JULY 2026

Case study

AFFCO Horotiu

Switching from natural gas to wood pellets for meat processing using repurposed coal boiler

ENERGY EFFICIENCY & CONSERVATION AUTHORITY
TE TARI TIAKI PŪNGAO

aurecon

Executive Summary

Project Introduction

AFFCO is one of New Zealand's largest meat processing companies and has been in business for over a century. With several sites across the country, the company has a number of projects aimed at reducing fossil fuel use across its operations.

A key challenge for AFFCO is finding renewable solutions that can reliably meet their site's highly variable steam demand, driven by the rapid fluctuations inherent in manual meat processing operations, while maintaining the unattended, low-labour operation they are accustomed to with their natural gas boiler operations.

At their Horotiu plant AFFCO replaced the aging natural gas-fired boiler with a wood pellet-fired boiler and fuel handling system. This case study provides details of the two and a half year project from concept to completion, showcasing how AFFCO were able to cut annual carbon emissions by an estimated 4,450 tCO_2e, and reduce energy costs without compromising the operational performance required by the site.

Shown above: The AFFCO Horotiu biomass boiler (left) and storage silos (right)

Project Financials

Following a Class 3 capital cost estimate the project was initially budgeted at $10M on a new-build basis. The final capital cost, outlined below, was approximately 35% under budget ($3.4M under budget). This was due to taking an in-house approach to project management, and reusing a reconditioned Maxitherm boiler and suitable ancillary equipment with a pragmatic approach to warranties. This brought the total project costs down from approximately $1.2M per MWth to $0.78M per MWth.

Modelling of running costs by AFFCO found that a pellet boiler had lower running costs compared to a gas boiler using 2023 gas price - which will be even more favourable with the current gas price. De-commissioning the gas boiler allowed the gas line to be capped, eliminating ongoing fixed gas connection charges.

#	Item	Capital Cost (NZ$ exc. GST)
1	Main boiler asset and fuel handling	$4,500,000
2	Civil, structural and roading	$1,100,000
3	Ancillary	$330,000
4	Engineering and Project Management	$170,000
5	Electrical and Automation *excluding boiler system	$480,000
6	**Total Capital Cost**	**$6,580,000**
7	GIDI Co-funding	$1,999,258

Shown above: Final capital costs

Project Operations

AFFCO's wood pellet-fired boiler has proven to be a reliable replacement for its natural gas boiler, delivering unattended operation while consistently meeting the highly variable steam demands of meat processing. Its high level of automation, combined with remote monitoring and supervision, provides an operating experience comparable to a natural gas-fired boiler with minimal operator intervention. With a 6:1 turndown ratio, the boiler can accommodate a wide range of steam loads and responds rapidly to the fluctuations in steam demand inherent in manual meat processing, maintaining a stable and dependable steam supply throughout production.

Key Learnings

#	Category	Key Industry Lessons
1	Concept & Feasibility Design	a) Set-up energy projects for success early by completing structured energy transition studies or energy optimisation studies to identify practical, financially viable and low risk options independent consultants can be engaged with government support through EECA b) Ensure biomass supply chains are mature and reliable to minimise operational and delivery risk c) Leverage prior experience, or review relevant publicly available information, such as case studies d) Sustainability goals can be progressed alongside asset management plans e) Accurate steam demand data not available in legacy plant, it was estimated through hourly gas usage, equipment information and operating schedules f) The new boiler size was minimised, to avoid over-capitalisation, by adjusting operational schedules to stagger peak steam demands across the site
2	Detailed Design & Procurement	a) Use proven suppliers and contractors with prior relationships to streamline procurement, reduce costs, and mitigate delivery risk b) Procurement of a second-hand boiler and associated equipment proved low risk and lowered capital expenditure, albeit with a pragmatic approach to performance guarantees c) Silo suppliers, such as Central Silo Systems, can supply silos which provide compact dry storage for wood pellets with pneumatic handling that allows for fast deliveries with a blower truck and the pellet store to be installed away from the boiler house d) If practical, select installation sites that allow ongoing operation of existing equipment to minimise downtime and ensuring no interruption to operations e) Design for future environmental compliance by allowing footprint and infrastructure for additional particulate control

#	Category	Key Industry Lessons
3	Project Delivery	a) Client/owner (in-house)managed project delivery can reduce overall costs and increase flexibility, but requires strong coordination, clear scope definition, and proactive interface management to identify and mitigate any potential risks between suppliers b) Comprehensive safety processes, including Hazard and Operability Studies (HAZOP) studies, Site-Specific Safety Plans (SSSPs), permits, and daily toolbox meetings, ensured high-risk activities were managed effectively. c) Automation and remote supervision reduce labour requirements and enable rapid troubleshooting d) Attention to small design and operational details, such as floor painting, landscaping, dust and noise control, and equipment tidiness, supports a culture of high-quality operations and asset maintenance
4	Commercial Aspects	a) Use standardised cost classifications (e.g., AACEi Class 1–5) to communicate estimate accuracy and manage stakeholder expectations b) The project received board approval based on a business case which benefited from Government Investment in Decarbonising Industry (GIDI) co-funding, which reduced capital costs and financial risk c) The capital cost of $6,580,000 for an 8.4 MWth steam boiler, at this delivery quality, pace and scale, is below market expectation at $0.78M/MWth d) Whole-of-life cost modelling should include all operational changes and fixed costs, such as removal of gas connection charges, to provide a realistic financial assessment e) Wood pellets can be cost competitive with natural gas on an energy basis f) Processing multiple consents simultaneously led to a 4-month delay in commissioning. This approach to consenting provided key lessons for future projects, such delay could be avoided by processing consents individually and as early as practical

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Acronym List

Acronym	Description
AACEi	Association for the Advancement of Cost Engineers international
ACOP	Approved Code of Practice
BFD	Block Flow Diagram
EECA	Energy Efficiency and Conservation Authority
ETS	Emissions Trading Scheme
GIDI	Government Investing in Decarbonising Industry
HAZOP	Hazard and Operability Study
HMI	Human Machine Interface
IPMVP	International Performance Measurement and Verification Protocol
IRR	Internal Rate of Return
MCC	Motor Control Centres
MCR	Maximum Continuous Rating
SCADA	Supervisory Control and Data Acquisition
SSSP	Site Specific Safety Plan
VSD	Variable Speed Drive

1 Project Introduction

This Chapter introduces AFFCO as a major New Zealand meat processor and outlines its sustainability initiative. It provides an overview of AFFCO's transition to wood pellet boilers across multiple sites.

1.1 AFFCO

AFFCO is one of New Zealand's largest meat processing companies that has been operating for over 100 years. It is owned by Talley's Group which is a major producer, processor, and exporter of New Zealand food products and wood pellets.

