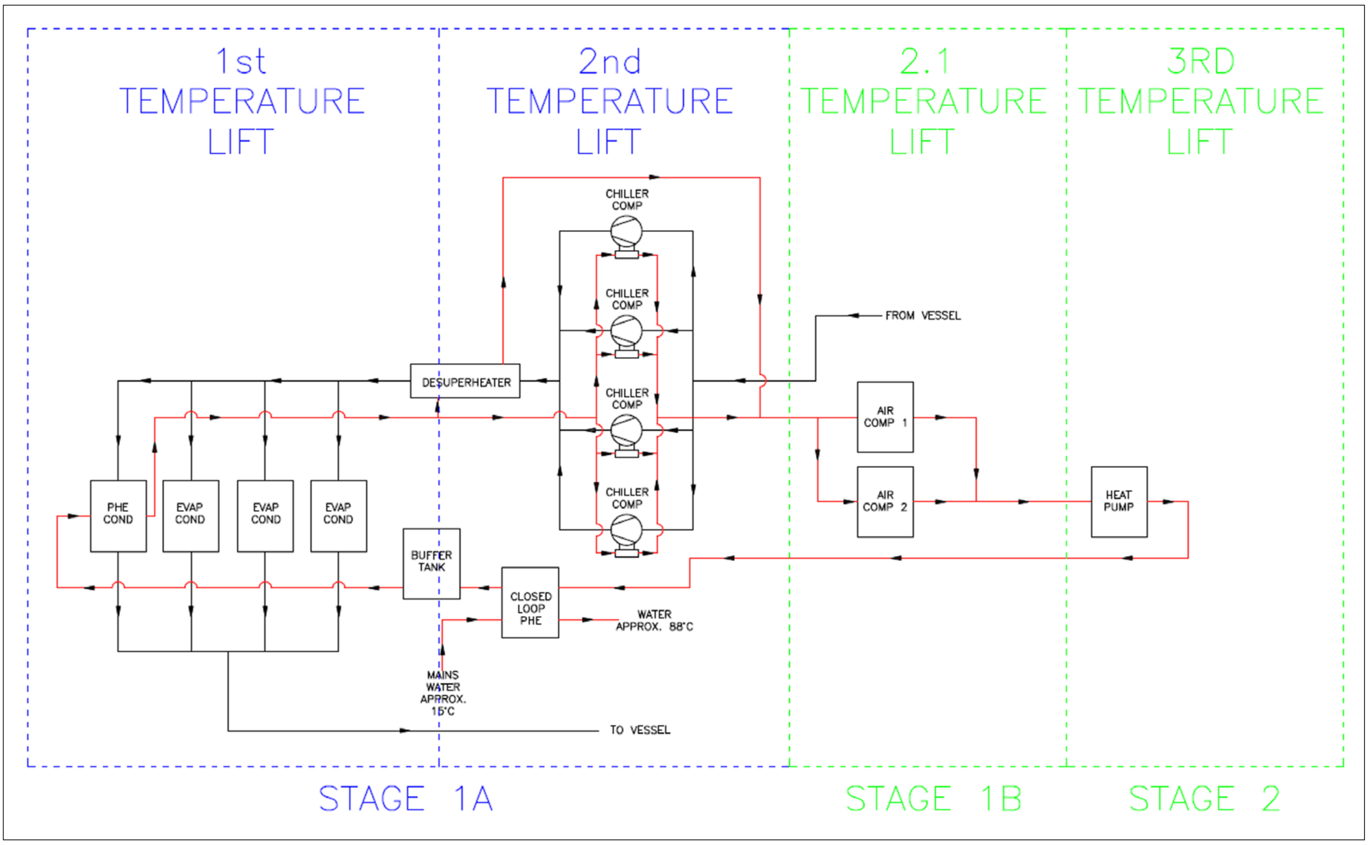
4.4 Future Stage 2 — Industrial Heat Pump

The current installation represents Stage 1A of a broader decarbonisation strategy.

