Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Pelletisation Feasibility Study

Project code
2021-1212

Prepared by
All Energy Pty Ltd

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Contents

1.0 Author

ALL ENERGY PTY LTD (AEPL) is a Queensland owned and operated high-tech engineering company. AEPL is an award winning Australian company with accolades in the areas of renewable energy, water recycling, sustainability, green chemicals, and digital twins.

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Sub-contractor (pelletisation plant OEM):

Pelleton Renewables Pty Ltd

3.0 Glossary & Definition of Terms

DAF	Dissolved Air Flotation (technology for removing particles down to ~15 µm from liquid)
GJ	Gigajoules (unit of energy).
Green stream	Washdown of offal processing. High TSS from paunch and other grit. Typically lower FOGs and N content than red stream.
HHV	Higher heating value (heat of combustion, assumes all heat in water vapour is recovered).
kWe	kilowatts of electrical energy
kWh	kilowatt-hours. Within this report refers to kWh of electrical energy
kWt	kilowatts of thermal energy
LHV	Lower heating value (heat of combustion taking into account the presence of water, with water staying in a vapour phase after combustion). This is the “practical” heat available from fuels.
Paunch	Rumen stomach contents.
Red Stream	Liquid waste from rendering plant
RMP	Red Meat Processor
Sludge	Residual solids from WWTP process, including Waste Activated Sludge (WAS) and sludge produced by the DAF system (refer report for more information).
Yellow stream	Wash down water from lairage

4.0 Executive summary

This report summarises a feasibility study for the production of a renewable energy pellet suitable for co-firing in an existing coal fired boiler at an Australian Red Meat Processor (RMP) facility. Key variables are the moisture content of the paunch, sludge and sawdust. Sawdust is utilised as the economics of incorporating sawdust at $7.31 (10% moisture) to $9.80 (30% moisture) / GJ LHV is strong compared to coal at $10.46 / GJ LHV, plus avoids capital costs of dewatering equipment for the feedstock. The additional cost of more low moisture sawdust is almost balanced out by the value in the additional pellets, as shown below.

The key metrics are summarised in the table below.

Metric	Feasibility study findings
Total Capital Investment (owner's costs excluded).	$7.543 mil. Refer Appendix 2 for detailed information.
Annual operational and maintenance costs for 10% to 30% moisture sawdust	$0.971 to $1.213 mil pa
Annual cost savings and revenue for 10% to 30% moisture sawdust	$2.39 to $2.59 mil pa
Net EBITDA for 10% to 30% moisture sawdust	$1.42 to 1.39 mil pa
Simple payback for 10% to 30% moisture sawdust	5.31 to 5.46 years
IRR first 20 years without indexation (assumes emissions reduction value remains constant)	17.6 to 18.1 %
Scope 1, 2 & 3 Life Cycle Assessment GHG emissions reduction	5044 to 6261 t CO2-e pa (at 41.7 and 51.7% coal offset)

Where the $/GJ LHV of sawdust remains lower than coal, there exists the opportunity to produce more pellets thereby offsetting more coal.

Further, the use of more sawdust enables the capture of more suspended solids / sludge from the primary wastewater (estimated at up to 14,900 tpa sludge utilisation compared to the "business as usual" base case of 8,355 tpa, both assumed at 17% solids) thereby reducing pond aeration, WWTP operations and outfall costs. More boiler fuel is then made out of the recovered suspended solids that otherwise are "burnt off" in the ponds (consumed via aerobic microbes). Some low energy options include lamellar flow separators, sand bed filters and DAF. As the red stream already goes through a DAF, the green stream would be the first target for this opportunity. By procuring 1716 tpa of sawdust, towards 5250 tpa of pellets is estimated to be produced, offsetting 60.3% of coal usage, with a 5.0 year payback being achieved (19.6% IRR over first 20 years); this excludes the economic advantages of removing solids from entering the WWTP.

Sale of pellets as organic fertilizer for $359.50 / tonne provides a 3.5 year payback and an IRR over 20 years of 28.8%, noting that the viability of fertilizer depends upon the sale price and market demand for 5250 tonnes per annum of pellets (with one viable scenario being the sale of some pellets as premium organic fertiliser with the balance used as boiler fuel).

5.0 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 (after taking volume and loading rates into account, $86.19 per tonne for paunch and $130.52 per tonne for sludges).

Further, there is a demand for low emissions fuels to reduce Scope 1 green house 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.

6.0 Methodology

6.1 Basis of design

The following table summarises the basis of design for the pelletisation plant.

TARGET: 75% moisture	30% Moisture Content Sawdust							
	Material	**"As delivered" tpa**	**tpd 5 dpw, 50 wpa.**	**kg/h (5 dpw, 20 hpd, 50 wpa)**	**Moisture**	**Solids**	**Dry weight as delivered**	**Water in substrate "As delivered"**
	Paunch solids	7,050	28.2	1,410	81%	19%	1,339.43	5,710
	Combined sludge (DAF+WAS+screenings)	8,355	33.4	1,671	83%	17%	1,420.29	6,934
	Subtotal from Jul '25 - Jan '26 Invoices.	15,404	61.6	3,081	82.1%	18%	2,760	12,645
	Minus 9% for screenings & contamination	14,018	56.1	2,804	82.1%	18%	2,511.34	
	Sawdust [Goal Seek to 75% final moisture]	2199.09			30%	70%	1,539.36	
	TOTAL ORGANICS TO EXTRUDER	16,217			75%	25%	4,050.71	
	Final Dry Pellets (assumes minimal volatiles losses during drying)	***4,501***	18.0	563	10%	90%	4,050.71	
TARGET: 78% moisture	10% Moisture Content Sawdust							
	Material	**"As delivered" tpa**	**tpd 5 dpw, 50 wpa.**	**kg/h (5 dpw, 20 hpd, 50 wpa)**	**Moisture**	**Solids**	**Dry weight as delivered**	**Water in substrate "As delivered"**
	Paunch solids	7,050	28.2	1,410	81%	19%	1,339.43	5,710
	Combined sludge (DAF+WAS+screenings)	8,355	33.4	1,671	83%	17%	1,420.29	6,934
	Subtotal from Jul '25 - Jan '26 Invoices.	15,404	61.6	3,081	82.1%	18%	2,760	12,645
	Minus 9% for screenings & contamination	14,018	56.1	2,804	82.1%	18%	2,511.34	
	Sawdust [Goal Seek to 78% final moisture]	837.59			10%	90%	753.83	
	TOTAL ORGANICS TO EXTRUDER	14,855			78%	22%	3,265.17	
	Final Dry Pellets (assumes minimal volatiles losses during drying)	***3,628***	14.5	453	10%	90%	3,265.17	

Allowing for 9% by mass (wet weight) as screenings and contaminant, the final pulp is 14,018 tpa, which after processing is ~3572 tpa of 10% moisture pellet.

Material	Bulk loose packed density kg/m^3	Ash % DW	Total Carbon (TC %)	VM (VM/TS%)	CV - Gross Dry GJ/t	CV - Net wet GJ/t
Paunch solids	265	10.26667	42.66	72.03	17.3	2.96
Combined sludge	838	11.20%	48.4	79.70	22.5	14.27
TOTAL		10.8%	45.8%	76.2%	20.09	9.09

Colour Legend:

Earlier works
Calculated
Lab data / Site Data / Invoice data
Pelleton Renewables Pty Ltd Data

The goal is to create a mixed slurry of approximately 22% to 25% moisture mixed slurry for pelletisation. Sawdust is added to control the moisture percentage as it avoids the need to additional CAPEX and OPEX for pre-drying. Additionally, where the $/GJ for biomass is lower than that of coal, pelletisation offers a route to “upgrade” low value biomass to boiler fuel. There are no waste cardboard / paper products generated for consideration as all of these materials are recycled.

The pelletisation plant is designed to process 62 tonnes per day of organic wastes into dried pellets. Individual equipment items generally have a design margin of +30 to 100% above nominal duty. The dryer is designed to operate for 7200 hours per annum or 82.2% utilisation (6 days per week, 300 days per year), with the other unit operations operating for 20 hours per day, 5 days per week or 57.1% utilisation.

6.2 Biomass Pellets

There are two different types of heating value, which are the lower heating value (LHV) and the higher heating value (HHV). By definition the higher heating value is equal to the lower heating value with the addition of the heat of vaporization of the water content in the fuel (i.e. the HHV may be thought of as the available heat where all of the energy within any water vapour is recovered via the condensation of the water). Within a commercial boiler system, the flue gas is maintained >115 DegC, hence it is the LHV that provides the practical amount of available heating from a boiler fuel.

Total Moisture	
Moisture, % (ar)	14.1
Ash Content at 550°C	
Ash, % (db)	9.3
CHN	
Carbon, % (db)	48.6
Hydrogen, % (db)	6.5
Nitrogen, % (db)	4.1
Calorific Value	
Gross Dry Calorific Value, MJ/kg (db)	21.0
Gross Wet Calorific Value, MJ/kg (ar)	18.1
Net Wet Calorific Value, MJ/kg (ar)	16.6
Halides	
S, % (db)	0.27
Cl, % (db)	0.15
Br, %(db)	<0.01
I, % (db)	<0.01
F, % (db)	<0.01

Mathematically the relation between both values can be expressed by the following formula [2006 IPCC Guidelines, Vol. II, Section 1.4.1.2, Box 1.1] Equation 16: Conversion of higher to lower heating values in GJ/t (= MJ/kg)

$$LHV = HHV - 0.212 \times H - 0.0245 \times M - 0.008 \times Y$$

HHV = Higher heating value

H = Percent hydrogen

M = Percent moisture

Y = Percent oxygen from an ultimate analysis which determines the amount of carbon, hydrogen, oxygen, nitrogen and sulphur as received.

Utilising the above equation and the HRL data, for a pellet with 10.0% moisture, a LHV of 17.38 GJ/t is estimated which is the value utilised in the business case.

6.3 Original Boiler Design

The original boiler design incorporated a coal and paunch blending system. The paunch system was decommissioned due to clogging of the feeding system (pre-2016, exact date unknown).

The boiler feeding system has a capacity of 0.7 kg/sec (2.52 tph), and can be reduced down to 0.18 kg/sec. Where the typical coal usage rate is 1.296 tph, a 60.3% pellet / 39.7% coal blend would require 1.66 tph which is below the rated fuel feeding rate of 2.52 tph.

6.4 Emissions to Air - Previous Works

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

NOx (nitrogen oxide) emissions: switching to biomass is expected to bring the boiler operating emissions well within the acceptable NOx limit of 500 mg/Nm^3.

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

Table 4: Stack emissions results.

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 are statistically significant. The results are summarised in the following table.

Table 5: 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 x 10^-22	Very strong evidence of a statistically significant variation in SO2 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 SO2 levels between 80% paunch / 20% woodchip and 100% woodchip
NOx: 80% paunch / 20% woodchip and 100% woodchip	0.873	No evidence that there was a statistically significant variation in NOx levels between 80% paunch / 20% woodchip and 100% woodchip
Comparing all fuels for NOx, SO2 and CO.	2.8 x 10^-121; 2.5 x 10^-262; 6.4 x 10^-103	Very strong evidence of a statistically significant variation in chemistry between all fuels.

A trial using the boiler, in a following phase of work, can confirm the impact to emissions on pelleted utilisation.

