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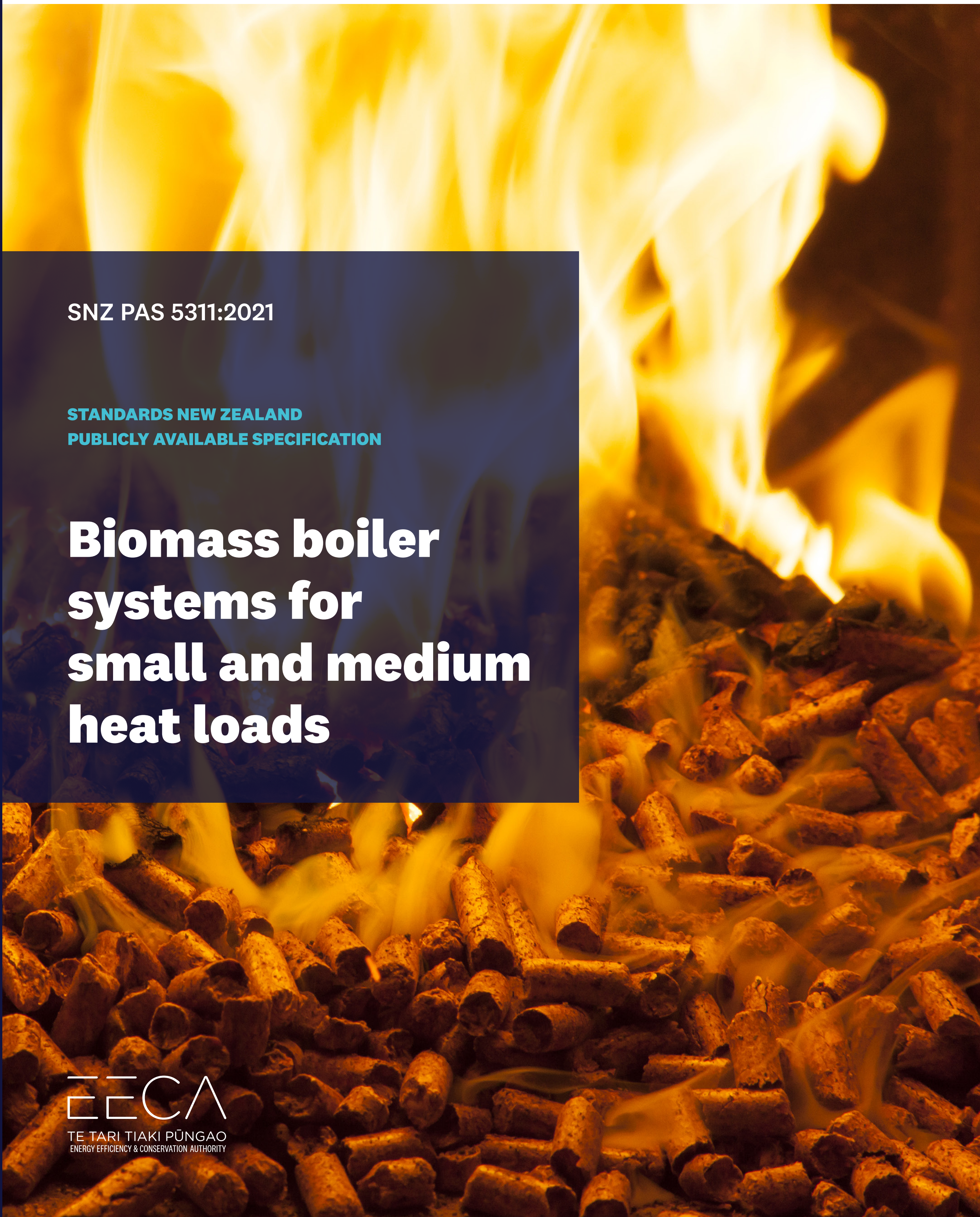

SNZ PAS 5311:2021

STANDARDS NEW ZEALAND
PUBLICLY AVAILABLE SPECIFICATION

Biomass boiler systems for small and medium heat loads

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

SNZ PAS 5311:2021

TECHNICAL ADVISORY GROUP REPRESENTATION

This publicly available specification was prepared by the P5311 Biomass Boilers Technical Advisory Group (TAG). The membership of the TAG was approved by the New Zealand Standards Executive.

The TAG consisted of representatives of the following nominating organisations:

Bioenergy Association of New Zealand

Carbon and Energy Professionals New Zealand

Coal Action Network Aotearoa

Energy Efficiency and Conservation Authority

Great South

Scion

Toimata Foundation, Enviroschools

University of Otago, Otago Energy Research Centre

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REFERENCED DOCUMENTS

Reference is made in this document to the following:

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NZS 1170:----	Structural design actions
Part 5:2004	Earthquake actions – New Zealand

Joint Australian/New Zealand standards

AS/NZS 1170:----	Structural design actions
Part 2:2011	Wind actions
AS/NZS 4536:1999	Life cycle costing – An application guide
AS/NZS 3598:----	Energy audits
Part.2:2000	Industrial and related activities

International standards

ISO 17225:----	Solid biofuels – fuel specifications and classes
Part 1:2014	General requirements
Part 2:2014	Graded wood pellets
Part 3:2014	Graded wood briquettes
Part 4:2014	Graded wood chips
Part 5:2014	Graded firewood
Part 6:2014	Graded non-woody pellets
Part 7:2014	Graded non-woody briquettes (new draft standard 2020)
Part 8:2016.	Graded thermally treated and densified biomass fuels
Part 9:2020	Graded wood hog fuel and wood chips for industrial use
ISO 17831:----	Solid biofuels – Determination of mechanical durability of pellets and briquettes
Part 1:2015	Pellets
Part 2:2015	Briquettes
ISO 17827:----	Solid biofuels – Determination of particle size distribution for uncompressed fuels
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Websites

www.bioenergy.org.nz

www.eeca.govt.nz

www.forestresearch.gov.uk

www.legislation.govt.nz

www.mfe.govt.nz

www.scionresearch.com

www.usewoodfuel.org.nz

worksafe.govt.nz

LATEST REVISIONS

The users of this specification should ensure that their copies of the above-mentioned New Zealand standards are the latest revisions. Amendments to referenced New Zealand and joint Australian/New Zealand standards can be found on www.standards.govt.nz.

REVIEW

Suggestions for improvement of this specification will be welcomed. They should be sent to the Manager, Standards New Zealand, PO Box 1473, Wellington 6140.

FOREWORD

This document has been prepared as a guidance document and published as a publicly available specification (PAS). A PAS is an ISO-recognised category for documents that are not national standards, but are produced by a national standards body to respond to a market need, representing either consensus in an organisation or industry, or consensus of the experts within a working group.

This guidance document has been prepared by representatives of the biomass energy sector as a collation of best practice advice for potential new owners of biomass boiler systems and their advisers.

Biomass boiler systems are not complex or new but there are many new entrants to the sector who are seeking guidance. This document provides that guidance in a single place.

The objective of this publicly available specification (SNZ PAS 5311:2021 *Biomass boiler systems for small and medium heat loads*) is to provide best practice guidance to support the adoption of low-emission biomass boiler systems in commercial, institutional, and industrial heat applications. Small to medium heat loads are those between 50 kW and 2 MW, providing hot water below 100°C.

Biomass provides a safe, environmentally friendly, clean, reliable, and economic alternative to other sources of energy. A biomass boiler system typically heats water, which heats buildings via radiators. However, biomass boiler systems are also suitable for many other higher-temperature heating applications.

The New Zealand Government is setting ambitious targets under the Climate Change Response (Zero Carbon) Amendment Act 2019 to achieve net zero carbon emissions by 2050. Reducing fossil fuel use across New Zealand is an obvious step towards these targets. Fossil fuels continue to be used in many hot-water heating applications in schools, hospitals, prisons, and much of industry. Biomass boiler systems have excellent potential to replace fossil fuels and mitigate climate impact in a cost-effective way. Biomass systems are also increasingly cost competitive compared to fossil fuels, as the price of carbon and gas increases, and as sustainability becomes an increasingly important factor.

Biomass boiler systems have been available for many years. However, advances in technology have made them ideally suited to a wide range of heating applications.

Biomass energy has numerous benefits including:

(a) Biomass fuel is renewable, sourced as wood from residual plantation forests, agricultural operations, processing wood, and other biomass applications, and is therefore environmentally friendly in comparison to fossil fuel options;

(b) Solid biofuels can be produced to meet any biomass boiler specification;

(c) Solid biofuels are not subject to carbon taxes like fossil fuels;

(d) Biomass boiler systems use proven technology and as a result, are cost effective;

(e) Biomass fuel long-term availability is managed by accredited solid biofuel suppliers and is in no threat of running out;

(f) Accredited solid biofuel suppliers have third-party auditing and monitoring of their quality assurance processes so that fuel is reliably and consistently supplied;

(g) Use of biomass energy supports community employment and well-being, because fuel and engineering support is sourced locally.

Publicly Available Specification

Biomass boiler systems for small and medium heat loads

1 GENERAL

1.1 Scope

1.1.1 Inclusions

This publicly available specification (PAS) provides advice and information on biomass boiler systems for small to medium heat loads (50 kW to 2 MW) providing hot water below 100°C. A biomass boiler system includes all primary and ancillary equipment for fuel reception and storage, through to the point of delivering hot water to the application reception point. Within this document, a biomass boiler system is one fuelled by wood chip, wood briquettes, wood pellets, or other biomass.

This PAS includes both technical and non-technical guidance on the following:

(a) Evaluating heat demand and energy efficiency;

(b) Generic site requirements;

(c) Greenhouse gas and local particulate emissions;

(d) Fuel quality, supply, reception, storage, and handling;

(e) Operation and maintenance;

(f) System efficiency;

(g) Seasonal efficiency;

(h) Regulatory and non-regulatory health and safety aspects;

(i) Consenting.

1.1.2 Exclusions

Excluded from this document are the following:

(a) Biomass boiler systems larger than 2 MW;

(b) Steam boilers;

(c) High temperature hot water boilers (over 100°C);

(d) Systems that are intended to supply potable water;

(e) Co-firing coal boilers;

(f) Use of industrial effluents, municipal biosolids, anaerobic digestion, and algae as biomass fuel.

Much of the best practice advice included in this guidance document will be equally applicable to the excluded biomass boiler systems but expert advice specific to those technologies should be sought if an excluded application is being considered.

1.2 Objective

The intended audience for this PAS includes potential owners, evaluators, installers, maintenance and operations staff, purchasers, consultants, designers, equipment and service suppliers, and any others wanting to make an informed choice around biomass boiler system options.