1.2 AFFCO Sustainability Goals

Since 2014, AFFCO has partnered with the Energy Efficiency and Conservation Authority (EECA) to implement an energy management programme at 11 sites. The programme includes annual energy management plans, establishing energy teams at each site, energy audits, and developing energy baselines to record energy and carbon savings to the standard of a recognised international protocol International Performance Measurement and Verification Protocol (IPMVP). Since June 2019, AFFCO has reduced its annual energy use by 45 GWh and reduced annual carbon emissions by 9,800 tonnes of carbon dioxide equivalent.

Talley's Group Limited have 11 approved Government Investment in Decarbonising Industry Programme (GIDI) co-funded projects across their food manufacturing sites totalling $35 million in co-funding to abate over 107,000 tonnes CO_2e annually. GIDI was a New Zealand government co-funding programme designed to help businesses reduce industrial greenhouse gas emissions by switching away from fossil fuels and improving energy efficiency.

AFFCO's GIDI projects mainly focus on fuel switching (coal to electricity or biomass), biogas utilisation, and heat recovery, to reduce fossil-fuel use in meat processing plants across New Zealand. It was estimated to save 4,450 tonnes of CO_2e annually when compared to the previous natural gas usage.

1.3 Pellet Boilers

AFFCO have installed three pellet boilers to date.

1.3.1 Moerewa

AFFCO Moerewa, which is in Northland, was AFFCO's first wood pellet boiler installation. The installation consists of a 6 MWth steam fire-tube boiler with two pellet silos, with pneumatic delivery and handling. It was commissioned in late 2021 / early 2022.

1.3.2 Wairoa

AFFCO have a site in Wairoa, Hawke's Bay, which had an 8 MWth coal boiler, which was replaced with a 6 MWth steam Maxitherm water-tube pellet boiler, commissioned in 2024. This project also included heat recovery from an ammonia engine room to reduce heat demand, enabling a smaller biomass pellet boiler to be used. GIDI co-funding was $2,800,000 and estimated lifetime emissions reduction was ~200,525 tCO_2e.

1.3.3 Horotiu

The AFFCO Horotiu site is in the Waikato region and is approximately 15 km from Hamilton City. The site is the largest beef processing plant in the company by capacity - it processes bovine and bobby calves. The site had a natural gas fired boiler which was removed and replaced with a wood pellet boiler, which was commissioned in 2025, to provide process heat to its meat work operations and steam to its rendering plant. AFFCO's previous experience at Moerewa and Wairoa was leveraged for AFFCO Horotiu.

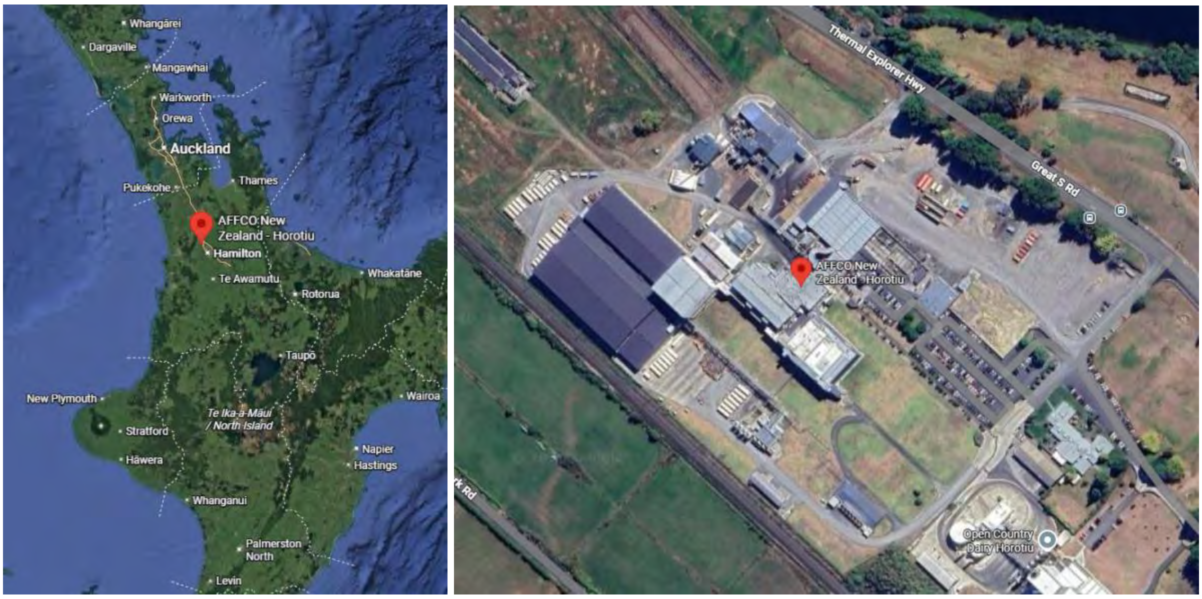


Figure 1: Location of AFFCO Horotiu Site

1.4 Project Timeframe

Table 1 below shows a high-level project timeframe which shows a 2.5-year total project timeframe from concept to completion. This extended case study will run through the project in chronological order.

Table 1: Project Timeframe

Project Phase	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Concept, Feasibility & Preliminary Design												
Final Investment Decision (FID)												
Detailed Design & Procurement												
Project Delivery												

1.5 Resources & Stakeholders

All information in this case study was obtained from the resources and stakeholders listed in Table 2.

Table 2: Resources & Stakeholders

#	Who	Location	Role & Expertise	Useful Links & Contacts
1	AFFCO Group	Horotiu, New Zealand	Meat Producer	Home | Affco New Zealand
2	Natures Flame	Taupō, New Zealand	Wood Pellet supplier	Nature's Flame | Premium Wood Pellets New Zealand
3	Lyttleton Engineering	Lyttleton, New Zealand	Boiler installer and integrator	Conversion of 8MW Coal Boiler to Biomass - Lyttelton Engineering https://lytteng.co.nz/
4	Prolec	Christchurch, New Zealand	Boiler controls	https://www.prolec.co.nz/Contact-Us/
5	EECA (the Energy Efficiency and Conservation Authority) (EECA)	Christchurch, Wellington and Auckland, New Zealand	Leadership, support and co-funding	Co-funding and Support | EECA Biomass boilers for industrial process heat | EECA EECAEnquiries@eeca.govt.nz
6	Central Silo Systems	Palmerston North, New Zealand	Design, supply and installation of silos	Central Silo Systems Ltd | Grain Silo - Feed Milling - Meal Feed Specialists https://www.centralsilosystems.co.nz/
7	Futura	Cambridge, New Zealand	Design & supply of boiler house	https://futura.nz/
8	Hennessey Electrical	Hamilton, New Zealand	Electrical contractor	https://hennessy.co.nz/
9	Maple Construction	Hamilton, New Zealand	Installed the boiler house	https://www.mapleconstruction.co.nz/
10	Connor Consulting	Christchurch, New Zealand	D esign of civil and structural engineering for the boiler house foundations	https://www.connorconsulting.co.nz/
11	Pemberton Group	Hamilton, New Zealand	Specialist civil construction company	https://pembertongroup.co.nz/contact-us

1.6 Types of Biomass

Common types of solid biomass fuel are listed in the Table 3.

