STANDARDS DOCUMENT

MCS 034 ISSUE 1.0 DRAFT

Biomass
Pre-sale information and performance calculation

To be used in conjunction with MIS 3004

This Standard was prepared by the MCS Working Group 4 'Biomass Heating Systems'

It is published by The MCS Service Company Ltd on behalf of the MCS Charitable Foundation.

The MCS Service Company Ltd welcomes comments of a technical or editorial nature and these should be sent to *meetings@mcscertified.com*

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ABOUT MCS

Giving you confidence in home-grown energy

With energy costs constantly rising and climate change affecting us all, low-carbon technology has an ever increasing role to play in the future of UK energy.

We're here to ensure it's a positive one.

Working with industry we define, maintain and improve quality – certifying products and installers so people can have confidence in the low-carbon technology they invest in. From solar and wind, to heat pumps, biomass and battery storage, we want to inspire a new generation of home-grown energy, fit for the needs of every UK home and community.

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The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd) trades as MCS and is wholly owned by the non-profit MCS Charitable Foundation. Since 2007, MCS has become the recognised Standard for UK products and their installation in the small-scale renewables sector.

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MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources. It is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry standards; highlighting quality, competency and compliance.

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To see MCS certified products and installations in every UK home and community.

Mission

To give people confidence in low-carbon energy technology by defining, maintaining and improving quality.

Values

1. We are expert – ensuring quality through robust technical knowledge
2. We are inspiring – helping to reshape energy in UK homes and communities
3. We are collaborative – working with industry and government to create positive change
4. We are principled – operating in a way that's clear, open and fair
5. We are determined – supporting the UK's drive towards a clean energy future

CHANGES TO STANDARDS

When MCS Standards are revised, the issue number is also revised to indicate the nature of the changes. This can either be a whole new issue or an amendment to the current issue. Details will be posted online, www.mcscertified.com

Technical or other significant changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number is given on the left of the decimal point, and the amendment number on the right. For example, issue 3.2 indicates that it is the third significant version of the document which has had two sets of minor amendments.

Users of this Standard should ensure that they are using the latest issue.

Issue No.	Amendment Details	Date
1.0	First Publication	XX/XX/2023

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1 SCOPE

This Standard describes the method to estimate the amount of renewable energy which might be delivered, along with the fuel consumed, by a biomass heating system during a typical year. This document is to be used in conjunction with MIS 3004: The Biomass Standard. The format in which this shall be presented to the customer is also given along with the technical information to accompany the estimate.

A copy of this calculation shall be retained by the contractor for the minimum period defined within MCS001 and made available for audit.

2 METHOD

2.1 Site evaluation

Obtain:

(a) The property **Space Heating Demand** (kWh/year); and

(b) The **Hot Water Demand** (kWh/year)

(c) Combine (a) and (b) to give the total heat to be supplied in kWh/year.

(d) Where the biomass boiler is not intended to provide 100% of either the space heating and/or DHW, deduct the percentage of heat to be supplied by the other source(s) to leave heat to be supplied only by the Biomass Heating System **(BHS)** in kWh/year.

using:

- a valid Energy Performance Certificate (EPC); or
- where the property is being newly built or renovated, a Standard Assessment Procedure (SAP 2012) calculation; or
- where it is not possible to obtain a valid EPC (or SAP assessment) an estimate of the annual space heating and hot water demands shall be made using a suitable method for the type of building. Such a method shall be clearly described and justified.

Commented [A1]: Question for consultation: we welcome suggestions for a suitable method(s) for calculating annual energy demand where not possible to obtain a valid EPC (e.g. non-domestic or large refurbishment/extension to a dwelling).

Earlier drafts suggested historic energy bills but these would be erroneous if the property was being extended or refurbished.