Sections 1 and 2 are written to be broadly accessible to a non-technical audience who are making decisions about the purchase and use of biomass boiler systems. Section 2 also includes a checklist of key questions to ask and elements to consider.

Section 3 of this document is a specification and is written primarily for a technical audience.

The guidance in this document covers New Zealand safety requirements. It refers to regulatory requirements as well as providing non-regulatory best practice recommendations.

Much of the guidance provided assumes that the biomass boiler system will be used to heat hot water, but where applicable the advice provided is also valid for other applications.

1.3 Definitions

For the purposes of this specification the following definitions apply:

Ash content	Mineral content of biomass left after combustion
Ash	Ash produced by a boiler may contain unburnt carbon as well as the non-combustible minerals.
Auger	Screw type device for moving fuel from the bunker into the combustion zone and taking ash out of the combustion zone into a bin
Basic energy density	Measured in gigajoules per tonne (as opposed to bulk or volumetric energy density, see below, which is measured in gigajoules per cubic metre)
Biomass	Wood or herbaceous material derived from living, or recently living plants
Biomass boiler system	Heating plant designed to produce hot water fuelled by combusting biomass, including associated fuel handling and storage equipment up to the point of connection with the applications receptor of the hot water.
Briquettes	A densified form of wood fuel, where small particles (such as sawdust) are squeezed into a larger, dryer, denser form

Bulk or volumetric energy density	Measured in gigajoules per cubic metre (as opposed to basic energy density, see above, which is measured in gigajoules per tonne)
Calorific value	Energy content of fuel per weight, usually expressed in megajoules per kilogram (MJ/kg) or gigajoules per tonne (GJ/t). The calorific value of a fuel can be described as either net calorific value (NCV) – lower heating value – or gross calorific value (GCV) – higher heating value. The lower heating value accounts for the impact of moisture content in the fuel. GCV assumes that the moisture content of the fuel that is driven off in the flue gas can be recovered by condensing the evaporated water on a heat exchanger. The values for NCV and GCV by moisture content are shown in Appendix A, Table A1
Carbon dioxide equivalent (CO_2-e)	A metric measure used to compare the emissions from various greenhouse gases based on their global-warming potential, by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential
Clinker	Ash that has partially melted and formed into hard lumps
Combustion	A chemical process in which a substance reacts rapidly with oxygen and gives off heat
Copper-chrome-arsenate (CCA)	A wood preservative
Design working life or economic life	Assumed period for which a structure or a structural element is to be used for its intended purpose without major repair being necessary. Includes for periodic replacement of some equipment with less than the overall expected operational life of the facility. Usually taken as 20 to 30 years
Energy storage tank	An energy storage tank is a water tank that stores energy in the form of heat (hot water). An energy storage tank allows a small boiler to operate at a steady load with fluctuations or peaks in heat demand being able to be met by extraction of heat stored in the tank
Escalation clause	A provision in a contract allowing for an increase in prices
Financial life	The term of facility operation used to calculate the levelised cost of energy. Usually taken as a minimum of 15 years
Fuel oil	Liquid fossil fuel suitable for burning in a boiler
Gas	(Natural) gas, LPG, biogas and hydrogen
Grate	Part of a boiler that supports the fuel during combustion

Hog fuel — Biomass, usually wood that has been through a hogger (a large hammer mill) in order to reduce the particle size of the biomass

Kilogram of carbon dioxide equivalent per gigajoule — The amount of carbon dioxide emitted for every gigajoule of energy produced

Levelised cost of energy (LCOE) — Calculates the present value of the total cost of the energy plant and operating of the plant over an assumed lifetime

Lignocellulosic — Biomass that is made from lignin and cellulose (herbaceous as well as wood)

Miscanthus — A giant fast-growing grass that can be used as a biomass energy crop

Moisture (or water) content — Wood fuels can have moisture contents that vary a lot. This affects their fuel value and their weight. There are two ways of expressing the moisture content of the wood. These are on a wet or dry basis.

When referring to wood fuels, typically moisture content on a wet basis is used; that is the amount of moisture on the wood is expressed as a percentage of the as-delivered weight. Wood fuels are likely to be between 8% and 55% moisture content wet basis.

The wood processing industry produces kiln-dried wood products, and they often use moisture content on a dry basis as a measure of the moisture content of the wood. This is where the moisture content is expressed as a percentage of the dry weight of the wood (this can result in numbers of over 100% for freshly cut material).

It is important to be clear about which method has been used or is to be used when determining wood fuel supply contracts

Particle size — The dimensions of the fuel particles: the target size and the distribution of sizes around this

Particulates — Very small pieces of ash and unburnt fuel than can exit a solid fuel boiler in the flue gas stream. These emissions must meet National Air Quality standards and local resource consents. These particulates are generally referred to measured and assessed as PM 10 (particulate matter less than 10 microns) and PM 2.5 (less than 2.5 microns). A micron is 1000th of a millimetre

Biomass residues — A by-product of forest harvesting and sawmill and wood processing that will otherwise go to waste and has limited financially viable use

Soil amendment	Material added to a soil to improve its physical properties, such as water retention, permeability, drainage, aeration and structure
Stoker	A device for moving fuel into the combustion zone
Term sheet	A written document the parties exchange, containing the important terms and conditions of the project. The document summarises the main points of the agreement and sorts out the differences before actually executing the legal agreements and starting with time-consuming due diligence. The term sheet is non-binding as it reflects only the key and broad points between parties under which the project will go ahead. It also acts as a template for the in-house or external legal teams to draft definitive agreements. The contents and clauses of the term sheet vary from transaction to transaction
Turndown	A boiler's combustion unit will vary its fuel feed and output or 'turn down' as the demand for heat decreases, in attempt to meet only the required load. The turndown ratio tells you the minimum output the boiler can achieve before turning off and then cycling on and off frequently
Wood chip	Wood (pulp logs or offcuts from timber production) that has been processed by a chipper into small pieces for further processing or to be used as a fuel
Wood pellet	Densified form of wood fuel, made from compressed sawdust. Pellets are denser than the original wood and have standardised size and fuel content characteristics

1.4 Abbreviations

For the purposes of this specification the following abbreviations apply:

CHP	Combined heat and power
CO_2-e	Carbon dioxide equivalent
Cubic metre	Measurement of volume; a unit that is a cube with all sides being 1 m
GHG	Greenhouse gas
GJ	Gigajoule (unit of energy – for context 1 green tonne of wood at 58% moisture content = ~6.9 GJ nett basis)
J	Joule
kWh	Kilowatt hour
LCOE	Levelised cost of energy

➤

LPG	Liquid petroleum gas
m^3	Cubic metre
MC	Moisture content
MJ	Megajoule
MW	Megawatt
MWe	Megawatt electric
MWth	Megawatt thermal
MWW	Municipal wood waste
MSW	Municipal solid waste
NCV	Net calorific value
NPV	Net present value
Odt	Oven-dry tonne
pa	Per annum
Wh	Watt hour
wb	Wet basis

Conversions:

1 MW = 1000 kW

1 kWh = 3.6 MJ

1 MWh = 3.6 GJ

1 GJ = 277.778 kWh

2 OVERVIEW

2.1 What is a biomass boiler system?

A biomass boiler system (see Figure 1) is a renewable energy heat plant specifically designed to combust fuels derived from biomass such as wood chip (see Figure 2), wood pellets (see Figure 3) or hog fuel (see Figure 4).

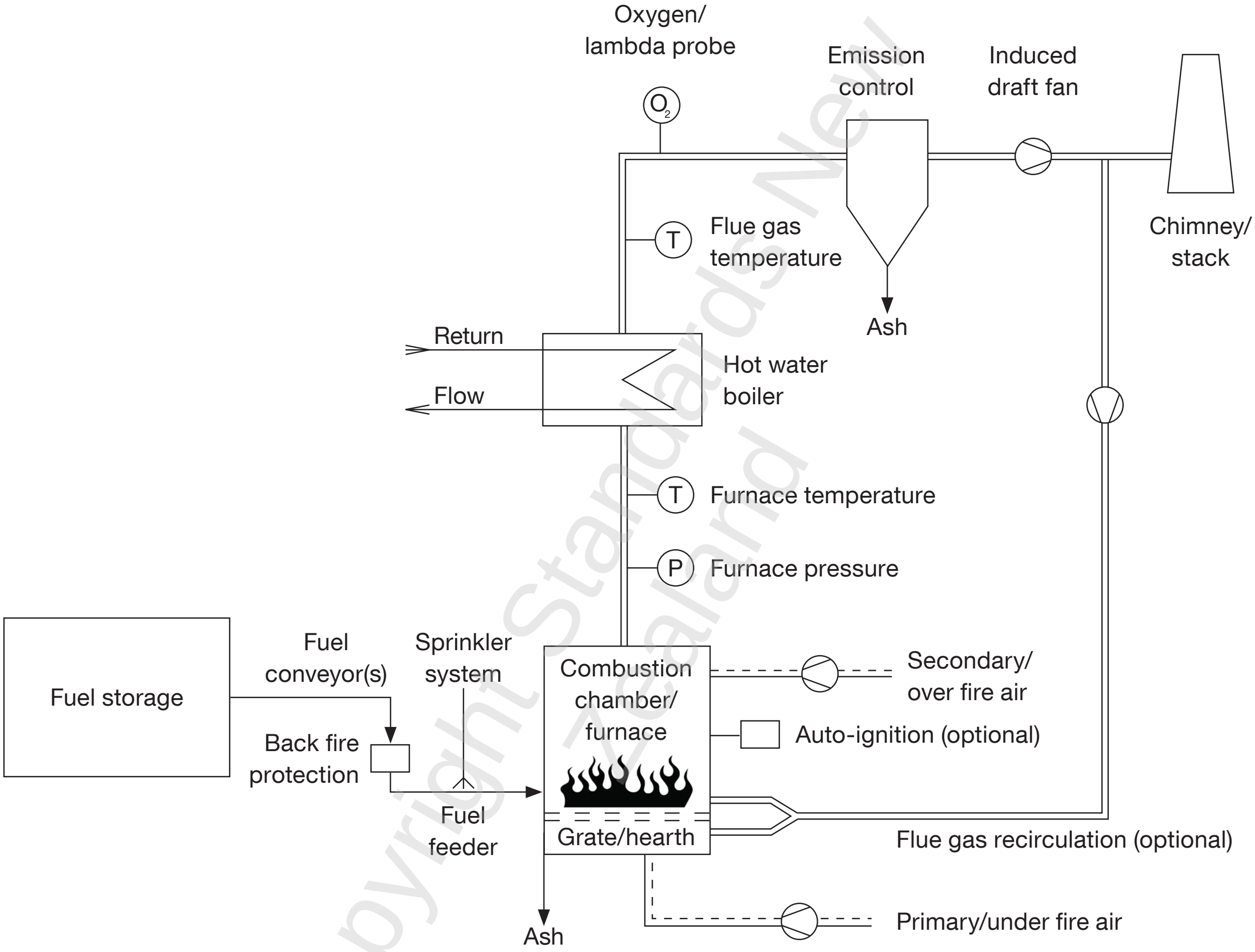

Figure 1 – Stoker biomass boiler system

Figure 2 – Wood chips

Figure 3 – Wood pellets

Figure 4 – Hog fuel

Biomass boilers do not combust fuel in the same manner as a fossil fuel boiler and are very different in design and operation to a gas or fuel oil boiler. A biomass boiler system has ancillary equipment for fuel reception, storage, and handling, and ash removal. Together the boiler and ancillary equipment make up a biomass boiler system.

