

# Study on Biomass Combustion Emissions



irbea

irish  
bioenergy  
association



December 2016

A report completed by Fehily Timoney & Co. and kindly supported by the Sustainable Energy Authority of Ireland

## IRISH BIOENERGY ASSOCIATION (IrBEA)

### PROJECT REPORT FOR BIOMASS COMBUSTION EMISSIONS STUDY

December 2016

**Keywords:** emissions, PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>x</sub>, design, wood fuel, quality, installation, combustion, RHI, ecodesign, ELVs

**Abstract:** This report presents the findings of a study undertaken by Fehily Timoney & Company (FT) on behalf of the Irish Bioenergy Association (IrBEA) in relation to emissions from biomass combustion and identifies a number of recommendations for implementation that could beneficially mitigate the impact of these emissions. A Technical Literature Review, that provides an overview of the relevant technical aspects of biomass combustion and emissions, is provided as Appendix 1 to this document.

Kindly Supported by the SEAI Sustainable Energy Research, Development & Demonstration Programme 2016

## Foreword

**Michael Doran, President of the Irish BioEnergy Association**

Ireland is committed to reducing its dependence on fossil fuels, and reducing its carbon emissions under many European and international agreements. The global issue of climate change is considered one of the most important of the era and one that requires changes in our economy and our society to reverse the reliance on high carbon fossil fuels. European and international agreements from the National Renewable Energy Action Plan, to the Paris Agreement, place a responsibility on Ireland to act, to reduce carbon emissions, to replace fossil fuels, to become more efficient and to switch to renewable energy.

The largest source of renewable energy in Europe is bioenergy. Everything from the combustion of firewood, to turning waste food into biogas, to powering our vehicles on diesel and petrol derived from plant material, is part of the bioenergy industry. In Ireland bioenergy does feature, however its potential has yet to be fully explored or utilised. Biomass in its most basic forms of woodchip, wood pellets, firewood or indeed straw or miscanthus, is an excellent replacement fuel for oil and kerosene heating fuels. We can produce these fuels in Ireland, creating value for the grower, employment for processing, fuel cost savings, and reduced carbon emissions. The full socio-economic value of switching from fossil fuels to biomass, is considerable and must be considered in its full impact.

Technology for the combustion of biomass around Europe and Ireland has advanced greatly in the past 30 years, improvements to automation, efficiency, reliability and controllability have ensured that biomass can readily replace fossil fuels while being as convenient and reliable as the technology that has built up around oil and gas over the last century. It is now possible to purchase “plug and play” biomass systems and for fully automated fuelling systems to ensure the minimum of input from the heat user. However, the capital costs of these systems are higher than their fossil fuel counterparts, and unless the user gets value for the carbon and societal benefits, then the role-out of biomass will not occur fast enough for Ireland to meet its commitments.

Over the past 3 years the Department of Communications, Climate Action and Environment (formerly DCENR) have been working on the implementation of a Renewable Heat incentive. The purpose of the RHI is to financially incentivise the installation of renewable heating systems such as biomass, and for the state to then benefit from the reduced carbon emissions through our reduced reliance on fossil fuels. Biomass brings benefits in terms of reduced carbon emissions, and enhanced local benefits to the economy (circa 80% of the spend on biomass fuels stays in the local economy as opposed to less than 10% from fossil fuels).

However, the question has been raised about other emissions to air. If we are to start to burn increasing amounts of biomass for heating, could this effect air quality and have an effect on health and the local environment. This is an important question and one that needs to be answered. For this reason, in March 2016, the Irish BioEnergy Association approached SEAI and sought assistance in answering this question. SEAI agreed to fund a study into the Emissions from Biomass Combustion, and IrBEA retained the expertise of Fehily Timoney & Co. to conduct a detailed report on the topic. All combustion creates emissions of some form or another, this report however concentrates on emissions associated with biomass, and on the technology available to mitigate emissions

The report itself is brief and does not answer all the questions, nor was it designed to, in the time available. However, it does offer an excellent opportunity for policy makers and stakeholders to better

understand emissions, the cause of and how they are controlled and can be mitigated. It will be an important tool in the development of future policy and we hope it will assist, to guide sensible and sustainable development into the future.

All future development must be conducted in a manner that protects our environment, whether that is with regards to the effects on health, air, water, terra-firma or ecology. The bioenergy industry is committed to this task, indeed it is one of our founding principles and it is one that we will continue to fully embrace in the years to come.

Finally we would like to thank the Sustainable Energy Authority of Ireland, the voluntary stakeholder group, industry members and public bodies who have supported this report with their time, expertise and guidance.

**Michael Doran**

**December 2016**

## TABLE OF CONTENTS

## PAGE

1	<b>INTRODUCTION.....</b>	<b>1</b>
2	<b>OVERVIEW – FOCUS AREAS FOR EMISSIONS CONTROL.....</b>	<b>3</b>
2.1	EMISSIONS FROM BIOMASS COMBUSTION .....	3
2.1.1	<i>Particulate Matter (PM)</i> .....	3
2.1.2	<i>Oxides of Nitrogen (NOx)</i> .....	3
2.2	BIOMASS COMBUSTION APPLIANCES .....	4
3	<b>FUEL TYPE &amp; QUALITY.....</b>	<b>5</b>
3.1	POTENTIAL TO INFLUENCE EMISSIONS .....	5
3.2	FUEL QUALITY CERTIFICATION SCHEMES .....	5
3.2.1	<i>Current Situation.....</i>	5
3.2.2	<i>Interaction with the Proposed RHI .....</i>	6
3.2.3	<i>Other options for increasing quality assured fuel uptake .....</i>	7
4	<b>APPLIANCE TYPE, DESIGN, OPERATION &amp; ABATEMENT.....</b>	<b>8</b>
4.1	POTENTIAL TO INFLUENCE EMISSIONS .....	8
4.2	DOMESTIC SCALE APPLIANCES .....	9
4.2.1	<i>Current situation.....</i>	9
4.2.2	<i>Options to influence domestic scale ELVs .....</i>	10
4.3	COMMUNITY, COMMERCIAL & INDUSTRIAL SIZED APPLIANCES .....	10
4.3.1	<i>Interaction with Proposed RHI .....</i>	10
4.3.2	<i>MCP Directive ELVs compared with the UK RHI Values .....</i>	12
4.3.3	<i>500kW to 1 MW ‘gap’ .....</i>	12
4.3.4	<i>Triple E Register.....</i>	12
5	<b>APPLIANCE INSTALLATION.....</b>	<b>14</b>
5.1	POTENTIAL TO INFLUENCE EMISSIONS .....	14
5.2	CERTIFIED (ACCREDITED) INSTALLER/COMPETENT PERSON SCHEME .....	14
5.2.1	<i>Current Situation.....</i>	14
5.2.2	<i>Case Studies from Ireland, the UK and Europe.....</i>	15
5.2.3	<i>Interaction with the Proposed RHI .....</i>	16
5.2.4	<i>Status of Certified (Accredited) Installer/Competent Person Scheme.....</i>	16
5.3	DEVELOPMENT OF AN EMISSIONS CALCULATOR ASSESSMENT TOOL .....	17
5.3.1	<i>DEFRA Case Study, UK.....</i>	17
5.3.2	<i>Potential Options for Implementation.....</i>	18
5.3.3	<i>Training for Local Authorities .....</i>	19
5.4	FURTHER CONSIDERATION REGARDING PLANNING PERMISSION .....	19
6	<b>RECOMMENDATIONS .....</b>	<b>21</b>

## LIST OF APPENDICES

Appendix 1: Technical Literature Review Report for Biomass Combustion Emissions Study

## GLOSSARY

CAFE Directive	The Cleaner Air for Europe (CAFE) Directive (2008/50/EC) is an EU Directive that aims to improve ambient air quality in Europe. Limit values for ambient concentrations of various pollutants are set by this Directive.
Competent Person Schemes	UK schemes which allow individuals and organisations to self-certify that the installation work they carry out is in compliance with the relevant regulations.
ELV	Emission Limit Values (ELVs) are limits, often enforceable through legislation, on the maximum permissible concentration of an air pollutant.
ENplus	A European approved fuel quality certification scheme that is managed by the European Pellet Council and relates specifically to part 2 of the EN ISO 17225 standard (for wood pellets).
HETAS	The Heating Equipment Testing and Approval Scheme (HETAS) is a UK based organisation that operates within the biomass and solid fuel heating sector. It provides recognition to high quality biomass heating appliances, installers and biomass fuels, while it also provides a number of appliance installer training courses.
IED	The Industrial Emissions Directive (IED) is an EU Directive that aims to reduce emissions from industrial production processes. ELVs for the concentrations of various pollutants from large combustion plants are set by this Directive.
MCP	A Medium Combustion Plant (MCP) is a plant that falls under the MCP Directive <b>and has a total rated thermal input of <math>\geq 1</math> MW and <math>&lt; 50</math> MW.</b>
MCP Directive	The Medium Combustion Plant Directive (MCP Directive) is an EU Directive that aims to protect human health and the environment across the EU by regulating pollutant emissions from MCPs. ELVs for the concentrations of various pollutants from MCPs are set by this Directive.
MCS Scheme	The Microgeneration Certification (MCS) scheme is a UK scheme that provides recognition to both high quality microgeneration appliance technologies and high quality microgeneration appliance installers.
METAC	The Midland Energy Training and Assessment Centre (METAC) is a provider of energy training and assessment in Ireland. It provides solid fuel training courses that are directly relevant to biomass combustion.
NOx	Oxides of Nitrogen (NOx) are emissions which may include Nitric Oxide (NO), Nitrogen Dioxide (NO <sub>2</sub> ) and Nitrous Oxide (N <sub>2</sub> O).
PAH	Polycyclic Aromatic Hydrocarbons (PAHs) are intermediated products which may be formed as a result of PM formation. PAHs are hazardous air pollutants such as benzo(a)pyrene, anthracene, benzaldehyde, chrysene, ethylbenzene and others.
PM <sub>10</sub>	Coarse particulate matter, including all particles that have an aerodynamic <b>diameter that is <math>\leq 10</math> micrometres.</b>
PM <sub>2.5</sub>	Fine particulate matter, including all particles that have an aerodynamic <b>diameter that is <math>\leq 2.5</math> micrometres.</b>

QualiCert	<b>'Common quality certification and accreditation for installers of small-scale renewable energy (RE) systems' (QualiCert) was an EU project that reviewed the quality certification and accreditation schemes in place for small scale RE appliance installers in countries throughout the EU.</b>
Registered Gas Installers Register	An Irish scheme put in place so as to ensure the safe installation of gas appliances in Ireland.
Renewable Installers Register	A SEAI implemented register which identifies installers in Ireland who are suitably qualified to carry out the installation of renewable energy technologies.
RHI	A Renewable Heat Incentive (RHI) is a system which encourages the generation of heat from renewable technologies by providing a fixed payment to the owners of such technologies.
SOx	Oxides of Sulphur (SOx) are emissions which may include Sulphur Dioxide (SO <sub>2</sub> ) and Sulphur Trioxide (SO <sub>3</sub> ).
Thermal Input	The design rating of an appliance, based on the amount of energy inputted.
Thermal Output	The realised energy (heat) that is produced from an appliance.
Triple E Products Register	The Triple E (Excellence in Energy Efficiency) Products Register is an initiative introduced by the SEAI which aims to gives recognition to renewable energy <b>products within Ireland that are 'best in class' in terms of energy efficiency.</b>
WFQA	The Wood Fuel Quality Assurance Scheme (WFQA) is an Irish scheme that aims to ensure consumer confidence in the purchase of wood fuels throughout Ireland. It does so through the application of the fuel requirements outlined in EN ISO 17225, parts 1-5.



## 1 INTRODUCTION

The Irish Bioenergy Association (IrBEA) retained Fehily Timoney & Company (FT) to undertake a study to assess the potential impacts, in terms of air quality, of an increase in biomass combustion in Ireland, along with the mitigation measures which may be put in place to limit these impacts. This study, which is funded **by the Sustainable Energy Authority of Ireland (SEAI) RD&D programme, is titled the 'Biomass Combustion Emissions Study' and is being overseen by a Steering Committee** selected by IrBEA, made up of policy makers, appliance manufacturers, consultants, fuel suppliers and other interested parties.

The requirement for this study is driven in no small part by the intended development of a renewable heat incentive (RHI) in Ireland, which is expected to be the catalyst for increased community, commercial and industrial scale biomass development and utilisation in this country. In addition, a general increase in residential wood fuel consumption is being reported nationally. In such a situation, positive impacts will result to the country in terms of increased renewable energy generation and contribution to the achievement of renewable heat targets, as well as the economic benefits resulting from increased demand for indigenous wood fuel products and related services.

However, a potential negative impact may result from increased biomass utilisation, in the form of increased pollutant emissions, particularly particulate matter (PM) and oxides of nitrogen (NO<sub>x</sub>). Emission of these pollutants is an issue when it comes to biomass combustion (as well as combustion of other fuels), with the potential for impacts on air quality (and hence human health) resulting from an increased, wide-scale, uncontrolled uptake of biomass. There is an evident need to ensure that these impacts are mitigated against.

The recent Residential Solid Fuel and Air Pollution Study<sup>1</sup>, published by the North South Ministerial Council (NSMC) in March 2016, identified some trends and issues in relation to biomass. It is identified that, between 2010 and 2013, biomass combustion contributed c. 10% of PM emissions across Ireland in each of those years, representing an increase from c. 5% in 2000. Almost all of these emissions were classified as PM<sub>2.5</sub>.

The potential negative air quality impacts arising from increased biomass utilisation may result in stresses between the national policy objectives of clean air versus renewable energy generation and climate change policy. In this context, this study aims:

- to provide a technical overview of the generation of emissions from biomass combustion and the factors that influence the extent and magnitude of these
- to examine mitigation measures which may be adopted in terms of biomass combustion emissions to limit the impacts of these emissions
- to identify for policy-makers some of the key factors to be considered in the development of appropriate policy measures that effectively balance the requirements to maintain a high level of national air quality while ensuring the promotion and uptake of high quality biomass fuels, in order **to realise it's economic, sustainability, energy security and climate change benefits**
- to make recommendations for specific policy measures and/or to identify specific actions to be undertaken or areas where further investigation or consideration is required, with the aim of satisfying the required balance identified

The technical overview of biomass combustion emissions is provided in a standalone report in Appendix 1 to this main Project Report. This report addresses the technical aspects of biomass emission under the headings of:

- relevant legislation, guidelines & standards
- biomass utilisation support scheme
- biomass combustion process
- recognition of quality biomass combustion appliances, servicers and installers
- biomass as a low carbon fuel
- emission from biomass combustion
- factors influencing emissions from biomass combustion

---

<sup>1</sup> Abbott et al. (2015) *Residential Solid Fuel and Air Pollution Study*. North South Ministerial Council (NSMC)



The following sections of this report identify the factors that can influence biomass combustion emissions and how they interact with the framework of current legislation, guidance and standards, existing schemes and how improvements can be made to the factors and issues that positively influence biomass combustion emissions. In addition, a number of recommendations are identified in Section 6 of this report.

*Note:*

*It should be noted that, due to budgetary limitations and timeline restrictions, the scope of this study is limited to an overview assessment of the relevant factors related to biomass combustion and emissions and is not intended as the definitive, detailed position for each of these factors. For the most part, the study relates to community, commercial and industrial scale biomass development and how this development might relate to the proposed RHI. However, domestic scale biomass development has also been considered and this has been reflected in the relevant sections of this report and the Technical Literature Review Report. Recommendations outlined herein can, where applicable, **be taken as 'starting points'** and can be revised or reviewed based on further assessment, input and consideration.*

## 2 OVERVIEW – FOCUS AREAS FOR EMISSIONS CONTROL

The Technical Literature Review Report, included in Appendix 1, identified a number of areas which have the potential to influence biomass emissions, namely:

- fuel type & quality
- appliance design, type, operation and abatement
- appliance installation

It is under these three headings that the potential for influencing biomass combustion emissions is discussed in the following sections of this report. A brief overview of the type of emissions generated from biomass combustion, which summarises the information presented in Appendix 1, is presented in this section, as well as reference to the type and nature of biomass combustion appliances.

### 2.1 Emissions from Biomass combustion

The principal emissions which may be released from biomass combustion are:

- Particulate Matter (PM) including; salts, soot, condensable organic compounds (COCs), volatile organic compounds (VOCs) & intermediate products – e.g. tars and polycyclic aromatic hydrocarbons (PAHs)
- Oxides of Nitrogen (NO<sub>x</sub>) including; nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) & nitrous oxide (N<sub>2</sub>O)
- Oxides of Carbon (CO<sub>x</sub>) including; carbon monoxide (CO) & carbon dioxide (CO<sub>2</sub>)
- Oxides of Sulphur (SO<sub>x</sub>) including; sulphur dioxide (SO<sub>2</sub>) & sulphur trioxide (SO<sub>3</sub>)
- Dioxins/Furans

Of these, PM (and its intermediate products) and NO<sub>x</sub> are considered to be the most relevant emissions when considering biomass combustion.

#### 2.1.1 Particulate Matter (PM)

PM is considered to be one of the most significant pollutants produced from biomass combustion. PM measured in the ambient air is a combination of primary aerosols, directly emitted from both natural and anthropogenic sources, and secondary aerosols, formed in the atmosphere from the conversion of other gaseous compounds such as SO<sub>2</sub> and ammonia (NH<sub>3</sub>).

The size of PM varies, with two categories commonly identified when analysing the impacts of PM on human health and the environment; PM<sub>10</sub> and PM<sub>2.5</sub>. PM<sub>10</sub>, or coarse particles, includes all particles that have an **aerodynamic diameter that is ≤10 micrometres**, while PM<sub>2.5</sub>, or fine particles, includes all particles that have **an aerodynamic diameter that is ≤2.5 micrometres**. Estimates indicate that >90% of PM emissions from the efficient combustion of wood fuel fall within the PM<sub>10</sub> category, while >75% fall within the PM<sub>2.5</sub> category. Along with the increasing levels of interest in PM<sub>2.5</sub> in recent years, there is also an increasing focus on the portion of PM known as **'black carbon'** which are the light absorbing fine soot like particles that are released from the incomplete combustion of fossil fuels. Black carbon is present in the ultrafine fraction of PM (PM<sub>0.1</sub>) and is known to be a significant component of diesel soot, a substance that the WHO has identified as being carcinogenic.

#### 2.1.2 Oxides of Nitrogen (NO<sub>x</sub>)

Alongside PM, oxides of nitrogen (NO<sub>x</sub>) are the pollutants that are of highest concern when considering emissions from biomass combustion. NO<sub>x</sub> emissions relevant to biomass combustion include nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O). N<sub>2</sub>O is generally less commonly produced from the combustion process than NO or NO<sub>2</sub>.

NO<sub>2</sub> is an irritant in the lungs that is known to have direct negative respiratory impacts on human health. NO<sub>x</sub> emissions can have significant adverse impacts on the environment. N<sub>2</sub>O, while not commonly produced from biomass combustion, is a greenhouse gas which contributes directly to the impacts of climate change. The various gaseous forms of NO<sub>x</sub> can react with SO<sub>2</sub> and other substances to form acid rain which can be damaging to vegetation and buildings, as well as contributing directly to eutrophication.

## 2.2 Biomass Combustion Appliances

There are a variety of biomass combustion appliances that can be utilised, depending on the scale of application and the fuel type to be combusted, including:

- Fireplaces (open, closed or partly closed)
  - Wood pellet and log stoves
  - Wood pellet and log boilers
  - Wood chip boilers
  - Stoker burner boilers
  - Underfed stoker boiler
  - Moving grate boiler
- } typically automatically fed

Further details and references to others sources of information in relation to biomass combustion appliances are presented in the Technical Literature Review Report provided in Appendix 1.

**For this report, appliances have been referenced as being of “domestic” scale and of “community, commercial and industrial” scale, where domestic scale appliances are typically fireplaces, wood pellet and log stoves or boilers, and appliances utilised at the community (e.g. municipal swimming pool), commercial (e.g. hotel) and industrial (e.g. large scale heat and/or power generation) scale typically being wood chip or pellet boilers and automatically fed boilers of stoker burner, underfed stoker burner or moving grate type.**

Biomass combustions appliances can be further categorised as operating within a regulatory approvals regime i.e. a licencing or permitting regime, or not. An appliance may be installed at a facility that operates within the Industrial Emissions (IE), Integrated Pollution Control (IPC) or waste licencing regimes of the Environmental Protection Agency (EPA) or within the waste permitting or (potentially) the air emissions licencing regimes of the local authorities.

It should be noted that the Medium Combustion Plant Directive (Directive 2015/2193) which is yet to be transposed in national legislation, is likely to result in the introduction of a further licencing or permitting regime, under which biomass appliances of between 1 MW and 50 MW will be regulated.

Appliances operating within a licencing or permitting regime have air emission limit values applied as part of the licence/permit requirements and often require either continuous monitoring of emissions or adequate spot check tests to ensure compliance with their licence/permit. Appliances that do not operate within such approval regimes generally do not have such requirements. Therefore, the fuelling of an appliance with an appropriate quality fuel and the correct installation of an appliance is of significant importance for appliances that do not operate within a licence/permit regime, when considering emissions control. These issues are discussed further in the remainder of this report.

## 3 FUEL TYPE & QUALITY

### 3.1 Potential to Influence Emissions

Both the type and the quality of a fuel that is used for biomass combustion can have potentially significant impacts on the levels of emissions that are produced from a biomass combustion appliance.

Emission levels vary according to the specific type of wood based fuel used for combustion, with wood pellets typically producing lower levels of PM and NO<sub>x</sub> than wood chips and wood logs.

While emission levels do vary according to the type of fuel used for combustion, a more suitable focus area in which to influence levels of emissions, is fuel quality.

The quality of a fuel that is used for biomass combustion has a direct influence on the levels of emissions that may be produced. Various fuel properties may impact on emissions, but it is often the moisture content, and by association, the calorific value, of a fuel which have the greatest level of influence. This is particularly the case for wood based fuels. Biomass appliances are generally designed on the basis of fuel moisture content, so the appropriate matching of fuel to appliance type is an important consideration also.

The use of an appropriate quality fuel for biomass combustion is vital in ensuring the control of emissions and potential resultant impacts on air quality, particularly for biomass appliances with limited or no abatement and/or monitoring of emissions. As such, the existence of an approved fuel quality certification scheme which is effective at ensuring the appropriate quality of a high proportion of the biomass fuel feedstock in Ireland, is of considerable importance and value.

Emission control in combustion plant can be controlled by many methods with all appliances requiring fuel of predictable quality, with smaller appliances being more sensitive. It is of particular importance that smaller appliances receive appropriate fuel for their design to ensure correct combustion and low emissions. Larger combustion plants, of large commercial and industrial scale, can accommodate fuels of greater variation in quality terms and also tend to have better inbuilt stack monitoring and abatement control. Therefore, the focus of ongoing control in smaller biomass appliances is best achieved through input fuel quality and plant servicing, maintenance etc., while control in larger plants is generally achieved through compliance with air emissions licence/permit requirements by methods such as combustion emissions monitoring, active combustion control and the use of abatement technologies.

An overview of a current approved fuel quality certification scheme in Ireland and how such a scheme, or a similar scheme, may be supported so as to ensure that it has the desired effect in the use of high quality fuels and the subsequent impact on emissions, is presented in the following section.

### 3.2 Fuel Quality Certification Schemes

Approved fuel quality certification schemes are currently in place both at the national level in Ireland and at the wider European level. The use of standardised fuels is an important emission control method for combustion appliances not operating within an approvals regime.

#### 3.2.1 Current Situation

The Wood Fuel Quality Assurance (WFOA) Scheme is an Irish scheme that comprises wood fuel suppliers who provide high quality wood fuel in Ireland. Of central importance in any approved fuel quality assurance scheme is that all fuels covered under the scheme meet appropriate quality standards. The WFOA scheme ensures that the quality requirements outlined in parts 1 to 5 (relating to wood based fuel) of the quality standard EN ISO 17225 are met for all wood fuel provided by suppliers that are approved by the scheme.

Further to this, all wood fuel covered under the scheme is required to be accurately described and to be produced in compliance with EU Timber Regulations. Certified members of the WFOA are subject to external audits of the wood fuel that they supply to ensure that it meets the requirements of the scheme. Currently, there are 16 wood fuel suppliers certified by the WFOA in Ireland, with membership on a voluntary basis at this moment in time.

The further development of the WFOA scheme in an attempt to increase the share of the market that it currently holds for wood fuel products in Ireland would have a significant positive effect in increasing the use of high quality fuels in Ireland, and subsequently mitigating potential impacts from emissions produced from biomass combustion.

In addition to the WFOA scheme in Ireland, an approved fuel quality certification scheme is also currently in place at the European level which relates to part 2 of the EN ISO 17225 standard (Solid biofuels: fuel specifications and classes). This scheme is managed by the European Pellet Council and is called *ENplus*<sup>2</sup>.

The scheme relates specifically to the quality of wood pellets and was put in place to ensure that consumers across Europe could easily identify wood pellets which meet the quality requirements of EN ISO 17225-2 and fall within the *ENplus* A1 (highest quality), *ENplus* A2 or *ENplus* B1 quality class.

The requirements of the *ENplus* quality classes are often stricter than those presented in EN ISO 17225-2. All wood pellet fuel that is certified to *ENplus* standards is specifically labelled as such. At present, there are just two certified producers of *ENplus* wood pellets on the island of Ireland.

The WFOA incorporates the *ENplus* scheme into its functioning. Prior to any wood pellets being approved by the WFOA, they must first meet the standards set by the *ENplus* scheme.

### 3.2.2 Interaction with the Proposed RHI

The Renewable Heat Incentive (RHI) which is proposed for implementation in Ireland in the near future provides a significant opportunity for increasing the uptake of the WFOA or similar scheme, which is currently offered on a voluntary basis. It may be the case that the WFOA scheme could require amendment to its current guise if incorporated into any proposed RHI, which could be readily facilitated.

The UK RHI provides a good example of how wood fuel quality is incorporated into such a scheme. In order to participate in the UK RHI, individuals must procure wood based fuel that meets certain sustainability criteria, in terms of lifecycle greenhouse gas emission value and land use criteria. A Biomass Suppliers List (BSL)<sup>3</sup> has been developed in the UK through which RHI participants can locate fuel suppliers that have demonstrated the sustainability of their fuel as per the identified requirements. While primarily a fuel sustainability scheme, the BSL supports the use of high quality wood fuel produced in accordance with the UK Woodsure scheme (equivalent of the WFOA) and *ENplus*.

While a technical review consultation of the proposed RHI in Ireland was launched by the Irish government in July 2015, the proposed RHI has yet to be implemented. As part of its development, it would be beneficial to link qualification for the proposed RHI with a requirement to purchase wood fuel from a supplier certified by the WFOA, or similar scheme.

The linking of the WFOA (or similar scheme) with the proposed RHI would likely result in a significant increase in the volume of wood fuel consumed in Ireland that is WFOA certified through the scheme, as the biomass market develops, driven by the RHI. Therefore, while an RHI may result in increased biomass consumption, resulting in increased biomass related emissions overall, the certification of wood fuel through the WFOA (or similar) scheme would ensure the minimisation of emission related impacts from this increased biomass consumption, to the extent this can be influenced by appropriate fuel quality.

It is understood that the proposed RHI in Ireland is likely to initially cover primarily the installation of community, commercial and industrial scale appliances, rather than the installation of domestic scale appliances. It is considered therefore that mandating of a wood fuel quality assurance scheme to the RHI will not initially have a significant impact on increasing the uptake of the WFOA scheme among producers who are currently producing wood fuel for the residential market and who are not currently members of a wood fuel quality assurance scheme.

---

<sup>2</sup> <http://www.enplus-pellets.eu/>

<sup>3</sup> <http://biomass-suppliers-list.service.gov.uk/>

### 3.2.3 Other options for increasing quality assured fuel uptake

In an effort to increase the quantity of high quality wood fuel that is produced and consumed by domestic scale appliances in Ireland, along with the increased quantity that would likely be purchased for community, commercial and industrial scale appliances through the linkage of the proposed RHI with the WFQA scheme, it would be of significant benefit to consider placing the WFQA scheme, in its current or revised guise, or a similar quality assurance scheme, on a mandatory footing for installations not covered under an air emissions licence/permit.

Direct placement of a wood fuel quality assurance scheme on a statutory footing through legislation would be the most directly effective means of increasing WFQA uptake, such that wood fuels produced in Ireland must be certified through the scheme in order to be placed on the market. This would require the drafting, review and making of appropriate legislation to facilitate this, as well as the identification of support and funding for the increased administration of the scheme. In addition, enforcement of any legislation developed would be required, albeit with potential scope for incorporation of same within current enforcement activities undertaken by local authorities for solid fuels, for example.

As an alternative to adopting a legislative route, uptake of wood fuel quality assurance scheme(s) should be promoted at every available opportunity by all relevant government departments and agencies. For example, the National Clean Air Strategy which is currently in development, could act as a useful driver for WFQA or similar scheme uptake, through the development of policies that promote or stipulate the requirement for WFQA certified fuel use.

**Government policy in relation to 'green' public procurement, outlined in *Green Procurement: Guidance for the Public Sector***, produced by the EPA in 2014, presents no reference to procurement of wood fuels and represents a missed opportunity to require the WFQA scheme in instances of public sector wood fuel purchase. This is exemplified by an instance, at the time of writing of this report (September 2016), of a local authority tendering for the procurement of woodchip and wood pellet fuels for 2 no. local authority buildings without any reference to quality, other than a maximum moisture content, in the case of the woodchip supply and reference to EN17225, but not in the context of the WFQA, or any other quality assurance scheme, in the case of wood pellet supply.

There is considerable scope for the undertaking of a specific body of work related to WFQA scheme promotion, promoted by relevant government agencies, to increase the profile of the WFQA among wood fuel retailers and end users, should a legislative route not be adopted. This would require administrative support and funding and could be targeted at, *inter alia*, internal government agencies, local authorities, forecourt retailers, garden centre retailers and other outlets known to place large volumes of wood fuel on the market. However, such a body of work would generate its maximum impact if carried out in the context of a legislative instrument or a clear policy environment supporting WFQA scheme uptake.

When considering the regulation of wood fuel producers and suppliers, it is important to take into account **both the 'traded' and the 'non-traded' (not officially traded) sectors of wood fuel production and supply in Ireland.**

The traded sector may be identified as the sector in which wood fuel is traded in the commercial arena (i.e. by commercial entities in direct sales to residential and non-residential customers), whereas the non-traded sector may be identified as the sector in which wood fuel is traded at a smaller scale in a more private arena (i.e. by individuals – sources of wood may include fallen trees, etc.).

While any legislative or policy measures introduced may seek to address both the traded and the non-traded sectors, it is likely that oversight of the non-traded sector would be significantly more difficult to enforce and this is likely to remain a challenge for the sector in the coming years.

However, by addressing from the outset the quality of wood fuels produced by large scale wood fuel suppliers and retailers placing significant quantities of wood fuel on the market, such that coverage of scheme uptake is maximised, any subsequent improvement in quality wood fuel use in Ireland, will ultimately contribute to the maintaining of high level of air quality.

## 4 APPLIANCE TYPE, DESIGN, OPERATION & ABATEMENT

### 4.1 Potential to Influence Emissions

Section 10 of the Technical Literature Review included in Appendix 1 presents detail on the means by which the type, design and operation of biomass combustion appliances and the application of abatement technologies to these appliances, have the potential to influence emissions generation across the range of appliances commonly utilised in domestic, community, commercial and industrial applications.

All of these factors come together to ensure, in most cases, that emissions for a range of parameters come within specific emission limit values (ELVs) applied by various legislative instruments and standards, relevant to the size of the appliance, such that the ELVs **act as a 'first step' in the minimisation of potential impacts on air quality**. Section 5 following identifies further influencers on air quality in terms of biomass appliance installation, with flue design identified as an important factor.

The application of appropriate ELVs can vary depending on the nature and scale of a biomass appliance, and the regime under which an appliance may be installed e.g. at an EPA licenced facility.

ELVs may be applied to biomass installations through the application of European legislative requirements, typically transposed through relevant national legislation, e.g. EU Directive 2010/75/EU on industrial emissions or EU Directive 2015/2193 on medium combustion plants (yet to be transposed in national legislation), or through the manufacture of appliances to operate in accordance with relevant standards, e.g. EN 303-5:2012. A number of European countries have adopted their own national emission limit standards, implemented through their national legislation.

In Ireland, ELVs are applied to biomass installations if they come within the regulatory regime of the EPA, i.e. if the biomass installation is part of a facility operating under an industrial emissions (IE), an integrated pollution control (IPC) or a waste licence, or would require an IE or IPC licence on its own. An installation may come under a local authority regime if it forms part of a facility requiring a waste facility permit or (potentially) an air emissions licence. In these instances, there is a legislative requirement for the appliance to operate within the relevant ELVs applied.

ELVs are also applicable where appliances are designed to operate in accordance with relevant standards, such as EN 303-5:2012. However, in Ireland, these standards are voluntary and do not have any legislative footing.

The current situation relating to ELVs applied to biomass appliances in Ireland is summarised as follows:

- ELVs for large scale plants (i.e. >50 MW thermal input) are applied by the Directive 2010/75/EU and transposed through S.I. 137 and 138 of 2013, and thus have a legislative footing
- **ELVs for medium scale plants (i.e. ≥1 MW to <50 MW thermal input) will be applied by the transposition of the Directive 2015/2193/EC ('the MCP Directive'), and will have legislative footing when transposed (required by December 2017) – it is likely that the majority of future commercial and industrial scale biomass development would fall within this bracket, dependent on the structure of the proposed RHI (note existing plant in this scale may have ELVs applied through licence conditions, with ELVs being determine on a case by case basis)**
- The voluntary standard EN 303-5:2012 sets ELVs for appliances up to 500 kW (rated by heat output)
- The Ecodesign Directive 2009/125/EC, through Commission Regulations 2015/1185 & 1189 (both transposed into national legislation) set ELVs for solid fuel local space heaters ≤50 kW and solid fuel **boilers ≤500 kW respectively** – however, these do not come into force until January 2022 and January 2020 respectively

**Biomass appliances of ≥1 MW have (or will have upon transposition of the Directive 2015/2193) legislative ELVs applied to their operation. Appliances ≤500 kW may be currently designed in accordance with EN 303-5:2012 and thus will operate within the remit of the ELVs required by that standard. From 2020 and 2022, local space heaters and solid fuel boilers up to 500 kW will be required to comply with the ecodesign requirements of Directive 2009/125/EC.**



Therefore:

- A 'gap' currently exists between the approximate 500 kW and 1 MW range (<sup>4</sup>see note) in terms of there being no legislative instrument or design standard in place that sets ELVs for biomass appliances in this range – it is understood that this gap is temporary until such time as further relevant standards are developed at European level to cover this range
- Until 2020, there is no legislative instrument in place to set ELVs for solid fuel boilers  $\leq 500$  kW, nor any similar instrument in place until 2022 for local space heaters  $\leq 50$  kW, other than EN 303-5:2012, which is currently voluntary

## 4.2 Domestic Scale Appliances

### 4.2.1 Current situation

The vast majority of domestic scale biomass appliances, typically stoves and small scale boilers, operate **within the  $\leq 50$  kW range, which is currently 'covered' within EN 303-5:2012**, and which will come under the remit of Commission Regulations 2015/1185 & 1189 when these are in force in January 2022 and January 2020 respectively.

Commission Regulation 2015/1185 is of more direct relevance in a domestic context in relation to local space heaters (open and closed face heaters), yet formal ELVs will not apply to these appliances until January 2022, approximately 5 years from the time of writing of this report.

The North-South Ministerial Council Residential Solid Fuel and Air Pollution Study<sup>5</sup> references an International Institute for Applied Systems Analysis (IIASA) study that utilises the 'Greenhouse gas Air pollution Interactions and Synergies' (GAINS) model that assessed the impact of the application of the Ecodesign Directive requirements (in terms of emission limit values for the appliances identified) to the domestic sector projected future emissions of PM<sub>10</sub> and PM<sub>2.5</sub>, showing a demonstrable reduction in future PM emissions in Ireland (and the UK).

Thus, the Ecodesign Directive requirements are the focus of the approach to be taken, at a European level, to biomass emissions reduction at the domestic scale across Europe. The delayed benefit as a result of the 2022 implementation of the relevant regulations is acknowledged by the Commission but is identified as being required until agreement is reached in relation to the harmonisation of testing methodologies for PM, given the variation that has been observed across the EU<sup>6</sup> - three test methods are currently allowed under the relevant regulations and the Commission is currently developing a harmonised standard that can be applied to PM emissions testing. In addition, there are technological challenges for manufacturers in developing fully compliant appliances that require an appropriate time period to be worked out.

In the interim, until such time as the implementation of Commission Regulation 2015/1185 in particular, only the ELVs that are specified in EN 303-5:2012 are 'available' as a means of influencing the emissions regime in the domestic sector in Ireland.

It is the Sustainable Energy Authority of Ireland (SEAI) that will have the responsibility for surveillance and enforcement of these regulations, as the market surveillance authority in relation to ecodesign and energy labelling in Ireland, while The Department of Jobs, Enterprise & Innovation (DJEI) has ultimate responsibility for the implementation of the Ecodesign Directive.

---

<sup>4</sup> Note: Directives 2010/75/EU & 2015/2193/EC are categorised per the 'total rated thermal input' which refers to the design rating of the plants in question, based on the amount of energy inputted, while Directive 2009/125/EC refers to 'total rated thermal output', which relates to the realised energy (heat) produced. This difference in classification means that the operating ranges identified in the different Directives are not directly comparable, and therefore the 'gap' identified is not clearly between 500 kW and 1 MW, but for the purposes of this report, it is taken as an approximation.

<sup>5</sup> [http://www.housing.gov.ie/sites/default/files/attachments/northsouth\\_residential\\_solid\\_fuel\\_and\\_air\\_pollution\\_study\\_1.pdf](http://www.housing.gov.ie/sites/default/files/attachments/northsouth_residential_solid_fuel_and_air_pollution_study_1.pdf)

<sup>6</sup> <http://www.cefacd.eu/news> - 'Ecodesign regulations & standardization request' presentation

#### 4.2.2 Options to influence domestic scale ELVs

The question therefore arises as to whether it is worthwhile or of benefit to take measures to attempt to influence domestic scale biomass emissions in the intervening c. 5 year period until Regulation 2015/1185 is enforceable.

The potential benefit is obvious, in terms of the positive air quality impacts that may be realised from a **'formalising' of ELVs** for domestic scale biomass appliances sooner rather than later. However, dependent on the measures that could be taken, there is potential for generating an unnecessary administrative burden and added costs on appliance manufacturers.

There are a number of initiatives that could be undertaken to influence future domestic scale biomass emissions without embarking on a legislative or significant administrative undertaking, such as:

- **Development of an 'early engagement' programme with relevant appliance manufacturers** by DJEI and/or SEAI, at an appropriate duration in advance of the relevant regulation enforcement dates (e.g. 24-36 months), such that the measures being taken by manufacturers<sup>7</sup> to ensure that their products will be compliant by the enforcement date, are identified well in advance. This programme could take the form of an industry discussion forum with quarterly or biannual meetings or could be carried out on a one to one basis
- Creation of specific policy measures through the development of the National Clean Air Strategy that promotes, at the very least, the application of the EN 303-5: 2012 standard for biomass appliances
- Given the role that appliance installation can play in emissions; introduction of flexibility in the Building Regulations 2014 so as to ensure that the recommendations of manufacturers and installers of domestic sized biomass appliances can be implemented

### 4.3 Community, Commercial & Industrial Sized Appliances

In terms of influencing emissions from the scale of biomass appliances that may be utilised in the community, **commercial and industrial sectors, i.e. biomass appliances of 50 kW to ≥50 MW, the presence of existing and imminent legislation with applicable ELVs**, as identified, ensures ELVs will have a legal footing for appliances **≥1 MW**.

It is as yet unclear as to when the transposition of the MCP Directive to Irish legislation will exactly occur, who will have responsibility for the application of these ELVs, i.e. the EPA or local authority, and how it will be implemented, e.g. through a permitting or **licencing regime**. **In any event, it's transposition will be welcomed as a definitive means of influencing emissions for appliances at this scale.**

The proposed RHI also provides a significant opportunity to influence emissions from biomass appliances at this scale.

#### 4.3.1 Interaction with Proposed RHI

As required by the UK RHI, the implementation of an emissions certification system for those larger scale biomass combustion appliances which are not subject to air emissions licencing/permitting in Ireland is a step which may be taken to ensure that appliances of the scale likely to be relevant in the proposed RHI, are adequately designed, operated and incorporate sufficient abatement technologies, if necessary. This in turn helps maintain control of pollutant emissions released from these appliances.

In considering the implementation of an emissions certificate system for biomass combustion appliances as part of an Irish RHI, thought must be given to the extent to which the certification held by appliance manufacturers, which may be compliant with the UK RHI, can or should be incorporated or adopted into any Irish RHI.

---

<sup>7</sup> Where 'manufacturers' also mean authorised representatives or importers, as per S.I. 454 of 2013.

The UK has embedded an emissions certificate system as part of their RHI, whereby emissions certificates for biomass combustion appliances are required to be submitted upon application to both the domestic and the non-domestic RHI. These emissions certificates must be approved by Ofgem prior to acceptance onto the RHI scheme. Prior to appliances being installed, appliance manufacturers must ensure that they meet the following emission limits set by the UK RHI:

- 30 g/GJ net thermal input for PM
- 150 g/GJ net thermal input for NO<sub>x</sub>

The emissions certificates required for submittal to Ofgem are required to be completed by an accredited testing laboratory and need to include the following information:

- Details of the testing laboratory and confirmation of accreditation to ISO 17025
- Detail of the appliance, including installation capacity, nature of feed and draught
- Fuel type used during the testing and the range of fuels that can be used in compliance with the relevant limit values (as derived from the testing)
- Maximum allowable moisture content of the fuels that can be used
- Details of testing and relevant test standards
- Measured emission of PM and NO<sub>x</sub>

As the emissions certificate system has now been in place in the UK for a number of years, a dedicated website<sup>8</sup>, which is administered by the Heating Equipment Testing and Approval Scheme (HETAS), a UK based organisation operating within the biomass and solid fuel heating sector, has now been developed which lists all appliances provided with RHI emissions certificates that have been approved by Ofgem.

