

Biomass Pelletisation Trial



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1.0 Abstract

This project considered pelletisation as a way to value add available organics (sludges and paunch streams generated at an Australian red meat processing plant) into a boiler fuel. Options for using biomass pellets include blending with coal in an existing boiler, with the burn test confirming the technical viability but highlighted that coal fired boilers will be volume limited i.e. limited by the volume of fuel that can be added into the combustion chamber, thereby limiting the percentage coal offset that can be achieved. The biomass pellet physical and thermodynamic properties were found to be ideal for direct firing in biomass boilers.

A pathway for the site to be a 100% renewable thermal energy facility was developed. Where onsite biogas can provide two thirds of required thermal heating, a further ~6.1 MWt of thermal heating is required. The paunch/sludge pellets can provide 4 MWt (when dried to 13.8% moisture). By blending 10.23 wt.% sawdust into the raw paunch/sludge mixture, site would be able to obtain all of its thermal energy from renewable sources, with 88.4% of thermal energy being generated from on-site wastes. Utilising sawdust is advantageous from an economic perspective as it is available at \$7.37 / GJ LHV versus coal at \$8.46 / GJ LHV, hence is a lower cost source of boiler fuel.

A key finding was that the economics of biomass pellet production is improved by blending onsite organics with sawdust as this negates the CAPEX and OPEX for paunch and sludge drying, is a lower cost fuel than coal on a cost per unit lower heating value and enables the desired gigajoules (GJ) per annum of fuel for a specific facility to be generated. Red meat process plants with rendering are not able to generate sufficient thermal energy from onsite paunch and sludge pellet firing in a boiler when added to biogas (from anaerobic digestion of pumpable wastes) hence an additional fuel, such as sawdust, enables facilities to achieve 100% renewable thermal energy. For the facility considered, 22% of thermal energy could be derived from sludge and paunch pellet, 66% from biogas with the final 12% from sawdust.

The pelletisation process outlined in this report is able to utilise high moisture feedstock (~75%) and requires no steam (as opposed to traditional pelletisation technology which requires 10-12% moisture feedstock and steam) hence is a technically and economically viable path for generating pellets from the high moisture wastes from red meat processing plants.

The pellet drying system can utilise low grade thermal energy (46 DegC or higher) hence is able to reduce the water and power loads of processing plants by reducing the loads on evaporative cooling towers.

2.0 Executive summary

Organic waste and by-product management is a mega-trend for Australia's red meat processors (RMPs). The aim of this project was to define how pelletisation offers a route for RMPs to beneficiate organics, in particular paunch and sludges, into a manufactured pellet via an economically viable process.

This project employed Pelleton Renewables Pty Ltd's commercial pilot to manufacture biomass pellets from sludge and paunch. The pellets were analysed then test fired as a blend with coal in a coal fired stoker grate boiler.

A Total Capital Investment (TCI) estimate (AACE Class 3/4; target accuracy +/- 15%) was developed for a fully installed plant based upon a detailed process equipment list, existing plant tie-ins and associated electrical load list. This data was integrated into a greenhouse gas emissions reduction estimate to calculate the Scope 1, 2 and 3 emissions implication for this integrated project. A detailed Gantt Chart was developed.

Laboratory data for biomass pellets manufactured from paunch and sludge, then also paunch, sludge and sawdust were considered in order to generate a detailed mass and energy balance and associated business case.

A wide range of scenarios were then considered and compared against the base case. The "Alpha Scenario" where a paunch/sludge/sawdust blend with a simplified materials handling system is used to offset 6.1 MWt of coal displayed an estimated 5.3 year simple payback, a 25 year internal rate of return (IRR) estimated at 18.62% (non-indexed). Where organics costs are indexed (increased at \$10/tonne pa through to FY29-30) with all other items indexed at +3.6% pa, the payback period was estimated at 4.4 years and the 25 year IRR estimated at 24.87%.

The base case was co-firing pellets into the existing coal boiler which required a more capital intensive materials handling system.

Where the installed CAPEX for a biomass boiler is included, the estimated simple payback is 7.3 years versus natural gas and 10.0 years versus coal.

The low temperature / high air flow pelletisation method proposed in this report provides a relatively low CAPEX and low OPEX solution as it is able to employ ~75% moisture starting feed compared to traditional pelletisation that requires a starting feed of 10 – 12% moisture and requires steam, with previous works on this low moisture / high energy method showing a simple payback of 16 years¹.

Key findings were that the vented air from the biomass pelletiser is of sufficient volume to dilute odorous molecules to below detectable levels. Co-firing of the biomass pellets in a coal fired boiler is not expected to result in emissions to air that exceed historical approved levels for a coal fired boiler. For a new boiler to be fired on 100% biomass pellets the volumetric throughput of pellets would \ be approximately triple that compared to coal which is the key physical limitation of using lower density pellets.

Greenhouse Gas Emissions reduction were estimated at 9,788 tonnes CO₂-e per annum for Scope 1 and 2 when off-setting coal with the paunch-sludge-sawdust pellet in a 6.1 MWt boiler (takes into account the grid power usage for running the pelletisation plant). The Scope 1, 2 and 3 emissions reduction was estimated at 11,278 tonnes CO₂-e per annum.

The energy content of the paunch/sludge only pellet is estimated at 4 MWt. By blending with sawdust (10.23 wt.% of raw paunch/sludge), 6.1 MWt of boiler fuel can be created, which when coupled with biogas, provides an opportunity for site to effectively be a 100% renewable thermal energy facility. The following table outlines

¹ AMPC / MLA Donor Company Project P.PIP.0454, "Pelletizing Plant Cost Benefit Analysis".

the scenarios of just making pellets from paunch and sludge, a pellet maximising coal off-set in the existing boiler and a paunch-sludge-sawdust pellet optimised for a 6.1 MWt biomass boiler.

Scenario	Fuel Offset of current coal consumption
Paunch-Sludge Pellets	34.57% coal offset
Paunch-Sludge Pellets with 20% sawdust	69.09% coal offset
NEW 6.1 MWt Biomass Boiler utilising pellets	Enhanced biogas (~12 MWt) & biomass boiler to provide 100%

Logarithmic modelling of the noise estimates that the compounding impact of a wall of multiple fans produces a maximum noise of ~90 dB right at the wall where the fans are mounted but will fall away rapidly and be 85 dB at ~1.25m (i.e. no hearing protection required) and 50 dB at ~195 m (i.e. dB at a sensitive residential receptor).

A key advantage of the design put forward in this report is that, after maximising biogas production, the paunch, sludge and 10.23 wt% sawdust can provide sufficient steam for site without the need for additional solid fuels such as woodchips.

A key advantage of processing organics into a dry pellet provides the opportunity to stockpile pellets to reclaim in the future or sell into the boiler fuel and/or organic fertiliser markets.

3.0 Introduction

Organic management fees in Australia are increasing. This is particularly prevalent in south-east Queensland where previously organics were, at best, “free issued” to composting operations however with increasing trucking costs and landfill levies, there are now considerable costs to deal with organics. In addition to this, residential encroachment on meat processing plant boundaries have added an additional need to strictly manage odour, meaning wastes cannot be stockpiled or composted onsite, instead must be dealt with immediately.

Further, there is a demand for low emissions fuels to reduce Scope 1 greenhouse gases (GHGs), such as replacing coal with biomass pellets which can reduce GHG by ~98% per gigajoule (GJ) of fuel consumed.

Future emissions reduction approaches, such as for the upcoming Product Guarantee of Origin scheme, requires calculation of Scope 1, 2 and 3 emissions. As shown in this project, utilising waste materials / co-products onsite to avoid the use of materials generated off-site and hauled to the point of use provide advantages from a Scope 1, 2 and 3 Life Cycle Assessment perspective.

The boiler specific requirements must also be kept in mind:

- Energy pellets have a lower GJ per tonne and per cubic metre than coal hence the volume of fuel to be added increases. Options include: higher bed height on the stoker and a fast stoker speed, especially where the fuel burns faster / hotter compared to 100% coal.
- The flowability / fluidisation (dependent upon true density and particle size), residence time and temperature on the boiler grate.
- The chemical composition of the fuel (sulphur, chlorine, fluorine, bromine, iodine) and ash fusion temperatures.
- More / less bottom ash; more / less fly ash.
- Changes in forced draught / induced draught fans.

4.0 Project objectives

The AMPC Project 2026-1076 objectives are presented below in the relevant Milestone.

Milestone 1: Pre-pilot testing analytics

Mass balance on organics; feedstock materials documentation (density, moisture).

Boiler fuel specification and materials handling.

Round table with stakeholders to create a Technical Specification; agree on performance requirements. Waste Heat Recovery Design Conditions: Pressures and Temperatures. Battery Limits / Interface / Tie-ins.

Basis of Design for:

- organics.
- boiler.
- burn test.

Milestone 2: Pilot scale pelletisation.

Organics freight to pilot plant. Pilot scale pelletisation testing. Chemical Speciation of vent to estimate odour potential: Third party sample testing: composition.

Milestone 3: Boiler testing

Sample freight from pilot plant to test site. Third party stack testing [excludes materials handling and access equipment].

Milestone 4: Prelim Pelletizer Facility Design

Design Margins; Line Sizing Criteria and Routing; Updates to Plot Plans and Approval by site proponent. Climatic Conditions: Barometric Pressure, Humidity, Rainfall, Wind, Dry bulb / wet bulb summation [Environmental and Planning Considerations Completed by site].

Integrated Project Plan/ Project Master Schedule – preliminary Gantt Chart; Escalation Strategy; Work Breakdown Structure; Contracting / Project Delivery Strategy / Business delivery model.

Flow Diagram; Digital Twin [Advanced Process Model] Heat & Material Balances; Stream Table. Integration of Testing / Pilot data [into Digital Twin] Extraction of mass and heat data from digital twin; Feed Products Co-products and By-products; Thermal and electrical energy balance; Vendor management (balance of plant); Process Equipment List & Utility Equipment List.

Milestone 5: CAPEX / OPEX / Business Case / GHG Emissions assessment.

Technical Specification to document requirements, Australian Standards, state and local govt requirements for sub-packages. General Equipment Arrangement Drawings preliminary; including foundations / structural estimate; 3D AutoCAD prelim layout; elevation and top plans. Bill of Materials Spare parts list and maintenance / operational strategy / OPEX considerations Grant considerations (i.e. summation of technical and CAPEX elements for grant submissions); Emissions credits / offsets estimation (e.g. ACCUs). Update Business case (e.g. Determination of CAPEX, OPEX; AACE Class 3); Emissions calculations; Scope 1, 2, 3 Life Cycle Assessment. Draft Terms of Agreement for offtake, pricing, and tie-in / haulage costs. Draft ACCU project application. Final Report.

The key deliverables in the Final Report:

- Fully installed CAPEX estimate,
- Detailed OPEX,
- Detailed cost savings / revenues: coal offset, organics haulage offset, ACCUs.
- Project specific Scope 1,2 and 3 greenhouse gas emissions estimates,
- Business case.

5.0 Methodology

5.1 Plant Location

The advantages of the proposed location are:

- Central for paunch and sludge delivery,
- Excellent truck access, in particular for delivery of semi-trailers (i.e. sawdust),
- Outside of historical flood zones,
- Reasonable infrastructure access (electrical and potable water tie-ins),
- Minimal earthworks,
- Sufficient surface area for expansion.

The disadvantages to the proposed location include

- Proximity to an uncovered wastewater pond. It is understood there are plans to cover this in the near future to increase biogas yield. This will mean that care should be given to the placement of the boiler relative to this new lagoon's hazardous area zone and appropriate safety measures installed such as enclosing the boiler, water cooling of the returning grate and ash, and storage of pellets and other biomass to prevent smouldering
- There are some recently installed structures for the stockmen in the proposed area which will have to be planned around
- The drainage culvert on the Southern and Eastern side of the plot can carry very large amounts of stormwater, meaning the ground is almost always saturated. If truck receipt is to be done over this area parallel to the truck turning circle, sufficient ground preparation of compaction, plinths, or foundations will need to be done. This was attempted to be designed and estimated in the total installed cost but is subject to review and signoff by a more experienced civil RPEQ

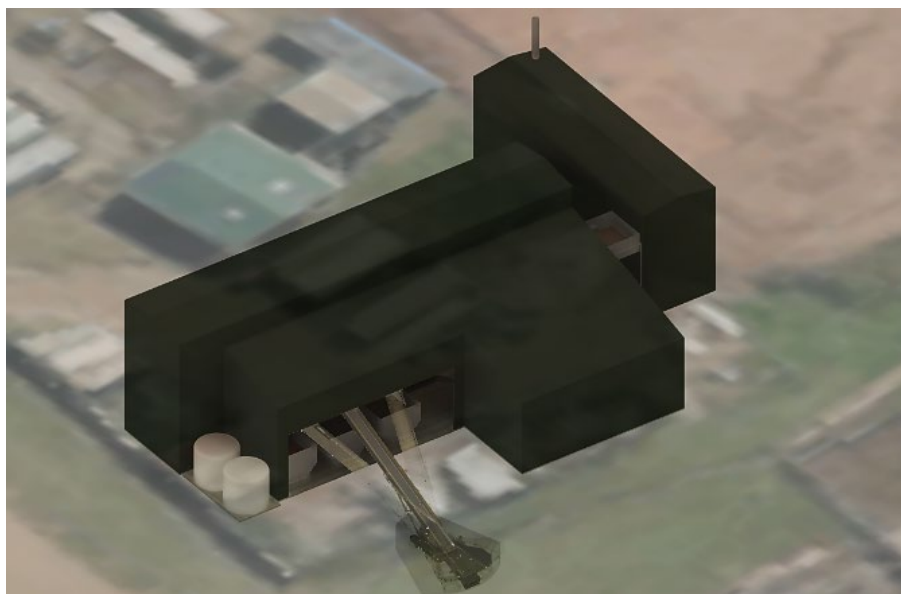


Figure 1: Indicative isometric view with building envelope showing pelletisation facility to the south and integrated biomass boiler to the north.