A modern biomass boiler system also has remote monitoring capability and controls, which automates the majority of the facility's operation. It can be easily monitored and controlled on or off site, providing high operating efficiency and safety.

2.2 Where to start? Evaluation of options

2.2.1 Energy efficiency and emission reduction

When considering an upgrade or change to your heat plant, energy efficiency and emission reduction should be some of the first things reviewed. In its simplest form, energy efficiency is obtaining the same level of energy service (for example, delivered hot water) for the lowest resource input (for example, fuel quantity and financial cost). Optimising energy efficiency and meeting applicable safety and compliance codes, while simultaneously mitigating climate impact is the ideal balance for heating applications, and biomass boiler systems are a potential solution.

2.2.2 Sizing

To suitably size a biomass boiler system it is recommended to calculate existing heat demand on an hourly basis and adjust for seasonal, weekly, and peak demand. Peak demand determines the capacity of the system. To meet peak demand the biomass boiler system can either be sized to the existing demand profile, or a smaller biomass boiler can be used along with an energy storage tank. An energy storage tank is a backup storage tank designed to help meet peak demand, maintain a more even boiler output and thus increase efficiency, reduce on/off cycling, and increase longevity due to reduced expansion and contraction. Energy storage tanks should allow the biomass boiler to be sized more efficiently and also might lower the overall economic cost of the system and help at morning start-ups.

2.2.3 Heat demand

When a fossil-fuelled boiler is being replaced by a biomass boiler system, it is recommended to reassess the site's overall site heating demand rather than attempt to match the hot water demand of the existing system. The possibility of future changes in the site should also be considered.

2.2.4 Improving current efficiency

However, all evaluations start with assessing the overall efficiency of the existing heating system. Even if this evaluation leads to a decision to upgrade the existing heating system, the process will help inform the investment decisions ultimately made. Organisations such as the Energy Efficiency and Conservation Authority have in-depth information and advice available to assist with this initial evaluation. (See their website: www.eeca.govt.nz.)

2.2.5 How to evaluation options

The following sections explore in detail the content of biomass boiler systems and the critical points to consider when assessing the potential for this technology. Section 2 is designed to be accessible to a non-technical reader and concludes with a checklist of questions. Each checklist question links to information supplied in section 2.

2.3 Biomass fuel

2.3.1 Fuel availability

Identification and analysis of the likely supply of biomass fuel suitable for the equipment proposed is the most important element in a biomass heating proposal. When considering the economic life of a biomass boiler system, it is important that the owner or operator of the heating equipment has a good understanding of the fuel supply risks for the lifetime of the equipment.

The biomass boiler system will be designed for a specific fuel type or a range of fuel types. Biomass fuel comes from two primary sources: forest and wood processing biomass residues. The long-term availability of fuel is directly related to fuel suppliers having access to one or both of these primary sources. Fuel availability should be checked with local suppliers. To find local fuel suitable to the needs of your site, see the Bioenergy Association's information sheet, 'Register of solid biofuel suppliers' online.

The biofuel supplier will provide information on what long-term fuel sources are available locally, how well these fit with your site and existing infrastructure, and the delivered cost of fuel.

Over the expected economic life of a heating system, the sources of biomass fuel can change and, as a result, fuel characteristics can alter. Combustion and storage equipment should be chosen or designed to handle variations in fuel characteristics.

2.3.2 Fuel characteristics

Biomass fuel characteristics are different from other fuel types such as coal. Biomass fuel is defined by characteristics such as ash content, particle size and moisture content. These characteristics are available from the Bioenergy Association's technical guide 'Solid Biofuel Classification Guidelines' (Technical Guide 01) available online (see the 'Referenced documents' section at the front of this specification).

Particle size and moisture content determine the energy content of the fuel, types of storage, delivery mechanism, and the consistency of optimal fuel supply impacting boiler system performance.

2.4 Fuel quality characteristics that effect boiler performance

2.4.1 Moisture content

The amount of moisture in a biomass fuel has a direct effect on the combustion performance of the fuel; the higher the moisture content, the less energy will be derived from the fuel per tonne (see Appendix A). Biomass boiler systems will not run well on fuels that are too wet. Typically, chip used as fuel in smaller boilers should be between 25% and 40% moisture content wet basis, depending on the boiler design. Green wood fuels with moisture contents of 55% or higher should not be used. Wood pellets will have a delivered moisture content of around 8-10%.

2.4.2 Particle size distribution

The particle size of the fuel and the distribution of particle sizes around the target size will affect the performance of the biomass boiler system and its emissions. Too many very fine particles can lead to particulate emissions and fouling issues, while oversize material can cause issues with fuel feeding and handling. Biomass boiler systems are typically designed to take a particular size or type of fuel.

2.4.3 Ash

The amount of ash in a fuel directly and proportionately affects its energy content and other aspects of boiler performance, such as particulate emissions and the frequency of ash removal and disposal.

2.4.4 Fuel energy density

Energy density of a fuel can be measured by weight (gigajoules per tonne). Another important metric when matching a fuel to a boiler is the energy by unit of volume (gigajoules per cubic metre). Bulk density is the weight of the fuel for a given volume (kilograms per cubic metre).

Compared to fossil fuels, biomass fuels have lower volumetric energy densities. The lower volumetric energy density effects the amount of storage required and the size of the handling equipment. For example, the volumetric energy density of woodchip (30% moisture content) is only 30% that of coal. For the same energy storage, a woodchip plant requires more than three times the fuel storage volume. Wood pellets, however, have a much higher energy density than woodchip so require very little additional storage space. The need for increased fuel storage space can be mitigated by scheduling more frequent fuel deliveries. The costs and benefits of both approaches requires evaluation as part of the overall project.

2.4.5 Fuel purchase

Biomass fuel is normally sold on an energy basis based on net calorific value, ideally with reference to a moisture content. A fuel supply contract will specify the characteristic of the fuel to be delivered and the payment mechanism. The contract may include an escalation clause (a provision allowing for an increase in prices) for contracts with a term longer than 1 year. The contract will set out the respective responsibilities of the buyer and the seller. More information can be found in the Bioenergy Association’s technical guide ‘Contracting to deliver quality solid biofuel to customers’ (Technical Guide 06), available online (see the ‘Referenced documents’ section at the front of this specification). ➤

The quality of the delivered fuel should be checked from time to time, as part of the supplier's legal obligation, to ensure it is meeting the specification set out in the contract. Moisture, ash, and fine particle content should be the focus. If the biomass boiler system's performance reduces, a check on the fuel quality should be a priority.

2.5 Fuel management and storage

2.5.1 General

The way that a biomass fuel is delivered, handled, and stored needs to be considered. Biomass fuels can have quite different requirements from other fuels. In particular, biomass fuels (especially densified fuels such as wood pellets) need to be kept dry at all times, including during delivery.

2.5.2 Fuel deliveries

Fuel handling and storage must be designed to avoid the introduction of water and contaminants such as dirt, stones, and waste materials. Delivery of wood fuels can be done by either bulk tipping or walking floor trucks, by auger conveyer, or pneumatically. Access to the fuel bunker will determine how delivery is made.

Verification that the fuel delivered meets the contract fuel specification is critical for ensuring fuel is always fit for purpose. An accredited wood fuel supplier is required to have a sampling and testing regime in place to ensure that the fuel delivered meets the fuel contract specification. The buyer would normally undertake a check on the characteristics of the fuel delivered as it is delivered to a storage bunker.

2.5.3 Fuel storage

Biomass fuels should be kept as dry as possible during storage and should not be stored outside where they are exposed to rain. This is critical in the case of pellets and briquettes, which are densified fuels made of small compressed particles that disintegrate very quickly if they get wet. Biomass fuel is also vulnerable to deterioration when exposed to high humidity. Damp wood fuel can develop fungal growth and exposure to spores is a health risk.

Handling and storage of biomass fuel can create dust, which can be hazardous to operators and create a potential explosion and fire hazard. This is most likely to occur when bunker doors are opened and dust is stirred up. If the fuel is correctly specified and delivered this risk is minimised.

2.6 Biomass boilers

A biomass boiler works in a very similar way to conventional fossil-fuelled boilers, combusting fuel to produce heat that is then used to heat water for space or water heating. An enclosed storage area is required to store biomass fuel so that the boiler only needs to be refuelled based on demand.

2.7 Operation, maintenance, and safety

2.7.1 Operation

Owners of new biomass boiler systems should expect the equipment supplier to provide manuals and other documentation that offer guidance for the safe operation and maintenance of the equipment as part of the handover or induction process. This should also include operational training or familiarisation.

Many modern biomass boiler systems are now largely automated, with software available to operate and monitor boilers remotely. However, some aspects still require manual checks and operation. Most important is the real-time monitoring of alarms and safety devices.

Owners of small and medium-sized biomass boiler systems will generally outsource the maintenance to professional maintenance service providers. Where operation or maintenance services are provided by a third party, the contract for such services should make clear the activities and responsibilities of the respective parties.

2.7.2 Operator training

It is essential that all staff, including on-site or temporary operating staff, have the relevant competence to ensure the equipment is operated safely, and also that it is maintained to maximise the life of the facility, and that the facility is operating at optimum efficiency.

The facility owner or operator should ensure that staff training (by the equipment supplier), and any qualifications or licences, are up to date to ensure safety of the plant and personnel and operating efficiently.

Staff refresher training should be a scheduled activity. Best practice is that staff training dates are posted in the boiler house so that the activities importance is recognised by staff.