A future industrial heat pump will provide the final temperature lift, from approximately 50°C (or 54°C) to 88°C. Because the passive stages will already have captured most of the available waste heat, this heat pump will operate under significantly better conditions than a conventional stand-alone installation, delivering:

- ✓ A smaller required heat pump capacity
- ✓ Higher CoP and lower electrical demand
- ✓ Reduced capital and maintenance cost
- ✓ Improved operating efficiency and overall system reliability

The completed three-stage system illustrated in the PFD below is expected to be one of the most efficient integrated industrial heat recovery solutions available to Australian meat processors, establishing a practical pathway to substantially reduced fossil fuel consumption.



5

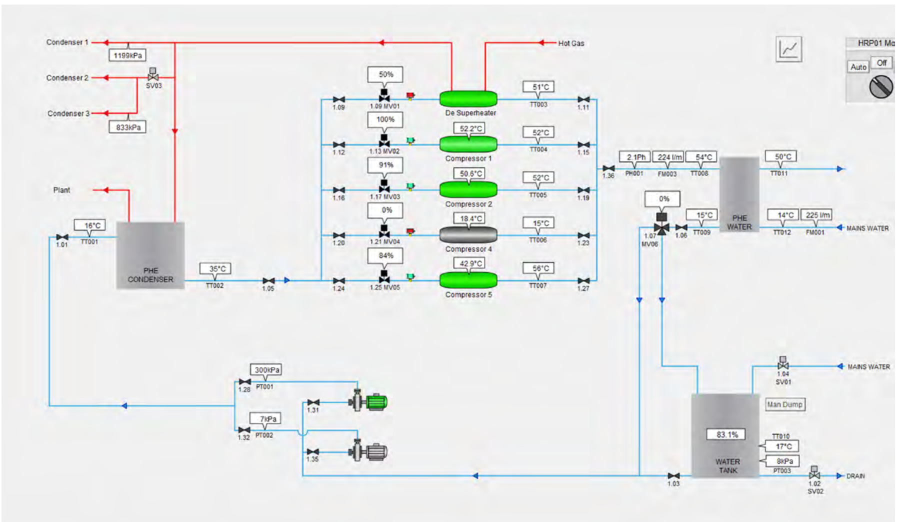
Results

5.1 Performance Verification

A key project objective was not only to implement the heat recovery system but to extensively verify its performance through comprehensive measurement; essential for demonstrating commercial viability and supporting broader industry adoption. An extensive instrumentation and monitoring system was integrated into the site's SCADA platform:

Measurement	Purpose
Gas gigajoule meter	Measure boiler gas consumption
Water flow meter	Measure recovered heat flow
Temperature sensors	Verify temperature lift across each heat exchangers
pH Monitoring	Confirm integrity of the closed-loop system
Refrigeration pressure monitoring	Assess refrigeration performance
Condenser fan speed monitoring	Quantify condenser load reduction
Boiler operating trends	Evaluate reduction in boiler firing
Historical SCADA trending	Long-term performance verification

The monitoring system provides continuous operational data, supporting ongoing optimization and building a robust evidence base for future installations.