On sulphur, it is noted that the sampled coal was 0.43% mass dry weight [0.180 kg S / GJ LHV] versus 0.23% mass dry weight [0.132 kg S / GJ LHV] for the pellets (i.e. a 26.7% reduction per GJ of energy). With sawdust at 0.0 to 0.1% S, there exists the opportunity to reduce sulphur amounts even further.

Carbon monoxide and nitrous oxide emissions are predominantly associated with the combustion occurring within the physical boiler itself i.e. NOx is produced by the reaction of N2 and O2 and CO is produced during the partial combustion of fuels. Hence, if NOx 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 NOX / CO. NOx 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 NOX 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% 14.0% for current fuel sources [4.39 kg / GJ LHV; 4.09 kg / GJ HHV], hence a keen area of interest will be particulates during burn tests.

6.4 Current Fuel Utilised

The original fuel specification was 6 to 25 mm; however the boiler was operated on unwashed RoM coal (wash plant conveyor spill) with a specification of 0 – 25 mm for a period of time. The current coal vendor states a LHV of 24.28 GJ/t. Particle size sampling showed a top size of 25 - 35 mm (15.8%) down to <0.4mm (1.35%). The presence of a very wide particle size distribution, high ash (11 to 14% for air dried coal), and in particular, particles < 0.9 mm (~1.61%) may be a contributing factor to elevated particulate emissions when compared to a biomass pellet with a tight 10 – 20 mm size, no fines, and lower ash content. A future AMPC project / All Energy Pty Ltd Research Provider will consider particulate, NOx, CO, and SOx emissions for a biomass pellet versus coal in an industrial boiler system.

6.5 Fuel Fluidisation

The fluidisation properties of the fuel need to be considered due to the requirement for boiler fuel to reside within the combustion chamber without being blown out before complete combustion. The key parameters are the particle size and the true density of the particle (estimated at 0.9 to 1.2 t/m^3, to be determined during the next phase of works). With the ash content of the pellets expected to be lower than coal and, a tight particle size distribution within the "spoutable" zone (refer below), it may be anticipated that particulate emissions could be reduced.

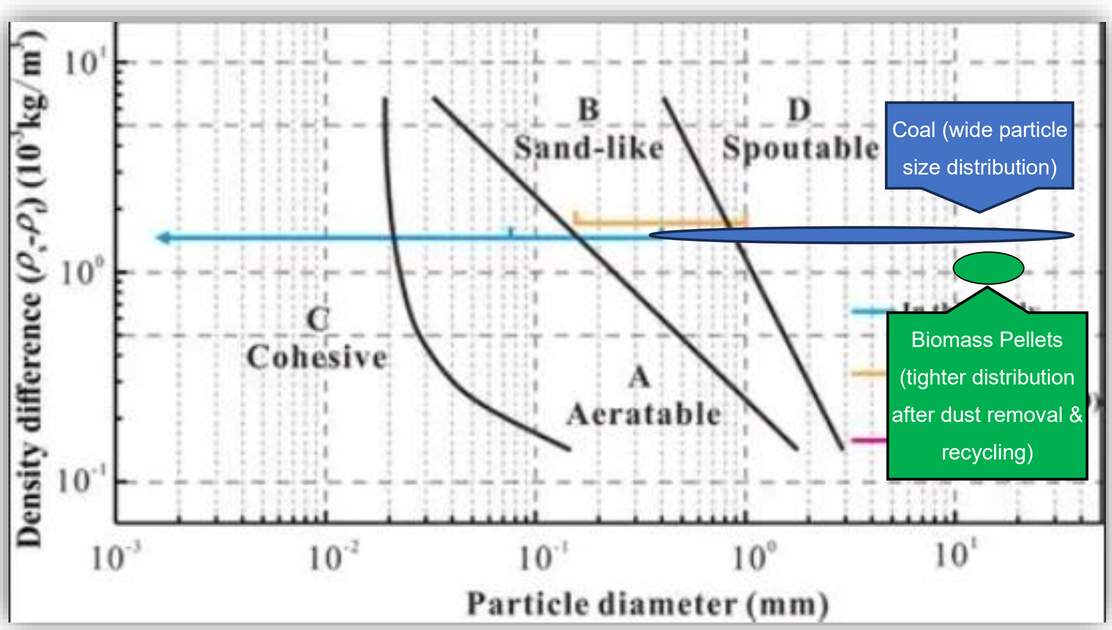


Figure 1: Impact of particle density and diameter on fluidisation characteristics of boiler fuels. The coal properties are shown in blue (wide distribution) with the biomass pellets shown in green (lower true density, but a tighter particle size distribution).

The size of the pellets will be in the range of 15mm to 30mm (1/2'' to 1 ¼'') wet, then will shrink as desiccated towards approx. 10 to 20 mm. The size of the extruder dye can be changed to manufacture pellets of the desired size.

6.6 Pelletisation Plant OEM

The pelletisation plant OEM selected was Pelleton Renewables Pty Ltd (contact: Brian Donald, E: Brian.Donald@pelletonrenewables.com; www.pelletonrenewables.com).

The following were excluded from the OEM's scope:

Original Exclusion Communication	Allowances made in Total Capital Investment (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 large 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 Renewables Pty Ltd 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 Renewables Pty Ltd 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

7.0 Results

7.1 Block Flow Diagram

The details of the pelletisation plant are commercial in confidence, however provided below is a simplified block flow diagram.

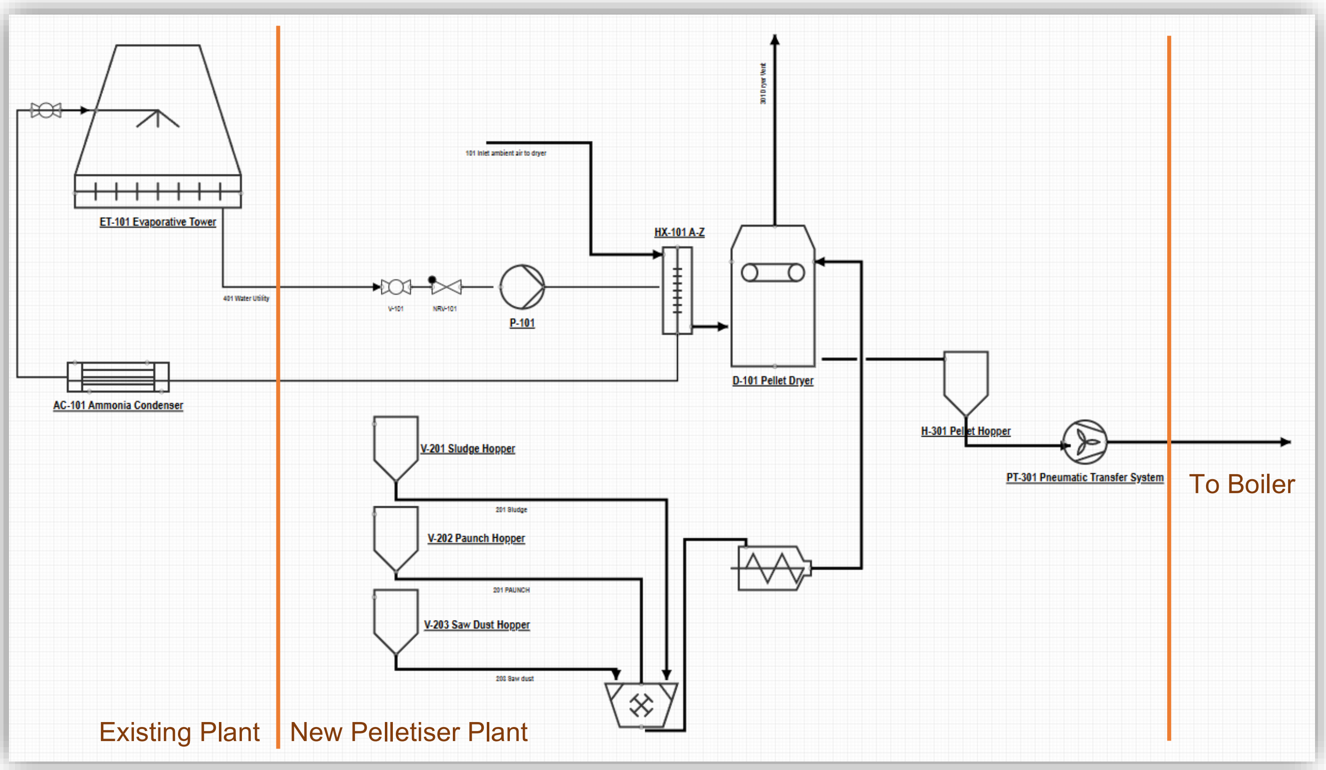


Figure 2: Simplified Block Flow Diagram for a pelletisation plant.

7.2 Waste Heat Utilisation

An exciting opportunity for organics pelletisation in a red meat processing (RMP) plant is for the drying system to provide a “heat sink” for low grade heat to save power and water in existing systems (such as evaporative cooling towers / condenser towers).

For an RMP with onsite refrigeration, it is common for the “engine room” (ammonia refrigeration system) to draw upon cooling water (say 28 DegC), heat exchange with hot ammonia to condense the ammonia refrigerant then return the cooling water at +7 DegC (say 35 DegC) to an evaporative cooling tower where the water is then cooled to approx. 5 – 10 DegC above the ambient wet bulb temperature (assumed at 28 DegC for the model below).

The following “Digital Twin” (Advanced Process Model) outlines the opportunity where a pelletisation system for a medium sized red meat processing plant can obtain 1.7 MW of Direct Air Cooling (also called “free cooling”) by heating the air for a dryer using the hot water outlet from an ammonia refrigeration system before this water reports to the evaporation towers (making use of the wet bulb temperature). Placing what is effectively a “Direct Air Cooler” of this size before the evap towers would save an estimated 63.6 kL per day in evaporated water, rising to 79.5 kL per day when blow down is included (worth approx. $143,000 pa in water savings alone, plus savings in avoided capital for evap towers, chemicals and equipment wear).