This training regime, once established, should be auditable.

2.7.3 System reliability, safety, maintainability, and after-sales support

System reliability and safe operation is dependent on facility owners ensuring that proper maintenance and operation procedures are established and appropriately known to all personnel with responsibility relating to the facility. These should be easily available within the facilities for personnel to reference when necessary. Audits to ensure that the actual maintenance and operation activities are being correctly implemented should be undertaken at least annually.

Owners and operators of facilities have obligations under the Health and Safety at Work Act 2015 to ensure safety of workers and the public. Obligations include, but are not limited to, the safe operation of the biomass boiler system. This requires that all personnel with responsibilities relating to the facility operation should be appropriately trained, with regular refreshers as appropriate.

To ensure safe and efficient operation, and the longevity of the system, a routine maintenance schedule shall be established and followed. This should be provided by the equipment supplier. It should include tasks that need to be completed at regular intervals. For example de-ashing, greasing, leak checking, and cleaning the heat exchanger. ➤

Dust is required to be cleaned from the fuel handling sections of the facility on a regular basis to ensure there is no dust build-up and to reduce the potential for explosion.

Regular inspection of all equipment in a biomass boiler system is recommended according to the operating manual.

The manual from the equipment suppliers will include a multi-year schedule for equipment maintenance and inspections. It will advise whether an inspection should be carried out by a qualified expert or can be carried out by suitably trained personnel. Backup or external technical support capability should be identified and kept up to date. Operational and maintenance personnel should be aware of the availability, or how to access spare parts at short notice.

Reliable continuous facility operation requires that contingency plans are prepared and easily available in case of a natural disaster. Plans should also cover planned and unplanned equipment outages.

2.8 Attributes of biomass boiler systems

2.8.1 Greenhouse gas emissions and particulates

Moving from fossil fuels to renewable biomass residues sourced from sustainably managed tree planting will substantially reduce the greenhouse gas emissions from your boiler system.

Based on Ministry for the Environment figures, emissions from a range of fuels are:

Coal	~100 kg of carbon dioxide equivalent per gigajoule
Gas	54 kg of carbon dioxide equivalent per gigajoule
Fuel oil	91 kg of carbon dioxide equivalent per gigajoule
Biomass	2 kg of carbon dioxide equivalent per gigajoule

Wood fuels are assumed to be largely carbon neutral, with the fuel used in the supply chain (harvesting and transport) offset by the low emissions of biomass fuels.

Particulate emission control systems can be designed to meet any required emission limits.

2.8.2 Environmental, social, and economic benefits

There are numerous environmental and social benefits from the installation and operation of biomass boilers. These include the reduction in reliance on fossil fuels, as well as providing additional renewable energy fuel offerings, thereby contributing to a diversified fuel market. Biomass boiler systems create value out of what is often a forestry and sawmill residue by-product. Using this residue by-product reduces the need for additional trees to be planted as fuel supply.

Biomass fuel and their supply systems provide a variety of regional economic benefits including in fuel harvesting, processing, delivery, system planning, installation, and maintenance. With increasing demand for biomass boiler systems, the economic value of recovering more forestry and sawmill residue grows.

Biomass fuels often come from local fuel suppliers, who provide regional economic benefits to forestry owners, sawmills, and delivery channels. Using local wood fuels also increases the attractiveness of forestry as a land-use option. Locally sourced fuels reduce the cost of transport and associated greenhouse gas emissions created by transport of fuels.

Changing the heating system in a school from fossil fuel to biomass provides real-life learning opportunities about energy and climate change for students and the wider community. For example, students can be involved in learning about climate change impacts, school energy audits, researching the properties of different fuels and their effect on climate change, and identifying changes in school practices to reduce greenhouse gas emissions and energy use.

Increasing the local knowledge of biomass boiler systems provides a competitive advantage in a rapidly growing biomass fuel market. This contributes to growing the innovation potential of a region, through research and development and knowledge capacity in renewable energy uptake.

While the initial capital cost of new biomass boiler systems may be higher than for some other technologies, it is important that the comparison of financial costs be taken over the equipment's financial lifetime and to include all maintenance and operating costs, including equipment replacement and future cost of fuel, so that the evaluation of each option is fair and accurate.

2.8.3 Limitations of biomass boiler systems

Although biomass boiler systems have many benefits, like any system, if not properly designed, managed, and operated they can have limitations. Biomass boiler systems require careful design that integrates combustion equipment, fuel reception, storage, and handling.

The supply chain of local biomass fuel is often more complex than other renewable energy sources because of the number of parties involved in the supply process (for example, the supply chain can include landowners, forest owners, forest harvesters, wood processors, and biomass resource aggregators). However, using an experienced, accredited solid biofuel supplier can mitigate the risk of supply failure.

Some biomass boiler system owners express concern over long-term biomass fuel availability, but like any market, supply increases to meet demand. New Zealand has large areas of unused biomass resource that could be collected and processed into fuel. There are also large areas of marginal land where additional biomass could be grown when demand increases. Furthermore, over a million tonnes of wood chip and raw logs are exported from New Zealand monthly, much of which has a value if used as fuel.

2.9 Scoping and conceptual assessment

When scoping a biomass boiler system, the checklist in 2.11 is recommended. It summarises critical elements from the previous sections. Developing a new biomass boiler system requires a site assessment and specialist knowledge. Choosing the right biomass specialist, someone who has experience, knowledge, or training in operating biomass boiler systems, and understands their fuel storage requirements and fuel supply, is an important element in ensuring you can efficiently and cost-effectively manage your heating requirements. A list of advisors and suppliers can be found on the Wood Energy website.

2.10 Consenting

Any new biomass boiler system will require resource and building consents as required by the Resource Management Act 1991. These consents are provided by the regional and territorial authorities according to the rules set out in the respective regional and district plans. The rules cover building safety, land use, and discharges to land, water, and air. It should be noted that while the principles may be similar the specific rules may differ significantly between each consent authority.

New facility owners (or their agents) are required to make application for consents that provide for the consenting authority to easily access the application and in particular identify the likely effects on the environment or people. When issued, a consent may come with conditions that form part of the consent. These conditions will likely put limits on the potential effects from the facility. When the facility is operating it is required to meet these conditions or the consent can be withdrawn and the facility will be unable to operate.

Applicants for consents for a new biomass boiler system should check with the local consent authorities on the rules applying to their proposed facility, in the location where the facility will be built. Early discussion with consenting staff will identify aspects that must be addressed in the design and operation of the facility. Most consenting staff want to assist new projects and can provide suggestions on how the facility may meet any likely conditions.

Successfully and easily obtaining a consent occurs when applicants work with the consenting authority as ‘partners’ and not ‘adversaries’. Essentially the facility obtains a social licence to operate from the community in which it is to be located. This will generally result in a facility operating without complaint or issues being raised by the community.

Preparing a conceptual plan of the proposed facility and taking this to the consent authorities near the beginning of a project will reduce risk of unnecessary costs later, or even not obtaining a consent. The conceptual plan assists consenting staff to see what is proposed and provide guidance on how the facility will meet the regional and district rules.

2.11 Checklist for biomass boiler systems

2.11.1 Biomass boiler system selection (see 2.2)

The main points to consider in relation to the selection of a biomass boiler system are:

(a) Evaluation of existing plant efficiency before purchasing new equipment;

(b) Determining current and future heat demand and options to improve efficiency;

(c) Connection to existing or future heat distribution systems;

(d) The range of system options, including boiler, fuel, and hot water storage;

(e) Attributes and costs over the economic life of the biomass boiler system.

2.11.2 Fuel checklist (see 2.3, 2.4, 2.5)

The main points to consider in relation to fuel are:

(a) Fuel selection – determined by type and availability over the life of the plant;

(b) Fuel quality – moisture, energy, size, and ash content;

(c) Fuel purchase – contracting agreements;

(d) Fuel management and storage – delivery, storage, space availability, and accessibility.

2.11.3 Operations, maintenance, and safety (see 2.7)

The main points to consider in relation to operations, maintenance, and safety are:

(a) Proper training of operations staff;

(b) Availability of maintenance and cleaning labour;

(c) Inspection requirements;

(d) System reliability, maintainability, spares, and after-sales support.

2.11.4 Consenting (see 2.10)

Local consenting process needs to be engaged with as early as practicable.

2.11.5 Benefits (see 2.8.2)

The main points to consider in relation to the benefits of a biomass boiler system are:

(a) Reduction in greenhouse gas emissions and particulates;

(b) Social and environmental benefits;

(c) Regional benefits;

(d) Financial benefits.

2.11.6 Limitations (see 2.8.3)

The main points to consider in relation to the limitations of a biomass boiler system are:

(a) The importance of good design for an efficient system;

(b) The relative complexity of the fuel supply chain.

3 TECHNICAL SPECIFICATION

3.1 General

This section provides more in-depth technical guidance on the components and specifications of biomass boiler systems. There are a range of documents with more details in the 'Referenced documents' section and in Appendix B.

A biomass boiler system is a renewable energy heat plant specifically designed to combust fuels derived from biomass such as wood chip or wood pellets.

3.2 Biomass fuel

3.2.1 Fuel availability

Fuel availability should be checked with local suppliers. There is a difference between a potential fuel resource (such as forest harvest residues) and that material being made available as a fuel. Long-term availability should also be considered as supplies of some materials will vary over time and possibly by season.

Because biomass-fuelled heating equipment has a long economic life, it is important that the owner and operator of the heating equipment has a good understanding of the fuel supply risks for the lifetime of the equipment. For more information see the Wood Energy website.

Wood chip, pellets, and briquettes are likely to be the most common fuel types used in the size of system covered by this PAS, because of their fuel handling and combustion attributes.

3.2.2 Fuel type

Biomass fuel is defined by specific characteristics such as particle size and moisture content. The main fuel types for heating systems covered by this specification, as shown in Table 1.

Table 1 – Fuel type features for heating systems covered by this specification

Fuel type	Features
Wood chips	Chipped woody biomass in the form of pieces, with a defined particle size produced by mechanical treatment with disc or drum chippers with sharp knives.
Hog fuel	Fuel wood in pieces of varying size and shape produced by crushing with blunt tools such as rollers, hammers, or flails.The wood pieces are more splintered as opposed to cut.
Wood pellets	Wood that has been hammer-milled to less than 3 mm particle size and then pelletised under heat (~100°C) and high pressure to produce a cylindrical wood-derived fuel of consistent size. Pellets are typically 6 mm to 8 mm diameter and 8 mm to 15 mm long.
Compressed fire logs and briquettes	A briquette is made up of small particle-sized wood compressed into medium or large dimension pieces. Common types of briquettes are fuel logs, charcoal briquettes, and biomass briquettes. Made from woody biomass and compressed into large dimension pieces (40 mm to 60 mm diameter and 300 mm long).
Herbaceous biomass fuels	These are lignocellulosic biomass derived fuels sourced from miscanthus, switchgrass, other grasses, and straw and may be shredded, pelletised, or baled. These fuels require specialist expertise to ensure they are effectively stored, handled, and combusted.