In considering an emissions certificate system for an Irish RHI, options for implementation of such a system may include:

1. 'Straight' adoption of the ELVs and parameters stipulated by the UK RHI and acceptance of emission certificates that appliance manufacturers currently have for the UK RHI
2. Development of different ELVs (and potentially parameters) for an Irish RHI, requiring the undertaking of laboratory testing as evidence of an appliances ability to meet these values

A third option may be removed from the emission certificate based system and could be based around emissions monitoring versus identified limit values. While this is likely to be a requirement of any emissions **permit or licence that may be applicable to a biomass installation, it could also facilitate the 'grandfathering'**<sup>9</sup> of any currently planned, under construction or existing biomass installation through the demonstration of compliance with the relevant ELVs through an emissions monitoring programme.

In terms of the most expedient means of development of an emissions certificate based system, it is considered that adoption of the UK system would result in the least administrative burden for the Irish RHI administrators, as well as ensuring that appliance manufacturers do not have to undertake a further round of laboratory testing to potentially different parameters and limit values, which would have the potential to impact the timeline of RHI uptake nationally. This could take the form of submission of proof by the appliance manufacturer that their appliance is approved by Ofgem in the UK, or there could be direct interaction with Ofgem by the Irish RHI administration team

Were this approach to be taken, it is considered however, that it should be supported by a separate body of work to assess or confirm the appropriateness of the relevant ELVs in an Irish air quality context. While it is assumed that this will be the case, verification of same would be beneficial.

A further point of consideration in relation to the proposed RHI relates to the potential for impact on emissions **resulting from the 'banding' of appliances, such that different financial incentives apply to different sized biomass installations**, if this approach is taken within the proposed Irish RHI.

---

<sup>8</sup> <http://rhieclist.org.uk/>

<sup>9</sup> 'Grandfathering' means that any eligible renewable installations (incl. biomass), completed during the period from the date of the announcement to the date that the proposed RHI becomes operational, will benefit from the new support as if the installation had been completed on the date the relevant scheme launches

There is potential here for biomass appliances to be sized to 'fit' the banding rather than the actual energy demand, resulting in appliances which may not operate at their optimal performance or which are shut down/started up more frequently than necessary. Sub-optimal operation of frequent shut down/start up can result in increased emissions generation and so this issue should be contemplated closely as part of RHI emissions certificate consideration.

#### 4.3.2 MCP Directive ELVs compared with the UK RHI Values

In addition, the means by which the MCP Directive, when transposed, will 'tally' with the RHI emission certificate values, should the UK values be adopted, should be considered. The UK RHI presents ELVs for PM and NO<sub>x</sub> in units of g/GJ, whereas the MCP Directive presents ELVs in mg/Nm<sup>3</sup> (calculated at a standardised O<sub>2</sub> content of 6% for solid fuels). The conversion between g/GJ and mg/Nm<sup>3</sup> is based on the emission concentration at a specified O<sub>2</sub> content<sup>10</sup>. On that basis, the MCP Directive ELVs compared with the UK RHI ELVs are shown in the following table:

Table 4-1: MCP Directive ELVs compared with UK RHI ELVs

Parameter	UK RHI g/GJ	UK RHI as mg/Nm <sup>3</sup> @ 6% O <sub>2</sub>	MCP Directive ELVs
PM	30	85 mg/Nm <sup>3</sup>	20 – 50 <sup>1</sup> mg/Nm <sup>3</sup> (expressed as 'dust')
NO <sub>x</sub>	150	423 mg/Nm <sup>3</sup>	300 – 650 <sup>2</sup> mg/Nm <sup>3</sup>

<sup>1</sup> Existing MCPs ≥1 & ≤20 MW: 50 mg/Nm<sup>3</sup>  
Existing MCPs >20 & <50 MW: 30 mg/Nm<sup>3</sup>  
New MCPs ≥1 & ≤5 MW: 50 mg/Nm<sup>3</sup>  
New MCPs >5 & ≤20 MW: 30 mg/Nm<sup>3</sup>  
New MCPs >20 & <50 MW: 20 mg/Nm<sup>3</sup>

<sup>2</sup> Existing MCPs ≥1 & <50 MW: 650 mg/Nm<sup>3</sup>  
New MCPs ≥1 & ≤5 MW: 500 mg/Nm<sup>3</sup>  
New MCPs >5 & <50 MW: 300 mg/Nm<sup>3</sup>

Therefore, when compared in common units, the ELVs of the MCP Directive are seen to be more stringent in terms of PM (or dust). For NO<sub>x</sub>, the ELVs are more stringent for new MCPs with a high total rated thermal input, but less stringent for new MCPs with a low total rated thermal input and for all existing MCPs.

Whether or how the two regimes can 'co-exist', in terms of potentially being applicable to the same appliances in the same installation, should be considered.

It may simply be a case of adopting the UK RHI ELVs as previously discussed, in terms of application to the RHI, with a separate requirement for the biomass installation to comply with the requirements of the MCP Directive, in whatever means it is transposed, e.g. through licence or permit conditions.

#### 4.3.3 500kW to 1 MW 'gap'

The application of an emission certificate system to the proposed RHI could, dependant on the structure of the RHI in terms of applicability to biomass appliance thermal capacity ranges, play a beneficial role in 'filling the gap' that exists for appliances between ~ 500 kW and 1 MW, as previously identified, in terms of applying ELVs to this range of appliances.

#### 4.3.4 Triple E Register

The Triple E (Excellence in Energy Efficiency) Products Register is an initiative introduced by the SEAI which gives recognition to products within Ireland that are 'best in class' in terms of energy efficiency. Under the European Communities (Energy Efficient Public Procurement) Regulations 2011 (S.I. 151 of 2011), it is a requirement that public bodies must purchase products that are specifically listed on the register.

<sup>10</sup> AEA (2012) – Conversion of biomass boiler emission concentration data for comparison with Renewable Heat Incentive emission criteria. Available from: [https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1205310837\\_Conversion\\_of\\_biomass\\_boiler\\_emission\\_data\\_rep\\_Issue\\_1.pdf](https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1205310837_Conversion_of_biomass_boiler_emission_data_rep_Issue_1.pdf)

In this regard, the emission limits of the Triple E register, which refer to dust emissions, should also be reviewed in the coming years to ensure that the Register reflects the requirements of the MCP Directive and/or the Commission Regulation 1189 in regard to emission limit values.

This ties in with the previous point made in relation to public procurement in Section 3.2.3, such that public bodies that are required to procure products from the Triple E Register will thus be acquiring compliant products in terms of ELVs.

## 5 APPLIANCE INSTALLATION

### 5.1 Potential to Influence Emissions

In addition to its operation within relevant ELVs, as discussed in Section 4, the appropriate installation of a biomass appliance is important in ensuring that elevated levels of emissions are not encountered at ground level at nearby locations to the appliance installation, such that no or negligible impacts on air quality result.

When considering the installation of a biomass appliance, the siting of the appliance in relation to its surroundings and the design of the appliance flue needs to be taken into account to ensure that high ground level emissions are avoided. Ideally, the installation of a biomass appliance should consider:

- the flue design
- the flue height relative to the appliance
- the flue height relative to nearby buildings
- the proximity of nearby buildings
- the topography of the locality surrounding the appliance &
- the existing background air quality

Biomass appliance installation is a focus area for emissions control which can be influenced by an increased level of training, education and awareness for all players involved in design and installation, as well as those determining and assessing the location of a biomass appliance installation.

Options may include considering the implementation of a mandatory certified installer/competent person scheme and an emissions calculator assessment tool, as well as the delivery of targeted training for relevant decision makers, e.g. local authorities.

It is also important to consider the role of commissioning (and subsequent maintenance) as part of the installation **process, such that the term “installation” should be taken as also referring to the commissioning phase** – in some cases, a biomass installation could be installed by one entity and commissioned by another, with potential for incorrect set up of an appliance during commissioning, should the commissioning individual/organisation not be trained or certified in an appropriate manner.

### 5.2 Certified (Accredited) Installer/Competent Person Scheme

#### 5.2.1 Current Situation

In order to influence emissions from biomass combustion appliances, there is scope for improvement of the means by which appliance installation is overseen in Ireland. Poor appliance installation that does not take into consideration the siting of the appliance in relation to its surrounds and/or the design of the appliance flue, has the potential to lead to significant ground level emissions, particularly for the installation of domestic or small community/commercial/industrial scale appliances, with resultant negative impacts on local air quality.

**There is currently no “centrally approved” certified (or accredited) installer/competent person scheme in existence for biomass combustion appliances in Ireland.** Such a scheme would be a positive development in ensuring the appropriate installation of appliances throughout Ireland and the subsequent minimisation of emission impacts resulting therefrom.

While no centrally approved certified installer/competent person scheme is currently in place, training is provided for the installation of appliances by recognised providers. Training courses (H003: Dry Appliance Installer Course, H004: Wet Appliance Installer Course, H006: System Chimney Course) that are approved by HETAS are provided by Oriel Flues at the Ardee Enterprise Centre in Ardee, County Louth.

In addition, HETAS approved training courses are provided in Ireland at the Midland Energy Training and Assessment Centre (METAC), based in County Laois. These are specific dry solid fuel and wet solid fuel stove installer courses and are independently certified and verified, as well as being recognised by organisations such as SOLAS, QQI, City & Guilds, UKAS, Bord Gais and OFTEC. METAC also provides solid fuel awareness training for retail and sales staff, which is a one day course developed to raise awareness for retail staff when dealing with customers in choosing the correct solid fuel appliance and to recognise the installation and fuel requirements for this appliance.

The above training courses could act as potential starting points for the implementation of a centrally approved certified installer/competent person scheme in Ireland. When considering the functioning of such a scheme, it would be of benefit that, for any individual/organisation to be certified as a member of the scheme, there is a legislative requirement for them to have completed an appropriate approved biomass appliance installer training course and to provide detail of same through a self-certification process, for example.

### 5.2.2 Case Studies from Ireland, the UK and Europe

Some certified installer/competent person schemes are already in place in Ireland, the UK and Europe. While not directly relating to biomass, the Registered Gas Installer (RGI)<sup>11</sup> scheme was initiated by the Commission for Energy Regulation (CER) in 2006 so as to ensure the safe installation of gas appliances in Ireland. It is illegal for individuals not registered on this scheme to install gas appliances in Ireland. This scheme could be used as a useful guide in implementing a biomass specific certified installer/competent person scheme. Alternatively, it could be a biomass specific scheme could potentially be incorporated into the RGI scheme in its current form.

The renewable installers register<sup>12</sup> is a further Irish certified installer/competent person scheme currently in place. This is a SEAI developed register which identifies installers in Ireland who are suitably qualified to carry out the installation of renewable energy technologies. In addition to other technologies, small scale biomass boilers and stoves are covered by this register. In order for installers to be included on this register, they must provide the SEAI with proof that they hold qualifications relating to the installation of the appropriate technology. While the SEAI ensures that all individuals listed on the renewable installers register are appropriately qualified, it does not assess the work of the installers included on the register.

In the UK, a number of competent person schemes are currently in existence which allow individuals and organisations to self-certify that the installation work they carry out is in compliance with the Building Regulations. Seven competent person schemes, each accredited by the United Kingdom Accreditation Service (UKAS), are presently identified by the UK Department of Communities and Local Government (DCLG) to cover the installation of solid fuel (including biomass) combustion appliances<sup>13</sup>. Of these schemes, the most specialised in terms of the certification of installers of biomass appliances is commonly considered to be the HETAS competent person scheme. In order for installers to be certified by this scheme, they are required to have completed the appropriate HETAS approved installation training course and to complete refresher training courses a minimum of every five years to ensure that their skills are up to date.

The Microgeneration Certification (MCS) scheme<sup>14</sup> is a separate UK scheme that was introduced by the (now disbanded) Department of Energy & Climate Change) DECC in the UK in 2008 to provide recognition to both high quality microgeneration appliance technologies and high quality microgeneration appliance installers. This scheme covers a range of renewable energy technologies, including biomass. For installers to be MCS certified, they are assessed by one of eight certification bodies according to the quality of both the installation and the commissioning of an appliance. MCS certification is linked to financial incentives that are available for renewable energy use in the UK, with all domestic appliances and all non-domestic appliances below 45 kW in size required to be installed by an MCS approved installer to qualify for the RHI.

---

<sup>11</sup> <http://www.rgii.ie/>

<sup>12</sup> [http://www.seai.ie/Renewables/Renewable\\_Installers\\_Register/](http://www.seai.ie/Renewables/Renewable_Installers_Register/)

<sup>13</sup> <https://www.gov.uk/guidance/competent-person-scheme-current-schemes-and-how-schemes-are-authorised>

<sup>14</sup> <http://www.microgenerationcertification.org/>



A number of additional certified installer/competent person schemes, or similar, are in place in other countries within the EU. The majority of these schemes are not biomass specific and typically relate to a wide range of renewable energy technologies. In an effort to gauge the presence and the functioning of all certified installer/competent person schemes relating to renewable energy within the EU, a project entitled 'QualiCert'<sup>15</sup> was recently carried out at the European level. QualiCert stands for "common quality certification and accreditation for installers of small-scale renewable energy (RE) systems". This project reviewed the quality certification and accreditation schemes in place for small scale RE appliance installers in countries throughout the EU. It did not address the presence of similar schemes for large scale RE appliance installers. Findings of the QualiCert project are presented in the Technical Literature Review Report, included in Appendix 1.

### 5.2.3 Interaction with the Proposed RHI

The linking of eligibility for the proposed RHI with a requirement to demonstrate that an installation has been installed, commissioned and maintained by an appropriate qualified or certified individual/organisation, is an appropriate recommendation for the development of the RHI scheme.

However, as it is understood that the proposed RHI is likely to be initially focussed towards larger scale commercial and industrial non-emissions trading scheme (non ETS) scale development, any installers associated with the design and installation of biomass appliances of that scale are likely to be competent in their ability to appropriately design and install appliances, such that they undertake the installation in a manner that meets all appropriate technical standards and guidance.

In this case, it could be argued that specifying the requirement for linking a certified installer/competent scheme to the proposed RHI may be of negligible impact or benefit at the initial stages of RHI roll-out.

Nonetheless, it is considered that the proposed RHI scheme should, from the outset, specify a requirement in relation to the means by which RHI eligible biomass (and other) installations must be installed by an appropriate qualified and certified individual/organisation and through any adopted or approved certification scheme.

As identified, while initial benefits in terms of ensuring appropriate installation may not be realised during the early phases of the RHI, the requirement for certification of installers is an important principle to incorporate into the RHI from the outset, such that this requirement remains a part of the scheme should it be expanded during its lifetime to capture a wider range of installations beyond larger scale non ETS installations.

In addition, further to the point previously made in relation to commissioning being considered as a part of installation, the requirement for the submission of a commissioning certificate, similar to the UK RHI, should be a requirement of the proposed RHI, whereby it should be demonstrated that the commissioning phase has been undertaken by an individual/organisation that is part of a certified installer/competent person scheme. Similarly, proof that an installation is or will be maintained by an appropriate certified/competent individual/organisation would be beneficial.

### 5.2.4 Status of Certified (Accredited) Installer/Competent Person Scheme

As identified, there are a number of organisations in Ireland, such as Oriel Flues and METAC, that currently provide appropriate training related to biomass appliance installation. This is evidence of the efforts undertaken to date by the wider industry to address installation related issues in terms of biomass combustion emissions, as well as safety related to biomass appliance installation.

However, no mandatory scheme is in place to ensure that installer of biomass combustion appliances, from domestic to large scale industrial, are appropriately trained and qualified to install, as well as commission, biomass appliances.

---

<sup>15</sup> <https://ec.europa.eu/energy/intelligent/projects/en/projects/qualicert>

The placement of such a scheme on a mandatory footing would be an important mitigation measure for any resultant impact on air quality (as well as health and safety) that could result from increased or widespread implementation and uptake of biomass. While schemes to date may have had benefit in terms of those installations carried out by installers trained under them, it is considered that their voluntary nature limits the extent to which they can have impact, and that a mandatory footing for such a scheme is necessary to ensure the maximum benefit in terms of the protection of air quality is realised.

The most direct means of ensuring the mandatory nature of such a scheme is its enactment on a statutory basis through legislation, in a similar manner to the RGI scheme previously referenced. While this would clearly enshrine the requirement for such a scheme, the timeline for implementation of same would be influenced by the timeline required for legislative drafting, review and implementation, followed by the period required to identify the appropriate body for certification of the scheme. In addition, the administration required for such a scheme may not be warranted for the scale of scheme that may actually result.

A more expeditious approach to develop such a scheme could see the engagement of all relevant stakeholders through a consultation process, overseen by an appropriate body, with the subsequent development of such a scheme and tendering for its oversight and operation, along with significant promotion of same through appropriate government and sectoral organisations, such that any scheme developed would adopt a non **legislative, yet 'quasi-mandatory' status as the scheme which must be complied with.**

A further approach may be the incorporation of such a scheme into the existing RGI scheme. The exact method of this incorporation would need to be considered, given the current legislative footing on which the RGI scheme is placed.

### 5.3 Development of an Emissions Calculator Assessment Tool

The development of a national emissions calculator assessment tool is another measure which may be taken to influence emissions from biomass combustion in Ireland. Such a tool would take into consideration mean background air quality concentrations of specific pollutants and seek to determine the impact that emissions from appliances will have on air quality at the location of appliance installation.

The use of an emissions calculator assessment tool in Ireland would help assess the impact from the installation of biomass combustion appliances in areas where they could have a significant impact on mean background air quality concentrations, resulting in exceedance of limit values for these concentrations. Limit values for the mean background concentration of PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> in Ireland, as set by the EU CAFE Directive, are identified in the Technical Literature Review Report, which forms Appendix 1 to this report.

A national emissions calculator tool has been developed and is currently in operation in the UK. An overview of the functioning of this tool is provided in Section 5.3.1, with potential options for implementing a similar tool in Ireland outlined in Section 5.3.2.

#### 5.3.1 DEFRA Case Study, UK

The Department for the Environment, Food and Rural Affairs (DEFRA) in the UK has developed a biomass emissions calculator tool<sup>16</sup> which is used to screen emissions from biomass combustion appliances to ensure that such emissions do not result in exceedances of mean background air quality concentrations limit values.

This tool determines the effective stack height of an appliance and subsequently the maximum emission rate (target emission rate (TER)) that is permissible from an appliance for specific pollutants before mean background concentration limit values for these pollutants are exceeded. In order to calculate the TER for each pollutant, values for the following are required:

- Building height (i.e. the height of the tallest building within 5 stack heights of the stack)
- Stack diameter
- Stack height
- Location of the appliance
- Annual mean background concentration of the pollutant being analysed in the above location

---

<sup>16</sup> <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#biomass>

An outcome of the design of this tool is that lower TER values are required in areas with high mean background concentration values than those that are required in areas with low mean background concentration values.

In determining the annual mean background concentration of a pollutant in a specific location in the UK (identified by local authority area), this tool makes use of background air quality concentration maps<sup>17</sup> which are published by DEFRA and provide estimates of background concentrations for specific pollutants on a measured (historic) and modelled (future) basis. These maps contain estimates for the pollutants PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>x</sub> and NO<sub>2</sub> and are spatially detailed, with maps presented in 1km x 1km grid squares throughout the UK.

A similar approach is utilised in Scotland but is based on Scottish specific emissions data for PM<sub>10</sub>, NO<sub>x</sub> and NO<sub>2</sub> only.

### 5.3.2 Potential Options for Implementation

In considering the implementation of an emissions calculator assessment tool for biomass combustion appliances in Ireland, the tool implemented by DEFRA in the UK provides a very useful starting point. The development and implementation of a similar tool in Ireland would likely bring significant benefits in terms of emissions control through ensuring that an assessment step is undertaken to determine the potential impacts on air quality, especially in circumstances where a more formal air quality assessment (for example through the environmental impact assessment (EIA) process) is not required, dependent on the scale of the installation.

While the tool in the UK is well designed and operates effectively, the implementation of an exact replica of this tool in Ireland would not be possible at this moment in time. As outlined in Section 5.3.1, the UK tool makes use of spatially detailed background air quality concentration maps which present information according to 1km x 1km grid squares throughout the UK. Detailed background concentration data at that scale (i.e. 1 km x 1 km) is not currently available in Ireland.

Should an emissions calculator assessment tool be implemented in Ireland in the future, it would likely need to be in the form of a modified, less spatially detailed version of the UK tool. Given that the EPA has responsibility for the monitoring of air quality in Ireland, there is also a potential role for the EPA in the development of the emissions calculator assessment tool. Background air quality concentration values from EPA air quality monitoring stations located throughout the country, that are used to inform the four national Air Quality Management Zones (AQMZs) and the six national Air Quality Index for Health (AQIH) regions, could be incorporated into the functioning of this tool.

In implementing a biomass emissions calculator assessment tool in Ireland, its utilisation could be ensured in a number of ways:

- In assessing development comprising a biomass emissions element, that would require approval from the EPA, through applications for waste, industrial emissions (IE) or integrated pollution control (IPC) licences, such development could be assessed in accordance with the requirements of the emission calculator assessment tool as part of the licence application assessment process
- In assessing development comprising a biomass emissions element, that would require approval from a local authority, i.e. planning permission, a waste facility permit or an air pollution licence approval, the calculator assessment tool could be utilised in the assessment of such development applications
- In assessing development comprising a biomass emissions element, that may require a future permit or licence from the EPA or local authority, to ensure compliance with the MCP Directive, the calculator assessment tool could be used in such development assessment

In developing such a tool, consideration should also be given to providing training in its utilisation, particularly to local authority staff, as considered in the following section.

---

<sup>17</sup> <http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html>

### 5.3.3 Training for Local Authorities

When considering the installation of larger sized biomass combustion appliances at the community, commercial and industrial level, it is important to take into account potential planning and other approval requirements associated with these installations.

Planning permission will typically be required for larger sized biomass combustion developments but these developments may not be of a scale that warrants a mandatory environmental impact assessment (EIA), in accordance with Part 10 of the Planning & Development Regulations 2001, as amended. In addition, they may not specifically require an approval from the EPA.

In such cases, the processing of these applications by local authorities in Ireland may not take sufficient consideration of the impacts that poor biomass appliance installation and/or operation can have on air quality. In particular, it is considered unlikely that the relevant departments of most local authorities in Ireland have developed sufficient expertise on how the siting of a biomass appliance in relation to its surrounds and the design of an appliance flue can impact on ground level emissions, given the relatively low level of biomass utilisation to date in Ireland.

As such, it is important that relevant individuals within the relevant departments of local authorities throughout Ireland are appropriately trained in these issues so as to gain a thorough understanding of them, which they can subsequently make use of to ensure the adequate assessment of planning applications for larger sized biomass combustion appliances, as and when the need may arise.

The delivery of such training should be carried out by a recognised individual or organisation with appropriate knowledge of the above issues. For ease of delivery, it may be best that such training courses are provided by the Environment Services Training Group (ESTG)<sup>18</sup>, a subsidiary of the Local Authority Services National Training Group (LASNTG). The ESTG was established in 1996 for the provision of environmental training courses for a broad range of disciplines for staff within both local authorities and the private sector, with five regional training centres in Ireland which deliver these courses.

## 5.4 Further consideration regarding Planning Permission

**The issue of 'exempted development' in a planning context** and in relation to the assessment of emissions from biomass installations developed in this manner, requires consideration.

Class 56 of Part 1 of Schedule 2 of the Planning & Development Regulations 2001, as amended, provides a **number of exemptions for 'small scale' renewable energy installations such as biomass installations, CHP installations and wind turbines**, as outlined in Section 3.5 of the Technical Literature Report included in Appendix 1.

While such exemptions are considered very beneficial to the promotion and utilisation of renewable technologies from the point of view of facilitating the easier development of same, a case could arise where a relatively sizeable biomass appliance installation can be undertaken without having to enter the planning or any other approval process, with the resultant potential implications for local air quality not having been assessed (notwithstanding the future means by which the Medium Combustion Plant Directive 2015/2193 could be implemented).

For example, a biomass fuelled CHP occupying a structure of up to 500 sq. metres, 10 m in height, with a flue height of up to 20 m, can be developed in an industrial building, as an exempted development<sup>19</sup>. A structure of this size would likely be suitable for housing an appliance of several MW capacity, which in the context of emissions, should enter a process whereby potential impacts on local air quality are assessed.

---

<sup>18</sup> <http://www.estg.ie/>

<sup>19</sup> Class 56 (a) Part 1 of Schedule 2 of the Planning & Development Regulations 2001, as amended – *'the construction, erection or placing within the curtilage of an industrial building of a structure for the purposes of housing a fully enclosed Combined Heat & Power system'*

While not wishing to dilute or remove this exemption, as it serves a very positive purpose in terms of facilitating biomass technology roll-out, and should be maintained, it is considered that, in the event of the development of a biomass emissions calculator assessment tool as described previously, there is scope for the revision of this legislation to incorporate a requirement for exempted development to either:

- require utilisation of the calculator assessment tool as part of the development process, through undertaking the relevant assessment as part of the design process and the submission of this assessment to the local authority by the developer (or other engagement with the local authority that achieves the same result) or
- at the least, align the applicability for the identified exemptions with data from local EPA air quality monitoring stations such that an air quality assessment using the emissions calculator assessment tool must be undertaken based on the applicable development being located in known areas of low background air quality

As identified above, these suggestions are made in the absence of knowing the means by which the MCP Directive will be implemented, such that any resultant permitting or licencing programme resulting from its implementation may address this issue, for appliances of greater than 1 MW thermal capacity. However, for sub 1 MW installations, this issue remains.

## 6 RECOMMENDATIONS

The following summarises the information presented in the preceding sections, such that a number of recommendations are made, with the expressed objective of contributing to the improvement of a number of factors and situations that can directly and positively influence potential impacts resulting from emissions generated from biomass combustion in Ireland. Following each recommendation, the organisation(s) which are suggested as having a role in the implementation of these recommendations are identified.

### Recommendation 1

Link qualification for the proposed RHI with the requirement to demonstrate adequate operational control of emissions through:

- fuel quality assurance e.g. WFQA or similar, and servicing/maintenance in accordance with the manufacturers requirements (predominantly for non-domestic smaller scale appliances) and;
- appropriate fuel supply and monitoring, combustion emissions monitoring and active combustion control, or other methods as deemed appropriate (for larger scale appliances not operating under an appropriate air emission licence/permit).
- in the first instance, compliance with appropriate air emission licences/permits.

Suggested Organisations: Department of Communications, Climate Action and Environment (DCCAE) & Department of Agriculture, Food and the Marine (DAFM)

### Recommendation 2

- (a) Consider the broadening of the WFQA scheme, or a similar approved scheme, and placement of the same on a legislative footing, with quality approved fuels being required for utilisation at biomass facilities which are not covered by an appropriate air emissions licence/permit.
- (b) Consider the mandating of wood fuel purchase through Green Public Procurement by appropriate public bodies<sup>20</sup> as being WFQA, or similar, certified, where the biomass facility is not covered by an appropriate air emission licence/permit.

Suggested Organisations: DCCAE & DAFM

### Recommendation 3

**Develop an 'early engagement' programme by SEAI and/or DJEI with biomass appliance manufacturers to facilitate and encourage adoption of the Eco-design related Commission Regulations 2015/1185 and 2015/1189.**

Suggested Organisations: SEAI, DJEI & Enterprise Ireland

---

<sup>20</sup> Where public bodies refer to local authorities, government departments, educational organisations etc.

## Recommendation 4

Develop specific policy measures that promote the EN 303-5:2012 standard and Ecodesign requirements for biomass appliance design and the WFOA scheme, or a similar approved scheme, for wood fuel quality.

Suggested Organisation: DCCAE, DJEI, Department of Housing, Planning, Community and Local Government (DHPCLG) & Enterprise Ireland

## Recommendation 5

Consider the development and implementation of a national communication and awareness campaign (for example, through the proposed National Clean Air Strategy) which presents information on issues relating to biomass combustion that are deemed pertinent for public knowledge (e.g. the use of an appropriate fuel, the correct operation of biomass combustion appliances).

Suggested Organisations: DCCAE, DAFM, DHPCLG & DJEI

## Recommendation 6

Introduce flexibility in the Building Regulations 2014 (particularly in relation to flue sizing) so as to ensure that the recommendations of manufacturers and/or installers of domestic sized biomass combustion appliances can be implemented.

Suggested Organisation: DHPCLG

## Recommendation 7

Link qualification for the proposed RHI with the requirement for compliance with an appropriate air emissions permit/licence where applicable, or the provision of an emission certificate, in absence of same. Consider the adoption of the existing UK RHI emission certification system, for biomass installations which do not have an appropriate air emissions permit/licence, as part of the RHI. Support this recommendation by verifying applicability of the UK RHI emission limit values in an Irish context and assessing the interactions of these values with requirements of the Eco-design and MCP Directives.

Suggested Organisation: DCCAE

## Recommendation 8

Ensure that any scaling or banding applied within the proposed national RHI considers potential impacts on emissions and energy efficiency resulting from same.

Suggested Organisation: DCCAE

## Recommendation 9

Revise the SEAI Triple E Register at an appropriate time to ensure it reflects the requirements of Commission Regulation 2015/1189 when in force.

Suggested Organisation: SEAI



## Recommendation 10

- (a) Ensure that as part of the proposed RHI, RHI applicants are required to provide a certificate of competency in accordance with the manufacturers installation requirements, indicating that their installation and commissioning of appliances is carried out by a suitably trained individual/organisation.
- (b) In a non-RHI context, develop and implement a biomass<sup>21</sup> appliance installers certification or accreditation scheme (to include commissioning) based on existing or new scheme(s), as required, preferably placing same on a mandatory footing – consider potential for incorporation of same within the existing RGI scheme.
- (c) Consider means of developing a mandatory scheme for the inspection and cleaning (if required) of the flues of biomass<sup>22</sup> combustion appliances at an appropriate interval, at a minimum at the community and commercial scales and at the domestic scale, should this be considered appropriate.

Suggested Organisation: DCCAE, DAFM & DJEI

## Recommendation 11

- (a) Develop appropriate guidance to support the assessment of potential air quality impacts resulting from individual biomass installations.
- (b) Consider the development of a national Emission Calculator Assessment Tool (similar to the UK DEFRA tool) to support the assessment of potential air quality impacts resulting from individual biomass installations for use by local authorities.
- (c) Develop and provide training on the use of same to relevant authorities.

Suggested Organisations: EPA & Local Authorities

## Recommendation 12

Consider means of addressing the absence of assessment of potential air quality impacts resulting from **biomass installations developed as 'exempted development'**.

Suggested Organisations: DCCAE, DHPCLG, EPA & Local Authorities

---

<sup>21</sup> While the original scope of this project was to focus solely on biomass appliances, it is recommended that an overall solid fuel appliance installers certification or accreditation scheme is developed, implemented and preferably placed on a mandatory footing, should this be considered appropriate.

<sup>22</sup> While the original scope of this project was to focus solely on biomass appliances, it is recommended that means of developing a mandatory scheme for the inspection and cleaning of the flues of all solid fuel appliances, at an appropriate interval, is considered, should this be deemed appropriate.



IRISH BIOENERGY ASSOCIATION (IRBEA)

TECHNICAL LITERATURE REVIEW REPORT FOR  
BIOMASS COMBUSTION EMISSIONS STUDY

OCTOBER 2016



# IRISH BIOENERGY ASSOCIATION (IRBEA)

## TECHNICAL LITERATURE REVIEW REPORT FOR BIOMASS COMBUSTION EMISSIONS STUDY

User is Responsible for Checking the Revision Status of this Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
2	Issue for Client	SG/DFM/CF	DFM	DFM	28.10.16

Client: Irish Bioenergy Association (IRBEA)

Keywords: emissions, PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>x</sub>, design, wood fuel, flue, standards, combustion

Abstract: This report provides a technical overview of factors related to the generation of emissions from the combustion of biomass fuel in biomass combustion appliances. It is not intended to be an exhaustive presentation of relevant factors but identifies the issues of relevance, such that this can inform the development of a final report to be prepared as part of the Sustainable Energy Authority of Ireland (SEAI) funded project, being undertaken by the Irish Bioenergy Association (IrBEA), entitled the "Biomass Combustion Emissions Study".

# TABLE OF CONTENTS

## PAGE

1	INTRODUCTION .....	1
2	RELEVANT LEGISLATION .....	2
2.1	AIR QUALITY LEGISLATION .....	2
2.1.1	<i>EU Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the CAFE Air Quality Directive)</i> .....	2
2.1.2	<i>EU Directive 2001/81/EC on National Emission Ceilings for Certain Atmospheric Pollutants (the NEC Directive)</i> .....	8
2.1.3	<i>National Clean Air Strategy</i> .....	9
2.2	EMISSIONS – INDUSTRIAL PLANT .....	10
2.2.1	<i>EU Directive 2010/75/EU on industrial emissions (IED)</i> .....	10
2.2.2	<i>EU Directive 2015/2193 on medium combustion plants (MCP)</i> .....	11
2.3	BIOMASS APPLIANCES - EMISSIONS .....	12
2.3.1	<i>EU Ecodesign Directive 2009/125/EC</i> .....	12
2.4	BIOMASS APPLIANCES – ENERGY PERFORMANCE .....	14
2.4.1	<i>EU Ecodesign Directive 2009/125/EC</i> .....	14
2.4.2	<i>EU Energy Labelling Directive 2010/30/EU</i> .....	15
2.5	BIOMASS APPLIANCES – INSTALLATION .....	18
2.5.1	<i>Building Regulations (Part J Amendment) 2014 (S.I. 133 of 2014)</i> .....	18
2.5.2	<i>Planning Permission Requirements for Biomass Installations</i> .....	19
2.6	BIOMASS APPLIANCES – HEALTH & SAFETY .....	20
3	RELEVANT GUIDELINES & STANDARDS .....	21
3.1	AIR QUALITY GUIDELINES .....	21
3.1.1	<i>World Health Organisation</i> .....	21
3.2	BIOMASS APPLIANCES DESIGN STANDARDS .....	22
3.2.1	<i>EN 303-5: 2012</i> .....	22
3.2.2	<i>EU National Standards</i> .....	23
3.3	FUEL QUALITY STANDARDS & QUALITY ASSURANCE SCHEMES .....	24
3.3.1	<i>CEN/TC 335</i> .....	24
3.3.2	<i>ENplus Scheme</i> .....	28
3.3.3	<i>Wood Fuel Quality Assurance Scheme</i> .....	28
4	BIOMASS UTILISATION SUPPORT SCHEMES .....	30
4.1	PROPOSED RENEWABLE HEAT INCENTIVE – IRELAND .....	30
4.2	RENEWABLE HEAT INCENTIVE – UK .....	31
4.3	FEED IN TARIFFS SCHEME – UK .....	32
4.4	RENEWABLES OBLIGATION SCHEME – UK .....	33
4.5	OTHER EU NATIONS .....	33
4.5.1	<i>France</i> .....	33
4.5.2	<i>Austria</i> .....	33
4.5.3	<i>Germany</i> .....	34
4.5.4	<i>Netherlands</i> .....	34
4.5.5	<i>Italy</i> .....	34
4.5.6	<i>Switzerland</i> .....	34
4.5.7	<i>Slovenia</i> .....	34
4.5.8	<i>Denmark</i> .....	34
4.5.9	<i>Sweden</i> .....	35
5	BIOMASS COMBUSTION APPLIANCES .....	36
5.1	OVERVIEW .....	36
5.2	DOMESTIC APPLIANCES .....	37
5.2.1	<i>Fireplaces</i> .....	37

5.2.2	<i>Stoves</i>	38
5.2.3	<i>Boilers</i>	40
5.3	COMMUNITY, COMMERCIAL & INDUSTRIAL APPLIANCES	41
5.3.1	<i>Manually fed boilers</i>	41
5.3.2	<i>Automatically fed boilers</i>	42
5.4	FURTHER INFORMATION SOURCES	47
6	BIOMASS COMBUSTION PROCESS	48
7	RECOGNITION OF QUALITY BIOMASS COMBUSTION APPLIANCES, SERVICERS AND INSTALLERS	50
7.1	TRIPLE E PRODUCTS REGISTER – IRELAND	50
7.2	RENEWABLE INSTALLERS REGISTER – IRELAND	51
7.3	METAC TRAINING – IRELAND	52
7.4	REGISTERED GAS INSTALLER SCHEME – IRELAND	52
7.5	COMPETENT PERSON SCHEMES – UK	52
7.6	MCS SCHEME – UK	53
7.7	QUALITY RENEWABLE ENERGY APPLIANCE INSTALLERS – EUROPEAN STUDY	54
8	BIOMASS AS A LOW CARBON FUEL	55
9	EMISSIONS FROM BIOMASS COMBUSTION	57
9.1	OVERVIEW	57
9.1.1	<i>Oxides of Carbon (CO<sub>x</sub>)</i>	58
9.1.2	<i>Oxides of Sulphur (SO<sub>x</sub>)</i>	59
9.1.3	<i>Dioxins/Furans</i>	59
9.2	PARTICULATE MATTER (PM)	60
9.2.1	<i>Overview</i>	60
9.2.2	<i>Human Health Impacts</i>	60
9.2.3	<i>Formation of PM and Intermediate Products</i>	63
9.2.4	<i>Comparison of Biomass Emissions with Fossil Fuel Emissions</i>	64
9.3	OXIDES OF NITROGEN (NO <sub>x</sub> )	65
9.3.1	<i>Overview</i>	65
9.3.2	<i>Human Health Impacts</i>	65
9.3.3	<i>Environmental Impacts</i>	65
9.3.4	<i>Formation of NO<sub>x</sub></i>	66
9.3.5	<i>Comparison of Biomass Emissions with Fossil Fuel Emissions</i>	67
10	FACTORS INFLUENCING EMISSIONS FROM BIOMASS COMBUSTION	68
10.1	OVERVIEW	68
10.2	FUEL TYPE	68
10.3	FUEL QUALITY	69
10.4	APPLIANCE TYPE	70
10.5	APPLIANCE DESIGN AND OPERATION	75
10.5.1	<i>Sizing/Fuel Loading of Appliances</i>	75
10.5.2	<i>Point of Fuel Ignition within Appliances</i>	75
10.5.3	<i>Use of Staged Combustion within Appliances</i>	75
10.5.4	<i>Continuous Operation of Appliances</i>	76
10.5.5	<i>Maintenance of Appliances</i>	77
10.6	ABATEMENT TECHNOLOGIES	77
10.6.1	<i>PM Abatement Techniques</i>	77
10.6.2	<i>Performance of PM Abatement Techniques</i>	80
10.6.3	<i>NO<sub>x</sub> Abatement Techniques</i>	82
10.7	APPLIANCE INSTALLATION	83
10.7.1	<i>Guidance &amp; Standards</i>	83
10.7.2	<i>Appropriate Flue Installation Principles</i>	84
11	SUMMARY	87

## LIST OF APPENDICES

- Appendix 1: UK RHI Emissions Certificate Example
- Appendix 2: Unit conversion factor tool
- Appendix 3: List of Biomass Appliances on the Triple E Products Register
- Appendix 4: Biomass Appliance Products available in Ireland
- Appendix 5: Emissions Test Data for Biomass Appliances between 50kW and 20MW