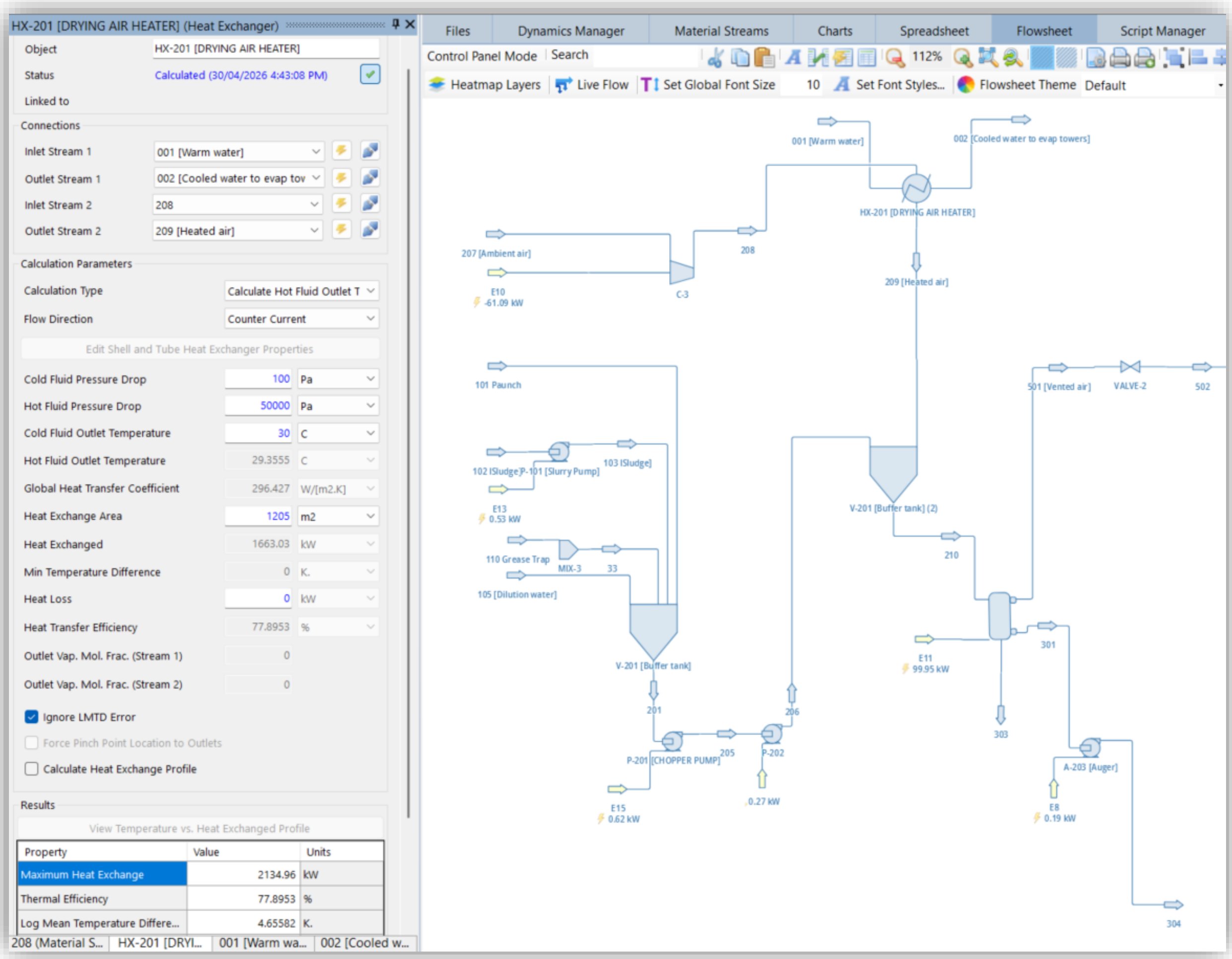


Figure 3: Digital twin for system providing heated drying air for a pelletiser plant.

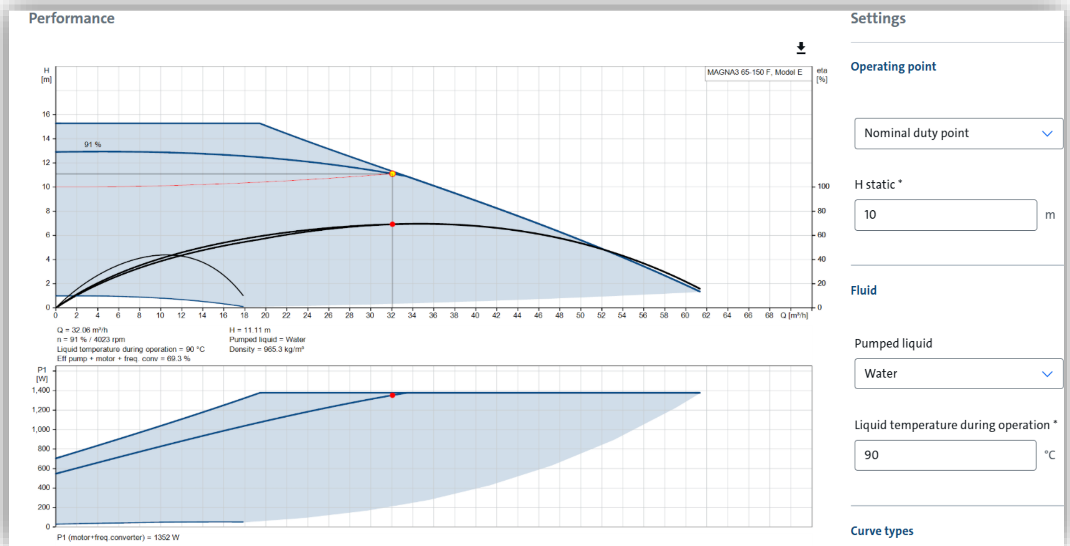
Alternatively, the condensate return tank can be used as a source of waste heat (7.2m to the building envelope; 40m to the drying unit operation) where temperatures higher than ~30 DegC are required, however due to the large volumes of air the use of this energy may eventually be seen in additional load on the boiler. During operational shifts, steam is freely released from the top of this vessel hence it is an adjacent source of waste heat that could be utilised for heating the drying air. The hot water (up to 98 DegC) can be pumped to the air dryer system, then through a radiator to heat the drying air, then return to the condensate tank.

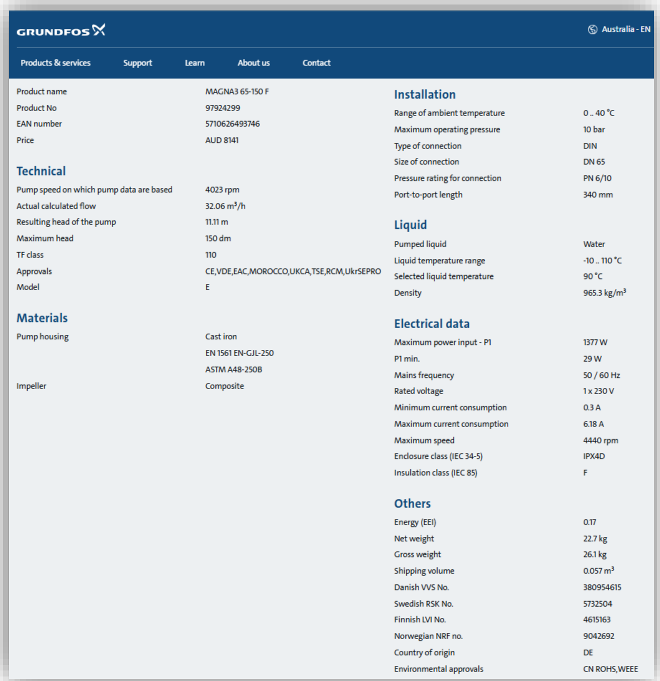
A suitable hot water to air heat exchanger (radiator; Heat Exchanger Water to Air multi-aluminium fins Heat Exchanger for Forced Air Heating) was selected; a drying system may have towards 14 or more air inlets, hence as many of these radiators as required can be utilised to achieve the desired increase in air temperature. These systems are rated from -40 to +180 DegC and up to 25 Bar. Air side pressure drop is routinely 150 to 400 Pa.

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 / fitting the fan ducting cross section to the heat exchanger cross section.
(3) Optimal use of available waste heat.

The Grundfos MAGNA3 65-150 F (No. 97924299)[1] was selected due to being designed to pump hot water to 110 DegC and designed specifically for commercial hot water circulation. The pump can operate to 10 Bar. At 32 m^3/h (shown below) a supply temperature of 90 DegC and a return temperature of 72.6 DegC, the dT of the total drying air would be 2 DegC (i.e. drying air 2 DegC warmer than incoming air) with the heat exchanged modelled at 628 kW. In practice, the drying air would not always require heating, further only a portion of the drying air may require heating (i.e. the final stages of drying). Electrical load modelled at 1.96 kW.





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Product name	MAGNA3 65-150 F
Product No	97924299
EAN number	5710626493746
Price	AUD 8141

Technical

Pump speed on which pump data are based	4023 rpm
Actual calculated flow	32.06 m³/h
Resulting head of the pump	11.11 m
Maximum head	150 dm
TF class	110
Approvals	CE,VDE,EAC,MOROCCO,UKCA,TSE,RCM,UkrSEPRO
Model	E

Materials

Pump housing	Cast iron
	EN 1561 EN-GJL-250
	ASTM A48-250B
Impeller	Composite

Installation

Range of ambient temperature	0 .. 40 °C
Maximum operating pressure	10 bar
Type of connection	DIN
Size of connection	DN 65
Pressure rating for connection	PN 6/10
Port-to-port length	340 mm

Liquid

Pumped liquid	Water
Liquid temperature range	-10 .. 110 °C
Selected liquid temperature	90 °C
Density	965.3 kg/m³

Electrical data

Maximum power input - P1	1377 W
P1 min.	29 W
Mains frequency	50 / 60 Hz
Rated voltage	1 x 230 V
Minimum current consumption	0.3 A
Maximum current consumption	6.18 A
Maximum speed	4440 rpm
Enclosure class (IEC 34-5)	IPX4D
Insulation class (IEC 85)	F

Others

Energy (EEI)	0.17
Net weight	22.7 kg
Gross weight	26.1 kg
Shipping volume	0.057 m³
Danish VVS No.	380954615
Swedish RSK No.	5732504
Finnish LVI No.	4615163
Norwegian NRF no.	9042692
Country of origin	DE
Environmental approvals	CN ROHS,WEEE

Figure 4: Pump suitable for up to 110 DegC hot water performance curves (Reference: Grundfos).

[1] MAGNA3 65-150 F - 97924299 | Grundfos, accessed 31 March 2026.

7.3 Sludge Transfer System

The dewatered WAS and DAF sludge will be transferred from a port on the existing sludge hopper via the use of a rotary lobe pump which provides a low shear solution for moving sludge from the WWTP hopper against an elevation of 12 m and a distance of 65 m. The long run sludge average is 0.95 tph, however assuming operation for 50 weeks pa, 5 days pw, 20 hours per day, a flow of 1.671 tph is required during production hours. Multiple tie-in points to the hopper will reduce the chance of clogging. Alternatively, a T-section with suitable valving can be installed to the end of the auger for extraction of the sludge.