3.2.3 Treated wood (including construction and demolition waste)

Wood that has been chemically treated with copper chrome arsenate (CCA) is not suitable for use as a fuel due to potential toxic emissions and ash contamination. Biomass with high levels of coatings, paints, and glues such as demolition waste will likely be problematic due to the presence of chemicals in the glues, coatings, and additives in paints. While some of these materials can be used for fuel under some circumstances (at high operating temperatures and/or with a long residence time or as a small percentage of the total fuel), a resource consent is required that specifically allows the combustion of those materials. The amount of the treated or contaminated wood that is allowed as a proportion of the fuel being fed into the boiler will be limited and specified in the consent. Typically, these materials are only used in larger process heat systems.

3.2.4 Moisture content

Biomass has inherent moisture content. Green wood can be 56% to 58% moisture by weight, but moisture at this level makes it a low energy content fuel, which requires higher loads and specially designed plants. Biomass can be air-dried or force-dried to lower moisture contents (20% to 40%) to improve energy content. At 20% moisture content biomass fuel is likely to reabsorb some moisture from humidity in the air. Air-dried wood will have an equilibrium moisture content of 20% to 25% wet basis, depending on the ambient temperature and humidity. The moisture content affects the net calorific value of the wood or any other biomass. Dried wood, at 30% moisture content, has a net calorific value of around 12.5 GJ per tonne (GJ/t), but if harvested at 58% moisture content it will be reduced to around 6.5 GJ/t. (See Table A1 in Appendix A for energy content by moisture content.)

An example of moisture content (wet basis) is as follows. For fresh radiata pine log, if the log weighs 960 kg/m^3, of this, approximately 400 kg will be wood and 560 kg will be water.

$(\frac{560}{960}) \times 100 = 58.3\%$ moisture content wet basis.

It is important that the moisture content of biomass be below 55% at a minimum. However, the moisture content required by specific boiler systems or wood fuel standards is often much lower than this. Densified wood fuels such as pellets and briquettes have moisture contents of 8% to 10% (± 2%). Most small wood chip boiler systems are designed to run on fuel between 25% and 40% moisture content.

Moisture content of delivered fuel should be checked on a regular basis to ensure that the required level is maintained. If fuel is below the required level, then the boiler output will reduce and fuel consumption will increase.

The contract for purchase of fuel should clearly specify the fuel characteristics, including moisture content, which the fuel is required to meet. The contract should specify delivered fuel sampling and testing requirements. Purchasing fuel from an accredited solid biofuel supplier will ensure that there is third-party monitoring of the supplier's quality assurance system.

It is also important that all biomass fuels be kept as dry as possible. Biomass fuels should not be stored outside where they are exposed to rain because water absorbed into the fuel will lower its calorific value. This is critical in the case of pellets and briquettes as these densified fuels are made of small compressed particles that disintegrate very quickly if they get wet. They are also vulnerable to deterioration when exposed to high humidity.

Wet fuels can also cause problems with emissions as they might not completely combust, leaving particulates to be carried out in the flue gases. Wet fuels can also cause fouling of the flue.

3.2.5 Particle size distribution

The distribution of particle size around the target size will affect the performance of a biomass boiler system and its emissions. Too many very fine particles in the fuel can lead to excessive particulate emissions, while oversize material can cause issues with fuel feeding. Particulates are very small pieces of ash and unburnt fuel that can exit a solid fuel boiler in the flue gas stream.

Most biomass boiler systems are designed to run on a fuel with a specified particle size range. It is important that the particle size of the fuel be matched to the boiler design and that the fuel does not contain much material outside the specified particle size. A high amount of fines is likely to cause a high level of particulate emissions, however, this can be mitigated with an appropriate system design (which may include emissions testing).

The fuel supply contract should specify the fuel particle size, as agreed to by the boiler system manufacturer.

3.2.6 Ash

Ash is the non-combustible mineral part of lignocellulosic biomass. Ash varies with biomass type. Clean wood has an ash content of 0.2% to 0.4% on a dry basis. Bark has an inherent ash content of 1% to 2%. Most biomass fuels have ash contents as delivered slightly higher than the levels inherent in a clean sample due to minor contamination that can occur at various points through the supply chain. The level of contamination should be minimal and can be managed by good handling and screening. The ash levels in wood and bark are lower than most coals burnt in New Zealand, which tend to have ash contents of 3% to 8% depending on the source mine. Unlike ash from coal, biomass ash may be used as a soil amendment under certain circumstances.

Ash contents of herbaceous fuels (such as miscanthus and straw) are typically higher than that of wood or bark and can be problematic unless the system is well designed and managed. Many biomass fuels have ash contents higher than the numbers quoted above, due to contamination during fuel processing and handling.

Fuel handling and storage shall be designed to avoid the introduction of contaminants such as dirt, stones, and waste materials that contain ash. A higher ash content reduces the calorific value of the fuel, increases the amount of ash to be disposed of, and, depending on the nature of the contaminants, can lead to lower ash fusion temperatures and increased sintering in the boiler, with associated issues due to clinker build-up.

Ash fusion temperatures (particularly the softening temperature) of the proposed fuel should be provided to the boiler manufacturer after testing in a laboratory as it will influence design and operating parameters.

3.2.7 Fuel energy density

Fuel energy density is commonly measured by weight, for example in gigajoules per tonne. However, when it comes to specifying a fuel for the biomass boiler system, it is important to consider the volumetric energy density (gigajoules per cubic metre). If the fuel material is either wetter than it should be or has lower bulk density than it should, the boiler may not run at its rated output. While some biomass fuels have low volumetric energy densities, this is not a major issue as long as the boiler is designed to run on that type of fuel. Volumetric fuel energy density has an important impact on supply and fuel storage. See Table 2 for a comparison of energy densities and moisture content.

Table 2 – Fuel specifications

Fuel	Moisture content (%)	Basic energy density (GJ/t)	Conversion from GJ/t to GJ/m^3	Volumetric energy density (GJ/m^3)
Wood chip	25 to 50	13.6 to 8.2	2.50	5.4 to 3.3
Wood pellets	8 to 10	17.2 to 16.7	1.35	12.7 to 12.4
Hog fuel	25 to 50	13.6 to 8.2	2.80	4.8 to 3.0
Briquettes and fire logs	8 to 10	17.2 to 16.7	1.13	15.2 to 14.8
Herbaceous fuels	15 to 25	15.6 to 13.5	3.00	5.2 to 4.5

3.2.8 Fuel specification knowledge

It is important that the fuel being used in the biomass boiler system meets the specifications agreed with the manufacturer. These specifications should be kept in a place known by all those involved in operating the boiler and ordering fuel to ensure that correctly specified fuel is ordered and delivered. If there are changes in personnel within an organisation, this information is an important part of the handover of responsibilities. A critical step when specifying a fuel is to understand what fuel the biomass boiler system was designed for. To check the applicable standards for wood fuels, refer to the Bioenergy Association's technical guide 'Solid Biofuel Classification Guidelines' (Technical Guide 01) available online (see the 'Referenced documents' section at the front of this specification).

3.3 Chip

3.3.1 General

The origin and source of wood chip material varies with the grade of chip. Sources typically include whole trees, stems, logging residues, and chemically untreated processed or post-consumer untreated wood residues (for example, old shipping pallets).

The measures for chip are:

(a) Particle size – target size, and percentage outside of target size, plus minimum and maximum size;

(b) Net calorific value – minimum must be stated (on a mass basis, for example gigajoule per tonne or megawatt per tonne);

(c) Ash – limit varies with grade;

(d) Moisture content – limit varies with grade.

3.3.2 Bulk density

Bulk density will vary based on the particle size of the chip produced. Underlying assumptions are that the basic density of wood (based on the resource being largely softwoods in New Zealand) is around 400 kg/m^3, and that 1.0 solid cubic metre of wood converts to between 2.5 m^3 and 3.0 m^3 of chip (~2.7 m^3 is typical for pulp grade chip). Moisture content also affects the bulk density, with dryer material having a lower bulk density, but with slightly increased energy content on a volume basis.

3.3.3 Elemental composition (trace and mineral elements)

The principal elemental components of dry wood are carbon (50% to 51%), oxygen (42% to 43%) and hydrogen (~6%). Other elements are usually only present in trace amounts, with ash being mostly silica. For international (ISO) standards for wood fuels, see Appendix B.

3.4 Hog fuel

Hog fuel is typically an industrial fuel for larger boiler systems, and has the same measures as chip (see 3.3), but different limits. Ash contents and elemental component limits are generally higher than for chip. Suppliers of hog fuel are expected to state the minimum calorific value and the bulk density.

3.5 Pellets

Wood or biomass pellets have additional measures in their specifications, their mechanical durability, and the percentage of fines that are allowed. The pellets themselves can be made in either 6 mm or 8 mm diameters and lengths are expected to be above 3.15 mm and less than 40 mm. The upper limit on length is to avoid binding and bridging during feeding.

The net calorific value of a pellet fuel must be above 16.5 GJ/t, with moisture content of 8% to 10%.

The bulk density of the pellets is expected to be above 600 kg/m^3.

Unlike chip or hog fuel, wood and biomass pellets are manufactured to specified limits set out in the ISO standards (see Appendix B). Manufacturers of pellet fuel have very stringent quality assurance systems as pellets are a consistently manufactured fuel with tight tolerances on the product.

3.6 Briquettes

Briquettes are densified wood or biomass material, typically in the form of cylinders 20 mm to 80 mm in diameter and 200 mm to 300 mm in length. They can also be produced as pillow briquettes, although these are less common. Fine material is likely to be limited. Briquettes typically have a high basic energy density (similar to pellets) and volumetric density. They have low moisture content (around 6% to 8% wet basis). They can be used for boiler fuel, but their most common application is in log fires.

Briquette manufacture is similar to that of wood and biomass pellet manufacture in that they are a consistently manufactured fuel.