The fall from the highest point (at south-western corner) to lowest point (north-eastern corner) is less than 2m (~1.5 m) thereby minimising earthworks requirements.

5.2 Paunch grit removal and maceration system

It is proposed that the grit removal system be located downstream of the existing paunch surge tank and upstream of the existing lift pumps and fan presses. There exists the opportunity to install a high efficiency rotary lobe pump suited for pumping high solids slurries as opposed to the parallel centrifugal pumps currently used.

Paunch was measured at 76.8% moisture post fan-press, routinely being 80 to 88% moisture before a fan press.

RotaCut®

The RotaCut® macerator with integrated heavy material separator –
for reliable processes and reduced costs



Type	Max. throughput*	Optional speed	Optional drive power	Required oil pressure	Required oil quantity	Heavy material separator / available design	Cutting screen with available free passage
	m ³ / h	min ⁻¹	kW	bar	l / min		mm
Electric driven							
RCQ-20	90	87-320	1.1-2.2			Inline	10 15 20
RC 3000	180	76-326	1.5-4.0			Inline, MXL	4 8 10 12 15 20 28
RCQ-26	180	72-326	2.2-5.5			Inline	4 8 10 12 15 20 28
RC 5000	300	66-330	1.5-7.5			Inline, Compact XL, MXL M/MX	4 6 8 10 12 15 24 30
RCQ-33	300	72-326	2.2-7.5			Inline, Compact XL	4 6 8 10 12 15 24 30
RC 10000	600	66-319	2.2-7.5			Inline, Compact XL, MXL	4 8 10 12 16 20 25 34 38
RCQ-43	600	115-292	5.5-7.5			Inline, Compact XL	4 8 10 12 16 20 25 34 38
RCX-48	600	114-311	5.5-11			RCX, DRS	4 8 10 12 16 20 25 34 38
RCX-58	780	94-276	7.5-15			RCX, DRS, MXL	4 8 10 12 16 25 34 40 50
RCX-68	1,200	98-243	11-18.5			RCX, DRS	30 40 50

Figure 2: Suitable maceration and grit removal pump for installation prior to fan press. This will remove grit from the paunch, improving pellet structure and reducing risk of ash problems, along with reducing particle size enabling more effective dewatering, reducing drying load and improving calorific value of the pellet.

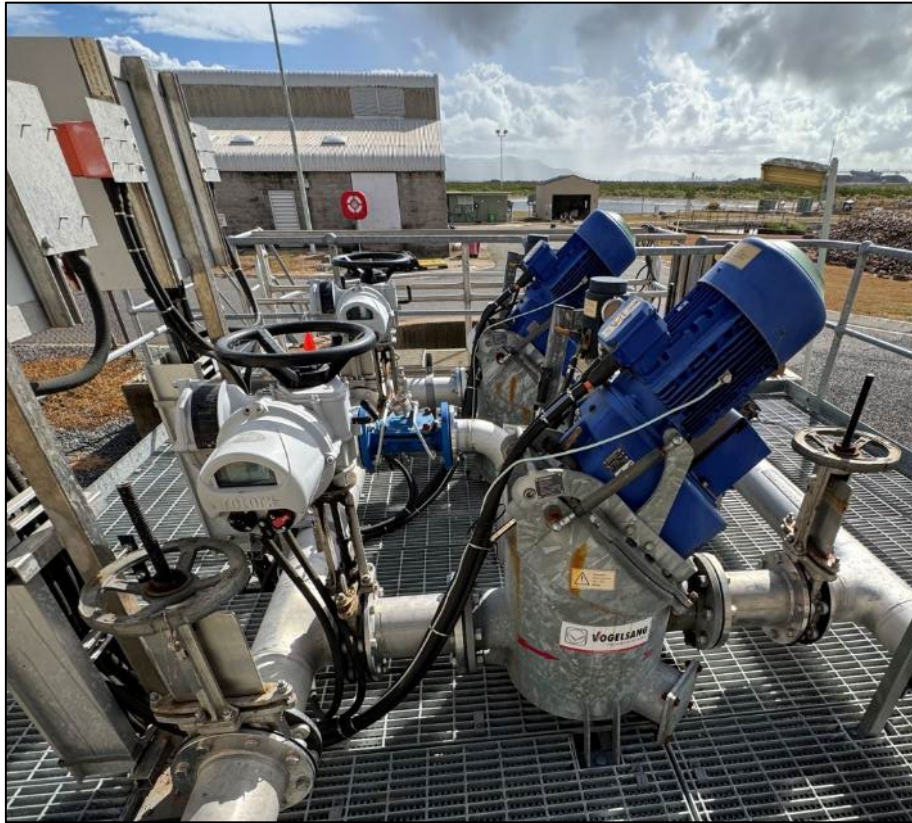


Figure 3: Example of an RCQ-33 Installed at a WWTP, constructed 2015.

The FAN separator has no specified particle sizing; however the manufacturer provides screen gap widths from 0.1 to 1.0mm. Where solids recovery is lower than desired, a screen with a smaller gap width can be selected. The fibrous solids themselves form a filter layer on the screen, allowing finer particles to be separated; this is fundamental to how the FAN separator operates.

5.3 Sludge, Paunch and Sawdust Loadout

Three (3) separate hoppers are required for paunch, sludge, and sawdust. The swept path of the load out system is shown in Figure 1. Figure 9 below shows the “Alpha Scenario” loadout stacker (\$0.234 mil) and Figure 10 shows a drive over system and radial stacker (\$0.945 mil) utilised in the base case. As can be seen in Figure 1, the “Alpha Scenario” would require the stacker to be recessed ~1.5 m below the level of the tipper truck to enable direct unloading into the blue hopper.

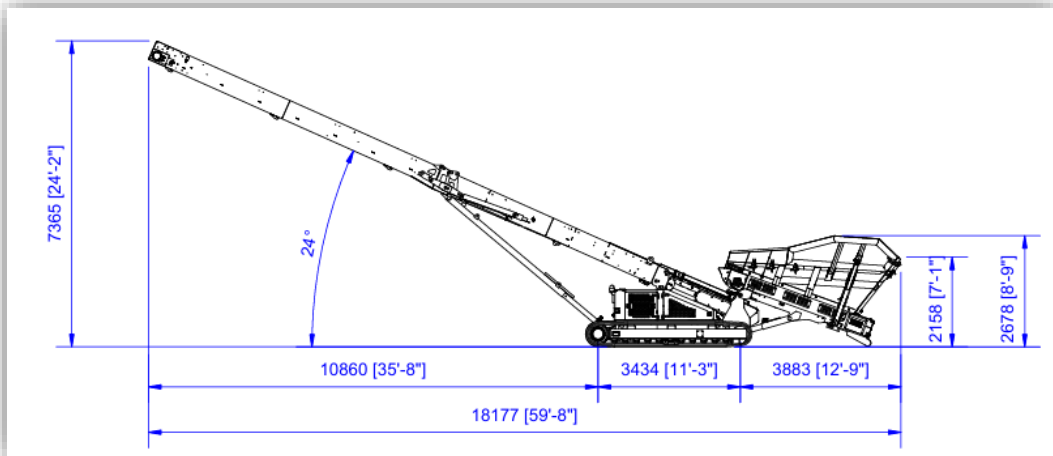


Figure 4: Alpha Scenario unloading system.

5.4 Dryer Heating and Integration with a Biomass Boiler

Rendering plant heat / condensate return can be utilised as a source of heat for pelletisation. A portion of the condensate / hot water (88 DegC) from the rendering plant can be utilised to heat dryer air (17.6% of the time excess heat from the render plant is dissipated via an evaporation cooler). This hot water can then be blended with make-up water and sent to a new biomass boiler economiser then to a new boiler feed water tank for the biomass boiler. If the dryer requires additional heat, some of the feed water tank hot water can be utilised (it is assumed that there will also be a deaerator downstream of the feed water tank).

The economic advantages of sending excess heat to the dryer have been excluded in this analysis as mass flow data would be required to estimate water and power savings.

The sizing of the biomass boiler is based upon:

- 1400 to 1500 m³ biogas (1100 m³/h utilised; 300 to 400 m³/h flared).
- MJ/m³ = 0.3581 * methane %. Assume 65% hence 23.28 MJ/m³.
- Utilised 18 hrs per day, with production at 24 hrs per day.

- 12.07 to 12.93 MWt available from biogas.
- With a site load of 18 MWt steam load, 6 MWt solid biomass boiler to provide sufficient steam.
- Additional biogas into the future from the additional pond and temperature control / enhanced mixing / additional organics digestion / higher efficiency CSTRs.

This approach:

- provides sufficient energy to enable the retirement of the coal fired boiler whilst maximising the use of biogas.
- rather than investing in retro fitting an old coal boiler, the CAPEX is directed towards a system that future proofs the site to make renewable steam.
- a 100% renewable energy system is more attractive for 3rd party grants / funding.
- Locating the biomass boiler adjacent to the biomass boiler reduces materials handling costs.

Alternative waste heat options:

- Compressor oil waste heat recovery.
- Biogas fired cogen engines with waste heat to the dryer.
- Ammonia de-superheater. Semi-welded line is used when gaskets are not suitable for one of the process media. The semi-welded line can also withstand a higher design pressure compared to fully gasketed plate-and-frame heat exchangers. The compressors discharge ammonia at around 70–120°C, depending on the discharge pressure, suction conditions and compressor type. Rule of thumb: ~15% refrigeration capacity recoverable as hot water. The desuperheater transfers this sensible superheat into water. It is anticipated that an ammonia desuperheater on the closest engine room will be able to provide 3.2 MWt of heat (70 DegC supply; 45 DegC return) at ~110 m³/h (pump rated to 202 m³/h at modelled flow rate).



Figure 2: View of three (3) of the five (5) WXR2000 cooling towers.

5.5 Pellet Delivery System & Buffering Capacity

Pellets could be pneumatically conveyed to an adjacent biomass boiler thereby reducing materials handling requirements (trucking / auger / elevator costs). As the biomass boiler is to be 100% fired on pellets, a 30 m³ pellet hopper has been allowed for to enable pellet production to occur through the entire week.

Outlined in the table below is the buffering capacity presented in hours from the buffer silos through to the inlet to the boiler fuel screw. It is recommended that the pelletisation process be considered “just in time” manufacturing with minimisation of non-processed organics storage to reduce odour and biological activity, but with some buffering to account for unscheduled stoppages in upstream equipment. It is anticipated that the silos will be “run down” towards the end of each day to minimise the amount of unprocessed organics held but retaining sufficient amounts for morning start-up, then inventories of feedstock will be built back up throughout each operational day. A Hino 1728 has a cargo box / payload volume of 2.4 W x 1.5 H x 5 L = 7.2 m³, which is ~1.5 hours of sludge and 0.6 hours of paunch. The sludge/paunch pellets are produced at a rate of 4100 tpa, or 16.4 tonnes per operational day.

Table 1: Buffering capacity for paunch/sludge pellets sent to existing coal fired boiler.

Unit Operation	Hrs of Storage
Feed hopper: 30m ³ sludge	8.8
Feed hopper: 30m ³ paunch	4.3
System inventory (dryer plus balance of plant)	24.0
Final pellet silo: 30m ³	10.2
TOTAL	38.5

The following table considers the scenario where the sludge/paunch is blended with sawdust to generate pellets for an adjacent 6.1 MWt boiler. The energy content of the paunch/sludge/sawdust pellets were 16.0 GJ/t LHV, with a density up to 340 kg/m³. When blended with sawdust at a rate of 10.23 wt.% of raw paunch/sludge, a 6.1 MWt boiler is estimated to use 1.373 tonnes per hour of pellet during operational hours. This solution, coupled with biogas, provides an opportunity for site to effectively be a 100% renewable thermal energy facility.

Table 2: Buffering capacity for paunch/sludge/sawdust pellets sent to a new biomass boiler.

Unit Operation	Hrs of Storage
Feed hopper: 30m ³ sludge	8.8
Feed hopper: 30m ³ paunch	4.3
Sawdust hopper: 30m ³	11.6
System inventory (dryer plus balance of plant)	24
Final pellet 30m ³ hopper	6.05
TOTAL	34.35

5.6 Electrical Tie-in

Power for the pelletisation facility and boiler is proposed to be supplied from the adjacent engine room switch board (162 m from the new pelletisation plant). An alternative tie-in option, if required, is provided in the appendix.

5.7 Auxiliary Liquid Ties-ins:

Process waste water: reports to adjacent tun dish / waste collection drain.

Ablutions: utilise existing infrastructure. No allowance for amenities.

Process / plant / cleaning water: ~1 m³ per day via use of adjacent rainwater tanks and electric water pump with potable water top-up via existing riser where required.

5.8 Pelletiser Plant Battery Limits

Inlet to Battery limits

Outlet from Battery limits

Crosses battery limit but not a flow of materials

Table 3: Inlets to facility battery limit.

Inlet Item	Description	Battery limit
Sludge	WWTP Sludge; screenings.	The lip of the tipper truck load out (i.e. receival conveyor for truck deliveries). Site responsible for transporting organics to the pelletisation plant.
Paunch	Paunch press; green stream screenings.	The lip of the tipper truck load out (i.e. receival conveyor for truck deliveries). Site responsible for transporting organics to the pelletisation plant.
Cleaning water / process water (Intermittent).	Rainwater from engineered roof surfaces.	Collected from facility roof into a raw water tanks. Intermittent top up with UF water (or potable water) as required.
Power	Electrical energy from grid power	Tie-in to engine room (162 m).
Ambient air	Air for drying	Inlet point is the intake to the dryer facility.
Waste heat source	Warm / hot water from render plant and also feed water tank of adjacent biomass boiler	Warm water (48 DegC or higher). Hot water from render plant utilised to heat dryer air then sent through biomass boiler economiser before reporting to boiler feedwater tank.
LAN/internet	One (1) internet connection.	LAN terminal of LAN cabling provided at the Test Station battery limit. Test station requires one network connection for monitoring and data transferring internal to customer MES.
Control & Process Data	I/O points: - Boiler status; - Boil fuel consumption rate, - Waste heat flow rate and temperature.	SCADA: Profibus platform. IEC62443 for Industrial Automation and Control Systems (IACS), and ISO/IEC 27002:2022 for cybersecurity.