Table 3: Common Types of Solid Biomass Fuel

Biomass Type	Description	Image	Typical Pricing
Wood Pellets	Wood that has been pulverised and densified (pelletised) under heat and high pressure to produce a cylindrical wood derived fuel of consistent size. The tend to be made from forestry residues and timber shavings.		17.1 - 25.4 $/GJ 61.6 – 91.4 $/MWh
Wood Chips	Chipped woody biomass in the form of pieces, with a defined particle size produced by mechanical treatment with sharp tools such as knives.		13.5 - 20.5 $/GJ 48.6 – 73.8 $/MWh
Hog fuel	Fuel wood in pieces of varying size and shape produced by crushing with blunt tools such as rollers, hammers or flails. These fuels are typically of a lower quality compared to wood chip.		11.2 – 17.9 $/GJ 40.3 – 64.4 $/MWh
Urban Wood Fuel	Wood residues derived from the urban activities including packaging materials, off cuts from manufacturing, construction and demolition used wood residues, yard trimmings, arborist trimmings, urban tree residues and from land clearing		Highly variable
*Pricing obtained from EECA's Regional Transition Accelerator (RETA) Programme			

Wood pellets offer several operational advantages over other biomass fuels, including more consistent fuel quality, higher energy density, improved combustion performance, and reduced storage requirements. Their higher energy density also results in fewer fuel deliveries, reducing truck movements and associated logistics. Together, these characteristics contribute to more reliable boiler operation, simplified fuel handling, and a smaller on-site fuel storage footprint. However, as shown in Table 3, these operational benefits come at a higher fuel cost on an energy basis, with wood pellets having a higher price per gigajoule (GJ) than other biomass fuel options.

Wood pellets can meet the following international fuel standards (which includes the European DIN Plus and EnPlus). Pellets have low moisture <10% by weight and high energy density of 16-17 MJ/kg. Wood chips, hog fuel and urban wood fuel can have a range of fuel properties, which can be classified according to technical standard *'ISO 17225-1:2021(en): Solid biofuels — Fuel specifications and classes'*. A guide for biomass fuel specification is provided by the Bioenergy Association which is based on ISO 17225. Biomass fuel is typically described by the following properties: particle size (P), fine fraction, moisture content (M), ash (A), bulk density (kg/m3) and energy density (MJ/kg). Classified biomass fuels must be free from non-wood contamination, such as soil and stones.

As of 2026, there are three large-scale industrial wood pellet suppliers in New Zealand:

1. North Island: Natures Flame based in Taupo
2. South Island: Azwood based in Nelson
3. South Island: Niagara based in Invercargill

2 Concept & Feasibility Design

This Chapter outlines the technical and strategic assessment undertaken by AFFCO to identify and implement a viable pathway for transitioning away from fossil gas at the site. It summarises the energy transition analysis, technology screening process, boiler sizing methodology, and the selection of biomass fuel handling systems that informed the final project design.

2.1 Energy Transition

AFFCO completed an Energy Transition Accelerator (ETA) with DETA Consulting. The ETA programme is administered by the Energy Efficiency and Conservation Authority (EECA), it is a study that maps a pathway to decarbonise industrial sites. The ETA was completed in detail for the Wairoa site and then lessons learned were applied to other AFFCO sites such as Horotiu and other sites. This study highlighted various electrification (direct and heat pumps) and biomass fuel pathways (wood chips and pellets).

Electrification was screened out due to:

a) Insufficient site electrical capacity to accommodate electrification of heat plant

b) High electricity rates

c) Distance onsite between refrigeration plant rooms for heat recovery, and difference in heat source and sink profiles, which would require a back-up heat source with fast ramp rates and a high turn-down

Wood chips were screened out due to:

a) High manual labour requirements

b) High capital cost

c) Large space requirements for fuel handling

Wood pellets were selected based on:

a) Proven wood pellet supply chain at the required scale

b) Low labour requirements

c) Low capital cost

d) Small space requirements for fuel delivery, storage and handing

e) Proven performance within the business having a 6 MW pellet boiler at Wairoa successfully installed, lower operator labour, and an ability to execute rapidly within board timelines.

AFFCO also have an inhouse engineering team who carried on the front-end engineering work, post the ETA, for energy transition projects in the business.

2.2 Boiler Sizing

Gas-fired boilers tend to be oversized, due to the low capital costs to add more capacity. The old gas boiler was sized at 10 MWth. As the peak steam load is likely below the gas boiler capacity, replacing like for like would probably result in a higher capital cost than is required.

Figure 2: Former Gas Boiler House

The site did not have visibility of the steam demand and installing steam meters in an operating meat works is challenging due to integration with legacy Supervisory Control and Data Acquisition (SCADA) systems, limited available I/O capacity, restricted shutdown windows, insufficient straight pipe length for correct meter installation, and capital cost constraints.

AFFCO used a combination of the following methods to size the boiler:

a) Gas meter data, which provided gas average usage over one hour. This does not provide enough granularity to determine peak instantaneous load but is a good starting point. Also, the gas boiler was the only appliance using gas, so there was no need to estimate a split of gas usage.

b) Built a steam demand schedule via listing all equipment that uses steam and what their steam rating is, coupled with observations of all equipment that uses steam on site, and noting down start-up times and base load running usage

c) AFFCO determined that some high steam demands could be staggered to reduce the steam peak usage by operational changes, which are low cost and managed via paperwork changes and staff training

AFFCO were confident that the peak steam demand would be less than 8 MWth.

2.3 Biomass Delivery, Storage & Feed

Once the pellet boiler was chosen, AFFCO's internal engineering team evaluated different pellet handling systems. These included but were not limited to:

a) Silos for pellet storage

b) Bucket elevators for pellet delivery

c) Pneumatic systems for pellet delivery and feed

d) Conveyors for pellet feed

Silos with pneumatic delivery and feed, were favoured for the following reasons:

a) They keep pellets dry, which from previous project experience was a key factor in boiler operation

b) Reasonable capital costs

c) Low running costs as the only moving parts are a fan and two valves

d) Relatively small footprint

3 Detailed Design & Procurement

This Chapter outlines the development of the biomass fuel supply chain and the technical design decisions for the pellet handling system and boiler plant. It describes how fuel supply, storage, delivery, and boiler technology were selected, as well as the procurement approach used to reduce capital costs and delivery risk.

3.1 Biomass Supply Chain

AFFCO chose Nature’s Flame to supply wood pellets to the Horotiu site via blower trucks. AFFCO and Nature’s Flame are both owned by the Talley’s group; however, pricing is set on competitive market aligned terms rather than internal subsidy.

3.2 Biomass Handling & Feed System

AFFCO obtained pricing for silos with pneumatic delivery and handling from the following: PMR Grain Systems; REL Group; Conveyor Industries; Lyttelton Engineering; JP Marshall and Central Silo Systems.