3.7 Herbaceous fuels

Herbaceous fuels are comprised of materials such as straw, corn stover, and giant grasses such as miscanthus. New Zealand has a significant straw resource in Canterbury. Straw has a moisture content at harvest of around 15% and an ash content of 3% to 5%. It can be used as a boiler fuel either as chopped but loose material in bales, or densified into pellets. Specialist straw boilers are required for this material as the ash has a fusion temperature lower than wood. A special design is required to lower the combustion temperature in order to avoid ash forming clinker.

3.8 Specifying the right fuel

Specifying and using the right fuel for your biomass boiler system maximises the efficiency and lifetime of your boiler. Boiler systems are generally designed for a specific type of fuel (typically pellets, chip, or briquettes). They do not run as efficiently, if at all, on a fuel that they are not designed for. Further, if a fuel is outside of the specification the boiler was designed for, there will be a drop in energy conversion efficiency and a loss in output from the boiler. In extreme cases a boiler can be damaged when run on an inappropriate fuel.

Typical issues are with:

(a) Particle size – If there are too many fine particles there may be a loss of energy as some particles exit the combustion chamber unburnt, contributing to inefficient use of fuel. Excessive dust can also be an explosion risk and health hazard;

(b) Ash content – If the ash content is too high then the calorific value of the fuel is reduced. Minor variations that occur in biomass may not be noticeable or substantial, but if a fuel is particularly dirty the drop in calorific value and rise in ash can have a significant effect. The deposition of fly ash on boiler tubes and heat exchanger surfaces can cause a drop in the conversion of fuel energy into heat output. It may also mean that more frequent removal of ash is required, with more frequent shutdowns leading to reduced availability and use of the boiler;

(c) Ash contamination – Any contaminants causing ash can have a critical effect on the ash fusion temperature. A lower than normal ash fusion temperature can cause sintering, slagging, and fouling of the grate and in the combustion system. This can lead to a partially blocked grate and flue gas path, and compromised boiler performance. Contaminants can also lead to an increase in maintenance and repair. There are laboratories in New Zealand that perform tests on a fuel to determine its ash content, elemental composition of the ash, and ash fusion temperature. It is worth getting fuel tested at the start of any fuel supply contract, or if there is a noticeable change in ash production;

(d) Moisture content – The fuel specification should refer to a target moisture content and acceptable range limits around that target. This will ensure the right moisture content fuel is delivered.

3.9 Fuel supply contracts

Contracting for fuel is a critical aspect for any biomass-fuelled facility, as the availability and cost of fuel may change over the life of the biomass boiler system.

Fuel should be purchased on a delivered price per gigajoule basis (with reference to the net calorific value) rather than price per tonne or price per cubic metre because the weight of the fuel can be increased by higher moisture content, which reduces energy content. In addition, this price can be impacted by the number and size of deliveries.

The contract for purchase of fuel must set out the important aspects of fuel supply including escalation of fuel price for contract terms of over one year. A model contract and other guidance on best practice for the supply and purchase of biomass fuel is set out in the Bioenergy Association's technical guide 'Contracting to deliver quality solid biofuel to customers' (Technical Guide 06), available online (see the 'Referenced documents' section at the front of this specification).

3.10 Fuel management and storage

3.10.1 Fuel management and handling

Management and handling of fuel to keep it clean and free of moisture is an important aspect of efficient operation and will avoid plant stoppages. The design of the management and handling system should be such that these issues are minimised.

3.10.2 Fuel deliveries

Fuel deliveries need to be planned around the size and loading of the biomass boiler system, its rate of fuel consumption, and the size of the fuel storage bunker (including contingency requirements). These are relatively simple calculations and should be part of the design process. The ability to deliver a reasonable volume to a specific bunker needs to be considered, particularly if the plant is in a remote or difficult-to-access location. That is, can a large tipper truck access it, or does the site require the use of smaller trucks, or specialist trucks that can auger, blow, or convey fuel into a raised or otherwise difficult-to-access bunker?

3.10.3 Fuel storage

The storage of solid biomass fuels can be critical to the success of a biomass boiler system operation. This is particularly so for densified solid fuels such as pellets and briquettes. These fuels must be stored in covered, dry, and low humidity (not damp) environments. Pellets have no resistance to water exposure (rainfall or puddles) and will deteriorate in high humidity or damp environments. This deterioration can be either complete disintegration (water exposure) or reduced resistance to handling or movement by augering (high humidity exposure).

Storage conditions for chip and hog fuel are not so stringent. Individual pieces will not disintegrate under wet or humid conditions, but they will absorb water from rainfall or puddles so should be kept under cover and on a dry floor.

Wet chip or hog fuel in very large piles, or stored in moist circumstances, can provide conditions suitable for biological activity that may lead to fungal growth, resulting in degradation of fuel and health risks. It can also lead to pile heating and associated mass loss.

Any fuel bunkering should ensure that there are no 'dead' spots or bridging, so that all the fuel in the bunker flows cleanly to the boiler feed. It is important for wood chip, but for wood pellets it is critical.

Of equal criticality for wood chip is that the fuel store design ensures there are adequate means to periodically agitate the chip in the store to break or prevent bridging.

3.10.4 Space requirements

The space required to store the fuel will depend on the type of fuel, its volumetric energy density and whether the fuel is to be delivered in small or large quantities. The likely daily consumption of fuel should be calculated. This can be converted into a volume of fuel. Then delivery options should be considered.

Some indicative figures for fuel densities are given in Table 3.

Table 3 – Indicative fuel densities

Fuel type	Bulk density; t/m^3	Moisture content; wet basis percentage	Volumetric energy density GJ/m^3
Green chip	0.32	50	2.63
Dry chip	0.21	25	2.87
Green hog	0.30	50	2.44
Dry hog	0.20	25	2.67
Wood pellets	0.65	8	11.0

3.10.5 Fuel verification

Once a facility is operational, it is essential that a method of fuel verification is established by the facility operator. The methodology should include receiving documentation from the supplier that includes reports on testing the supplier has completed to confirm that the fuel supplied fits the fuel contract specification.

As moisture content is the most critical fuel characteristic affecting fuel cost and plant performance, the facility owner shall also undertake their own simple checking of the moisture content of fuel as delivered. This check would normally be done with a bin meter (backed up by regular in depth checking).

Guidance on methods for verification of delivered fuel is set out in in the Bioenergy Association's technical guide 'Standard methods for verifying the quality of solid biofuels' (Technical Guide 05).

3.11 Equipment selection

3.11.1 Biomass boiler systems

Biomass fuels burn in quite a different way to many coal fuels, and in three different (overlapping) stages:

(a) Firstly, moisture is driven off (for a high-moisture fuel, this step is very important and may require specific boiler design features);

(b) As the particles are dried, combustible volatiles are progressively driven off, so need to be well-mixed with correct proportions of over-fire air for good combustion. Failure to design this aspect correctly will lead to the deposit of tars and other volatiles on gas-side boiler surfaces;

(c) Finally, carbon is burned out, primarily relying on under-fire air, and residual ash is discharged down through or off the grate.

Wood chip, depending upon its delivered moisture content will first absorb a certain amount of energy from the combustion process in drying. Coal will also do this, but generally to a lesser extent, depending upon the particular coal type.

When combustion starts, coals require more air supplied beneath the fuel bed to initiate combustion, drive off the volatiles, and complete the combustion of the carbon fraction of the fuel, and relatively less air supplied into the space immediately above the fuel bed to complete the combustion of the volatiles. Due to the high amount of volatiles in biomass fuels, biomass boiler systems typically require larger furnaces and less heat absorption near the combustion zone.

With wood fuels, the proportions are reversed, with relatively less air supplied beneath the fuel bed and more supplied into the space above the bed.

3.11.2 Biomass combustors

Biomass combustors require specialised design (which is the responsibility of boiler suppliers) and can be generally characterised as:

(a) Pile burners – Biomass is either dropped onto a pile or fed vertically upwards into a pile;

(b) Inclined grates (static, vibrating, or reciprocating grates, with or without water cooling) – Biomass is fed onto the top of an inclined grate and moves down the grate as it burns. If refractory surfaces are arranged above these grates, they are capable of handling high-moisture-content fuel;

(c) Horizontal grates (moving chain grates, ’vibrating‘ or ’dumping‘ grates) – Biomass is distributed by a feeder so that a relatively thin, even layer is maintained across the grate. This type of combustor is suitable for larger capacity units;

(d) Fluidised bed – Biomass is fed into a shallow bed of inert material that is fluidised by a controlled upwards air flow. This type has somewhat higher parasitic energy use (that is, power used when on standby) than other types, but is more tolerant of fuel specification changes. This type of combustor is suitable for larger capacity units.

This list is not exhaustive, some manufacturers have well-developed proprietary designs. The plant specifier will need to consider track record and ongoing service and spares support – as well as the capability to use the identified fuel – when selecting a combustor type.

3.11.3 Biomass boiler system construction type.

Noting the exceptions (see 1.1.2), several types of boiler commonly fall within the scope of this specification. Noting the following:

(a) One such system is the sectional hot water heater, which contains modular heating sections (for hot water) that enclose the combustion chamber, and contains ash removal systems;

(b) Some biomass boiler system designs have the combustion chamber incorporated within an enclosure formed by heat transfer surfaces;

(c) Often, a separate refractory-lined combustion chamber is used, and flue gases are passed into the heat transfer portion of the boiler.

3.11.4 Boiler selection:

Factors to be established prior to boiler selection are:

(a) The boiler's capability to burn the selected type of fuel. Note that boilers are generally designed to only burn fuel that is within a certain specification band (which may not be a wide band);

(b) The detailed and signed-off heat demand profile;

(c) The fuel type and specification;

(d) The high-level system design;

(e) Compliance with relevant New Zealand safety regulations.

3.11.5 Technical factors in boiler selection

Technical factors to be established prior to boiler selection are:

(a) Any highly project specific requirements (for example, site prohibitions on storage of particular chemicals, particularly stringent specifications regarding dust, noise, and vehicle movements);

(b) Boiler attendance level required;

(c) Boiler turndown and response times;

(d) Number of start-ups and shutdowns;

(e) Security of fuel supply specific to the boiler;

(f) Local availability of skilled operators for particular boiler types;

(g) Local availability of service and repair facilities;

(h) Flue gas clean-up requirement to achieve required air emission standards;

(i) Availability of automated cleaning systems;

(j) Compatibility of control systems with other client systems.

A guide to the technical aspects to be considered when developing a biomass boiler system is provided in 'Consultant/specifier practice paper for wood fuel industrial and commercial heating systems' (Bioenergy Association Technical Guide 10), available online (see the 'Referenced documents' section at the front of this specification).

