September 2025

Biomass boilers

Case studies from across New Zealand industries

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

aurecon

Executive summary

Industrial and commercial process heat is one of the largest energy demands in New Zealand. Improving efficiency and reducing reliance on fossil fuels in these systems is critical for lowering operating costs and strengthening energy resilience. To explore practical solutions EECA commissioned 4 case studies of businesses that have recently transitioned from coal to biomass. They highlight a range of technologies, woody biomass fuels, and implementation pathways. Together, they provide valuable insights for other energy users considering similar investments.

The 4 projects represent distinct scenarios. Golden Bay Cement installed a large-scale biomass fuel system at New Zealand's only cement plant, co-firing waste wood residues with purpose-built handling infrastructure. Fonterra Waitoa introduced a new 30 MWth bubbling fluidised bed boiler for its ability to fire a wide range of fuels and resilience for high-pressure dairy processing. McCain Timaru converted an existing 14 MWth lignite coal boiler to biomass using a traveling grate furnace, a pragmatic choice delivering immediate efficiency gains and reduced costs. JS Ewers, a Nelson-based horticultural producer, replaced and converted multiple boilers while also installing 4 million litres of thermal storage, allowing its glasshouses to operate on a steady baseload at high efficiency.

Across all projects, common themes emerge. Each company achieved clear improvements in boiler efficiency, system automation, and reduced maintenance compared with coal. Paying for biomass on an energy basis rather than mass proved critical for consistent fuel quality and fair value. Reliable fuel supply chains were essential, with companies working closely with engineering partners and suppliers. At the same time, each project faced challenges – from technical adjustments to feed blockages, to supplier insolvency – but all demonstrated resilience and follow-through.

The benefits are evident. Biomass boiler efficiencies now exceed that of previously burning coal, carbon costs are lower, operational demands on staff are lighter, and maintenance costs are lower. These efficiency gains are paired with emissions reductions strengthened long-term energy resilience and reputational value through industry recognition.

Taken together, the case studies show no single pathway to move from coal to biomass. The diversity of approaches demonstrates biomass can be applied effectively across a wide range of industrial settings, offering both operational and environmental benefits.

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Acronym & units

Acronym & units	Description
AACEi	Association for the Advancement of Cost Engineers International
BMS	Boiler Management System
CDW	Construction and Demolition Waste
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
EECA	Energy Efficiency and Conservation Authority
ESP	Electrostatic Precipitator
ETS	Emission Trading Scheme
FBG	Fletcher Building Group
FID	Final Investment Decision
GBC	Golden Bay Cement
IEA	International Energy Agency
ISCA	Infrastructure Sustainability Council of Australia
ISO	International Organization for Standardization
LVL	Laminated Veneer Lumber
MfE	Ministry for the Environment
MJ/kg	Megajoules per kilogram
MWth	Megawatts thermal, a unit of thermal power
NES-AQ	National Environmental Standards for Air Quality
NZE	Net Zero Emissions
O&M	Operational and Maintenance
PoC	Proof of Concept
PM	Particulate Matter
PM10	Particulate Matter less than 10 microns
PM2.5	Particulate Matter less than 2.5 microns
P&ID	Piping and Instrumentation Diagram
R&D	Research and Development
SME	Subject Matter Expert

1 Introduction

1.1 Extended case studies

In 2025 EECA engaged Aurecon to complete four extended case studies on recent industrial scale biomass process heat projects in New Zealand, that are outside of the timber industry. The four sites included:

- Milk processing plant:
  The installation of a new biomass Bubbling Fluidised Bed (BFB) boiler at Fonterra site in Waitoa
- Cement factory:
  Biomass co-firing in the cement making process at Golden Bay Cement in Whangarei
- Glasshouses:
  The installation of new biomass Step Grate Boilers at JS Ewers in Nelson
- Food processing plant:
  Boiler conversion from coal to biomass in a Traveling Grate Boiler at McCain site in Timaru

The studies included an overview and shared learning on the project lifecycle as listed below:

- Concept & feasibility design
- Detailed design & procurement
- Installation, commissioning & handover
- Approvals & consents

A summary from each study is presented at the end of the report. Note that the terms 'carbon price' and 'carbon costs' are used in the industry which represent units in the Emission Trading Scheme (ETS) in New Zealand.

1.2 Project lifecycle

The four case studies follow the project lifecycle from concept to operation as illustrated below. This summary report summarises the key phases shown in this figure. Note that this figure should be used as a guide because each project is unique and will have its own specific phases and durations.

The initial design phases aim to provide stakeholders with realistic project information, including capital cost estimates within -20% to +30% accuracy, running costs, site functionality, carbon savings and project schedule in order to make an informed Final Investment Decision (FID). Typically, 3-5% of total project cost is committed before reaching FID.

On FID approval, the project implementation includes procurement, detailed design (often by suppliers), construction, installation, commissioning, handover and then operation. Typically, 8-15% of total project cost is committed on engineering and project delivery at close-out.

This graphic also shows the ability to influence project cost throughout the project lifecycle. To de-risk the project cost-effectively, the appropriate time and resources need to be invested in the initial phases where the ability to influence project outcomes is utmost.