Note: A valid EPC is one which has not expired and where the given annual heat demand is not expected to change such as by, for example, an extension or refurbishment of the building, and where the BHS is intended to supply that changed heat demand. Where no valid EPC exists on the public register, but it is possible to obtain one through a Domestic Energy Assessment, then an EPC should be obtained and lodged. Neither the annual heat demand of the building nor the annual energy performance of the system are appropriate for sizing the system.

2.2 Fuel calculation

Calculate the minimum mass and volume of fuel required each year

(e) For the specified biomass fuel type lookup the gross calorific value (**H_M**) in kWh/kg in **Appendix A, Table 1.**

(f) For the specified biomass fuel type lookup the bulk density of the fuel (ρB) in kg/m^3 in **Appendix A, Table 2**.

(g) Identify the boiler seasonal efficiency (η_s) as a percentage as listed in either the Products Characteristics Database (as "SAP seasonal efficiency") or the default value from Table 4a of SAP (see **Appendix A, Table 3)**.

(h) Calculate the estimate of **minimum** total fuel mass required (MA_{min}) in kg/yr as follows:

a. Where η_s is taken from Table 4a of SAP:

$$MA_{min} = \frac{Heat\ supplied\ by\ the\ BHS \div (\eta_s \div 100)}{H_m}$$

b. Where η_s is taken from the Products Characteristics Database:

$$MA_{min} = \frac{Heat\ supplied\ by\ the\ BHS \div ([\eta_s\ x\ 0.90] \div 100)}{H_m}$$

Where:

- Heat supplied by the BHS is as identified in paragraph (d); and
- η_s is the seasonal efficiency of the boiler as identified in paragraph (g); and
- H_M is the gross calorific value of the specified fuel identified in paragraph (e).

Note: calculation b. includes a factor of 0.9 to account from overall system losses.

(i) Calculate the estimate of fuel required minimum volume (V_{min}):

$$V_{min} = \frac{MA_{min}}{\rho B}$$

Where:

- MA_{min} is the minimum total fuel mass required in kg/yr calculated in paragraph (h); and
- ρB is the bulk density of the fuel in kg/m^3 identified for paragraph (f).

2.3 Calculate the Utilisation Factor

(j) Identify the **Nominal Heat Output Rating** of the proposed boiler in kW (R_n).

Note: *this can be determined either by undertaking a full heat loss calculation as described in MIS 3004 clause 5.5 or using the optional method described in Section 3 of this document.*

(k) Calculate the utilisation factor (UF) as a percentage of the hours in a year that the BHS is operating:

$$UF = \frac{Heat\ supplied\ by\ the\ BHS \div R_n}{8760}\ x\ 100$$

Where:

- **Heat supplied by the BHS** is the total energy to be generated by the biomass system as identified in paragraph (d); and
- and R_n is **the Nominal Heat Output Rating**.

3 CAPACITY CALCULATION (OPTIONAL)

Note: this is included as a simple means to give the customer an approximation of the system that might be required ahead of completing a full system design. It is not a substitute for a system design.

To estimate the likely **Boiler heating capacity**:

(l) Using the property postcode lookup in **Appendix A, Table 4**: the appropriate number of **Degree Days**; and the **Outdoor Low Temperature**.

(m) Calculate the **Property Specific Heat Loss ($P_{specific}$)** in W/K:

$$P_{specific} = \frac{1000\ x\ Q}{24\ x\ D}$$

Where:

- Q is the **Space Heating Demand** (kWh/year) identified in paragraph (a); and
- D is the **Degree Days**.

(n) Calculate the **Total Heat Loss (P_t)** in **W**:

$$P_t = P_{specific}\ x\ (d_i - d_o)$$

Where:

- $P_{specific}$ is the **Property Specific Heat Loss** and

- d_i is the design inside temperature at of 21°C; and
- d_o is the **Outdoor Low Temperature** as described in paragraph (e) above. Where this is a negative number then, mathematically, subtracting a negative number becomes addition.