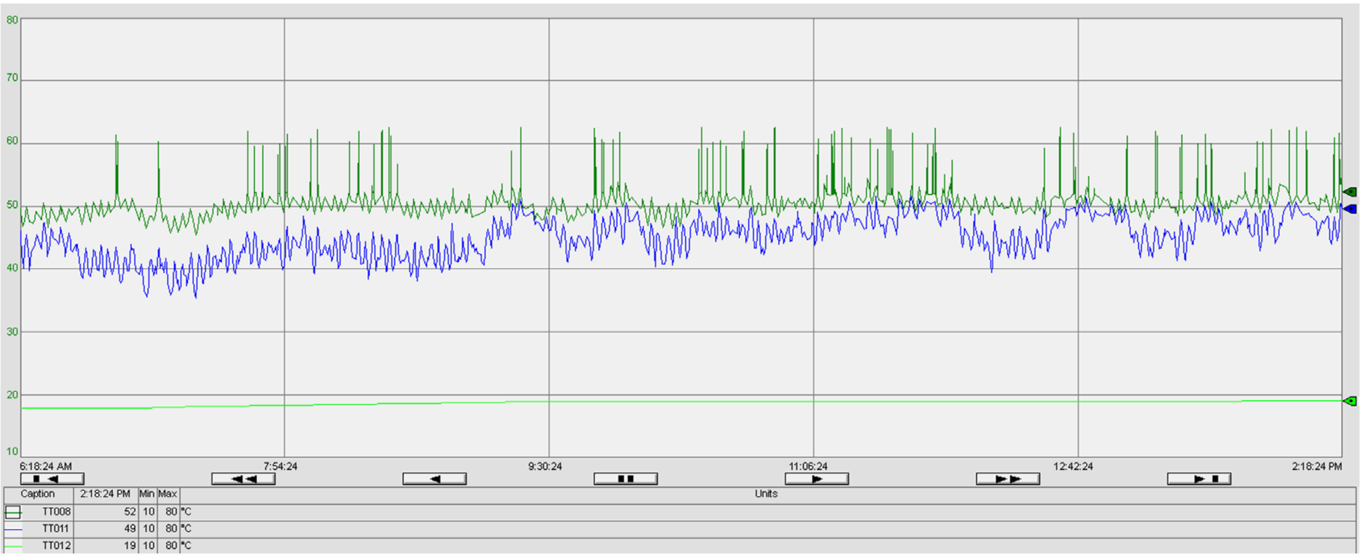


5.2 Temperature Performance

Commissioning confirmed that the staged system consistently lifts incoming water temperature to approximately 50°C, matching the design intent. Temperature trending across the plate heat exchangers showed stable operation, minimal loss across the final exchanger, excellent thermal transfer efficiency and reliable automatic control; substantially reducing the thermal energy required from the gas-fired boiler and forming the basis of the project's ongoing gas savings.

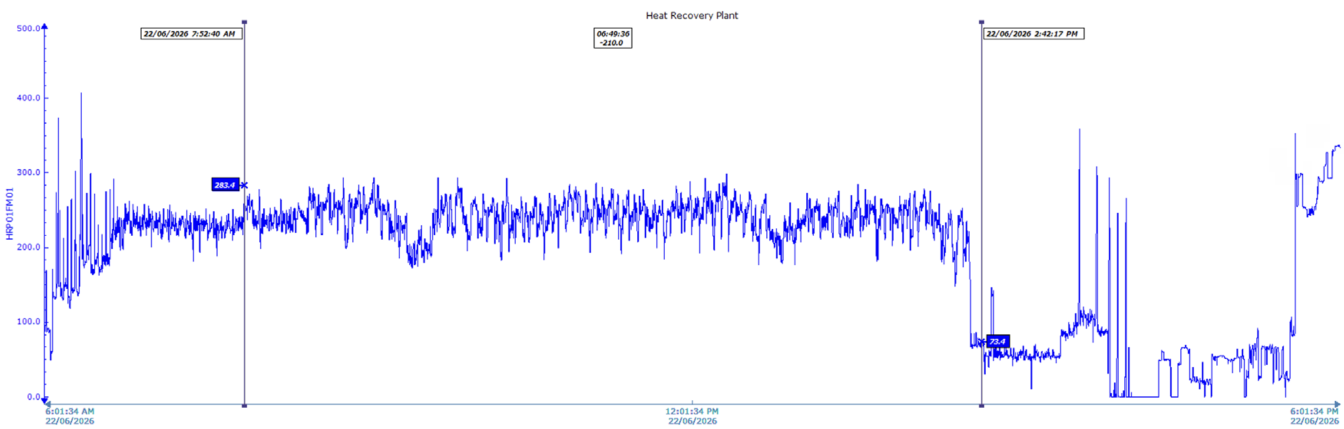
Green trend Water temperature inside closed loop

Blue trend Water temperature to the boiler



Hot water flow trend

This data allows us to understand how the system performs under different flow rates and the system design capabilities.