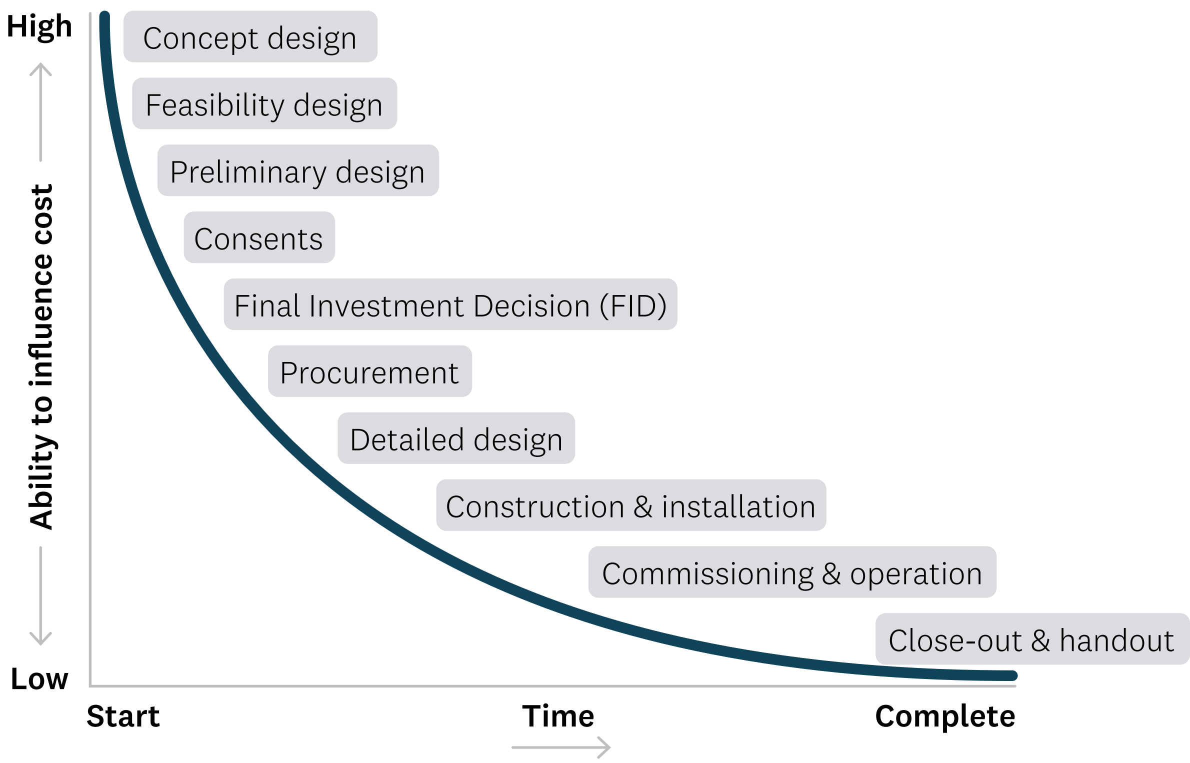

Figure 1: Biomass project lifecycle

1.3 Summary of shared learnings

The four case studies on each fuel-switch project highlight the importance of early stakeholder engagement, technical due diligence, cross-functional collaboration and robust planning, in order to achieve successful outcomes. These projects demonstrate that biomass is a financially viable, secure and sustainable alternative to fossil fuels.

This summary report summarises the shared learnings, in the following Chapters, from these case studies and other general knowledge from industry, and the tables below provide a high-level overview of the key learnings.

Table 1: Summary of shared learnings – engineering aspects

Category	Shared learnings
Concept & feasibility	In the early concept and feasibility phases, experienced consultants and engineers played a vital role. They helped secure reliable biomass supply chains, explore design alternatives, and assess both technical and economic feasibility. For sites that are converting existing equipment, the owner can complete Proof-of-Concept (PoC) tests, which include trials of biomass in the existing equipment, such as the boiler. In some cases, international expertise was required, particularly for specialist equipment or complex system integration, where local experience was limited.
Biomass supply chain: quality & security	The quality and security of the biomass supply chain are crucial for project success. Fuel quality is controlled through standards such as ISO 17225 and DIN Plus, with suppliers ensuring quality control while owners perform spot checks on moisture content. Payment based on energy content rather than weight further incentivises consistently high fuel quality. To secure a supply of biomass, a transparent and contractually aligned supply chain is essential, with back-to-back agreements between forestry, processing, distribution, and the end user. Additionally, multiple suppliers can provide diversity to ensure consistent supply and meet large quantities of fuel demand if required.
Biomass handling, storage & feed system	A significant amount of the project investment goes into the design and build of the biomass handling storage and feed infrastructure. This depends on what assets are reused, what new assets are required and what biomass type is handled. Various systems were employed including front loaders and moving floors, to fully automated Toploader systems, each tailored to the project scale and operational needs. It can be beneficial to install fuel handling plants away from the point of use (i.e. boiler), with connecting utility pipework or fuel conveyors. It can allow better utilisation of space, simpler construction, and improved logistics. Switching to biomass often offers the opportunity to improve energy resilience by maintaining backup fossil fuel capacity. For example, a new biomass boiler presents the opportunity to maintain the existing coal boiler as a back-up boiler or converting an existing boiler by adding a new biomass store, presents the opportunity to maintain the coal store and ability of the boiler to fire coal, as a back-up.

Category	Shared learnings
Boiler performance, efficiency & heat recovery	In terms of combustion technology, projects either converted existing coal boilers or installed new biomass boilers. Both options offered well developed/mature, reliable technology for process heat. Boiler conversions often led to improved thermal efficiency and reduced maintenance, thanks to automated fuel feed systems, high combustion efficiency and reduced wear. Converting a boiler to biomass can reduce the thermal rating, this can be compensated for by implementing thermal efficiency projects on site to reduce the thermal demand. For new boilers, projects utilised fluidised bed and grate boilers depending on fuel characteristics, system scale and site demands. New biomass boilers often employ Flue Gas Recirculation (FGR) to optimise combustion temperature and reduce emissions, with a significant amount of refractory material used to minimise heat loss. Most heat loss occurs through the flue gases, typically at temperatures ranging from 90–150°C. This heat can be captured using economisers to preheat cold make-up water or combustion air, improving system efficiency. Additionally, condensing economisers can capture the latent heat by cooling the flue below its dew point. Modern biomass boilers can achieve greater than 90% net thermal efficiency, or 80% gross thermal efficiency. Future improvements are likely to be incremental, focusing on emissions control and digital optimisation.
Operational & maintenance (O&M) considerations	Despite the challenges presented by increased complexity in new biomass handling, storage and feed systems, it is evident that O&M requirements tend to improve with the adoption of modern technologies. The advantages of reduced maintenance, fewer assets needing oversight, and improved by-product management significantly outweigh the potential complications introduced by new operational technologies.