## LIST OF TABLES

### PAGE

TABLE 2.1:	LIMIT VALUES OF THE CAFE DIRECTIVE .....	2
TABLE 2.2:	NEC DIRECTIVE LIMIT VALUES RELATING TO IRELAND .....	8
TABLE 2.3:	EU MEMBER STATE PROGRESS IN MEETING NEC DIRECTIVE EMISSION CEILINGS .....	9
TABLE 2.4:	ELVS SET BY THE IED – PERMIT GRANTED PRIOR TO 7 <sup>TH</sup> JANUARY 2013.....	10
TABLE 2.5:	ELVS SET BY THE IED – PERMIT GRANTED ON OR AFTER 7 <sup>TH</sup> JANUARY 2013 .....	11
TABLE 2.6:	ELVS SET BY THE MCP DIRECTIVE – EXISTING MCPs .....	11
TABLE 2.7:	ELVS SET BY THE MCP DIRECTIVE – NEW MCPs .....	12
TABLE 2.8:	ELVS SET BY COMMISSION REGULATION EU 2015/1185 .....	13
TABLE 2.9:	ELVS SET BY COMMISSION REGULATION EU 2015/1189 .....	13
TABLE 2.10:	MINIMUM SEASONAL SPACE HEATING ENERGY EFFICIENCY STANDARDS SET BY COMMISSION REGULATION EU 2015/1185 .....	14
TABLE 2.11:	MINIMUM SEASONAL SPACE HEATING ENERGY EFFICIENCY STANDARDS SET BY COMMISSION REGULATION EU 2015/1189 .....	15
TABLE 2.12:	ENERGY EFFICIENCY CLASSES OF LOCAL SPACE HEATERS AS SET BY DELEGATED COMMISSION REGULATION 2015/1186.....	15
TABLE 2.13:	ENERGY EFFICIENCY CLASSES OF SOLID FUEL BOILERS AS SET BY DELEGATED COMMISSION REGULATION 2015/1187.....	17
TABLE 2.14:	FLUE SIZING AS PER BUILDING REGULATIONS 2014, TECHNICAL GUIDANCE DOCUMENT J – HEAT PRODUCING APPLIANCES .....	18
TABLE 3.1:	COMPARISON OF WHO LIMIT VALUES AND CAFE DIRECTIVE LIMIT VALUES .....	21
TABLE 3.2:	ELVS SET BY EN 303-5 FOR HEATING BOILERS ≤ 500 kW USING BIOGENIC FUELS .....	23
TABLE 3.3:	HEAT EFFICIENCY REQUIREMENTS FOR CLASS 3, 4 AND 5 BOILERS AS SET BY EN 303-5 .....	23
TABLE 3.4:	DUST ELVS FOR BIOMASS HEATING APPLIANCES IN AUSTRIA, DENMARK, GERMANY AND SWITZERLAND .....	24
TABLE 3.5:	CLASSIFICATION OF ORIGIN AND SOURCES OF WOODY SOLID BIOMASS .....	25
TABLE 3.6:	OVERVIEW OF PROPERTIES FOR FIVE OF THE MAIN WOOD FUELS.....	27
TABLE 3.7:	WFQA CERTIFIED SUPPLIERS .....	28
TABLE 5.1:	DOMESTIC BIOMASS COMBUSTION TECHNOLOGIES.....	36
TABLE 5.2:	COMMUNITY, COMMERCIAL & INDUSTRIAL BIOMASS COMBUSTION TECHNOLOGIES .....	36
TABLE 5.3:	OVERVIEW OF MANUALLY FED STOVES .....	39
TABLE 5.4:	OVERVIEW OF OVERFED STOKERS .....	42
TABLE 7.1:	TRIPLE E REGISTER EFFICIENCY AND DUST EMISSION STANDARDS .....	51
TABLE 8.1:	COMPARISON OF LIFE CYCLE CO <sub>2</sub> EMISSIONS.....	56
TABLE 9.1:	LIFE CYCLE ASSESSMENT FOR ENVIRONMENTAL IMPACTS OF WOOD CHIP COMBUSTION .....	57
TABLE 9.2:	COMPARISON OF SO <sub>2</sub> EMISSIONS FROM BIOMASS AND FOSSIL FUELS IN SMALL BOILERS.....	59
TABLE 9.3:	COMPARISON OF NUMBER OF LIFE YEARS LOST/ADULT DEATHS ATTRIBUTABLE TO PM <sub>10</sub> AIR POLLUTION WITH NUMBER OF DEATHS ATTRIBUTABLE TO TOBACCO USE IRELAND .....	61
TABLE 9.4:	NUMBER OF LIFE YEARS LOST/ADULT DEATHS PREVENTED FROM PM <sub>10</sub> REDUCTIONS IN IRELAND .....	61
TABLE 9.5:	COMPARISON OF NUMBER OF LIFE YEARS LOST/PREMATURE DEATHS ATTRIBUTABLE TO PM <sub>2.5</sub> AIR POLLUTION ACROSS EU COUNTRIES IN 2012.....	61
TABLE 9.6:	PM <sub>10</sub> EMISSIONS FROM A WOOD PELLET BOILER ACCORDING TO ITS MODE OF OPERATION .....	64
TABLE 9.7:	PM <sub>10</sub> EMISSIONS FROM OIL AND GAS BURNING BOILERS ACCORDING TO THEIR MODE OF OPERATION .....	64
TABLE 9.8:	COMPARISON OF PM <sub>10</sub> AND PM <sub>2.5</sub> EMISSIONS FROM BIOMASS AND FOSSIL FUELS IN SMALL BOILERS ....	65
TABLE 9.9:	NOX EMISSIONS FROM A WOOD PELLET BOILER ACCORDING TO ITS MODE OF OPERATION.....	67
TABLE 9.10:	NOX EMISSIONS FROM OIL AND GAS BURNING BOILERS ACCORDING TO THEIR MODE OF OPERATION ....	67
TABLE 9.11:	COMPARISON OF NOX EMISSIONS FROM BIOMASS AND FOSSIL FUELS IN SMALL BOILERS .....	67
TABLE 10.1:	OVERVIEW OF BIOMASS FUEL TYPES.....	68
TABLE 10.2:	AVERAGED PM <sub>10</sub> EMISSIONS FROM THE COMBUSTION OF EN CERTIFIED AND NON-CERTIFIED WOOD PELLETS IN A WOOD PELLET BOILER .....	70
TABLE 10.3:	EMEP/EEA AVERAGE EMISSION LEVELS FROM APPLIANCES <50 kW .....	70
TABLE 10.4:	REDUCTION RATES IN PM <sub>10</sub> AND PM <sub>2.5</sub> USING DIFFERENT ABATEMENT TECHNIQUES.....	80



## LIST OF FIGURES

### PAGE

FIGURE 2.1:	AIR QUALITY ZONES IN IRELAND .....	4
FIGURE 2.2:	EU PM <sub>10</sub> CONCENTRATIONS IN 2013 .....	5
FIGURE 2.3:	EU PM <sub>2.5</sub> CONCENTRATIONS IN 2013 .....	6
FIGURE 2.4:	EU NO <sub>2</sub> CONCENTRATIONS IN 2013 .....	7
FIGURE 2.5:	EXAMPLE OF A PRODUCT ENERGY LABEL FOR A LOCAL SPACE HEATER (INCOMPLETE).....	16
FIGURE 2.6:	EXAMPLE OF A PRODUCT ENERGY LABEL FOR A SOLID FUEL BOILER (INCOMPLETE) .....	17
FIGURE 3.1:	WFQA QUALITY MARK.....	29
FIGURE 5.1:	OPEN FIREPLACE .....	37
FIGURE 5.2:	CLOSED FIREPLACE .....	38
FIGURE 5.3:	EXAMPLES OF MANUALLY FED WOOD STOVES'.....	38
FIGURE 5.4:	EXAMPLE OF A PELLET STOVE .....	39
FIGURE 5.5:	OPERATING PRINCIPLE AND EXAMPLE OF A DOWN DRAUGHT BOILER .....	40
FIGURE 5.6:	AUTOMATIC PELLET BOILER .....	41
FIGURE 5.7:	OVERFED, UNDER FIRE BOILER .....	41
FIGURE 5.8:	OVERFED STOKER BURNER BOILER .....	43
FIGURE 5.9:	LARGE, OVERFED STEPPED GRATE BOILER.....	43
FIGURE 5.10:	OVERFED MOVING GRATE ROTARY COMBUSTION CHAMBER BOILER.....	44
FIGURE 5.11:	UNDERFED STOKER BOILER .....	44
FIGURE 5.12:	BUBBLING FLUIDISED BED COMBUSTION SYSTEM .....	45
FIGURE 5.13:	CIRCULATING FLUIDISED BED COMBUSTION SYSTEM .....	46
FIGURE 6.1:	MAIN STAGES OF BIOMASS COMBUSTION .....	48
FIGURE 6.2:	DURATION OF INDIVIDUAL COMBUSTION PROCESSES.....	48
FIGURE 8.1:	TYPICAL LOW CARBON BIOMASS CYCLE.....	55
FIGURE 9.1:	OVERVIEW OF PM FORMATION .....	63
FIGURE 9.2:	THE OCCURRENCE OF FUEL, THERMAL AND PROMPT NOX.....	66
FIGURE 10.1:	PM EMISSIONS FROM VARIOUS DOMESTIC (<50 kW) COMBUSTION APPLIANCES.....	71
FIGURE 10.2:	PM EMISSIONS FROM VARIOUS DOMESTIC (<50 kW) COMBUSTION APPLIANCES (DT: DILUTION TUNNEL, SPC: SOLID PARTICLE CONDENSABLES) .....	72
FIGURE 10.3:	PM EMISSION LEVELS FROM UNDER STOKER BOILERS 70 – 500 kW.....	73
FIGURE 10.4:	PM EMISSION LEVELS FROM GRATE BOILERS 70 – 500 kW.....	73
FIGURE 10.5:	PM EMISSION LEVELS FROM UNDER STOKER BOILERS 500 kW – 10 MW .....	74
FIGURE 10.6:	PM EMISSION LEVELS FROM GRATE BOILERS 500 kW – 10 MW .....	74
FIGURE 10.7:	CONVENTIONAL TWO-STAGE COMBUSTION, AIR STAGING COMBUSTION AND FUEL STAGING COMBUSTION MEASURES .....	76
FIGURE 10.8:	SINGLE CELL CYCLONE.....	77
FIGURE 10.9:	MULTI CELL CYCLONE .....	78
FIGURE 10.10:	FABRIC FILTER (BAGHOUSE) .....	79
FIGURE 10.11:	PRINCIPLE OF ELECTROSTATIC PRECIPITATOR OPERATION.....	80
FIGURE 10.12:	ELECTROSTATIC PRECIPITATOR.....	80
FIGURE 10.13:	PM SEPARATION EFFICIENCY USING DIFFERENT ABATEMENT TECHNIQUES.....	81
FIGURE 10.14:	MATRIX COMPARING PM REMOVAL EFFECTIVENESS, CAPITAL COSTS AND MAINTENANCE COSTS ASSOCIATED WITH DIFFERENT ABATEMENT TECHNIQUES.....	82
FIGURE 10.15:	AIRFLOW VARIATION AROUND BUILDING STRUCTURE (INDICATIVE).....	85
FIGURE 10.16:	DEFRA BIOMASS CALCULATOR TOOL EXAMPLE (PM <sub>10</sub> ) .....	86

## GLOSSARY

CAFE Directive	The Cleaner Air for Europe (CAFE) Directive (2008/50/EC) is an EU Directive that aims to improve ambient air quality in Europe. Limit values for ambient concentrations of various pollutants are set by this Directive.
CEN/TC 335	The Technical Committee (TC) formed by the European Committee for Standardisation (CEN) for the development of standards for all forms of solid biofuels within Europe.
CfD Scheme	The Contracts for Difference (CfD) scheme is a UK support scheme for large scale renewable electricity generating installations. Unlike the Renewable Obligation scheme, the CfD scheme also provides support to electricity that is generated by nuclear and carbon capture and storage installations.
Competent Person Schemes	UK schemes which allow individuals and organisations to self-certify that the installation work they carry out is in compliance with the relevant regulations.
Devolatisation	Thermal degradation in the absence (pyrolysis) or presence (gasification) of an externally supplied oxidising agent.
ELV	Emission Limit Values (ELVs) are limits, often enforceable through legislation, on the maximum permissible concentration of an air pollutant.
EN <sup>plus</sup>	A European approved fuel quality certification scheme that is managed by the European Pellet Council and relates specifically to part 2 of the EN ISO 17225 standard (for wood pellets).
FIT	A Feed in Tariffs (FIT) scheme is a scheme which aims to promote the installation of renewable and low carbon electricity generation appliances.
Fuel NO <sub>x</sub>	The formation of NO <sub>x</sub> during combustion as a result of the complete oxidation of a fuel.
HETAS	The Heating Equipment Testing and Approval Scheme (HETAS) is a UK based organisation that operates within the biomass and solid fuel heating sector. It provides recognition to high quality biomass heating appliances, installers and biomass fuels, while it also provides a number of appliance installer training courses.
IED	The Industrial Emissions Directive (IED) is an EU Directive that aims to reduce emissions from industrial production processes. ELVs for the concentrations of various pollutants from LCPs are set by this Directive.
LCP	A Large Combustion Plant (LCP) is a plant that falls under the IED.
Life Cycle Emissions	Emissions that take into consideration not only the direct emissions captured by the growth of biomass and released from the combustion of biomass, but also the indirect emissions produced from the cultivation, harvesting, processing and transportation of biomass.
MCP	A Medium Combustion Plant (MCP) is a plant that falls under the MCP Directive and has a total rated thermal input of $\geq 1$ MW and $< 50$ MW.
MCP Directive	The Medium Combustion Plant Directive (MCP Directive) is an EU Directive that aims to protect human health and the environment across the EU by regulating

pollutant emissions from MCPs. ELVs for the concentrations of various pollutants from MCPs are set by this Directive.

MCS Scheme	The Microgeneration Certification (MCS) scheme is a UK scheme that provides recognition to both high quality microgeneration appliance technologies and high quality microgeneration appliance installers.
METAC	The Midland Energy Training and Assessment Centre (METAC) is a provider of energy training and assessment in Ireland. It provides solid fuel training courses that are directly relevant to biomass combustion.
MTC	A Minimum Technical Competence (MTC) is a requirement that needs to be met by installers of biomass appliances in the UK in order to be approved as a member of a UK Competent Persons Scheme.
NEC Directive	The National Emission Ceilings for Certain Atmospheric Pollutants (NEC) Directive (2001/81/EC) is an EU Directive that required all EU Member States to meet specific ELVs or 'ceilings' for specific air pollutants by 2010 and thereafter.
NERT	The National Exposure Reduction Target (NERT) is a target required to be set for PM <sub>2.5</sub> for each EU Member State under the CAFE Directive. Ireland's NERT for PM <sub>2.5</sub> was set at 10% and this NERT is required to be obtained by 2020.
NO <sub>x</sub>	Oxides of Nitrogen (NO <sub>x</sub> ) are emissions which may include Nitric Oxide (NO), Nitrogen Dioxide (NO <sub>2</sub> ) and Nitrous Oxide (N <sub>2</sub> O).
PAH	Polycyclic Aromatic Hydrocarbons (PAHs) are intermediated products which may be formed as a result of PM formation. PAHs are hazardous air pollutants such as benzo(a)pyrene, anthracene, benzaldehyde, chrysene, ethylbenzene and others.
PM <sub>10</sub>	Coarse particulate matter, including all particles that have an aerodynamic diameter that is $\leq 10$ micrometres.
PM <sub>2.5</sub>	Fine particulate matter, including all particles that have an aerodynamic diameter that is $\leq 2.5$ micrometres.
Primary Air	The supply of air at the level of the fuel bed during the combustion process.
Prompt NO <sub>x</sub>	The formation of NO <sub>x</sub> during combustion as a result of the oxidation of nitrogen in the air at high temperatures, with hydrocarbons present during the process. Only becomes significant at temperatures of approximately 1300°C – not usually considered relevant for biomass combustion.
Pyrolysis	The chemical decomposition of a compound as a result of high temperatures and the absence of oxygen.
QQI	Quality and Qualifications Ireland (QQI), the national awarding body for further education and training in Ireland.
QualiCert	'Common quality certification and accreditation for installers of small-scale renewable energy (RE) systems' (QualiCert) was an EU project that reviewed the quality certification and accreditation schemes in place for small scale RE appliance installers in countries throughout the EU.
Registered Gas Installers Register	An Irish scheme put in place so as to ensure the safe installation of gas appliances in Ireland.

Renewable Installers Register	A SEAI implemented register which identifies installers in Ireland who are suitably qualified to carry out the installation of renewable energy technologies.
RES	A binding target put in place by the EU that 16% of Ireland's energy is to be generated from renewable energy sources by 2020.
RES-H	A national, non-binding target set by the Irish government that 12% of Ireland's heat demand is to be met by renewable energy sources by 2020.
RHI	A Renewable Heat Incentive (RHI) is a system which encourages the generation of heat from renewable technologies by providing a fixed payment to the owners of such technologies.
RO	The Renewables Obligation (RO) scheme is a UK scheme which provides support for large scale renewable electricity generating installations in the UK.
SCR	The Selective Catalytic Reduction (SCR) technique of NO <sub>x</sub> abatement operates according to the same principles of the SNCR technique (see below), with the difference being that catalysts are used to speed up the reaction and keep temperatures lower.
Secondary Air	The supply of air above the fuel bed during the combustion process.
SNCR	The Selective Non-Catalytic Reduction (SNCR) technique of NO <sub>x</sub> abatement involves the injection of a reducing agent (either urea or ammonia) into the flue gas – the reducing agent will react with the NO <sub>x</sub> that has been produced from the combustion process to form nitrogen.
SO <sub>x</sub>	Oxides of Sulphur (SO <sub>x</sub> ) are emissions which may include Sulphur Dioxide (SO <sub>2</sub> ) and Sulphur Trioxide (SO <sub>3</sub> ).
TER	The Target Emission Rate (TER) is the maximum emission rate permissible from a biomass appliance before the background limit values are exceeded. TERs are used for the biomass calculator tool that is currently in use in the UK.
Thermal Input	The design rating of an appliance, based on the amount of energy inputted.
Thermal NO <sub>x</sub>	The formation of NO <sub>x</sub> during combustion as a result of the oxidation of nitrogen in the air at high temperatures. Only becomes significant at temperatures of approximately 1300°C – not usually considered relevant for biomass combustion.
Thermal Output	The realised energy (heat) that is produced from an appliance.
Triple E Products Register	The Triple E (Excellence in Energy Efficiency) Products Register is an initiative introduced by the SEAI which aims to give recognition to renewable energy products within Ireland that are 'best in class' in terms of energy efficiency.
WFQA	The Wood Fuel Quality Assurance Scheme (WFQA) is an Irish scheme that aims to ensure consumer confidence in the purchase of wood fuels throughout Ireland. It does so through the application of the fuel requirements outlined in EN ISO 17225, parts 1-5.

## 1 INTRODUCTION

The Irish Bioenergy Association (IrBEA) retained Fehily Timoney & Company (FT) to undertake a study to assess the potential impacts, in terms of air quality, of an increase in biomass combustion in Ireland, along with the mitigation measures which may be put in place to limit these impacts.

This report, included as Appendix 1 to the main Project Report provides a technical overview of the generation of emissions from biomass combustion and the factors that influence the extent and magnitude of these emissions.

It is by no means intended to be exhaustive, as the technical aspects of biomass emissions generation are very broad and can be quite complex – rather, it attempts to present an overview of relevant factors related to biomass emissions, in terms of, *inter alia*, legislative requirements, availability of guidance and standards, the combustion process, types of biomass appliances, the nature of emissions and the factors that influence their generation.

## 2 RELEVANT LEGISLATION

### 2.1 Air Quality Legislation

#### 2.1.1 EU Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the CAFE Air Quality Directive)<sup>1</sup>

The CAFE Air Quality Directive was published on the 21<sup>st</sup> of May 2008 and entered into force on the 11<sup>th</sup> of June 2011. This Directive consolidated the following earlier EU Air Quality Directives:

- Air Quality Framework Directive, 1996/62/EC
- First Daughter Directive, 1999/30/EC
- Second Daughter Directive, 2000/69/EC
- Third Daughter Directive, 2002/3/EC

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. 180 of 2011)<sup>2</sup>. The Directive outlines a number of air quality objectives for the protection of human health and the environment within the EU. It sets limit values for ambient concentrations of the following pollutants:

- Particulate Matter (PM<sub>10</sub> and PM<sub>2.5</sub>)
- Nitrogen Dioxide (NO<sub>2</sub>) and other oxides of nitrogen
- Sulphur Dioxide (SO<sub>2</sub>)
- Carbon Monoxide (CO)
- Benzene (C<sub>6</sub>H<sub>6</sub>)
- Ozone (O<sub>3</sub>)

New standards relating to fine particulate matter (PM<sub>2.5</sub>) were introduced by the Directive. PM<sub>2.5</sub> is considered to be particularly harmful to human health, due to its contribution to respiratory and cardiovascular illnesses. The Directive requires Member States to reduce exposure to PM<sub>2.5</sub> in urban areas by 20% by 2020 based on 2010 levels.

The CAFE Directive also provided more flexibility to Member States for meeting air quality standards by allowing for time extensions (three years for PM<sub>10</sub> or up to five years for NO<sub>2</sub> and benzene) for compliance with limit values. The Directive indicated that when limit values were not complied with by the set deadline, the areas where exceedances were noted must enact and implement air quality plans.

Annex XI of the CAFE Directive outlines limit values for ambient concentrations of specific pollutants. Limit values for the pollutants which are directly relevant to biomass emissions are identified in Table 2.1.

Table 2.1: Limit values of the CAFE Directive

Pollutant	Averaging Period	Limit Value (ug/m <sup>3</sup> )	Basis of Application of Limit Value	Limit Value Obtainment Date
PM <sub>10</sub>	24 hours (daily mean)	50	Exceedance no more than 35 times a year	1 <sup>st</sup> Jan 2005
PM <sub>10</sub>	Calendar year (annual mean)	40	Not to be exceeded	1 <sup>st</sup> Jan 2005
PM <sub>2.5</sub> – Stage 1	Calendar year (annual mean)	25	Not to be exceeded	1 <sup>st</sup> Jan 2015

<sup>1</sup> European Parliament (2008) <http://eur-lex.europa.eu/eli/dir/2008/50/oj>

<sup>2</sup> Government of Ireland (2011a) <http://www.irishstatutebook.ie/eli/2011/si/180/made/en/print>

Pollutant	Averaging Period	Limit Value (ug/m <sup>3</sup> )	Basis of Application of Limit Value	Limit Value Obtainment Date
PM <sub>2.5</sub> – Stage 2	Calendar year (annual mean)	20	Not to be exceeded	1 <sup>st</sup> Jan 2020
NO <sub>2</sub>	1 hour	200	Exceedance no more than 18 times a year	1 <sup>st</sup> Jan 2010
NO <sub>2</sub>	Calendar year (annual mean)	40	Not to be exceeded	1 <sup>st</sup> Jan 2010
SO <sub>2</sub>	1 hour	350	Exceedance no more than 24 times a year	1 <sup>st</sup> Jan 2005
SO <sub>2</sub>	24 hours (daily mean)	125	Exceedance no more than 3 times a year	1 <sup>st</sup> Jan 2005
CO	8 hours	10,000	Not to be exceeded	1 <sup>st</sup> Jan 2005
Benzene	Calendar year (annual mean)	5	Not to be exceeded	1 <sup>st</sup> Jan 2010

In addition to the above listed pollutant limit values, the CAFE Directive requires the setting of a National Exposure Reduction Target (NERT) for PM<sub>2.5</sub> for each Member State. NERTs are established based on the Average Exposure Indicator (AEI), which in Ireland's case was determined from air quality monitoring carried out by the EPA over a number of consecutive years<sup>3</sup>. Based on this historical data provided by the EPA, Ireland's NERT for PM<sub>2.5</sub> was set at 10% and this NERT is required, under the CAFE Directive, to be obtained by 2020. The 10% reduction target identified equates to a reduction in PM<sub>2.5</sub> levels of 1 µg/m<sup>3</sup> by 2020 (from the calculated AEI of 10.4 µg/m<sup>3</sup> to 9.4 µg/m<sup>3</sup>).

Under the CAFE Directive, EU Member States are required to designate 'zones' for the assessment and management of air quality. Ireland defined four such zones in the Air Quality Standards Regulations 2011. These zones are presented in Figure 2.1 and are defined as follows<sup>3</sup>:

- Zone A: Dublin
- Zone B: Cork
- Zone C: Other cities and large towns with a population >15,000
- Zone D: Rural Ireland, i.e. the remainder of Ireland excluding Zones A, B and C

<sup>3</sup> EPA (2015) *Air Quality in Ireland 2014 – Key Indicators of Ambient Air Quality*.

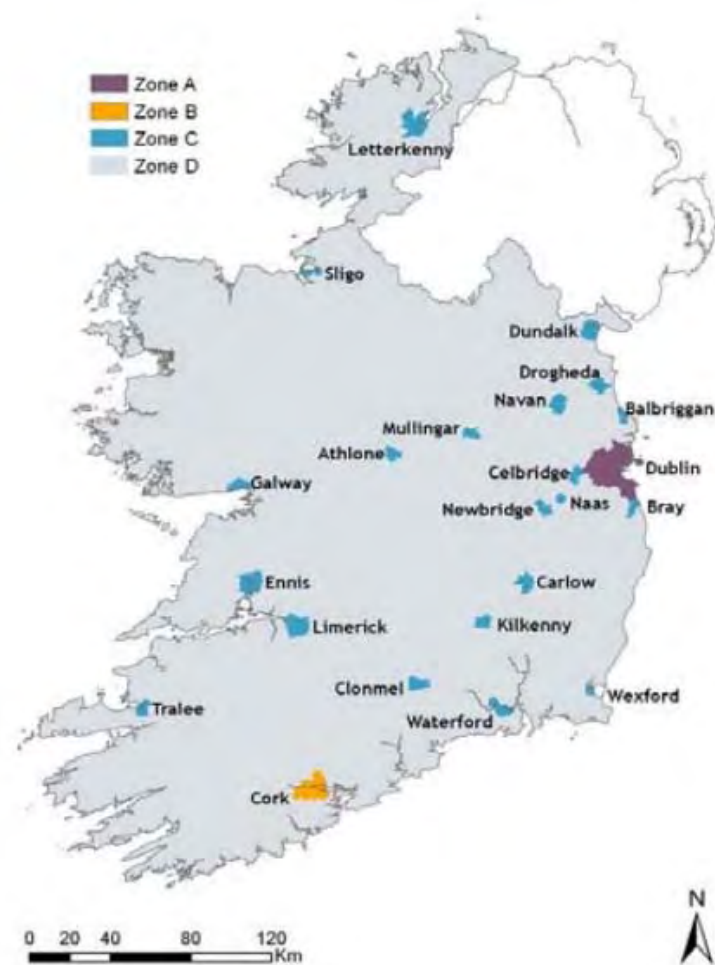


Figure 2.1: Air quality zones in Ireland<sup>3</sup>

The air quality zones in Ireland were amended in 2013 to reflect the results of the 2011 census. Air quality is assessed at monitoring stations within each of the four zones on a regular basis, with the collected data subsequently compared to the limit values set by the CAFE Directive.

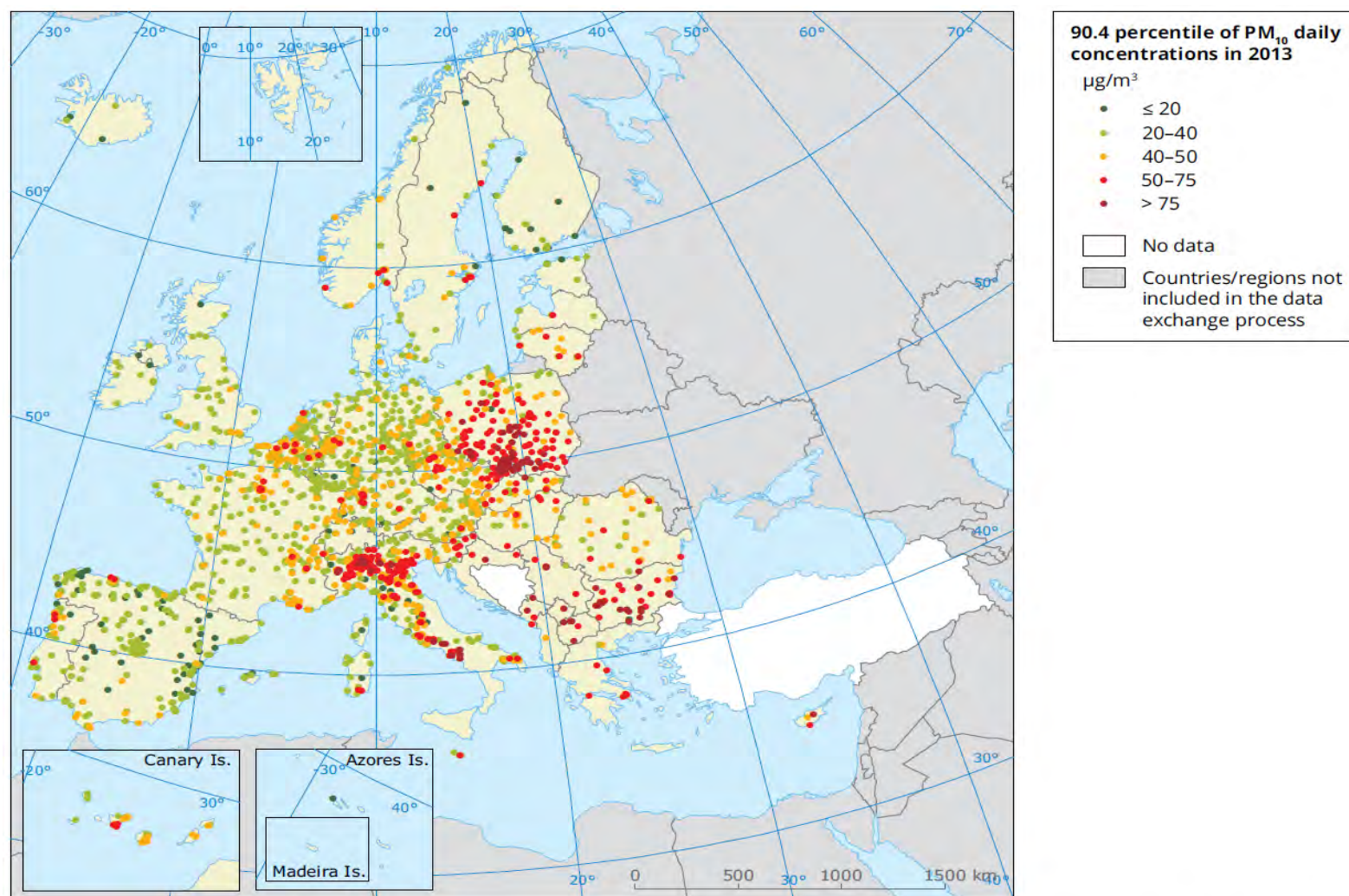
The attainment of PM<sub>10</sub> daily limit values, PM<sub>2.5</sub> annual mean values and NO<sub>2</sub> annual mean values across all EU Member States for the year 2013 are presented in Figure 2.2, Figure 2.3 and Figure 2.4<sup>4</sup>. PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> are considered to be the most significant pollutants in terms of biomass emissions. As can be seen from the below figures, Ireland has a generally good ambient air quality compared with other EU Member States.

No exceedances of the CAFE Directive limit values for PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO or Benzene were reported to the European Commission by Ireland in 2014<sup>5</sup>.

<sup>4</sup> EEA (2015) *Air Quality in Europe 2015*.

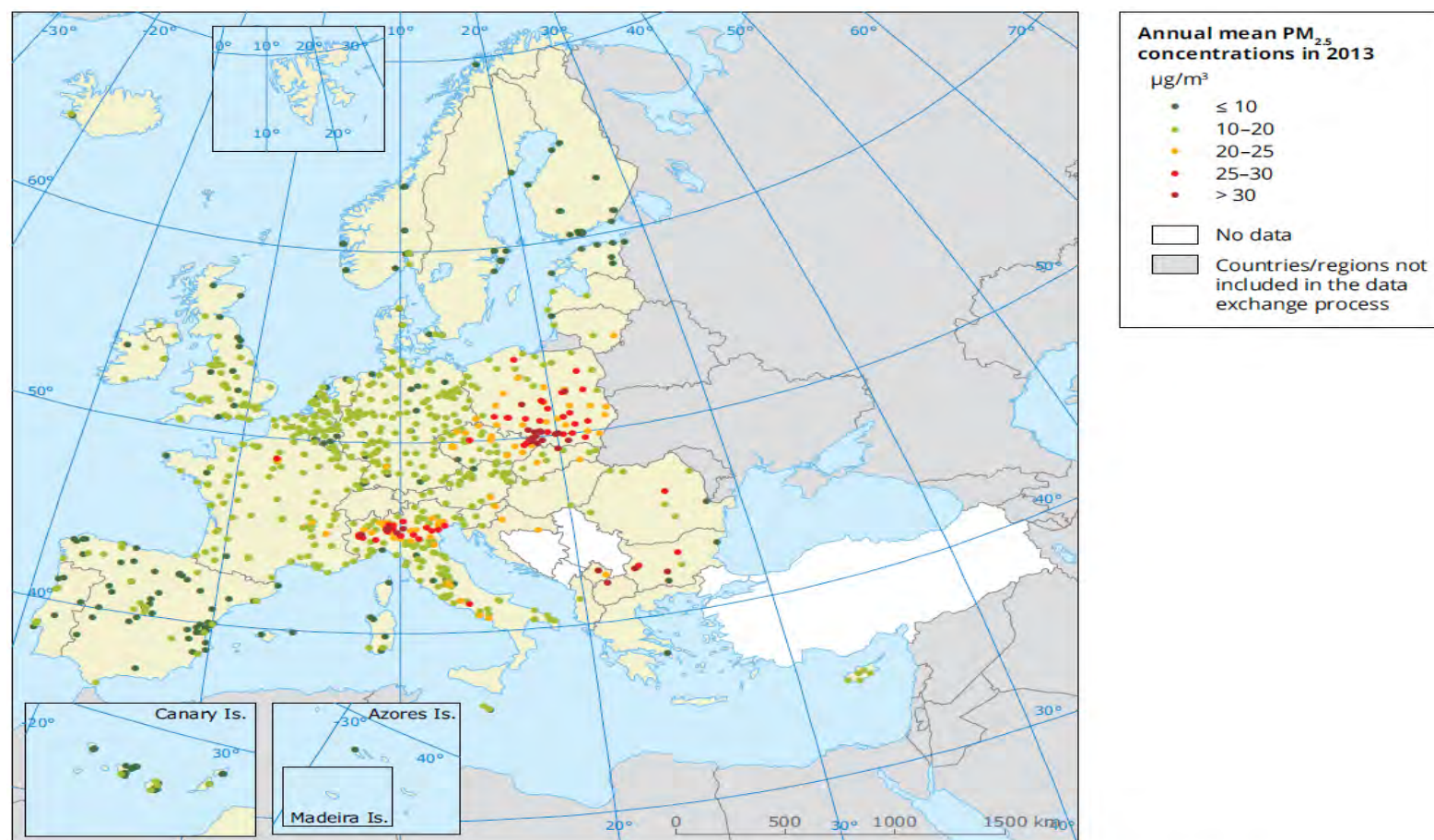
<sup>5</sup> Nagl, C., Schneider, J. & Thielen, P. (2016) *Implementation of the Ambient Air Quality Directive*. European Parliament.





**Notes:** The map shows the 90.4 percentile of the data records in one year, representing the 36th highest value in a complete series. It is related to the PM<sub>10</sub> daily limit value, allowing 35 exceedances over 1 year of the 50 µg/m<sup>3</sup> threshold. The red and dark-red dots indicate stations with exceedances of this daily limit value. Only stations with > 75% of valid data have been included in the map.

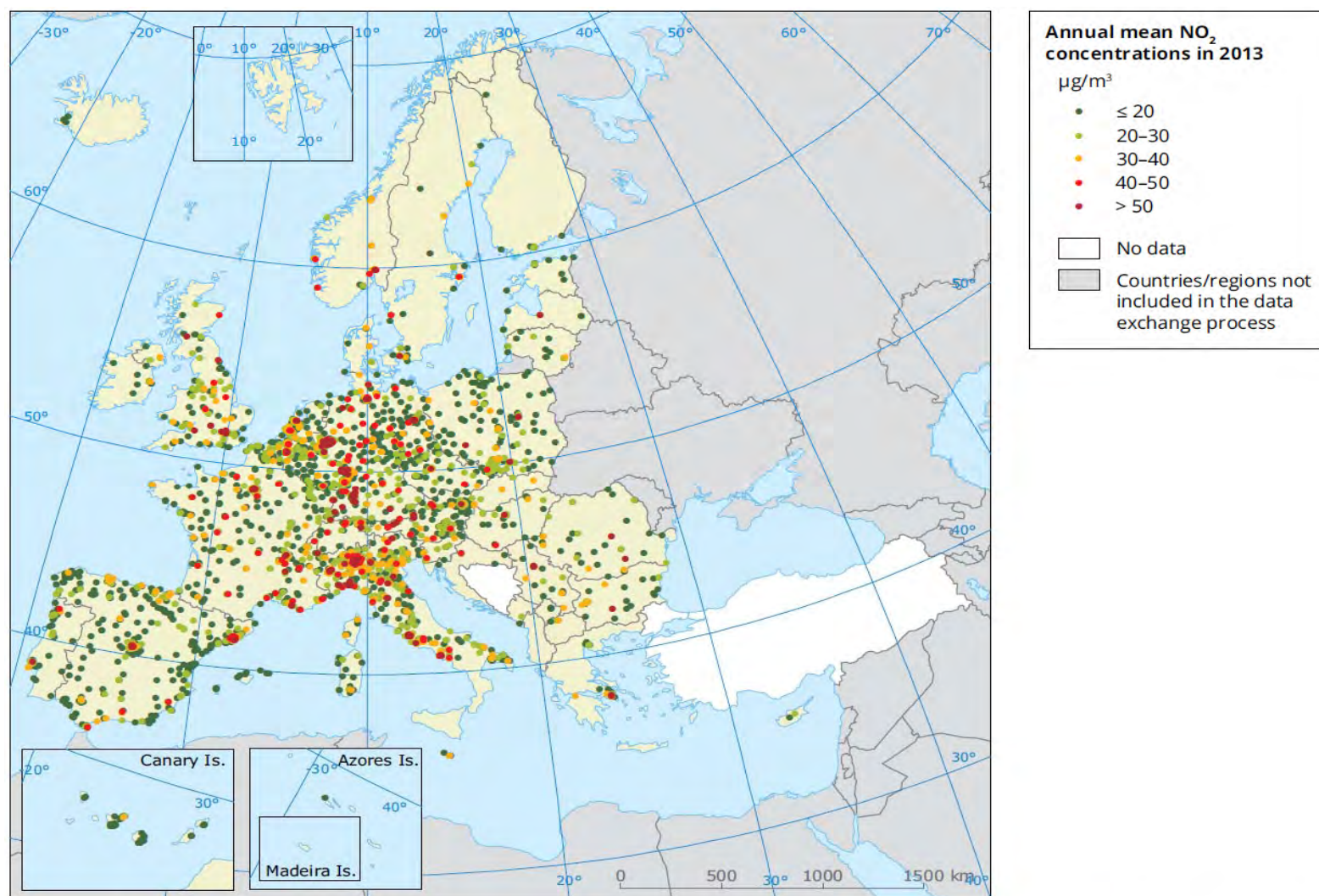
Figure 2.2: EU PM<sub>10</sub> concentrations in 2013<sup>4</sup>



**Notes:** The dark-red dots indicate stations reporting exceedances of the EU annual target value ( $25 \mu\text{g}/\text{m}^3$ ) plus at least  $5 \mu\text{g}/\text{m}^3$ .  
 The red dots indicate stations reporting exceedances of the EU annual target value ( $25 \mu\text{g}/\text{m}^3$ ).  
 The orange dots indicate stations reporting exceedances of the 2020 EU indicative annual limit value ( $20 \mu\text{g}/\text{m}^3$ ).  
 The light-green dots indicate stations reporting exceedances of the WHO AQG for PM<sub>2.5</sub> ( $10 \mu\text{g}/\text{m}^3$ ).  
 The dark-green dots indicate stations reporting values below the WHO AQG for PM<sub>2.5</sub> ( $10 \mu\text{g}/\text{m}^3$ ).  
 Only stations with  $> 75\%$  of valid data have been included in the map.

Figure 2.3: EU PM<sub>2.5</sub> concentrations in 2013<sup>4</sup>





**Notes:** Red and dark-red dots correspond to exceedances of the EU annual limit value and the WHO AQG (40 µg/m<sup>3</sup>). Only stations reporting hourly data and with > 75% of valid data have been included in the map.

Figure 2.4: EU NO<sub>2</sub> concentrations in 2013<sup>4</sup>

2.1.2 EU Directive 2001/81/EC on National Emission Ceilings for Certain Atmospheric Pollutants (the NEC Directive)<sup>6</sup>

The NEC Directive was published on the 23<sup>rd</sup> of October 2001 and entered into force on the 27<sup>th</sup> of November 2001. This Directive was transposed into Irish legislation by the European Communities (National Emission Ceilings) Regulations 2004 (S.I. 10 of 2004)<sup>7</sup>, which were subsequently amended by the European Communities (National Emission Ceilings) (Amendment) Regulations 2012 (S.I. 303 of 2012)<sup>8</sup>.

The NEC Directive required all EU Member States to meet specific emission limit values or 'ceilings' for the following four air pollutants by 2010 and thereafter:

- Oxides of Nitrogen (NO<sub>x</sub>)
- Sulphur Dioxide (SO<sub>2</sub>)
- Non-Methane Volatile Organic Compounds (NMVOCs)
- Ammonia (NH<sub>3</sub>)

Annex I of the NEC Directive outlines limit values for the above pollutants for each of the EU Member States. Limit values identified for Ireland are presented in Table 2.2.

Table 2.2: NEC Directive limit values relating to Ireland

NO <sub>x</sub> (kilotonnes)	SO <sub>2</sub> (kilotonnes)	NMVOCs (kilotonnes)	NH <sub>3</sub> (kilotonnes)
65	42	55	116

The attainment of NO<sub>x</sub>, SO<sub>2</sub>, NMVOC and NH<sub>3</sub> limit values across all EU Member States for the years 2010 to 2014 are presented in Table 2.3<sup>9</sup>. NO<sub>x</sub> is considered to be a principal pollutant in terms of biomass emissions. As can be seen from Table 2.3, Ireland has exceeded its NO<sub>x</sub> emission ceilings each year between 2010 and 2014.

As part of the Clean Air Programme announced by the European Commission in 2013, it was proposed that the NEC Directive be revised. The revision of this Directive is currently in progress and it is expected that the revised Directive will be voted in in late 2016<sup>10</sup>. The revised Directive will outline new national emission reduction commitments for both the pollutants listed above and additional pollutants; namely fine particulate matter (PM<sub>2.5</sub>) and Methane (CH<sub>4</sub>)<sup>10</sup>. The new national emission reduction commitments will be applicable from 2020 and from 2030<sup>10</sup>.

<sup>6</sup> European Parliament (2001) <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32001L0081>

<sup>7</sup> Government of Ireland (2004) <http://www.irishstatutebook.ie/eli/2004/si/10/made/en/print>

<sup>8</sup> Government of Ireland (2012) <http://www.irishstatutebook.ie/eli/2012/si/303/made/en/print>

<sup>9</sup> EEA (2016) *NEC Directive Reporting Status 2015*.