5.3 Natural Gas Reduction

Controlled testing alternated the heat recovery system between "ON" and "OFF" modes under comparable production conditions, with daily and hourly gas usage captured via SCADA; allowing the impact of any change to be seen almost immediately. Results demonstrated a clear reduction in boiler fuel consumption.

Day	Gas usage	Heat recovery
Monday	7.89GJ	Ignore
Tuesday	94.14GJ	● Off
Wednesday	68.38GJ	● On
Thursday	93.76GJ	● Off
Friday	65.48GJ	● On

Hourly Gigajoule (GJ) capture from the SCADA system

Date & Time (GJ)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
17/06/2026 23:51:18.894	1.35	0.28	0.00	0.00	0.00	2.10	3.98	0.36	5.12	4.65	4.93	4.64	4.46	4.66	3.02	0.44	0.38	1.94	3.31	2.98	2.61	1.31	1.98	2.83
16/06/2026 23:51:18.593	1.33	0.14	0.00	0.00	0.00	2.64	5.95	0.72	7.88	6.68	7.26	7.40	6.77	7.20	7.46	2.62	0.34	2.05	2.64	2.65	2.87	1.12	1.67	2.61
15/06/2026 23:51:18.367	0.00	0.00	0.00	0.00	0.00	2.70	4.07	0.37	5.17	4.62	4.85	4.75	4.26	4.52	4.08	1.73	0.37	2.06	2.86	3.10	2.58	1.07	1.87	2.41
14/06/2026 23:51:18.213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.15	0.00	0.00	0.00	0.00	0.00
13/06/2026 23:51:17.927	1.89	0.44	0.00	0.00	0.00	0.00	0.26	0.32	0.23	1.42	1.61	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.98	0.12	0.00	0.00	0.00
12/06/2026 23:51:17.736	0.79	0.00	0.00	0.00	0.00	2.51	4.76	0.43	5.38	4.74	4.55	4.57	4.76	4.54	4.73	0.94	1.01	2.30	2.78	3.37	2.69	1.39	1.98	2.36
12/06/2026 11:19:28.626	0.79	0.00	0.00	0.00	0.00	2.51	4.76	0.43	5.38	4.74	4.55	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/06/2026 23:51:17.550	1.14	0.35	0.00	0.00	0.00	2.42	6.30	0.24	7.03	7.05	6.88	6.70	7.05	6.66	5.62	0.31	0.67	2.04	2.90	3.00	2.52	1.47	2.50	2.51
10/06/2026 23:51:17.268	1.19	1.02	0.00	0.00	0.23	2.38	4.75	0.26	5.21	4.98	4.85	4.77	4.86	4.64	3.89	0.83	1.36	2.02	3.02	2.93	2.69	0.97	1.61	2.93
9/06/2026 23:51:17.116	0.00	0.00	0.00	0.00	0.00	0.78	6.15	0.23	5.78	5.40	4.96	4.93	5.09	4.79	3.81	1.62	1.00	2.07	4.07	3.77	2.77	1.88	1.68	2.68
8/06/2026 23:51:16.889	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/06/2026 23:51:16.816	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/06/2026 23:51:16.620	2.76	1.61	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5/06/2026 23:51:16.379	1.19	0.13	0.00	0.00	0.00	2.58	4.94	0.89	5.60	4.84	5.05	4.90	5.11	4.91	4.75	2.07	1.20	1.87	3.52	3.02	2.67	1.50	1.20	0.85

Each line represents 24 hours in a day.

These savings were achieved under relatively conservative operating conditions.

As refrigeration loads increase during warmer months, additional waste heat becomes available, providing the opportunity for even greater gas reductions.