Table 2: Summary of shared learnings – project aspects

Category	Shared learnings
Financial Considerations	Financially, all projects demonstrated lower running costs due to reduced fuel, maintenance, operational and carbon costs. Biomass boilers, like any boilers, have high upfront capital costs. For biomass boilers which have replaced coal boilers that had usable remaining life, the payback periods ranged from 5 to 12 years.
Project Delivery, Approvals & Consents	Project delivery varied depending on project scale. Smaller projects used turnkey EPC (Engineering, Procurement, and Construction) contracts to simplify the process – such turnkey contracts included the biomass handling and biomass boiler systems. Larger and more complex projects with multiple owner managed contracts benefited from integrated project management teams and more active owner involvement. All projects successfully obtained the necessary building and resource consents, thanks to early and proactive engagement with local authorities. Biomass combustion results in lower particulate emissions than coal, contributing to improved air quality and wastewater management. Future-proofing emissions control was also considered, ensuring the systems would meet evolving environmental standards, such as PM2.5. Modern particulate control systems, such as baghouses, can achieve high particulate capture efficiency. Ash from biomass is considered a fertiliser which can be used in the site operations or sold.
Stakeholders and Suppliers	Stakeholders across government, industry, and engineering sectors were involved in these projects. For the four sites considered, key suppliers and contractors included Windsor, Lyttleton Engineering, and Polytechnik for boiler systems. Engineering and project management services were provided by Aurecon and Beca. Materials handling services were delivered by companies including Living Energy, Hendl & Murray Engineering (HME), Culham Engineering, and Conveyor Industries NZ. Biomass fuel was sourced from Pioneer Energy, Canterbury Woodchip and Azwood. Importantly, these suppliers and contractors were all highly experienced in their field of expertise and had strong track records of success in projects of a similar nature in NZ.

2 Concept & feasibility design

In the early concept and feasibility design phases, all four projects engaged suitably qualified professionals, such as specialist advisers and engineering consultants, to assist in the design development of the projects. This is valuable because it brings in different experience and options for the implementation of a biomass boiler project, including best practises in other sectors and which are the market leading suppliers for such technology, with the associated advantages and disadvantages of such options.

Industrial sites may be able to utilise in-house engineering and project delivery teams to complete the concept and feasibility design phases. Engaging with industry professionals is an option should there not be sufficient resource or expertise internally.

For projects that utilise existing process heat equipment, such as boilers and fuel handling systems, it may be possible to complete a Proof-of-Concept (PoC) test to demonstrate that the proposed solution is technically feasible and highlight any risks that would need to be mitigated before implementation. For example, this could include trials of wood in an existing coal boiler.

3 Biomass specifications

A robust supply chain for the biomass fuel is essential for biomass combustion projects. Common types of biomass fuel are listed in the table below. The biomass handling, storage, feed and boiler systems are design for the type of biomass fuel available.

Table 3: Common types of solid biomass fuel

Biomass type	Description	Image
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.	
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.	
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.	
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	

Wood pellets can meet the following standards, DIN Plus and/or ENplus and 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.

4 Biomass supply chain

All of the four projects had worked with stakeholders to develop and secure a biomass supply chain which included the following:

- Developed a biomass specification, which meets a standard as explained previously, that is suitable for the biomass handling, storage, feed and boiler systems.

  This process can be iterative, depending on the range of biomass fuels available and types of biomass plant that could be implemented onsite.

- Ensuring the entire supply chain works together. There can be multiple stakeholders in the biomass supply chain, as listed below:
  - Forestry owners
  - Wood processors, from tree to biomass fuel such as wood chip / hog fuel / wood pellets
  - Logistics companies that transport biomass fuel from a depot or processing plant to the point of use
- The supply chain can be made up of back-to-back agreements, as shown below. Each agreement can contain the biomass specifications required at that stage.
- The biomass supply chain can include diverse suppliers to provide diversity to ensure consistent supply. This is more practical with large fuel demands.

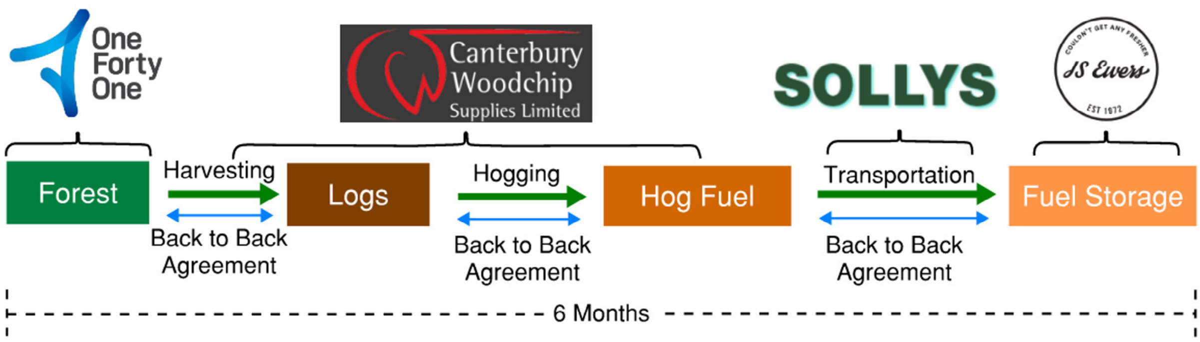

Figure 2: Example biomass supply chain

4.1 Biomass payments

Biomass can be paid for on an energy basis ($/GJ), not a mass basis ($/tonne), which is measured with heat meters on the boiler, which are calibrated and certified, and calculated in the Boiler Management System (BMS). Payment on an energy basis ensures the owner is getting good value for the fuel, as they are not paying for fuel that does not meet the required specifications/standards, such as fuel with a high moisture content and lower energy content than required. Another, or an additional, option is to contractually agree moisture thresholds and agreed penalties if that is exceeded multiple times.

5 Biomass handling, storage & feed system

The biomass boiler itself is a key part of a biomass project, however the handling, storage and feed of biomass, is a significant amount of the engineering work and equipment installed. For new boiler installations, the approximate capital spend on the handling, storage and feed of biomass could be around half of the capital spend in some instances. For conversions of existing coal boilers, the approximate capital spend on the handling, storage and feed of biomass could be up to three quarters of the capital spend. This depends on many variables, such as what assets are reused, what new assets are required and what biomass type is handled.