AFFCO worked with Central Silo Systems in Palmerston North because of previous working relationships and cost-effective solutions – the same system was previously installed at AFFCO Wairoa boiler project. Central Silo’s specified silos which are imported from Symaga in Spain and are constructed from galvanised steel, rather than the powder-coated steel that is typically used. This specification is selected due to the higher humidity and salt-laden air present in New Zealand, which increases the corrosion classification under ISO 12944 to approximately C4–C5, compared with C1–C2 conditions typically available. The silos are also designed to comply with New Zealand seismic design requirements. Standard silo capacities generally range from 10 to 150 tonnes, although larger silos with capacities exceeding 7,000 tonnes are available. Lead times typically range from 6 to 12 months, depending on the project scope and configuration.

Figure 3 shows a Block Flow Diagram (BFD) of the main components of the biomass handling and feed system.

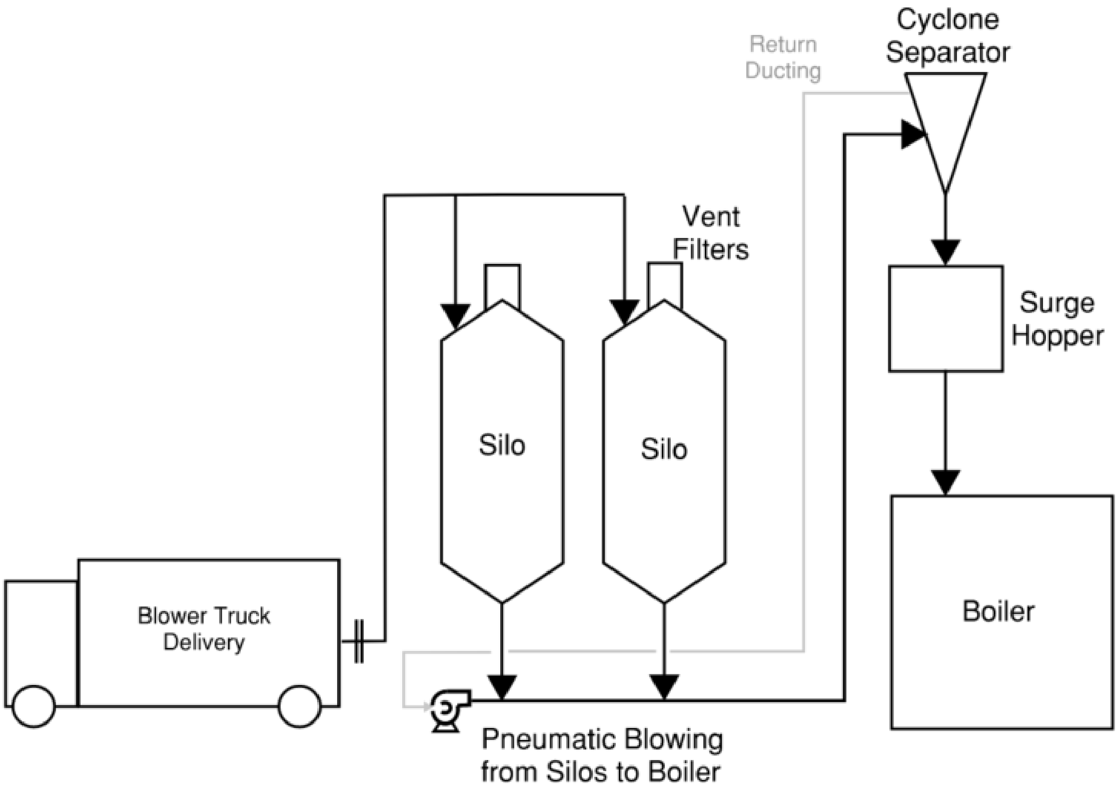


Figure 3: Pellet Delivery, Storage & Handling System Schematic

The following list describes how the process works:

a) Trucks to rotary valve:

   i) Trucks enter the site and pneumatically feed pellets into the top of each silo

   ii) A truck and trailer load can contain approximately 36 tonnes of pellets, which takes 90 minutes to unload, but deliveries are often less tonnage than this

   iii) A flexible hose is attached to the truck and at the bottom of the silos at a fill port

   iv) The truck is tipped slightly and an internal auger feeds pellets through a fan which blows pelted through the flexi hose, up through a galvanised pipe into the top of the silos

   v) The air pressure is around 1.2 bar(g) to prevent damaging the pellets and turning them into dust, which can create all sorts of feed issues

   vi) There is a filter vent mounted at the top of a silo to prevent the vessel being over pressurised by the airstream, and there are emergency explosion relief panels

b) Rotary valve to surge hopper:

   i) The pellets are fed from the silos into the boiler surge hoopers, through a rotary valve and galvanised pipe via a forced draft fan

   ii) The surge hopper is a small intermediate storage bin that acts as buffer control between the main pellet silo and the boilers fuel-feeding mechanism – they ensure that the boiler receives a steady flow of pellets

   iii) The surge hoppers have a return line to the forced draft fan to prevent pellets/dust entering the boiler room

   iv) Both silos feed into the same boiler pellet supply circuit

v) The rotary valves at bottom of silos were tie-in point between Central Silo Systems and Lyttleton Engineering

vi) The silos have level sensors, and the boiler operator can see when the levels are low, and they decide when to make an order from Nature's Flame

vii) The silos store 75 tonnes of pellets each, which totals 150 tonnes. This equates to approx. 5 to 6 days of fuel storage

viii) AFFCO had part of the pellet delivery pipe from the bottom of the silo noise insulated to stay within noise consent limits. In hindsight they would have installed more noise insulation to reduce site noise

c) Mechanical augers convey pellets from the surge hopper to the boiler feed thrower

3.3 Boiler Design

AFFCO worked with Lyttelton Engineering to specify a steam boiler. AFFCO had a pre-existing relationship with Lyttelton Engineering from previous boiler projects and continued working with them for this project.

Before purchasing second-hand boilers from Christchurch hospital, AFFCO worked with Lyttelton Engineering to specify and price up a water-tube Maxitherm steam boiler. Lyttleton Engineering design and manufacture Maxitherm boilers in Lyttelton, New Zealand, which include the following features:

a) Fuel throwers for coal, wood chips or wood pellets

b) Maxitherm water-tube boiler:

  i) Generates 7.6 MWth of steam on coal

  ii) Generates 8 MWth of steam on wood pellets

c) Economiser which adds 400 kWth, to make 8.4 MWth of steam

d) Louver travelling grate with automatic deashing

e) Refractory lined

f) Saturated steam generation

g) Automatic blow down

h) Full electrical and automation system for unattended operation

Boiler has no redundancy - the redundancy is achieved through diversity of sites as other AFFCO sites can provide additional processing capacity, and potentially temporary diesel boilers.