The impact of heat recovery on boiler fuel consumption

Parameter	Result
Average gas reduction	30 GJ/day
Gas saving	Approx. 30%
Est gas saving PA	Approx. 7,530 GJ
Est cost saving PA	Approx. $135,500.00

5.3 Natural Gas Reduction continued

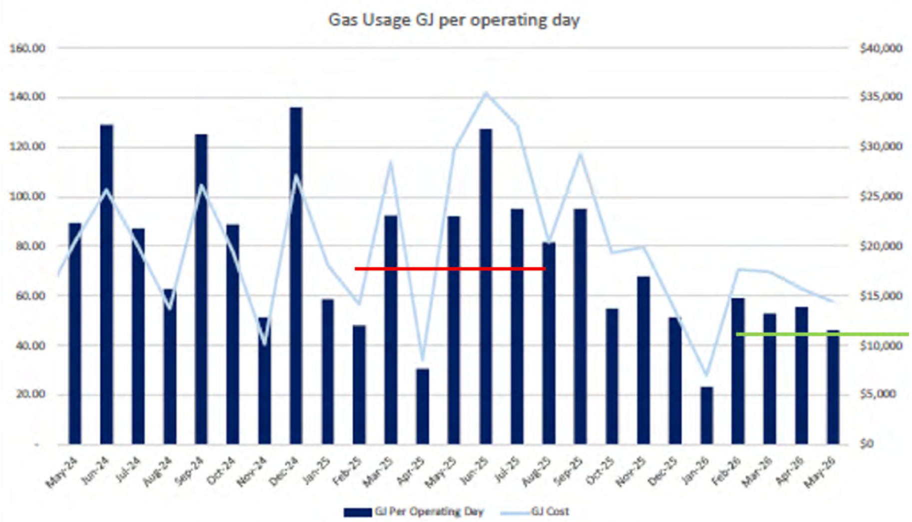
Plant monthly gas usage

Note — variance is due to the read date of the month.

Monthly gas usage trends confirm average consumption has fallen consistently since heat recovery began operating in October.

Green line Average from December to May 2026

Red line Average from December to May 2025



5.4 Boiler Performance

Boiler trends provide further evidence of the system's effectiveness. Before installation, the boiler frequently operated at high fire to maintain hot water demand. A four-day comparison alternating heat recovery ON and OFF showed the boiler cycling steadily between high and low fire when heat recovery was on, versus sitting predominantly in high fire when it was off, with gas usage tracking the same pattern.

The trend line in the background is the gas usage, as you can see when the **heat recovery is on** the gas usage is low and the boiler is not working as hard.

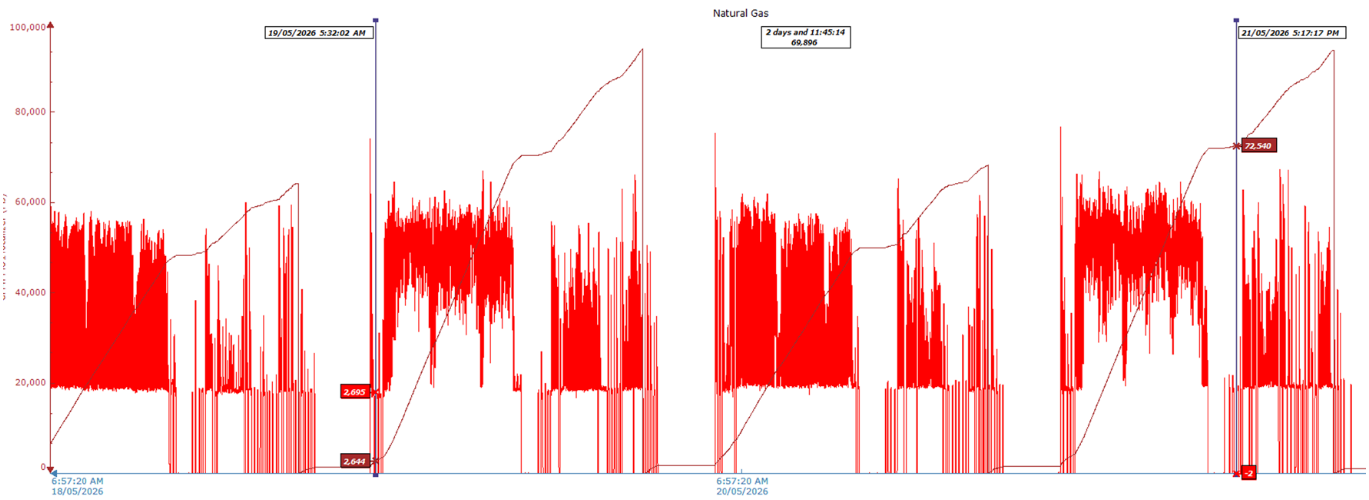
This shows a significant impact to the Boiler performance.