Of the four case studies, two used the following biomass handling, storage and feed system:

- Delivery to site with tipping trucks
- Covered biomass storage area
- A front loader to move biomass from the storage area to a hopper or moving floor

The other two used the following biomass handling, storage and feed system:

- Delivery to site with tipping trucks
- Storage in Toploader system, which effectively replaced a front loader and moving floor/hopper
  - The Toploader can be filled directly from a reversing tipping truck, or the tipping truck can tip into an in-ground reception pit through a grizzly/grate and convey fuel to the Toploader.

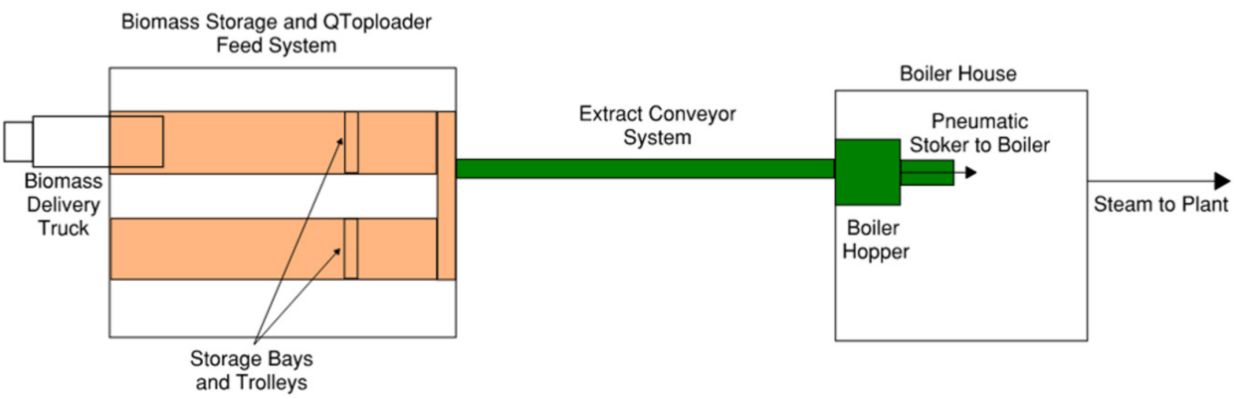

Figure 3: Example of toploader system

Figure 3: Example of toploader system

5.1 Biomass storage

For all systems, sufficient biomass should be stored onsite to suit delivery timeframes and potential supply disruptions to site. Biomass is less energy dense than coal and needs more area to store the same amount of energy. The amount of fuel stored will depend on what is practical for the site, but generally 2-3 days would be good practice. Biomass can also be stored offsite to mitigate such supply chain risks.

The biomass fuel store can be installed away from the boiler, and new dedicated biomass boilers can also be installed away from the steam demand. This allows the following advantages:

- Potential to use free space onsite
- Construction can be ring fenced and managed by main contractors
- Minimal disruptions to site operation during the construction of the fuel store
- Improved fuel delivery logistics.

6 Converting existing coal boilers

In some cases, an existing grate boiler may be able to be converted to fire solid biomass. Lignite coal boilers are generally suitable because they have a large furnace volume. To fire biomass, modifications are made to the fuel feeders, including additional air flow nozzles are required, and adjustment of combustion parameters is needed.

Energy from biomass combustion is from approximately 80% volatile combustion and 20% char combustion. This is the opposite for most coal where the majority of heat is from char combustion. Coal boilers have most of the combustion air fed through under the grate, for char combustion, with some over fire air for volatile combustion. Instead, biomass requires more over fire air than under fire air, hence the addition of air nozzles into furnace above the fuel.

Converting coal boilers to fire biomass is well understood and demonstrated in New Zealand. It is a low-cost pathway to transition from coal to biomass, provided the existing boiler is suitable.

Generally, coal boilers designed to fire low grade fuels such as lignite and sub-bituminous coal, are suitable to fire hog fuel and wood chip less than say 30-50% moisture by weight depending on the boiler. Coal boilers design to high grade bituminous coal, are suitable to firewood pellets which are 7% moisture by weight. Proof-of-Concept tests can be completed to determine if the existing boiler is suitable for co-firing.

7 Dedicated biomass boilers

New dedicated biomass boilers can be split into fluidised bed boilers and grate boilers. There are also pulverised coal boilers through which wood pellets could be pulverised and fired, but the deployment of this technology would be on a much larger scale. The only three pulverised coal boilers in New Zealand are at Huntley power station, which are 10-50x the size of typical boiler on industrial sites.

Different boiler types and biomass fuel types of combinations will have different performance characteristics. The biomass specification, boiler type and utility demand have to be mapped and managed accordingly.

7.1 Fluidised bed boilers

Fluidised bed boilers are primarily used in power plants and large-scale industrial applications to generate steam. Fluidised bed boilers can fire a wide range of fuel with an average moisture content of up to 60%, with short-term spikes up to 64%. Difficult and high moisture content fuels, such as hog fuels or sludge-type wastes, are handled and completely combusted due to the large thermal mass of the fluidised bed and mechanisms of combustion. For comparison, grate boilers can generally fire fuels with an average moisture content of up to 57-58%.