Table 4: Outlets from facility battery limit

Outlet Item	Description	Battery limit
Pellets	Final pellets	Outlet nozzle of the pellet pneumatic delivery system fed into adjacent 30 m3 hopper then fed into the boiler fuel splitter box.
Free water from organics and intermittent cleaning water	Free water from organic feedstock and water from periodic cleaning (~1 m3 per day).	Reports to a drain port at the low point of each hopper then flows to adjacent waste water collection point.
Vent from dryer	Moist vent air	Vent exit nozzle on outlet of fans to atmosphere.
Control & Process Data	TBA [anticipated to be for critical I/O points: - E-stops. - Production: on / off / fault. - Pellet production rate. - Feed hopper levels.	TBA.

6.0 Results

6.1 Burn Test – Boiler Information

The existing boiler is a coal fired wetback firetube boiler manufactured in June 1977. It is rated to 4550 kg/hr steam (at 1020 kPa). Typically, the system operates at ~35.35% of its rated capacity when operating at steady state.

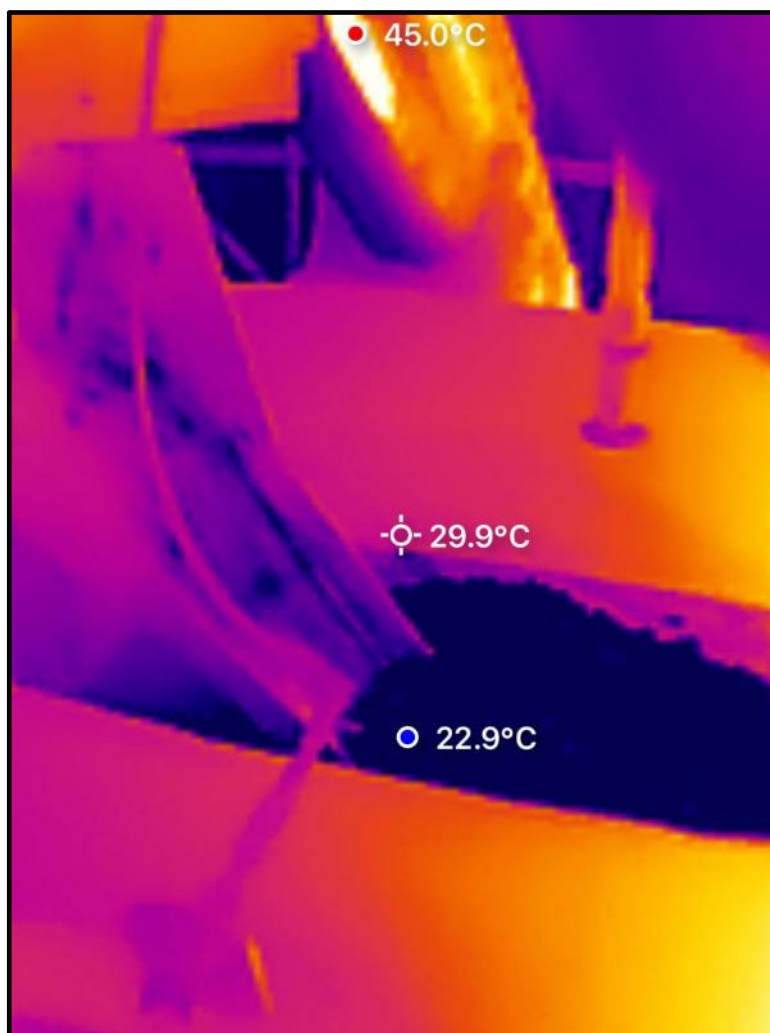


Figure 3: “Top bunker” which holds ~3 hours of fuel; Thermal image of “top bunker” at the inlet to the stoker bed. The temperature of the top bunker is constantly monitored to prevent “back fire” where the feed coal begins to combust. The hose above the top bunker is an automated fire water system which activates should the top bunker temperature increase.

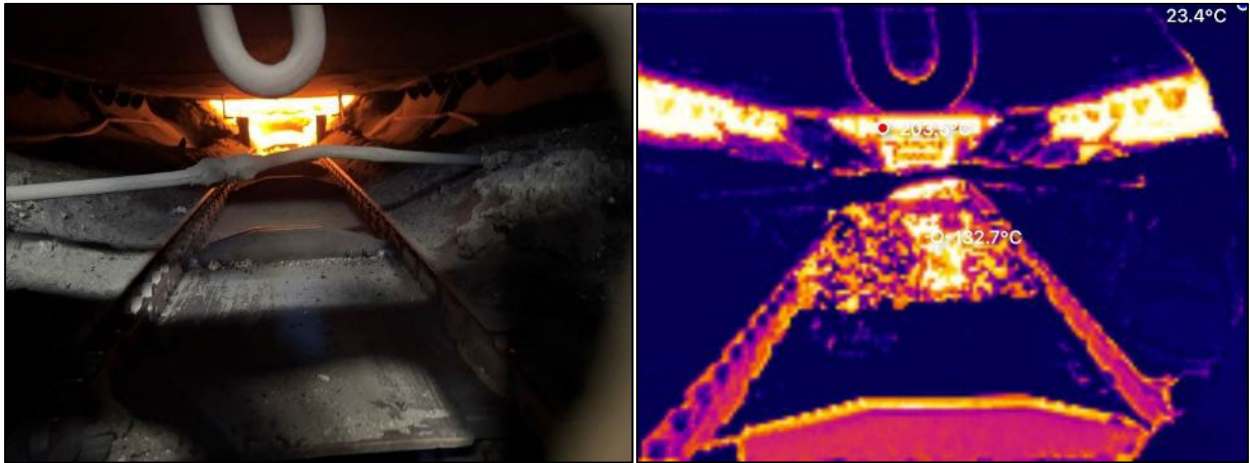


Figure7: Ash handling system (below boiler section) and associated thermal image.

6.2 Burn Test – Fuel Considerations and Burn Test Preparation

Boiler was started up at 4:10am on Wed 24th June 2026, then run on 100% coal at a 3.5" bed height. Stack emissions testing was then performed via port A then B from ~5am to 7am, with the boiler run in modulating mode (i.e. fuel feed rate varied from 9 to 72%) to achieve a target pressure of above 810 kPa (less than 845 kPa; averaged 833 kPa) at a steam mass flow rate of around 1600 to 1650 kg/h. The coal top bunker was then run down then the main hopper augers turned on to load the top bunker with biomass pellet / coal fuel. Biomass pellet / coal mix was fed into the boiler at a bed height of 6.5" from 8:00am onwards, with the stokers operated at 70% speed. At the conclusion of the mixed fuel testing at 11am the stoker speed was increased to 85% to show that the target pressure and steam production could be achieved (912 kPa and 1764 kg/h was reached).

The roundtable on 12th May 2026 decided to extrapolate the CY2025 data from 219 to 250 operational days.

Previous RMP pellets had 0.23% mass dry weight [0.099 kg S / GJ dry ash free] for the pellets, equivalent to 33.4 7% in sulphur per GJ of energy. With sawdust at 0.0 to 0.1% S, there exists the opportunity to reduce total sulphur amounts to the boiler per GJ of energy even further.

1.141 tonnes of biomass pellet / coal mix (~4 hours of burn time) were pre-mixed into two (2) green hoppers (refer images below). Additional reserve of 0.445 tonnes of pellets were available.

The pellet/coal mix has a lower GJ per cubic meter compared to pure coal. Hence, the bed height is expected to be required to be increased. Using the HRL data, 100% coal requires ~0.298 m³ / hour, whilst the pellet/coal mix is estimated at ~0.747 m³/hour.

These fuel ratios are based upon the HRL lower heating values (GJ / tonne). In practice, the lower density and higher voidage of the biomass pellets is expected to result in the overall mix burning faster and hotter. Due to the more complete combustion of the carbon present within the fuel, it is anticipated that the overall heat available (per GJ LHV HRL assay) could be higher than for pure coal.

Some considerations for operation of boiler on pellet/coal mix:

- running at a higher bed height (e.g. increase from 3" to 6"; noting that the indicator on the feedlot boiler can go up to 9"),
- slight increase in combustion air fan (specifically FD fan) amps due to higher primary air pressure / higher back pressure from higher bed (noting that the GJ of fuel combusted is the same). On 18th June were 49 and 69 respectively.
- slight increase in stoker speed (e.g. +25%). On 18th June was 40.
- HRL lab data on biomass fuel attached.



Figure 8: Pellet / coal mix prepared on 18 June 2026 ready for the burn test on 24th June 2026.



Figure 9: an additional 0.28 tonnes of pellet / coal mix (1 hour of fuel) was prepared on 23 June 2026 as reserve fuel ready for the burn test on 24th June 2026.

6.3 Burn Test Description

The 1.141 tonnes of pellet / coal mix was loaded out of the hoppers into a front end loader then transferred into the main hopper (refer images below). A key finding from the trial was that the coal-pellet mixture underwent granular convection (known as the Brazil Nut Effect”) where smaller particles (in this case coal) fall into spaces underneath larger particles, sped up by shaking / vibrating, with density having no impact. In a commercial setting, adding the pellets as close as possible to the point of use (i.e. mixing the required mass ratios of coal and pellet) as close as possible to the boiler feeding system (e.g. right at the fuel distributor mechanism) would reduce the granular convection effect.

Particularly large pellets (>30 mm) were generally aggregations of multiple smaller pellets and generally had very low tear strength thresholds (i.e. <10 N or below cardboard), whilst the tear strength of smaller pellets (<20 mm) was higher (>10 N) i.e. could not be torn by hand. A higher tear strength is typical of higher fibre binding and more dense fibre bonding.



Figure 10: initial and final charge of pellets in main hopper.

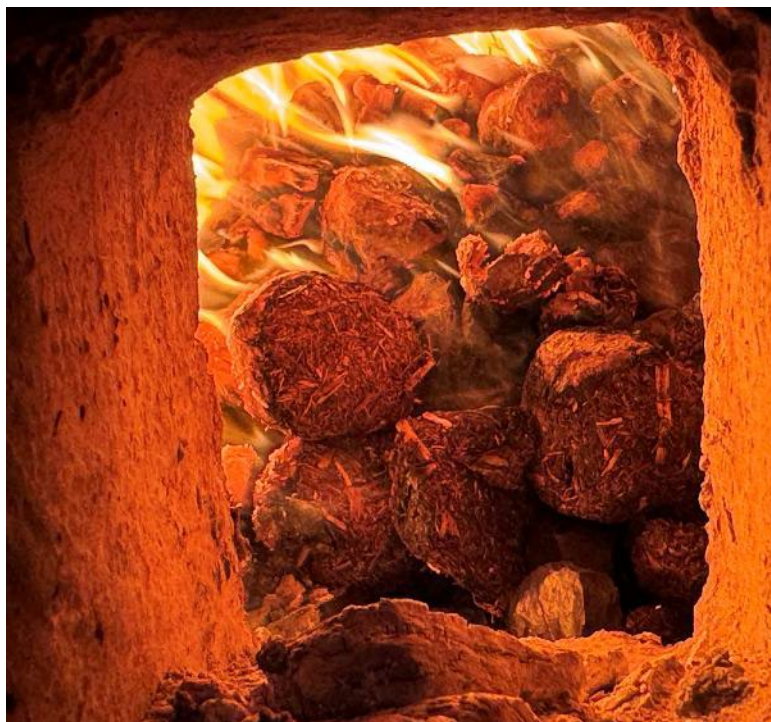
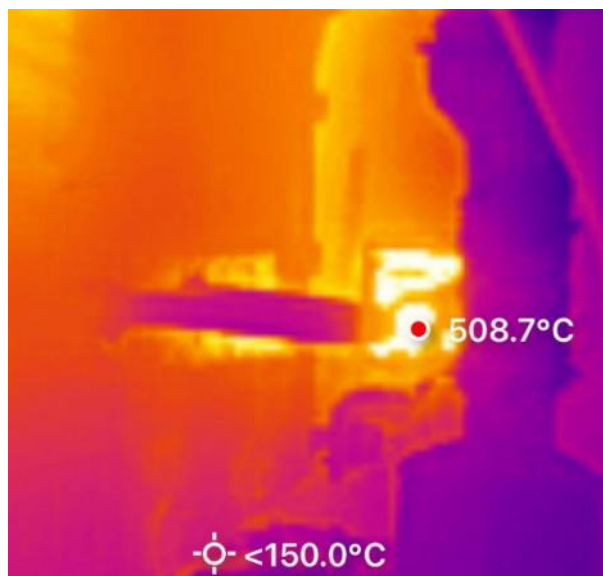


Figure 11: Arch view port. Bottom left shows coal and bottom right shows pellets/coal mix.

One of the key variables, especially for a lower energy density fuel, is the bed height of the fuel. Coal for the boiler is routinely at 3 to 4". Whilst the indicator goes up to 9", the arch limits the practical operational bed height to 6.5 ".



Figure 12: close up of the bed height manual controller indicator (left) set at ~3.5" for coal; (right) set at 6.5" for the pellet/coal mix.

Flame location: a higher fuel bed and a faster stoker bed speed will push the flame front towards the back of the boiler. Too much fuel moving too fast will result in un-combusted fuel (a source of inefficiency), reduces the dwell / contact time for heat exchange between the combusting material and can result in hot / still burning solids in the ash handling systems.