Following implementation, SCADA trends consistently show that whenever heat recovery is enabled:

- ✓ Boiler cycling becomes more stable and high-fire operation is substantially reduced
- ✓ Operating hours at maximum load, gas consumption and firing rate all fall immediately
- ✓ Temperature control and hot water supply stability both improve

Reducing boiler load not only lowers fuel use but also reduces thermal stress on the boiler, potentially extending equipment life and lowering maintenance requirements.

On **Off** **On** **Off**



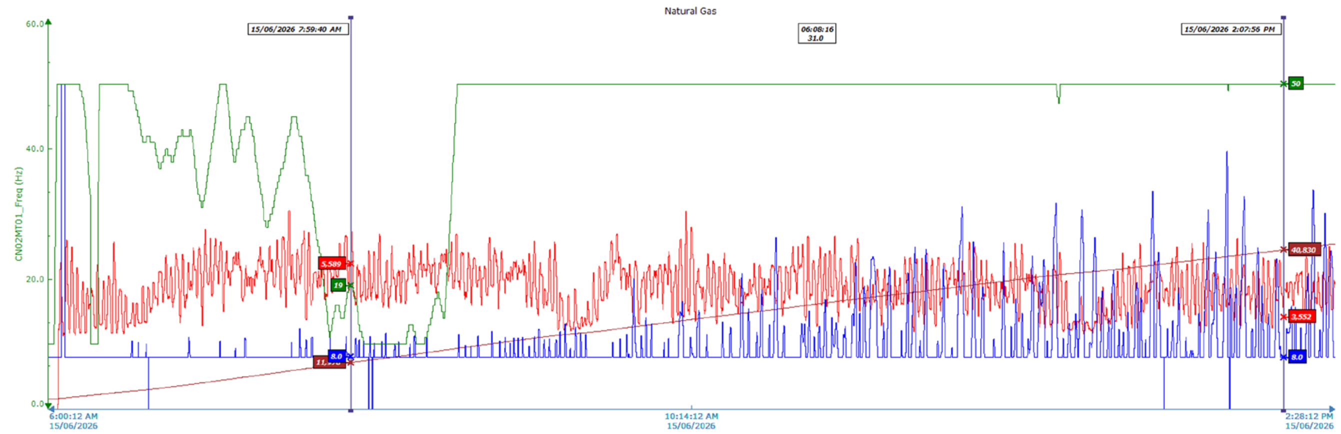
5.5 Refrigeration System Benefits

The GMP project also measurably improved refrigeration performance. By extracting heat before it reaches the evaporative condensers, condensing load is reduced. SCADA fan-speed trends confirm this with heat recovery ON and OFF.

Red line	Gas usage
Green line	Condenser 1 fan speed
Blue line	Condenser 2 fan speed

Heat recovery on

Summary — condenser 1 fan at 100% and condenser 2 fan on and off most of the day but commonly at low speed. Gas usage low.



	Tag	Historical Model	?...	/...	Style	Axis Min	Axis Max	Unit	Precision	Format	Tag Min	Tag Max	Left Cursor	Right Cursor	X Delta
	CH4FM01_MJ_HR	DataLogPro	1			0	15,000	MJ/h	0	Decimal					
	CH4FM01Totalizer	DataLogPro	2			0	100,000	MJ	0	Decimal					
	CN01MT01_Freq	DataLogPro	3			0.0	60.0	Hz	1	Decimal					
	CN02MT01_Freq	DataLogPro	4			0.0	60.0	Hz	1	Decimal					

Heat recovery off

Summary — both Condenser fans at 100% speed all day (Blue line behind green line at 100%). Gas usage high.