3.4 Boiler Procurement

Through industry networks, AFFCO and Lyttelton identified two second-hand Maxitherm boilers for sale from Christchurch Hospital with around 6-years operation each, operated in duty/standby for 10 years (2011-2022). They were rated 8 MWth with an economiser when fired on coal. They were for sale due to the identified seismic risk of the existing boiler house, the facility was completely replaced, and the decision was made to replace the boilers with new Polytechnik biomass boilers instead of converting and relocating the existing ones.

These boilers were originally coal-fired and Lyttleton Engineering confirmed they could be converted to fire on pellets, the biggest change on the boiler is a replacement of coal throwers with pellet throwers, and all upstream pellet delivery, storage and handling would need to be installed.

AFFCO chose to purchase the two boilers and associated vessels and any equipment that could be reused and re-use only one of the boiler systems at AFFCO Horotiu. This significantly reduced capital costs by NZ$1.2M, albeit with a less comprehensive warranty. AFFCO have commonly transferred equipment, including boilers, between sites to improve reduce costs on procuring new assets, and understand how to manage the risks.

Lyttleton suggested which components could and could not be reused, which are listed in Table 4.

Table 4: Reused and New Equipment

#	Re-used Items	New Items
1	Maxitherm Boiler	Feedwater tank (old copper feedwater tank was not suitable)
2	Forced draft fan and induced draft fan	All pipework
3	Deaerators lift pumps and feedwater pumps	All wiring and control panels (Schneider/Rockwell via Prolec)
4	Deaerator	Variable Speed Drives (VSD)
5	Condensate tank and blow down tank	Motor Control Centres (MCC)
6	Economisers	Flue stack and ducting

3.4.1 Travelling Grate Furnace

The travelling grate allows for optimal distribution of biomass throughout the combustion system to ensure complete burnout, minimal emissions and maximum efficiency. As the fuel moves across the furnace it goes through the following stages of combustion, listed below and illustrated in Figure 4 and 5:

a) **Pre-drying** to remove all moisture prior to pyrolysis and combustion

b) **Pyrolysis** is where the gaseous volatiles are released from the fuel

c) **Volatile combustion** is where the volatiles are burned in the gaseous phase

d) **Char burnout** is where the larger organic polymer structure breaks down and oxidise, such as hemi-cellulose, cellulose and lignin

e) **Bottom ash** falls into a conveyor which is fed into a dedicated skip bin

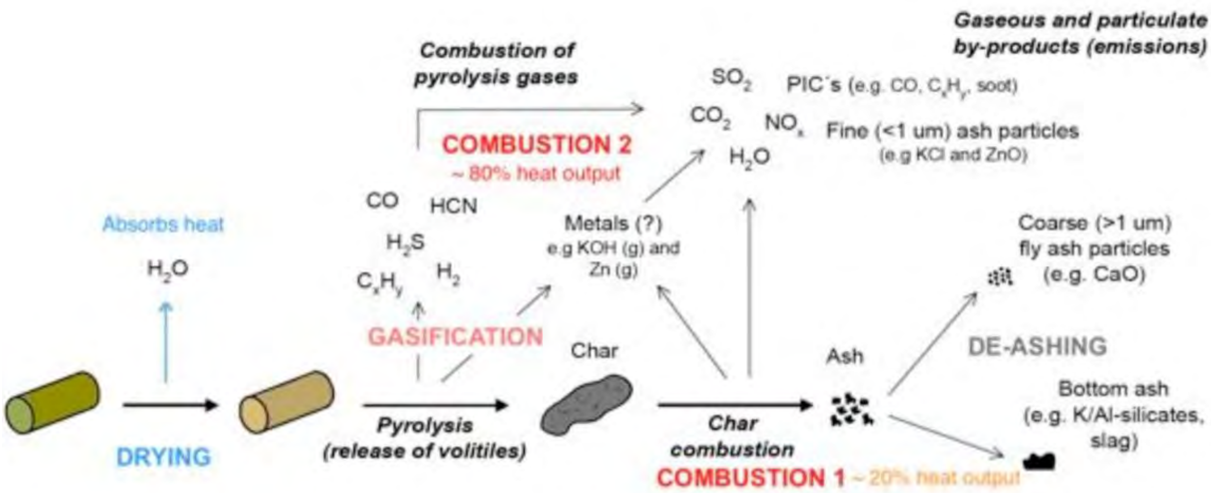


Figure 4: Stages of Combustion (Polytechnik)

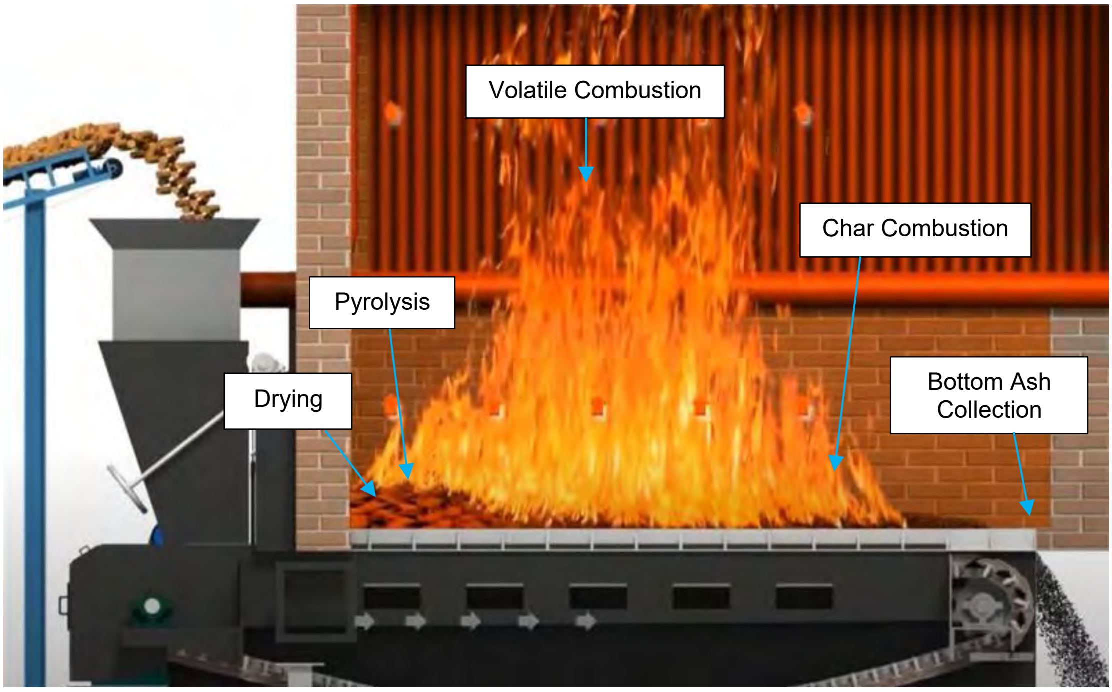


Figure 5: Travelling Grate Boiler

3.4.1 Combustion Air

Energy from coal combustion is approx. 80% char combustion and 20% volatile combustion. Whereas biomass combustion is 20% char combustion and 80% volatile combustion. A Maxitherm coal boiler has most of the combustion air fed through under the grate, for char combustion, with some over fire air for volatile combustion. A Maxitherm biomass boiler, therefore, has additional over fire air nozzles to account for the increased volatile combustion of biomass.