VOGELSANG Data sheet

Date: 19.12.2012

Customer:
Project: Tarnaveni wwtp
Project pos. no.: 1 (piggy-back)

Type: VX136-105Q

Process conditions

Medium: Primary sludge, 20,0 °C
Required volume flow: 25 m³/h
Pressure at inlet: 0,0 bar
Pressure at discharge: 3,0 bar
Differential pressure: 3,0 bar
Shaft deflection: 0,083 mm
Density: 1000,0 kg/m³
Temperature: 20,0 °C
Viscosity: 1,0 mPas
pH value: neutral
Dry matter content: 5 %

Design data

Operating points:

m³/h	Hz	min⁻¹	kW
25	50	281	3,9

Starting torque: 145 Nm
Operating torque: 132 Nm
Max. requ. operating power: 3,9 kW
Volumetric efficiency: 75,23%
NPSHR (water, 20 °C): 2,00

Pump specification

Housing segments: Grey cast iron 250
Wear plates: HVSS High wear resistant special steel
Shaft Ø pump chamber: 60 mm
Lobes: NBR / HiFlo / 4 Wings
Max. free passage : 40 mm
Seal type: Blockring SS 304 Cr2O3/Duronit
Seal carrier: Mild steel, nitrated
Pressure disc/strain screw: Mild steel
O-rings in touch with medium: NBR
Buffer chamber medium: Oil
Buffer chamber options: Buffer fluid tank, pressurised
Shaft deflection/bar: 0,028 mm

Assembly specification

Motor manufacturer:
Motor type: M132/MX6-955
Drehzahl (min^{-1}): 955 min^{-1}
Power: 5,5 kW
Voltage: 400/690 V
Frequency: 50 Hz
Isolation class: F
Motor efficiency classification:
Thermistor sensor: ☑ Yes ☐ No
Drive is suitable for the enlarged temperature range of -20 °C to +45 °C.
Connector left: 90° bend to shaft DN125, With flange according to DIN2633 PN16
Connector right: 90° bend for base, type belt drive 4", With flange according to ANSI B16.5 150lbs RF
Connector material: Galvanized
Base: Base, type belt drive bended, galvanized
Type of drive: Belt drive (i=3,4)
Coupling or belt guard: Belt guard, galvanized
Total weight: Approx. 310 kg

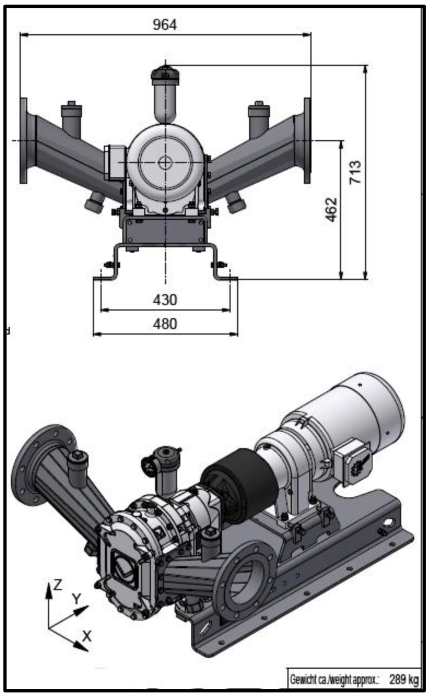


Figure 5: Sludge pump option.

Consideration needs to be given to shearing within the unit operations (i.e. pumping) and its impact on the substrates.

7.4 Materials Storage / Buffer Capacity

Outlined in the table below is the buffering capacity presented in hours (of 446 kg/hour final pellets) from the buffer silos through to the inlet to the boiler fuel screw.

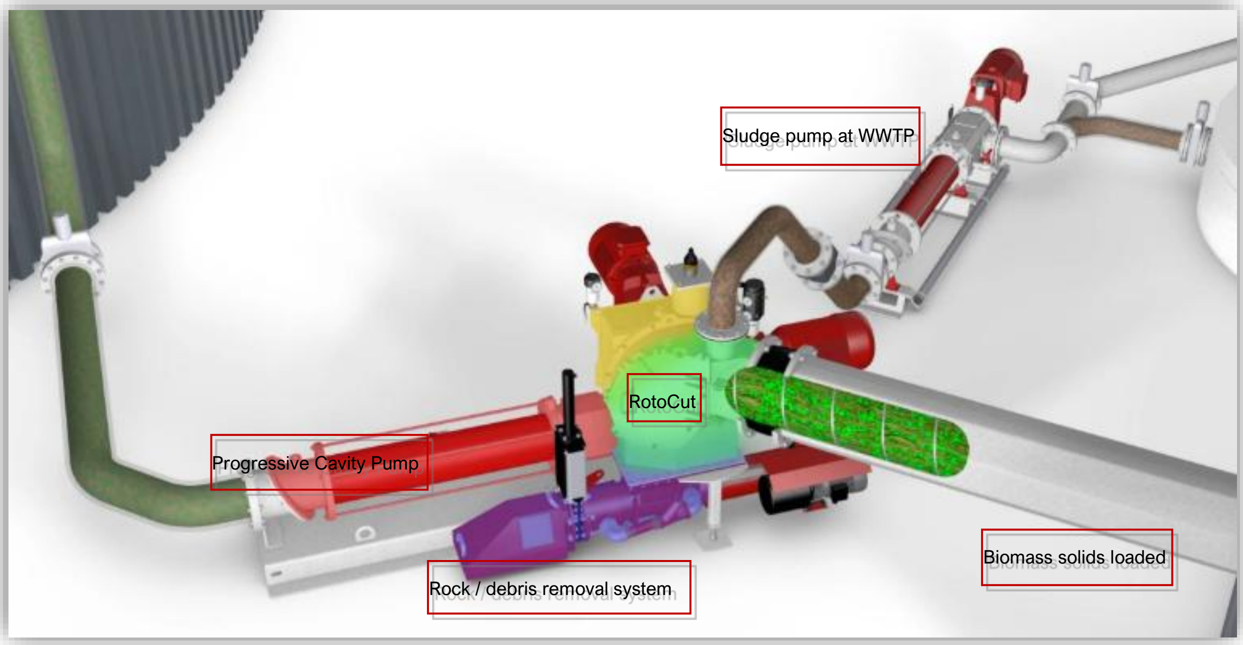
The specific example is a plant wide shut down / pause or breakdown in upstream equipment resulting in paunch and/or sludge no longer being produced by the main RMP site.

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. With the buffering estimated at 50 to 55 hours, this is considered sufficient for a "just in time" approach. 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 built back up early each day.

Unit Operation	Hours storage – Equivalent of 446 kg/h pellets
Sludge silo; 30m^3 [Paunch silo; 30m^3]	15.05 [5.63 + 3.75 for 20m^3 dump truck]
Final pellets silo; 30m^3	22.11
Surge tank	0.62
System Inventory (dryer plus balance of plant and materials handling equipment)	18.00
Pneumatic system	0.16
TOTAL	**55.78 hrs for sludge as limiting item** **50.11 hrs for paunch as limiting item**

7.5 Option for Paunch and Sludge Mixing

This solution is not finalised and requires testing to confirm viability for WAS handling. A key consideration is how to de-grit paunch without the addition of additional moisture.



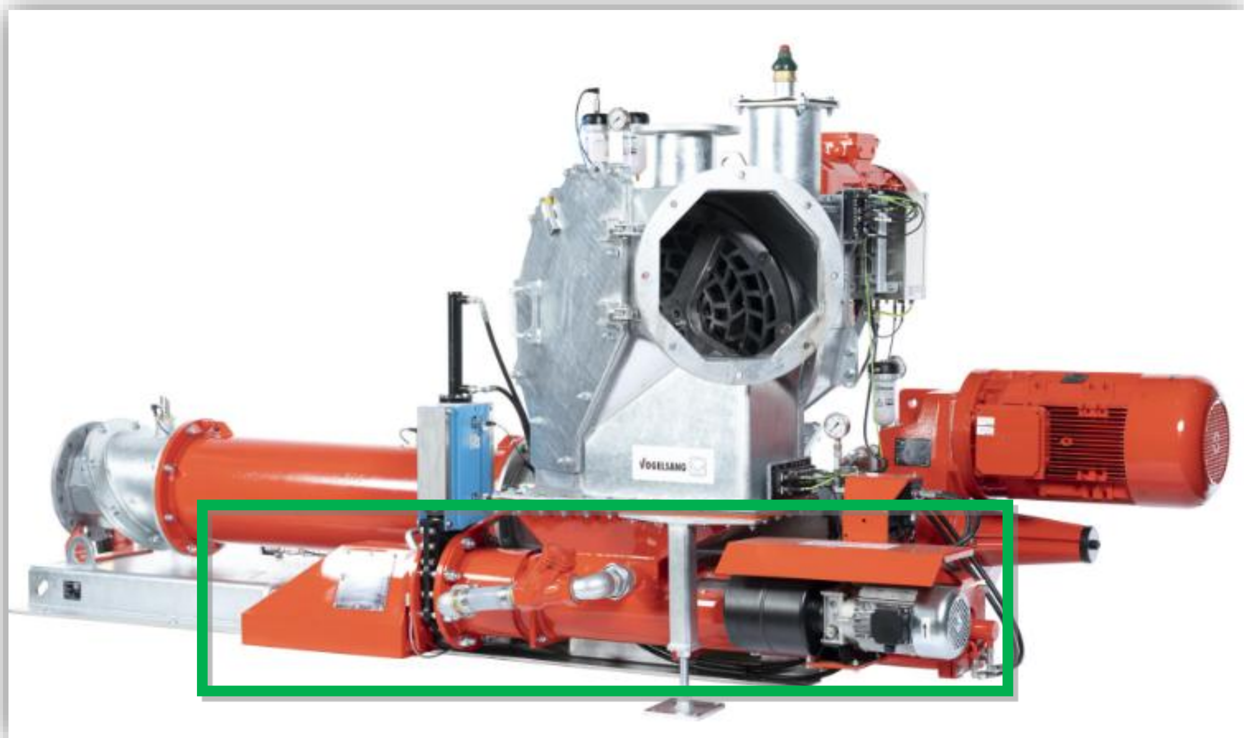


Figure 6: Photo of grinding, mixing and debris removal system (green box). Reference: "Pre-mix" system from Vogelsang.

For DAF sludge: high shear is an advantage to emulsify fats / oils / grease; also helps to remove air; not advisable where the DAF floc is to be separated via gravity, centrifuge or a belt press which has already occurred (hence not anticipated as being an issue for this project).

For WAS sludge: may release bound water to free water (can be a good thing to reduce free water before pelletising / drying); is an issue for gravity thickening / centrifuges / belt presses (not an issue for this project); results in blending and homogenisation which could be advantageous. The activated sludge cells are exposed to high shear in the aeration ponds, clarifier / WAS recycle pump, belt press, and WAS transfer system into the load out hopper.

The main issue would be lysis of cells resulting is a sticky / more viscous material or variable rheology. However, it is anticipated that mixing would overall help to create a more homogenous material. Whilst the large flocs may be impacted (mm to cm), the diameter of WWTP cells are in the range of 0.2 to 2 microns. Shear rates in positive cavity pumps can routinely be kept at <0.4 Pa whilst the shearing rate for cell lysis is required to be >450 Pa, with WAS floc breakage usually occurring at ~3.0 Pa or higher. Hence pumping is not anticipated to generate shearing rates that would lyse cells.

As the aim is a well-mixed and homogenous paste, use of a Rota-cut could be advantageous for mixing. The shear rates can be reduced by tuning the blade pressure, screen geometry, and rotational speed. **The suitability of the Rota-cut requires testing during the detailed design phase.**

Further, optioneering has shown that more sludge / solids could be recovered from the raw wastewater streams that can then be mixed with paunch and processed through a Rota-cut at a relatively high moisture level to then be mixed with sawdust in the surge tank / plough shear mixer system to achieve the desired solids percentage for extrusion.

7.6 Paunch Receival

A range of different hopper systems exist. A truck unloader (below) can lift paunch into a buffering hopper.

Figure 7: Dump truck unloading system. Photo of grinding, mixing and debris removal system (green box). Reference: "Pre-mix" system from Vogelsang

This Extended End Dump Truck Unloader can load out to a height of 4.572 m and shift 22.5 tonnes per minute via a 29.83 kW motor. Hopper is 3.35m wide hence suited to all normal tipper trucks. Grizzly grates ensures that no large objects enter the system. CAPEX $AUS 123,827[2]. Note: anticipated that additional machine guarding would be required for this specific unit.

Tipper truck options:

Info	Volume	Image
International with standard steel bin. $45,000.	11.5 (~15 m^3 heaped)	
Mitsubishi Tipper with Extra long Bisalloy body (5.65 m). Hub mid-point: ~435 mm. $19,500.	~15 m^3 (~20 m^3 heaped) = 4.5 to 6.1 t. Capacity: 6.95 t.	