Each condenser fan is driven by an 18.5 kW motor, meaning even modest reductions in operating speed translate into measurable electricity savings over the course of a year.

In total, the project created the equivalent of approximately 400 kW of additional condenser capacity without installing new condensers, providing valuable flexibility for future production expansion.

	Tag	Historical Model	?...	/...	Style	Axis Min	Axis Max	Unit	Precision	Format	Tag Min	Tag Max	Left Cursor	Right Cursor	X Delta
	CH4FM01_MJ_HR	DataLogPro	1			0	15,000	MJ/h	0	Decimal			7,666	6,285	-1,381
	CH4FM01Totalizer	DataLogPro	2			0	100,000	MJ	0	Decimal			31,116	62,254	31,138
	CN01MT01_Freq	DataLogPro	3			0.0	60.0	Hz	1	Decimal			50.0	50.0	0.0
	CN02MT01_Freq	DataLogPro	4			0.0	60.0	Hz	1	Decimal			50.0	50.0	0.0

5.6 Capital Expenditure Avoidance

One of the project's most significant outcomes has been avoided capital expenditure.

GMP had anticipated replacing its 2 MW boiler with a 2.5 MW unit at an estimated cost of $400,000. Following successful commissioning of heat recovery project, this upgrade is no longer required. Similarly, the 400 kW increase in effective condenser capacity defers the future need for additional refrigeration condenser infrastructure as production expands; a minimum 1,000 kW condenser installation would typically cost in the order of $240,000. These avoided costs substantially improve the project's overall financial return, on top of the ongoing utility savings.

Description	Estimated value
Boiler upgrade avoided	~$400,000.00
Condenser capacity upgrade avoided (pro-rata to its capacity)	~$96,000.00

5.7 Financial Performance

Based on measured operating data, the project is already delivering substantial savings (Stage 1A only):

Benefit	Estimated value/year
Gas savings	~$135,500.00
Simple reduced condenser power	~$7,100.00
Simple reduced condenser water use (6.88kL)	~$6,900.00
Simple reduced condenser wastewater discharge cost (2.76kL)	~$1,300.00
Total savings	**~$150,800.00**

Additional net savings are expected following implementation of Stage 1B and Stage 2 as estimated below.

Stages	Estimated value
Stage 1B	~$15,000.00/year
Stage 2 (Heat pump)	~$108,000.00/year

5.8 Coefficient of Performance (CoP) and System Efficiency

The performance of industrial heat recovery systems is commonly measured using the Coefficient of Performance (CoP), which compares useful thermal energy delivered against the energy required to produce it.

Unlike conventional heating systems that generate heat through combustion, heat recovery systems recycle energy that has already been consumed elsewhere within the process. Consequently, passive heat recovery stages achieve exceptionally high effective CoP values because very little additional energy is required beyond circulating pumps and system controls.

The staged approach adopted at GMP maximises passive heat recovery before introducing active temperature lifting. This significantly improves the overall system efficiency compared with relying solely on a high-temperature industrial heat pump.

	Stage 1A Condenser + oil cooler	**Stage 1B** Compressed air	**Stage 2** Heat pump	**Combined**
Avg equiv boiler load recovered	671.3 kW	68.0 kW	721.4 kW	1460.6 kW
Cooling load			478.0 kW	478.0 kW
Absorbed power	3.0 kW	0.5 kW	113.0 kW	116.5 kW
CoP				
Heating	223.75	135.92	6.38	12.54
Cooling			4.23	4.10
Combined	223.75	135.92	10.61	16.64
Gas offset	~30%	~4%	~66%	100%

5.9 Return on Investment (ROI)

The project's financial performance demonstrates that energy efficiency investments can deliver both immediate operational savings and significant long-term capital benefits. Repeating this project today is estimated to cost approximately $450,000. The return on investment can be accessed on three different bases:

1. Cost-avoidance basis: the project is effectively cash-positive from day one once the avoided boiler upgrade (~$400,000) and unrealised condenser capacity avoidance (~$96,000) are included.
2. Utility savings basis: simple payback of approximately 3 years ($450k project cost against ~$150.8k p.a. in combined utility savings).