3.4.2 Air-to-fuel Ratio

The boiler is operated with excess air overall, which is a Lambda just over 1. The air-to-fuel ratio varies across the combustion zones, it is lambda <1 in the pyrolysis and >1 in the volatile and char combustion. An overall Lambda just over 1 provides the optimum combustion environment which achieves the highest combustion efficiency and minimises emissions of hydrocarbons, carbon monoxide and particulates, as is illustrated in the Figure 6.

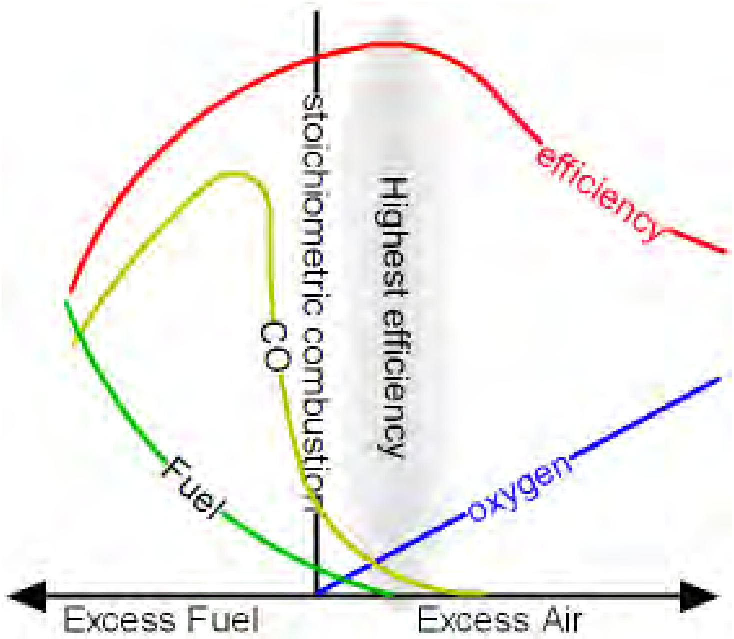


Figure 6: Optimum Air-to-Fuel Ratio

3.4.3 Flue Gas Temperature

Thermal efficiency of boilers is largely related to the flue gas exhaust temperature. Generally, the lower the flue gas temperature the high the efficiency and vice versa. Flue gas is used to pre-heat the make-up water and flue gas exit temperatures was designed to be approximately 120-160°C. The economiser was not installed at Christchurch Hospital, AFFCO has this newly installed in Horotiu to reach 8.4 MWth when fired on wood pellets.

3.4.4 Heat Exchange / Economiser System

The boiler is a water tube boiler, which has water walls and banks of water tubes over the furnace, to capture the heat from the gaseous products of combustion. This generates 8 MWth of steam and the economiser can capture an additional 400 kWth of heat, to make 8.4 MWth of steam

3.4.5 Particulate Control & Flue Stack

Bottom ash is collected from the boiler in a bin. The bin is emptied once a week onto nearby paddocks onsite.

Flue gasses pass through a grit arrestor to capture some fly ash and then through a 32m stack. This is a requirement to meet the air quality requirements from the local council. The site is future proofed with space and foundation for additional particulate control

3.5 Site Selection

AFFCO chose to install the plant at a new in a green field section on the Horotiu site because due to space and truck movement requirements of a new pellet boiler and silo systems. The new boiler house footprint lone if 18 m x 18 m, which is approx. 324 m^2. The boiler house and the silos are approx. 400 m^2.

This also allowed the exiting gas boiler to remain in operation until the new boiler was commissioned, which meant that the plant could continue operating as normal while the new boiler was installed. This was a de-risking factor in that AFFCO Horotiu could continue operation if there were delays in construction or commissioning. The existing gas boiler house, including the feedwater tank outside was 140 m^2.

4 Project Delivery

This Chapter describes how the project was delivered, including the project management approach, safety processes, construction of the new boiler house, and installation of the biomass boiler plant. It also outlines the commissioning outcomes, operational arrangements, and key performance characteristics of the system.

4.1 Project Management

The project was delivered under a client/owner-managed model, with AFFCO coordinating seven separate contracts from concept through to completion. Figure 7 illustrates this client-managed model for major contracts only – there were other minor contracts. The AFFCO project manager was a qualified project mechanical engineer, with a strong background in mechanical design engineering. The opposite project management approach would be to engage a turnkey contractor.

This multi-interface approach can reduce overall project costs by avoiding layered contractor margins, allowing more choice and cost transparency. It also increases flexibility in design and equipment selection, allowing contractors and suppliers to be chosen based on technical performance, innovation, and competitiveness rather than a single contractor's supply chain.

However, this model transfers significant coordination and integration risk to the client/owner. With multiple contracts, clear scope definition, proactive communication and strong interface management are critical to avoid gaps, overlaps, delays, and rework.

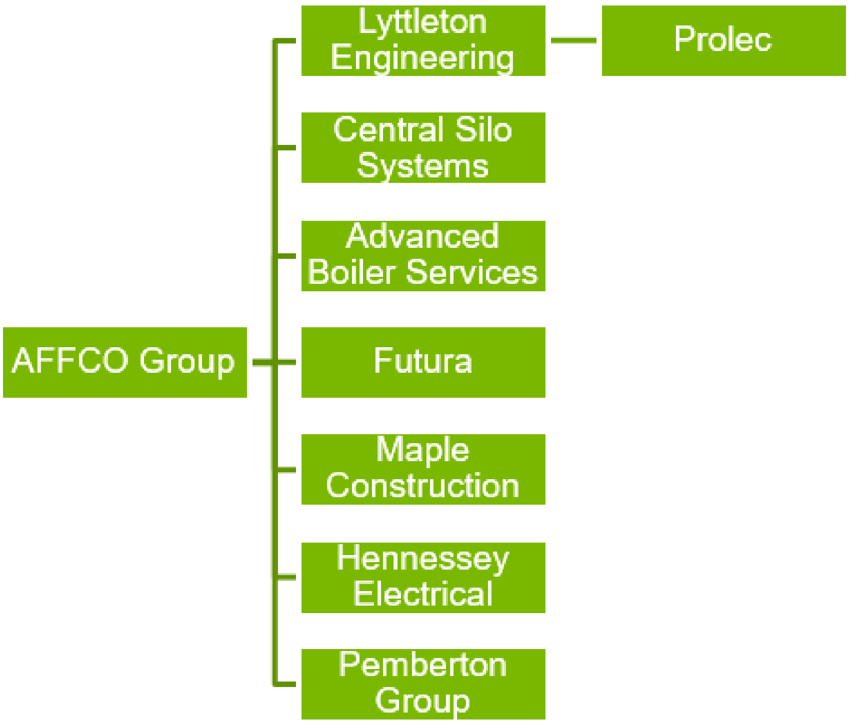


Figure 7: Client-Managed Model

4.2 Project Safety

For this project, several safety processes were implemented to ensure all works were carried out in accordance with good practice and safety requirements in New Zealand.