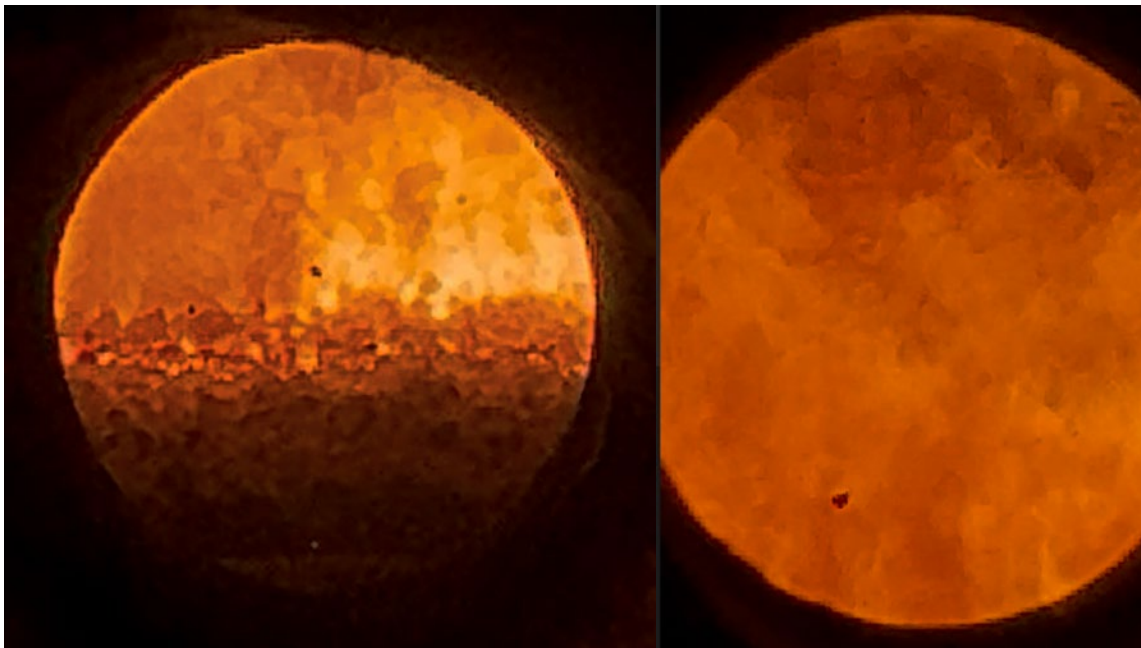


Figure 13: images looking through the rear port of the boiler showing the flame front towards the front of the boiler for coal (left), and the flame front towards the rear of the boiler for the pellet/coal mix (right) due to the higher bed height and faster stoker speed. This increases the chance of non-combusted fuel being carried over into the ash removal system.

6.4 Ash Considerations

Cameby Downs vendor data is for 10.5% ash as received with the pellet at 10.14% ash as received, however on a per GJ basis the pellets had a higher overall rate of ash production. For the pellet/coal blend, the overall increase in ash tonnage was estimated at 8.5% for the same GJ of energy.

Mass samples of ash were taken during the burn test, however due to the batch-wise nature of the ash removal system and the ash being immersed in water, there was considerable variation seen in water content and rate of production which impacted the accuracy of the mass measurements. For the samples taken, the measured rate of ash production was estimated at 22.0 to 35.4% higher for the pellet/coal blend compared to 100% coal which suggests incomplete combustion of the blend due to the combination of the higher fuel bed and faster stoker speed.

6.5 Stack Emissions Testing

Stack emissions testing of the 100% coal (stand operation) and pellet/coal mixture burn were completed. The tests completed were as follows:

- (1) Stack gas analysis of O₂,
- (2) Stack gas analysis of CO₂,
- (3) Stack gas moisture content,
- (4) Total Particles,
- (5) Solid particles,
- (6) Nitrous oxide (NO_x),
- (7) Volatile Organic Compounds (VOC)
- (8) Stack gas analysis of Sulphur Dioxide
- (9) Stack gas analysis of Carbon Monoxide.

Associated reporting of all results including raw data provided after data download.

6.6 Emissions to Air – Considerations for Biomass Pellets

In Queensland (QLD) there are no single fixed, statewide “stack emissions concentration limit” specifically prescribed for boilers in legislation in the same way as some other state or international jurisdictions. Instead, limits for a *new boiler* are set through a combination of policy, guidance, and site-specific approval conditions. Queensland’s framework (under the Environmental Protection Act 1994 and Environmental Protection (Air) Policy 2019) focuses on environmental outcomes (ambient air quality / dispersion modelling to predict maximum ground level concentrations (GLC) for contaminants of interest including contributions from all existing sources) rather than fixed stack limits; hence limits are determined case-by-case.

Limits are set via Environmental Authority (EA). The regulator (DETSI) will set **licence conditions**, which may include:

- Stack concentration limits (mg/Nm³)
- Mass emission limits (g/s or t/year)
- Monitoring requirements

These conditions are based on:

- Best practice / Best Available Technology (BAT)
- Fuel type (gas, coal, biomass, etc.)
- Scale and location
- Dispersion modelling results (ground-level impacts)

Although QLD doesn’t prescribe fixed values, regulators commonly reference the NSW Clean Air Regulation (used as guidance): QLD assessments may adopt NSW “benchmark” stack limits for new plant

Table 5: NSW Stack Emission Limits (Boilers / Combustion Plant).

Pollutant	Typical Environment Protection Licence (EPL) limit (new biomass boiler / modern plant)	Key References
NO_x (as NO₂)	~150 – 300 mg/Nm ³	https://www.energycouncil.com.au/analysis/nsw-clean-air-reforms-a-delicate-juggling-act
Particulate Matter (PM₁₀)	~10 – 30 mg/Nm ³ (baghouse/ESP controlled); 50 as upper bound	https://www.epa.nsw.gov.au/Your-environment/Air/industrial-emissions
CO	~50 – 250 mg/Nm ³ (combustion control driven)	https://www.epa.nsw.gov.au/Your-environment/Air/industrial-emissions
SO₂	Typically low for clean biomass; site-specific limits 50 - 200	https://legislation.nsw.gov.au/view/html/inforce/current/s1-2022-0811
VOC	<20 – 50	
HCI	10 - 30	
Load-based limits (t/year)	Set in EPL via Load-Based Licensing (LBL) scheme	https://www.epa.nsw.gov.au/Licensing-and-Regulation/Licensing/Environment-protection-licences

(Exact limits depend heavily on plant type and size)

Ambient air quality drives the limits for specific projects. Projects must demonstrate compliance with National Environment Protection (Ambient Air Quality) Measure (NEPM) and QLD Air EPP objectives. This is done via Atmospheric dispersion modelling and showing ground-level concentrations meet health criteria. It may be required

to complete air dispersion modelling and propose emission limits. Proposed limits will then be compared to NSW / international BAT benchmarks, the tightened if near sensitive receptors (residential, hospitals), large plant, poor dispersion conditions.

Table 6: Model emissions standards example (for combustion-based EFW facilities).

Pollutant	Unit of measurement	100th percentile concentration limit (1 hour average)	100th percentile concentration limit (24 hour average)
Solid Particles (Total)	mg/m ³	30	6.5
Nitrogen Oxides (NO_x)	mg/m ³	357	144
Sulphur Dioxide (SO₂)	mg/m ³	200	39
Hydrogen Chloride (HCl)	mg/m ³	60	8.4
Volatile Organic Compounds (VOC)	mg/m ³	20	10
Hydrogen Fluoride (HF)	mg/m ³	4 ¹	-
Cadmium and thallium	mg/m ³	0.02 ¹	-
Mercury	mg/m ³	0.035 ¹	-
Type 1 and Type 2 substances (in aggregate)	mg/m ³	0.3 ¹	-
Dioxins and furans	ng/m ³	0.04 ²	-

1. Averaging period of a minimum of 30 minutes and a maximum of 8 hours as part of extractive testing as specified in the relevant test method, not measured continuously.
 2. Averaging period of a minimum of 6 hours and a maximum of 8 hours as part of extractive testing as specified in the relevant test method, not measured continuously.
- Expressed at dry, 273 K, 101.3 kPa and 11 % oxygen.

Table 7: Results from burn test stack emissions testing.

	Unit	Coal	Pellet/Coal
Average stack gas temp	K	471	470
Average velocity	m/s	30.7	27.3
Actual gas flow rate	m ³ /min	231	206
Average oxygen concentration	%v/v dry basis	15.81	14.63
Average CO ₂ concentration	%v/v dry basis	4.08	5.03
Water vapour concentration	%v/v dry basis	4.07	4.85
Dry gas flow rate at STP	Nm ³ /min	127	112
Total solid particulates	conc mg/Nm ³	126	141
	emission g/min	16	15.8
NO _x	conc mg/Nm ³	avg 135	avg 232
	emission g/min	avg 17.1	avg 26.0
VOC	conc mg/Nm ³	avg 6.3	avg 8.6
	emission g/min	avg 0.8	avg 0.96
SO ₂	conc mg/Nm ³	avg 329	avg 521
	emission g/min	avg 41.8	avg 58.4
CO	conc mg/Nm ³	avg 119	avg 204
	emission g/min	avg 15.1	avg 22.8

A multicyclone followed by a bag house may be sufficient to drop particulates towards the required levels. If this is not sufficient, then an electro-static precipitator (ESP) can also be employed. Further flue gas treatment options include the use of additives (chemicals; activated carbon) added to the flue gas where required to bind target species upstream of the baghouse, with the target species then retained within the particles removed by the bag house.

SO₂ in the exhaust gas is almost entirely dependent upon the chemical composition of the fuel as opposed to how the boiler is operated. Mass fraction sulphur at 0.39% for pellets is slightly below that of coal (0.43% mass dry weight). However on an energy basis coal displays 0.180 kg S / GJ LHV versus 0.253 kg S / GJ LHV for pellets i.e. a 26.7% reduction per GJ of energy, hence a 1.4 increase factor per GJ. This would support emissions increase towards 463, however 521 mg/Nm³ is unexpectedly high which suggests another chemical mechanism is at play. It is possible that a lower calcium or potassium content in the fuel/ash is not capturing sulphur as CaSO₄ or K₂SO₄. A higher temperature can also decompose CaSO₄ and K₂SO₄. A higher chlorine concentration diverts Ca/Na/K chemistry away from sulphation with sulphur exiting the boiler as SO₂ rather than leaving in the ash. QLD coal is known as being low chlorine, typically 0.02 – 0.03 wt.% whilst the biomass pellets are comparatively high in chlorine at 0.16%. Chlorine reacts with calcium, sodium and potassium first making CaCl₂, NaCl and KCl rather than making CaSO₄, Na₂SO₄ or K₂SO₄, hence driving up the SO₂ in the flue gas.

A boiler vendor will routinely specify <0.02 % dry weight chlorine, however in practice towards 0.15% to 0.2% Cl may be acceptable via appropriate materials or construction and temperature control. In addition to emissions considerations, where chlorine levels are known to be high then the formation of moisture in the exhaust system can lead to HCl acid and alkali chlorides being formed with associated corrosion implications. A key operational requirement is to keep flue gases hot, especially in the superheater and boiler tube sections, to avoid water or alkali chlorides condensing. Where a flue gas is known to have elevated chlorine, appropriate materials of construction with corrosion resistance can be selected.

Alkali chlorides also reduce the ash melting point which ultimately causes “sticky” ash which can then coat the inside of combustion chambers.

With sawdust at 0.0 to 0.1% S, there exists the opportunity to reduce sulphur amounts per GJ. This could be a much more cost effective strategy than the CAPEX / OPEX for scrubbers.

All Energy Pty Ltd has previously completed paunch, paunch/sludge pellet and woodchip tests showing NO_x emissions <112 ppm post multicyclone. The lab composition data is presented in Appendix 2.

NO_x (nitrogen oxide) emissions: switching to biomass is expected to bring the boiler operating emissions well within the acceptable NO_x limit of 500 mg/Nm³.

Sulphur is expected to be naturally low in biomass (certainly compared to coal), hence particulates is the key area for monitoring.

Table 8: Stack emissions results from pilot testing.

AVERAGE (1 hour)	% O2	ppm CO	ppm SO2	ppm NO	ppm NO2	ppm Nox "Oxide of nitrogen"
Pellet - High	14.805	242.554	85.554	110.286	0.000	110.286
Pellet - Low	15.433	365.467	83.900	111.967	0.000	111.967
80% paunch/20% woodchip - High	14.464	147.000	17.200	85.517	0.248	85.783
80% paunch/20% woodchip - Low	15.793	295.317	1.917	48.500	0.537	49.117
100% woodchip - High	15.188	163.817	0.000	84.567	0.958	85.517
100% woodchip - Low	15.822	245.883	0.000	64.483	0.247	64.817
100% woodchip - High, no flue gas recycle	15.535	101.855	0.200	73.964	0.520	74.455
mg/m ³ (Version: 6.10.2022, Published under the Legislation Revision and Publication Act 2002, South Australia, Environment Protection (Air Quality) Policy 2016 under section 28 of the Environment Protection Act 1993)		1000	1000			500
ppm (Kansas State University)		872.903	381.676			256.703
g/mol		56.02	64.06			46.01
mg/m ³ Group 6 (after 2005) A boiler operating on a fuel other than gas; NSW Protection of the Environment Operations (Clean Air) Regulation 2022 under the Protection of the Environment Operations Act 1997		None listed	None listed	500	500	500

ANOVA (single factor) data analyses were completed to determine if the difference in the data sets is statistically significant. The results are summarised in the following table.

Table 9: ANOVA analysis of results from 14 & 15 March 2023 emissions testing of the UNICONFORT 523 kW biomass pilot, NSW.

ANOVA: Single Factor	P-value	Summary
SO₂: 80% paunch / 20% woodchip and 100% woodchip	2.86×10^{-22}	Very strong evidence of a statistically significant variation in SO ₂ levels between 80% paunch / 20% woodchip and 100% woodchip
CO: 80% paunch / 20% woodchip and 100% woodchip	0.010845	Evidence of a statistically significant variation in SO ₂ levels between 80% paunch / 20% woodchip and 100% woodchip
NO_x: 80% paunch / 20% woodchip and 100% woodchip	0.873	No evidence that there was a statistically significant variation in NO _x levels between 80% paunch / 20% woodchip and 100% woodchip
Comparing all fuels for NO_x, SO₂ and CO.	2.8×10^{-121} ; 2.5×10^{-262} ; 6.4×10^{-103}	Very strong evidence of a statistically significant variation in chemistry between all fuels.