<sup>10</sup> European Council (2016) <http://www.consilium.europa.eu/en/policies/clean-air/national-emission-ceilings/>

Table 2.3: EU Member State progress in meeting NEC Directive emission ceilings<sup>9</sup>

Member State	NO <sub>x</sub>					NMVOCs					SO <sub>2</sub>					NH <sub>3</sub>				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Austria	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×
Belgium	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bulgaria	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Croatia					✓					✓					✓					✓
Cyprus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Czech Republic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Denmark	×	×	×	✓	✓	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×
Estonia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Finland	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×
France	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Germany	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×
Greece	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hungary	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ireland	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Italy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Latvia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lithuania	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Luxembourg	×	×	×	×	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Malta	×	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Netherlands	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×
Poland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Portugal	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Romania	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Slovakia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Slovenia	✓	×	×	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spain	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×
Sweden	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
United Kingdom	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
✓	15	16	17	21	22	22	22	23	23	24	27	27	27	27	28	21	21	21	21	22
×	12	11	10	6	6	5	5	4	4	4	0	0	0	0	0	6	6	6	6	6

Note: 2010, 2011, 2012 and 2013: final data; 2014: provisional data

### 2.1.3 National Clean Air Strategy

In an attempt to comply with the above pieces of European legislation, and by association, to ensure the protection of human health, the Irish government is currently working to produce a National Clean Air Strategy for the country<sup>11</sup>. While no policy or legislation is currently in place in relation to this Strategy due to its early stage of development, it is envisaged that the Strategy will provide a framework for the creation of policies relating to air quality in Ireland. The Strategy will take account of areas such as transport, energy, home heating and agriculture and the impacts that these are having on air quality. A public consultation in relation to the Strategy is being undertaken in 2016, with further development likely over the coming years.

<sup>11</sup> Department of Housing, Planning, Community and Local Government (2016)  
<http://www.housing.gov.ie/environment/air-quality/national-clean-air-strategy>

## 2.2 Emissions – Industrial Plant

### 2.2.1 EU Directive 2010/75/EU on industrial emissions (IED)<sup>12</sup>

The IED was adopted on the 24<sup>th</sup> of November 2010. It entered into force on the 6<sup>th</sup> of January 2011 and was required to be transposed by Member States by the 7<sup>th</sup> of January 2013. The IED repealed seven previous EU Directives, including the IPPC Directive (2008/1/EC).

The IED was transposed into Irish legislation by the European Union (Industrial Emissions) Regulations 2013 (S.I. 138 of 2013)<sup>13</sup> and the Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013 (S.I. 137 of 2013)<sup>14</sup>.

The primary aim of the Directive is to reduce emissions from industrial production processes which account for considerable levels of pollution across Europe. The Directive takes account of not only air emissions, but also the generation of waste and emissions to land and water.

The IED sets out the main principles for the permitting and control of installations according to:

- An integrated approach, taking into account the entire environmental performance of installations
- The use of Best Available Techniques (BAT)
- Flexibility in relation to emission limit values – only in specific cases
- Environmental inspection requirements – site visits by a competent authority required every 1-3 years
- The right to allow public participation in the permitting process

Emission Limit Values (ELVs) are set for selected pollutants from Large Combustion Plants (LCPs) in Annex V to the IED. The ELVs set for LCPs in the IED replaced those set in the previous LCP Directive (2001/80/EC) from the 1<sup>st</sup> of January 2016. LCPs are defined in the IED as having a total rated thermal input of  $\geq 50$  MW. The total rated thermal input applies to the entire combustion plant. To date, there are no dedicated biomass plants of this scale in Ireland, albeit that Edenderry Power (128 MW) co-fires biomass at a c. 30% substitution rate.

ELVs for dust<sup>15</sup>, NO<sub>x</sub> and SO<sub>2</sub> and as set in the IED are presented in Table 2.4 and Table 2.5. Dust, NO<sub>x</sub> and SO<sub>2</sub> are pollutants which are directly relevant to biomass emissions. ELVs presented in Table 2.4 apply to LCPs that were granted a permit prior to the 7<sup>th</sup> of January 2013, whereas ELVs presented in Table 2.5 apply to all other LCPs.

All ELVs were calculated at a temperature of 273.15 K, a pressure of 101.3 kPa and a standardised O<sub>2</sub> content of 6% for solid fuels.

Table 2.4: ELVs set by the IED – permit granted prior to 7<sup>th</sup> January 2013

Total rated thermal input (MW)	Dust (mg/Nm <sup>3</sup> )	NO <sub>x</sub> (mg/Nm <sup>3</sup> )	SO <sub>2</sub> (mg/Nm <sup>3</sup> )
50-100	30	300	200
100-300	20	250	
>300	20	200	

<sup>12</sup> European Parliament (2010a) <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075>

<sup>13</sup> Government of Ireland (2013a) <http://www.irishstatutebook.ie/eli/2013/si/138/made/en/pdf>

<sup>14</sup> Government of Ireland (2013b) <http://www.irishstatutebook.ie/eli/2013/si/137/made/en/pdf>

<sup>15</sup> 'Dust' means particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions (IED 2010/75/EU)



Table 2.5: ELVs set by the IED – permit granted on or after 7<sup>th</sup> January 2013

Total rated thermal input (MW)	Dust (mg/Nm <sup>3</sup> )	NO <sub>x</sub> (mg/Nm <sup>3</sup> )	SO <sub>2</sub> (mg/Nm <sup>3</sup> )
50-100	20	250	200
100-300		200	
>300		150	150

### 2.2.2 EU Directive 2015/2193 on medium combustion plants (MCP)<sup>16</sup>

The MCP Directive entered into force on the 18<sup>th</sup> of December 2015 and is required to be transposed by Member States by the 19<sup>th</sup> of December 2017. To date, it has yet to be transposed into Irish legislation.

MCPs are significant sources of NO<sub>x</sub>, SO<sub>2</sub> and dust emissions throughout Europe. There are an estimated 143,000 MCPs currently in the EU<sup>17</sup>. The MCP Directive aims to protect human health and the environment across the EU by regulating dust, NO<sub>x</sub> and SO<sub>2</sub> emissions from MCPs. The Directive also aims to ensure that CO emissions from MCPs are monitored.

The Directive sets ELVs for selected pollutants. MCPs are defined in the Directive as having a total rated thermal input of  $\geq 1$  MW and  $< 50$  MW. For existing MCPs, ELVs will be required to be complied with from either 2025 or 2030 onwards, depending on the size of the MCP. For new MCPs, ELVs will be required to be complied with from the 20<sup>th</sup> of December 2018 onwards. It is likely that, in an Irish context, any industrial or large commercial biomass installation would fall within this scale – the larger, existing or proposed biomass facilities currently fall within this range, examples being Aurivo, Ballaghadereen, Co. Roscommon (12 MW), Astellas, Killorglin, Co. Kerry (1.8 MW) and Mayo Renewable Power (42.5 MW).

ELVs for dust<sup>18</sup>, NO<sub>x</sub> and SO<sub>2</sub> as set in the MCP Directive are presented in Table 2.6 and Table 2.7. Dust, NO<sub>x</sub>, and SO<sub>2</sub> are pollutants which are directly relevant to biomass emissions. ELVs presented in Table 2.6 apply to existing MCPs, whereas ELVs presented in Table 2.7 apply to new MCPs. All ELVs were calculated at a temperature of 273.15 K, a pressure of 101.3 kPa and a standardised O<sub>2</sub> content of 6% for solid fuels.

Table 2.6: ELVs set by the MCP Directive – existing MCPs

Total rated thermal input (MW)	Dust (mg/Nm <sup>3</sup> )	NO <sub>x</sub> (mg/Nm <sup>3</sup> )	SO <sub>2</sub> (mg/Nm <sup>3</sup> )
$\geq 1$ & $\leq 5$	50	650	200 <sup>1,2</sup>
$> 5$ & $\leq 20$	50		
$> 20$ & $< 50$	30		

<sup>1</sup> The value does not apply in the case of plants firing exclusively woody solid biomass

<sup>2</sup> 300 mg/Nm<sup>3</sup> in the case of plants firing straw

<sup>16</sup> European Parliament (2015) <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32015L2193>

<sup>17</sup> European Commission (2016a) <http://ec.europa.eu/environment/industry/stationary/mcp.htm>

<sup>18</sup> 'Dust' means particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions (MCP Directive 2015/2193)

Table 2.7: ELVs set by the MCP Directive – new MCPs

Total rated thermal input (MW)	Dust (mg/Nm³)	NOx (mg/Nm³)	SO₂ (mg/Nm³)
≥1 & ≤5	50	500	200¹
>5 & ≤20	30	300	
>20 & <50	20		

<sup>1</sup> The value does not apply in the case of plants firing exclusively woody solid biomass

## 2.3 Biomass Appliances - Emissions

### 2.3.1 EU Ecodesign Directive 2009/125/EC<sup>19</sup>

The Ecodesign Directive entered into force on the 20<sup>th</sup> of November 2009. This Directive repealed the earlier Ecodesign Directive (2005/32/EC), while it also amended Directives 92/42/EEC, 96/57/EC and 2000/55/EC.

The Ecodesign Directive regulates the environmental performance of energy related products across the EU by setting minimum mandatory requirements for the energy efficiency of these products. A number of EU Commission Regulations have been set which relate to specific products that fall under the Ecodesign Directive. The following two Regulations are considered relevant for this study in terms of biomass products:

- Regulation 2015/1185 with regard to eco-design requirements for solid fuel local space heaters<sup>20</sup>
- Regulation 2015/1189 with regard to eco-design requirements for solid fuel boilers<sup>21</sup>

The above Commission Regulations were implemented by the Ecodesign Directive and were both transposed into Irish legislation by the European Union (Ecodesign Requirements for Certain Energy-related Products) (Amendment) Regulations 2016 (S.I. 228 of 2016)<sup>22</sup>.

Commission Regulations 2015/1185 and 2015/1189 set ELVs for selected pollutants. Pollutants covered are PM, NO<sub>x</sub>, CO and Organic Gaseous Compounds. The ELVs are set for specific product types that fall under the above Regulations.

It is important to note that, unlike the MCP Directive and the IED, the Ecodesign Directive sets ELVs according to the thermal output, rather than the thermal input of the appliance. Thermal output relates to the realised energy (heat) that is produced from an appliance, whereas thermal input refers to the design rating of an appliance, based on the amount of energy inputted. The above difference between measured thermal output and thermal input means that these two separate classifications, while often close, are not directly comparable. Care should be taken by the reader when directly comparing ELVs between the MCP Directive/IED and the Ecodesign Directive.

### Commission Regulation 2015/1185

ELVs set by Commission Regulation 2015/1185 for solid fuel local space heaters are presented in Table 2.8. These ELVs are for solid fuel local space heaters with a nominal thermal output of ≤50 kW. The ELVs will be required to be complied with from the 1<sup>st</sup> of January 2022 onwards.

All ELVs refer to dry exit flue gas, calculated at a temperature of 273.15 K, a pressure of 101.3 kPa and a standardised O<sub>2</sub> content of 13%.

<sup>19</sup> European Parliament (2009) <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125>

<sup>20</sup> European Commission (2015a) [http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L\\_.2015.193.01.0001.01.ENG](http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2015.193.01.0001.01.ENG)

<sup>21</sup> European Commission (2015b) [http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L\\_.2015.193.01.0100.01.ENG](http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2015.193.01.0100.01.ENG)

<sup>22</sup> Government of Ireland (2016) <http://www.irishstatutebook.ie/eli/2016/si/228/made/en/print>



Table 2.8: ELVs set by Commission Regulation EU 2015/1185

	PM (mg/m <sup>3</sup> )	NO <sub>x</sub> (mg/m <sup>3</sup> )	CO <sub>x</sub> (mg/m <sup>3</sup> )	Organic Gaseous Compounds (mg C/m <sup>3</sup> )
Open Fronted Space Heaters	50	200	2,000	120
Closed Fronted Space Heaters <sup>1</sup> and Cookers	40		1,500	120
Closed Fronted Space Heaters <sup>2</sup>	20		300	60

<sup>1</sup> The value does not apply in the case of plants firing exclusively woody solid biomass

<sup>2</sup> 300 mg/Nm<sup>3</sup> in the case of plants firing straw

### Commission Regulation 2015/1189

ELVs set by Commission Regulation 2015/1189 for solid fuel boilers are presented in Table 2.9. These ELVs are for solid fuel boilers with a total rated thermal output of  $\leq 500$  kW. The ELVs are presented as 'seasonal space heating emissions' of the selected pollutant. This means:

- For automatically stoked solid fuel boilers, a weighted average of the emissions at rated heat output and the emissions at 30% of the rated heat output, expressed in mg/m<sup>3</sup>;
- For manually stoked solid fuel boilers that can be operated at 50% of the rated heat output in continuous mode, a weighted average of the emissions at rated heat output and the emissions at 50% of the rated heat output, expressed in mg/m<sup>3</sup>;
- For manually stoked solid fuel boilers that cannot be operated at 50% or less of the rated heat output in continuous mode, the emissions at rated heat output, expressed in mg/m<sup>3</sup>;
- For solid fuel cogeneration boilers, the emissions at rated heat output, expressed in mg/m<sup>3</sup>

The ELVs presented in Commission Regulation 2015/1189 will be required to be complied with from the 1<sup>st</sup> of January 2020 onwards.

All ELVs refer to dry exit flue gas, calculated at a temperature of 273.15 K, a pressure of 101.3 kPa and a standardised O<sub>2</sub> content of 10%.

Table 2.9: ELVs set by Commission Regulation EU 2015/1189

	PM (mg/m <sup>3</sup> )	NO <sub>x</sub> (mg/m <sup>3</sup> )	CO <sub>x</sub> (mg/m <sup>3</sup> )	Organic Gaseous Compounds (mg C/m <sup>3</sup> )
Automatically Stoked Boilers	40	200	500	20
Manually Stoked Boilers	60		700	30

## 2.4 Biomass Appliances – Energy Performance

### 2.4.1 EU Ecodesign Directive 2009/125/EC<sup>19</sup>

In addition to the ELVs set by Commission Regulations 2015/1185 and 2015/1189 under the Ecodesign Directive (presented in Section 2.3.1), minimum standards for product energy efficiency were also set by these Regulations. As identified in Section 10.4 following, the efficiency of a biomass appliances can have a considerable impact on the generation of biomass emissions from the unit.

### Commission Regulation 2015/1185<sup>20</sup>

Minimum standards for the 'seasonal space heating energy efficiency' of solid fuel local space heaters are presented in Table 2.10. These standards are for solid fuel local space heaters with a nominal thermal output of  $\leq 50$  kW and will be required to be complied with from the 1<sup>st</sup> of January 2022 onwards.

'Seasonal space heating energy efficiency' refers to the ratio between the space heating demand, supplied by a solid fuel local space heater and the annual energy consumption required to meet this demand, expressed as a percentage<sup>19</sup>.

Table 2.10: Minimum seasonal space heating energy efficiency standards set by Commission Regulation EU 2015/1185

Type of solid fuel local space heater	Minimum seasonal space heating energy efficiency
Open fronted	30%
Closed fronted using solid fuel other than compressed wood in the form of pellets	65%
Closed fronted using compressed wood in the form of pellets	79%
Cookers	65%

### Commission Regulation 2015/1189<sup>21</sup>

Minimum standards for the 'seasonal space heating energy efficiency' of solid fuel boilers are presented in Table 2.11. These standards are for solid fuel boilers with a total rated thermal output of  $\leq 500$  kW and will be required to be complied with from the 1<sup>st</sup> of January 2020 onwards.

'Seasonal space heating energy efficiency' means:

- For automatically stoked solid fuel boilers, a weighted average of the usual efficiency at rated heat output and the usual efficiency at 30% of the rated heat output, expressed as a percentage;
- For manually stoked solid fuel boilers that can be operated at 50% of the rated heat output in continuous mode, a weighted average of the usual efficiency at rated heat output and the usual efficiency at 50% of the rated heat output, expressed as a percentage;
- For manually stoked solid fuel boilers that cannot be operated at 50% or less of the rated heat output in continuous mode, the usual efficiency at rated heat output, expressed as a percentage;
- For solid fuel cogeneration boilers, the usual efficiency at rated heat output, expressed as a percentage

Table 2.11: Minimum seasonal space heating energy efficiency standards set by Commission Regulation EU 2015/1189

Total rated thermal output (kW)	Minimum seasonal space heating energy efficiency
≤20	75%
>20 & ≤500	77%

#### 2.4.2 EU Energy Labelling Directive 2010/30/EU<sup>23</sup>

The Energy Labelling Directive entered into force on the 19<sup>th</sup> of June 2010. This Directive amended the earlier EU Directive on Energy Efficiency (2012/27/EU).

The Energy Labelling Directive establishes a framework for the provision of labelling and information to consumers that relates to the energy consumption of energy related products. Similar to the Ecodesign Directive (2009/125/EC), a number of EU Commission Regulations were set relating to specific products that fall under the Energy Labelling Directive. The following two Delegated Regulations are considered relevant for this study in terms of biomass products:

- Delegated Regulation 2015/1186 with regard to energy labelling local space heaters<sup>24</sup>
- Delegated Regulation 2015/1187 with regard to energy labelling of solid fuel boilers and packages of solid fuel boilers, supplementary heaters, temperature controls and solar devices<sup>25</sup>

The Energy Labelling Directive was transposed into Irish legislation by the European Union (Energy Labelling) (Amendment) Regulations 2014 (S.I. 351 of 2014)<sup>26</sup>. While these Regulations have also transposed a number of individual Delegated Regulations that fall under the Energy Labelling Directive, Delegated Regulations 2015/1186 and 2015/1187 have yet to be transposed into Irish legislation.

Delegated Regulations 2015/1186 and 2015/1187 both present specific information which should be included with products so as inform consumers on the energy consumption levels of these products. This information is outlined below.

#### Delegated Commission Regulation 2015/1186

All local space heaters should have their class of energy efficiency determined on the basis of their energy efficiency index, as set out in Table 2.12. The energy efficiency index is calculated according to a specific method outlined in Delegated Commission Regulation 2015/1186.

Table 2.12: Energy efficiency classes of local space heaters as set by Delegated Commission Regulation 2015/1186

Energy efficiency class	Energy efficiency index (EEI)
A++	EEI ≥ 130
A+	107 ≤ EEI < 130
A	88 ≤ EEI < 107
B	82 ≤ EEI < 88
C	77 ≤ EEI < 82

<sup>23</sup> European Parliament (2010b) <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32010L0030>

<sup>24</sup> European Commission (2015c) <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1186&from=EN>

<sup>25</sup> European Commission (2015d) <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R1187&from=EN>

<sup>26</sup> Government of Ireland (2014) <http://www.irishstatutebook.ie/eli/2014/si/351/made/en/print>

Energy efficiency class	Energy efficiency index (EEI)
D	$72 \leq \text{EEI} < 77$
E	$62 \leq \text{EEI} < 77$
F	$42 \leq \text{EEI} < 62$
G	$\text{EEI} < 42$

A product energy label should also be included on all local space heaters indicating the following information:

- Supplier's name or trade mark
- Supplier's model identifier
- Energy efficiency class
- Symbol for direct heat output
- Direct heat output in kW
- Symbol for indirect heat outputs (for local space heaters with heat transfer to a fluid)
- Indirect heat output in kW (for local space heaters with heat transfer to a fluid)

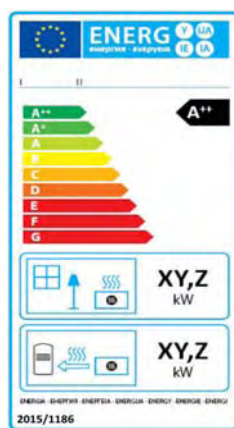


Figure 2.5: Example of a product energy label for a local space heater (incomplete)

In addition to determining the energy efficiency class of the product and providing a completed product energy label, Delegated Commission Regulation 2015/1186 also requires for a product fiche and technical documentation to be included which provide detailed information on the product.

In terms of timetable requirements, Delegated Commission Regulation 2015/1186 requires for the above information to be provided with all local space heaters by either the 1<sup>st</sup> of January 2018 (for local space heaters that with flues) or the 1<sup>st</sup> of January 2022 (for local space heaters without flues). As identified previously, Delegated Commission Regulation 2015/1186 has yet to be transposed into Irish legislation.

### Delegated Commission Regulation 2015/1187

All solid fuel boilers should have their class of energy efficiency determined on the basis of their energy efficiency index, as set out in Table 2.13. The energy efficiency index is calculated according to a specific method outlined in Delegated Commission Regulation 2015/1187.

Table 2.13: Energy efficiency classes of solid fuel boilers as set by Delegated Commission Regulation 2015/1187

Energy efficiency class	Energy efficiency index (EEI)
A+++	$EEI \geq 150$
A++	$125 \leq EEI < 150$
A+	$98 \leq EEI < 125$
A	$90 \leq EEI < 98$
B	$82 \leq EEI < 90$
C	$75 \leq EEI < 82$
D	$36 \leq EEI < 75$
E	$34 \leq EEI < 36$
F	$30 \leq EEI < 34$
G	$EEI < 30$

A product energy label should also be included on all solid fuel boilers indicating the following information:

- Supplier's name or trade mark
- Supplier's model identifier
- Space heating function
- Energy efficiency class
- Rated heat output in kW
- Additional water heating function (for combination boilers)
- Additional electricity generation function (for solid fuel cogeneration boilers)

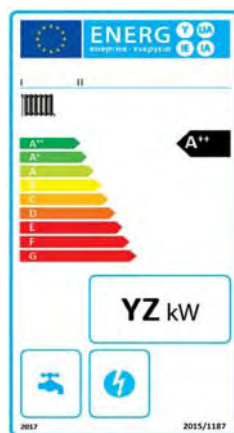


Figure 2.6: Example of a product energy label for a solid fuel boiler (incomplete)

In addition to determining the energy efficiency class of the product and providing a completed product energy label, Delegated Commission Regulation 2015/1187 also requires for a product fiche and technical documentation to be included which provide detailed information on the product.

In terms of timetable requirements, Delegated Commission Regulation 2015/1187 requires for the above information to be provided with all solid fuel boilers by the 1<sup>st</sup> of April 2017. From the 26<sup>th</sup> of September 2019, printed and electronic product energy labels will need to be updated on products. As identified previously, Delegated Commission Regulation 2015/1187 has yet to be transposed into Irish legislation.

## 2.5 Biomass Appliances – Installation

### 2.5.1 Building Regulations (Part J Amendment) 2014 (S.I. 133 of 2014)<sup>27</sup>

A technical guidance document<sup>28</sup> has been published by the Department of the Environment, Heritage and Local Government which provides guidance in relation to Part J of the Building Regulations 2014 (S.I. 133 of 2014), which fall under the wider Building Regulations 1997-2014.

Part J of the Building Regulations 2014 relates specifically to heat producing appliances. General information is presented in the guidance document on the provisions which should be made for the construction of appliances burning all fuel types, while specific information is also presented on additional provisions which should be made for solid fuel burning appliances (including solid biofuel) with a rated output of up to 50kW.

Technical guidance relating to a range of areas is provided, including the location of appliances, air supply to appliances, flues, connecting flue pipes, chimneys, fireplace gathers, hearths, fireplace recesses, sealing around fireplace openings, the danger of carbon monoxide releases and the appropriate storage of woody biomass fuel.

Taking the guidance provided on flues as a specific example, information is provided in the guidance document on the appropriate size, height, location and direction of flues. Table 2.14, reproduced from the guidance document, illustrates the specific level of detail which should be considered when determining solely the correct size of the flue that should be connected to a biomass appliance.

**Table 2.14: Flue sizing as per Building Regulations 2014, Technical Guidance Document J – Heat Producing Appliances<sup>28</sup>**

Installation	Minimum Flue Size
Fireplace recess for an open fire or other open appliance with an opening up to 500 mm x 550 mm	200 mm diameter or square section of equivalent area
Fireplace recess with an opening in excess of 500 mm x 550 mm, or fireplace open on 2 or more sides, e.g. fireplace with canopy	A free area of 15% of the area of the recess or fireplace openings
Closed appliance up to 20 kW rated output burning bituminous coal, peat or seasoned timber	150 mm diameter or square section of equivalent area
Other closed appliance up to 20 kW rated output burning smokeless, low volatile fuel or wood pellets	125 mm diameter or square section of equivalent area
Closed appliance above 20 kW and up to 30 kW rated output	150 mm diameter or square section of equivalent area
Closed appliance above 30 kW and up to 50 kW rated output	175 mm diameter or square section of equivalent area

Note: All dimensions refer to internal measurements

A number of the areas covered in the guidance document can have significant impacts on emission levels from biomass combustion. The effect of appliance installation on emission levels is explored further in Section 10.7.

<sup>27</sup> Government of Ireland (2014a) <http://www.irishstatutebook.ie/eli/2014/si/133/made/en/print>

<sup>28</sup> Government of Ireland (2014b) *Building Regulations 2014 - Technical Guidance Document J - Heat Producing Appliances*.

### 2.5.2 Planning Permission Requirements for Biomass Installations

The requirement for planning permission for biomass installations is a function of the scale of the development.

New, large scale development comprising biomass combustion is likely to fall with Part 10 of the Planning and Development Act 2000, as amended, as being development that requires environment impact assessment (EIA).

Such development is outlined in Schedule 5 of the Planning & Development Regulations 2001, as amended, and includes development which could be related to biomass fuelled installations, such as:

- A thermal power station or other combustion installation with a heat output of 300 MW or more
- Industrial installations for the production of electricity, steam and hot water, with a heat output of 300 MW or more

Note that both of these categories of development also fall within the Seventh Schedule of the Planning & Development Act 2000, in relation to strategic infrastructure, which may require direct application to An Bord Pleanála.

Note also that a planning authority may require the undertaking of EIA in instances of development below the thresholds identified in Schedule 5 of the Planning & Development Regulations, should they consider there to be the potential for significant impacts on the environment resulting from the proposed development.

It is unlikely that there would be many or any biomass fuelled installations of this scale in Ireland, with the majority of future commercial and industrial installations likely to fall within the scope of Directive 2015/2193 on medium combustion plants i.e. <50 MW category. The requirements here are less clear and in some instances, particularly the sub 10 MW range, could come within the scope of 'exempted development' i.e. planning permission is not required, dependent on the size of the building/infrastructure used to house a biomass installation.

Schedule 2 of the Planning & Development Regulations 2001, as amended, outlines classes of exempted development that could be applicable to a biomass installation:

- Class 56(a) (General) – the construction, erection or placing within the curtilage of an industrial building of a structure for the purposes of housing a (fully enclosed) combined heat and power system – conditions include:
  - Gross floor area  $\leq$  500 sq. m
  - Height  $\leq$  10 m, length  $\leq$  50m
  - Not within 200 m of residences etc., 10 m of road
  - No more than 2 flues, neither of which is greater than 20 m or flue diameter not greater than 1 m
- Class 56(b) (General)– the construction, erection or placing within the curtilage of a business premises, or a light industrial building, of a structure for the housing of a (fully enclosed) combined heat and power system – conditions include:
  - Gross floor area  $\leq$  300 sq. m
  - Height  $\leq$  8 m, length  $\leq$  40m
  - Not within 200m of residences etc., 10 m of road
  - No more than 2 flues, neither of which is greater than 16 m or flue diameter not greater than 1 m
- Class 56(i) (General) – the provision as part of a heating system for an industrial building or light industrial building or business premises of a biomass boiler, including a boiler house, flues mounted on the boiler house and over ground fuel storage tank or structure – conditions include:
  - Gross floor area  $\leq$  20 sq. m
  - Boiler house height or fuel storage unit  $\leq$  3 m
  - Fuel storage tank  $\leq$  75 cu.m
  - Not within 100m of residences etc., 10 m of road
  - No more than 2 flues, neither of which is greater than 16 m or flue diameter not greater than 1 m

- Class 18 (a) (Renewable Technologies) - the construction, erection or placing within the curtilage of an agricultural holding of a structure for the purposes of housing a (fully enclosed) combined heat and power system – conditions include:
  - Gross floor area  $\leq$  300 sq. m
  - Height  $\leq$  8 m, length  $\leq$  40m
  - Not within 100m of residences etc., 10 m of road
  - No more than 2 flues, neither of which is greater than 16 m or flue diameter not greater than 1 m
- Class 18 (e) (Renewable Technologies) - the provision as part of a heating system for an agricultural holding of a biomass boiler, including a boiler house, flues mounted on the boiler house and over ground fuel storage tank or structure – conditions include:
  - Gross floor area  $\leq$  20 sq. m
  - Boiler house height or fuel storage unit  $\leq$  3 m
  - Fuel storage tank  $\leq$  75 cu.m
  - Not within 100m of residences etc., 10 m of road
  - No more than 2 flues, neither of which is greater than 16 m or flue diameter not greater than 1 m

Should a proposed biomass development come within any of these classes of activity, it can be considered exempted development. In the event of a developer, or any other person, wanting a determination on the applicability of exempted development to a proposed biomass installation, a request can be made under Section 5 of the Planning & Development Act 2000, as amended, to a local authority, and to An Bord Pleanála on appeal, to determine the applicability of same.

Should a development not be exempted, or not considered as strategic infrastructure, then a direct application to the relevant planning authority is required. As identified, the planning authority may make a determination that an EIA is warranted, if the development is considered a part 10 activity but is below the threshold identified (in this case, a thermal power station, combustion installation or industrial installations for the production of electricity, steam and hot water).

Should an EIA not be warranted, a planning authority will still require a detailed environmental report assessing potential impacts on factors such as traffic, air quality, noise, ecology etc. relating to the development and its location.

## 2.6 Biomass Appliances – Health & Safety

A number of health and safety regulations, at both the national and European level, are also considered to be of relevance to this project. Health and safety is important to take into account when considering emissions from biomass combustion, as when appliances are designed, installed and/or operated with little to no attention paid to health and safety, these appliances will typically (although not always) have been designed, installed and/or operated in a manner so as to incur the lowest possible financial cost. This in turn will have an impact on the performance of the appliance, its efficiency and subsequently the level of emissions that will be produced.

In considering health and safety, the following Irish and EU regulations, while not specific to biomass appliances, are considered to be relevant:

- The Safety, Health & Welfare at Work (General) Regulations 2007, as amended
- The Safety, Health & Welfare at Work (Construction) Regulations 2013
- The Safety, Health & Welfare at Work (Confined Space) Regulations 2001
- The Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015
- The European Communities (Machinery) Regulations 2008, as amended
- The European Communities (Pressure Equipment) Regulations 1999, as amended



### 3 RELEVANT GUIDELINES & STANDARDS

#### 3.1 Air Quality Guidelines

##### 3.1.1 World Health Organisation

The World Health Organisation (WHO) have set guideline limit values for air quality so as to inform relevant policy makers worldwide. These values are outlined in the WHO global update report 2005<sup>29</sup>. Separate guidelines are presented for PM<sub>10</sub> and for PM<sub>2.5</sub>.

Unlike the limit values set in the CAFE Directive, the WHO values are guidelines only and are not legally binding. The WHO limit values are based solely on the public health aspects of air quality, whereas the limit values set by the CAFE Directive also take into account the technical, economic, political and social aspects of attaining these values. As a result, the WHO limit values are noticeably more stringent. Similar to the CAFE Directive, the values presented by the WHO relate to different averaging times, taking into consideration both the long term and short term effects of pollutants.

Guideline limit values set by the WHO for PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> are presented in Table 3.1. PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> are pollutants which are directly relevant to biomass emissions. Table 3.1 also presents the limit values set by the CAFE Directive for comparative purposes.

Table 3.1: Comparison of WHO limit values and CAFE Directive limit values

Pollutant	Averaging Period	WHO Limit Value (ug/m <sup>3</sup> )	CAFE Directive Limit Value (ug/m <sup>3</sup> )	Basis of Application of Limit Value
PM <sub>10</sub>	24 hours (daily mean)	50	50	<u>WHO</u> : exceedance no more than 3 times a year <u>CAFE</u> : exceedance no more than 35 times a year
PM <sub>10</sub>	Calendar year (annual mean)	20	40	Not to be exceeded
PM <sub>2.5</sub>	24 hours (daily mean)	25	-	<u>WHO</u> : exceedance no more than 3 times a year
PM <sub>2.5</sub>	Calendar year (annual mean)	10	25 <sup>1</sup>	Not to be exceeded
NO <sub>2</sub>	1 hour	200	200	<u>WHO</u> : not to be exceeded <u>CAFE</u> : exceedance no more than 18 times a year
NO <sub>2</sub>	Calendar year (annual mean)	40	40	Not to be exceeded

<sup>1</sup> There is also an exposure concentration obligation of 20 ug/m<sup>3</sup> (Stage 2)

<sup>29</sup> WHO (2006) *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide – global update 2005*.

While the WHO guideline limit values have not been altered since 2005, extensive reviews of the public health aspects of air quality have been conducted in the interim. Once such review was the 'Review of Evidence on Health Aspects of Air Pollution' (REVIHAAP) project. This project resulted in the publication of a report<sup>30</sup> which recommended the revision of some of the current guideline limit values set by the WHO.

A significant amount of this report focusses on PM and the new evidence that has arisen in recent years in relation to the harmful human health impacts of this pollutant. Recent long-term studies of PM<sub>2.5</sub> have shown links between PM<sub>2.5</sub> and death rates at levels lower than current WHO guideline limit values and considerably lower than the current CAFE Directive limit values. As a result, the report concludes that the current WHO PM guideline limit values should be updated.

The report also recommends the revision of current WHO NO<sub>2</sub> guideline limit values. It suggests that the short term limit value for NO<sub>2</sub> should be more epidemiologically based while it also points towards the need to take into account the accumulation of new outdoor studies on NO<sub>2</sub> in recent years. The report concludes that taking consideration of the above would likely result in the setting of lower NO<sub>2</sub> guideline limit values.

## 3.2 Biomass Appliances Design Standards

### 3.2.1 EN 303-5: 2012<sup>31</sup>

The European Standard EN 303-5 is titled 'Heating boilers – Part 5: Heating boilers for solid fuels, hand and automatically stocked, nominal heat output of up to 500kW – Terminology, requirements, testing and marking.'

This standard was published by the European Committee for Standardization (CEN) on the 1<sup>st</sup> of June 2012. It replaced the initial version of EN 303-5 which was published in 1999. EN 303-5 is not a harmonised standard. A harmonised standard is prepared with a view to fulfilling a requirement of a specific Directive.

EN 303-5 applies to heating boilers with a nominal heat output of up to 500 kW that burn solid fuels only and are operated in accordance with the instructions of the boiler manufacturer. The standard covers a range of issues, including safety, combustion quality, boiler operation, boiler maintenance and emissions. Requirements and test methods relating to some of the above are provided in the standard.

EN 303-5 refers to three classes in terms of boiler specification – classes 3, 4 and 5. Class 3 is considered to be the least favourable, while class 5 is considered to be the most favourable. In order for a boiler to be assigned to one of the above classes, it must meet specific conditions relating to both boiler heat efficiency and ELVs.

ELVs are set in EN 303-5 for both biogenic<sup>32</sup> and fossil fuels at various nominal heat outputs. Biogenic fuel ELVs set for dust<sup>33</sup>, CO and Organic Gaseous Compounds are presented in Table 3.2.

<sup>30</sup> WHO (2013) *Review of evidence on health aspects of air pollution – REVIHAAP Project – Technical Report*.

<sup>31</sup> CEN (2012)

[https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP\\_PROJECT,FSP\\_ORG\\_ID:31991,6041&cs=1100D6CE64CB9F31161CF531501CE2F79](https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT,FSP_ORG_ID:31991,6041&cs=1100D6CE64CB9F31161CF531501CE2F79)

<sup>32</sup> CEN (2012) notes that biogenic fuels refer to biomass in a natural state in the form of:

- Log wood with a moisture content  $w \leq 25\%$
- Chipped wood with a moisture content from  $w 15\%$  to  $w 35\%$
- Chipped wood with a moisture content  $> 35\%$
- Compressed wood (e.g. pellets without additives, made of wood and/or bark particles; natural binding agents such as molasses, vegetable paraffins and starch)
- Compressed wood (e.g. briquettes without additives, made of wood and/or bark particles; natural binding agents such as molasses, vegetable paraffins and starch)
- Sawdust with a moisture content  $w \leq 50\%$
- Non-woody biomass, such as straw, miscanthus, reeds, kernels and grains

<sup>33</sup> 'Dust' means particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions (CEN, 2012)

All ELVs refer to dry exit flue gas, calculated at a temperature of 273.15 K, a pressure of 101.3 kPa and a standardised O<sub>2</sub> content of 10%.

Table 3.2: ELVs set by EN 303-5 for heating boilers ≤ 500 kW using biogenic fuels<sup>31</sup>

Feeding	Nominal Heat Output (kW)	Dust (mg/m <sup>3</sup> )			CO (mg/m <sup>3</sup> )			OGC (mg/m <sup>3</sup> )		
		Class 3	Class 4	Class 5	Class 3	Class 4	Class 5	Class 3	Class 4	Class 5
Manual	≤ 50	150	75	60	5,000	1,200	700	150	50	30
	> 50 & ≤ 150				2,500			100		
	> 150 & ≤ 500				1,200					
Automatic	≤ 50	150	60	40	3,000	1,000	500	100	30	20
	> 50 & ≤ 150				2,500			80		
	> 150 & ≤ 500				1,200					

In addition to the ELVs set in EN 303-5, this European Standard outlines specific requirements and test methods in relation to biomass boiler appliances with a nominal heat output of up to 500kW.

The test method adopted for determining conformity to the EN 303-5 standard takes account of both manually and automatically fed boilers and examines these boilers on the basis of two firing rates; a nominal load and a 30% load (50% for manually fired units)<sup>34</sup>.

In determining the specific class of boiler specification, the boiler must meet heat efficiency requirements in addition to the ELVs outlined above. Table 3.3 identifies the level of boiler heat efficiency that is required to meet the different classes of specification.

Table 3.3: Heat efficiency requirements for class 3, 4 and 5 boilers as set by EN 303-5<sup>31</sup>

Class	Heat Efficiency
3	82%
4	84%
5	89%

While conformity with EN 303-5 indicates that a boiler operates at an appropriate level of efficiency and produces emissions within set limits, it also demonstrates that the boiler is constructed to an adequate safety standard. Biomass boilers for sale in the EU are labelled with either a TUV or a CE sticker<sup>35</sup> if they have been tested and found to conform with the EN 303-5 standard<sup>34</sup>.

### 3.2.2 EU National Standards

EN 303-5 has automatically become a national standard in all EU member countries. However, as identified above, this standard is not a harmonised standard, meaning that it is voluntary and there is currently no legal obligation to apply it.

Some countries within the EU have deviated from EN 303-5 to enable consistency with their national standards and law. These countries are Austria, Denmark, Germany and Switzerland.<sup>36</sup> ELVs for dust have been set in the national legislation of the above countries. These are outlined in Table 3.4.

<sup>34</sup> CONEG Policy Research Center Inc. (2009) *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States – Evaluation and Options for Regional Consistency*.

<sup>35</sup> TUV: Technischer Ueberwachungs Verein – a leading international testing organization.

CE: 'Conformité Européenne' – indicates conformity with the requirements of the applicable EC Directive.

<sup>36</sup> European Commission (2015e) *Abatement of Emissions from Domestic and Agricultural Biomass Burning*. AIRUSE.

Table 3.4: Dust ELVs for biomass heating appliances in Austria, Denmark, Germany and Switzerland<sup>36</sup>

Country	Fuel/Appliance	ELV (mg/m <sup>3</sup> )	Notes
Austria	Manual/room heater	35	From 01.01.2015
	Manual/central heater	30	
	Automatic/room heater/pellets	25	
	Automatic central heater/pellets	20	
	Automatic/other wooden fuels	30	
	Automatic/other standardised biogene fuels	35	
Denmark	Space heater	40	@ 13% O <sub>2</sub> From 24.01.2017
		30	@ 13% O <sub>2</sub> From 24.01.2017
	Manual/boiler	60	@ 10% O <sub>2</sub> From 24.07.2015
	Automatic/boiler	40	@ 10% O <sub>2</sub> From 24.07.2015
Germany	All	20	From 4 kW
Switzerland	Wood logs/manual	50	@ 13% O <sub>2</sub>
	Wood chips/automatic	60	
	Wood pellets/automatic	40	

### 3.3 Fuel Quality Standards & Quality Assurance Schemes

There has been a substantial increase in the use of biomass for energy throughout Europe in recent years. This has led to the need for the development of international standards to ensure the quality and correct use of biomass fuels. The standards and quality schemes for biomass fuels which are currently in place both in Europe and Ireland are outlined below. Additional information relating to the types and quality of biomass fuels and the impacts that these two factors can have on air emissions is presented in Section 10.2 and Section 10.3, respectively.

#### 3.3.1 CEN/TC 335<sup>37</sup>

The European Committee for Standardization (CEN) has formed a Technical Committee (CEN/TC 335) for the development of standards for all forms of solid biofuels within Europe. In recent years, many of the European Norm (EN) standards have been updated to worldwide ISO standards and are now identified as EN ISO standards.

The standards produced in recent years relating to solid biofuels have covered a range of aspects, including terminology, physical fuel properties, chemical fuel properties, fuel origin, fuel quality assurance and safety associated with fuel handling and storage<sup>38</sup>.

There are currently 39 EN or EN ISO standards published by CEN/TC 335 in relation to solid biofuels, while there are also a number of standards which are currently under drafting and will be published in the coming years.