[2] Extended End Dump HD Truck Unloader – Iron City Supply, accessed 12th March 2026.

The following summarises decades of experience in storage and handling of moist biomass and can be considered as part of detailed design:

- Hoppers are subjected to acidic and abrasive conditions hence should be fabricated from stainless steel (not mild steel).
- Conveyor belts are susceptible to long strings (hay cord) or tapes. They will get caught around the rollers which then causes friction which can lead to fires. All solid conveying systems experience wear and benefit from preventive maintenance.
- The slope of a conveyor belt should not exceed 20°, which is a slope ratio of 2.75 to1. For example, a conveyor belt that must transport a feed stock to the top of a 4 m high hopper must be at least 11 m away.
- From over 80 years of operational data, solid conveying systems were responsible for almost a third of unplanned downtime.
- Conveyor belts for transporting feed stock over longer distances have a lower energy requirement than augers.
- Feed hoppers should be placed as near as possible to the next unit operation to reduce the length of solid transporting systems.
- Hoppers are placed on plinths / pedestals so that material can be cleared from out of it.
- Horizontal milling drums are used to loosen biomass before falling into the horizontal discharge.
- Hoppers should be designed to be emptied for maintenance, hence have acess / service hatches which enable access in a safe manner. Generally, are <4m in height.
- Hoppers must be designed to manage acidic leechate i.e. watertight.
- The most prominent methods for transporting solid feed stock from the feed hopper are augur systems (better for short distances), followed by conveyors.
- Moving parts / motors are installed outside of hoppers for ease of maintenance.
- Empty augers after each batch to prevent drying / sticking of biomass and hence high torque during the next start up.
- Load cells can be used for hoppers to measure the rate of mass addition of biomass. Alternatives are weigh belts or auger / rotary values then can be calibrated to motor speed.

7.7 Pellet Transfer

This project would produce a pellet of ~10 to 20 mm. There is an existing coal conveying system utilising compressed air. There exists an opportunity to utilise a pneumatic system that provides pellet to the boiler via a “just in time” approach (i.e. pellets are made then utilised with storage minimised).

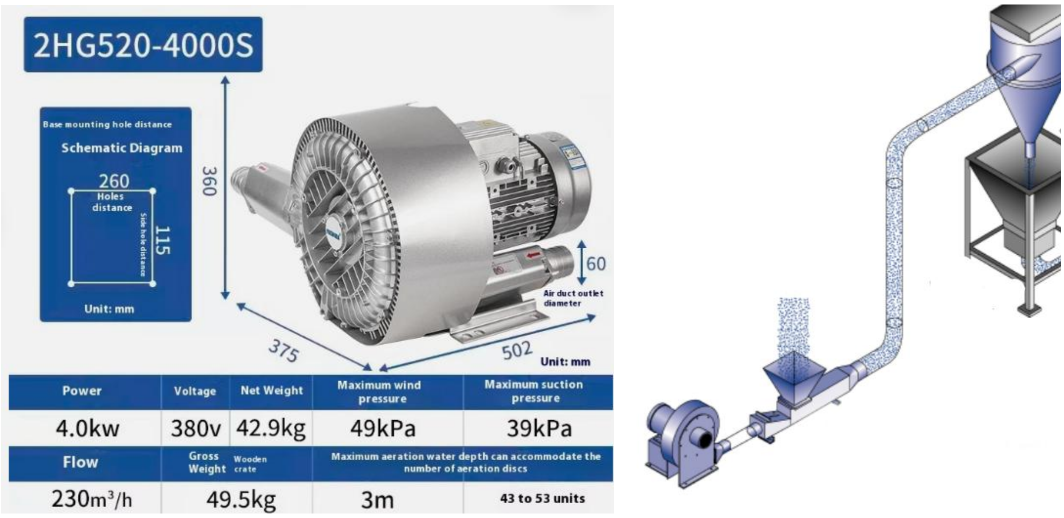


Figure 8: Pellet transfer option.

Pellet Transfer CAPEX estimation basis:

Pellet flow: 500 kg/h
Pellet diameter: 12 mm
Distance: 50 m
Typical dilute phase: pellets/granules: 3–6
Loading ratio = 4 kg solids / kg air
Air mass flow:
$\dot{m}_{air}$ = 0.139 / 4
= 0.0348 kg/s

Air Volumetric Flow:
Air density ≈ 1.2 kg/m^3
Q = 0.0348 / 1.2
= 0.029 m^3/s
Q ≈ 105 m^3/h

For 12 mm pellets Typical pickup velocity: 18–22 m/s
Use: V = 20 m/s

Pipe cross-section: A = Q / V
A = 0.029 / 20
A = 0.00145 m^2

Diameter: D = $\sqrt{(4A/\pi)} \approx 0.043$ m. Next size 50 ND.

Airflow: 105 m³/h
Power: P = $(Q \times \Delta P) / \eta$
$\eta \approx 0.65$
$\Delta P = 22{,}000$ Pa (increase to 60 kPa for safety margin)
$P = (0.029 \times 60000) / 0.65$
$P \approx 2.7$ kW

Parameter Value
Airflow 100–120 m³/h
12 mm pellets.
Keep velocity ≤20 m/s
Use long radius bends to prevent clogging and reduce pressure drop.
Slight upward slope toward boiler prevents fuel entering boiler during shutdown.
Dust control: vent filter on receival section.
Explosion proof fan.

Pellet flow: 500 kg/h
Conveying design

Parameter	Value
Pipe	DN50
Velocity	20 m/s
Airflow	105 m³/h (to 230 m³/h)
Pressure	0.6 bar
Blower	4 kW

Pellet Hopper: 4x4x3m = 48m^3 x 0.329 = 15.8 tonnes = 35.4 hours of production.

As an alternate source of input, preliminary advice was received from the Australian representative for Lummus[3] specialising in pneumatic conveying of cotton seed, with similar physical properties to pellets. Recommendation for a 12mm pellet was a blower operating at 6-7 psi (0.4 to 0.5 Bar) with a 6–8-inch conveying line. Indicative costs reported were

- $35k ex GST for blower
- $7k for relief valve
- $30k for 2 * silencers at inlet and discharge to dampen >100 dBA
- $3k for 2 * expansion joints

The key exclusion here is pipe and cyclone fabrication which can be completed locally.

[3] Contact | Lummus Ag Solutions

7.8 Mass Flow Metering / Control

Mass flow metering will be finalised during detailed design. A suitable system for accurately measuring and controlling the mass flow of sawdust, paunch and dry pellets includes static load cells under the hoppers which control a suitably mounted auger with a VSD motor. This system can handle the mass of the biomass in the 30 m^3 hopper whilst being able to accurately measure and control the mass flow rate of biomass (sawdust and paunch for pellet production; pneumatic system for conveying dry pellets).

Figure 9: Hopper silo weighing system.

Rotary valves or volumetric screw feeders could be utilised (suited up to 300L of product in a hopper), or belt scale / weigh belts on conveyors.

The rotary value shown below has a system for rapidly removing and cleaning of the rotor (https://transmin.com.au/rotary_valves).

U-trough screw conveyors are well suited to paunch due to ease of access for cleaning and the ability to meter the dosage of paunch via a mass flow screw.

7.9 Facility Layout Including New Dryer Building

Note: the following layout is *indicative only* to show that it is possible for the equipment to be located within the available shed area; the layout will be finalised as part of the detailed design. A building envelope of 39m (W) x 6.5m (L) x 10.000 m (H) was requested for the new dryer building (note: to ensure these dimensions, an industrial shed of 42 x 9 x 11 m was recommended by one supplier). The following isometric views show a layout concept located within an existing shed.

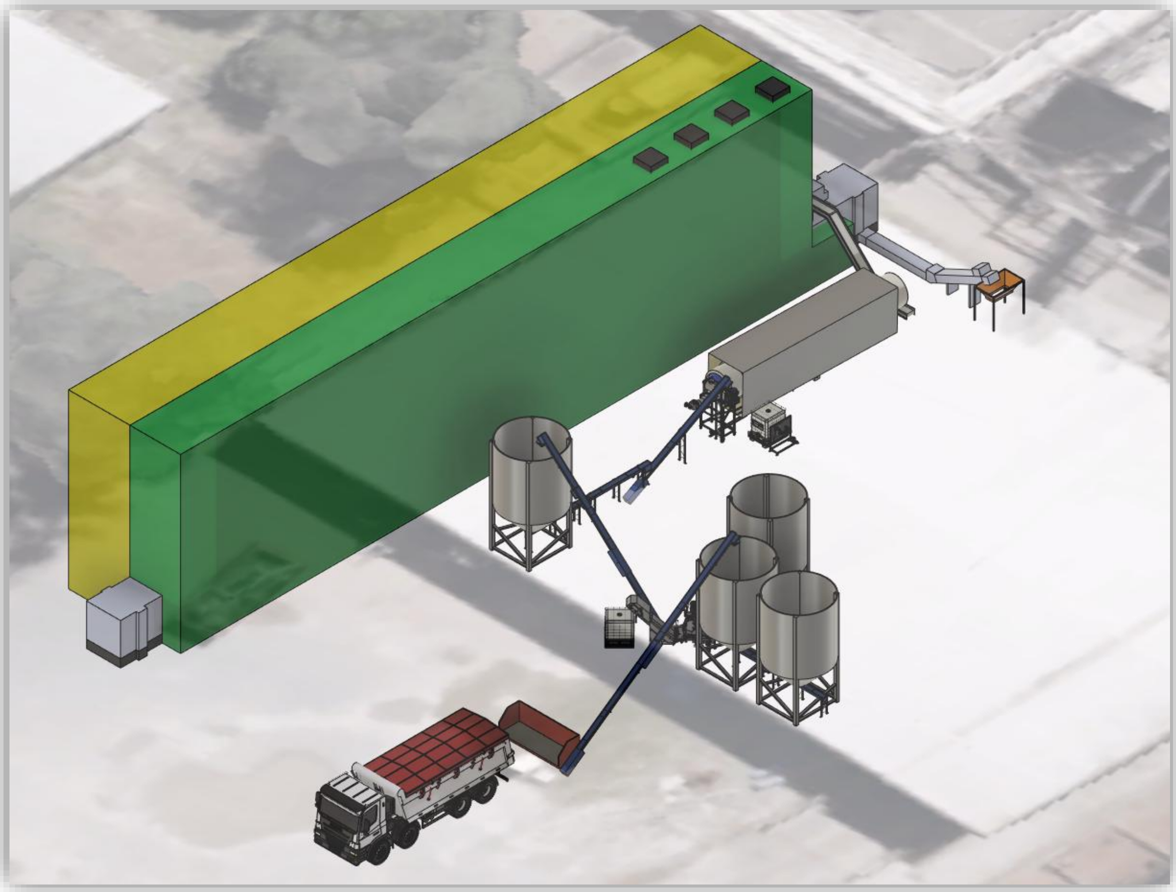


Figure 10: Preliminary facility isometric.

7.10 Electrical Load List Estimate

A detailed electrical load list was created utilising OEM data and the digital twin results. The creation of a detailed load list supports estimation of Scope 2 emissions for the Life Cycle greenhouse gas (GHG) estimate.

8.0 Discussion and Conclusions

This section should include a full interpretation of the results. It should outline what the results mean for use and adoption by processing businesses or other industry stakeholders or for future/related research projects.