Carbon monoxide and nitrous oxide emissions are predominantly associated with the combustion occurring within the physical boiler itself i.e. NO_x is produced by the reaction of N₂ and O₂ and CO is produced during the partial combustion of fuels. Hence, if NO_x and CO have not historically been an issue for a particular boiler system, it is not anticipated that shifting to a biomass fuel will dramatically impact NO_x / CO. NO_x and CO are routinely managed by increasing oxygen availability (at stages throughout the boiler), optimising combustion temperatures, flue gas recirculation, and optimising fuel-air ratios.

For particulates, as for NO_x and CO, particulate emissions are dominated by the physical boiler itself (air/fuel ratios; stage combustion with optimal air addition; flue gas recirculation; soot blowing / management) with a key aiming being to achieve complete combustion and then, in particular, the operation of flue gas control systems such as bag houses, and multi-cyclones. The biomass pellets are expected to have a tighter particle size (10 – 20 mm; where dust and small particles can be recycled back into the pelletisation process) compared to coal of 35 mm down to <0.4 mm which provides an opportunity to increase particle dwell time and not “blow” small particles straight out of the primary combustion chamber. The ash content according to the HRL data for the biomass pellets is 8.15% as received [4.69 kg / GJ LHV; 4.43 kg / GJ HHV] compared to 11% for Cameby Downs and 14.0% for New Acland [4.39 kg / GJ LHV; 4.09 kg / GJ HHV], hence a keen area of interest will be particulates during burn tests.

6.7 Current Fuel Utilised & Fuel Fluidisation

Presented in this section is the vendor fuel data and HRL lab data for the coal utilised.

Table 50: Vendor Coal Information.

Analysis/Basis	
Proximate Analysis	
Total Moisture (% ar)	12.5
Moisture (% ad)	8
Ash (% ad)	11
Ash (% ar)	10.5
Volatile matter (% ad)	41
Volatile matter (% ar)	39
Fixed Carbon (% ad)	40
Fixed Carbon (% ar)	38
Total Sulphur (% ad)	0.40
Total Sulphur (% ar)	0.38
Fuel Ratio	0.98
Gross Calorific Value (kcal/kg GAD)	6420
Gross Calorific Value (kcal/kg GAR)	6105
Gross Calorific Value (kcal/kg NAR)	5803
Ultimate Analysis	
Carbon (% daf)	79
Hydrogen (% daf)	6.17
Nitrogen (% daf)	1.16
Total Sulphur (% daf)	0.49
Oxygen (by difference) (% daf)	13.2
Hardgrove Grindability Index	36
Ash Fusion Temperatures:	
Initial Deformation (°C Reducing)	1520
Spherical (°C Reducing)	1550
Hemispherical (°C Reducing)	1560
Flow (°C Reducing)	1560
Sizing:	8 x 28mm

LHV = 24.28 GJ/t.

Table 6: QLD sourced coal sample was analysed by HRL in Jan 2026.

Table 1: Analysis Results

Sample ID	Description	% as received	% dry basis		Calorific Value MJ/kg			g/cm3 dry basis
		Moisture	Hydrogen	Sulphur	Gross Dry CV	Gross Wet CV	Net Wet CV	True Density
251490-01	Coal Crumb 05-11-2025	9.6	5.7	0.43	29.10	26.31	23.90	1.350

Table 2: Analysis Results

Sample ID	Description	% in range							
		>63 mm	63-35mm	35-25mm	25-16mm	16-13.2mm	13.2-12.5mm	12.5-6.2mm	6.2-4.8mm
251490-01	Coal Crumb 05-11-2025	0	0	15.8	62.6	9.5	2.5	6.7	0.39

Table 3: Analysis Results

Sample ID	Description	% in range							
		4.8-4mm	4-3.35mm	3.35-2.36mm	2.36-1.4mm	1.4-1.18mm	1.18-0.6mm	0.6-0.4mm	<0.4mm
251490-01	Coal Crumb 05-11-2025	0.18	0.10	0.16	0.18	0.12	0.15	0.11	1.35

The fluidisation properties of the fuel needs to be considered due to the need for the particles to reside on the stoker bed. The key parameters are the particle size and the true density of the particle:

- For coal a true density 1.35 t/m³, particles from 35 mm down to very fine.
- For biomass pellets a true density of 0.372 t/m³ (at 40% voidage), particles from 45 mm down to 9mm.

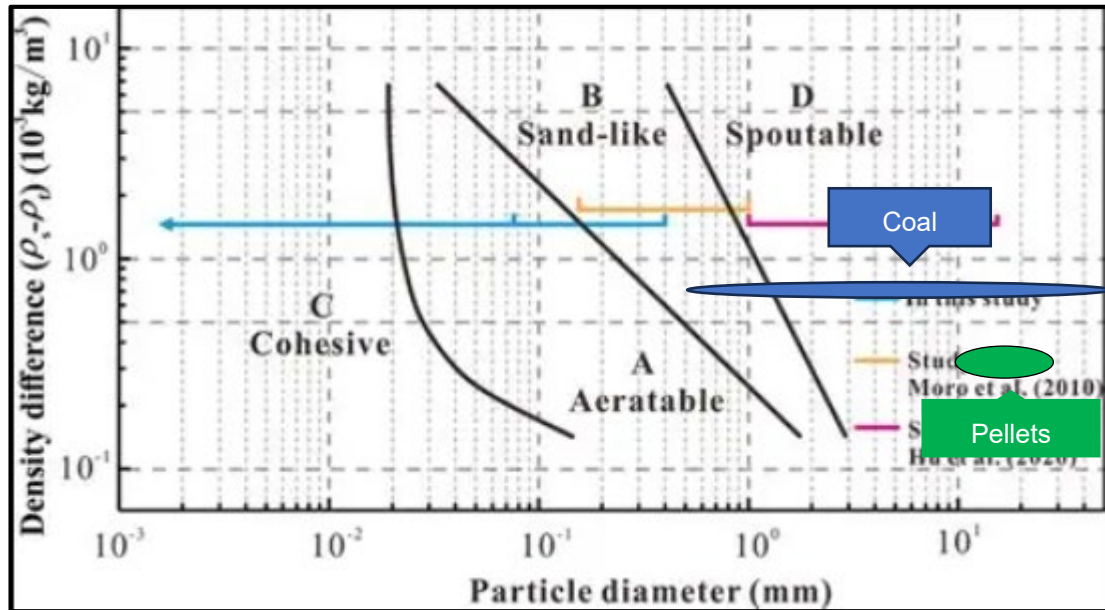


Figure 14: Impact of particle density and diameter on fluidisation characteristics of boiler fuels. The coal properties are shown in blue (wide distribution) with the biomass pellets shown in green (lower true density, but a tighter particle size distribution).

With the ash content of the pellets (8.45% ash for pellets at 10% moisture) expected to be lower than coal (11 to 14% ash vendor data; measured at 11.9 and 12.1%) and, in general, a larger and tighter particle size distribution, it may be anticipated that particulate emissions could be reduced.

The size of the pellets will be in the range of 15mm to 30mm (1/2" to 1 1/4") wet, then will shrink as desiccated towards approx. 10 to 20 mm. The size of the extruder die can be changed to manufacture pellets of the desired size. There will be the occasional oversize / undersize pellet.

6.8 Key Findings of Burn Test of Pellets

Key findings from burn trial:

- The pellets have a low specific and volumetric energy density of 15.4 GJ LHV/t (versus 24.47 for coal) and 3.44 GJ LHV/m³ (versus 18.99 for coal). At the fuel mixture in Table 1 above, the volume of the mixed fuel is 2.51 times that of the coal (i.e. 2.51 m³ of mixed fuel contains the same energy as 1 m³ of coal). Some boilers may not be able to process this larger volume of fuel.
- The volume of fuel can be increased for a boiler by increasing the bed height and increasing the stoker speed, however there are limitations to changes, for example:
- Boiler fuel feeding geometry – limited by arch height / opening cross section thereby limiting the bed height i.e. arch height is fixed for a given boiler.
- Stoker bed speed: routinely modulated to achieve a specific pressure / steam mass flow rate set point (i.e. don't want to run a bed at 100%). A bed moving too fast may result in the flame front moving towards the back of the boiler and un-combusted material existing in the ash handling system. Increasing the bed height and stoker speed together further increases the likelihood of un-combusted fuel and/or very hot ash entering the ash handling system.
- Materials handling system from hopper to fuel feeding system but would require CAPEX (i.e. gear box or motor changes; increases in sizing of systems (e.g. larger screws)).
- Increased bed height will increase the back pressure on the forced draft fan which may impact combustion. At a minimum, tuning is required to ensure that O₂ and other gases in the exhaust are at desirable levels (i.e. O₂ towards 8%; other gases adhere to EPA requirements).
- Ash composition data predicted an increase in ash per GJ LHV for the biomass pellets compared to coal (85.7%) which at the ratios was estimated to result in a 28.57% increase. Due to the water handling system it was not possible to capture exact ash mass flows, however for the samples taken the ash increase per GJ was in the range of 25 to 34%.
- Fuel mix displayed granular convection (known as the "Brazil Nut Effect") where smaller particles (in this case coal and smaller pellets) fall into spaces underneath larger particles, sped up by shaking / vibrating, with density having no impact. In a commercial setting, adding the pellets as close as possible to the point of use (i.e. mixing the required mass ratios of coal and pellet) as close as possible to the boiler feeding system (e.g. just before the fuel distributor mechanism) would reduce the granular convection effect.
- Increasing the fuel bed height from 3.5" to 6.5" compared to coal, which at 1.86 times the volume resulted in ~74.1% of the energy delivery rate compared to coal firing at steady state stoker speed (stoker speed was set at 55 to achieve stable operation for the stack testing) with an associated reduction in steam mass flow and steam pressure. At the conclusion of the stack testing the stoker bed speed was increased to as high as 85, representing towards a 54.5% increase which enabled the boiler to reach the target steam mass flow and pressure.

- No bridging or materials handling issues within the feedlot boiler system (other than granular convection noted above).
- There was noticeable more dust in the top hopper than for coal.
- Site personnel noted a slight brown / yellow colouring in the stack compared to coal.

6.9 Basis of Design: Pelletisation Feedstock

Images are provided below of the ICBs of paunch and sludge received by Pelleton Renewables Pty Ltd on Wednesday 17th June 2026. Pelletisation was undertaken on the Wednesday and Thursday followed by drying.

The paunch was at 61.94 to 64.11% moisture which is acceptable.

Sludge dewatering issues were experienced by site resulting in variable sludge moisture levels, with one ICB considered acceptable 79.59% at and the second with a sub-optimal moisture content of 86.4% (i.e. longer drying time or in a commercial setting would require mixing with saw dust).



Figure 15: Sludge feedstock sample, 17th June 2026. The thermal image shows that the sludge temperature is close to that of the wet bulb temperature.



Figure 16: Paunch feedstock sample 17th June 2026. The thermal image shows that the temperature has reached 40.4 DegC. The paunch would have high microbial activity as evidenced by the temperatures shown in the thermal image.

6.10 Pelletisation Results & Post-Burn Test Optimisation

The organics pellets were analysed by HRL with the results utilised within the mass and energy balance design.

Mass fraction sulphur at 0.39% is slightly below that of coal (0.4%). Whilst not considered a serious operational issue, the chlorine levels at 0.16% are slightly higher than an ideal threshold of <0.15% or lower from previous works, however, are similar to QLD coal levels of 0.1 to 0.15%. Elevated chlorine levels can contribute to the production of HCl and ultimately accelerated corrosion, especially in the heat exchangers, superheaters and stacks. Fouling can also be a by-product. The current environmental approval (EPPR00807613) requires S < 1% w/w, which is met by the pellets.

Table 7: HRL Laboratory Results for Organic Pellets.

HRL: Sample Description	260663-01
Clients sample Description	
Total Moisture	
Moisture, % (ar)	13.8
Ash Content at 550°C	
Ash, % (db)	14.0
CHN	
Carbon, % (db)	45.7
Hydrogen, % (db)	6.1
Nitrogen, % (db)	3.3
Calorific Value	
Gross Dry Calorific Value, MJ/kg (db)	19.4
Gross Wet Calorific Value, MJ/kg (ar)	16.8
Net Wet Calorific Value, MJ/kg (ar)	15.4
Halides	
S, % (db)	0.39
Cl, % (db)	0.16
Br, % (db)	<0.01
I, % (db)	<0.01
F, % (db)	<0.01



Figure 17: PAUNCH/SLUDGE PELLETS used in the burn test showing particle diameters of 9 to 40 mm, with the median range being 20 to 30 mm. Fines were less than 0.4% by mass.

Following the burn test, further optimisation of the pellets was conducted, concentrating on reducing the particle size, increasing the mass and energy density and the impacts of blending organics with different sawdust sources; with pine and hardwood sawdust considered in detail with hardwood exhibiting results most suited to the manufacture of biomass fuel. A sample of organics with 20% hardwood sawdust was analysed by HRL with the results utilised within the mass and energy balance design. Mass fraction sulphur at 0.21% is almost half that of coal (0.4%), with the current environmental approval (EPPR00807613) requires $S < 1\%$ w/w, which is met by the pellets.

With chlorine levels at 0.14%, slightly below a target threshold of $<0.15\%$, the blend of sawdust would be expected to reduce corrosion issues compared to the paunch/sludge only pellets. The calorific value of the pellets is at the higher end of what is suitable for a biomass boiler, however this can be managed via the fuel moisture. For higher calorific fuels, a water cooled stoker grate may be preferable to an air cooled stoker grate. Density was measured at 277 to 340 kg/m³. The pellets with 20% sawdust displayed a particle size of 11 – 23 mm.

Table 83: Pellet analysis results for paunch and sludge mixed with sawdust (at 20 wt.% of the raw organics as delivered).