(o) Estimate the **Boiler heating capacity**:

$$\text{Boiler heating capacity} = P_t \div 1000$$

(p) Use the result of paragraph (o) as the Nominal Heat Output Rating of the proposed boiler in kW (R_n).

Notes:

- *For Hybrid installations, estimate the Biomass capacity using **Heat Supplied by BHS** calculated in paragraph (d) at paragraphs (m) and (n), to calculate **P_t** at paragraph (o).*

- *The estimate of the Biomass capacity for Space Heating is indicative only and may change following the detailed heat loss assessment and system design stage.*

4 PRESENTATION FORMAT

Biomass System Performance Estimate		
Your energy requirements		
Energy Required for Heating:		**kWh**
Energy Required for Hot Water:		**kWh**
Total Heat to be delivered by Biomass Boiler per annum:		**kWh**
Proposed system (subject to design)		
Nominal Heat Output Rating of the proposed boiler:		**kW**
Is your property in a smoke control area? (Delete as applicable)	Yes / No	
Any Biomass products installed in Smoke Control Areas must be recorded as an 'exempt appliance.'		
Proposed Boiler Seasonal Efficiency:		**%**
Note: The proposed boiler's expected efficiency over the whole year. The higher the efficiency, the lower the running costs.		
Biomass fuel type: (Select one)	**Pellets** **Wood Chip** **Logs**	
Source of exact Fuel Specification: Where you can find the specification of the fuel you must use in the boiler		
Gross Calorific Value of the Specified Fuel:		**kWh/kg**
Bulk Density of the Specified Fuel:		**Kg/m^3**
Performance		
Estimate of Total Fuel **Mass** required each year (allowing for system losses)		**kg**
Note: The estimated amount of fuel mass you will need per annum after allowance is made for system efficiency losses. Please see the 'Key Information' accompanying this estimate.		
Estimate of Total Fuel **Volume** required each year (minimum)		**m^3**
Biomass Boiler Utilisation		
Utilisation Factor (UF)		**%**
Note: The UF is the estimate of time per year that the boiler will operate to generate heat. 20% or higher is considered ideal. Less than 15% may signal that the boiler is over-sized for the demand and should be avoided unless there are exceptional circumstances.		

5 KEY INFORMATION

The heat demand of a building, and therefore the performance and running costs of heating systems, is difficult to predict with certainty due to the variables discussed here. These variables apply to all types of heating systems, although the efficiency is sensitive to good system design and installation. For these reasons your estimate is given as guidance only and should not be considered as a guarantee.

Utilisation factor and oversizing

It is important that a biomass boiler is the right size for your home. If it is too small it may not be able to provide enough warmth on the coldest days. If it is too big this can lead to higher installation and running costs, it can be less reliable, and have increased maintenance costs.

The Utilisation Factor (UF) is an estimate of how much time per year that the biomass boiler will be operating. 20% or higher is considered ideal, but if the UF is 15% or less this can be a sign that the boiler might be oversized. Your installer must then provide you with the following statement in your contract:

"Note: the UF calculated may indicate the boiler is oversized and this may result in low efficiency. Consider design changes unless there are exceptional circumstances."

If the boiler is oversized, resulting in a low UF, then it may not be able to turn down to a sufficiently low heat output leading to frequent on/off cycles. A biomass boiler tends to be less efficient whilst starting up and shutting down so burning more fuel. This is also when particulate emissions are higher.

As part of the design process your installer needs to carry out a heat loss calculation for your property. This will tell them the peak heating load which is the amount of heat needed to keep your property warm enough when it is very cold outside. They can then suggest a boiler with a heat output that is a close match to the peak heating load, helping to avoid oversizing.

There are circumstances where a low utilisation factor of 15% can ben acceptable, and so we do suggest you discuss this with your installer.