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8.1 Business Case

The following business case is for a higher sawdust utilisation scenario where 30% Moisture Sawdust is blended into the pelletiser feed to create a 75% moisture feed (i.e. the dry sawdust is used to drop the moisture of the sludge/paunch blend from 82% moisture to 75% moisture):

			SUM ANNUAL OPEX	**$ 1,209,522**
REVENUE	**RATE**	**UNIT**	**QUANTITY**	**ANNUAL OPEX**
Feedstock				
Waste management cost reduction via converting 91% by mass to pellets				$ 1,543,924
Coal offset [$250/tonne delivered; 23.9 GJ/t]	$ 10.46	per GJ for coal. Pellets 17.38 GJ/t:	78,223.62	$ 818,239
ACCUs (30th April 2026, coremarkets.co)	$ 37.80	Replacing bituminous coal, Scope 1,2&3	6,263.29	$ 236,752
			SUM ANNUAL REVENUE	**$ 2,598,915**
Total Capital Investment (TCI; CAPEX)	**$ 7,543,037**		Net	$ 1,389,393
Payback	**5.43**			
Coal tpa (2025-1100 Final Report_Techno economic s	6,329.0			
Ash tpa	14%			
HRL Coal LHV	23.9000			
GJ pa	151,263.10			
% pellets	51.7%			
Tonnage pellets	4,500.78			
Tonnage coal	3,478.07			
TOTAL boiler fuel tpa	7,978.85			
% increase tonnage	26.1%			

The following business case is for a lower sawdust utilisation scenario where 10% Moisture Sawdust is blended into the pelletiser feed to create a 78% moisture feed (i.e. the dry sawdust is used to drop the moisture of the sludge/paunch blend from 82% moisture to 78% moisture):

			SUM ANNUAL OPEX	**$ 971,306**
REVENUE	**RATE**	**UNIT**	**QUANTITY**	**ANNUAL OPEX**
Feedstock				
Waste management cost reduction via converting 91% by mass to pellets				$ 1,543,924
Coal offset [$250/tonne delivered; 23.9 GJ/t]	$ 10.46	per GJ for coal. Pellets 17.38GJ/t:	63,054.10	$ 659,562
ACCUs (30th April 2026, coremarkets.co)	$ 37.80	Replacing bituminous coal, Scope 1,2&3	5,046.00	$ 190,739
			SUM ANNUAL REVENUE	**$ 2,394,224**
Total Capital Investment (TCI; CAPEX)	**$ 7,543,037**		Net	$ 1,422,918
Payback	**5.30**			
Coal tpa (2025-1100 Final Report_Techno economic study for a	6,329.0			
Ash tpa	14%			
HRL Coal LHV	23.9000			
GJ pa	151,263.10			
% pellets	41.7%			
Tonnage pellets	3,627.97			
Tonnage coal	4,200.43			
TOTAL boiler fuel tpa	7,828.40			
% increase tonnage	23.7%			

8.2 GHG Emissions Estimates

Shown in the figure below is the National Greenhouse Emissions Reporting Scheme (NGERS) emissions associated with the coal combusted (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 CO_2 released from combustion of biogenic carbon fuels is zero.

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

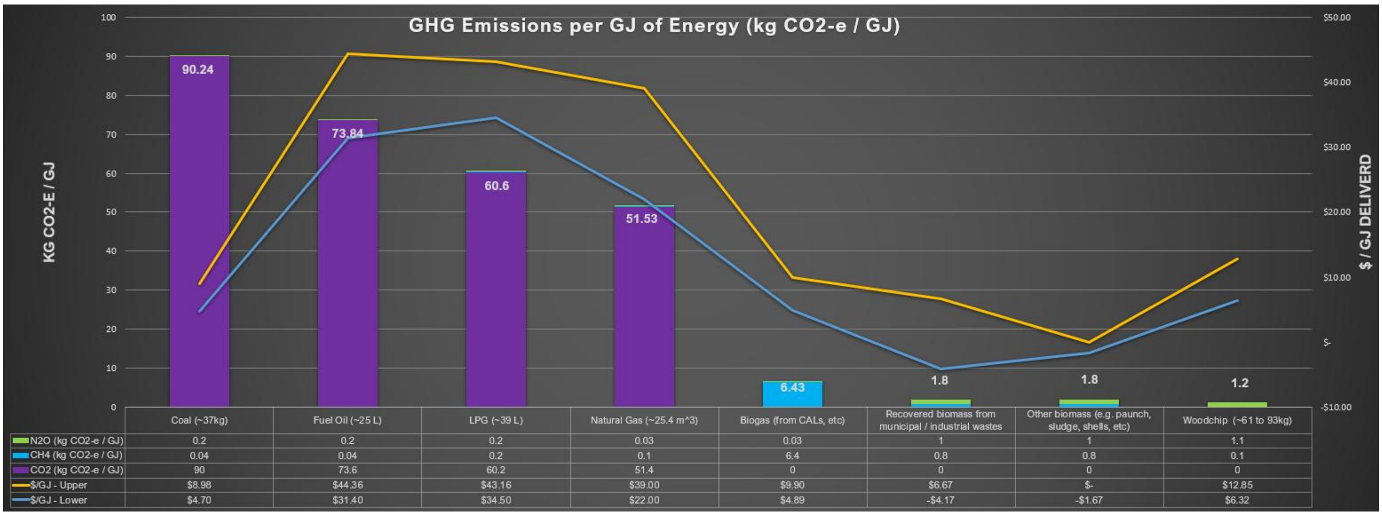
Item	Fuel combusted	Energy content factor GJ/t	Emission factor kg CO_2-e/GJ (relevant oxidation factors incorporated)		
			CO_2	CH_4	N_2O
1	Bituminous coal	27.0	90.0	0.04	0.2
10	Dry wood	16.2	0.0	0.1	1.1
11	Green and air dried wood	10.4	0.0	0.1	1.1
14	Biomass municipal and industrial materials, if recycled and combusted to produce heat or electricity	12.2	0.0	0.8	1.0

Figure 11: Emissions for different fuels from the National Green House Emissions Reporting Scheme Measurement Determination.

Scope 1,2 and 3 Life Cycle Assessment for 30% moisture sawdust estimates 6261 tpa CO2-e Scope 1, 2 and 3 emissions reduction (dropping to 5,044 t CO2-e GHG emissions reduction when using 10% moisture sawdust). The full analysis is commercially confidential information. Key references in calculation of Scope 1, 2 and 3 emissions were:

- 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 3 was generated by All Energy Pty Ltd utilising the data from the National Greenhouse and Energy Reporting (Measurement) Determination 2008[4]. 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.



	Coal (~37kg)	Fuel Oil (~25 L)	LPG (~39 L)	Natural Gas (~25.4 m^3)	Biogas (from CALs, etc)	Recovered biomass from municipal / industrial wastes	Other biomass (e.g. paunch, sludge, shells, etc)	Woodchip (~61 to 93kg)
N2O (kg CO2-e / GJ)	0.2	0.2	0.2	0.03	0.03	1	1	1.1
CH4 (kg CO2-e / GJ)	0.04	0.04	0.2	0.1	6.4	0.8	0.8	0.1
CO2 (kg CO2-e / GJ)	90	73.6	60.2	51.4	0	0	0	0
$/GJ - Upper	$8.98	$44.36	$43.16	$39.00	$9.90	$6.67	$-	$12.85
$/GJ - Lower	$4.70	$31.40	$34.50	$22.00	$4.89	-$4.17	-$1.67	$6.32

Figure 12: 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.

[4] National Greenhouse Emissions Reporting Scheme, Measurement Determination, https://www.legislation.gov.au/F2008L02309/2022-07-01/text

8.3 Optioneering

Where the $/GJ LHV of sawdust remains lower than coal, there exists the opportunity to process more pellets by procuring 1716 tpa of sawdust and offset 60.3% of coal usage (5.0 year payback).

Further, the use of more sawdust enables the capture of more suspended solids / sludge from the primary waste water (estimated at 14,900 tpa rather than 8,355 tpa at 17% solids) thereby saving aeration, WWTP operations and outfall costs. More boiler fuel is then made out of the solids that otherwise are just “burnt off” in the ponds. Some low energy options include lamellar flow separators, sand bed filters and DAF. As the red stream already goes through a DAF, the green stream would be the first target for this opportunity.

Excluding the CAPEX of additional unit operations, the business case for this last option is presented below. This business case excludes the economic advantages of:

- Avoided capital spend via improved performance, longer life and lower maintenance on existing WWTP via a lower solids load in the aeration ponds, less solids in the gravity settler, less solids in the belt press (noting that whilst there would be less WAS solids, there would be more solids recovered overall as the solids are removed earlier in the process),
- savings on aeration energy and equipment costs,
- savings on pumping costs via lower viscosity and slightly lower volume of water to be pumped,
- lower WWTP operations costs (i.e. less WAS sludg
- e chemicals),
- lower outfall costs / lower excursions from allowable outfall levels.

TARGET: 78% moisture	30% Moisture Content Sawdust. MAXIMUM PELLETS						
	Material	**"As delivered" tpa**	**tpd 5 dpw, 50 wpa.**	**kg/h (5 dpw, 20 hpd, 50 wpa)**	**Moisture**	**Solids**	**Dry weight as delivered**
	Paunch solids	7,050	28.2	1,410	81%	19%	1,339.43
	Combined sludge (DAF+WAS+screenings)	14,900	59.6	2,980	83%	17%	2,533.00
	Subtotal from Jul '25 - Jan '26 Invoices.	21,950	87.8	4,390	82.4%	18%	3,872
	Minus 9% for screenings & contamination	19,974	79.9	3,995	82.4%	18%	3,523.91
	Sawdust [Goal Seek to 75% final moisture]	1716.00			30%	70%	1,201.20
	TOTAL ORGANICS TO EXTRUDER	21,690			78%	22%	4,725.11
	Final Dry Pellets (assumes minimal volatiles losses during drying)	***5,250***	21.0	656	10%	90%	4,725.11

Figure 13: Estimated maximum pellet increasing from 7200 to 8400 hours per annum operation.

			SUM ANNUAL OPEX	**$ 1,245,212**
REVENUE	**RATE**	**UNIT**	**QUANTITY**	**ANNUAL OPEX**
Feedstock				
Waste management cost reduction via converting 91% by mass to pellets				$ 1,543,924
Coal offset [$250/tonne delivered; 23.9 GJ/t]	$ 10.46	per GJ for coal. Pellets 17.38GJ/t:	91,247.13	$ 954,468
ACCUs (30th April 2026, coremarkets.co)	$ 37.80	Replacing bituminous coal, Scope 1,2&3	7,188.18	$ 271,713
			SUM ANNUAL REVENUE	**$ 2,770,105**
Total Capital Investment (TCI; CAPEX)	**$ 7,543,037**		Net	$ 1,524,893
Payback	**4.9**			
Coal tpa: 2025-1100 Final Report_Techno economic study	6,329.0			
Ash tpa	14%			
HRL Coal LHV	23.9000			
GJ pa	151,263.10			
% pellets	60.3%			
Tonnage pellets	5,250.12			
Tonnage coal	2,857.90			
TOTAL boiler fuel tpa	8,108.03			
% increase tonnage	28.1%			

From some earlier analytics, assuming solids are at 0.5 to 1% w/w for 2 ML per day of raw waste water (pre-aeration ponds), the potential solids that could be recovered is at 1250 to 2500 tpa dry weight. At 17% solids this is 7352 to 14706 tpa. The pelletising plant could process an additional 9484 tpa of 17% solids, hence there exists an opportunity for most of the solids present in the red and green stream outfall to be re-purposed as boiler fuel. In practice, it would only be economically viable to recover a fraction of these solids (e.g. most solids >15 to 50 microns), with the economic viability reducing as the particle size decreases.