Total Moisture	
Moisture, % (ar)	12.7
Ash Content at 550°C	
Ash, % (db)	8.8
Carbon, Hydrogen, Nitrogen	
Carbon, % (db)	48.3
Hydrogen, % (db)	6.3
Nitrogen, % (db)	1.7
Calorific Value	
Gross Dry Calorific Value, MJ/kg (db)	20.0
Gross Wet Calorific Value, MJ/kg (ar)	17.4
Net Wet Calorific Value, MJ/kg (ar)	16.0
Halides	
S, % (db)	0.21
Cl, % (db)	0.14
Br, % (db)	<0.05
I, % (db)	<0.05
F, % (db)	<0.01



Figure 18: PAUNCH/SLUDGE/20% SAWDUST PELLETS developed after findings from the burn test showing particle diameters of 11 to 23 mm.

Biomass Fuel Specification

The colour coding in the table shows that chlorine levels are of the highest concern with other items of high sulphur, high ash and deformation / softening temperatures being lower than that for woodchip.

Table 94: Comparison of typical biomass boiler fuels with Organic Pellets.

Fuel Specification	Biomass boiler examples (n = 3)	Pellets
Moisture	Range: 25 – 50% All: 35%	13.8 %. Easily controllable to desired moisture via drying.
LHV / net calorific value	Range: 8.4 – 16 MJ/kg. Ideal: 11.5 to 12.71 MJ/kg.	15.4 to 16 MJ/kg. Towards the upper typical range; easily controllable to desired LHV via optimisation of moisture levels (i.e. less drying).
Particle size	All: 75% 8 to 45 mm; Maximum (range): 200 to 350 mm.	Within the desired range; without separation fines were less than 0.4% by mass.
Chlorine	Target <0.15%, with optimal levels <0.02 %	0.16 %. Options: blend with low chlorine biomass e.g. clean sawdust (299% of energy in pellets required, hence diluted towards 0.053%). 0.14% with sawdust.
Sulphur	Ideally <0.05 %	0.39%. Not expected to be an issue but should be discussed with boiler vendor. 0.21% with sawdust.
Density	Range: 200 to 400 kg/m ³ bulk density All: 230 to 350 kg/m ³ bulk density Ideal: 300 MJ/kg.	223.2 kg/m ³ bulk density unscreened. 276 kg/m ³ bulk density <10 mm pellets. 277 kg/m ³ bulk density with sawdust.
Ash	Range: 0.5 to 2%. Note: trials have used up to 7%.	High at 14%. Grit removal plus blending will reduce ash percentage. Not expected to be an issue but the high ash content should be made clear to the boiler vendor. 8.8% with sawdust.
Deformation temp Softening temp Hemi Flow	1140 - 1230 1250 - 1260 1260 - 1310 1280 - 1340	1075 (lowest of lab results) 1130 1190 1360 Not expected to an issue, but these results do need to be shared with the boiler vendor.

6.11 Feedstock Review

A detailed review of the individual substrates confirmed that chlorine in the sludge as the primary source (90.9 wt.% of chlorine). A mass balance suggests that chlorine in the pellets should be higher than amounts measured, however at low pH levels, more chlorine exists as Cl_2/HOCl (hypochlorous acid), which is volatile and can be lost to the atmosphere by drying. Chlorine in organic, hypochlorous or salt forms are not volatile and are expected to remain in the pellet.

Table 15: Hardwood sawdust composition. The low moisture, low ash, low sulphur and high calorific value are advantageous in the production of the biomass fuel.

Sample Reference	NCL25-17064.001		
Description	HARD WOOD SAWDUST		
	% ar	% ad	% db
Total Moisture	10.5		
Inherent Moisture		9.8	
Ash	0.9	0.9	1.0
Total Sulfur	0.02	0.02	0.02
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	4364	4398	4876

Net calorific value: 18.26 GJ / tonne (as received)

6.12 Pelletisation Emissions

AirLabs completed vent stack monitoring on 18th June 2026 at the Pelleton facility (Test Report # JUN26092.1). The results show that the Pelleton vent was within the Dept. Environment, Technology Science and Innovation maximum release limits for Total Solid Particulates and Total Volatile Organic Compounds (VOCs). For a commercial facility, these results would need to be scaled to the mass of materials being dried and the air flow rate.

The dryer design has two near-identical vent stacks; hence testing was completed on the southern and northern stacks as per the tables below.

Table 16: Detailed stack testing results for pelletisation vent (South-West vent).

Gas Flow Conditions	
Stack diameter at sampling plane (m)	1.20 x 1.20
Average stack gas temperature (K)	293 (20°C)
Average barometric pressure (mB)	1019.6
Average static pressure (mB)	+ 0.09
Average stack pressure (mB)	1019.7
Average velocity at sampling plane (m/s)	6.32 (DETSI Minimum 6 m/s)
Actual gas flow rate (Am ³ /min)	546
Average oxygen concentration, dry basis (%v/v)	20.95
Average carbon dioxide concentration, dry basis (%v/v)	0.04
Dry gas density of stack gas (kg/m ³)	1.287
Dry molecular weight of stack gas (g/g mole)	28.84
Wet molecular weight of stack gas (g/g mole)	28.79
Water vapour concentration (% v/v)	0.46
Dry gas flow rate at STP (m ³ /min)	508

Test Parameter	Gas Reference Conditions	Concentration (mg/Nm ³)	DETSI Maximum Release Limit (mg/Nm ³)	Mass Emission Rate (g/min)
Total Solid Particulates	0°C, 101.3 kPa, dry	0.73	50	0.37
Total Volatile Organic Compounds as <i>n</i> -propane equivalent	0°C, 101.3 kPa, dry	7.8 – 10.1 (Av. 9.1)	40	4.0 – 5.1 (Av. 4.6)

Note: Green shading indicates that the test result complies with the DETSI maximum release limit.

Table 17: Detailed stack testing results for pelletisation vent (Nth-East vent).

Gas Flow Conditions	
Stack diameter at sampling plane (m)	1.20 x 1.20
Average stack gas temperature (K)	293 (20°C)
Average barometric pressure (mB)	1019.1
Average static pressure (mB)	+ 0.09
Average stack pressure (mB)	1019.2
Average velocity at sampling plane (m/s)	6.21 (DETSI Minimum 6 m/s)
Actual gas flow rate (Am ³ /min)	537
Average oxygen concentration, dry basis (%v/v)	20.95
Average carbon dioxide concentration, dry basis (%v/v)	0.04
Dry gas density of stack gas (kg/m ³)	1.287
Dry molecular weight of stack gas (g/g mole)	28.84
Wet molecular weight of stack gas (g/g mole)	28.79
Water vapour concentration (% v/v)	0.50
Dry gas flow rate at STP (m ³ /min)	499

Test Parameter	Gas Reference Conditions	Concentration (mg/Nm ³)	DETSI Maximum Release Limit (mg/Nm ³)	Mass Emission Rate (g/min)
Total Solid Particulates	0°C, 101.3 kPa, dry	0.66	50	0.33
Total Volatile Organic Compounds as <i>n</i> -propane equivalent	0°C, 101.3 kPa, dry	7.2 – 9.6 (Av. 8.4)	40	3.6 – 4.8 (Av. 4.2)

Note: Green shading indicates that the test result complies with the DETSI maximum release limit.

Assuming a 12 hour drying time, the above data can be used to estimate “shrinkage” or materials losses through the vent.

At average solids of 0.695 mg/m³, losses over 12 hours for ave. 503.5 m³/min, solids shrinkage is estimated at 0.252 kg per drying cycle.

At an average VOC of 8.75 mg/m³, losses over 12 hours for an ave. 503.5 m³/min equates to 3.172 kg per drying cycle.

With a starting total solids mass at 528.658 kg (solids within the batch of paunch and sludge Bulka bag), the shrinkage of solids due to ventilation is estimated at 0.65%.

Condensation could occur where the temperature of the vent gas drops leading to the creation of a corrosive environment and build-up of solids in the vent. Fouling will happen hence design strategies can be implemented to manage fouling:

- Maintain high gas velocities to prevent settling,
- Avoid dead zones / dead legs / sharp turns,
- Install clean-out ports: large access ports for cleaning,
- Use smooth or coated duct surfaces,
- Add air purges or sonic horns for cleaning,
- Periodic inspection and maintenance.

Table 18: Consideration of main sources of odour from pellet dryer vents.

Chemical	Concentration (mg/Nm ³)	Limit of human detection	Approximate % contribution
Acetic acid	0.094	~0.5–2 mg/m ³ [~.094 to 0.5 OU]	0.2%
Butyric acid	0.014	~0.0007 to 0.035 mg/m ³ [~2.8 to 70 OU]	5.9%
Propionic acid	0.051	~0.015 to 0.15 mg/m ³ [1.02 to 51 OU]	2.2%
Hydrogen sulphide	0.086	~0.0007 to 0.028 mg/m ³ [~17.2 to 123 OU]	36.5%
Dimethyl sulphide	0.022	~0.0005 to 0.003 mg/m ³ [~22 OU]	46.7%
Dimethyl disulfide	0.012	~0.001 to 0.01 mg/m ³ [~4 to 40 OU]	8.5%

Proponents of new facilities may undertake an impact assessment with relevant inputs of emissions and local meteorology to an air dispersion model to provide estimates of the likely odour impacts in the surrounding

environment. The inputs should be as detailed as possible, reflecting any variation of emissions with time and including at least a full year of representative hourly meteorological data. The modelled odour concentrations at the “most exposed existing or likely future off-site sensitive receptors” should be compared with the following guideline values: 0.5 ou, 1-hour average, 99.5th percentile for wake-free stacks.

Some very preliminary estimates without prejudice, using an advanced PRIME (Plume Rise Model Enhancement) model downwash algorithm alongside Briggs' plume rise equations, Neutral Stability (Class D) at a downwind distance of $x = 0.17$ km, 1.354 m diameter stack, extrapolating to 94638 ouv/s and 18518 Wet gas flow rate at Nm³/min, the vertical momentum plume rise dominates the equation entirely. Therefore, the Good Engineering Practice (GEP) formula remains the absolute floor constraint: $h(\text{physical}) > H(\text{building}) + 1.5$ (lesser height or width), which is expected to be $11\text{m} + 1.5 \times (9) = 24.5$ m.

6.13 Exclusions from OEM Plant

Table 19: Exclusions from OEM's (Pelleton's) scope of works.

Original Exclusion Communication	Allowances made in TCI
General civil works including design for any required shed additions, modifications.	Y
Shed floor concreting	Y
Shed doors	Y
Exterior cladding	Y
Odour control related to the building area: m^3/h , T, P.	The huge volume of drying air will dilute any volatiles released from the pellets. The mass release of odorous molecules can be tested during the trial to confirm this.
Site electrical upgrades and/or routing/connection to shed	Y
Industrial air system and connection to the shed. [Pneumatic air]	Y
Paunch delivery system to PR holding hopper.	Y
Heat exchanger and connections - supply and return. Excluded until designed	Y
Dry pellets holding storage hopper. $30m^3$	Same as other hoppers; additional hopper added to Pelleton Scope
Pellets from drier to boiler delivery system.	Y
Bio-filter connection/ducting, from PR drier, including any new bio filter if installed, and/or any extraction fans/vent hoods.	Y
Pre-mixer, feed hopper, plant interface, Pelleton plant interface	Y
For detailed design: test Pre-mix with sludge and punch to confirm suitability for extrusion feed (i.e. does not create mixture unsuitable for pelletisation).	To be completed during FEED / detailed design

6.14 Waste Heat Utilisation

An example of a hot water to air heat exchanger (radiator) is shown below. This system is rated to 47 kWt; hence a suitable number of units can be installed to provide the required heating. During the detailed design phase, the cross section of the dryer inlet needs to be matched to the heating system. These systems are rated from -40 to +180 DegC and up to 25 Bar. Air side pressure drop is not listed, however for similar radiators dP is routinely 150 to 400 Pa; the pressure drop through the dryer will need to be considered in detail to ensure that the extraction fans are suitably sized for the drying application.

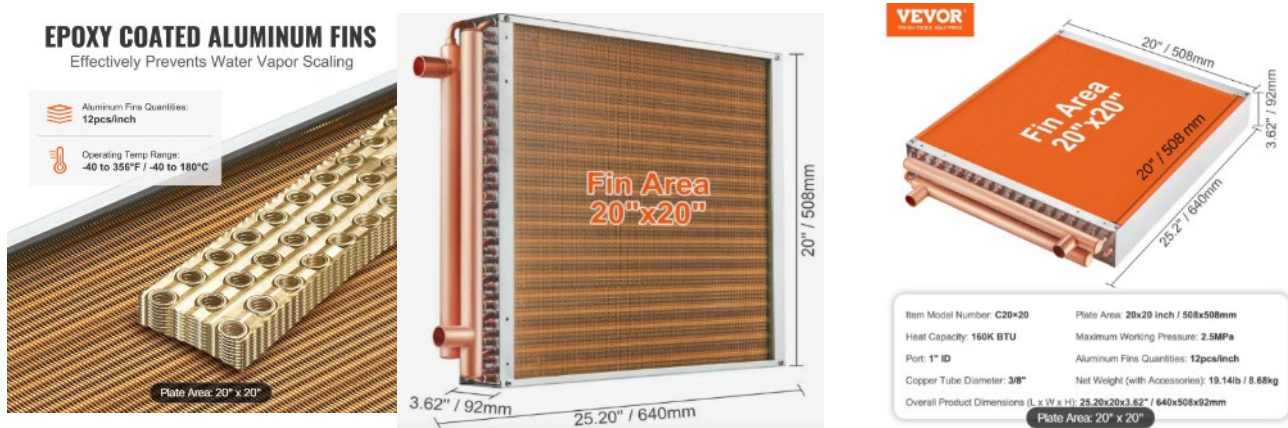


Figure 19: VEVOR Heat Exchanger Water to Air 242 Aluminium Fins Heat Exchanger for Forced Air Heating.

During detailed design, consideration will need to be given to:

- (1) Checking the pressure drop through the drying system accounting for the heat exchanger, ducting, elbows and vent;
- (2) Matching the air inlet dimensions to the heat exchanger cross section.
- (3) Optimal use of available waste heat.

6.15 Noise

The fan vendor (SKOV) specifies **75 dB(A) at 2 m and 45° from the exhaust** for the DA 1700-6. Logarithmic modelling estimates that the compounding impact of a wall of multiple fans produces a maximum noise of ~90 dB right at the wall where the fans are mounted but will fall away rapidly and be 85 dB at ~1.25m (i.e. no hearing protection required) and 50 dB at ~195 m (i.e. dB at a sensitive residential receptor).