<sup>37</sup> CEN/TC 335 (2016) – Solid Biofuels

[https://standards.cen.eu/dyn/www/f?p=204:7:0:::FSP\\_ORG\\_ID:19930&cs=17158638AB0C35D5E52A369017E54A1D6](https://standards.cen.eu/dyn/www/f?p=204:7:0:::FSP_ORG_ID:19930&cs=17158638AB0C35D5E52A369017E54A1D6)

<sup>38</sup> CEN/TC 335 (2014a) <https://standards.cen.eu/BP/19930.pdf>

The following three standards are generally considered to be of most use for producers and consumers of solid biofuels:

- EN ISO 16559 – *Solid biofuels: terminology, definitions and descriptions*<sup>39</sup>
- EN ISO 17225 – *Solid biofuels: fuel specifications and classes*, parts 1-7<sup>40</sup>
- EN 15234 – *Solid biofuels: fuel quality assurance*, parts 1-6<sup>41</sup>

## EN ISO 16559

EN ISO 16559 defines and describes many of the terms used in the CEN/TC 335 standards relating to solid biofuels. The different solid fuel types including wood chips, wood pellets, wood briquettes, firewood and hogfuel are outlined in this standard.

## EN ISO 17225

EN ISO 17225 is divided into 7 separate parts. Part 1 provides a general list of properties for each fuel class. An overview of the classification of the origin and source of the different woody solid biomass fuels is presented in part 1 of EN ISO 17225 and this has been reproduced in Table 3.5.

Table 3.5: Classification of origin and sources of woody solid biomass<sup>40</sup>

1. Woody Biomass		
1.1 Forest and plantation wood	1.1.1 Whole trees without roots	1.1.1.1 Deciduous
		1.1.1.2 Coniferous
		1.1.1.3 Short rotation coppice
		1.1.1.4 Bushes
		1.1.1.5 Blends and mixtures
	1.1.2 Whole trees with roots	1.1.2.1 Deciduous
		1.1.2.2 Coniferous
		1.1.2.3 Short rotation coppice
		1.1.2.4 Bushes
		1.1.2.5 Blends and mixtures
	1.1.3 Stemwood	1.1.3.1 Deciduous
		1.1.3.2 Coniferous
		1.1.3.3 Blends and mixtures
	1.1.4 Logging residues	1.1.4.1 Fresh/Green, Deciduous (including leaves)
		1.1.4.2 Fresh/Green, (including needles) Coniferous
		1.1.4.3 Stored, Deciduous
		1.1.4.4 Stored, Coniferous
		1.1.4.5 Blends and mixtures
	1.1.5 Stumps/roots	1.1.5.1 Deciduous
		1.1.5.2 Coniferous
		1.1.5.3 Short rotation coppice
		1.1.5.4 Bushes
		1.1.5.5 Blends and mixtures
	1.1.6 Bark (from forestry operations) <sup>1</sup>	
	1.1.7 Wood from garden, park, roadside maintenance, vineyards and fruit orchards	
	1.1.8 Blends and mixtures	

<sup>39</sup> CEN/TC 335 (2014b)

[https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP\\_PROJECT:39528&cs=11ADA56E5584DB1817815C88126EFD510](https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT:39528&cs=11ADA56E5584DB1817815C88126EFD510)

<sup>40</sup> CEN/TC 335 (2014c)

[https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP\\_PROJECT:39131&cs=1D71D6D8661FDD010555C381013211288](https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT:39131&cs=1D71D6D8661FDD010555C381013211288)

<sup>41</sup> CEN/TC 335 (2011 & 2012)

[https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP\\_PROJECT:33732&cs=1B7733A442FBC23841931071F259C2E27](https://standards.cen.eu/dyn/www/f?p=204:110:0:::FSP_PROJECT:33732&cs=1B7733A442FBC23841931071F259C2E27)

1. Woody Biomass		
1.2 By-products and residues from wood processing industry	1.2.1 Chemically untreated wood residues	1.2.1.1 Without bark, Deciduous
		1.2.1.2 Without bark, Coniferous
		1.2.1.3 With bark, Deciduous
		1.2.1.4 With bark, Coniferous
		1.2.1.5 Bark (from industry operations) <sup>1</sup>
	1.2.2 Chemically treated wood residues, fibres and wood constituents	1.2.2.1 Without bark
		1.2.2.2 With bark
		1.2.2.3 Bark (from industry operations) <sup>1</sup>
1.2.2.4 Fibres and wood constituents		
1.3 Used wood	1.2.3 Blends and mixtures	
	1.3.1 Chemically untreated wood	1.3.1.1 Without bark
		1.3.1.2 With bark
		1.3.1.3 Bark <sup>1</sup>
	1.3.2 Chemically treated wood	1.3.2.1 Without bark
		1.3.2.2 With bark
		1.3.2.3 Bark <sup>1</sup>
1.3.3 Blends and mixtures		
1.4 Blends and mixtures		

<sup>1</sup> Cork waste is included in bark sub-groups

Section 1.3 of Table 3.5 identifies types of used wood (also commonly referred to as 'waste' wood) which are covered by EN ISO 17225. While EN ISO 17225 classifies the majority of used wood, some specifications are not covered by this standard. Specifically, EN ISO 17225 does not cover solid recovered wood containing greater levels of halogenated organic compounds and heavy metals than virgin wood, and hazardous wood which has been treated with wood preservatives. Solid recovered wood is classified according to the standard EN 15359 for Solid Recovered Fuels.

Parts 2-7 of EN ISO 17225 provide quality classes for specific fuel types and outline the criteria which must be met for these fuel types to be assigned to each quality class. Parts 2-7 are intended for boilers with a capacity <500 kW in the domestic market. These standards are not intended for the industrial market.

The specific fuel types covered in parts 2-7 are as follows:

- Part 2: wood pellets
- Part 3: wood briquettes
- Part 4: wood chips
- Part 5: firewood
- Part 6: non-woody pellets
- Part 7: non-woody briquettes

Quality classes are generally presented as two A class fuels (A1 and A2) and either one or two B class fuels, with the A class fuels having higher quality requirements. A range of properties are required to be met for a specific quality class to be assigned. Some properties are identified as normative, indicating that it is mandatory that the required information is stated for the fuel, while others are identified as informative, indicating that it is recommended that the information is stated, but it is not a mandatory requirement. Examples of normative and informative properties of five of the main wood fuel types are presented in EN ISO 17225 and reproduced in Table 3.6.

Table 3.6: Overview of properties for five of the main wood fuels<sup>40</sup>

Property	Wood briquettes	Wood pellets	Wood chips	Hogfuel	Firewood
Origin	norm	norm	norm	norm	norm
Traded from	norm	norm	norm	norm	norm
Dimensions	norm	norm	norm	norm	norm
Moisture content	norm	norm	norm	norm	norm
Ash content	norm	norm	norm	norm	norm
Mechanical durability	NA	norm	NA	NA	NA
Amount of fines	NA	norm	NA	NA	NA
Density	inform	inform	inform	inform	inform
Additives	inform	inform	NA	NA	NA
Net calorific value	inform	inform	inform	inform	inform
Nitrogen content	norm/inform	norm/inform	norm/inform	norm/inform	NA
Sulphur content	norm/inform	norm/inform	inform	inform	NA
Chlorine content	norm/inform	norm/inform	norm/inform	norm/inform	NA
Ash melting behaviour	inform	inform	inform	inform	NA

norm: normative, has to be stated

inform: informative, may be stated

norm/inform: has to be stated if base material is chemically treated, otherwise informative

NA: not applicable

## EN 15234

EN 15234 relates to the quality control and quality assurance of solid biofuels. The overriding aim of EN 15234 is to guarantee that consumers can be provided with a quality declaration upon purchase of a solid biofuel that guarantees the quality of that fuel.

EN 15234 is divided into 6 separate parts. Part 1 provides general descriptions of the steps necessary to fulfil quality requirements (quality control), while it also describes steps which may be taken to ensure that the biofuel is of an appropriate specification (quality assurance).

Parts 2-6 of EN 15234 provide quality control and quality assurance information that is related to specific fuel types. The fuel types covered in parts 2-6 are as follows:

- Part 2: wood pellets
- Part 3: wood briquettes
- Part 4: wood chips
- Part 5: firewood
- Part 6: non-woody pellets

### 3.3.2 ENplus Scheme

An approved fuel quality certification scheme is also currently in place at the European level which relates specifically to part 2 of the EN ISO 17225 standard. This scheme is managed by the European Pellet Council and is called ENplus<sup>42</sup>.

The scheme relates specifically to the quality of wood pellets and was put in place to ensure that consumers across Europe could easily identify wood pellets which meet the quality requirements of EN ISO 17225-2 and fall within the ENplus A1 (highest quality), ENplus A2 or ENplus B1 quality class.

The requirements of the ENplus quality classes are often stricter than those presented in EN ISO 17225-2. All wood pellet fuel that is certified to ENplus standards is specifically labelled as such. At present, there are two certified producers of ENplus wood pellets on the island of Ireland.

### 3.3.3 Wood Fuel Quality Assurance Scheme<sup>43</sup>

The Wood Fuel Quality Assurance Scheme (WFQA) is an Irish scheme that aims to ensure consumer confidence in the purchase of wood fuels throughout Ireland. The scheme is supported by the Department of Agriculture, Food and Marine, the Irish BioEnergy Association, Teagasc and Waterford Institute of Technology (WIT).

The WFQA applies the fuel requirements outlined in EN ISO 17225, parts 1-5. It also incorporates the European ENplus scheme into its functioning. Prior to any wood pellets being approved by the WFQA, they must first meet the quality requirements of the ENplus scheme, which are often stricter than the quality requirements of EN ISO 17225-2.

All members of the WFQA scheme must be certified by the WFQA, with certification indicating that the wood fuel provided is accurately described, meets stated product specifications and is produced in compliance with EU Timber Regulation, ensuring the sustainability of the wood fuels produced.

Certified members must allow for outside auditing of the quality control of their products. This auditing includes random validation testing of the products at WIT, an independent organisation, to ensure product quality. In addition to external auditing of product quality, members are also required to frequently sample and test the quality of their product themselves.

A list of the suppliers currently certified with the WFQA at the time of writing is presented in Table 3.7.

Table 3.7: WFQA certified suppliers

Supplier	Fuel type provided
Forrest Fuels Ltd.	Firewood
Worrell Harvesting	Woodchip and Firewood
Aughrim Timber and Stake	Woodchip
Mc Cauley Wood Fuels	Woodchip
Woods Firewood Products	Firewood
Balcas Brites	Wood Pellets
Woodside Garden Products	Firewood
Cotter Bros Firewood	Firewood
Sherlock Warehousing & Trading Ltd. (Sherlogs)	Firewood
Celtic Logs (O'Brien Timber Products Ltd.)	Firewood

<sup>42</sup> <http://www.enplus-pellets.eu/>

<sup>43</sup> <http://www.wfqa.org/>



Supplier	Fuel type provided
BR Wood Fuels	Firewood
Wood 2 Go	Firewood
O'Hara Woodfuel Ltd.	Woodchip and Firewood
Coilte	Woodchip
Ecowood	Woodchip
BCH Fuels	Firewood and Kindling

The quality mark presented in Figure 3.1 has been developed to identify wood fuel products which comply with the requirements of the WFQA. This quality mark is listed on packaging materials and delivery notices, enabling consumers to easily identify products of high quality.



Figure 3.1: WFQA quality mark

#### Woodsure

A similar scheme to the WFQA operates in the UK, known as Woodsure. This scheme is operated by HETAS (Heating Equipment Testing and Approval Scheme) and follows a similar process as the WFQA, through the testing of fuels in accordance with ISO 17225, as well as prior standards where applicable, and the subsequent development of quality management plans and site verification through audit.

## 4 BIOMASS UTILISATION SUPPORT SCHEMES

### 4.1 Proposed Renewable Heat Incentive – Ireland

A Renewable Heat Incentive (RHI) is a system which encourages the generation of heat from renewable technologies by providing a payment to the owners of such technologies<sup>44</sup>. Payment may be based on the usage of these technologies, such as is the case for the UK RHI, or may arise in an alternative form, such as via an up-front grant payment.

The process for introducing a RHI in Ireland has begun. The following targets have acted as drivers towards the need to establish a RHI:

- 12% of Ireland's heat demand to be met by renewable energy sources by 2020 (RES-H; a national, non-binding target set by the Irish government; set following the binding target put in place by the EU that 16% of Ireland's energy is to be generated from renewable energy sources by 2020 (RES))<sup>45</sup>
- A 20% reduction in Ireland's non-Emissions Trading Scheme (non-ETS) sector greenhouse gas emissions by 2020 (based on 2005 levels; a binding EU target)<sup>46</sup>

The 2020 RES-H target is of most pressing concern and is considered to be the principal driver towards the need to establish a RHI. Estimates by the Sustainable Energy Authority of Ireland (SEAI) indicate that by 2020 there will likely be a shortfall of between 2 and 4% of the 12% target, equating to approximately 2,300 GWh<sup>47</sup>. IrBEA predicts that the shortfall will be closer to higher end of this scale as there has yet to be a concentrated effort from the relevant authority on determining how this scheme will be designed and administered.

In September 2015, IrBEA released a report<sup>52</sup> which analysed in detail the introduction of a RHI in Ireland, and provided recommendations on the same. This report takes into account RHI schemes already in place in other EU Member States, such as the UK scheme which is outlined in Section 4.2. It provides detail on the key attributes of a successful scheme and recommendations on how the RHI should be introduced in Ireland. A key recommendation from the report is that the RHI needs to be set up so as to encourage not only users of LPG and oil technologies to switch to renewables, but also for users of natural gas technologies to do likewise<sup>52</sup>.

While the introduction of a RHI is unlikely to prevent Ireland from falling short of the 2020 target and incurring substantial EU fines as a result, it will likely limit the level of these fines. In addition, the following benefits will likely be delivered from the introduction of a RHI scheme<sup>48</sup>:

- Reduction of Ireland's reliance of fossil fuel imports
- Reduction of Ireland's greenhouse gas emissions
- Improvement of Ireland's domestic fuel security
- Contribution towards national efforts to tackle climate change
- Improvement of the competitiveness of Irish industry through the minimisation of carbon taxes, the reduction of fuel costs and protection against fossil fuel price volatility
- Stimulation of local job development and rural development
- Provision of a domestic outlet for Ireland's growing timber resource
- Development of a strong Irish bioenergy industry, consequently enhancing the general competitiveness of Irish industry and increasing Ireland's attractiveness for foreign direct investment

<sup>44</sup> Department of Energy and Climate Change (2011) *Renewable Heat Incentive*.

<sup>45</sup> European Parliament (2009) <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0028>

<sup>46</sup> European Commission (2016) [http://ec.europa.eu/clima/policies/strategies/2020/index\\_en.htm](http://ec.europa.eu/clima/policies/strategies/2020/index_en.htm)

<sup>47</sup> SEAI (2011) *Energy Forecasts for Ireland to 2020*.

<sup>48</sup> Hegarty, M. (2016) [http://www.coillte.ie/coillteenterprise/blog/renewable\\_heat\\_incentive/](http://www.coillte.ie/coillteenterprise/blog/renewable_heat_incentive/)

While the benefits of introducing a RHI in Ireland are evident, progress in doing so has been slow to date. A technical review consultation of the Irish RHI was launched by the Irish Government in July 2015<sup>49</sup>. It was indicated in the Draft Bioenergy Plan 2014<sup>50</sup> that the RHI should be ready for launch in early 2016 subject to state aid clearance from the European Commission and government approval.

However, at the time of writing, a RHI has yet to commence. In addition to the impact that a delay in the release of a RHI will have on the achievement of Ireland's 2020 target, it has also been noted that there is a currently little activity within the Irish biomass industry due to the lack of clarity regarding the progress of the scheme<sup>52</sup>. It is clear that there is a need for an adequate RHI scheme to be introduced and implemented in Ireland in the near future to ensure the continued development of the Irish biomass industry.

As previously identified, any increased development of the biomass sector has the potential to result in increased emissions, with possible knock on effects on air quality. The development of an indigenous RHI which supports biomass combustion will require the inclusion of some mechanisms related to emissions control.

## 4.2 Renewable Heat Incentive – UK

A RHI system was introduced across the UK in recent years. In the mainland UK, this system was introduced in two phases; the first in in 2011 for non-domestic installations and the second in 2014 for domestic installations<sup>51</sup>. The RHI for both non-domestic and domestic installations in the mainland UK remains open for applications at the time of writing.

The Northern Ireland scheme was also introduced in two phases; the first in in 2012 for non-domestic installations and the second in 2014 for domestic installations<sup>52</sup>. As of the 29<sup>th</sup> of February 2016, new applications for both non-domestic and domestic installations closed due to a lack of government funding<sup>53</sup>. Existing installations which had received accreditation under the Northern Ireland RHI prior to this date will continue to receive support<sup>53</sup>.

Focusing solely on biomass, some differences between the mainland UK and Northern Ireland schemes are evident. For example, different banding systems have been used in both schemes<sup>52</sup>. The mainland UK scheme has also introduced air quality emission limits for all installations that are accredited under the RHI. Owners of both non-domestic and domestic installations applying for the scheme must now ensure that their installations meet strict emission limits. These limits are as follows<sup>51</sup>:

- 30 g/GJ net thermal input for PM
- 150 g/GJ net thermal input for NO<sub>x</sub>

Proof that an installation does not produce emissions in exceedance of the above limit values is required to be submitted upon application to the scheme in the form of either a RHI emissions certificate or an environmental permit<sup>51</sup>. An example of an emission certificate is provided in Appendix 1.

It is noticeable that the above limit values are presented using the units g/GJ. Generally, most emission measurements (and all those up to this point in this report) are reported as emission concentrations (i.e. as mg/m<sup>3</sup> at specified reference conditions). In order to enable operators to demonstrate compliance with the above RHI emission limit values, the UK Department for Environment, Food and Rural Affairs (DEFRA) commissioned the development of a tool<sup>54</sup> for the conversion of g/GJ units into mg/m<sup>3</sup> units and vice versa. The functioning of this tool is outlined in Appendix 2.

---

<sup>49</sup> DCENR (2015) *Renewable Heat Incentive – Technology Review Consultation*.

<sup>50</sup> DCENR (2014) *Draft Bioenergy Plan*.

<sup>51</sup> DECC (2015) *Policy Paper: 2010 to 2015 government policy: low carbon technologies*.

<sup>52</sup> IrBEA (2015) *Delivering a Renewable Heat Incentive for the Republic of Ireland*.

<sup>53</sup> Ofgem (2016a) <https://www.ofgem.gov.uk/publications-and-updates/suspension-northern-ireland-rhi>

<sup>54</sup> AEA (2012) *Conversion of biomass boiler emission concentration data for comparison with Renewable Heat Incentive emission criteria*.

In order for a biomass installation to be awarded an RHI emissions certificate, the particular appliance or range of appliances must be accredited by Ofgem, prior to certificate award. Information to be provided by the appliance manufacturer as part of the accreditation process includes:

- Details of the testing laboratory and confirmation of accreditation to ISO 17025
- Detail of the appliance including installation capacity, nature of feed & draught
- Fuel type used during testing and range of fuels that can be used in compliance with relevant limit values (as derived from testing), maximum allowable moisture content
- Details of testing and relevant test standards; measured emission of PM and NOx

In addition, since October 2015, in order to participate in the UK RHI, participants must procure fuel (pellets, briquettes, chip and firewood) that meets certain sustainability criteria, in terms of lifecycle greenhouse gas emission values<sup>55</sup> and land use criteria. A biomass supplier list (BSL)<sup>56</sup> has been developed through which RHI participant can locate fuel suppliers that have demonstrated the sustainability of their fuel as per the identified requirements.

The UK RHI schemes have been successful, with over 1.5 GW of biomass thermal capacity having been installed across the UK as a result of their introduction<sup>52</sup>. Despite their success, they are not considered to be schemes of perfection. A review of the UK schemes conducted by IrBEA<sup>52</sup> indicated that there are a number of areas associated with these schemes which may be improved on. The following issues have been noted and should be considered closely prior to the complete roll out of a RHI in Ireland which is likely to occur in the near future<sup>52</sup>:

- The UK RHI scheme is behind both target and budget. IrBEA notes that the roll out of a RHI takes time, with effective momentum unlikely to be achieved instantly.
- A RHI scheme requires a substantial administrative cost for the processing and accreditation of applications. The UK RHI has had to incorporate an administrative function, through Ofgem, to ensure the appropriate management of the scheme. A similar administrative function would likely be required for the proposed RHI in Ireland.
- The UK RHI has not had the desired success in stimulating the installation of large scaled appliances (>1 MW) or Combined Heat and Power appliances. This has likely been due to the tariff sizes specified by the RHI for these appliance types. The proposed RHI in Ireland should consider tariff introduction carefully to ensure appropriate uptake across the different size ranges.
- The UK RHI has seen an uptake in the 0-199 kW size range which is considered to be disproportionately large in comparison to the larger size categories. Examples in the UK of individuals installing a group of appliances in this size range in series on one site, rather than one individual, larger sized appliance on this site, so as to improve their benefit from the incentives on offer, have been observed. The proposed RHI in Ireland should consider the introduction of rules in relation to the installation of a group of small sized appliances so as to prevent the above from occurring.

#### 4.3 Feed in Tariffs Scheme – UK<sup>57</sup>

The Feed in Tariffs (FIT) scheme is a UK scheme which aims to promote the installation of small scale renewable and low carbon electricity generation appliances. This scheme involves the payment of a tariff to the owner of the appliance covered under the scheme for both the amount of electricity produced by that appliance and the amount of electricity produced from that appliance that is sold to the UK grid. While the FIT scheme covers technologies such as solar photovoltaic (PV), wind, hydro and anaerobic digestion, it is the micro combined heat and power (CHP) technology which is most applicable in terms of biomass combustion. The scheme provides payments for approved micro CHP installations with a total installed capacity of ≤2 kW.

<sup>55</sup> 34.8 g CO<sub>2</sub> equivalent per MJ of heat, or 60% GHG savings against the EU fossil fuel average.

<sup>56</sup> <http://biomass-suppliers-list.service.gov.uk/>

<sup>57</sup> Ofgem (2016b) [https://www.ofgem.gov.uk/system/files/docs/2016/07/fit\\_factsheet\\_july\\_16\\_-\\_final.pdf](https://www.ofgem.gov.uk/system/files/docs/2016/07/fit_factsheet_july_16_-_final.pdf)

#### 4.4 Renewables Obligation Scheme – UK<sup>58</sup>

The Renewables Obligation (RO) scheme is a UK scheme which provides support for large scale renewable electricity generating installations in the UK. It requires electricity suppliers to source increasing amounts of their electricity supply from renewable technologies in order to qualify for the scheme. Approval to this scheme is generally ensured through the keeping of a Renewables Obligation Certificate (ROC), payment into a buy-out fund, or a mixture of both of the above. The RO scheme will close to all new installations on the 31<sup>st</sup> of March 2017, with it being replaced by the Contracts for Difference (CfD) scheme, a new support scheme for large scale renewable electricity generating installations. Unlike the RO scheme, the CfD scheme will also provide support to electricity that is generated by nuclear and carbon capture and storage installations.

#### 4.5 Other EU Nations

##### 4.5.1 France

A renewable heat fund was implemented in France in 2009 by ADEME<sup>59</sup>. This fund focusses on a range of renewable energy heating technologies. In addition to biomass heating appliances, it supports solar, geothermal, waste heat, district heat and biogas appliances. The goal of the fund is to support the production of 5.5 million toe (tonnes oil equivalent) of renewable heat between 2009 and 2020<sup>60</sup>. During the period 2009 to 2013, a total of 1.4 million toe of renewable heat was produced – this arose from the heat fund contributing €1.12 billion for the support of approximately 3,000 appliances<sup>52</sup>. In delivering financial support from the heat fund, ADEME puts out annual calls for projects at both national and regional levels, with investment grants provided to projects that are deemed most suitable. In assessing whether such a scheme could be applicable in an Irish context, IrBEA suggest that it would be unlikely to have the same impacts due to the narrow market segment on which this scheme focusses on in France and the significant input of management that one organisation (ADEME) devotes to the scheme<sup>52</sup>.

In addition to the above renewable heat fund, two further funding mechanisms that are relevant to biomass are in place in France:

- A FIT scheme, which provides support for energy from wind power, solar power, hydro power, biomass and geothermal sources, among other technologies. The FIT scheme is the key Renewable Energy System (RES) support mechanism. It was introduced and imposed on EDF and non-national distributors on the 10<sup>th</sup> of February 2000. The system is financed through public contribution to the electricity service. Tariffs available in relation to biomass vary according to energy efficiency, system capacity and fuel type.
- A tender system for large renewable projects (used for offshore wind power, solar power, biomass, hydro and other projects built at scale)

##### 4.5.2 Austria

Financial incentive programmes aimed specifically at biomass boilers (logwood, pellet and chip systems) are provided at the federal government, individual province and local municipality level. Support is provided specifically for the investment cost required for the purchase and installation of biomass boilers. While incentive levels vary from programme to programme, the total of incentives at all levels (federal, provincial and municipal) can often reach a figure which is as high as 50% of total investment costs for domestic biomass systems<sup>34,61</sup>. The above financial incentive programmes were introduced in a response to the smog and poor air quality issues that were evident in alpine valleys of Austria such as those in the Tyrol province<sup>62</sup>.

<sup>58</sup> Ofgem (2016c) [https://www.ofgem.gov.uk/system/files/docs/2016/04/renewables\\_obligation\\_ro\\_faq.pdf](https://www.ofgem.gov.uk/system/files/docs/2016/04/renewables_obligation_ro_faq.pdf)

<sup>59</sup> [www.ademe.fr](http://www.ademe.fr)

<sup>60</sup> IEA (2012) <http://www.iea.org/policiesandmeasures/pams/france/name-30673-en.php>

<sup>61</sup> Egger et al. (2015) *Biomass Heating in Upper Austria – Green Energy, Green Jobs*.

<sup>62</sup> OECD (2003) *OECD Environmental Performance Reviews: Austria*.

#### 4.5.3 Germany

Germany has a federal financial incentive programme for renewable energy, including biomass boilers, known as the Market Incentive Programme (MAP). All incentives provided are subject to the appliances meeting a minimum energy efficiency requirement of 90% based on the lower heating value of the fuel used<sup>34</sup>. Incentives vary depending on the type of biomass boilers as identified below<sup>34</sup>:

- Pellet fired boilers up to 100 kW: €1000 base incentive plus €24 for each 1 kW capacity over 40 kW
- Chip fired boilers: fixed incentive of €500
- Logwood fired boilers: fixed incentive of €750

#### 4.5.4 Netherlands

Renewable incentives in the Netherlands are based on the SDE (Stimulerend Duurzame Energieproductie), which came into force in 2008, and was further amended in 2011 and renamed the SDE+. SDE+ incentives are structured as feed-in premiums and are financed through a levy on the energy bill of end consumers. SDE+ is opened in phases, where each phase is opened for tender bids with a higher maximum subsidy amount than the former phase to encourage generators to submit the lowest tender amount possible. The SDE+ subsidy is granted for a period of between 12 and 15 years (depending on the technology).

In 2013, for heat and CHP generation, tender phase values varied from €19.40/GJ for Phase 1 to €41.70/GJ for Phase 6.

#### 4.5.5 Italy

Since 2002, all energy plants fuelled by other types of RES (wind, biomass, etc.) qualified to participate in an incentive regime based on green certificates (GCs), which were issued by the GSE (Gestore Servizi Energetici), traded between operators on a dedicated market, and surrendered to GSE at a fixed price. Each GC represented 1 MWh of energy produced. However, from 2016 the GC regime was replaced by a dedicated FIT, which is calculated on the basis of the average price for the sale of electricity during the relevant year.

In addition to the above, a specific biomass support scheme is also in operation in the Italian province of Southern Tyrol. This scheme provides a financial incentive of 30% of total investment cost for biomass boilers<sup>34</sup>.

#### 4.5.6 Switzerland

A number of Swiss provinces provide financial incentives for biomass boilers ranging from €2,000 to €3,000 depending on the size of the appliance used and the likely annual wood consumption<sup>34</sup>.

#### 4.5.7 Slovenia

Slovenia provides a financial incentive of 40% of total investment cost for biomass boilers<sup>34</sup>. The incentive limit varies depending on the type of appliance used.

#### 4.5.8 Denmark

Denmark provides financial support via feed-in premium tariffs for renewable electricity that is produced from biomass<sup>63</sup>. The Energy Agreement of 2012 also provides tax advantages for biomass use over alternative fuel use for district heating schemes<sup>63</sup>. A requirement is in place in Denmark for a proportion of all heat that is provided by district heating schemes to be supplied by biomass fuels.

---

<sup>63</sup> Jonas Dahl, J. and Stelte, W. (2015) *Country report 2014 for Denmark*. IEA Bioenergy Task 40.

#### 4.5.9 Sweden

The use of biomass as a fuel has increased significantly in Sweden over the past three decades. In 2013, it was estimated that a quarter of the Swedish energy supply was provided by biomass and waste<sup>64</sup>. Biomass has been incentivised in Sweden through the application of a high tax on the use of other fuel types such as coal. An energy tax reform occurred in Sweden in 1991, resulting in the doubling of the cost of coal production in district heating<sup>64</sup>. Biomass subsequently became the cheapest fuel to use in district heating, resulting in a large uptake in its use<sup>64</sup>.

---

<sup>64</sup> Ericsson, K. and Werner, S. (2016) The introduction and expansion of biomass use in Swedish district heating systems. *Biomass and Bioenergy*, 94: 57-65.

## 5 BIOMASS COMBUSTION APPLIANCES

### 5.1 Overview

Biomass combustion technologies may be categorised according to a variety of characteristics. Technologies are often differentiated according to aspects such as their size, the specific appliance type, the type of fuel used, the method of fuelling and the direction of air flow through the fuel bed<sup>65</sup>.

A range of biomass appliances are available that are suitable for use in domestic, community, commercial and industrial settings. Generally, appliances that are used in domestic settings are smaller, with a heat output of <50 kW, while appliances that are used in community, commercial or industrial settings are larger, with heat outputs of between 50 kW and 200 MW<sup>65</sup>.

For the purpose of this study, biomass appliances have been differentiated on the basis of whether they are generally used in a domestic setting or whether they are generally used in a community, commercial or industrial setting. Table 5.1 presents the various types of domestic appliances that are commonly available, while Table 5.2 presents the various types of community, commercial and industrial appliances that are commonly available. The fuel types that are used for all appliances are also identified in Table 5.1 and Table 5.2. Further detail on the different types of biomass appliances is provided in Section 5.2 and Section 5.3.

Table 5.1: Domestic Biomass Combustion Technologies<sup>65</sup>

Class of Appliance	Type of Appliance	Fuel Type Used
Fireplace	Open fireplace	Log, lump wood and biomass briquettes
	Partly closed fireplace	
	Closed fireplace	
Stove	Manually fed stove	Pellets
	Pellet stove	
Boiler	Over-fire boiler	Log, lump wood and biomass briquettes
	Down draught boiler	
	Pellet boiler	Pellets

Table 5.2: Community, Commercial & Industrial Biomass Combustion Technologies<sup>65</sup>

Class of Appliance	Type of Appliance	Fuel Type Used
Manually fed boiler	Overfed, under fire boiler	Lump wood
	Overfed, upper fire boiler	Wood chips/fine coal mixture
Automatically fed boiler	Moving bed combustion boilers	Wood chips, pellets, sawdust, co-combustion with coal
	Down draught boiler	Logs
	Gasification system	Wood chips, pellets
	Pre-ovens combustion system	Wood chips
	Fluidised bed combustion system	Wood chips, pellets, sawdust, co-combustion with coal

When categorising biomass combustion technologies according to their method of fuelling rather than according to their size, specific appliance type or type of fuel used, there are two primary fuelling methods used; batch fuelling and continuous firing. Batch fuelling involves the intermittent loading of a batch of fuel into the combustion chamber of an appliance, whereas continuous firing involves the continuous fuelling of an appliance with fuel<sup>65</sup>. Batch fuelled appliances are usually smaller than continuously fired appliances and are therefore more commonly used in domestic settings<sup>65</sup>.

<sup>65</sup> Environmental Protection UK (2010) *Biomass and Air Quality Guidance for Scottish Local Authorities*.



## 5.2 Domestic Appliances

### 5.2.1 Fireplaces

#### Open fireplaces

Open fireplaces are a traditional type of biomass appliance that are particularly common in rural Irish homes. They contain a basic combustion chamber which is connected to a chimney and the majority of heat energy is transferred to the room via radiation<sup>66</sup>. Nowadays, they are unlikely to be the appliance of choice when arranging to have a new biomass appliance installed as they have a very low efficiency and produce significant emissions due to the incomplete combustion of the fuel used<sup>66</sup>. Open fireplaces are at best 20% efficient as a result of the significant volumes of warm air which are lost up the chimney<sup>67</sup>. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat open fireplaces<sup>65</sup>.

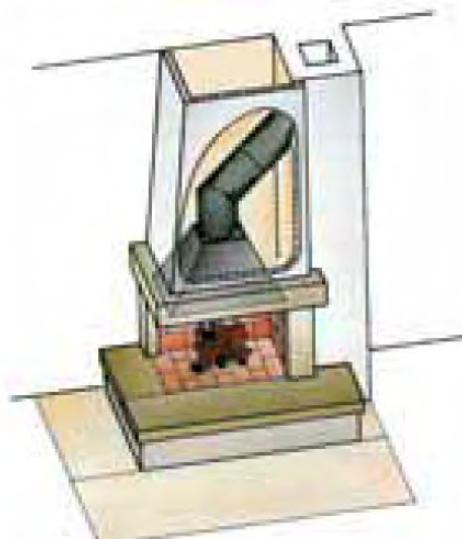


Figure 5.1: Open fireplace<sup>116</sup>

#### Partly closed fireplaces

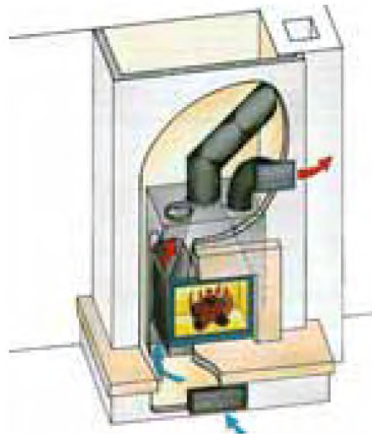
Partly closed fireplaces often incorporate louvers and glass doors and have a greater level of efficiency than open fireplaces<sup>66</sup>. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat partly closed fireplaces<sup>65</sup>.

#### Closed fireplaces

Closed fireplaces are installed with front doors and often have systems to distribute combustion gases and discharge exhaust gases<sup>66</sup>. They are more efficient (usually >50%) and produce less emissions than either open or partly closed fireplaces<sup>66</sup>. They differ from stoves in that they are typically inset into a wall or chimney breast; this is not always the case for stoves, which are often, but not always, free-standing. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat closed fireplaces<sup>65</sup>.

<sup>66</sup> EMEP/EEA (2013) *EMEP/EEA air pollutant emission inventory guidebook – Technical Report No. 12/2013*.

<sup>67</sup> Palmer et al. (2011) *Biomass heating: a guide to small log and wood pellet systems*. Biomass Energy Centre, Forest Research, Farnham.

Figure 5.2: Closed fireplace<sup>116</sup>

### 5.2.2 Stoves

#### Manually fed stoves

Manually fed stoves are more efficient and produces less emissions than fireplaces<sup>66</sup>. In terms of the combustion process, there are generally two main types of manually fed stoves; up-draught (down-burning combustion) and down draught (up-burning combustion)<sup>66</sup>. Up-draught stoves are generally more common due to their simpler design<sup>66</sup>.



A number of manually fed stove appliances are available, ranging from those used simply to heat a single room to those used for heating, cooking and the provision of hot water<sup>66,67</sup>. Heat transfer from stoves is generally by either radiation from the hot surfaces of the stove or by convection from air that is drawn around the stove<sup>67</sup>.

In comparison with open and partly closed fireplaces, stoves are operated in an almost sealed enclosure that has a well-regulated air supply<sup>67</sup>. A permanent combustion air supply to a stove is of high importance, as the failure to ensure such a supply can result in incomplete combustion and a subsequent increase in PM emissions, while it can also result in the production of unburned carbon monoxide which can have potentially significant health and safety consequences.

Stoves allow for the almost complete combustion of fuels due to the presence of higher combustion temperatures, resulting in greater efficiency levels and the production of lower emissions and fewer deposits in the connecting flue<sup>67</sup>. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat manually fed stoves<sup>65</sup>. Table 5.3, overleaf, provides an overview of the main types of biomass manually fed stoves which are available.

Figure 5.3: Examples of manually fed wood stoves<sup>65,116</sup>

Table 5.3: Overview of manually fed stoves<sup>66</sup>

Stove type	Notes	Efficiency	Emissions
Conventional	<ul style="list-style-type: none"> <li>Poor combustion process</li> <li>Occasionally used for cooking and hot water provision</li> </ul>		
Energy efficient	<ul style="list-style-type: none"> <li>More effective use of secondary air in combustion chamber</li> </ul>	40-50%	
Advanced combustion	<ul style="list-style-type: none"> <li>Advanced combustion process – multiple air inlets and pre heating of secondary combustion air</li> <li>Ecolabel often provided for these stoves</li> </ul>	55-75%	
Heat accumulating	<ul style="list-style-type: none"> <li>Constructed with heat accumulating materials (e.g. ceramic tiles)</li> <li>Slow release of heat to surrounding area</li> </ul>	70%	
		70-80%	Lowest

In addition to the above, technology is now available to allow for the installation of catalytic converters in manual feed stoves. These reduce emission levels and also increase efficiency levels by ensuring that the fuel is oxidised completely<sup>66</sup>. Stoves with catalytic converters installed are uncommon<sup>66</sup>.

### Pellet stoves

Pellet stoves, designed for the burning of wood pellets only, are more sophisticated appliances than manually fed stoves. The use of pellets, which are free flowing and generally have a low moisture content and a consistent size and shape, allows for the design of these stoves to be more efficient and effective<sup>65</sup>.

Pellet stoves often incorporate a range of more advanced technologies, including automatic ignition, automatic feeding of pellets to the combustion chamber from an internal hopper (and the automatic metering of the same), segregation of primary and secondary air supplies (ensuring adequate combustion control) and combustion air fans<sup>67</sup>. Internal hoppers in pellet stoves can provide up to two days' fuel supply<sup>67</sup>. Combustion air fans in pellets stoves are often accompanied by control circuits which incorporate oxygen sensors for the determination of excess oxygen levels within the appliance, ensuring that emission levels are maintained at low levels<sup>65</sup>.

Similar to manually fed stoves, pellet stoves transfer heat by either radiation from the hot surfaces of the stove or by convection from air that is drawn around the stove<sup>67</sup>. Pellet stoves may be used to heat a single room or an entire house by incorporating an internal boiler along with the appliance<sup>67</sup>. As a result of the advanced technology used in pellet stoves, the correct air/fuel mixture ratio is maintained within the combustion chamber throughout the combustion process – this results in high efficiency levels (80% to 90%) and the production of low levels of emissions<sup>66</sup>.

Figure 5.4: Example of a pellet stove<sup>68</sup>

<sup>68</sup> <http://smartheat.ie/>

### 5.2.3 Boilers

Boilers are appliances which generally generate heat for central heating systems (including hot air systems) or hot water, or sometimes both<sup>66</sup>. They typically have a nominal heat output of between 12 kW and 50kW and there are a number of different boiler types that are commonly available<sup>66</sup>:

#### Over-fire boilers

Over-fire boilers have a simple method of operation and are generally the cheaper form of boiler available on the market – as a result, they are commonly used in residential settings<sup>66</sup>. Natural draught within over-fire boilers causes a non-optimal combustion air supply, which results in an incomplete combustion process within the combustion chamber<sup>66</sup>. This incomplete combustion process in turn results in relatively low efficiency levels (50% to 65%) and high levels of emissions, particularly if the appliance is not operated at a full load<sup>66</sup>. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat over-fire boilers<sup>65</sup>.

#### Down draught boilers

Down draught boilers are sophisticated appliances which incorporate advanced technology. They contain two chambers; fuel is fed into the first chamber for partial devolatilisation and combustion of the fuel layer, while all released combustible gases are burned in the second chamber<sup>66</sup>. This process results in the forcing down of flue gases and the resultant burning of them at a high temperature within the secondary combustion chamber<sup>66</sup>. The above process ensures that emissions produced are low as the occurrence of incomplete combustion is less likely<sup>66</sup>. Logs, lump wood and biomass briquettes are the main forms of biomass fuels used to heat down draught wood boilers<sup>65</sup>.