Additional areas:

- Improving existing DAF system to recover more sludge.
- Optimising existing WWTP / WAS system (i.e. a lower TSS loading rate into the WWTP will change the performance of the WWTP which needs to be considered).
- Commence project utilising existing sludge; future expansion to use sludge from red and green streams with maximum sawdust utilisation.
- Sale of pellets as "organic fertilizer" first; then off-set coal. It is anticipated that the market for high value organic fertiliser is finite, hence some pellets can be sold as high value fertiliser with the balance used as boiler fuel.
- Opportunities to increase $ / m^3 of sawdust: higher lignin (more wood, less bark), lower moisture (air dry first), higher density (compaction).
- Understand economic cut off on solids removal from red and green streams i.e. DAF at 50 microns versus chemically dosed DAF towards 15 microns; versus low CAPEX / OPEX options such as lamellar separation.
- Boiler trials larger tonnages of pellets for stack emissions testing.

On sawdust procurement:

It is highly recommended that a long term contract (10 - 15 years +5 +5) for sawdust be locked in for the project with the aims being:
[1] **minimising the $/GJ LHV by procuring low moisture sawdust** (suppliers can undertake actions to minimise moisture), and

[2] **compacting sawdust when loaded into semi-trailers to increase the GJ per m^3.** This can be via hydraulic systems, vibration and/or roller-compactors (see below).

These are the two key variables to minimise $/GJ LHV. There are other items to optimise such as selecting sawdust with higher lignin / wood as less leaf matter / bark.

Figure 14: Compactor options for increasing density of sawdust. Source: https://wasteinitiatives.com.au/

8.4 Sale of Pellets as Fertiliser

Pellets made from poultry manure at bulk are retailing per tonne at $716[5] to $1116.50[6] (NPK: 3.5-1.1-1.6), with pellets from cattle manure retailing at $1400 per tonne[7]. With urea (46-0-0) currently at $1465 / tonne supply only (i.e. excluding delivery)[8] and supplies limited there exists the opportunity for alternative fertilisers such as organic fertilizers, especially for the retail market.

The base case presented below is $359.50 / tonne is one half of the lowest retail pricing for organic pellets from chicken or 26% that of cattle manure pellets. The maximum pellet production scenario (8400 hpa operation) is calculated here, delivering a 28.8% IRR over 20 years.

			SUM ANNUAL OPEX	$ 1,245,212
REVENUE	RATE	UNIT	QUANTITY	ANNUAL OPEX
Feedstock				
Waste management cost reduction via converting 91% by mass to pellets				$ 1,543,924
Organic Fertiliser	$ 359.50	per tonne	5,250.12	$ 1,887,419
ACCUs (12th March 2026, coremarkets.co)	$ 36.85	Replacing bituminous coal, Scope 1,2&3	-	$ -
			SUM ANNUAL REVENUE	$ 3,431,343
Total Capital Investment (TCI; CAPEX)	$ 7,543,037		Net EBITDA	$ 2,186,130
Payback	3.5			

The main risks with producing fertilizer are the price point and what tonnage can actually be sold at this price point. Local councils and golf courses are examples of large and on-going bulk purchasers of organic fertilizer. With lawn (0.1 kg/m^2) to garden (0.3 kg / m^2) application rates, 5250 tpa would be sufficient for 1750 Ha per annum. Hence there could be a scenario where some of the pellets are sold at the higher $ per tonne fertilizer, with the majority of pellets utilised as boiler fuel.

The break even against boiler fuel (8000 hpa production) is sale of pellets as fertiliser at ~$236.32 / tonne which is about 20% of the retail pricing. The price point for a one tonne bulka bag of organic fertiliser has increased from $1053.90 on 9th October 2025 to $1173.80 on 7th May 2026[9].

The plot below shows the change in payback period (years) as a function of the $ / tonne final fertilizer sold.

[5] Super Booster - Composted Poultry Manure Fertiliser, https://northsideproduceagency.com.au, accessed 7th April 2026.
[6] Dynamic Lifter Bulk Bags 1T - Non TFES – Yolla Co-Op, https://yollacoop.com.au, accessed 7th April 2026.
[7] Garden Range – Mort & Co Garden Range, accessed 7th April 2026.
[8] INCITEC PIVOT FERTILISERS UREA GRANULAR 1TON BAG 090684, https://tgrm.com.au/, accessed 7th April 2026.
[9]

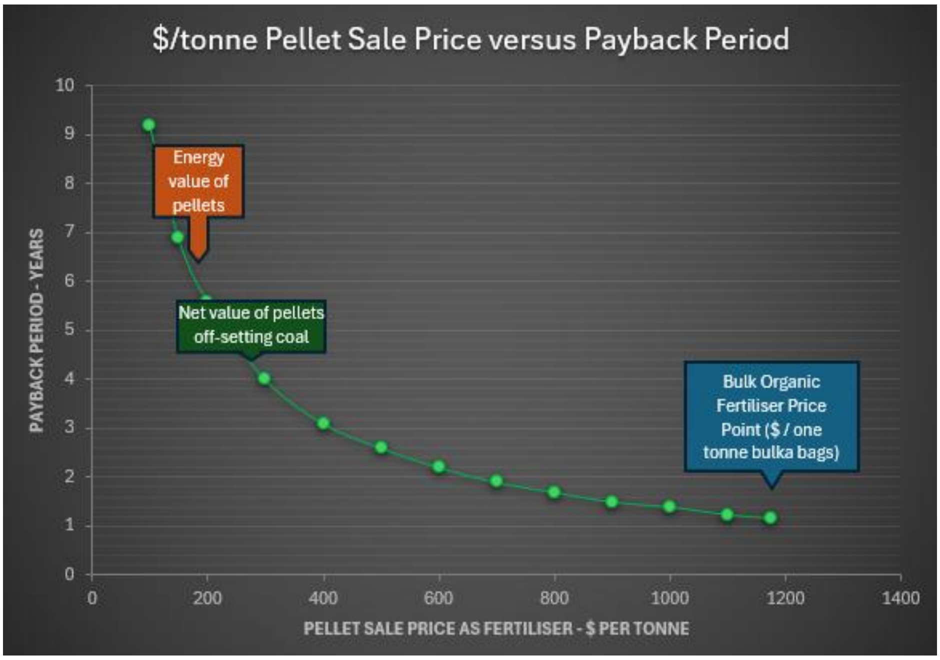


Figure 15: Estimated payback period (years) as a function of value of the pellet. At the far right is the current market price for a one tonne bulka bag of organic pellets, whilst also shown is the energy value of the pellets then the net value after accounting for ACCUs, haulage savings and OPEX.

Whilst organic fertiliser is advertised as heat treated to kill weed seeds and reduce harmful bacteria, there appears to be no specific requirement for this for organic fertilizer. Fertilizers are treated different in the Australian market to composts. There is a range of legislation at the state level (legislated) and national codes (not legislated, but if you say you meet a code or standard you must back this up) for fertilizer, with some of interest:
[1] Guide-to-Victorian-Fertiliser-Regulations_July 23.docx

[2] https://www.legislation.qld.gov.au/view/whole/html/2016-05-27

[3] National Code of Practice for Fertilizer Description and Labelling 20241031.doc

Each state is relatively similar but with nuances. For example, in Victoria labelling is important:

• state the name of the fertiliser. This means a name identifying the fertiliser from another fertiliser that may have a similar name.

• state the quantity (by weight or volume) of the fertiliser.

• state the name and full business address of the Australian wholesale dealer or the seller of the fertiliser (for a label) or the name and full business address of the seller of the fertiliser (for an advice note).

• contain the relevant warning statements prescribed under Regulation 10. (i.e. dust etc.)

Cadmium (Cd), mercury (Hg), and lead (Pb) are the key contaminants to consider (historically not an issue for RMP organics). Iiron, nickel, and zinc which are histirically above detectable levels in RMP organics, no specific levels for these metals are listed. Some key points:

- **Organic fertilizer must contain at least 95% organic matter (matter derived from plants or animals).**
- **Organically-based fertilizer must contain at least 65% organic matter (matter derived from plants or animals).**

All federal and state regulations as of February 2026 were silent on pasteurisation. The closest discussion was on digestate in the Victoria legislation, requiring to be held at 70 DegC for >1 hour; or "Outcome-based pasteurisation". Compliance with determination and designation | epa.vic.gov.au

Fertiliser is defined as a growth enhancer, promotant or regulator that aids plant growth, with the proposed pellets occupying a niche area of the fertiliser market known as "organic fertiliser" sourced from animal, plant or microbial origins; as opposed to chemical fertilisers (i.e. urea, anhydrous ammonia, ammonium sulphate, etc) or mined fertiliser[10] (e.g. potash). Organic fertilizers deliver nutrients to plants through a slower, decomposition-dependent process. Soil microorganisms, bacteria and fungi, break down complex organic matter into simpler forms, like nitrate and ammonium ions for nitrogen, which plants then absorb through their roots. This gradual release ensures a sustained supply of nutrients over an extended period, reducing the risk of over-fertilization and root burn. The plant response is one of steady growth as nutrients become available over weeks or months (where chemical fertilizers dissolve quickly in water, allowing plants to absorb them directly through their roots providing rapid nutrient availability but can lead to nutrient run-off). Organic fertilisers are considered better for long term soil health[11].

Information on red meat industry sludge + paunch pellets from earlier projects:

Parameter	Results
Bulk Density – Loosely packed	0.329 tonnes / m^3
Moisture	8 – 10 %
N (Nitrogen)	2.8 %
P (Phosphate)	0.31 %
K (Potassium)	0.0856 %
S (Sulfur)	0.215 %
C (Carbon; from previous data)	48.89 %

Fertilizer from RMP organics appears to have a more desirable nitrogen and phosphate profile than other current organic fertiliser options.

Poultry Manure

- Formulated for organic growers in easy-to-use pellets
- Contains composted poultry manure, meat meal, fish meal, kelp meal, and zeolite for an organic feed
- Improves moisture retention and microbial activity

[10] Australian Federal Government Department of Agriculture, Fisheries and Forestry, agriculture.gov.au/biosecurity-trade/import/goods/fertiliser, accessed 29th Dec 2025.
[11] Organic vs Chemical Fertilizer: Pros and Cons - Biology Insights, biologyinsights.com/organic-vs-chemical-fertilizer-pros-and-cons/, accessed 29 Dec 2025.

The recent spike in nitrogen fertiliser pricing (refer Figure 26 below) caused by a reduction in shipping of urea and crude oil which is also impacting the supply chain / availability of urea, is driving an interest in non-fossil based fertiliser. There has been a 720% increase in urea pricing since 2000, 56.96% increase compared to the 2025 average and a 5.87% increase in just the last 2 weeks.