7 Discussion

7.1 Coal Off-set Calculations: Paunch and Sludge Pellets

The base case design is the creation of paunch and sludge pellets to offset coal usage. A range of scenarios utilising sawdust blending was also considered.

The mass and energy balance showed that where 12 MWt of energy is obtained from biogas, the balance of 6.1 MWt can be obtained from a paunch-sludge-sawdust (10.23 wt.%) pellet.

7.2 Mass and Energy Balance on Blending Biomass Pellets into Coal Boiler

A key limitation in the existing coal boiler is the fuel bed height (historically limited to 6.5") which reduces the volume of fuel that can be added into the boiler. By utilising a dedicated biomass boiler, this volume limitation does not apply.

A 6.1 MWt (fuel consumption rated) boiler would use 6863 tpa biomass (20 hours per operational day, 250 days per annum) for pellets at 16.0 GJ/tonne LHV.

7.3 Capacity Expansion

The amount of biomass pellet produced can be increased by bringing other sources of biomass for blending with the paunch and sludge, which could include:

- Sawdust,
- Unrecyclable paper and cardboard,
- Green waste,
- Recycled construction / demolition timber,
- Forestry residues,
- Agri-residues.

7.4 Draft Facility Layout

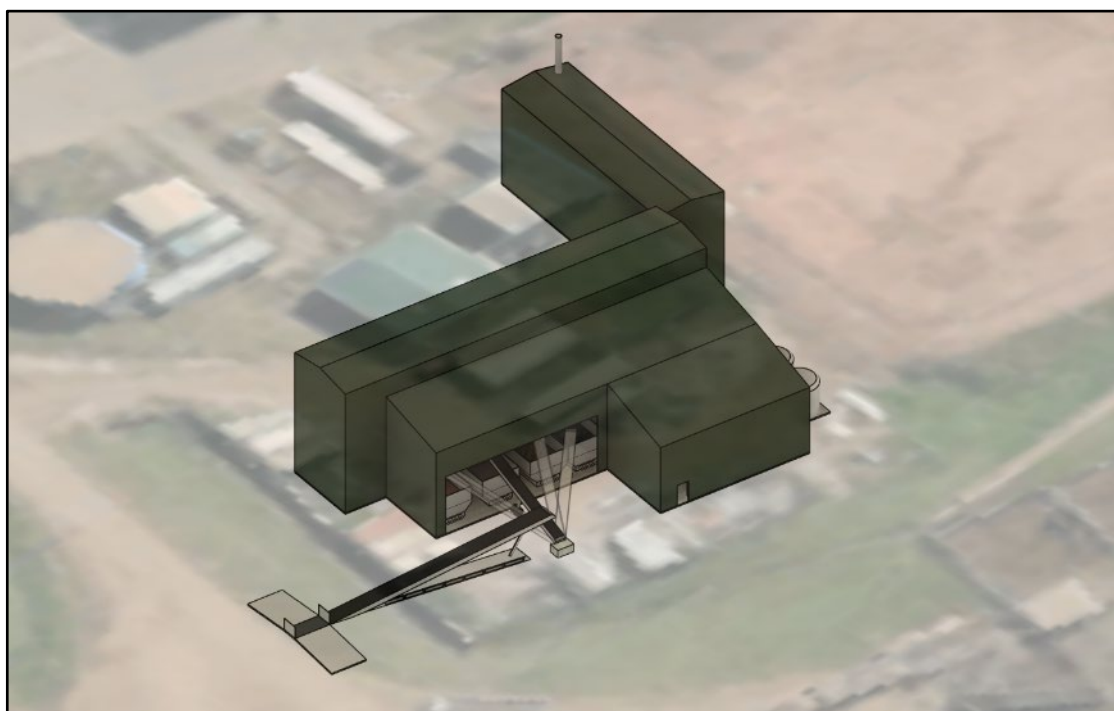


Figure 20: “Base Case” Isometric view of indicative layout showing greater detail on drive over receival grate (will be supported as there is approximately a 1m drop between the road and bottom of drainage culvert) and mobile conveyor for loading into separate hoppers.

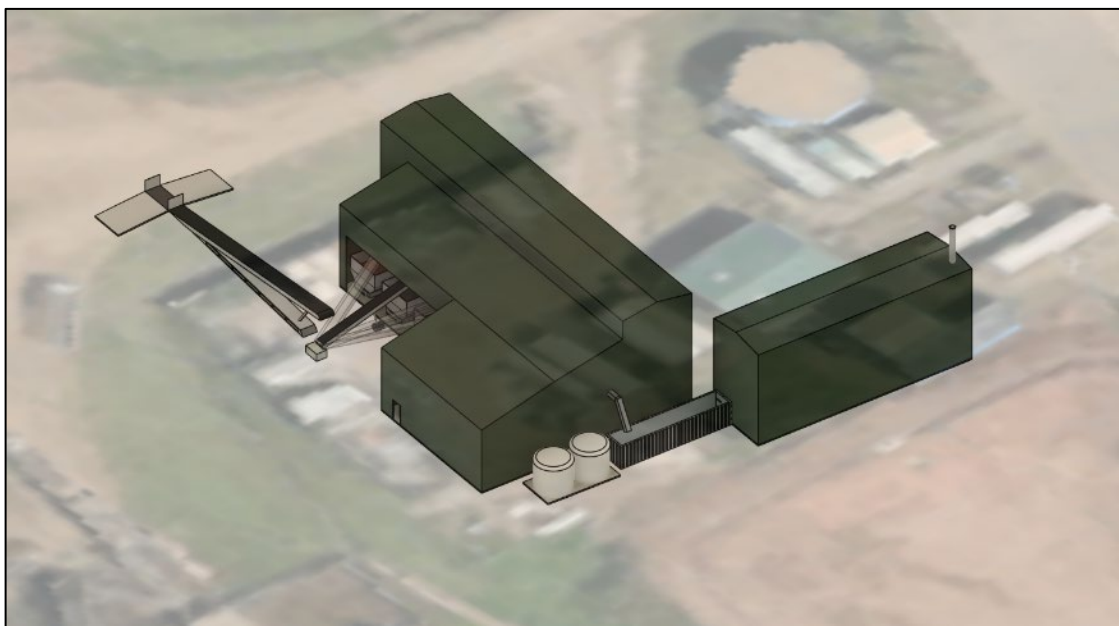


Figure 21: "Base Case" Isometric view showing chute from finished pellet elevator into 40' open top container, fed into biomass boiler.

7.5 GHG Emissions Estimates

Shown in the figure below is the National Greenhouse Emissions Reporting Scheme (NGERS) emissions associated with the coal combusted at site (red box) and the emissions associated with the paunch / sludge pellet (green box). As can be seen, per GJ of energy consumed, the overall GHG emissions would be 98.32% lower as the CO₂ from biomass is biogenic (alive within the last 100 years) with some minor nitrous oxide and methane emissions associated with combustion of fuel at elevated temperatures. The blue box shows the emissions associated with woodchip (very similar to biomass from industrial materials).

Schedule 1—Energy content factors and emission factors

(section 2.4, subsections 2.5(1), 2.6(1), 2.20(1) and 2.21(1), paragraph 2.38(2)(b), section 2.41, subsections 2.42(1) and 2.48(2), section 3.14, subsections 4.31(1), 4.42(1) and 4.55(1), section 4.60 and subsections 4.71(2), 4.94(2), 5.19(1), 5.37(1), 5.48(1), 5.53(2), 6.3(1) and (3), 6.5(1) and (4), 7.2(1) and 7.3(1))

Note: Under the 2006 IPCC Guidelines, the emission factor for CO₂ released from combustion of biogenic carbon fuels is zero.

Part 1—Fuel combustion—solid fuels and certain coal-based products

Item	Fuel combusted	Energy content factor GJ/t	Emission factor kg CO ₂ -e/GJ (relevant oxidation factors incorporated)		
			CO ₂	CH ₄	N ₂ O
1	Bituminous coal	27.0	90.0	0.04	0.2
10	Dry wood	16.2	0.0	0.1	1.1
11	Green and air dried wood	10.4	0.0	0.1	1.1
14	Biomass municipal and industrial materials, if recycled and combusted to produce heat or electricity	12.2	0.0	0.8	1.0

Figure 22: Emissions for different fuels from the National Green House Emissions Reporting Scheme Measurement Determination.

Key references:

- NGERS (Measurement) Determination
- Future Made in Australia (Guarantee of Origin) Methodology Determination 2025

- Commuting distances:

https://www.bitre.gov.au/sites/default/files/is_073.pdf#:~:text=The%20larger%20capital%20cities%20had%20relatively%20long,was%2011.5%20km%E2%80%94reflecting%20the%20smaller%20urban%20footprint.

- Ielab Scope 3 GHG emissions Factors, forecasted for 2021: 0.18 kg CO₂-e/\$
- AusLCI_1.42_EF_Published; <https://www.climatiq.io/data/emission-factor>
- National Greenhouse Factors, 2025.

The following Figure was generated by All Energy Pty Ltd utilising the data from the National Greenhouse and Energy Reporting (Measurement) Determination 2008². It is acknowledged that the Determination is silent on gross heating value versus lower heating value for materials and that in practice, especially for biomass, lower heating values can range dramatically especially as a function of moisture. However, the Determination is used for emissions reporting within Australia hence the numbers presented below are calculated for the main thermal energy sources utilised within Australia red meat processing plants.

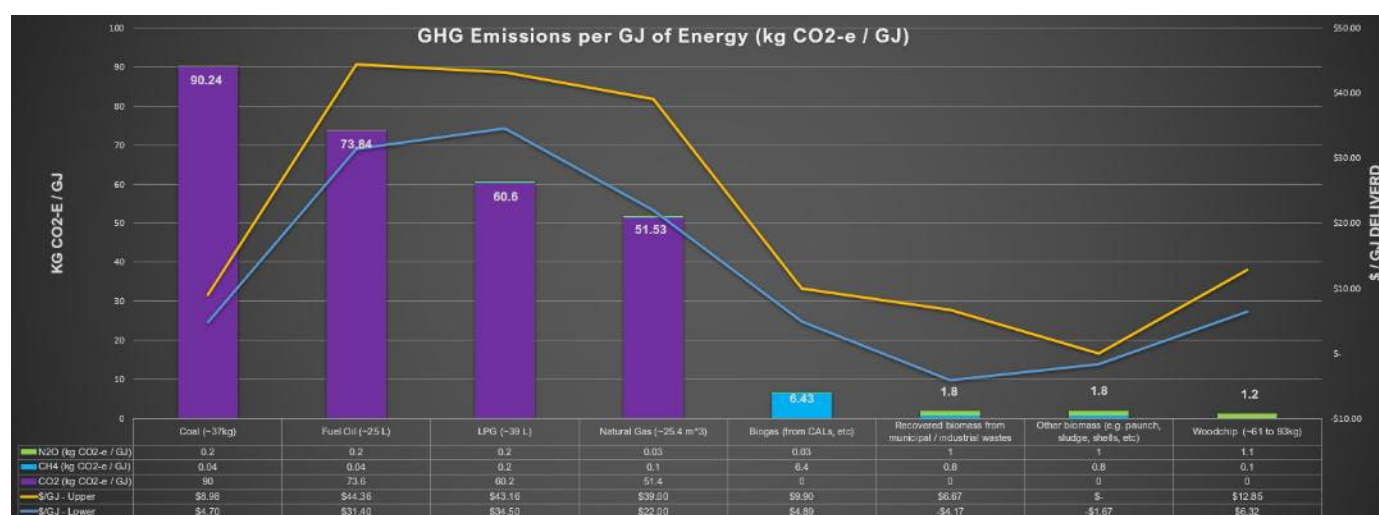


Figure 23: GHG emissions comparison between common RMP boiler fuels presented as kg of CO₂ equivalent (CO₂-e) per GJ based upon NGERS energy content and emissions factors. Energy cost estimates for “delivered including storage” on a \$ per GJ Lower Heating Value (i.e. taking moisture into account) have been estimated based upon H1 2024 east coast Australia data.

² National Greenhouse Emissions Reporting Scheme, Measurement Determination, <https://www.legislation.gov.au/F2008L02309/2022-07-01/text>

Summary of Project Scope 1, 2 and 3 Greenhouse Gas (GHG) Emissions Estimate for a 6.1 MWt biomass boiler offsetting coal (i.e. Alpha Scenario GHG emissions):

- Gross Scope 1 emissions savings from reduced coal combustion: 10,932.80 t CO₂-e pa.
- Net Scope 1 emissions savings from reduced coal combustion: 10,773.44 t CO₂-e pa (i.e. accounts for methane and nitrous oxide emissions from biomass combustion).
- Net Scope 1 & 2 emissions savings from reduced coal combustion: 9,788.38 t CO₂-e pa (i.e. accounts for electricity usage in the pelletising plant).
- Net Scope 1,2,3 emissions savings from reduced coal combustion: 11,277.83 t CO₂-e pa (i.e. accounts for reduced diesel usage and other upstream Scope 3 emissions).

7.7 Business Case – Base Case

A business case for the “Base Case” (paunch/sludge only pellet off-setting coal) is presented in the following table showing a 7.9 year payback for the TCI estimate in section 7.6. In this base case a paunch/sludge pellet only is used in the existing coal fired boiler to displace 34.57% of the site’s coal usage. Note that contingency was excluded from the business case analyses presented below. Year to date 2026 organics data invoice data was utilised to inform this business case, then extrapolated. to the target 250 operational days per annum yielded 19,696.73 tpa of organics.

7.7 Business Case – Optioneering

A range of Optioneering scenarios were modelled to consider impacts on the overall business case. The “Alpha Scenario” utilises a sufficient amount of sawdust to create a pellet for firing a 6.1 MWt boiler. A range of equipment optimisations were also implemented. The proposed “Alpha Scenario” can achieve a simple payback period of 5.3 years (excluding TCI contingency).