3.12 Capacity ratings

3.12.1 General

Biomass boiler system capacity rating is commonly specified in terms of thermal output (for example, '2 MW'). However, more detailed definitions of output should be used in the design process. The consultant should note that smaller package boilers may only be available in nominated capacities, whereas larger designs are adjusted for specific output requirements. Turndown ratio should be specified and sufficient to meet the overall heat demand.

Refer to Bioenergy Association Technical Guide 10.

3.12.2 Heat demand

The magnitude and characteristics of the proposed heat demand must be defined in detail as an authoritative basis for the design or selection of the biomass fuelled system. Failure to accurately clarify the patterns and quanta of heat demand is one of the more common causes of biomass boiler system project problems.

If the existing system is poorly maintained or has obvious inefficiencies, such as poorly insulated pipework, leaking valves, or inadequate fan and vent controls, these should be corrected before heat demand is assessed. Failure to correct pre-existing faults will waste time and may result in an oversized heat-generating system and ongoing economic loss.

3.12.3 Existing design revision

Careful consideration should also be given to the possibility of revising the design, configuration, and operation of the existing system. It may be possible to reduce the size of a new boiler (or even avoid the need for one) if significant energy savings can be made at the site.

When converting an existing boiler, or fitting a new boiler to an existing system, the existing controls are likely to be inadequate and obsolete. Consideration of effective 'zoning' in systems to ensure that heat is only supplied to those areas which require it, when they require, is important. The combination of effective zoning and control can often have a significant impact on the sizing of a biomass boiler system.

3.12.4 Energy audit

Once maintenance and system improvements are complete, an energy audit of the existing plant should be carried out, preferably to the requirements of the latest edition of AS/NZS 3598.2.

In a situation where heat load does not currently exist (that is, a new plant is planned), an energy audit is impossible. However, future heat demand must be characterised carefully and at the same level of scope and detail as for an existing heat load. This is likely to be done by using data from the designers of the new plant, or from the performance of a similar plant installed elsewhere. Suitable margins of tolerance should be applied.

3.12.5 Proposals

Proposals (including scope, timing, and contingencies) for business expansion, change, or retraction should have been established in the course of preparing the 'basis of design' documents. System design and plant selection is difficult when business changes are likely. A boiler selected for a future major load may not be capable of stable operation at a current load, and it may not be economic to specify a boiler plant for current load if the business intends to expand by 100% in the next few years (or, conversely, if it intends to downsize or move away from existing markets). Contingency options may also be required, in the event that planned changes to business do not materialise.

Changes to existing systems that 'smooth' heat demand should also be considered. Such options may be significantly less costly than design and selection of a system for very 'peaky' heat demand. Options could include the continued or part operation of an older existing boiler system for peak loads, and the use of various energy storage options.

Following investigation of the above issues, an 'agreed heat demand' description should be drawn up. This document should address:

(a) Absolute maximum project heat demand;

NOTE – If this demand only occurs over short periods or infrequently, then plant design options might allow this to be met without incurring the cost of an oversized boiler.

(b) The detailed pattern of demand (calculated hourly and adjusted weekly, seasonally, and during peak demand). Variability of the heat demand will be a key consideration in the selection of the boiler and related equipment;

(c) Business expansion provisions. Any heat project should include a careful consideration of likely future changes, such as:

  (i) Expansions or contractions of the plant

  (ii) Likely adoption of new processing technologies

  (iii) The retirement of a plant that will reach end of life;

(d) Specific issues that will affect plant design, for example the number of start-ups and shutdowns and the possibility of periodic significant reduction in temperature of returning circulating water;

(e) Appropriate margins of uncertainty, based upon the quality of data available.

Refer to Bioenergy Association Technical Guide 10.

3.12.6 Energy efficiency aspects of biomass boiler systems

The efficiency of a biomass boiler system is based on its ability to convert the net calorific value in the fuel into energy in the form of heat. Modern well-designed and specified biomass boilers should have a net efficiency of greater than 85% at full load. This efficiency may be reduced by the use of an off-specification fuel, or poor tuning of the boiler system. Different biomass boiler system designs have different efficiencies, and some are designed to use particular fuels.

3.12.7 Inclusion of energy storage tanks

The inclusion of temperature stratified energy storage tanks can improve the operational and economic efficiency of the system. If a site has a fluctuating demand over a 24-hour period, and a temperature difference between flow and return temperature of at least 30°C, a correctly designed energy storage tank can allow a smaller biomass boiler system to operate at higher loads more continuously, at high efficiency, and not waste heat by being in turndown mode for long periods. The heat generated outside of the peak load time is stored in the tank and used when it is required. This issue needs careful analysis to determine its merits for a specific site.

3.12.8 Combustion efficiency

Combustion efficiency can be affected by a number of issues, including changes in fuel quality. Combustion efficiency can be checked by testing the flue gas composition. An excessive level of carbon monoxide (CO) in the flue gas (> 2000 mg/m^3) indicates incomplete combustion. Tuning of the boiler to reduce CO emissions can be done by adjusting under and over-fire air inputs.

3.13 Operation, maintenance, and safety

3.13.1 Operation

The biomass boiler system should be operated as per the manufacturer's manual and instructions. Making alterations to these operating parameters can lead to unsafe equipment operation, excess fuel consumption, boiler fouling, high emissions, and damage to the boiler in extreme cases.

3.13.2 Maintenance and cleaning

It is recommended that the system design includes flue gas clean-up to reduce particulate emissions. Options include baghouse, and electrostatic precipitators. Cyclone separators are often fitted to boilers. However, these have a lower efficiency than the other options.

If the system has filters installed, these should be kept clean in order to function effectively. Cleaning fuel dust out of the storage area is also important to avoid fires and explosions.

Good system design, and matching of the fuel type to that design, can allow applications as covered by this specification to avoid the need for expensive flue gas clean-up equipment to be installed.

3.13.3 Site inspection

It is recommended that biomass boiler systems be inspected regularly according to the equipment manufacturer's, or the system designer's, instructions. These inspections should include a review of:

(a) Erosion of fuel feed components;

(b) Missing parts;

(c) Corrosion;

(d) Adhesive deposits;

(e) Non-combustible rubbish;

(f) Tar deposits;

(g) Water deposits;

(h) Water leaks;

(i) Water ingress to insulation;

(j) Functionality of backfire protection and sprinkler systems;

(k) Functionality of automatic cleaning systems;

(l) Functionality of important instruments and probes (such as the lambda probe).

3.13.4 Safety and training

For a biomass boiler system, safety considerations shall be made during design, construction, operation, and end of life of the system. These include:

(a) Consideration around safety during construction and operation stages of the biomass boiler system;

(b) The safety of personnel operating the biomass boiler system (including access to the equipment);

(c) Providing training to operation and maintenance personnel.

3.14 Consenting, financial life cycle, and environmental and social assessment

3.14.1 Scoping and conceptual assessment

The choice of biomass boiler system type will be largely dictated by the preferred fuel type and the heating application.

Overall biomass boiler system design is an important consideration. For a new boiler installation, the heating demand of the site should be assessed holistically rather than simply trying to meet the heat demand of the old boiler. Biomass-based heating is often the least expensive method of heating, so as much space and water heating as possible should be included in the new installation. This can require an upgrade of the piping network but such an upgrade will provide long-term benefits.

The possibility of future changes in the site should also be taken into account when assessing heat demand. For example, if the heat network might be extended in the future, the boiler should be sized with this in mind. In addition, the inclusion of energy storage tanks can enable a smaller biomass boiler system than the old one, as discussed above.

Fuel storage and site access are also important considerations in biomass boiler system design. The size of the fuel storage dictates the frequency of fuel delivery, and easy access to a fuel bunker can significantly reduce costs of fuel delivery.

When scoping a potential commercial biomass boiler system it is important, at the start of a project, that a term sheet be prepared on the proposal so that every party has a clear understanding of what the project is to achieve and the range of options allowed. A clear project scope avoids key aspects being missed and decisions being locked in without due evaluation of the options.

3.14.2 Consenting

As part of investigating the feasibility of a new biomass boiler system, a check sheet should be prepared for all the required consents and permits that will be necessary for the system to be installed and operated. Details of likely consent conditions should be obtained as these will provide boundary conditions in which the facility will be allowed to be constructed and operated.

A project plan should be prepared setting out who is responsible for obtaining the necessary consents. In many situations the equipment supplier is providing a turnkey solution and is often best placed to obtain the necessary consents, acting in the capacity as agent to the system owner, because they understand the performance characteristics ➤

of their equipment and fuels and under specific conditions. The owner is required to obtain consent, while the equipment supplier contracts to supply equipment which meets consent limits. For larger systems, the primary site contractor may undertake these responsibilities.

Clarity of the responsibility of each party is critical to mitigate the risk of future issues. Issues that are likely to be part of a resource consent process are:

(a) Flue emissions – Particulates and smell;

(b) Deliveries – Timing, type and number of vehicle movements;

(c) Noise;

(d) Greenhouse gas emissions.

Building consents will also be required relating to:

(e) Building structural performance;

(f) Fire safety systems;

(g) Safety of operators;

(h) Safe movement of people.

More information can be found by contacting the appropriate regional council for resource consents and the local territorial authority for building consents.

3.14.3 Fuel costs

The overall long-term financial implications of a choice around biomass boiler systems and fuels needs to be considered. What looks inexpensive today (a low capital cost, low fuel cost coal boiler) might not be cheaper in the long run as maintenance costs can be high, and ash disposal costs and the cost of carbon emissions associated with fossil fuel combustion could increase over time. Careful examination of these costs is necessary to ensure that the best decision around the long-term costs of the system, and the fuel chosen, are optimised for the site. Gas boilers typically have a low capital cost and take up comparatively very little space, but the cost of gas is expected to rise (unrelated to the cost of carbon) as supply constraints occur over the next 10 to 20 years. The cost of carbon and its trajectory also needs to be considered.

Decisions on the fuel type chosen should be clearly recorded and posted in the boiler building to assist future operators. The most common problem relating to future operation of well-designed and constructed biomass boiler systems arise when future facility operators change to a different fuel from what the system was designed for because of the then-cost of the originally specified fuel.

3.14.4 Tendering

Tender requests should include all ancillary equipment and services necessary for the facility to be successfully operated and maintained for the assumed economic life. This includes fuel reception, handling, and storage.

A summary, including diagrams and photos of the site showing fuel reception, handling, and storage areas should be provided so that when tenders are received all parties have good information on which to base a tender.

The request should seek information and data that shows that tendered equipment is suitable for the fuels likely to be available for the assumed economic life of the facility.