Fuel store

Unlike gas or electricity biomass fuel does not come into your property through a pipe or a cable so you'll need a store large enough to hold enough fuel between deliveries. The store needs to be readily accessible with space around it to receive deliveries and undertake maintenance. The potential size of the delivery vehicles should be considered, as well as the likely means of moving the fuel to the boiler. Your local installer will be able to advise on the correct fuel store sizing to allow for a sizable inventory and compliant construction.

If you are considering a manually fed boiler then also consider how you'll carry the fuel from the store to the boiler when you're deciding where to locate the store. This is especially important if there are, or are anticipated to be, vulnerable members of the household. This applies typically with a log boiler or a hand-fed wood pellet boiler.

Keeping the fuel dry is very important - the fuel store should protect the fuel from both rain and moisture. Wet fuel, if it will burn at all, will not burn efficiently, resulting in reduced heat output, higher running costs, and higher particulate emissions. Wet fuel can also damage and corrode the boiler and its components, resulting in increased failures, higher maintenance costs, and potential periods without heating. Saturated wood pellets are completely unusable and your boiler will be unable to process them through the fuel delivery system.

If wood pellets are to be blown into the fuel store then care should be taken with the design of this aspect of the store so that the pellets are not damaged during this process. If they end up breaking due to impacts when they are blown in this can create large amounts of dust which can clog the delivery mechanisms, will be a waste of that fuel, and creates an inconsistent fuel which can lead to reduced efficiency, and higher maintenance costs.

It is also important to check, when safe to do so, the inside of your fuel store. Damp wood pellets can "clump" together and your local fuel supplier may offer a fuel store cleaning service or someone who can do this on their behalf.

<u>Energy Performance Certificate</u>

An energy performance certificate (EPC) is produced in accordance with a methodology approved by the government. As with all such calculations, it relies on the accuracy of the information input. Some of this information, such as the insulation and air tightness properties of the building may have to be assumed and this can affect the final figures significantly leading to uncertainty especially with irregular or unusual buildings.

<u>Identifying the uncertainties of energy predictions for heating systems</u>

We have identified 3 key types of factor that can affect how much energy a heating system will consume and how much energy it will deliver into a home. These are 'Fixed', 'Variable' and 'Random'. Most factors are common to ALL heating systems regardless of the type (e.g oil, gas, solid fuel, heat pump etc.) although the degree of effect varies between different types of heating system as given in the following table.

The combined effect of these factors on energy consumption and the running costs makes overall predictions difficult however an accuracy ± 25-30% would not be unreasonable in many instances. Under some conditions even this could be exceeded (e.g. considerable opening of windows). Therefore it is advised that when making choices based on mainly financial criteria (e.g. payback based on capital cost verses net benefits such as fuel savings and financial incentives) this variability is taken into account as it could extend paybacks well beyond the period of any incentives received, intended occupancy, finance agreement etc.

Factor	Impact
'Fixed' which include:	
Equipment selection	System Efficiency
Energy assessment via the EPC (e.g. assumptions as to fabric construction and levels of insulation; the variation in knowledge and experience of Energy Assessors)	Energy Required
'Variable' which are affected by the system design and include:	
Accuracy of sizing of the biomass boiler - i.e. closeness of unit output selection (kW) to demand heat requirement (kW)	System Efficiency
Design space and ambient (external) temperatures	Energy Required
'Random' which cannot be anticipated and include:	
User behaviour:	
• Room temperature settings	Energy Required
• Hot water usage and temperature settings	Energy Required
• Occupancy patterns/times	Energy Required
• Ventilation (i.e. opening windows)	Energy Required
Annual climatic variations (i.e. warmer and colder years than average)	Energy Required

Key:

The statement at the end of each item indicates the major factor affected as follows:

Energy Required: the heat energy output requirement of the system which directly impacts on running costs. This requirement exists regardless of the heating system chosen as it is the heat required to keep the space comfortable. Opening windows or increasing room temperatures will demand more heat output, which means more energy input but this would NOT directly affect the efficiency. Thus increased energy demand does NOT automatically mean reduced efficiency.