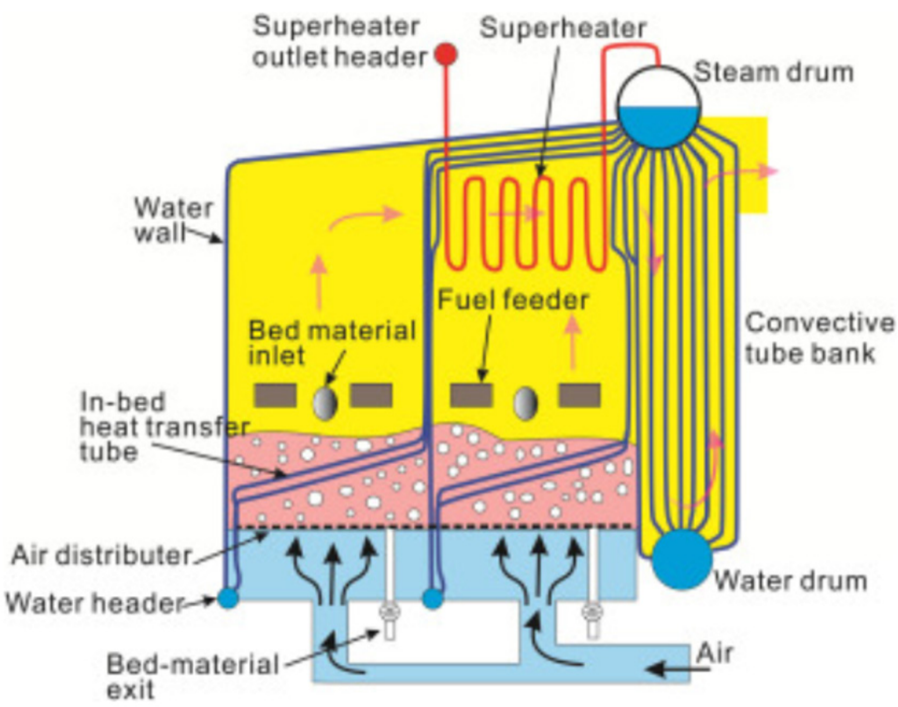

Figure 4: Typical fluidised bed boiler (ScienceDirect)

7.2 Grate boilers

Grate boilers are commonly used in small to large-scale industrial applications to generate steam or hot water for various processes. There are different types of grate boilers, each suited for different fuel types, scales and utility demand profiles - they are listed below:

- Step, or Reciprocating, Grate: Features a back-and-forth motion for even fuel distribution and efficient combustion
- Fixed Grate: No moving parts, requires manual ash handling.
- Pinhole Grate: A stationary grate with steam jets for ash removal.
- Travelling, or Chain, Grate: Moving grates to continuously convey fuel.
- Dumping, of Tipping, Grate: The grate rotates or tilts to remove ash.
- Vibrating Grate.
- Rotating/Rotary Grate.

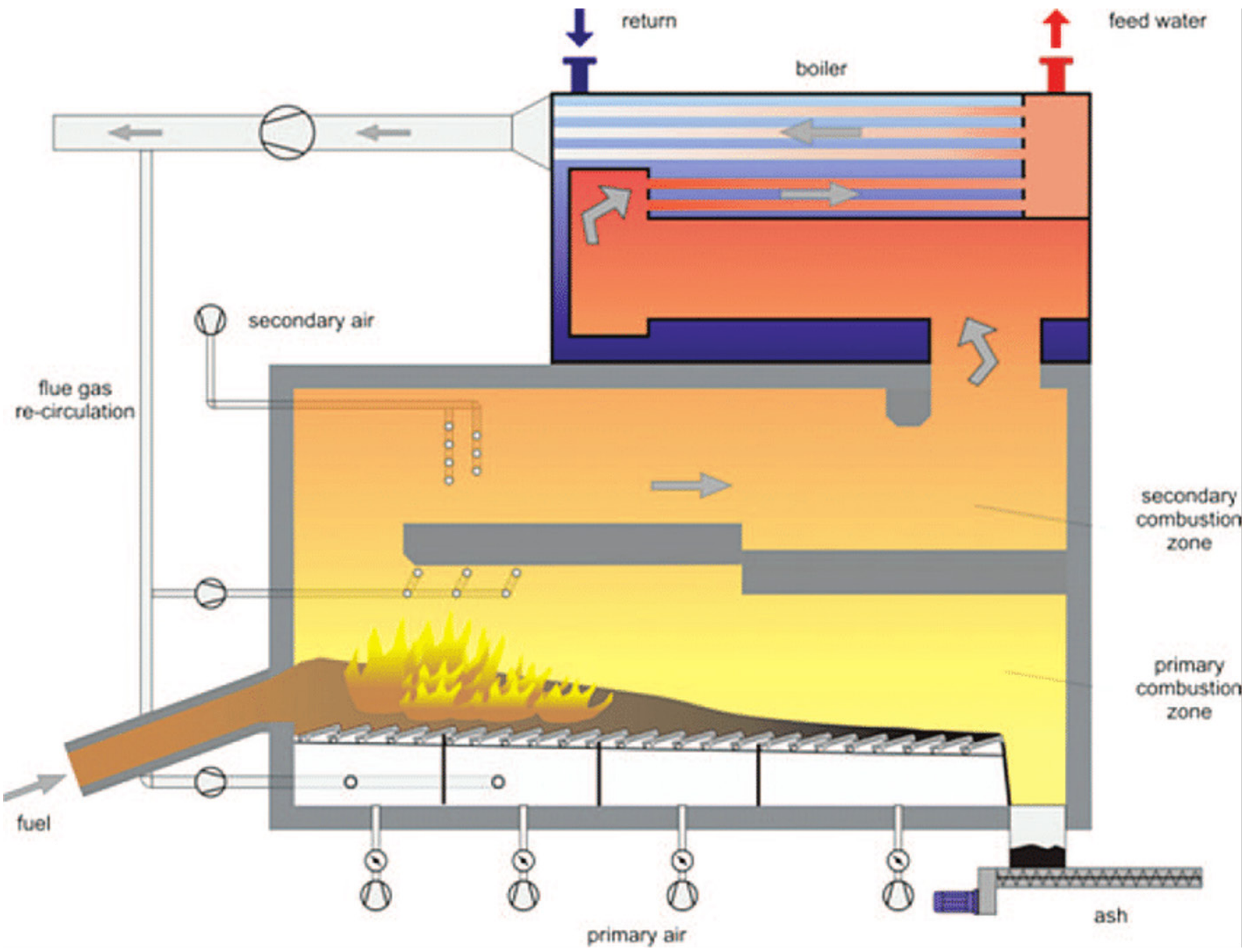

Figure 5: Typical grate boiler (TU-Graz)

8 Redundancy & resilience

For conversion projects, if there is a disruption in the supply of biomass then coal, if available, could be fired to maintain site utility, if the coal storage, handling and feed equipment is in place and maintained, or the equivalent biomass equipment is suitable for coal.

The same applies for new dedicated biomass boilers, which may also be able to fire coal. For example, a fluidised bed is capable of firing a wide range of difficult fuels and has wide fuel versatility.

For new biomass boiler projects, there may also be the option of maintaining the previous fossil boiler, which can be used as a back-up for redundancy in equipment, resilience in the energy supply chains and to provide site utility whilst the biomass boiler is offline for planned or unplanned maintenance.