Available monitored performance data of the proposed equipment and fuel used in other similar facilities should be requested. This should include fuel consumption, operating characteristics, and heat outputs.

References to other similar facilities with the same equipment and fuel type should be sought.

Information should be sought that outlines why the equipment and fuel is proposed, with comparisons to alternative solid biofuel options provided.

3.14.5 Financial lifecycle

A full financial life-cycle assessment of the proposed project should be undertaken, including assessment of the tangible and intangible costs and benefits over the economic life of the project. Guidance on how this should be done is set out in the Bioenergy Association guide ‘Best practice guideline for life cycle analysis of heat plant projects’ (Technical Guide 14), available online (see the ‘Referenced documents’ section at the front of this specification).

To determine the cost-effectiveness of biomass boiler systems compared to other boilers or other types of energy solutions, it is recommended to undertake a financial life-cycle analysis of the boiler. A financial life-cycle analysis determines the cost-effective option, which includes the cost of use. AS/NZS 4536 provides a good overview of the principles for life-cycle costing.

To compare the cost of running different technologies or to make a decision around replacement of a new technology, apply the levelised cost of energy (LCOE) metric for guidance on the average net present cost of energy production over the assumed lifetime. LCOE also provides guidance on whether the project will be profitable, cover cost, or be unprofitable.

LCOE can be derived by using the net present value (NPV) of the total plant and operation cost (including initial cost of investment, maintenance, operations, and fuel) divided by energy production over the assumed lifetime. LCOE allows the comparison of different technologies (for example, wind, solar, natural gas) of unequal life spans, project size, different capital cost, risk, return, and capacities as well as comparison to replacement cost with new technologies. LCOE is critical to making an informed decision to proceed with development of a facility, community, or commercial-scale energy project.

NOTE – All options should be evaluated for operation over the same period, that is, number of years. Where a technology might need significant equipment replacement to achieve that economic life such expenses should be included in the assumptions.

A financial example comparison is set out in Table 4.

Table 4 – Financial example comparison

	Reticulated gas hot water	Electric hot water	Biomass hot water
Capital cost ($M)	1.0	0.5	2.0
Financial life	15 years	15 years	15 years
Capital cost ($ per annum)	106,667	53,333	213,333
Operating, repair, and maintenance cost ($ per annum)	100,000	5,000	200,000
Output (MWh)	5000	5000	5000
Fuel cost ($/MWh)	50	170	40
Fuel ($ per annum)	250,000	850,000	200,000
Levelised energy cost ($/MWh)	91	184	123[a]

[a] Includes residual value.

It is recommended to integrate risk analysis into your evaluation. Scenario analysis incorporates different risks, including finance, technological, fuel, operational, and economic risks. This informs the management of risks, which can be included in different scenarios over the financial lifetime of the boiler. Ancillary electricity costs should be included in the operating cost calculation.

3.14.6 Environmental and social assessment

The operation of a heating facility is no different from many other similar manufacturing operations where the activity has to exist and operate in harmony with the neighbouring community. Environmental and social impacts assessment and consideration are integral to the successful operation of a biomass boiler system. These include consideration of the effects of discharge of emissions to land, water, and air, greenhouse gas emissions, noise, smells, traffic, and general environment and biodiversity impacts.

To obtain a consent to install and operate a biomass boiler system there are a range of requirements to adhere to, which include discharges to land, air, and water, covered under the regional plan; and noise and traffic, covered under the district plan. These can be obtained from your regional council (see the page 'An everyday guide: Applying for a resource consent' on the Ministry for the Environment website), or your territorial authority.

As set out in 2.10, it is recommended that requirements for a consent are investigated early in the facility development process. This should also establish whether ongoing monitoring may be stipulated as a condition of your consent.

An environmental impact report might be required for larger projects. Environmental impact assessment can require the expertise of an environmental resource specialist.

Environmental impact should consider the travel distance of fuel, even though this is likely to change over the economic life of the facility. Local or carbon-neutral wood-fuel suppliers should be utilised where possible.

To reduce climate change impacts, mitigation of greenhouse gas emissions may be available. Biomass boiler systems are considered carbon neutral during their operation (see the Scion info sheet 'Energy from wood is good for New Zealand and the climate', available online).

For more information on how to assess the carbon neutrality of your biomass boiler system operation, see the page 'Measuring, reporting and offsetting greenhouse gas emissions' on the Ministry for the Environment website.

Consideration should be given to the likelihood that the project will be affected by increasing climate change impacts such as flooding and inundation. This information can be provided by your council.

Social impacts of projects should be considered during construction and operation. Adverse social impacts can include traffic noise traffic affecting neighbours.

It is too late if social impacts are considered during construction. Possible social impacts should be identified and addressed prior to the project being made public. Opposition from neighbours and others is probably the second biggest risk (after fuel supply) that will stop a project proceeding. Best practice is that engagement with neighbours and providing good information on possible effects should be addressed at the start of a project.

APPENDIX A – WOOD FUEL VALUE BY MOISTURE CONTENT

(Informative)

The net calorific value is determined by the following equation:

$$\mathrm{NCV} = \underbrace{\mathrm{GCV}\left[1 - \frac{w}{100}\right]}_{①} - \underbrace{2.447\frac{w}{100}}_{②} - \underbrace{2.447\frac{h}{100}9.01\left[1 - \frac{w}{100}\right]}_{③}$$

Where:

NCV = net calorific value in MJ/kg fuel (wet basis)

GCV = gross calorific value in MJ/kg fuel (dry basis)

w = water content of fuel as percentage of weight

h = concentration of hydrogen as percentage of weight (dry basis).

The first term simply converts the gross calorific value to the wet basis. The second term is due to the latent heat of vaporisation of the water contained in the wood. The specific latent heat of vaporisation of water at 25°C and constant pressure is 2.447 MJ/kg. The third term is due to the vaporisation of the water produced when the hydrogen in the wood is combusted. The concentration of hydrogen in woody biomass is typically about 6% (dry basis).

Table A1 itemises the net calorific value (NCV) for wood fuel by moisture content.

Table A1 – Indicative moisture content and energy

Moisture content; % wet basis	GCV; GJ/t	NCV; GJ/t	Moisture content; % wet basis	GCV; GJ/t	NCV; GJ/t
1	19.99	18.66	**36**	12.92	11.20
2	19.79	18.45	**37**	12.72	10.99
3	19.59	18.24	**38**	12.51	10.77
4	19.39	18.02	**39**	12.31	10.56
5	19.18	17.81	**40**	12.11	10.35
6	18.98	17.60	**41**	11.91	10.13
7	18.78	17.38	**42**	11.71	9.92
8	18.58	17.17	**43**	11.50	9.71
9	18.37	16.96	**44**	11.30	9.49
10	18.17	16.74	**45**	11.10	9.28
11	17.97	16.53	**46**	10.90	9.07
12	17.77	16.32	**47**	10.70	8.85
13	17.57	16.11	**48**	10.49	8.64
14	17.36	15.89	**49**	10.29	8.43
15	17.16	15.68	**50**	10.09	8.22
16	16.96	15.47	**51**	9.89	8.00
17	16.76	15.25	**52**	9.69	7.79
18	16.56	15.04	**53**	9.48	7.58
19	16.35	14.83	**54**	9.28	7.36
20	16.15	14.61	**55**	9.08	7.15
21	15.95	14.40	**56**	8.88	6.94
22	15.75	14.19	**57**	8.67	6.72
23	15.55	13.97	**58**	8.47	6.51
24	15.34	13.76	**59**	8.27	6.30
25	15.14	13.55	**60**	8.07	6.08
26	14.94	13.33	**61**	7.87	5.87
27	14.74	13.12	**62**	7.66	5.66
28	14.54	12.91	**63**	7.46	5.44
29	14.33	12.69	**64**	7.26	5.23
30	14.13	12.48	**65**	7.06	5.02
31	13.93	12.27	**66**	6.86	4.80
32	13.73	12.05	**67**	6.65	4.59
33	13.52	11.84	**68**	6.45	4.38
34	13.32	11.63	**69**	6.25	4.16
35	13.12	11.41	**70**	6.05	3.95

NOTE –

(1) Moisture content wet basis = (total weight – dry weight) / total weight

(2) Moisture content dry basis = (total weight – dry weight) / dry weight

APPENDIX B – OTHER RESOURCES

(Informative)

B1 International fuel standards

The following international biofuel standards provide a thorough specification of the solid biofuels field. These standards cover internationally accepted specifications for a wide range of possible wood and biomass fuels. These standards can be used as a guide to setting the specifications for the boiler fuel.

ISO 17225:----	Solid biofuels – fuel specifications and classes
Part 1:2014	General requirements
Part 2:2014	Graded wood pellets
Part 3:2014	Graded wood briquettes
Part 4:2014	Graded wood chips
Part 5:2014	Graded firewood
Part 6:2014	Graded non-woody pellets
Part 7:2014	Graded non-woody briquettes (new draft standard 2020)
Part 8:2016.	Graded thermally treated and densified biomass fuels
Part 9:2020	Graded wood hog fuel and wood chips for industrial use
ISO 17831:----	Solid biofuels – Determination of mechanical durability of pellets and briquettes
Part 1:2015	Pellets
Part 2:2015	Briquettes
ISO 17827:----	Solid biofuels – Determination of particle size distribution for uncompressed fuels
Part 1:2016	Oscillating screen method using sieves with apertures of 3.15mm and above
Part 2:2016	Oscillating screen method using sieves with apertures of 3.15mm and below

B2 National guidance

The following regulations and standards set out national guidance on biomass boiler systems in New Zealand.

Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999. https://www.worksafe.govt.nz/dmsdocument/419-health-and-safety-in-employment-pressure-equipment-cranes-and-passenger-ropeways-regulations-1999

AS/NZS 1170:----	Structural design actions
Part 2:2011	Wind actions
NZS 1170:----	Structural design actions
Part 5:2004	Earthquake actions – New Zealand

B3 Publications and websites

The following websites and the publications available from them have more information on biomass boiler systems, their fuel, and related considerations. They are additional to the publications referred to in this specification, which can be found in the 'Referenced documents' section at the front.

Wood Energy. Wood Energy Knowledge Centre. Available at https://www.usewoodfuel.org.nz/wood-energy-knowledge-centre (accessed 27 November 2020).

Bioenergy Association. Bioenergy Knowledge Centre. Available at https://www.bioenergy.org.nz/bioenergy-knowledge-centre (accessed 27 November 2020).

Forest Research. Publications on woodfuel. 2009. Available at https://www.forestresearch.gov.uk/research/publications-on-woodfuel/ (accessed 27 November 2020).

NOTES

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