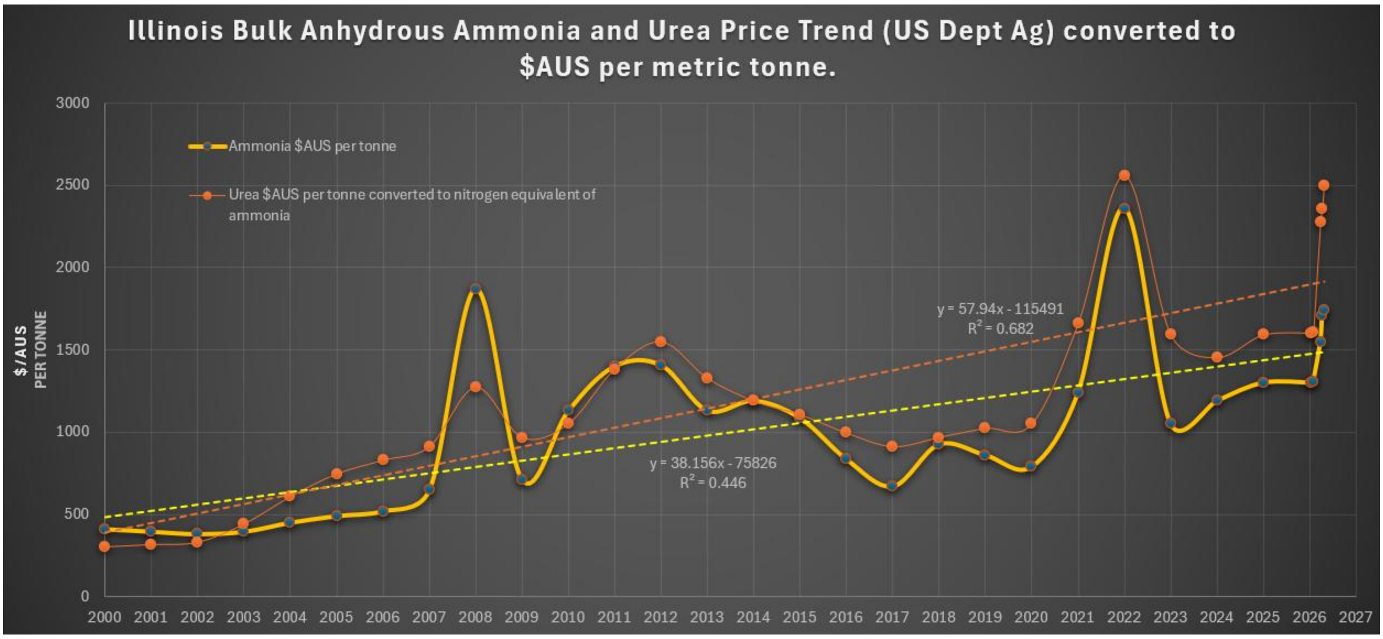


Figure 16: $AUS / tonne fertiliser converted to ammonia equivalent as at 17th April 2026.

9 Bibliography

References are provided throughout the report or in report footnotes.

10.0 Appendices

Appendix 1: Summary of Pelleton Renewables Australia Pty Ltd Results

Grain fed, no sawdust (6 March 2026): 49% WAS, 41% Paunch, 5% DAF, 5% Green Stream.

Grass fed with sawdust (4th March 2026): RMP organics of 49% WAS, 41% Paunch, 5% DAF, 5% Green Stream. Then mixed at a ratio of 170 g sawdust, 830 g RMP organics.

Based on the laboratory test work conducted, the received materials were assessed over a 10-day sampling period to evaluate moisture consistency and pelletisation performance. The trials demonstrated that, with appropriate conditioning, the blend is capable of producing good-sized, well-formed pellets, confirming the technical viability of the process. While the average moisture content of WAS and paunch is generally higher than the optimal range for pelletisation, the addition of sawdust has proven to be an effective method for moisture adjustment. This approach enables the processing of feedstock with variable and elevated moisture levels while still achieving consistent pellet quality. Importantly, the required sawdust dosing can be adapted based on daily feedstock conditions, allowing efficient handling of variability, particularly during higher moisture periods such as Organics Days. This demonstrates that waste streams with elevated moisture content can still be successfully converted into valuable pelletised products through controlled blending. In the longer term, the reliance on sawdust can be reduced by improving the effectiveness of the RMP organics dewatering process. Overall, the results support the feasibility of the process and provide a strong basis for further optimisation and scale-up toward commercial application. This report relates only to the material tested as received by Pelleton Renewables Pty Ltd. Results are representative of the sample provided and may not reflect variability in subsequent deliveries. This report is intended for the named customer only and shall not be reproduced or relied upon by third parties without written consent.

Appendix 2: Pine Saw Dust Composition

A3.1: 30% Moisture

Pine Sawdust (#3160): Phyllis2 - ECN Phyllis classification, phyllis.nl/Browse/Standard/ECN-Phyllis#sawdust

ID-number	#3160
Material	Pine Sawdust
Alternative name	Pine
Description	Sawdust from pine wood
Classification	CEN/TS 14961 classification ‣ Solid biofuels ‣ Woody biomass ‣ Forest and plantation wood ‣ Whole trees without roots ‣ Coniferous
	ECN Phyllis classification ‣ untreated wood ‣ fir/pine/spruce ‣ pine sawdust
	NTA 8003 classification ‣ [100] hout ‣ [110] vers hout ‣ [115] zaagsel
Sample date	1996-01-01
Sample location	Finland

Sample lot size	0,2-1 m3
Country	Finland
Submitter	VTT
Submitter organisation	ECN (Netherlands)
Submission date	2008-09-01
Remarks	ash data, taken from original publication, added by ECN in 2012
Literature	C. Wilén, A. Moilanen and E. Kurkula: Biomass feedstock analyses, VTT publications 282, Espoo 1996.

Values

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
Main biomass properties										
Proximate analysis										
Moisture content	wt%	30								
Ash content at 550°C	wt%	0.06	0.08						CEN/TS 14775	
Volatile matter	wt%	58.17	83.10	83.17						
Fixed carbon	wt%	11.77	16.82	16.83					Calculated	
Ultimate analysis (macroelements)										

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
Halides										
Chlorine (Cl)	mg/kg (dry)					50.0				below detection limit of neutron activation
Heating value										
Net calorific value (LHV)	MJ/kg	12.59	19.03	19.05					CEN/TS 14918	
HHV_{Milne}	MJ/kg	14.11	20.16	20.18					Calculated	
Trace elements composition										
Potassium (K)	mg/kg (dry)			480.0						neutron activation
Sodium (Na)	mg/kg (dry)			20.0						neutron activation
Ash melting behaviour										
American standard method, measured in oxidizing conditions										
IDT (initial deformation temperature)	°C			1 150					ASTM D 1857	Leco AF-600
SOT (softening or spherical temperature)	°C			1 180					ASTM D 1857	Leco AF-600
HT (hemispherical temperature)	°C			1 200					ASTM D 1857	Leco AF-600

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
FT (fluid temperature)	°C			1 225					ASTM D 1857	Leco AF-600
American standard method, measured in reducing conditions										
IDT (initial deformation temperature)	°C			1 135					ASTM D 1857	Leco AF-600
SOT (softening or spherical temperature)	°C			1 165					ASTM D 1857	Leco AF-600
HT (hemispherical temperature)	°C			1 185					ASTM D 1857	Leco AF-600
FT (fluid temperature)	°C			1 205					ASTM D 1857	Leco AF-600
Physical Properties										
Commonly used properties										
Bulk density (ar)	kg/m³ (ar)			177						loose, not shaken
Ash Properties										
Ash composition										
SO_3	wt% (ash)			1.95						
P_2O_5	wt% (ash)			5.25						
SiO_2	wt% (ash)			8.34						
Fe_2O_3	wt% (ash)			1.84						

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
Al_2O_3	wt% (ash)			2.00						
CaO	wt% (ash)			41.84						
MgO	wt% (ash)			11.81						
Na_2O	wt% (ash)			0.24						
K_2O	wt% (ash)			12.29						
TiO_2	wt% (ash)			0.12						

A3.2: 10% Moisture

Pine Sawdust (#3160)

ID-number	#3160
Material	Pine Sawdust
Alternative name	Pine
Description	Sawdust from pine wood
Classification	CEN/TS 14961 classification ‣ Solid biofuels ‣ Woody biomass ‣ Forest and plantation wood ‣ Whole trees without roots ‣ Coniferous
	ECN Phyllis classification ‣ untreated wood ‣ fir/pine/spruce ‣ pine sawdust

	NTA 8003 classification ‣ [100] hout ‣ [110] vers hout ‣ [115] zaagsel
Sample date	1996-01-01
Sample location	Finland
Sample lot size	0,2-1 m3
Country	Finland
Submitter	VTT
Submitter organisation	ECN (Netherlands)
Submission date	2008-09-01
Remarks	ash data, taken from original publication, added by ECN in 2012
Literature	C. Wilén, A. Moilanen and E. Kurkula: Biomass feedstock analyses, VTT publications 282, Espoo 1996.

Values

Property	**Unit**	**Value**			**Std dev**	**Det lim**	**Lab**	**Date**	**Method**	**Remarks**
		user	**dry**	**daf**						
Main biomass properties										
Proximate analysis										
Moisture content	wt%		Restore 'ar'							
Ash content at 550°C	wt%	0.07	0.08						CEN/TS 14775	

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
Volatile matter	wt%	74.79	83.10	83.17						
Fixed carbon	wt%	15.14	16.82	16.83					Calculated	
Ultimate analysis (macroelements)										
Halides										
Chlorine (Cl)	mg/kg (dry)					50.0				below detection limit of neutron activation
Heating value										
Net calorific value (LHV)	MJ/kg	16.88	19.03	19.05					CEN/TS 14918	
HHV_{Milne}	MJ/kg	18.14	20.16	20.18					Calculated	
Trace elements composition										
Potassium (K)	mg/kg (dry)	480.0								neutron activation
Sodium (Na)	mg/kg (dry)	20.0								neutron activation
Ash melting behaviour										
American standard method, measured in oxidizing conditions										
IDT (initial deformation temperature)	°C	1 150							ASTM D 1857	Leco AF-600

Property		Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
			user	dry	daf						
	SOT (softening or spherical temperature)	°C			1 180					ASTM D 1857	Leco AF-600
	HT (hemispherical temperature)	°C			1 200					ASTM D 1857	Leco AF-600
	FT (fluid temperature)	°C			1 225					ASTM D 1857	Leco AF-600
American standard method, measured in reducing conditions											
	IDT (initial deformation temperature)	°C			1 135					ASTM D 1857	Leco AF-600
	SOT (softening or spherical temperature)	°C			1 165					ASTM D 1857	Leco AF-600
	HT (hemispherical temperature)	°C			1 185					ASTM D 1857	Leco AF-600
	FT (fluid temperature)	°C			1 205					ASTM D 1857	Leco AF-600
Bulk density (ar)		kg/m^3 (ar)			177						loose, not shaken
Ash Properties											
SO_3		wt% (ash)			1.95						
P_2O_5		wt% (ash)			5.25						
SiO_2		wt% (ash)			8.34						
Fe_2O_3		wt% (ash)			1.84						
Al_2O_3		wt% (ash)			2.00						

Property	Unit	Value			Std dev	Det lim	Lab	Date	Method	Remarks
		user	dry	daf						
CaO	wt% (ash)			41.84						
MgO	wt% (ash)			11.81						
Na_2O	wt% (ash)			0.24						
K_2O	wt% (ash)			12.29						
TiO_2	wt% (ash)			0.12						