As Australian electricity generation continues to decarbonise, industrial heat recovery and electrification technologies will become increasingly attractive. Projects such as this installation is eligible for energy efficiency incentive programs, subject to jurisdictional requirements and prevailing regulations.

Mechanisms available:

- NSW Energy Savings Certificates (ESCs)
- Victorian Energy Efficiency Certificates (VEECs)
- Australian Carbon Credit Units (ACCUs), where applicable

This brings us to our 3rd ROI assessment.

3. Utility savings plus incentives: payback of approximately 2 years, including a roughly $150,000 estimated benefit from energy efficiency incentive certificates (ESC in this instance).

Future implementation of Stage 1B and Stage 2 is expected to further increase gas displacement, improve overall system efficiency and reduce operating costs.

6

Conclusions and Industry Outlook

The GMP Heat Recovery Project has successfully demonstrated that significant reductions in natural gas consumption can be achieved by recovering waste heat from existing refrigeration systems using commercially available technology.

The project has shown that meaningful energy savings, improved refrigeration performance and reduced greenhouse gas emissions can be realised without major disruption to plant operations.

By adopting a staged approach to heat recovery, GMP has established a practical pathway towards industrial electrification. Rather than relying on a single large capital investment, the project demonstrates how passive heat recovery can be progressively expanded to maximise the utilisation of available waste heat before introducing an industrial heat pump for the final temperature lift.

The staged implementation pathway adopted at GMP is recommended for other Australian meat processing facilities modified as follows:

Stage 1 — Recover waste heat from refrigeration condenser, refrigeration compressor oil coolers and from compressed air systems.

Stage 2 — Install an industrial heat pump to provide the final temperature lift and maximise natural gas displacement.

Each stage delivers measurable operational and financial benefits while establishing the infrastructure required for future expansion. This staged philosophy allows processors to spread capital investment over time, minimise production disruption and progressively reduce reliance on natural gas as business needs and funding permit.

Although every processing facility has different production requirements, refrigeration systems and heat demands, the engineering principles demonstrated by this project can be readily adapted to most meat processing plants. A site-specific assessment should be undertaken to identify available waste heat sources, evaluate process heating demands and determine the most suitable staged implementation strategy.

This project was developed and delivered by Hoctor Refrigeration in collaboration with GMP and with support from AMPC. The project provides a proven example of how practical engineering solutions can improve energy efficiency while supporting the industry's decarbonisation objectives. Meat processors considering similar opportunities are encouraged to engage experienced industrial refrigeration and heat recovery specialists, such as Hoctor Refrigeration, to undertake detailed energy assessments and develop tailored heat recovery solutions.

As energy prices continue to rise and the Australian meat industry moves towards lower-carbon operations, recovering waste heat should become a fundamental part of refrigeration system design rather than an optional enhancement. Every gigajoule of waste heat recovered is a gigajoule of natural gas that no longer needs to be purchased or combusted.

The GMP Heat Recovery Project demonstrates that staged heat recovery is technically proven, commercially viable and readily scalable. Wider adoption across the Australian meat processing industry has the potential to significantly reduce operating costs, improve plant efficiency, lower greenhouse gas emissions and strengthen the industry's long-term sustainability and competitiveness.

Appendix

Figures used in case study calculation

Notes — site averaging operating @ 8.5 hours shift.

Parameters		Value
Natural Gas	/GJ	$18.00
Electricity	/kWh	$0.15
Water	/kL	$4.00
Waste Water Discharge	/kL	$2.00
Boiler Efficiency	%	80
Plant Ops Hours	/day	24
Heat Recovery Ops Hours	/day	16
Operating Days	/year	251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