Thermal storage, in the form of large hot water tanks, can be used to reduce boiler size and lower capital costs.

9 Project delivery

For smaller projects, engaging a single party who can deliver a 'turnkey' Engineering, Procurement and Construction (EPC) contract reduces owner input, in terms of project management and involvement, and may reduce potential issues with interfaces between multiple suppliers and installers. Such turnkey contracts included the biomass handling and biomass boiler systems. The disadvantages are that this approach may lack some view on best practices and best available technology, and cost more due to compounding margin.

For some projects, suppliers may bring in equipment from overseas, in which case a thorough design development framework is required to derisk the project prior to ordering equipment. This ensures that overseas equipment is specified correctly and meets New Zealand's standards, especially around pressure equipment, electrical and the high seismic requirements compared to most other countries. Owner involvement during the design development phases is critical to ensure that the asset has minimal issues over its lifetime. Generally, reactive remediation costs more and takes longer than upfront proactive engineering design work.

For large complex projects with multiple stakeholders, including for example designers, suppliers, civil and structural, and installers, it can be beneficial to have an integrated project management team, to ensure thorough communication of key developments and decisions throughout the project. Such projects may have multiple interfaces to site, with numerous services and communication, in which case it could be worth engaging a multidisciplinary consultancy to manage such interfaces.

For all projects, owner input into the design development, procurement and construction phases is important to ensure that the solution is fit for purpose and has minimal issues over the project lifetime. The owner needs to communicate and collaborate well with the stakeholders to reach design that is optimal for the site, which also future proofs the plant for potential changes over the asset lifetime.

When specialist equipment is installed, a construction supervisor, potentially from overseas, may be required to guide contractors based in New Zealand to complete the installation. This is to ensure quality control of the installation to ensure successful operation. For some specific construction tasks, construction specialists from overseas maybe brought in. Examples include laying of refractory brick in biomass boilers and commissioning certain boilers.

Sometimes, issues arise which are uncontrollable, such as incorrect delivery of equipment. However, such issues may be resolved with innovation and collaboration within the project team. Generally, all commissioning issues were resolved as with other commissioning of combustion systems.

In some instances, equipment may be specified that is from specialist suppliers from overseas. The costs and lead times may be prohibitive. In which case, it is worth investigating other routes, e.g. can the equipment, or similar piece of equipment, be procured from elsewhere or manufactured in New Zealand with assistance from overseas specialists, or can there be a temporary solution whilst the equipment is delivered in from overseas.

A list of key stakeholders involved in delivering the four biomass fuel switch projects studied is shown in the final Chapter.

10 Operational & maintenance considerations

The operational requirements, in terms of employees required to operate the plant, and maintenance requirements, in terms of work require to keep the plant performing well, range depending on the project.

Improvements in the Operational & Maintenance (O&M) requirements can be seen with the following:

- New assets generally have higher levels of automation and require less maintenance. This is evident with new biomass boiler plant
- New assets can replace multiple older assets, resulting in fewer assets, which reduces O&M requirements
- The tasks around ash management significantly improved due to:
  - Less ash is generated
  - Remove coal ash which is full of pollutants
  - Biomass ash is classed as a fertiliser, due to its high nutrient content, and can be sold or used onsite

Challenges in the O&M requirements can be seen with the following:

- More complex handling storage and feed systems can result in increased operations and maintenance, partly due to troubleshooting new complex equipment.

Generally, O&M requirements improve with the move to biomass process heat.

11 Building & resource consent

All building works gained building consent if required. New boilers met limits on noise and gained consent for land use change. All projects had to prove that they meet the air discharge limits for particulate emissions. In all cases, early engagement and collaboration with the local authority aids the consenting process. It may be that the particulate emissions are measured during the Proof-of-Concept test to demonstrate that limits can be met and to gain pre-approval from the local authority before proceeding with a project. No significant roadblocks have been found with obtaining consent for these projects, largely because the consenting processes have been communicated well by the regional authority and the project team.

In the four cases studied it is understood that the biomass combustion had to be within the same limits as the coal combustion. Generally, biomass contains less ash than coal, and in all instances, the particulate emissions reduced when firing biomass. However, particulate emissions limits can become more stringent over time, with decreasing concentration limits and total mass emissions. Currently particulate emission limits are measured using PM10, which is particulate matter less than 10 microns in diameter.

Future particulate emission limits may also include measurement of PM2.5, which is particulate matter less than 2.5 microns in diameter. The National Environmental Standards for Air Quality (NES-AQ) set limits for air pollutants to protect public health in New Zealand, and they are currently awaiting the implementation of a national standard for PM2.5. Therefore, it is prudent to futureproof the emissions control, where practical. Future proofing can include installing fabric filters or electrostatic precipitators (ESP) systems capable of reaching more stringent limit, with little to no upgrades, or by leaving a suitable space onsite for installation of additional particulate control. Cyclones would unlikely meet more stringent limits.

12 Project approvals

In the four case studies, the projects were large enough to require approval of the Final Investment Decisions (FID) at Board level. The Board can be far removed from a particular biomass process heat project and could be unfamiliar with the potential project. All of the projects required a business case to be presented for the project to be considered. The business cases varied in content, but generally included the following:

- A capital cost estimate - after sufficient engineering design has been completed – sometimes fixed or quoted, or meeting a Class 3, 2 or 1 accuracy level in accordance with the AACEi Cost Estimation Classification, which is shown below.
- A running cost estimate which is made up of the following:
  - Operational costs
  - Maintenance costs
  - Energy costs
  - Carbon price.
- A secure and well understood biomass supply chain.
- Ability to meet building and resource consent.
- A risk register with project level risks and mitigations, including some of the items above and some additional listed below:
  - A common risk the project avoided was the exposure to the carbon price and its forecasted increases
  - Ash removal plan
  - Safety risks with project construction and operation
  - Effect on social license to operate
  - National suppliers of major equipment items and key consumables.

Fuel switching projects are large projects that take a few years to develop and deliver. It is pertinent to engage early with key decision makers by socialising the fuel switch project from the initial concept to procurement phases. The early engagement helps the key decision makers to understand the project key details sufficiently and build trust in the business case.