A Hazard and Operability Study (HAZOP) was completed with Lyttelton Engineering in relation to the boiler design to identify potential operational and safety risks, and to ensure appropriate mitigation measures were in place prior to commencement of works.

The site was fully ring-fenced, and all activities were managed under a Site Specific Safety Plan (SSSP). Major contractors working on the project were required to provide their own SSSPs, which were reviewed and incorporated under the overarching site safety framework.

All contractors were required to sign in and out of the site each day to maintain accurate records of personnel on site at any given time. In addition, a daily toolbox meeting was held at 7:00 a.m., attended by the lead representative from each contractor, to discuss the day's activities, identify potential hazards, and confirm safety controls.

Permits were required for any high-risk work activities, including hot works, crane lifts, and working at height, ensuring that appropriate controls and approvals were in place before these tasks were undertaken. AFFCO were the permit issuer, and the contractors were permit receivers.

4.3 New Boiler House

The new boiler house, foundation and roading was designed, constructed and installed by four separate companies. Connor Consulting designed the civil and structural engineering for the foundations, and the Pemberton Group constructed the foundations, which included 12-metre-deep wooden piles for the boiler house. Futura deigned and supplied the steel-portal framed boiler house and Maple construction installed the boiler house.

Figure 8: Selected Adjacent Site & Piled Foundation in Construction in July 2024

4.4 Boiler Installation

One boiler was trucked from Christchurch to Horotiu. The boiler is 2.4m wide, which required traffic management during road transport. Figure 9 shows photos of the boiler installation – photos provided by AFFCO.

Crane lift of roof onto boiler house frame

Boiler house and grit arrestor

Boiler, economise and grit arrestor

Figure 9: Boiler Installation

4.5 Boiler Performance & Guarantee

The boiler was commissioned in May 2025, and the main performance details are listed in Table 5. There was a performance guarantee on the boiler installation that was 5% penalty of total contract fee if performance was breached within the first 12 months of operation. The expected lifetime of the plant is at least 20 years.

Table 5: Boiler Performance Details

#	Parameter	Unit
1	Boiler Model	Maxitherm 8LCD 4150 with Flue Gas Economiser
2	Maximum Continuous Rating (MCR)	8.4 MWth total with economiser 12 t/hr of 9 bar(g) steam
3	Turndown Ratio	6:1
4	Net Thermal Efficiency	82.9% Gross Calorific Value (GCV), 91.8% Net Calorific Value (NCV)
5	Carbon Savings	Estimated to abate 4,450 tonnes CO_2e per annum compared to the previous gas boiler

4.6 Boiler Operation & Supervision

Boiler supervision requirements are detailed in the Approved Code of Practice (ACOP) for the design, safe operation, maintenance and servicing of boilers, which can be downloaded from the WorkSafe website. Table 6 is a simplified version of the supervision requirements. This new boiler at AFFCO is an unattended boiler.

The boiler control system sends an SMS message to operators if there is an alert. Lyttelton Engineering also have remote access to the boiler Human Machine Interface (HMI) for troubleshooting purposes.

Table 6: Simplified Supervision Requirements

Mode	Boiler Size / Type	Who Checks	How Often	Maintenance
Attended	Up to 20 MW	Qualified operator	Continuous	Every 3 months
Limited attendance	Up to 6 MW	Qualified operator	Every 8 hours	Every 3 months
Unattended	Large boilers > 1.2 MW	Responsible person	Every 24 hours	Every 3 months
Small / Shell boilers	Up to 1.2 MW	Responsible person	Every 2 hours or as authorised	Every 3 months
Small boilers	Under 500 kW	Responsible person	As needed	Every 3 months
Hot water boilers	Over 100 °C or 200 kPa(g)	Responsible person	As needed	Every 3 months

4.7 Presentation

The boiler room floor was painted, and some landscaping was completed at the front of the boiler house. Although these were relatively small improvements, they contribute significantly to the overall presentation of the site. This enhanced presentation encourages a higher standard of care and supports a culture focused on maintaining and operating assets to a high standard.

Notably, the boiler house was not tidied prior to the site photographs being taken. This highlights how well these new assets are maintained in practice, as well as the minimal dust generated during the delivery, storage, and handling of wood pellets.

4.8 Photos

Pellet silos adjacent to boiler house

Maximum delivery pressure of 1.2 bar to prevent degrading pellet integrity

Silos showing, noise insulation on delivery tubes

Air fan which blows pellets to boiler day hopper

Figure 10: Biomass Supply

Pellet surge hoppers and throwers

Shared control room & MCC room (rated 400 amp & uses 230 amp)

Figure 11: Pellet Feed to Boiler & Control Room

Water treatment: Softener, Spirax Sarco Alpha, Theta Gold, Omega Green

Feedwater tank

Deaerator

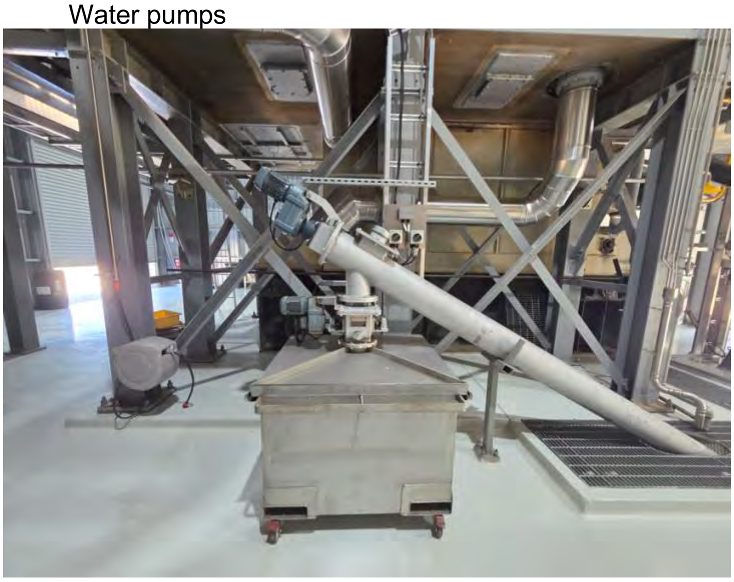
Steam header

Maxitherm Steam Boiler

Figure 12: Water Treatment & Boiler

Water pumps

Bottom ash collection



Bottom ash collection bin

Figure 13: Pump sets & Bottom Ash

Forced draft fan for over fire and under fire air

Particulate control is currently a grit arrestor with space to install further particulate control if required in the future. Photo shows forced draft fan and blow down tank.