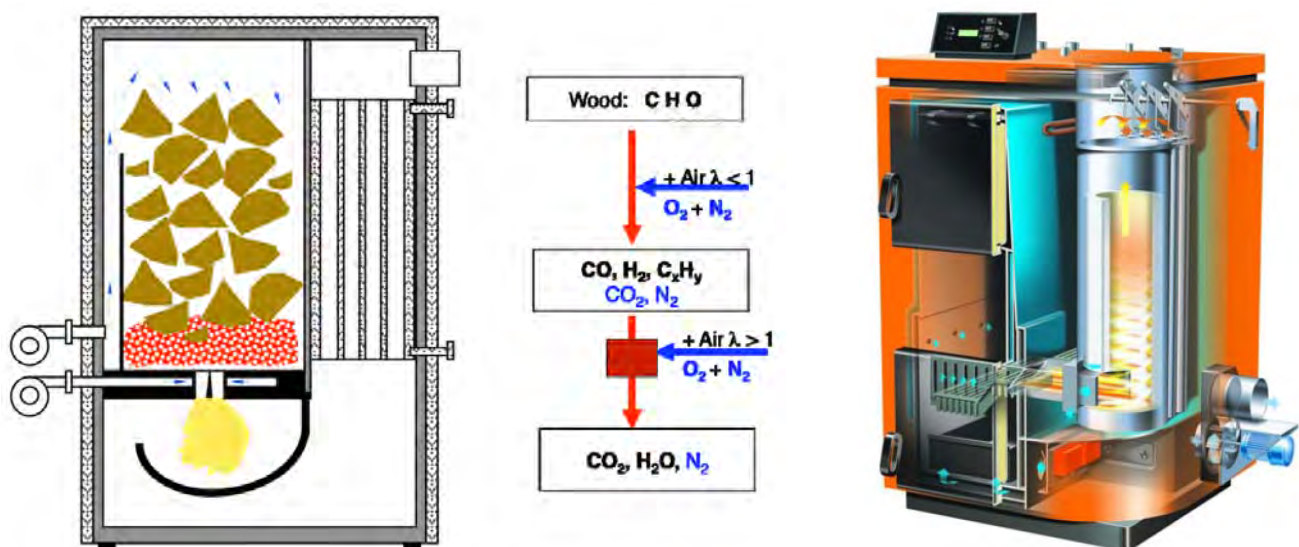


Figure 5.5: Operating principle and example of a down draught boiler<sup>70</sup>

#### Pellet boilers

Pellet boilers contain an automatic system which regulates the feeding of pellets and the supply of combustion air in both the primary and secondary chambers of the appliance<sup>66</sup>. Pellets are loaded through the top of the boiler into an internal hopper, from where they are automatically fed into the burner by screw<sup>66,67</sup>. Internal hoppers are generally only able to supply a limited burn time, meaning that pellet boilers are only available in sizes up to 25 kW<sup>67</sup>. Pellet boilers have high levels of efficiency (generally >80%) and produced relatively low levels of emissions<sup>66</sup>.



Figure 5.6: Automatic pellet boiler<sup>65</sup>

## 5.3 Community, Commercial & Industrial Appliances

### 5.3.1 Manually fed boilers

Manually fed boilers are generally smaller appliances than automatically fed boilers, with most appliances having heat outputs of <1 MW. This is primarily due to the costs associated with operating manually fed boilers as they become larger in size<sup>66</sup>. The combustion process in manually fed boilers used in community, commercial and industrial settings is more effective than the combustion process for similar boilers used in domestic settings, resulting in higher efficiency levels and the production of lower emissions<sup>66</sup>.

The following are the main types of manually fed boilers that are commonly used in community, commercial and industrial settings:

#### Overfed, under fire boilers

Overfed, under fire boilers have two combustion chambers; fuel is fed into the first chamber for partial devolatilisation and combustion of the fuel layer, while all released combustible gases are burned in the second chamber<sup>66</sup>. These boilers have efficiency levels of between 60% and 80% and produce relatively high levels of emissions<sup>66</sup>. Lump wood is the main form of biomass fuel used to heat overfed, under fire boilers<sup>65</sup>.



Figure 5.7: Overfed, under fire boiler<sup>116</sup>



### Overfed, upper fire boilers

The point of ignition differs between overfed, upper fire boilers and under fire boilers. Ignition in overfed, upper fire boilers commences from the top of the boiler – this impacts positively on the combustion process within the boiler, resulting in higher efficiency levels (75% to 80%) and the production of lower levels of emissions than those produced by overfed, upper fire boilers<sup>66</sup>. Wood chips or a combination of wood chips and fine coal are the main forms of fuels used in overfed, upper fire boilers<sup>65</sup>.

#### 5.3.2 Automatically fed boilers

Automatically fed boilers generally have heat outputs >1 MW, have a more effective combustion process than manually fed boilers and are typically fed by fuels which are standardised and of high quality<sup>66</sup>. These boilers also occasionally incorporate abatement technologies, which are reviewed further in Section 10.6. As a result of the above, automatically fed boilers are generally more efficient and produce significantly lower emissions than manually fed boilers<sup>66</sup>.

The following are the main types of automatically fed boilers that are commonly used in community, commercial and industrial settings:

### Moving bed combustion boilers

Moving bed combustion boilers are generally categorised according to how fuel is added to the boiler. There are two types; overfed and underfed stokers.

#### Overfed stokers

Fuel is supplied to the grate of overfed stokers from above<sup>69</sup>. There are a number of different types of overfed stokers which all vary slightly in terms of their technology and how they are operated. The different overfed stokers are identified in Table 5.4.

Table 5.4: Overview of overfed stokers<sup>69</sup>

Overfed stoker type	Notes
Stoker burner boiler	<ul style="list-style-type: none"> <li>Simplest overfed stoker technology with the lowest capital cost</li> <li>Accept wood chips or wood pellets</li> <li>Accept fuel up to 30% moisture content – requires fuel with a small particle size</li> <li>Primary and secondary air cannot be controlled independently – can result in incomplete combustion and low efficiency levels</li> <li>Generally, up to 1 MW in size</li> </ul>
Stepped grate boiler	<ul style="list-style-type: none"> <li>Flexibility in boiler design – can tolerate various fuel sizes and qualities</li> <li>Accept wood chips</li> <li>Accept fuel up to 55% moisture content</li> <li>Primary and secondary air supplies may be varied – ensuring combustion optimisation</li> <li>Available in a range of sizes up to 10 MW</li> </ul>
Chain grate boiler	<ul style="list-style-type: none"> <li>Boiler design incorporates a constantly moving chain link belt in the grate</li> <li>Accept various biomass fuel types</li> <li>Accept fuel up to 55% moisture content – fuel size required is dependent on boiler capacity</li> </ul>
Moving grate rotary combustion chamber boiler	<ul style="list-style-type: none"> <li>Technology that results in complete combustion and high efficiency levels</li> <li>Complete combustion and consistent, optimum temperatures result in low emission levels</li> <li>Accept fuel up to 40% moisture content</li> </ul>

<sup>69</sup> Palmer, D., Ashford, C., Kinnibrugh, J. & Smith, G. (2014) *Biomass heating: CIBSE AM15: 2014*. CIBSE.



Figure 5.8: Overfed stoker burner boiler<sup>69</sup>

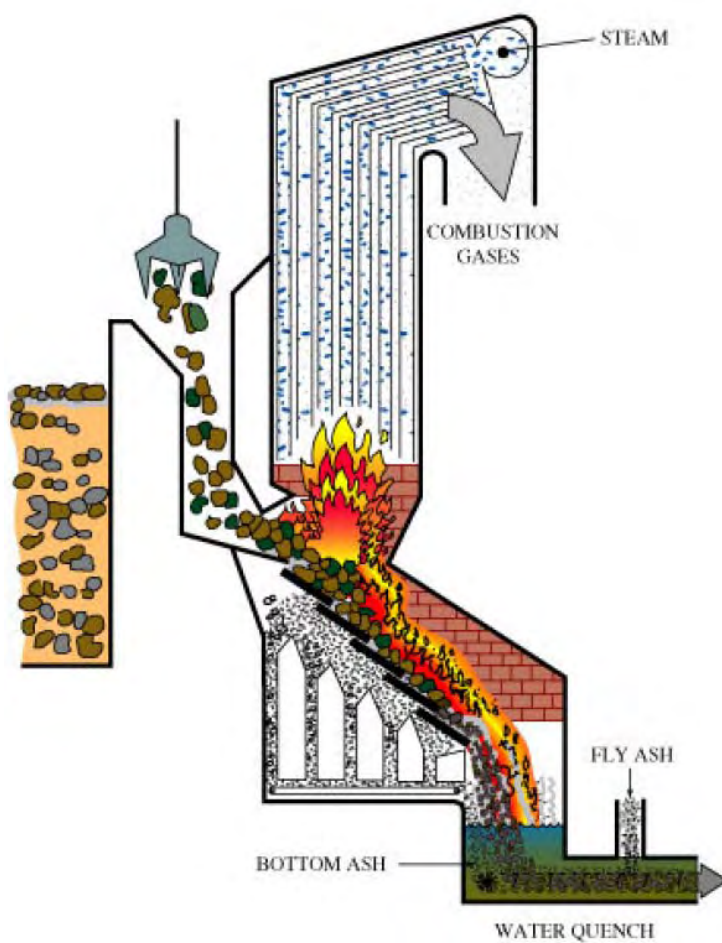


Figure 5.9: Large, overfed stepped grate boiler<sup>103</sup>



Figure 5.10: Overfed moving grate rotary combustion chamber boiler<sup>69</sup>

#### Underfed stokers

Underfed stokers incorporate a simple technology where fuel is supplied to the combustion chamber from the bottom of the appliance. Fuel is fed through the bottom of the appliance to form a dome of fuel, above which combustion takes place<sup>69</sup>. Underfed stokers provide good separation between primary and secondary air and are available in a range of sizes, typically up to 5 MW<sup>69</sup>. This type of moving bed combustion boiler generally accepts fuel up to a moisture content of 30%<sup>69</sup>.

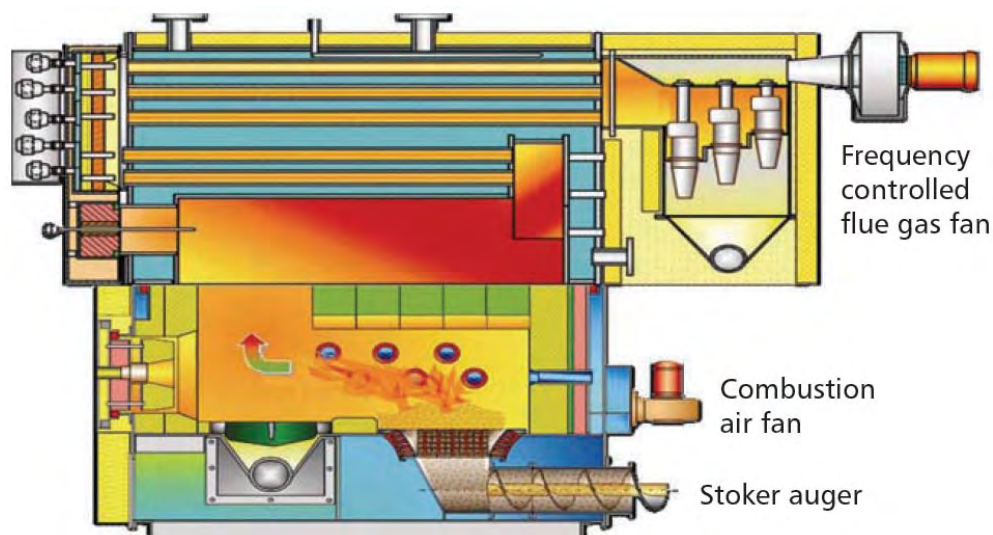


Figure 5.11: Underfed stoker boiler<sup>69</sup>

#### Down draught boiler

These boilers are designed and operate in a similar manner to the domestic down draught boilers outlined in Section 5.2.3. They differ in that they are automatically fed and are generally significantly larger than domestic draught boilers. Logs are the main form of biomass fuel used to heat community, commercial or industrial automatically fed down draught wood boilers<sup>65</sup>.



### Gasification system

Gasification systems are relatively new technologies that use a gas boiler system in combination with a biomass appliance for the combustion of the gases derived from biomass fuel at high temperatures<sup>65</sup>. Gasification systems are highly efficient, advanced systems that are advantageous not only for their high efficiency levels, but also because they ensure low emission levels and they allow for the use of fuel that is wet and not of optimum quality<sup>66</sup>. Wood chips and pellets are the main form of biomass fuel used with gasification systems<sup>65</sup>.

### Pre-ovens combustion system

This system uses well-insulated pre-ovens in combination with the main biomass appliance to ensure that a full combustion process is applied, thus ensuring that emission levels are low<sup>66</sup>.

### Fluidised bed combustion system

Fluidised Bed Combustion (FBC) systems can be separated into two different types depending on the fluidisation velocity adopted; Bubbling Fluidised Bed (BFB) and Circulating Fluidised Bed (CFB) combustion systems<sup>66</sup>. BFB systems operate at a lower fluidisation velocity<sup>116</sup>. Both systems are characterised by very high combustion efficiencies.

BFB systems contain a bed, typically comprised of silica sand, at the bottom of the appliance which is supplied with primary air so as to fluidise it<sup>116</sup>. The particle size and moisture content of fuels used in BFB systems may vary considerably<sup>116</sup>. These systems are regularly used for the co-combustion of coal along with biomass fuels<sup>66,116</sup>.

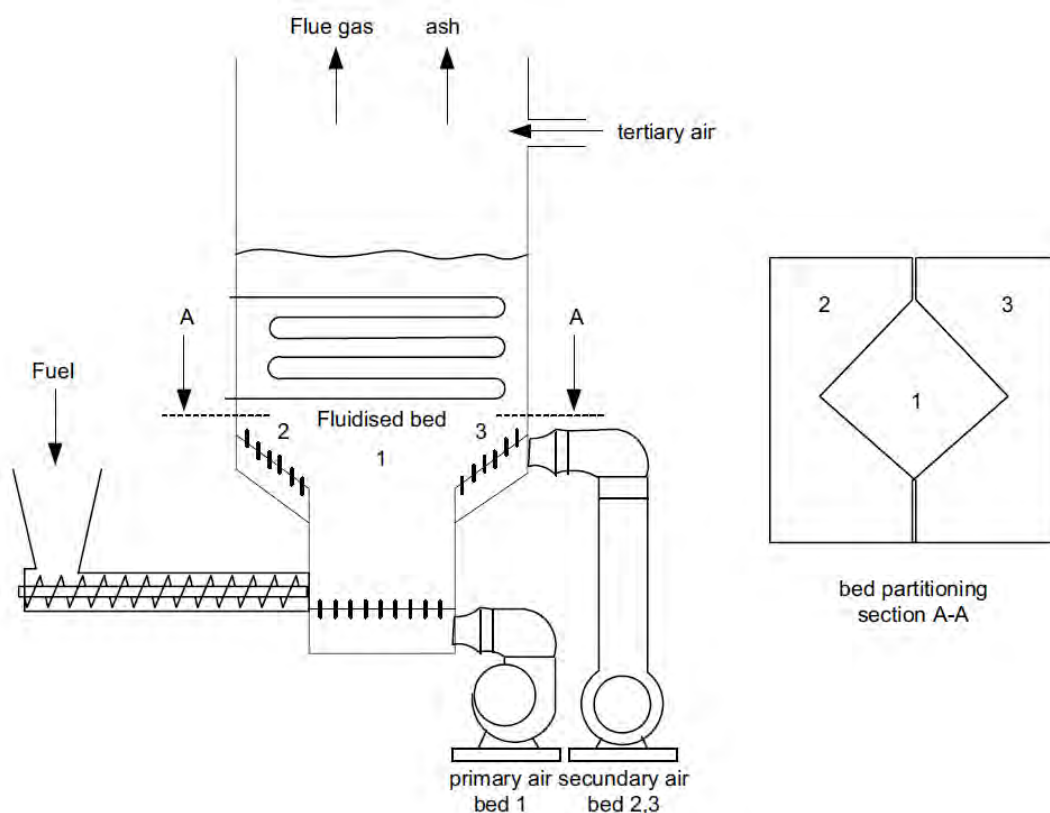


Figure 5.12: Bubbling Fluidised Bed Combustion System<sup>116</sup>

The higher fluidising velocity of CFB systems allow for similar combustion temperatures and concentrations to be achieved, enabling a high quality of burnout at low excess air<sup>70</sup>. CFB systems are also designed to allow for heat to be removed from the bed of the system, enabling combustion temperature control and the operation of the system at low levels of excess air<sup>70</sup>. These systems are generally large in size and require fuel which has a small particle size – initial investment costs and fuel pre-treatment costs are high as a result<sup>116</sup>. Similar to BFB systems, CFB systems are regularly used for the co-combustion of coal along with biomass fuels<sup>66,116</sup>.

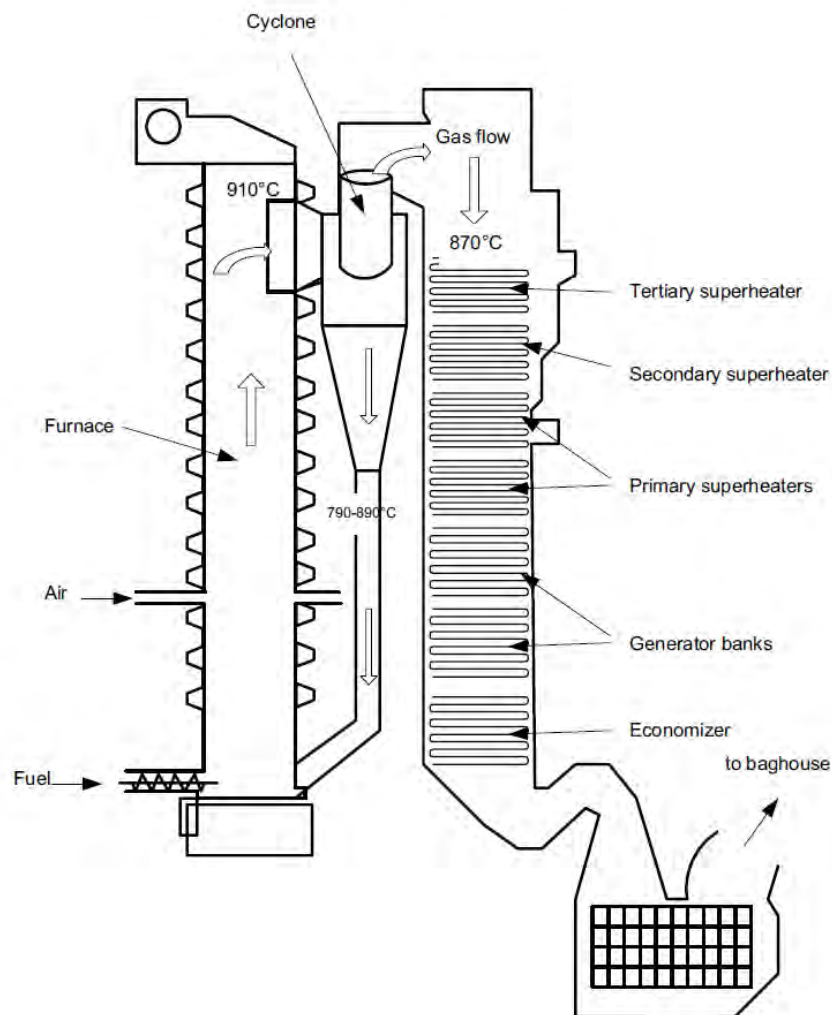


Figure 5.13: Circulating Fluidised Bed Combustion System<sup>116</sup>

Wood chips, pellets and sawdust are the main form of biomass fuels used with both BFB and CFB systems<sup>65</sup>. Generally, the use of FBC systems in community, commercial and industrial settings is less common than the use of alternative automatically fed boilers<sup>66</sup>.

<sup>70</sup> Nussbaumer, T. (2010) *Overview on Technologies for Biomass Combustion and Emission Levels of Particulate Matter*. Prepared for: Swiss Federal Office for the Environment (FOEN).

## 5.4 Further Information Sources

While the above information provides an effective overview of the range of biomass combustion appliances that are available for use today, further detail is available on these appliances from a number of sources. The following sources are considered to be pertinent should the reader be interested in exploring this detail further:

- *Planning and Installing Bioenergy Systems: A Guide for Installers, Architects and Engineers*. German Solar Energy Society (Dgs), 2005. Earthscan Limited<sup>71</sup>
- *The Handbook of Biomass Combustion and Co-firing*. Van Loo, S. & Koppejan, J., 2010. Earthscan Risk in Society Series<sup>72</sup>
- *Biomass Heating: A Guide to Small Log and Wood Pellet Systems*. Palmer, D., Tubby, I., Hogan, G. & Rolls, W., 2011. Biomass Energy Centre, Forest Research, Farnham<sup>73</sup>
- *Biomass Heating: A Guide to Medium Scale Wood Chip and Wood Pellet Systems*. Palmer, D., Tubby, I., Hogan, G. & Rolls, W., 2011. Biomass Energy Centre, Forest Research, Farnham<sup>74</sup>
- *Biomass Heating: A Guide to Feasibility Studies*. Palmer, D., Tubby, I., Hogan, G. & Rolls, W., 2011. Biomass Energy Centre, Forest Research, Farnham<sup>75</sup>
- *Biomass Heating: CIBSE AM15: 2014*. Palmer, D., Ashford, C., Kinnibrugh, J. & Smith, G., 2014. CIBSE<sup>76</sup>
- *Biomass Heating: A Practical Guide for Potential Users*. Carbon Trust, 2008. Carbon Trust: CTG012<sup>77</sup>
- *Health & Safety in Biomass Systems: Design and Operation Guide*. Nicol, A. et al., 2011. The Combustion Engineering Association/Carbon Trust<sup>78</sup>

<sup>71</sup> <https://books.google.ie/books?id=OFTIY81crJUC&printsec=frontcover#v=onepage&q&f=false>

<sup>72</sup> <https://books.google.ie/books?id=KE565zmFumQC&printsec=frontcover#v=onepage&q&f=false>

<sup>73</sup> [http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC\\_TECHNICAL/BEST%20PRACTICE/36491\\_FOR\\_BIOMASS\\_1.PDF](http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC_TECHNICAL/BEST%20PRACTICE/36491_FOR_BIOMASS_1.PDF)

<sup>74</sup> [http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC\\_TECHNICAL/BEST%20PRACTICE/37821\\_FOR\\_BIOMASS\\_2\\_LR.PDF](http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC_TECHNICAL/BEST%20PRACTICE/37821_FOR_BIOMASS_2_LR.PDF)

<sup>75</sup> [http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC\\_TECHNICAL/BEST%20PRACTICE/38215\\_FOR\\_BIOMASS\\_3\\_LR.PDF](http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC_TECHNICAL/BEST%20PRACTICE/38215_FOR_BIOMASS_3_LR.PDF)

<sup>76</sup> <http://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008176dAAC>

<sup>77</sup> [http://www.forestry.gov.uk/pdf/eng-yh-carbontrust-biomass-09.pdf/\\$FILE/eng-yh-carbontrust-biomass-09.pdf](http://www.forestry.gov.uk/pdf/eng-yh-carbontrust-biomass-09.pdf/$FILE/eng-yh-carbontrust-biomass-09.pdf)

<sup>78</sup> [http://www.hetas.co.uk/wp-content/mediauploads/health\\_and\\_safety\\_in\\_biomass\\_s.pdf](http://www.hetas.co.uk/wp-content/mediauploads/health_and_safety_in_biomass_s.pdf)

## 6 BIOMASS COMBUSTION PROCESS

Biomass combustion may be defined as a sequence of complex endothermic (heat-absorbing) and exothermic (heat-producing) chemical reactions between a biomass fuel and an oxidant<sup>79</sup>. Rather than being seen as taking place in one general stage, it is more commonly identified as a process which incorporates a number of separate stages. The main stages which occur in biomass combustion, shown in Figure 6.1, are:

- Drying
- Devolatilisation (pyrolysis & gasification)
- Combustion of gaseous products and charcoal

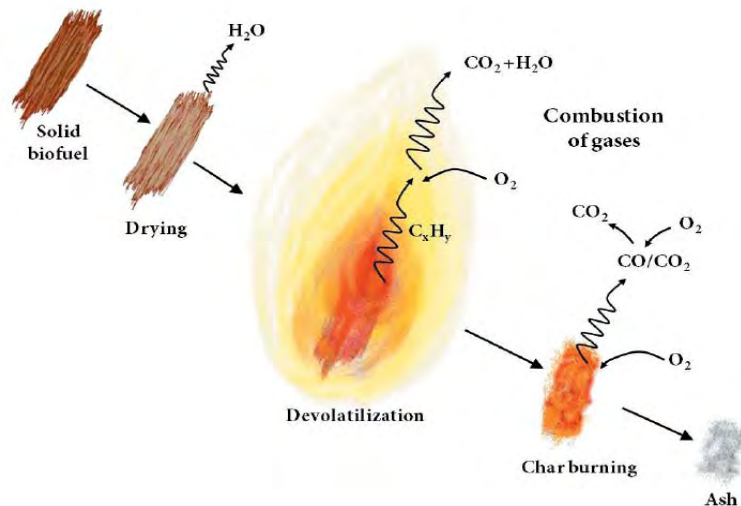


Figure 6.1: Main stages of biomass combustion<sup>69</sup>

The temperatures achieved at each stage of the biomass combustion process vary. The time that it takes for each stage to complete also varies considerably, as shown in Figure 6.2. This is dependent on numerous aspects such as the type, size, dimensions and quality of the fuel used, the exact temperature within the biomass appliance and the conditions of combustion present within the biomass appliance<sup>70</sup>.

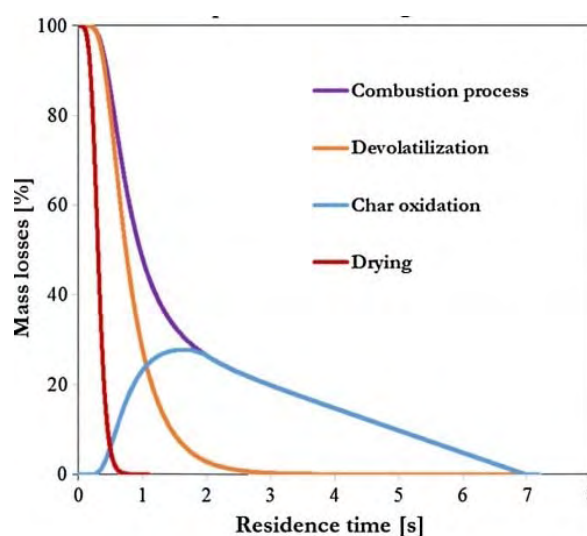


Figure 6.2: Duration of individual combustion processes<sup>80</sup>

<sup>79</sup> [https://www.researchgate.net/figure/260243997\\_fig1\\_Figure-2-Stages-in-combustion-of-a-solid-biomass-particle](https://www.researchgate.net/figure/260243997_fig1_Figure-2-Stages-in-combustion-of-a-solid-biomass-particle)

<sup>80</sup> J Li et al. (2015) *Characterization of biomass combustion at high temperatures based on an upgraded single particle model*.

It is also important to note that the stages identified in Figure 6.1 do not always occur independently, with overlaps often occurring – this is particularly the case for automatically fed systems which can be designed to ensure that different stages of the combustion process occur simultaneously within different areas of the appliance<sup>70</sup>.

The initial stages of biomass combustion are commonly identified as the 'preheating stages' in which endothermic reactions take place so as to ensure the fuel reaches a high enough temperature for the commencement of the oxidation process<sup>69,79</sup>. Fuel is firstly warmed above its storage temperature (generally between 0 and 25°C) before moisture is driven off the fuel at a higher temperature and further heating takes place<sup>69,79</sup>. The fuel is subsequently broken down via pyrolytic decomposition, resulting in the formation of liquid tars and gases<sup>69</sup>.

Following the occurrence of pyrolytic decomposition and the attainment of a high enough temperature, the fuel reaches a 'flash point' (generally at approximately 230°C) at which stage exothermic reactions will begin<sup>69,79</sup>. These reactions occur in the presence of oxygen and are commonly identified as the 'gaseous stages' of biomass combustion<sup>69,79</sup>. Gases are given off by the fuel during these stages and are subsequently ignited, affecting the previously formed liquid tars and gases and resulting in the production of both heat and light, which are visible as flames within the combustion chamber<sup>69,79</sup>. Following the production of flames, all gases produced from the previous stages of combustion will begin to oxidise at high temperatures, resulting in the release of energy<sup>69</sup>.

The final stage of biomass combustion is commonly identified as the 'solid stage' in which the fuel being used is no longer combustible as quantities of gases released from the fuel are no longer high enough to produce flames, resulting in the visible sign of a glowing and smouldering fuel<sup>79</sup>.

The complete combustion of fuel during the combustion process is of vital importance in ensuring the efficient operation of a biomass appliance and the production of low emissions. During the combustion process, the devolatilisation phase occurs in the absence (pyrolysis) or partial presence (gasification) of oxygen, while the combustion phase requires the presence of sufficient oxygen to ensure complete combustion. Complete combustion requires sufficient 'excess air', which refers to the quantity of air supplied in excess of the minimum air demand for a complete oxidation of the fuel (this being termed 'stoichiometric air').

In order to ensure complete combustion (through provision of sufficient excess air) and achieve optimum conditions, the supply of air at the level of the fuel bed (primary air) must be sufficiently separated from the supply of air above the fuel bed (secondary air)<sup>69,79</sup>. Well-designed appliances generally allow for approximately two thirds of combustion air to be secondary air and one third primary air<sup>79</sup>, relating to the greater requirement of air supply to the devolatilisation phase, occurring above the fuel bed. The impacts of appliance design and operation on the combustion process and subsequently the production of emissions is explored further in Section 10.5.

## 7 RECOGNITION OF QUALITY BIOMASS COMBUSTION APPLIANCES, SERVICERS AND INSTALLERS

### 7.1 Triple E Products Register – Ireland<sup>81</sup>

The Triple E (Excellence in Energy Efficiency) Products Register is an initiative introduced by the SEAI which gives recognition to products within Ireland that are 'best in class' in terms of energy efficiency<sup>82</sup>. Products identified on the Triple E Products Register are on average 10-15% more efficient when compared to standard products on the market, while they are also cheaper to operate and produce lower levels of emissions<sup>82</sup>.

While the Triple E Register provides confidence to private and public individuals and organisations that the product they are purchasing is of a high standard, it is of particular relevance to public bodies. Under the European Communities (Energy Efficient Public Procurement) Regulations 2011 (S.I. 151 of 2011)<sup>83</sup>, it is a requirement that public bodies must purchase products that are specifically listed on the register<sup>82</sup>. Incentives are also provided to large organisations that choose to purchase products listed on the register. The Accelerated Capital Allowance (ACA) incentive<sup>84</sup> is a corporate tax reduction incentive which allows organisations paying corporate tax to reduce their tax bill by 100% of the cost of the Triple E registered product that they purchase during the year of the purchase.

The SEAI notes that the Triple E Register currently contains over 7,000 products across 49 individual product types<sup>82</sup>. Biomass boilers are included as a product technology within the heating and electricity provision category. A list of all biomass boilers that are currently on the Triple E Products Register is presented in Appendix 3.

In addition to this list, a further list is presented in Appendix 4 which identifies a range of biomass products currently available in Ireland. This list comprises products from the Triple E Register and products which were approved by the former SEAI scheme, titled the Greener Homes Scheme. The Greener Homes Scheme operated until 2011 and aimed to increase the level of renewable energy technology use in Irish homes by providing assistance, in the form of a grant, to homeowners who had a desire to purchase a renewable energy technology. It should be noted that the list presented in Appendix 4 is not intended to be exhaustive.

A number of criteria are required to be met by biomass boilers in order to be eligible for Triple E registration as follows:

- CE-marked as per specific EU Directives
- Minimum size of 50 kW
- Appropriate operating and maintenance manuals must be available for end-user
- Must include for automatic operation without need for permanent supervision i.e. automatic start-up/shut down, slumber mode operation, fuel loading, ash removal and burn rate control
- Automatic prevention of burn back through the fuel feed
- Incorporate a fault monitoring system capable of remotely communicating a fault
- Mechanical or pneumatic system to facilitate heat exchanger tube cleaning
- Automatic system to trim combustion air
- Must incorporate a system to prevent water over heating in event of mains electricity failure
- Must meet certain efficiency and dust emission levels when burning wood pellet or wood chips as listed in Table 7.1.

<sup>81</sup> [http://www.seai.ie/Your\\_Business/Triple\\_E\\_Product\\_Register/](http://www.seai.ie/Your_Business/Triple_E_Product_Register/)

<sup>82</sup> SEAI (2016)

[http://www.seai.ie/Your\\_Business/Public\\_Sector/Best\\_Practice/Best\\_Practice\\_Procurement/TripleE\\_information\\_leaflet.pdf](http://www.seai.ie/Your_Business/Public_Sector/Best_Practice/Best_Practice_Procurement/TripleE_information_leaflet.pdf)

<sup>83</sup> Government of Ireland (2011b) <http://www.irishstatutebook.ie/eli/2011/si/151/made/en/print#>

<sup>84</sup> [http://www.seai.ie/Your\\_Business/Accelerated\\_Capital\\_Allowance/](http://www.seai.ie/Your_Business/Accelerated_Capital_Allowance/)

Table 7.1: Triple E Register Efficiency and Dust Emission Standards

Boiler Rating	Thermal efficiency <sup>1</sup>		Dust Emissions <sup>2</sup>
	Chips	Pellets	
50–150 kW	≥85%	90%	≤150
>150–500 kW	≥86%	91%	≤130
>500 kW	≥87%	92%	≤120

<sup>1</sup> efficiency based on net caloric value<sup>2</sup> mg/Nm<sup>3</sup> 13 vol% O<sub>2</sub>

When compared with dust emission limit values set by previously identified standards, the above values set by the Triple E Register are generally more lenient. The European Standard EN 303-5 (see Section 3.2.1) sets a dust emission limit value of 150 mg/m<sup>3</sup> for Class 3 appliances. While this is comparable to the values set by the Triple E Register, this value is for Class 3 appliances which are the least favourable. Dust emission limit values set by EN 303-5 are significantly lower for Class 4 (60-75 mg/m<sup>3</sup>) and Class 5 (40-60 mg/m<sup>3</sup>) appliances.

Dust emission limit values set by the different pieces of legislation relevant to biomass combustion are also significantly lower than those set by the Triple E Register. Values set by the Industrial Emissions Directive (see Section 2.2.1), the Medium Combustion Plant Directive (see Section 2.2.2) and the Ecodesign Directive (see Section 2.3.1) vary from 20-60 mg/m<sup>3</sup>, depending on the type and size of biomass combustion appliance.

## 7.2 Renewable Installers Register – Ireland<sup>85</sup>

Arising from requirements put forward in the EU Renewable Energy Directive (2009/28/EC), the Sustainable Energy Authority of Ireland (SEAI) has developed a renewable installers register, which identifies installers in Ireland who are suitably qualified to carry out the installation of renewable energy technologies. This register covers the installation of the following technologies:

- Small scale biomass boilers and stoves
- Solar photovoltaic (solar PV)
- Solar thermal systems (solar water heating)
- Shallow geothermal systems and heat pumps

In order for installers to be included on this register, they must provide the SEAI with proof that they hold qualifications relating to the installation of the appropriate technology. Qualifications must be awarded by Quality and Qualifications Ireland (QQI; formerly known as FETAC), the national awarding body for further education and training in Ireland. Eleven training centres currently provide QQI installation training relating to the above technologies and these are inspected by SEAI to ensure that they meet the standard requirements for a training facility.

While the SEAI ensures that all individuals listed on the renewable installers register are appropriately qualified, it does not assess the work of the installers included on the register. At the time of writing, there were 22 installers listed on the register who are recognised as appropriately qualified installers of small scale biomass boilers and stoves in Ireland.

<sup>85</sup> [http://www.seai.ie/Renewables/Renewable\\_Installers\\_Register/](http://www.seai.ie/Renewables/Renewable_Installers_Register/)



### 7.3 METAC Training – Ireland<sup>86</sup>

The Midland Energy Training and Assessment Centre (METAC) is a provider of energy training and assessment in Ireland. Based in County Laois, METAC provides independently certified and verified training courses which are recognised by organisations such as SOLAS, QQI, City & Guilds, UKAS, Bord Gáis and OFTEC. It trains approximately 2,700 people every year in a wide range of areas such as gas, oil, solid fuel, renewable, building technology, electrical and welding.

Of particular interest in terms of biomass combustion are the solid fuel training courses provided by METAC. In addition to a solid fuel awareness training course, METAC also provides dry solid fuel and wet solid fuel stove installer courses. These courses are important in ensuring the adequate training of biomass appliance installers so as to ensure the correct installation of appliances, and by association, to maintain emission levels as low as possible (see Section 10.7). METAC also provides solid fuel awareness training for retail and sales staff, which is a one day course developed to raise awareness for retail staff when dealing with customers in choosing the correct solid fuel appliance and to recognise the installation and fuel requirements.

### 7.4 Registered Gas Installer Scheme – Ireland<sup>87</sup>

While not directly relating to biomass, a certified/accredited installer scheme for heating appliance installation is currently in place in Ireland. The Registered Gas Installer (RGI) scheme was initiated by the Commission for Energy Regulation (CER) in 2006 so as to ensure the safe installation of gas appliances in Ireland. This scheme is implemented by the Register of Gas Installers of Ireland (RGII), who are responsible for the registration of safe gas appliance installers onto the scheme and the subsequent overview of these installers once they are on the scheme. The Energy (Miscellaneous Provisions) Act 2006<sup>88</sup> was enacted by the CER in 2009, making it illegal for individuals not registered on the RGI scheme to install gas appliances in Ireland and making it a mandatory requirement for all installers registered on the RGI scheme to issue a Declaration of Conformance (completion cert) to the customer upon completion of any gas installation work.

In considering the implementation of a potential certified/accredited installer scheme for biomass installations, while such a scheme would likely be of a considerably smaller size than the current RGI scheme in Ireland, it would nonetheless be useful to use the RGI scheme as a guide. Communication with the CER would be beneficial prior to the implementation of a certified/accredited installer scheme for biomass installations so as to help determine the most appropriate way to implement and operate such a scheme. An alternative option for the potential implementation of such a scheme for biomass installations would be to incorporate into the RGI scheme in its current form.

### 7.5 Competent Person Schemes – UK

In the UK, a number of competent person schemes are currently in existence which allow individuals and organisations to self-certify that the installation work they carry out is in compliance with the Building Regulations. The use of competent person schemes was put forward by the UK Department of Communities and Local Government (DCLG) so as to provide individuals and organisations with a viable alternative to the costly requirement of having a local council inspector or a private approved inspector to check all building related installation work upon its completion. While there are a large number of competent person schemes currently in operation, not all of them cover biomass combustion appliance installation work. Seven competent person schemes are identified by the DCLG to cover the installation of solid fuel (including biomass) combustion appliances<sup>89</sup>. Each of these schemes are accredited by the United Kingdom Accreditation Service (UKAS).

Authorisation of the competent person schemes is carried out by the DCLG, with the schemes required to follow certain rules and meet specific criteria so as to ensure that high standards of appliance installation are maintained throughout the UK.

---

<sup>86</sup> <http://metac.ie/>

<sup>87</sup> <http://www.rgii.ie/>

<sup>88</sup> Government of Ireland (2006) <http://www.irishstatutebook.ie/eli/2006/act/40/enacted/en/print.html>

<sup>89</sup> <https://www.gov.uk/guidance/competent-person-scheme-current-schemes-and-how-schemes-are-authorised>

In order to become a registered member of one of the above schemes, installers are required to meet specific minimum technical competence (MTC) requirements. A separate list of MTC requirements are identified for the installation of domestic biomass appliances and the installation of non-domestic appliances. Prior to approval for registration to one of the above schemes, installers are assessed to ensure that they meet all of the necessary MTC requirements. Following confirmed approval, installers will be inspected on an ongoing basis to ensure that they continue to meet the MTC requirements for the scheme.

Of the seven competent person schemes that are most relevant to biomass appliance installations, the most specialised is commonly considered to be the HETAS competent person scheme. HETAS<sup>90</sup> is a UK based organisation that operates within the biomass and solid fuel heating sector. In order for installers to be certified by this scheme, they are required to have completed the appropriate HETAS approved training courses. The following are a list of HETAS approved training courses which are directly relevant to the installation of biomass appliances:

- H003 – HETAS Dry Appliance Installer Course
- H004 – HETAS Wet Appliance Installer Course
- H005DE – HETAS Biomass Installer
- H006 – HETAS System Chimney Course
- H008 – Dry Pellet Stove Installer

The above courses are available at various locations throughout Ireland and the UK. In Ireland, HETAS approved courses are provided by Oriel Flues at the Ardee Enterprise Centre in Ardee, County Louth, while in Northern Ireland, HETAS approved courses are provided by the North West Regional College at the Springtown Training Centre, County Derry.

All certified members of the HETAS competent person scheme are also required to complete refresher installation training courses a minimum of every five years to ensure that their skills are up to date and that they continue to meet the necessary MTC requirements.

In addition to providing approval for the specific work provided by biomass installers and servicers, HETAS also provides approval for biomass heating appliances and high quality biomass fuels (see Section 3.3). Biomass heating appliances which are approved by HETAS have been tested according to a government approved scheme so as to ensure their high standard. A full list of all biomass appliances that are HETAS approved is available in Part 1 of *'The Official Guide to HETAS Approved Products & Services'*<sup>91</sup>, a document published by HETAS in 2016.

## 7.6 MCS Scheme – UK<sup>92</sup>

The Microgeneration Certification (MCS) scheme was introduced by the (now disbanded) Department of Energy & Climate Change) DECC in the UK in 2008 to provide recognition to both high quality microgeneration appliance technologies and high quality microgeneration appliance installers. This scheme covers a range of renewable energy technologies, including biomass. For appliances to be MCS certified, they are required to meet a range of both European and International Standards. For installers to be MCS certified, they are assessed according to the quality of both the installation and the commissioning of an appliance.

Eight certification bodies, all of which are also recognised as competent person schemes and are accredited by UKAS, assess both appliances and installers to determine whether they may be certified to MCS standards.

MCS certification is linked to financial incentives that are available for renewable energy use in the UK. All domestic appliances and all non-domestic appliances below 45 kW in size (70 kW for multiple installations) are required to be MCS certified and installed by an MCS approved installer for their user to avail of the benefits provided by the RHI. Furthermore, eligibility for the Feed in Tariffs (FIT) scheme for small scale renewable appliances in the UK requires that these appliances are MCS certified.