13 Cost estimation

A cost estimate classification system is set out by the Association for the Advancement of Cost Engineers international (AACEi). The classification system follows the project development framework. Additional project definition provides a more accurate cost estimate, as shown in the table below.

Cost estimates in business cases can follow the AACEi classification system to help understand the level of engineering and accuracy in the cost estimate, which could affect confidence in the project by key decision makers. If sufficient accuracy is not achieved, then further engineering can be completed to de-risk the project.

Table 4: AACEi cost estimation classification

AACEI classification	AACEI accuracy range	Input information
Class 5	Low: -20% to -50% High: +30% to +100%	Simple Bar Chart Schedule, Block Flow Diagram / Process Flow Diagram, Layout Sketch
Class 4	Low: -15% to -30% High: +20% to +50%	
Class 3	Low: -10% to -20% High: +10% to +30%	Preliminary Project Plan, Preliminary Risk Review, Bar Chart Schedule, Preliminary P&ID's, Preliminary Mass & Energy Balances, Preliminary Equipment List, Outline General Arrangements, Single Vendor Quotations
Class 2	Low: -5% to -15% High: +5% to +20%	Detailed Project Plan, Risk Review, Preliminary Gantt Chart, Detailed P&ID's, Detailed Mass & Energy Balances, Detailed Equipment List, Preliminary General Arrangements, Preliminary Piping Drawings, Single Line Diagrams, Multiple Vendor Quotations
Class 1	Low: -3% to -10% High: +3% to +15%	Detailed Project Plan, Risk Review, Detailed Gantt Chart, Frozen P&ID's, Frozen Mass & Energy Balances, Detailed Equipment List, Complete General Arrangements, Detailed Piping Drawings, Detailed Electrical Drawings, Competitive Vendor Quotations

14 Financials

All four case studies demonstrated lower running costs with the switch to biomass, which is made up of the following for boilers. Note that this does not include the cost of capital:

- Lower fuel costs.
- Lower carbon costs.
- Lower maintenance costs, generally due to newer assets and fewer assets.
- Lower operational costs, in terms of employees required to run the plant, due to newer assets, less assets and higher levels of automation.

The main barrier to fuel switching projects is the capital cost and payback period. The capital costs in the case studies ranged from NZ$3.4 to NZ$100M and known paybacks were in the five-to-twelve-year range with government co-funding.

15 Project timeframes

From an approved Final Investment Decision (FID) by the key decision makers, the total project delivery timeframes, including engineering design, procurement, earthworks, building construction, equipment lead times, installation and commissioning, ranged between two and three years.

This excludes the concept and feasibility phases which can vary significantly. Because it can include multiple Proof-of-Concept tests, some owners have been investigating biomass for up to eighteen years before committing to large scale biomass projects.

16 Summary of case studies

16.1 Fonterra Waitoa

Fonterra is a New Zealand-based multinational dairy co-operative that is one of the world's largest exporters of dairy products. Fonterra operate around 30 manufacturing sites across New Zealand producing products such as milk powder, cheese, butter and other dairy products.

Fonterra's site in Waitoa, New Zealand, recently installed a large-scale biomass boiler. The project, named as 'Project Kahikatea' by Fonterra, installed a 30 MWth biomass boiler which began in 2021 and was fully operation in 2024.

Figure 6: Biomass boiler at Fonterra Waitoa

The fuel switch from coal to biomass has resulted in the following outcomes, costs and co-benefits:

- The estimated reduction in carbon emissions is 48,000 tonnes of CO2-e per year, which significantly reduced carbon costs
- Removed exposure risk to the volatile carbon price
- Improved energy resilience. The BFB boiler is capable of firing a range of fuels, including coal, wood pellets, green hog fuel and potentially effluent derived sludge.
- The total project cost was just over $90M
  - This was under the capital cost estimate of $100M
- Maintenance has generally improved
- High automated plant has reduced operational needs compared with coal boiler

Read the full case study **-** **https://www.eeca.govt.nz/fonterra-biomass-case-study**

16.2 Golden Bay Cement

Golden Bay Cement (GBC) produces around 900,000 tonnes of New Zealand's supply of cement from their Whangarei site and are the only fully integrated plant in New Zealand. They have been producing a high-quality cement product for over 100 years which meets strict building and seismic requirements. The site is located adjacent a quarry for raw materials and loads bulk cement directly from the plant into its coastal ships in Whangarei Harbour. The plant is capital intensive and complex. Cement is a low margin commodity business, fully exposed to international competition. GBC competes with large suppliers who bring in cement from overseas, who likely have lower carbon prices.

Figure 7: Golden Bay Cement, Whangārei

GBC manages to compete due to the free allocations of carbon units and its alternative fuels programme, supported by MfE and EECA. The alternative fuels programme includes, but is not limited to using the following biomass fuels in the process:

- Laminated Veneer Lumber (LVL) Residue
- Construction and Demolition Waste (CDW)

GBC fires 10,000 tonnes per year of biomass residue, including LVL residue, and 50,000 tonnes of CDW per year. The incentives and co-benefits driving the locally sourced biomass co-firing project include:

- Lower energy costs
- Increased energy security
- Lower carbon emissions and exposure to volatile ETS charges
- But also a net increase in operations and maintenance due to more feed systems

Read the full case study - **https://www.eeca.govt.nz/golden-bay-cement-biomass-case-study**

16.3 JS Ewers

JS Ewers, located in Nelson, supplies tomatoes, capsicums and eggplants from 12 hectares of glasshouses to the New Zealand market. The concept of firing biomass was first investigated in the late 2000s and they have completed thermal efficiency projects to reduce heat demand. From 2021 to 2023, JS Ewers installed two new 4.5 MWth dedicated biomass boilers in a new main boiler house, which replaced eight distributed coal boilers. They also converted five smaller boilers which total 3.3 MWth, from coal to wood pellets. JS Ewers now use 100% biomass energy for process heat.