Figure 14: Combustion Air & Flue Gases

5 Commercial Aspects

This Chapter outlines the commercial considerations for the AFFCO pellet boiler project, including board approvals, regulatory consents, capital and running costs, and funding arrangements. It highlights the financial rationale, risk assessment, and cost management decisions that supported project delivery and ensured alignment with sustainability and operational objectives.

5.1 Approvals

The AFFCO Board approved the project based on the business case. The decision criteria included:

a) Long-term energy security of wood pellet supply and potential pellet price volatility

b) Emission abatement potential

c) Operational benefits such as increased automation and reduced labour requirements

d) Project readiness and delivery timeframes

e) Project delivery risk

f) Whole-of-life cost, such as payback period and Internal Rate of Return (IRR) compared with continued gas use

   a. Note that this was modelled before the recent nationwide increase in natural gas wholesale prices

   b. The availability of Government Investment in Decarbonising Industry (GIDI) co-funding lowered capital costs and reduced project payback period to below 10 years, which reduced financial risk

While other potential projects may have offered shorter payback periods, the business prioritised transitioning away from gas onto biomass alongside the opportunity to secure GIDI co-funding. This project was the final AFFCO project approved from the four AFFCO projects co-funded by the GIDI fund.

5.2 Consent

A building consent was required for the new boiler house and silos, and a new air-discharge resource consent was required for the pellet boiler. This new resource consent was packaged up with other site resource consents at the time, which contributed to a 4-month delay in project commissioning. The existing natural gas boiler was used to continue site operations.

5.3 Capital Costs

The Association for the Advancement of Cost Engineers international (AACEi) set out a classification system for cost estimates which follows the project development framework. Additional project definition provides a more accurate cost estimate, as shown in Table 7.

Table 7: AACEi Cost Estimation Classification

AACEi Classification	AACEi Accuracy Range
Class 5	Low: -20% to -50% High: +30% to +100%
Class 4	Low: -15% to -30% High: +20% to +50%
Class 3	Low: -10% to -20% High: +10% to +30%
Class 2	Low: -5% to -15% High: +5% to +20%
Class 1	Low: -3% to -10% High: +3% to +15%

According to a Class 3 capital cost estimate, the project was initially budgeted at $10M on a new-build basis, which is $1.2 million per MWth. The final capital cost was approx. 35% under budget as detailed in Table 8. The final budget was attributed to a client-managed project management approach, reuse of a reconditioned Maxitherm boiler and suitable ancillary equipment, and a pragmatic approach to warranties.

Table 8: Capital Costs

#	Item	Capital Cost (NZ$ exc. GST)
1	Main boiler asset and fuel handling	$4,500,000
2	Civil, structural and roading	$1,100,000
3	Ancillary	$330,000
4	Eng and PM	$170,000
5	Electrical and Automation *excluding boiler system	$480,000
6	Total Capital Cost	$6,580,000
7	Specific Capital Costs	$0.78M/MWth
8	GIDI Co-funding	$1,999,258
*Note that a new boiler and ancillary equipment would have increased this cost by $1.2M		

5.4 Running Costs

AFFCO have modelled running costs for a pellet boiler verses a gas boiler and have found that a pellet boiler had lower running costs on older gas prices. Running costs for the previous gas boiler and new pellet boiler are made up of the following:

1. Fuel Costs (Emissions Trading Scheme included)
   - Gas costs as of 2026 have increased significantly since 2023 when AFFCO completed the modelling
   - Removal of natural gas use has eliminated exposure to the volatility of natural gas energy prices
   - Transitioning from gas to biomass removes the associated carbon charges
2. Ash Removal Cost:
   - There is no ash with gas boilers
   - Note the ash from pellet boilers has the potential to be sold as potash compost, but this is currently not available for this site and ash is disposed of with other solid wastes
3. Maintenance and Annual Survey Cost
4. Operational Labour Cost
5. Fixed Gas Charges:
   - Decommissioning the gas boiler allowed the gas line to be capped, which eliminated the ongoing fixed gas connection charges

6 Shared Learnings

Table 9: Shared Learnings

#	Category	Key Industry Lessons
1	Concept & Feasibility Design	g) Set-up energy projects for success early by completing structured energy transition studies to identify practical, financially viable and low risk options independent consultants can be engaged with government support through EECA h) Ensure fuel supply chains are mature and reliable to minimise operational and delivery risk i) Leverage prior experience, or review relevant publicly available information, such as case studies j) Sustainability goals can be progressed alongside asset management plans k) Accurate steam demand data not available in legacy plant, it was estimated through hourly gas usage, equipment information and operating schedules l) The new boiler size was minimised, to avoid over-capitalisation, by adjusting operational schedules to stagger peak steam demands across the site
2	Detailed Design & Procurement	f) Use proven suppliers and contractors with prior relationships to streamline procurement, reduce costs, and mitigate delivery risk g) Procurement of a second-hand boiler and associated equipment proved low risk and lowered capital expenditure, albeit with a pragmatic approach to performance guarantees h) Silo suppliers, such as Central Silo Systems, can supply silos which provide compact dry storage for wood pellets with pneumatic handling that allows for fast deliveries with a blower truck and the pellet store to be installed away from the boiler house i) If practical, select installation sites that allow ongoing operation of existing equipment to minimise downtime and ensuring no interruption to operations j) Design for future environmental compliance by allowing footprint and infrastructure for additional particulate control
3	Project Delivery	e) Client/owner-managed project delivery can reduce overall costs and increase flexibility, but requires strong coordination, clear scope definition, and proactive interface management to identify and mitigate any potential risks between suppliers f) Comprehensive safety processes, including Hazard and Operability Studies (HAZOP) studies, Site-Specific Safety Plans (SSSPs), permits, and daily toolbox meetings, ensured high-risk activities were managed effectively. g) Automation and remote supervision reduce labour requirements and enable rapid troubleshooting h) Attention to small design and operational details, such as floor painting, landscaping, dust and noise control, and equipment tidiness, supports a culture of high-quality operations and asset maintenance
4	Commercial Aspects	g) Use standardised cost classifications (e.g., AACEi Class 1–5) to communicate estimate accuracy and manage stakeholder expectations h) The project received board approval based on a business case which benefited from Government Investment in Decarbonising Industry (GIDI) co-funding, which reduced capital costs and financial risk i) The capital cost of $6,580,000 for an 8.4 MWth steam boiler, at this delivery quality, pace and scale, is below market expectation at $0.78M/MWth j) Whole-of-life cost modelling should include all operational changes and fixed costs, such as removal of gas connection charges, to provide a realistic financial assessment k) Wood pellets can be cost competitive with natural gas on an energy basis l) Processing multiple consents simultaneously led to a 4-month delay in commissioning. This approach to consenting provided key lessons for future projects, such delay could be avoided by processing consents individually and as early as practical