---

<sup>90</sup> <http://www.hetas.co.uk/>

<sup>91</sup> HETAS (2016) <http://www.hetas.co.uk/professionals/hetas-guide/>

<sup>92</sup> <http://www.microgenerationcertification.org/>

## 7.7 Quality Renewable Energy Appliance Installers – European Study

In an effort to gauge the presence and the functioning of all certified installer schemes relating to renewable energy within the EU, a project entitled 'QualiCert'<sup>93</sup> was recently carried out at the European level. QualiCert stands for "common quality certification and accreditation for installers of small-scale renewable energy (RE) systems". This project reviewed the quality certification and accreditation schemes in place for small scale RE appliance installers in countries throughout the EU. It did not address the presence of similar schemes for large scale RE appliance installers. The project reviewed all renewable energy appliance installers and was not biomass specific.

The QualiCert project found that of the 19 EU Member States that were reviewed, 14 of these had implemented an appliance installer certification/accreditation scheme, while 5 Member States had not, but expressed interest in doing so. The following were identified as some of the main lessons which were learned from this project:

- Stakeholders across the EU identified the importance of establishing an appliance installer certification/accreditation scheme. It was identified that such schemes improve the quality of appliance installations, facilitate the development of best practices, increase consumer confidence and provide access to a network of high quality installers.
- Appliance installer certification/accreditation schemes appear in different forms across the EU. They may be voluntary or linked to a financial incentive scheme. They may be implemented by public authorities or by private organisations. They may or may not be accredited by a national accreditation body.
- The majority of appliance installer certification/accreditation schemes in the EU that incorporate numerous technologies began with the certification/accreditation of installers relating to just one technology before being extended to include other technologies.
- Training provided to appliance installers may be given by numerous institutions, depending on the country. The type of training provided varies between institutions. Training provided is not always accredited by public authorities or by a certified body.
- Not all appliance installer certification/accreditation schemes in the EU are audited. However, stakeholders involved in this project identified the importance of an audit process to ensure the delivery of high quality appliance installation training.
- Concern was raised by some stakeholders regarding the cost involved in the implementation and operation of an appliance installer certification/accreditation scheme.
- It was identified that public authority support is necessary for the implementation of all appliance installer certification/accreditation schemes, while there was also a requirement for the passing of new legislation prior to the implementation of some certification/accreditation schemes within the EU.

---

<sup>93</sup> <https://ec.europa.eu/energy/intelligent/projects/en/projects/qualicert>

## 8 BIOMASS AS A LOW CARBON FUEL

The use of a biomass as a fuel is regularly identified as a low carbon option when compared with the use of other fuels such as fossil fuels. Unlike the burning of fossil fuels, which releases CO<sub>2</sub> into the atmosphere that would otherwise have remained stored in the earth's crust, the burning of biomass fuels and the subsequent release of CO<sub>2</sub> is offset by the carbon that has been captured from the original growth of the biomass material or the growth of new biomass material that is planted as a replacement<sup>79,94</sup>. A general overview of the low carbon cycle that occurs from the use of biomass as a fuel is presented in Figure 8.1.

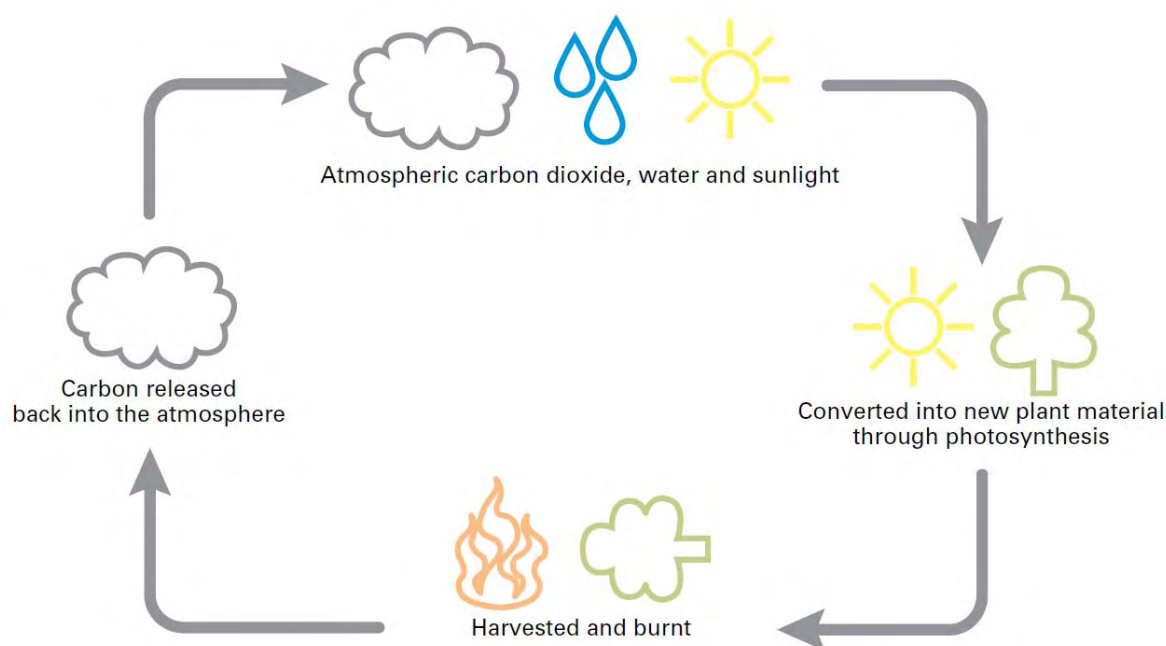


Figure 8.1: Typical Low Carbon Biomass Cycle<sup>95</sup>

Biomass is often identified as a 'carbon neutral' or 'zero carbon' fuel. CO<sub>2</sub> emissions from biomass combustion are accounted for in the Land Use, Land-Use Change and Forestry (LULUCF) sector, rather than in the energy sector, which is why CO<sub>2</sub> emissions from biomass combustion are often identified as zero<sup>96</sup>. While biomass is often identified as a 'carbon neutral' or 'zero carbon' fuel, some authors<sup>97,98</sup> have argued against the use of these terms, suggesting that it is a flawed assumption to consider biomass as having no adverse effects on the global carbon cycle. The need to take into consideration not only the direct carbon captured by and released from biomass, but also indirect emissions produced from the cultivation, harvesting, processing and transportation of biomass, is important<sup>79,99</sup>. These 'life cycle emissions' should also be considered when analysing the use of biomass as a fuel and it is for this reason that it is now seen as more appropriate to identify biomass as a low carbon fuel rather than a carbon neutral or zero carbon fuel<sup>99</sup>.

Table 8.1 presents a comparison from the World Energy Council of the life cycle CO<sub>2</sub> emissions produced from the use of woodchip as a fuel with those produced from the use of natural gas and oil as fuels.

<sup>94</sup> AEBIOM (2012) *AEBIOM statement: Biomass delivers climate change benefits*.

<sup>95</sup> Carbon Trust (2008) *Biomass Heating: A Practical Guide for Potential Users*. Carbon Trust: CTG012

<sup>96</sup> Agostini, A. et al. (2014) *Carbon accounting of forest bioenergy: conclusions and recommendations from a critical literature review*. JCR Scientific and Policy Reports. European Commission.

<sup>97</sup> Johnson, E. (2008) Goodbye to carbon neutral: Getting biomass footprints right. *Environmental Impact Assessment Review*, 29 (3): 165-168.

<sup>98</sup> Zanchi, G. et al. (2012) Is woody bioenergy carbon neutral? A comparative assessment of emissions from consumption of woody bioenergy and fossil fuel. *GCB Bioenergy*, 4(6): 761-772.

<sup>99</sup> Biomass Energy Centre (2011a) *Surely burning wood releases CO<sub>2</sub>? An extended discussion paper from the Biomass Energy Centre*.

Table 8.1: Comparison of life cycle CO<sub>2</sub> emissions<sup>100</sup>

Space heating	kg CO <sub>2</sub> /MWh
Biomass (wood chip)	10-23
Natural gas	263-302
Oil	338-369

It is evident that biomass produces significantly lower levels of CO<sub>2</sub> emissions across its lifecycle than fossil fuels. In addition to the low carbon benefit of biomass, the use of biomass as a fuel incentivises the global development of forestry. Increases in the demand of wood for use as a biomass fuel encourages investment in the harvesting of new forest plantations and the sustainable management of existing plantations<sup>94</sup>. As the forest stock in Europe is steadily increasing (3.5 million additional hectares planted between 2000 and 2010), the sustainable management of this stock, funded by the increasing demand of wood for use as a biomass fuel, is vital for its health, productivity and the prevention of pests and forest fires<sup>94</sup>.

The need to protect against the risks posed from unsustainable forestry practices such as large scale deforestation and land use change is evident. The UK is one example of where protection measures have been put in place. In order to participate in the UK RHI, participants must procure wood fuel that meets specific sustainability criteria, in terms of lifecycle greenhouse gas emission values<sup>55</sup>, and land use criteria. A similar step may be advisable in the future in Ireland following the initial implementation of the proposed national RHI.

<sup>100</sup> World Energy Council (2004) *Comparison of Energy Systems using Life Cycle Assessment: A Special Report for the World Energy Council*.

## 9 EMISSIONS FROM BIOMASS COMBUSTION

### 9.1 Overview

The combustion of biomass results in the release of pollutants which can impact on air quality and consequently the health of both human populations and the environment. While the positive impacts of the use of biomass as a fuel are evident, as outlined in Section 8, there is a need to ensure that these impacts are not outweighed by potential negative air quality impacts.

The principal emissions which may be released from biomass combustion are:

- Particulate Matter (PM), including:
  - Salts
  - Soot
  - Condensable Organic Compounds (COCs)
  - Volatile Organic Compounds (VOCs)
  - Intermediate products – e.g. tars and Polycyclic Aromatic Hydrocarbons (PAHs)
- Oxides of Nitrogen (NO<sub>x</sub>)
  - Nitric Oxide (NO)
  - Nitrogen Dioxide (NO<sub>2</sub>)
  - Nitrous Oxide (N<sub>2</sub>O)
- Oxides of Carbon (CO<sub>x</sub>)
  - Carbon Monoxide (CO)
  - Carbon Dioxide (CO<sub>2</sub>)
- Oxides of Sulphur (SO<sub>x</sub>)
  - Sulphur Dioxide (SO<sub>2</sub>)
  - Sulphur Trioxide (SO<sub>3</sub>)
- Dioxins/Furans

Of the above pollutants, PM (and its intermediate products) and NO<sub>x</sub> are considered to be the most relevant emissions when considering biomass combustion<sup>70</sup>. The results of a study<sup>101</sup> completed by the Swiss Federal Office for the Environment on a life cycle assessment for wood chip combustion are presented in Table 9.1. This study indicated that 75.1% of the environmental impact of wood chip combustion is attributed to PM<sub>10</sub> and NO<sub>x</sub> (36.5% to PM<sub>10</sub> and 38.6% to NO<sub>x</sub>), with the remainder attributed to all other pollutants.

Table 9.1: Life cycle assessment for environmental impacts of wood chip combustion<sup>101</sup>

	EIP/GJ	%
PM <sub>10</sub>	12,600	36.5
NO <sub>x</sub>	13,030	38.6
CO <sub>2</sub>	670	2.0
Other pollutants	8,200	22.9
Total	34,500	100

Note: EIP = Environmental Impact Points

<sup>101</sup> Kessler et al. (2000) <https://searchworks.stanford.edu/view/5516841>

As PM and NO<sub>x</sub> are of most relevance when analysing emissions from biomass combustion, these pollutants are focused on in depth in this assessment. Detailed information is provided on PM and NO<sub>x</sub> in Section 9.2 and Section 9.3, respectively, while the factors which influence the levels of these emissions are analysed in Section 10. While emissions of other pollutants from biomass combustion are not considered in detail, an overview of how the relevance of these pollutants to biomass combustion and the impacts that they may have is presented hereunder.

### 9.1.1 Oxides of Carbon (CO<sub>x</sub>)

Exposure to CO can alter the process of oxygen absorption in the bloodstream, having potentially fatal impacts should individuals be exposed to high enough levels<sup>69,102</sup>. The exposure of individuals to regular sub-clinical levels of CO over a prolonged period can also result in significant damage to a number of vital organs in the body<sup>69</sup>. Sub-clinical levels of CO are identified as being <50 ppm and usually produce no noticeable symptoms<sup>69</sup>.

When considering biomass combustion, the incomplete combustion of biomass fuels results in the release of unburned CO and heavier hydrocarbon compounds which have not been reduced to lower order hydrocarbons, therefore increasing biomass emissions. The use of good combustion practices is of vital importance in ensuring that incomplete combustion does not occur and that high levels of CO are not produced. Good combustion practices which minimise the likelihood of CO production include<sup>102,103,104</sup>:

- Ensuring the correct matching of appliance type with fuel type and quality (for quality; fuels with a low moisture content should be used for dry fuel combustion appliances, while fuels with a high moisture content should be used for wet fuel combustion appliances)
- Ensuring an adequate volume of primary air (on the grate) and secondary air (within the gas combustion zone) are maintained. A depleted O<sub>2</sub> environment is required on the grate to ensure pyrolysis occurs and the fuel is released into the gas combustion zone, while a sufficient quantity of excess O<sub>2</sub> is required within the gas combustion zone to ensure the complete combustion of the gas products produced from pyrolysis. However, the quantity of excess air introduced into the gas combustion zone should not be excessive, as this will result in unwanted cooling of the combustion chamber, resulting in a reduction in combustion efficiency and a subsequent increase in the production PM emissions.
- Ensuring adequate control and optimisation of the '3 Ts' of combustion, namely:
  - Time – adequate time is required within the combustion chamber to ensure the complete combustion of the fuel
  - Turbulence – adequate mixing of air and fuel gases is required within the combustion chamber to ensure the complete combustion of these gases
  - Temperature – a high enough temperature is required to be maintained within the combustion chamber to maximise the oxidation of CO to CO<sub>2</sub>

In addition to the need to ensure the above good combustion practices, it is also important that biomass combustion appliances are adequately ventilated and are not installed in enclosed spaces, where the impacts of CO can be exacerbated<sup>102</sup>.

The complete combustion of carbon in a fuel results in the formation of CO<sub>2</sub>, rather than CO and the subsequent release of energy. Complete combustion is the desired outcome in biomass combustion appliances. As a result of the low calorific value of wood, biomass combustion generally produces relatively high levels of CO<sub>2</sub>; a greenhouse gas which enhances the greenhouse effect and contributes to climate change<sup>105</sup>. However, as identified in Section 8, the CO<sub>2</sub> emissions that are produced from biomass combustion are generally offset by the carbon captured from the original growth of the biomass material or the growth of new biomass material that is planted as a replacement.

---

<sup>102</sup> PFPI (2011) *Air pollution from biomass energy*.

<sup>103</sup> Beauchemin & Tampier (2008) *Emissions from Wood-Fired Combustion Equipment*.

<sup>104</sup> Abbott, J. et al. (2007) Review of the Potential Impact on Air Quality from Increased Wood Fuelled Biomass Use in London. AEA Energy & Environment.

<sup>105</sup> Biomass Energy Centre (2011b)

[http://www.biomassenergycentre.org.uk/portal/page?\\_pageid=77,109191&\\_dad=portal&\\_schema=PORTAL](http://www.biomassenergycentre.org.uk/portal/page?_pageid=77,109191&_dad=portal&_schema=PORTAL)



### 9.1.2 Oxides of Sulphur (SO<sub>x</sub>)

Exposure to SO<sub>2</sub> can increase the onset of respiratory diseases and worsen existing conditions such as asthma<sup>102</sup>. Furthermore, exposure to SO<sub>2</sub> has been linked with reduced lung function and irritation of the eyes, nose and throat<sup>106</sup>. SO<sub>2</sub> is also known to have indirect human health effects (see Section 9.2) by contributing to the production of PM in the atmosphere<sup>102</sup>.

In addition to human health impacts, SO<sub>2</sub>, along with SO<sub>3</sub>, can have negative impacts on the environment. Both pollutants are direct contributors to regional haze and acid rain which often cause significant damage to ecosystems<sup>106</sup>.

The concentration of SO<sub>x</sub> in biomass fuels prior to their combustion are more of a determinant of the SO<sub>x</sub> emission released from combustion than the process of combustion itself<sup>104</sup>.

A high percentage (40 to 90%) of the sulphur developed from the combustion process condenses onto the particulate that is formed within the flue during this process, with the remainder released as SO<sub>2</sub> or SO<sub>3</sub> gas<sup>104</sup>.

Emissions of SO<sub>x</sub> (primarily SO<sub>2</sub>) from biomass combustion are generally quite low due to the low sulphur content of wood. Table 9.2 presents the results of a study<sup>107</sup> which compared typical SO<sub>2</sub> emission levels from the combustion of biomass, oil, coal and gas in small boilers (<1 MW). As can be seen from Table 9.2, SO<sub>2</sub> emissions from biomass combustion are considerably lower than SO<sub>2</sub> emissions from oil or coal combustion. Emission levels produced are higher than those produced from the combustion of natural gas, however.

Table 9.2: Comparison of SO<sub>2</sub> emissions from biomass and fossil fuels in small boilers<sup>107</sup>

	Biomass (wood)	Gas		Oil		Coal	
	<1 MW	<50 kW	<1 MW	<50 kW	<1 MW	<50 kW	<1 MW
SO <sub>2</sub> (g/GJ)	30	0.5	0.5	140	140	90	90

### 9.1.3 Dioxins/Furans

Dioxins/furans can be produced as products from the process of biomass combustion. These pollutants are often identified as 'Persistent, Bio-accumulative and Toxic (PBT)', and can have negative impacts on various aspects of human health including hormone levels and functions, foetal development, reproduction and immune system functioning<sup>102</sup>.

Dioxin/furan emissions from biomass combustion are known to increase as a result of incomplete combustion, while studies have also shown that a high SO<sub>x</sub> content in the fuel used for combustion can have the opposite effect, reducing emissions of dioxins/furans<sup>103</sup>.

<sup>106</sup> World Bank Group (1998) *Pollution Prevention and Abatement Handbook 1998*.

<sup>107</sup> Galbraith, D. et al. (2006) *Review of Greenhouse Gas Life Cycle Emissions, Air Pollution Impacts and Economics of Biomass Production and Consumption in Scotland*. Scottish Executive Environment and Rural Affairs Department.

## 9.2 Particulate Matter (PM)

### 9.2.1 Overview

PM is considered to be one of the most significant pollutants produced from biomass combustion. PM recorded in the ambient air is a combination of primary aerosols, directly emitted from both natural and anthropogenic sources, and secondary aerosols, formed in the atmosphere from the conversion of other gaseous compounds such as SO<sub>2</sub><sup>70</sup>.

The size of PM varies, with two categories commonly identified when analysing the impacts of PM on human health and the environment: PM<sub>10</sub> and PM<sub>2.5</sub>. PM<sub>10</sub>, or coarse particles, includes all particles that have an aerodynamic diameter that is  $\leq 10$  micrometres, while PM<sub>2.5</sub>, or fine particles, includes all particles that have an aerodynamic diameter that is  $\leq 2.5$  micrometres<sup>29</sup>. Estimates indicate that >90% of PM emissions from the efficient combustion of wood fuel fall within the PM<sub>10</sub> category, while >75% fall within the PM<sub>2.5</sub> category<sup>103</sup>.

While the concentration and particle size of PM are vital in assessing its impacts, other aspects such as the shape, morphology and chemical composition of PM have also been identified as important issues for consideration<sup>70</sup>.

### 9.2.2 Human Health Impacts

PM is a pollutant that is known to have a number of impacts on human health. Exposure to PM over both short and long time periods can result in a range of respiratory and cardiovascular illnesses – health impacts are understood to be more significant as a result of long term PM exposure<sup>104</sup>.

Individuals with lung disease and conditions such as hay fever and asthma are particularly affected by exposure to PM, while studies have also shown that PM can alter the circulation and clotting ability of blood cells<sup>104</sup>.

The different particle sizes of PM, identified in Section 9.2.1, have different consequences on human health. PM<sub>10</sub> is commonly known as the thoracic fraction of PM as particles of this size are deposited in the upper airway prior to settlement in the lungs, whereas PM<sub>2.5</sub> is commonly known as the respirable fraction of PM as particles of this size are finer and can pass through the lungs directly into the bloodstream as a result<sup>69</sup>. It is for this reason that interest in PM<sub>2.5</sub> and its impacts has risen in recent years. The WHO identifies PM<sub>2.5</sub> as a pollutant that can result in cardiovascular mortality and morbidity, atherosclerosis, birth defects and respiratory illnesses, while emerging evidence of a link between exposure to PM<sub>2.5</sub> and neurodevelopment, cognitive functioning and the onset of other diseases such as diabetes have also been noted by the WHO<sup>30</sup>. The fact that greater than 90% of the EU population are living in areas with PM<sub>2.5</sub> exposure levels above the WHO guideline limit has also raised interest levels relating to the impacts of this pollutant<sup>36</sup>. Along with the increasing levels of interest in PM<sub>2.5</sub> in recent years, there is also an increasing focus on the portion of PM known as 'black carbon' which are the light absorbing fine soot like particles that are released from the incomplete combustion of fossil fuels<sup>108</sup>. Black carbon is present in the ultrafine fraction of PM (PM<sub>0.1</sub>) and is known to be a significant component of diesel soot, a substance that the WHO has identified as being carcinogenic<sup>109</sup>.

A recent study, titled the Residential Solid Fuel and Air Pollution Study<sup>110</sup>, which was jointly commissioned by the Department of the Environment in Northern Ireland and the Department of the Environment, Community and Local Government in Ireland, quantified the impacts of PM and other pollutants on human health in Ireland. Table 9.3 presents the estimated number of life years lost and adult deaths throughout Ireland in 2011 that were attributable to PM<sub>10</sub> air pollution. For comparative purposes, the average annual number of deaths caused by the use of tobacco in Ireland are also presented in Table 9.3.

<sup>108</sup> EEA (2013) Status of black carbon monitoring in ambient air in Europe. EEA Technical Report, No 18/2013

<sup>109</sup> WHO (2012) *Health Effects of Black Carbon*. Joint WHO/UNECE Task Force on Health Aspects of Air Pollutants under UNECE's Long-Range Transboundary Air Pollution Convention (LRTAP)

<sup>110</sup> Abbott et al. (2015) *Residential Solid Fuel and Air Pollution Study*. North South Ministerial Council (NSMC)

Table 9.3: Comparison of number of life years lost/adult deaths attributable to PM<sub>10</sub> air pollution with number of deaths attributable to tobacco use Ireland

Life years lost due to PM <sub>10</sub> in 2011 <sup>110</sup>	Deaths >30 years due to PM <sub>10</sub> in 2011 <sup>110</sup>	Average annual deaths due to tobacco use <sup>111</sup>
13,566	1,148	5,200

Estimates were also presented in the Residential Solid Fuel and Air Pollution Study on the numbers of deaths and life years lost which would likely be prevented from reductions in PM<sub>10</sub> concentrations in Ireland. These are presented in Table 9.4.

Table 9.4: Number of life years lost/adult deaths prevented from PM<sub>10</sub> reductions in Ireland<sup>110</sup>

Reduction in PM <sub>10</sub> concentration	# life years lost prevented	# deaths >30 years prevented
20%	2,997	254
40%	5,966	505

While no estimates were presented in the Residential Solid Fuel and Air Pollution Study for deaths relating specifically to PM<sub>2.5</sub> emissions, a recent report<sup>4</sup> by the European Environment Agency (EEA) provides estimates of the number of life years lost and premature deaths which were attributable to PM<sub>2.5</sub> across EU countries in 2012. These are provided in Table 9.5. The EEA estimates that 14,400 life years were lost and 1,200 premature deaths were caused in Ireland in 2012 as a result of PM<sub>2.5</sub> air pollution.

Table 9.5: Comparison of number of life years lost/premature deaths attributable to PM<sub>2.5</sub> air pollution across EU countries in 2012<sup>4</sup>

Country	Life years lost due to PM <sub>2.5</sub> in 2012	Premature deaths due to PM <sub>2.5</sub> in 2012
Austria	65,400	6,100
Belgium	99,500	9,300
Bulgaria	141,500	14,100
Croatia	46,900	4,500
Cyprus	8,000	790
Czech Republic	116,300	10,400
Denmark	31,400	2,900
Estonia	7,000	620

<sup>111</sup> Department of Health (2013) *Tobacco Free Ireland: Report of the Tobacco Policy Review Group*.

Country	Life years lost due to PM <sub>2.5</sub> in 2012	Premature deaths due to PM <sub>2.5</sub> in 2012
Finland	20,800	1,900
France	508,900	43,400
Germany	645,200	59,500
Greece	116,700	11,100
Hungary	141,900	12,800
Ireland	14,400	1,200
Italy	652,200	59,500
Latvia	19,900	1,800
Lithuania	25,100	2,300
Luxembourg	2,800	250
Malta	2,300	200
Netherlands	112,700	10,100
Poland	560,400	44,600
Portugal	59,900	5,400
Romania	279,700	25,500
Slovakia	65,400	5,700
Slovenia	19,900	1,700
Spain	274,100	25,500
Sweden	35,200	3,700
United Kingdom	420,800	37,800
Albania	24,500	2,200
Andorra	600	60
Bosnia and Herzegovina	41,200	3,500
The Former Yugoslav Republic of Macedonia	32,200	3,000
Iceland	600	100
Liechtenstein	200	20
Monaco	300	30

Country	Life years lost due to PM <sub>2.5</sub> in 2012	Premature deaths due to PM <sub>2.5</sub> in 2012
Montenegro	6,800	570
Norway	16,400	1,700
San Marino	300	30
Serbia	140,200	13,400
Switzerland	46,500	4,300

### 9.2.3 Formation of PM and Intermediate Products

Figure 9.1 presents an overview of the process of PM formation from biomass combustion.

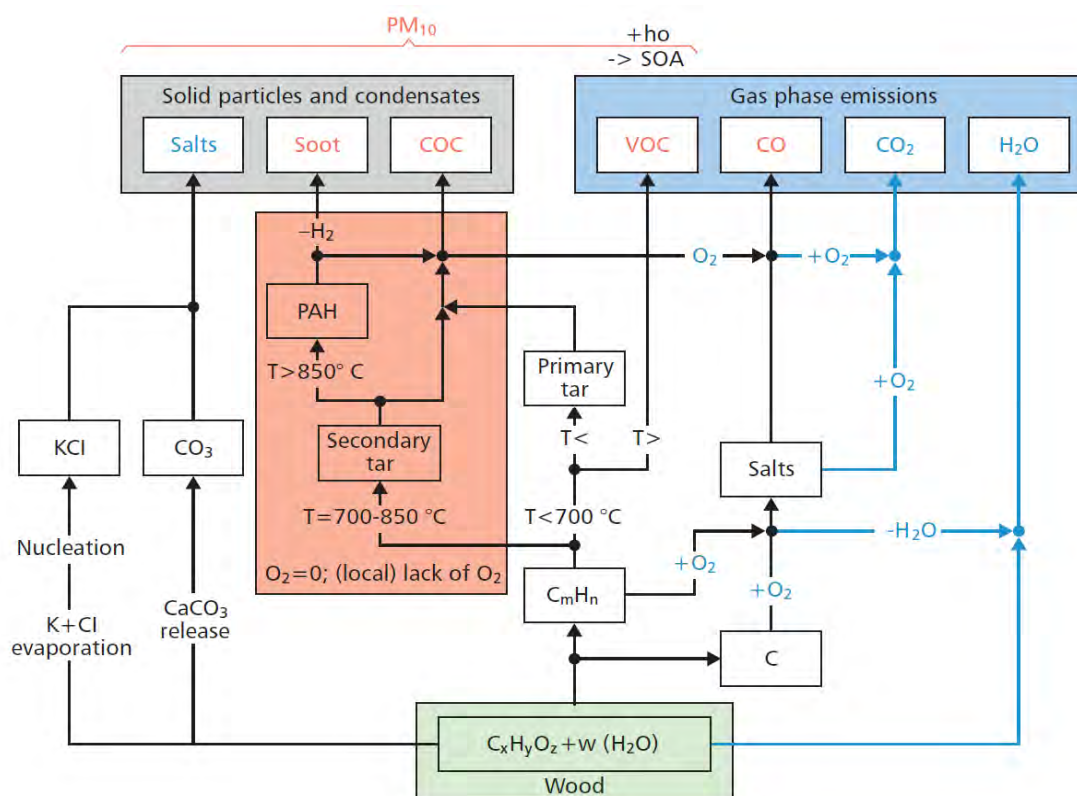


Figure 9.1: Overview of PM formation<sup>112</sup>

PM formation arises as a result of the incomplete combustion of a fuel<sup>69</sup>. As can be seen from Figure 9.1, the final products of PM include salts, soot, Condensable Organic Compounds (COCs) and Volatile Organic Compounds (VOCs). Depending on the pathway of PM formation which takes place, intermediate products such as tar and Polycyclic Aromatic Hydrocarbons (PAHs) may also be formed. PAHs are hazardous air pollutants such as benzo(a)pyrene, anthracene, benzaldehyde, chrysene, ethylbenzene and others<sup>103</sup>.

<sup>112</sup> Nussbaumer, T. and Lauber, A. (2010) *Formation mechanisms and physical properties of particles from wood combustion for design and operation of electrostatic precipitators*. 8th European Biomass Conference and Exhibition, Lyon, 3–7 May 2010.

The final product of PM that is formed is generally dependent on the combustion process which occurs and the conditions that are present within the combustion chamber at the time of this process. The following are the three main PM formation processes<sup>69</sup>:

1. Incomplete combustion at low temperatures – results in the formation of COCs and tar as an intermediate product
2. Incomplete combustion at high temperatures, but with a lack of oxygen – results in the formation of soot and tar/PAHs as intermediate products
3. Incomplete combustion with the presence of alkali metals and chlorine in the fuel – results in the formation of salts

#### 9.2.4 Comparison of Biomass Emissions with Fossil Fuel Emissions

Emissions of PM from biomass combustion are generally of a higher concern than emissions of other pollutants due to the relatively high levels that can be produced. Table 9.6 and Table 9.7 present the results of a recent study<sup>113</sup> carried out in Ireland which compared the emissions of PM<sub>10</sub> from the combustion of biomass (wood pellets), oil and gas in small combustion installations (<50 MW). The PM<sub>10</sub> emissions presented in Table 9.6 for the combustion of wood pellets vary according to the operating mode; power level 5 (PL 5) is the maximum output the appliance can achieve, whereas power level 1 (PL 1) is a considerably lower output. Different power levels result in different temperatures, fuel and air supplies, and subsequently the different levels of PM<sub>10</sub> emissions identified in Table 9.6. The PM<sub>10</sub> emissions presented in Table 9.7 for the combustion of oil and gas also vary according to the firing cycle phase during which the emissions were measured – there are three phases which are presented; steady state, cold start and warm start.

Table 9.6: PM<sub>10</sub> emissions from a wood pellet boiler according to its mode of operation<sup>113</sup>

Operating Mode	PM <sub>10</sub> (g/GJ)
PL 5	14.62
PL 4	21.55
PL 3	24.95
PL 2	28.97
PL 1	51.41
Start up	35.37

Table 9.7: PM<sub>10</sub> emissions from oil and gas burning boilers according to their mode of operation<sup>113</sup>

Operating Mode	Gas PM <sub>10</sub> (g/GJ)	Oil PM <sub>10</sub> (g/GJ)
Steady State	0.03 ± 23.2%	0.39 ± 12.9%
Cold Start	0.02 ± 27.9%	0.32 ± 14.9%
Warm Start	0.04 ± 22.4%	0.28 ± 15.1%

For comparison purposes, Table 9.8 presents the results of a separate study<sup>107</sup> which was carried out in Scotland and compared typical PM<sub>10</sub> and PM<sub>2.5</sub> emission levels from the combustion of biomass, oil, coal and gas in small boilers (<1 MW).

<sup>113</sup> Morrin, S., Smith, W. and Timoney, D. (2015) *Improved Emissions Inventories for NO<sub>x</sub> and Particulate Matter from Transport and Small Scale Combustion Installations in Ireland (ETASCI) – Part 2 of 2*. Report No. 149, EPA.

Table 9.8: Comparison of PM<sub>10</sub> and PM<sub>2.5</sub> emissions from biomass and fossil fuels in small boilers<sup>107</sup>

	Biomass (wood)	Gas		Oil		Coal	
	< 1 MW	< 50 kW	< 1 MW	< 50 kW	< 1 MW	< 50 kW	< 1 MW
PM <sub>10</sub> (g/GJ)	108	0.5	NA	3	3	260	170
PM <sub>2.5</sub> (g/GJ)	108	0.5	NA	3	3	260	170

As can be seen from the results of both of the above studies, PM emissions from biomass combustion are considerably higher than those from either gas or oil combustion. Levels of PM emissions from biomass combustion are lower than those from the combustion of coal, however.

### 9.3 Oxides of Nitrogen (NO<sub>x</sub>)

#### 9.3.1 Overview

Alongside PM, oxides of nitrogen (NO<sub>x</sub>) are the pollutants that are of highest concern when considering emissions from biomass combustion. NO<sub>x</sub> emissions relevant to biomass combustion include nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O). N<sub>2</sub>O is generally less commonly produced from the combustion process than NO or NO<sub>2</sub><sup>103</sup>.

#### 9.3.2 Human Health Impacts

NO<sub>2</sub> is an irritant in the lungs that is known to have direct negative respiratory impacts on human health<sup>29,67,102</sup>. The WHO identifies NO<sub>2</sub> as a pollutant that increases the bronchitic symptoms of asthmatics, while a link between reduced lung function growth in children and long term exposure to NO<sub>2</sub> has also been noted by the WHO<sup>29</sup>.

NO<sub>2</sub> also contributes to the formation of ozone and PM in the atmosphere, which can have resultant indirect impacts on human health. Ozone is formed from the reaction of NO<sub>2</sub>, VOCs, CO, CH<sub>4</sub> and sunlight and causes similar respiratory impacts as those resulting from direct NO<sub>2</sub> exposure<sup>102</sup>, while PM can cause a range of respiratory and cardiovascular illnesses (see Section 9.2.2).

#### 9.3.3 Environmental Impacts

Along with their impacts on human health, NO<sub>x</sub> emissions can have significant adverse impacts on the environment. N<sub>2</sub>O, while not commonly produced from biomass combustion, is a greenhouse gas which contributes directly to the impacts of climate change<sup>114</sup>.

The various gaseous forms of NO<sub>x</sub> can react with SO<sub>2</sub> and other substances to form acid rain which can be damaging to vegetation and buildings, as well as contributing directly to eutrophication<sup>115</sup>.

NO<sub>x</sub> emissions can also have adverse impacts on the environment as a result of to their contribution to the formation of ozone in the atmosphere. Ozone can damage vegetation, while it is also a greenhouse gas, worsening the impacts of climate change<sup>114</sup>.

<sup>114</sup> European Commission (2013) *Science for Environment Policy: Nitrogen Pollution and the European Environment Implications for Air Quality Policy*.

<sup>115</sup> US EPA (1998) *NO<sub>x</sub>: How nitrogen oxides affect the way we live and breathe*.



### 9.3.4 Formation of NO<sub>x</sub>

NO<sub>x</sub> is formed during combustion from one of the three below mechanisms:

1. Fuel NO<sub>x</sub>
2. Thermal NO<sub>x</sub>
3. Prompt NO<sub>x</sub>

The temperatures at which the above NO<sub>x</sub> formation mechanisms become relevant and the approximate levels of NO<sub>x</sub> emissions produced from these mechanisms are presented in Figure 9.2.

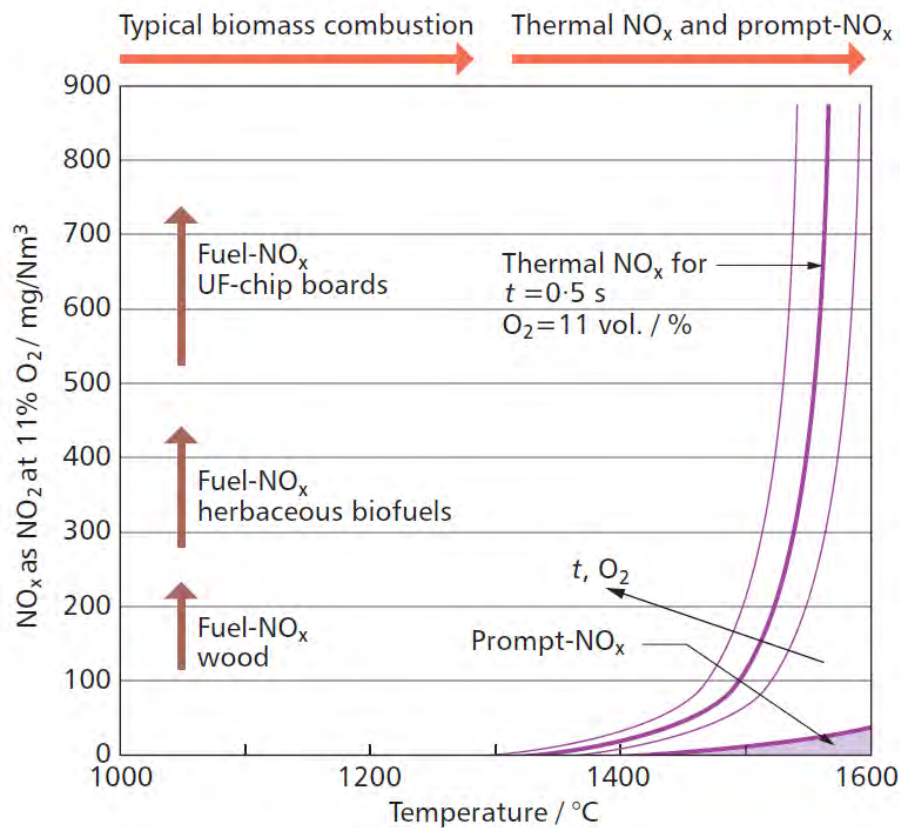


Figure 9.2: The occurrence of fuel, thermal and prompt NO<sub>x</sub><sup>69</sup>

Fuel NO<sub>x</sub> arises as a result of the complete oxidation of a fuel<sup>104,116</sup>. The level of NO<sub>x</sub> emissions produced by fuel NO<sub>x</sub> are dependent on the type of fuel used, as illustrated in Figure 9.2. The influence of fuel types on emissions is explored in detail in Section 10. Both thermal and prompt NO<sub>x</sub> arise as a result of the oxidation of nitrogen in the air at high temperatures, with the presence of hydrocarbons distinguishing prompt NO<sub>x</sub> from thermal NO<sub>x</sub><sup>104</sup>. Prompt NO<sub>x</sub> is a fast reaction which is of particular importance under fuel rich conditions<sup>104</sup>.

In biomass combustion appliances, NO<sub>x</sub> formation generally arises as a result of fuel NO<sub>x</sub>, rather than by thermal or prompt NO<sub>x</sub><sup>69,116</sup>. Thermal and prompt NO<sub>x</sub> only become significant at temperatures of approximately 1300°C and above – as maximum combustion temperatures in biomass appliances are rarely in exceedance of this figure, these processes of NO<sub>x</sub> formation are generally not considered relevant for biomass combustion<sup>116</sup>.

<sup>116</sup> Musil-Schl  ffer, B. et al. (2010) *European Wood Heating Technology Survey: An Overview of Combustion Principles and the Energy and Emissions Performance Characteristics of Commercially Available Systems in Austria, Germany, Denmark, Norway and Sweden*. New York State Energy Research and Development Authority.

### 9.3.5 Comparison of Biomass Emissions with Fossil Fuel Emissions

Table 9.6 and Table 9.7 present the results of a recent study<sup>113</sup> carried out in Ireland which compared the emissions of NO<sub>x</sub> (as NO<sub>2</sub>) from the combustion of biomass (wood pellets), oil and gas in small combustion installations (<50 MW). The NO<sub>x</sub> emissions presented in Table 9.6 for the combustion of wood pellets vary according to the operating mode; power level 5 (PL 5) is the maximum output the appliance can achieve, whereas power level 1 (PL 1) is a considerably lower output. Different power levels result in different temperatures, fuel and air supplies, and subsequently the different levels of NO<sub>x</sub> emissions identified in Table 9.6. The NO<sub>x</sub> emissions presented in Table 9.7 for the combustion of oil and gas also vary according to the firing cycle phase during which the emissions were measured – there are three phases which are presented; steady state, cold start and warm start.

Table 9.9: NO<sub>x</sub> emissions from a wood pellet boiler according to its mode of operation<sup>113</sup>

Operating Mode	NO <sub>2</sub> (g/GJ)
PL 5	57.08
PL 4	47.99
PL 3	44.89
PL 2	43.01
PL 1	45.42
Start up	36.88

Table 9.10: NO<sub>x</sub> emissions from oil and gas burning boilers according to their mode of operation<sup>113</sup>

Operating Mode	Gas NO <sub>2</sub> (g/GJ)	Oil NO <sub>2</sub> (g/GJ)
Steady State	25.81 ± 18.9%	42.82 ± 11.3%
Cold Start	18.05 ± 25.8%	44.77 ± 11.1%
Warm Start	16.75 ± 28.3%	48.82 ± 10.7%

For comparison purposes, Table 9.8 presents the results of a separate study<sup>107</sup> which was carried out in Scotland and compared typical NO<sub>x</sub> (as NO<sub>2</sub>) emission levels from the combustion of biomass, oil, coal and gas in small boilers (<1 MW).

Table 9.11: Comparison of NO<sub>x</sub> emissions from biomass and fossil fuels in small boilers<sup>107</sup>

	Biomass (wood)	Gas		Oil		Coal	
	<1 MW	<50 kW	<1 MW	<50 kW	<1 MW	<50 kW	<1 MW
NO <sub>2</sub> (g/GJ)	150	70	70	70	100	200	200

As can be seen from the results of both of the above studies, NO<sub>x</sub> emissions from biomass combustion are higher than those from gas combustion and are also generally higher than those from oil combustion. Levels of NO<sub>x</sub> emissions from biomass combustion are lower than those from the combustion of coal, however.