Figure 8: Biomass boiler at JS Ewers

The fuel switch from coal to biomass has resulted in the following costs and co-benefits:

- The combined project cost was $11.5M
  - The original estimated budget was $8M. Issues were encountered during the project that resulted in increased project costs from $8M to $11.5M. Such issues are listed below. Note that the construction and installation was completed during the COVID pandemic which was a key driver behind the increased project costs:
    - Polytechnik entered receivership before being purchased by new owners
    - Shipping costs increased.
    - Scope changes.
    - Increased costs of labour and materials, especially steel.
    - The timeframe increased.
  - The sub-total cost for the smaller conversion projects was NZ$430,000, which was higher than the estimated $200,000 due to increased costs of labour and materials post COVID.
  - EECA provided approximately $4M in co-funding through the Government Investment in Decarbonising Industry (GIDI)
- A reduction in fuel cost by approximately $2M, accounting for less carbon charges through the ETS.
- Annual maintenance costs have remained the same at around $60,000.
- Operational costs of have reduced to a fraction of previous levels.
- The project payback period with the final project costs is approximately 12 years.
  - This includes cost of capital, depreciation and labour cost savings.
  - Without co-funding from the EECA the payback period would be more than double.
- Improved energy resilience and redundancy for JS Ewers, because the biomass is sourced locally, and coal or biomass pellets are still available as a backup to be fired in the old coal boilers (note that wood chips cannot be fired in the coal boilers).
- The reduction in carbon emissions is estimated at 18,500 tonnes per year and the site has minimal scope 1 emissions for process heat.
- JS Ewers are no longer exposed to volatile carbon pricing for their process heat.
- The glasshouse operation now meets an industry standard of having 90°C hot water available instantaneously, which enables the glasshouses to maintain the required indoor air temperature even during cold spells in winter.

Read the full case study - **https://www.eeca.govt.nz/js-ewers-biomass-case-study**

16.4 McCain Timaru

McCain Foods Limited is a Canadian company that has produced frozen food for more than 60 years. It is the largest manufacturer of frozen food accounting for almost one third of global French fries supply. McCain NZ has two New Zealand processing sites – Timaru and Hastings.

The McCain Timaru site produces fries from raw potatoes in several process steps. Process heating and cooling are required, including for pre-heating, blanching, drying, frying, and freezing the potatoes. McCain Global has set the goal for the New Zealand sites to completely remove coal.

McCain Timaru have successfully switched fuel from coal to biomass on Boiler 2. The conversion project was within the planned schedule and below the estimated budget.

Figure 9: Biomass pneumatic feeder and fuel store at McCain Timaru

The fuel switch from coal to biomass has resulted in the following costs and co-benefits:

- The total projects cost was $3.4.M
  - EECA provided approximately $1.87M in co-funding through the Government Investment in Decarbonising Industry (GIDI).
  - Approx three quarters of this was attributed to the fuel storage, handling and feed system.
- Fuels costs have reduced by around $0.6M per year with the conversion.
- The reduction in carbon emissions is estimated at 30,000 tonnes per year which has significantly reduced McCain's exposure to the carbon tax for process heat.
  - Note that this also includes a fryer heat recovery project.
- Maintenance costs are less.
- Operation costs are the same.
- McCain now have plans to convert Boiler 1 to wood chips to remove the risk of firing coal should Boiler 2 fail:
  - Boiler 1 would be derated on conversion to woodchip, due to the lower energy density of wood chip compared to subbituminous coal, but the derated boiler still meets the site demand due to energy efficiency projects that McCain has implemented.
  - Cost estimates at currently at $0.5-1M. This cost is lower than the original $3.4M for Boiler 1 as no further fuel handling and storage is required.
  - No other McCain plant has a back-up boiler which is not standard practice at McCain.
  - Boiler 1 would have to be removed if still running on coal.

Read the full case study - **https://www.eeca.govt.nz/mccain-biomass-case-study**

16.5 Stakeholders

The following tables lists the key stakeholders involved in delivering the four biomass fuel switch projects studied. The list is not exhaustive.

Table 5: Government and associations

Who	Location	Role & expertise	Useful links
Energy Efficiency and Conservation Authority (EECA)	Wellington, New Zealand	Leadership and support	https://www.eeca.govt.nz
Bioenergy Association of New Zealand (BANZ)	Whangarei, New Zealand	Leadership and support	https://www.bioenergy.org.nz/
Ministry of the Environment (MfE)	Wellington, New Zealand	Administers the NZ Emissions Trading Scheme	Overview of the New Zealand Emissions Trading Scheme https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/ets/ Overview of industrial allocation | Ministry for the Environment

Table 6: Biomass handling, feed and boiler supplier & installers

Who	Location	Role & expertise	Useful links
Windsor	Napier, New Zealand	Boiler supplier and installer	https://www.windsorenergy.co.nz/contact/
Lyttleton Engineering	Lyttleton, New Zealand	Boiler supplier and installer	https://lytteng.co.nz/
Polytechnik	Hawkes Bay, New Zealand	Boiler supplier	https://polytechnik.com/en/contact/worldmap
Living Energy	Auckland, New Zealand	Biomass handling and feed systems	https://www.bioenergy.org.nz/living-energy

Table 7: Engineering & project management services

Who	Location	Role & expertise	Useful links
Aurecon	New Zealand	Engineering and project management services	https://www.aurecongroup.com/locations
Beca	New Zealand	Engineering and project management services	https://www.beca.com/

Table 8: Heavy engineering and equipment fabricators

Who	Location	Role & expertise	Useful links
Hendl & Murray Engineering (HME)	Hamilton, New Zealand	Equipment fabricator	https://hmengineering.co.nz/contact/
Culham Engineering	Whangarei, New Zealand	Heavy engineering and construction solutions	https://culham.co.nz/
Conveyor Industries NZ	Papamoa, New Zealand	Conveying equipment and turnkey solutions for the bulk materials handling	https://cil.co.nz/
Mount Steelcraft	Mount Maunganui	Material handling plant and screw conveyor systems	https://www.mountsteelcraft.com/

Table 9: Biomass energy suppliers *excludes logistics

Who	Location	Role & expertise	Useful links
Pioneer Energy	New Zealand	Biomass Energy Suppliers	https://www.pioneerenergy.co.nz/
Canterbury Woodchip	New Zealand	Biomass Energy Suppliers	https://canterburywoodchip.co.nz/
Azwood	Nelson, New Zealand	Biomass Energy Suppliers	https://azwood.co.nz/

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