System Efficiency: the efficiency of the system has been directly affected and will therefore demand more input energy to achieve the same heat output thus increasing running costs. However, increased energy input does NOT necessarily mean lower system efficiency (see above).

APPENDIX A – LOOKUP DATA

Fuel Type	**Gross calorific value (H_M)** kWh/kg
Pellets	4.8
Wood Chip	3.5
Logs	4.1

Table 1: Gross Calorific Value (Source: Forest Research)

Fuel Type	Bulk density of the fuel (ρB) in kg/m^3
Pellets	650
Wood Chip (30% moisture)	250
Wood Chip (50% moisture)	300
Logs (stacked & air dried)	350
Logs (kiln dried)	400

Table 2: Bulk Density (Source: Forest Research)

Solid Fuel Boiler Efficiency (Column (A) gives minimum values for HETAS approved appliances, use column (B) for other appliances.)	(A)	(B)
Manual feed independent boiler	65	60
Auto (gravity) feed independent boiler	70	65
Wood chip/pellet independent boiler	75	70
Closed room heater with boiler to radiators	67	65
Stove (pellet-fired) with boiler to radiators	75	70

Table 3: Boiler efficiency (Source: SAP10)

Postcode Index for Degree days and Outdoor Low Temperatures								
Post-codes AB-HG	**Low Temps (°C)**	**Degree days**	**Post-codes HP-S**	**Low Temps (°C)**	**Degree days**	**Post-codes SA-ZE**	**Low Temps (°C)**	**Degree days**
AB	-5.4	2668	**HA**	-3	2033	**PO**	-4.8	2224
AL	-3	2033	**HD**	-4.5	2307	**PR**	-4.5	2388
B	-5.1	2425	**HG**	-3.3	2307	**RG**	-4.6	2033
BA	-4.6	1835	**HP**	-3	2033	**RH**	-3	2033
BB	-4.5	2228	**HR**	-5.1	2425	**RM**	-3	2033
BD	-3.3	2307	**HS**	-5.6	1800	**S**	-3.3	2228
BH	-4.8	2224	**HU**	-3.3	2307	**SA**	-3.1	2161
BL	-4.5	2228	**HX**	-4.5	2228	**SE**	-3	2033
BN	-4.8	2224	**IG**	-3	2033	**SG**	-3	2033
BR	-3	2255	**IM**	-4.5	2228	**SK**	-4.5	2228
BS	-3.1	1835	**IP**	-4.6	2254	**SL**	-3	2033
BT	-3.2	2360	**IV**	-5.6	2668	**SM**	-3	2033
CA	-3.7	2388	**JE**	-4.8	1800	**SN**	-4.6	2425
CB	-3	2033	**KA**	-5.6	2494	**SO**	-4.8	2224
CF	-3.1	1835	**KT**	-3	2033	**SP**	-4.8	2224
CH	-4.5	2228	**KW**	-5.4	2668	**SR**	-3.7	2370
CM	-3	2033	**KY**	-5.4	2577	**SS**	-3	2033
CO	-4.6	2254	**L**	-4.5	2228	**ST**	-5.1	2228
CR	-3	2224	**LA**	-4.5	2388	**SW**	-3	2033
CT	-3	2255	**LD**	-3.1	2161	**SY**	-5.1	2161
CV	-5.1	2425	**LE**	-3.9	2425	**TA**	-1.5	1835
CW	-4.5	2228	**LL**	-4.5	2228	**TD**	-5.4	2483
DA	-3	2255	**LN**	-3.9	2307	**TF**	-5.1	2425
DD	-5.4	2577	**LS**	-3.3	2307	**TN**	-3	2255
DE	-3.9	2228	**LU**	-3	2033	**TQ**	-1.5	1858
DG	-5.6	2483	**M**	-4.5	2228	**TR**	-1.5	1858
DH	-3.7	2370	**ME**	-3	2033	**TS**	-3.7	2370
DL	-3.7	2388	**MK**	-4.6	2425	**TW**	-3	2203
DN	-3.3	2307	**ML**	-5.4	2494	**UB**	-3	2203
DT	-4.8	2224	**N**	-3	2033	**W**	-3	2203
DY	-5.1	2425	**NE**	-3.7	2370	**WA**	-4.5	2228
E	-3	2033	**NG**	-3.9	2254	**WC**	-3	2203
EC	-3	2033	**NN**	-3.9	2425	**WD**	-3	2203
EH	-5.4	2577	**NP**	-3.1	2425	**WF**	-3.3	2307
EN	-3	2255	**NR**	-4.6	2254	**WN**	-4.5	2228
EX	-1.5	1858	**NW**	-3	2033	**WR**	-5.1	2425
FK	-5.6	2577	**OL**	-4.5	2228	**WS**	-5.1	2425
FY	-4.5	2388	**OX**	-4.6	2425	**WV**	-5.1	2425
G	-5.6	2494	**PA**	-5.6	2494	**YO**	-3.3	2307
GL	-4.6	2425	**PE**	-4.6	2254	**ZE**	-5.4	2668
GU	-3	2033	**PH**	-5.6	2668			
GY	-4.8	1800	**PL**	-1.5	1858			