It is noted that the use of sawdust is not mandatory except in situations where feedstocks, particularly sludge, is abnormally high in moisture. However, in 2026 the \$/GJ LHV of sawdust was below the LHV of coal. Coupled with additional ACCU revenue there is a strong economic incentive to ensure sawdust replaces all coal requirements.

7.8 Sensitivity Analysis & Indexation

Sensitivity analysis was performed for the “Alpha Scenario” where the TCI was decreased by 30% (i.e. third party capital grant funding), decreased by 9.18% (average \$US to \$AUS foreign exchange change 2025 average to YTD2026; possible savings via procurement negotiation) then increased to +12.5% (minimum suggested contingency) to +25%.

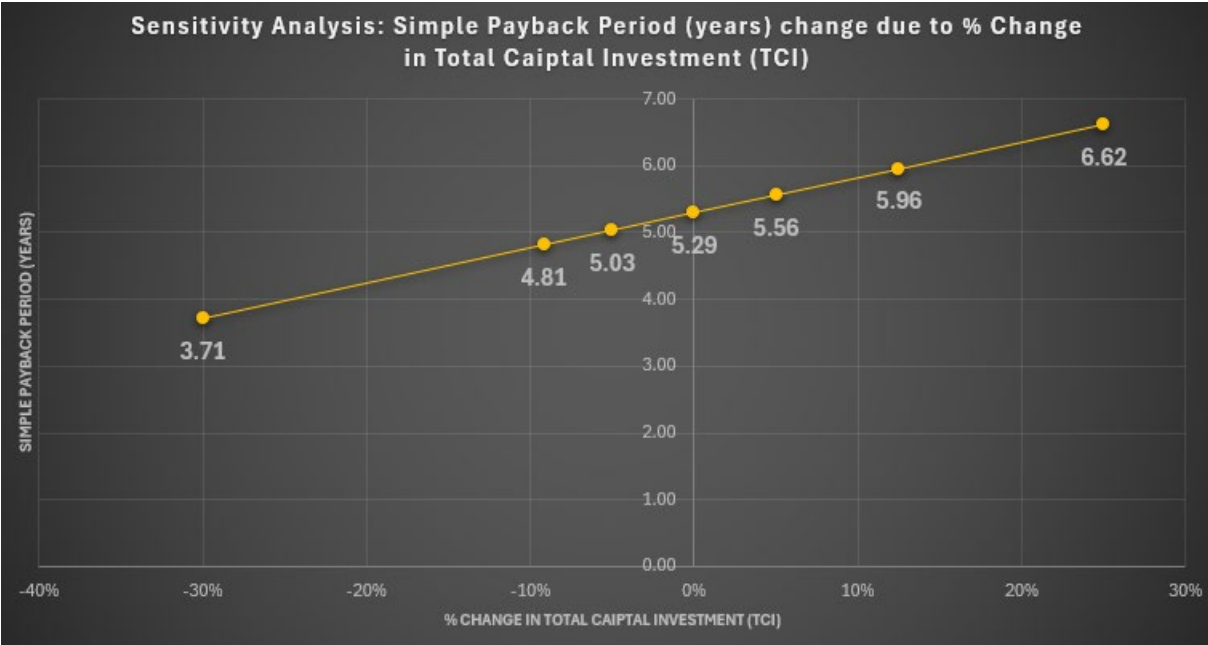


Figure 24: Impact of percentage change in Total Capital Investment (TCI) on the Simple Payback Period (years) for the “Alpha Scenario”.

The 25 year internal rate of return (IRR) was estimated at 18.62% (unindexed). An indexed scenario was modelled where organics handling costs are indexed at +\$10/tonne pa through to FY29-30 with all other revenue/savings and cost items indexed at +3.6% pa with the payback period estimated at 4.4 years (indexed) and the 25 year IRR estimated at 24.87% (indexed).

7.9 Waste Heat Utilisation

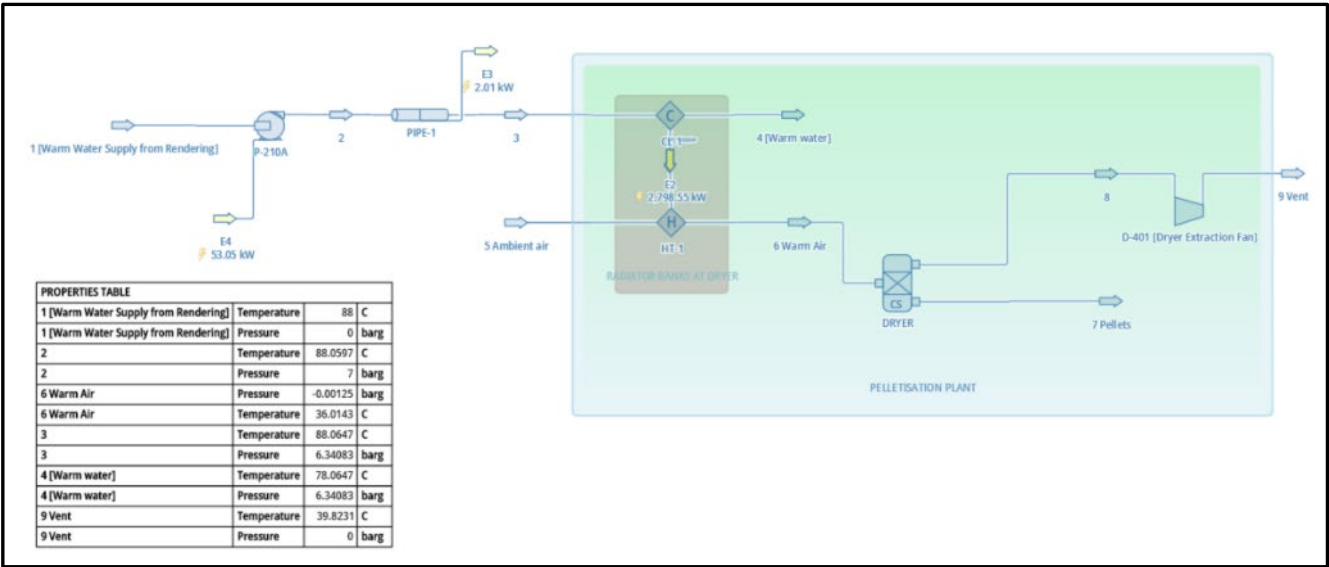
The economic advantages of send waste heat to the dryer have been excluded from this report, however the following section outlines some potential estimates.

A “Digital Twin” was developed based on 4000 L/m at 88 DegC hot water from the rendering plant into 21 fans of 36,100 m^3/h = 758,100 m^3/h. The dryer air is heated by 15.5 DegC when the hot water is cooled by 10 DegC. With a target dT of +3 DegC, then a hot water flow of 800 to 1500 L/m is modelled to be sufficient. Based on data for the week to 28th Sept 2026, this hot water was sent to an adjacent cooling tower 17.6% of the time. Using this hot water in the dryer / biomass system would reduce the load on the render plant cooling tower.

Assuming a dT of 10 DegC through evap towers for a flow of 3000 L/m for 1542 hours per annum, the water saving is estimated at 5139 kL pa, at the current bulk water rate of \$5.694 / kL this equates to \$29,261 pa in water savings. There are additional electricity and maintenance / chemical savings (not calculated).

The hot water can then report to the adjacent boiler plant as make up water / condensate return. Where rendering plant hot water is not available, heat could be utilised from the economiser / deaerator tank. Indeed, it may be that the render plant hot water reports to the biomass boiler plant first, then hot water sent to the drying plant as required.

Where two thirds of steam comes from biogas (12 MWt) and one third from biomass, then approximately 1000 to 1333 L/m of hot water from the rendering plant would be expected to be sent to the biomass boiler.



8 Conclusions

A key recommendation is to develop a strategy for the site to move to a 100% renewable thermal energy solution utilising biogas, biomass pellets and a suitably sized biomass boiler. A strategy should be developed to approach funding bodies at the State and Federal levels.

The “Alpha Scenario” is recommended to progress to detailed design and submission for grant funding.

From a capital utilisation perspective, a biomass boiler is more expensive per MWt at ~\$0.948 mil / MWt fully installed compared to a natural gas boiler at ~\$0.16 mil / MWt fully installed. Hence, it would be optimal to have the pelletisation plant and biomass boiler running at capacity with contingent capacity provided by a natural gas / blended biogas & natural gas boiler as this scenario would provide a lower overall CAPEX. A detailed steam demand strategy would consider the seasonality of this system.

The key sustainability credentials for this project include:

- Elimination of organic haulage off-site: 878 semi-trailer **load-outs** per annum,
- Elimination of coal trucks: 332 semi-trailer equivalent **deliveries** per annum,
- Net total truck movements (double the deliveries / load-outs) after accounting for sawdust deliveries: 1832 less semi-trailer equivalent truck movements per annum,
- GHG reduction: 11,278 t CO₂-e pa reduction in Scope 1, 2 and 3 Life Cycle emissions.
- Immediate loading of organics into a vessel within a negative pressure building envelope (rather than a stockpile) thereby reducing odour potential.
- Opportunity to reduce potable water and power consumption in evaporation towers (remove need to evaporate towers on render plant hot water system).

Renewable energy plants are suitable for funding from third parties / grant bodies at both the federal and state level. Some specific funds to follow closely at the state level are:

- **Resource Recovery Boost Fund.** \$170mil with \$60mil already handed out in Round 1 (\$20mil for small projects of <\$2mil; \$40mil for >\$2mil projects). Round 2 to be announced. Ref: [Resource Recovery Boost Fund - qld.gov.au](https://www.qld.gov.au/resources/recovery-boost-fund)
- **Waste Technology and Innovation Fund** — announced, not yet open — potentially relevant to recycled wood utilisation (as opposed to timber mill sawdust), but applications are not currently open. Queensland's new Less Landfill, More Recycling 2035 strategy includes \$11.7 million for this Waste Technology and Innovation Fund. The stated purpose is to support new waste technologies.
- **Residual Waste Fund** — announced, not yet open — specifically intended to support energy-from-waste. \$12.5 mil fund.
- Transforming Queensland Manufacturing Grants Program: up to \$1.5mil. [Queensland Government Grants Finder](https://www.qld.gov.au/resources/manufacturing-grants-program). Round 1 completed; Round 2 opening soon.

of biogas production against plant steam demand and size the biomass and biogas boilers accordingly.

Australia wide / federal options include:

- [Australian Renewable Energy Agency \(ARENA\)](#) for multi-million-dollar grants, with a culture of up to around 30% CAPEX funding.
 - Future Made in Australia Innovation Fund. [Current Grant Opportunity View - GO8141: GrantConnect](#)
 - Powering the Regions Industrial Transformation Stream. [Industrial-Transformation-Stream_Program-Guidelines_September-2025.pdf](#). Can support projects ranging from feasibility studies and front-end engineering and design (FEED) to trials, demonstrations and deployment. Two-stage projects combining a study and subsequent deployment will also be considered.
 - Advancing Renewables Program. [Advancing Renewables Program](#)
- Investing via equity / debt (92% or \$4.3 billion in debt funding, hence mostly debt) funding options via the **Clean Energy Finance Corporation (CEFC)**.
- Equity / debt funding options (e.g. For Rockhampton: **Northern Australia Infrastructure Fund (NAIF)** with 20 – 40% debt funding being quite common for NAIF.)

Other options include:

- Queensland Investment Corporation.
- Private funding groups (e.g. that may take an equity position in a special purpose vehicle (SPV).
- EaaS: Energy as a Service, also known as “Build Own Operate Maintain” (BOOM).
- Equipment financing.

9 Bibliography

Reference supplied in footnotes throughout the report.

10 Appendices

Appendix 1: Biomass pellets / coal ash analysis

Table 20: Ash analysis from burn trial.

Quantitative XRD Results wt.% - DL ~0.4wt% (semiquantitative) 0wt.% = bld

Phase	260868-1 Ash	260868-2 Ash	
Mullite	38.5	34	$3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ / $2\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$ SiO_2 SiO_2 (sodium aluminium silicate inclusions) $\text{NaAlSi}_3\text{O}_8$ C $\text{Ca}_9\text{Mg}(\text{PO}_4)[\text{PO}_3(\text{OH})]$ SiO_2 (no periodic crystalline arrangement)
Quartz	1.7	3.4	
Tridymite	0.3	0.3	
Albite	1	0.8	
Carbon-graphite	11.8	7.4	
Whitlockite	0	3.8*	
Amorphous glass	46.7	50.3	
Sum of Input	100	100	

Appendix 2: Sawdust data

Table 101: Lab data for different sawdust options.

Description	HARD WOOD SAWDUST		
	% ar	% ad	% db
Total Moisture	10.5		
Inherent Moisture		9.8	
Ash	0.9	0.9	1.0
Total Sulfur	0.02	0.02	0.02
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	4364	4398	4876

Sample Reference	NCL25-17064.003		
Description	HARD WOOD CHIP		
	% ar	% ad	% db
Total Moisture	15.2		
Inherent Moisture		11.3	
Ash	1.0	1.1	1.2
Total Sulfur	0.02	0.02	0.02
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	4090	4278	4823

Sample Reference	NCL25-17064.005		
Description	HARD WOOD FUEL		
	% ar	% ad	% db
Total Moisture	15.2		
Inherent Moisture		12.0	
Ash	7.1	7.6	8.4
Total Sulfur	0.04	0.04	0.04
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	3822	3966	4507

Description	GREEN WASTE - GW20		
	% ar	% ad	% db
Total Moisture	46.1		
Inherent Moisture		15.7	
Ash	26.9	45.0	49.9
Total Sulfur	0.12	0.20	0.22
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	1308	2046	2427

Sample Reference	NCL25-17064.004		
Description	PINE FUEL		
	% ar	% ad	% db
Total Moisture	10.3		
Inherent Moisture		8.4	
Ash	10.4	10.5	11.6
Total Sulfur	0.02	0.02	0.02
	kcal/kg ar	kcal/kg ad	kcal/kg db
Gross Calorific Value	4052	4138	4517

ar = As Received
ad = As Determined
db = Dry Basis