Table 4: Postcode Index for Degree days and Outdoor Low Temperatures (Source: CIBSE Guide A)

APPENDIX B – WORKED EXAMPLE

An existing property in rural Wales (postcode CF) has a total space heating demand (taken from a valid EPC) of 25,500kWh/year and hot water demand of 2,900kWh/year. A Wood Chip boiler is proposed to provide 100% of the space heating and hot water demand.

The calculations would be as follows:

(a) *Space Heating Demand = 25,500kWh*

(b) *Hot Water Demand = 2,900kWh*

(c) *Total = 28,400 kWh*

(d) *Not hybrid system so 100% = 28,400kWh*

(e) *Gross calorific value* H_M *from Table 1 = 3.5kWh/kg*

(f) *Bulk density* ρB *from Table 2 = 300kg/m*^{3}

(g) *Boiler efficiency* η_s *from Table 4a = 70%*

(h) *Minimum total fuel mass =*

$$MA_{min} = \frac{\text{Heat supplied by the BHS} \div (\eta_s \div 100)}{H_m}$$

$$MA_{min} = \frac{28400 \div (70\% \div 100)}{3.5}$$

$$MA_{min} = 11531 \text{ kg/yr}$$

(i) *Minimum total fuel volume =*

$$V_{min} = \frac{MA_{min}}{\rho \text{B}}$$

$$V_{min} = \frac{12483}{300}$$

$$V_{min} = 38.64\, m^3/yr$$

(j) *Nominal Heat Output Rating* R_n (calculated below) = 13.9kW

(k) *Utilisation factor=*

$$\text{UF} = \frac{\text{Heat supplied by the BHS} \div \text{R}_\text{n}}{8760} \text{ x } 100$$

$$\text{UF} = \frac{28400 \div 13.9}{8760} \text{ x } 100$$

$$UF = 23.3\%$$

(l) Degree Days = 1835 and Outdoor Low Temperature -3.1°C

(m) Property Specific Heat Loss $P_{specific}$ =

$$P_{specific} = \frac{1000 \text{ x } 25500}{24 \text{ x } 1835}$$

$$P_{specific} = 579\ W/K$$

(n) Total Heat Loss P_t =

$$P_t = P_{specific} \times (d_i - d_o)$$

$$P_t = 579 \times (21 + 3.1)$$

$$P_t = 579 \times (24.1)$$

$$P_t = 13953W$$

(o) Boiler heating capacity =

Boiler heating capacity = $P_t \div 1000$

Boiler heating capacity = 13953 ÷ 1000

Boiler heating capacity = 13.9kW