## 10 FACTORS INFLUENCING EMISSIONS FROM BIOMASS COMBUSTION

### 10.1 Overview

A range of aspects relating to biomass combustion can influence the level of emissions released from appliances. Emissions produced are generally a function of the following:

- Fuel type used
- Quality of fuel used
- Type of biomass combustion appliance used
- Design of the biomass combustion appliance used
- Operation of the biomass combustion appliance used
- Installation of the biomass combustion appliance used
- Emission control/abatement technologies used, if any

As noted in Section 9, PM and NO<sub>x</sub> are considered to be the most relevant emissions when considering biomass combustion. The influence of the above listed factors on these emissions in particular are therefore explored in detail in this section.

### 10.2 Fuel Type

An overview of the different fuel types used for biomass combustion is presented in Table 10.1.

Table 10.1: Overview of biomass fuel types

Fuel Type	Notes
Log wood	Typically, 300-500 mm in length, 70 mm in diameter and with an average density of 300-550 kg/m <sup>3</sup> . <sup>117</sup> Generally used in small scaled (<50 kW), batch fuelled systems <sup>65,79</sup> .
Wood pellets	Formed from the compression of sawdust and wood shavings <sup>117</sup> . Consistent in shape and size and generally remain dry <sup>117</sup> . Typically, 6-20 mm in length, 6-12 mm in diameter and with an average density of 600-700 kg/m <sup>3</sup> . <sup>117</sup> Generally used in small scaled (<150 kW) automatic systems <sup>65,79</sup> .
Wood chips	Formed from the reduction in size of larger wood stems by industrial chippers <sup>117</sup> . Typically, 15-30 mm in length, 5-100 mm in diameter and with an average density of 200-350 kg/m <sup>3</sup> . <sup>117</sup> The typical fuel that is used for automatic systems across various size ranges (50 kW to >1MW) <sup>65,79</sup> .
Sawdust	Some appliances, generally automatic and at the commercial or industrial scale, burn co-products of the wood industry such as sawdust <sup>65,79</sup> .
Agricultural residues	Some appliances, generally automatic and at the commercial or industrial scale, burn agricultural residues such as cereals, grains, straw, oilseed rape, animal litter and distillery draff <sup>65,79</sup> .

<sup>117</sup> Abbott, J. et al. (2008) *Measurement and Modelling of Fine Particulate Emissions (PM<sub>10</sub> & PM<sub>2.5</sub>) from Wood-Burning Biomass Boilers*. AEA Energy & Environment.

The specific type of fuel used for biomass combustion has a direct influence on the levels of emissions released. Wood based fuels (primarily log wood, wood pellets and wood chips) are more favourable than alternative biomass fuels such as agricultural residues as they produce lower levels of PM and NOx emissions<sup>69,70</sup>.

Agricultural residues contain a significantly higher nitrogen content than wood based fuels, resulting in the production of higher levels of NOx emissions (see Figure 9.2)<sup>69</sup>, while the higher sulphur, potassium and chlorine content of agricultural residues also results in the production of higher levels of PM emissions upon combustion<sup>70</sup>.

Along with the different emission levels produced from the combustion of wood based fuels and the combustion of alternative fuels such as agricultural residues, variations in emission levels are also noticeable between the specific types of wood based fuels. The use of wood pellets for biomass combustion generally results in the production of lower levels of emissions than the use of log wood or wood chips<sup>36</sup>.

A recent study<sup>118</sup> authorised by the European Commission found that emission levels of benzo(a)pyrene, a PAH that may be produced as an intermediate product from the combustion process (see Section 9.2.3), were approximately 8 times lower when using wood pellets than when using high quality wood logs. The same appliance was used for the combustion of both fuels during this study, while combustion also took place under the same conditions.

Emissions produced from the combustion of wood logs also vary depending on the specific type of wood used. Research has found that PM emissions generated from the combustion of pine and beech wood logs are lower than those generated from the combustion of olive and oak wood logs, with olive wood logs producing the highest levels of PM<sup>36</sup>.

### 10.3 Fuel Quality

In addition to the specific type of fuel that is used for biomass combustion, the quality of the fuel that is used also has an influence on the levels of emissions produced. There are several properties of biomass feedstocks that influence their potential as fuels. These are as follows:

- Calorific Value
- Moisture Content
- Bulk Density
- Energy Density
- Particle size/dimensions
- Mechanical durability
- Original source
- Ash content
- Chemical content

While some of the above properties such as particle size and bulk density vary naturally between fuel types due to the inherent nature of these fuel types, others such as moisture content do not and may be altered prior to combustion. For example, adequate storage of a biomass fuel in dry conditions for an appropriate length of time generally helps to reduce that fuel's moisture content.

Of the above properties, the most important (particularly for wood based fuels) in influencing the quality of a fuel are often considered to be the calorific value and the moisture content of a fuel<sup>79</sup>. Calorific value identifies the energy content and consequently the heating potential of a fuel<sup>79</sup>. It is influenced directly by moisture content – the higher the moisture content of a fuel, the lower its calorific value will be<sup>79</sup>.

The moisture content of a fuel has direct impacts on combustion efficiency levels and consequently emission levels. The use of a fuel with too high a moisture content will result in incomplete combustion and the production of high levels of PM as well as intermediate products such as tars and PAHs (see section 9.2.3)<sup>69,119,120</sup>. Tars produced may cover heat exchange surfaces within the biomass combustion appliance, resulting in reductions in levels of heat exchange which will subsequently lower efficiency levels and consequently emission levels further and may eventually result in the failure of the combustion appliance<sup>69</sup>.

---

<sup>118</sup> European Commission (2016b) *AIRUSE Summary Report*, January 2016.

<sup>119</sup> Webster, P. (2004) *Woodfuel: Relating Quality and Specification to Burner Types*. Forest Research.

<sup>120</sup> Johansson, L. et al. (2004) Emission characteristics of modern and old-type residential boilers fired with wood logs and wood pellets. *Atmospheric Environment*, 38(25): 4183-4195.

In general, the lower the moisture content of a fuel, the lower the level of emissions that will be produced. It is possible that should the moisture content of the fuel be too low, temperatures within the combustion chamber may subsequently become too high, resulting in the production of increased NO<sub>x</sub> levels due to the onset of the thermal and prompt NO<sub>x</sub> mechanisms (see Section 9.3.4)<sup>69</sup>. However, the occurrence of this process in biomass combustion is rare. Appliance designers generally ensure that this process is prevented by installing systems which re-circulate flue gas to the primary air within the appliance (see Section 10.5)<sup>69</sup>.

It is evident that the use of high quality fuels is important in reducing emission levels from biomass combustion. The use of fuels which meet EN Standards and are provided by certified and approved suppliers (see Section 3.3) is vital in ensuring that emission levels from biomass combustion are maintained at appropriate levels. A recent European Commission authorised study<sup>118</sup> which compared PM<sub>10</sub> emission levels produced from the combustion of wood pellets that were certified to EN Standards with those that were not showed that considerably lower levels of PM<sub>10</sub> emissions were produced when the EN certified wood pellets were used. The results of this study are presented in Table 10.2, which shows averaged PM<sub>10</sub> levels produced from the combustion of four different types of wood pellets in a wood pellet boiler; one which is certified to EN Standards and three that are commercially available from different sources in Europe, but are not certified to EN Standards.

Table 10.2: Averaged PM<sub>10</sub> emissions from the combustion of EN certified and non-certified wood pellets in a wood pellet boiler<sup>118</sup>

	EN certified pellets	Non-certified pellets 1	Non-certified pellets 2	Non-certified pellets 3
PM <sub>10</sub> (g/GJ)	27	86	102	76

## 10.4 Appliance Type

The type of appliance that is used for biomass combustion influences the levels of emissions that will be produced. While specific factors such as the design and operation of an appliance, the installation of an appliance and the use of emission abatement technologies within an appliance can have significant impacts on emission levels produced (see Section 10.5 – 10.6), inherent differences in emission levels are noticeable between generic appliance types.

Table 10.3 presents average emission levels for PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>x</sub> (measured as NO<sub>2</sub>) for a range of biomass appliances at the domestic scale (<50 kW). These emission levels were identified by the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA) in a recent technical report<sup>66</sup> on air pollution emissions. Wood based fuels were used in all of the appliances listed in Table 10.3.

Table 10.3: EMEP/EEA average emission levels from appliances <50 kW<sup>66</sup>

Appliance	PM <sub>10</sub> (g/GJ)	PM <sub>2.5</sub> (g/GJ)	NO <sub>2</sub> (g/GJ)
Open fireplaces	840	820	50
Conventional stoves	760	740	50
Conventional boilers <50 kW	480	470	80
Energy efficient stoves	380	370	80
Advanced/ecolabelled stoves and boilers	95	93	95
Pellet stoves and boilers	29	29	80

It is evident from Table 10.3 that PM emissions vary considerably between appliances. The levels of PM emissions produced are for the most part dependent on the efficiency of the combustion appliance<sup>36</sup>.

Efficiency levels are in turn determined by a variety of factors such as the temperature and oxygen levels within the combustion chamber, the mixing of fuel and air within the combustion chamber and point of ignition of the appliance. These factors are analysed in more detail in Section 10.5. PM emissions are higher from uncontrolled, inefficient appliances such as fireplaces than they are from controlled, more efficient appliances such as advanced/ecolabelled<sup>121</sup> stoves and boilers. Pellet stoves and boilers generally produce the lowest levels of PM emissions out of all the appliances available on the market due to their high levels of efficiency<sup>36</sup>.

Differences in PM emission levels produced are also evident depending on whether the appliance is manually or automatically operated. A study<sup>122</sup> has shown that PM emission levels from manually operated appliances using wood pellets or chips as the fuel are almost one order of magnitude higher than automatically operated combustion appliances. The mode of operation of an appliance is linked with the efficiency of an appliance, and subsequently emission levels, with automatically operated appliances generally more efficient than manually operated appliances<sup>36</sup>.

NOx emission levels do not vary as substantially between appliance types as do PM emission levels. Differences are noticeable however, as identified in Table 10.3. Higher levels of NOx emissions are produced when complete combustion takes place<sup>116</sup>. Appliances which are more efficient and are therefore more likely to result in complete combustion generally produce higher emission levels – this is evident from Table 10.3, where appliances in which incomplete combustion is common, such as open fireplaces, produce lower NOx emission levels than efficient appliances in which complete combustion is common, such as advanced/ecolabelled stoves and boilers.

Graphic representations of the different levels of PM emissions calculated for a range of biomass appliances at the domestic scale (<50 kW) from two separate studies<sup>70,123</sup> which were carried out in recent years are also presented in Figure 10.1 and Figure 10.2.

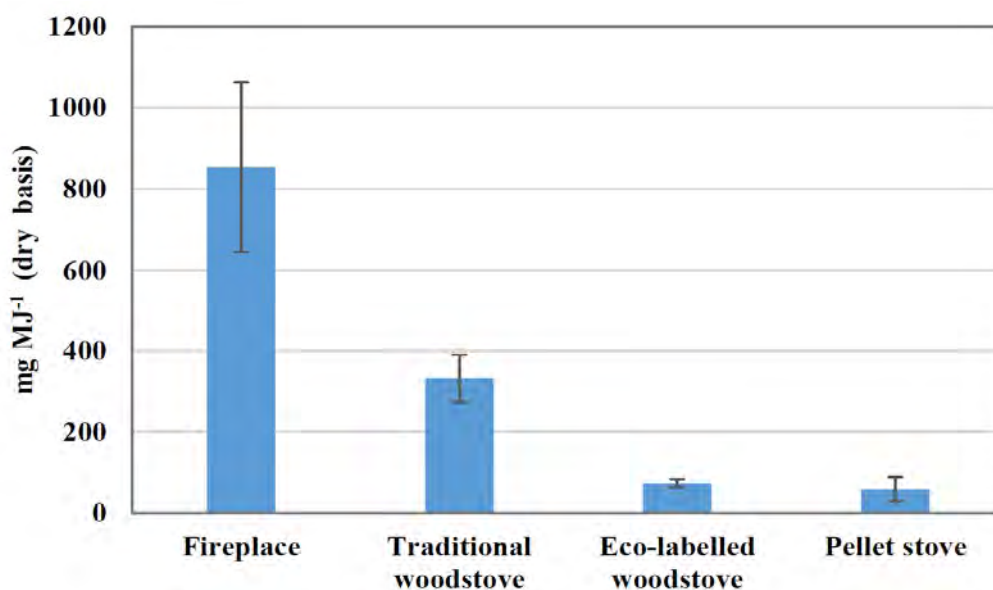


Figure 10.1: PM emissions from various domestic (<50 kW) combustion appliances<sup>123</sup>

<sup>121</sup> The European Ecolabel is a voluntary scheme, established in 1992 to encourage businesses to market environmentally friendly products and services.

<sup>122</sup> Schmidl, C. et al. (2011) Particulate and gaseous emissions from manually and automatically fired small scale combustion systems. *Atmospheric Environment*, 45(39): 7443-7454.

<sup>123</sup> European Commission (2016c) *Emission factors for biomass burning*. AIRUSE.

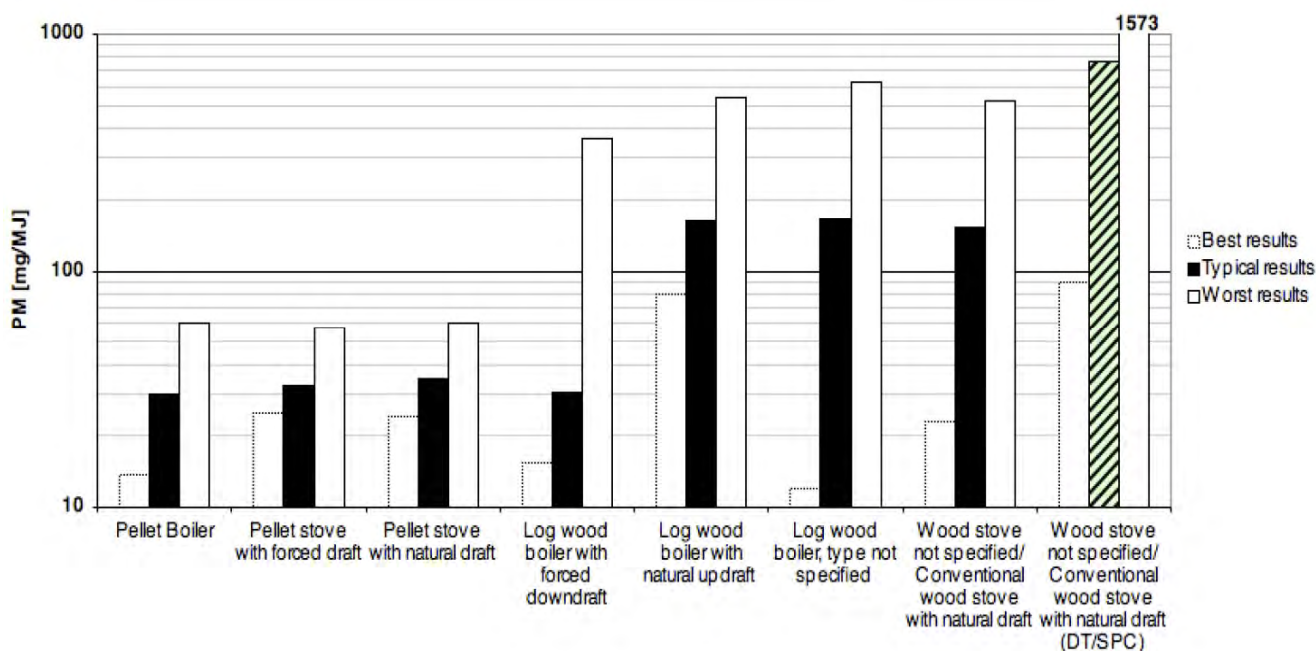
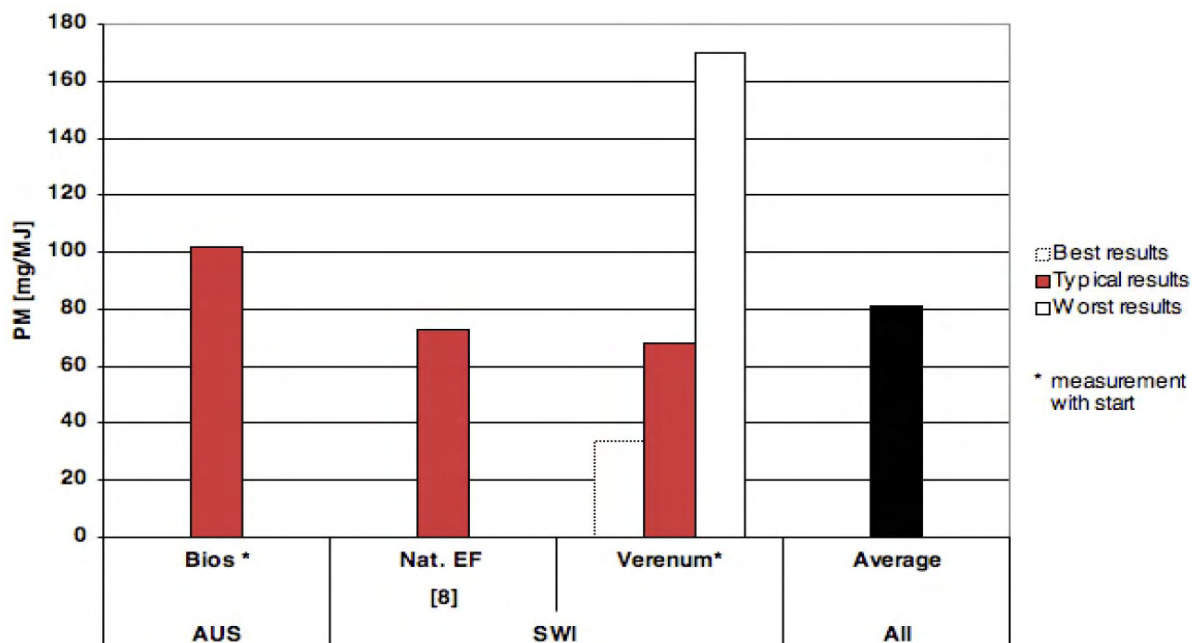
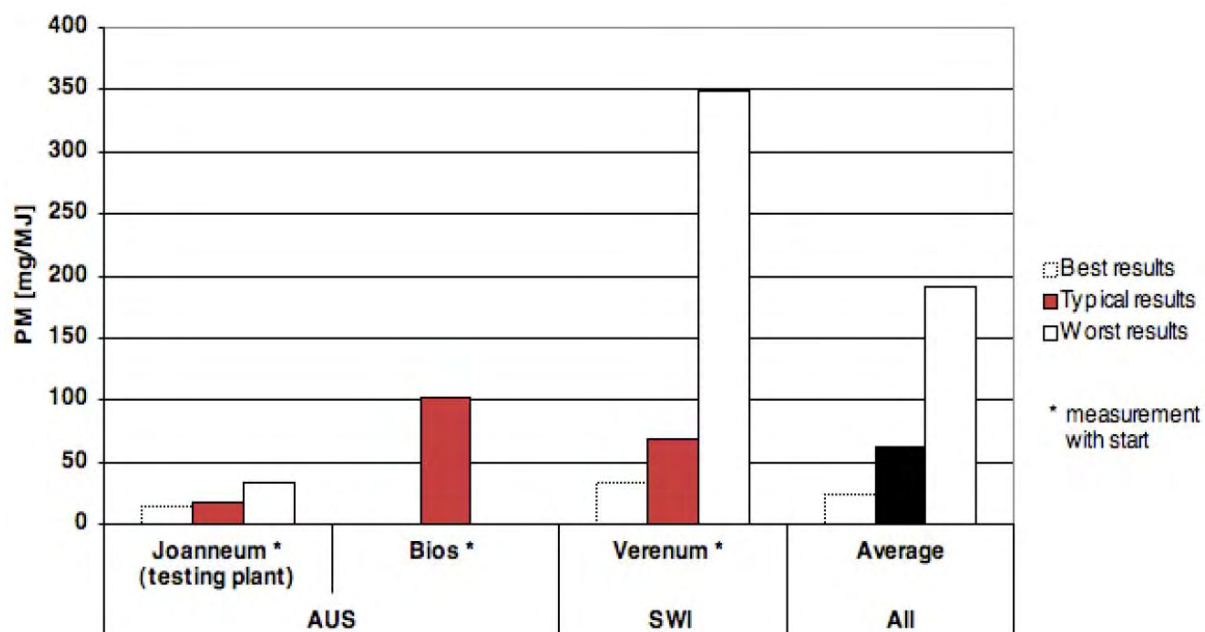


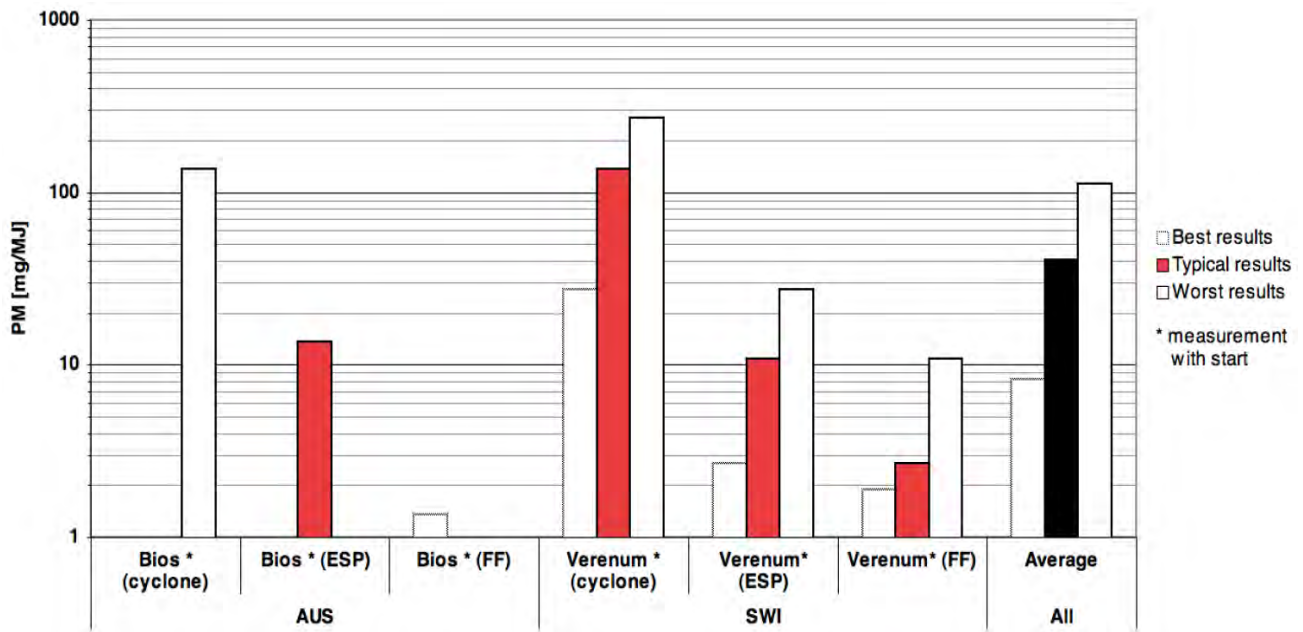
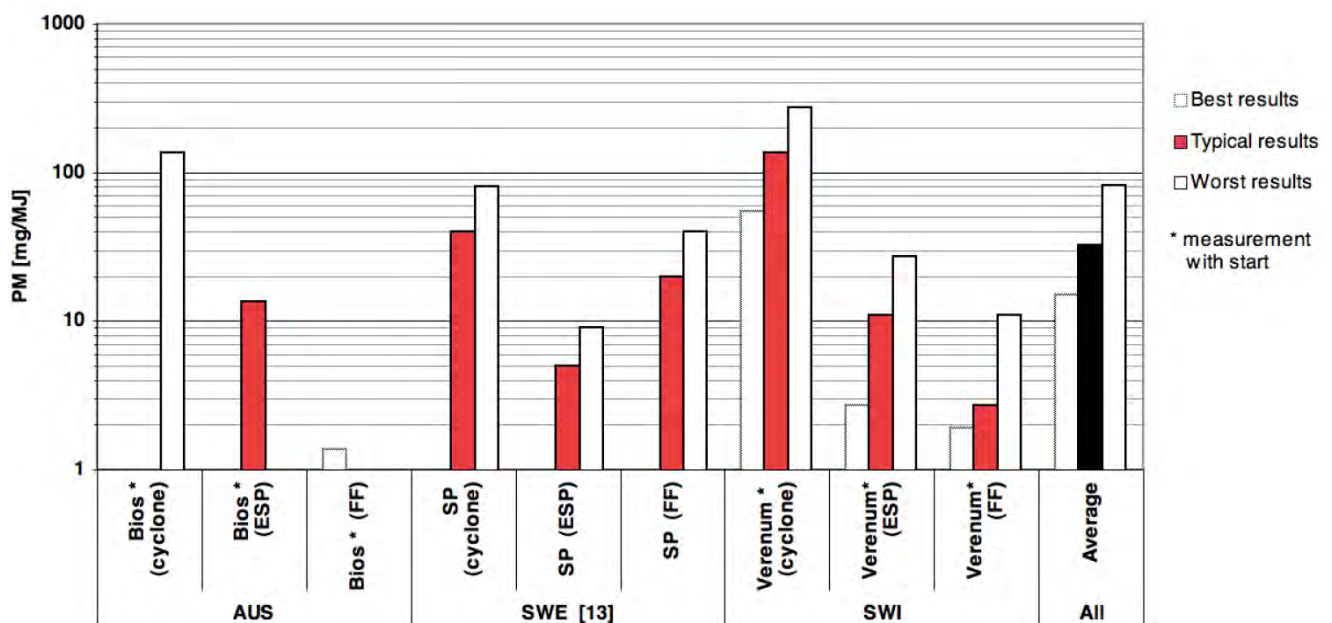
Figure 10.2: PM emissions from various domestic (<50 kW) combustion appliances (DT: Dilution Tunnel, SPC: Solid Particle Condensables)<sup>70</sup>

Similar differences in PM emission levels released from different combustion appliances at the domestic scale are evident between the above two studies and the figures presented by the EMEP/EEA in Table 10.3. Levels of PM emissions are evidently lowest in pellet stoves and boilers. The results of a recent study<sup>123</sup> authorised by the European Commission (see Figure 10.1) identified PM emissions from pellet stoves as being in the region of 12-fold lower than PM emissions from fireplaces. Along with the specific appliance type used, the study<sup>70</sup> completed on behalf of the International Energy Agency (see Figure 10.2) also took into account whether the appliance operated with downdraft or updraft combustion. These concepts and their impacts on emission levels are reviewed in further detail in Section 10.5.

In addition to differences in PM emission levels released from different combustion appliances at the domestic scale, noticeable differences are also evident in emissions released from different appliances at the community, commercial and industrial scale (>50 kW). PM emission levels vary depending on whether the appliance is an under stoker boiler or a grate boiler, while they also vary according to the size range of the boiler. Figure 10.3 to Figure 10.6 present PM emission levels from both under stoker boiler and grate boilers at various size ranges. These graphs were obtained from a study<sup>70</sup> completed on behalf of the International Energy Agency and present the results of PM emission levels which were calculated from a number of individual studies on large biomass combustion appliances that took place in Austria, Sweden and Switzerland.



Figure 10.3: PM emission levels from under stoker boilers 70 – 500 kW<sup>70</sup>Figure 10.4: PM emission levels from grate boilers 70 – 500 kW<sup>70</sup>

Figure 10.5: PM emission levels from under stoker boilers 500 kW – 10 MW<sup>70</sup>Figure 10.6: PM emission levels from grate boilers 500 kW – 10 MW<sup>70</sup>

As a result of a sufficient oxygen supply, high temperatures and the occurrence of complete combustion in most community, commercial and industrial sized biomass combustion appliances, PM emission levels are generally lower than in most domestic sized appliances (domestic pellet stoves and boilers are often the exceptions)<sup>70</sup>. Emissions of PM from appliances in the size range 500 kW – 10 MW are in a large part dependent on the specific type of flue gas cleaning system and emission abatement technology that is used in the appliance<sup>70</sup>.

NOx emission levels from community, commercial and industrial sized appliances are generally greater as incomplete combustion (resulting in lower NOx emission levels) typically only occurs in appliances of this size range which are poorly designed or operated (see Section 10.5)<sup>70</sup>.

In addition to the above, test data is available indicating average PM and NO<sub>x</sub> emissions levels from a range of biomass appliances using wood pellets and chips which are commercially available at different size ranges. This data was obtained from a 2010 study<sup>124</sup> completed for the Forestry Commission Scotland and is presented in Appendix 5. It is important to note that the levels of emissions presented are those obtained from testing of the appliances in ideal (laboratory) conditions, rather than emission levels which may be expected in the field.

## 10.5 Appliance Design and Operation

In addition to selecting an appropriate fuel type, fuel quality and appliance type for combustion, a range of alternative measures may be employed in order to control emission levels from appliances. The appropriate design and operation of a biomass appliance is seen as the primary measure which may be adopted to reduce emission levels – design and operational factors which influence emission levels from appliances are reviewed hereunder. Secondary emission reduction measures are generally more technological – an overview of these is provided in Section 10.6.

### 10.5.1 Sizing/Fuel Loading of Appliances

The appropriate design of an appliance to ensure that it is correctly sized so as to be operating at close to capacity under normal combustion conditions is important in limiting emission production levels. Studies<sup>122,125</sup> have shown that appliances that undergo combustion with a high fuel load produce lower levels of PM emissions than appliances that undergo combustion with a low fuel load. The reduced air combustion flow as a result of a high fuel load is considered to be critical in influencing emission levels<sup>122</sup>. Biomass combustion appliances which were initially oversized in the design process are commonly operated at low fuel loads, resulting in the production of higher emission levels<sup>126</sup>. It is therefore vital that appliances are sized correctly for the heat demands of a site.

### 10.5.2 Point of Fuel Ignition within Appliances

The point at which fuel is ignited within an appliance should be taken into account when considering emission levels. Fuels are generally lit either from the top (top-down) or the bottom (bottom-up) of an appliance. Top-down ignition typically produces lower levels of PM emissions – it leads to the gradual combustion of the fuel, which generally ensures complete combustion, while bottom-up ignition leads to more rapid combustion of the entire fuel batch, which results in high combustion rates, zones of insufficient oxygen and subsequently the more common occurrence of incomplete combustion of the fuel<sup>125</sup>.

A recent study<sup>125</sup> which compared PM<sub>10</sub> emission levels from top-down and bottom-up ignition found that when a softwood (pine) was ignited in a biomass combustion appliance using top-down ignition, levels of PM<sub>10</sub> produced were 50% lower than those produced when the same fuel was ignited in an appliance using bottom-up ignition. It is therefore evident that the point of fuel ignition within an appliance can potentially have an impact on the levels of emissions produced.

### 10.5.3 Use of Staged Combustion within Appliances

#### Conventional Two-Stage Combustion

Two-stage combustion is seen as the primary measure for reducing PM emissions from combustion appliances. This measure involves the injection of air in both the primary combustion zone, located on the grate, and the secondary combustion zone, located within the combustion chamber<sup>70,127</sup>. Drying and combustion takes place in the primary combustion zone, while gaseous emissions are released and burned in the secondary combustion zone<sup>127</sup>.

---

<sup>124</sup> Hamilton, S. et al. (2010) *The assessment of flue gas particulate abatement in wood burning boilers*. AEA Technology.

<sup>125</sup> Vicente et al. (2015) Emission of carbon monoxide, total hydrocarbons and particulate matter during wood combustion in a stove operating under distinct conditions. *Fuel Processing Technology*, 131: 182-192.

<sup>126</sup> BioRegional Development Group (2011) *Air quality and biomass installations – a briefing for local authorities*.

<sup>127</sup> Intelligent Energy Europe (2011) *A guide to specifying biomass heating systems*.

Two stage combustion allows for the mixing of burned air with burned gases, resulting in the presence of low levels of excess air which enables high efficiency levels and high temperatures, resulting in the complete combustion of the fuel and subsequently the production of low levels of PM emissions<sup>70</sup>.

Sufficient mixing of air and gases for the above process to occur is difficult to achieve in practice. Hence, fan assisted air supplies, 'lambda' (oxygen) sensors and mechanical dampers are now being used to ensure the appropriate distribution of air and control of the combustion process, and subsequently the levels of emissions produced<sup>65,70</sup>.

### Air Staging

Air staging is designed specifically to reduce levels of NO<sub>x</sub> emissions. It is a measure that operates in a similar manner to conventional two-stage combustion, with primary and secondary air injected into separate combustion chambers<sup>70,116</sup>. Reduction of NO occurs between these zones, resulting in the production of lower NO<sub>x</sub> levels. For air staging to occur, it requires an excess air ratio of 0.7 and a temperature of 1150°C in the reduction zone<sup>70</sup>. This measure is more commonly carried out in community, commercial or industrial sized appliances due to the high temperatures which are required. Air staging can result in NO<sub>x</sub> reductions of 50 – 80%, depending on the nitrogen content of the fuel that is used<sup>70</sup>.

### Fuel Staging

Fuel staging operates according to the same principles as air staging, with the creation of a NO<sub>x</sub> reduction zone within the appliance, but it requires two, independent fuel feeding systems<sup>70,116</sup>. For fuel staging to occur, it requires an excess air ratio of 0.6 – 0.8 and a temperature of 850°C or higher<sup>70</sup>. Similar to air staging, this measure can result in NO<sub>x</sub> reductions of 50 – 80%, depending on the nitrogen content of the fuel that is used<sup>70</sup>.

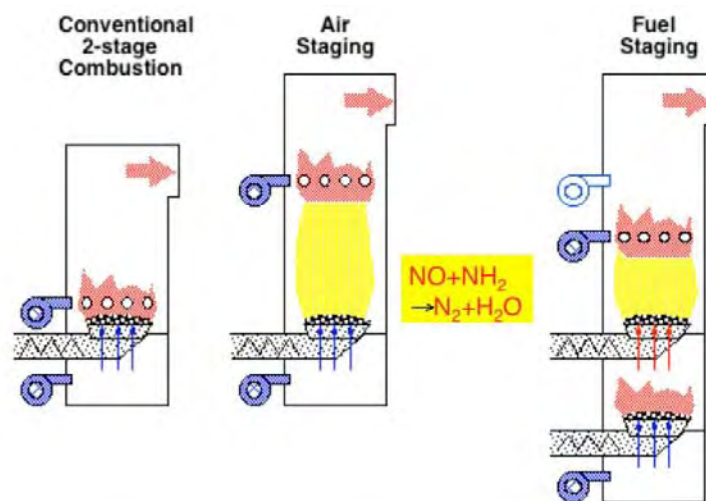


Figure 10.7: Conventional two-stage combustion, air staging combustion and fuel staging combustion measures<sup>70</sup>

#### 10.5.4 Continuous Operation of Appliances

Biomass combustion appliances generate higher levels of PM emissions during start up/shut down periods than they do when operated continuously. The reason for this is that temperatures within the combustion chamber are low during these periods, resulting in incomplete combustion and consequently higher levels of PM production<sup>125</sup>. It is therefore desirable that appliances are operated continuously rather than by short-cycling; a process where the appliance is continuously started up and shut down to meet variable heat loads<sup>126</sup>. Accumulators and/or advanced buffer tanks may be installed to enable appliances to operate continuously and at higher efficiency levels, resulting in the production of lower emission levels<sup>65,126</sup>.

Continuous operation and the avoidance of short-cycling is generally more achievable for larger sized appliances than it is for smaller sized appliances.

### 10.5.5 Maintenance of Appliances

The continued maintenance of biomass appliances is also important in limiting the generation of emissions. Maintenance of appliances, which may include the cleaning of the appliance, the de-ashing of the appliance or the fixing of appliance faults, should be carried out regularly to ensure that high levels of appliance efficiency, and consequently low levels of emissions, are maintained<sup>126</sup>.

In Germany, maintenance of biomass appliances is a legal obligation – German chimney sweeps are required to inspect appliances on an annual basis to ensure that they are appropriately certified, installed and maintained, that they meet specific emission limit values (see Section 3.2.2) and that their flues are sufficiently clean. Such regulation of appliances in Ireland is not currently in place<sup>36</sup>.

## 10.6 Abatement Technologies

Secondary measures to control emission levels from biomass combustion appliances are generally either technological (in the case of PM) or incorporate the artificial initiation of a reaction in the appliance (in the case of NO<sub>x</sub>) and are detailed hereunder. The use of secondary abatement techniques is generally more common in community, commercial and industrial sized appliances than it is in domestic sized appliances.

### 10.6.1 PM Abatement Techniques

#### Single Cell Cyclones

Cyclones make use of a centrifugal force within the rotating gases formed from combustion to separate PM. As heavier particles experience a higher centrifugal force, these particles cannot be maintained within the gas flow and hit the wall of the collector before sliding down into a container<sup>116,124,128</sup>. Cyclones are a highly reliable, simple technology that can work at a wide range of temperatures and are relatively cheap in terms of capital cost, when compared with other abatement technologies<sup>116,124</sup>. While cyclones are effective at reducing large sized particles, they are not capable of reducing fine PM that is <10 microns<sup>70</sup>.

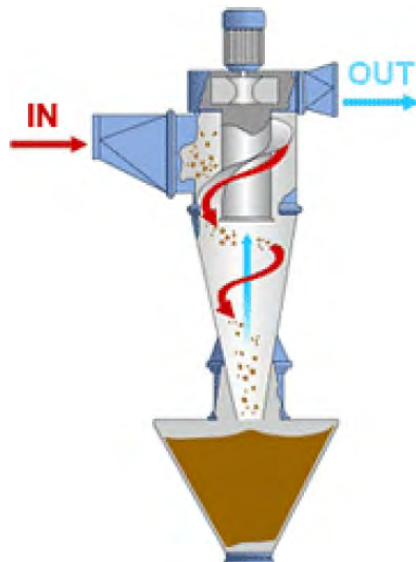


Figure 10.8: Single cell cyclone<sup>124</sup>

<sup>128</sup> Biomass Energy Resource Centre (2011) *Particulate Matter Emissions-Control Options for Wood Boiler Systems*.

## Multi Cell Cyclones

Multi cell cyclones are in effect a group of cyclones that are used in parallel. They are longer in length than single cell cyclones, enabling the PM to be retained within the cyclones for a longer period of time, while they are generally small in diameter (150 – 200 mm), allowing for a more efficient reduction of PM levels<sup>124,128</sup>. While multi cell cyclones remain relatively cheap in comparison to other PM abatement technologies, their more complex design makes them more expensive than single cell cyclones<sup>116</sup>.

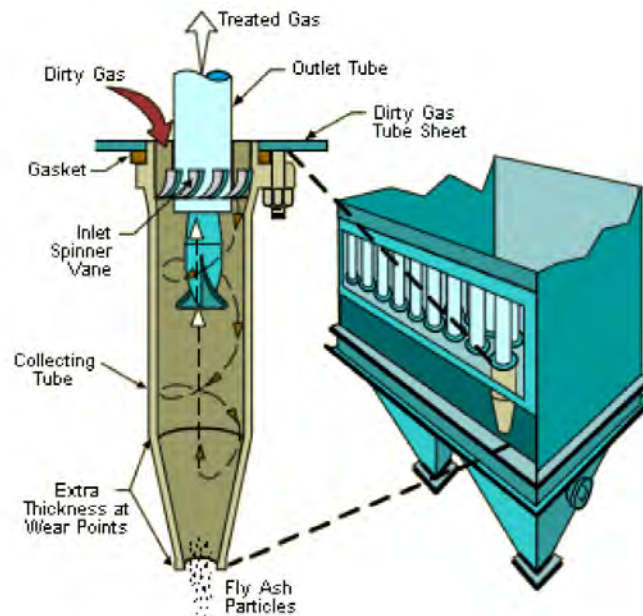


Figure 10.9: Multi cell cyclone<sup>128</sup>

## Core Separators

Core separators operate in a similar manner to cyclones, but incorporates the separation and the collection of PM into two separate parts of the system – a fan system cleans the gases produced from combustion within the core separator component, while the separated particles are collected within the cyclone component<sup>128</sup>. Core separators are not commonly adopted for the abatement of PM and such systems are rarely seen in the commercial market<sup>128</sup>.

## Wet Scrubbers

Scrubbers incorporate a 'wet' technology for the abatement of PM. This technology makes use of water droplets to collide with PM within the flue gas and remove or 'scrub' these particles from the gas<sup>116</sup>. A number of different variations of wet scrubbers exist, including counter current scrubbers, cross-flow scrubbers and venture scrubbers. These scrubbers differ mainly according to the direction of flow of both the flue gas and the water droplets within the system<sup>116</sup>.

While wet scrubbers are advantageous in that they remove finer particle sizes than dry cyclones, they consume higher amounts of energy, require a constant water supply and require the disposal of all wastewater produced – as a result, they are rarely used in small biomass combustion appliances that are <2 MW in size<sup>103,124</sup>.



## Fabric Filters (Baghouses)

Fabric filters comprise a fabric bag which acts as a filter, trapping particles in flue gas as they travel through this filter. As particles are collected onto the fabric bag, the efficiency of their separation is increased further due to the presence of a barrier layer – this continues until this layer becomes too significant, at which point cleaning of the filter system will be required using either pressurised air or vibration<sup>103,124</sup>.

Fabric filters are a highly effective PM abatement technology and become even more effective when used alongside a cyclone to ensure the removal of large sized particles<sup>128</sup>. As cyclones remove large burning particles, their concurrent use with fabric filters also reduces the likelihood of a fire occurring, a risk which is increased due to the material of fabric filters<sup>103,128</sup>.

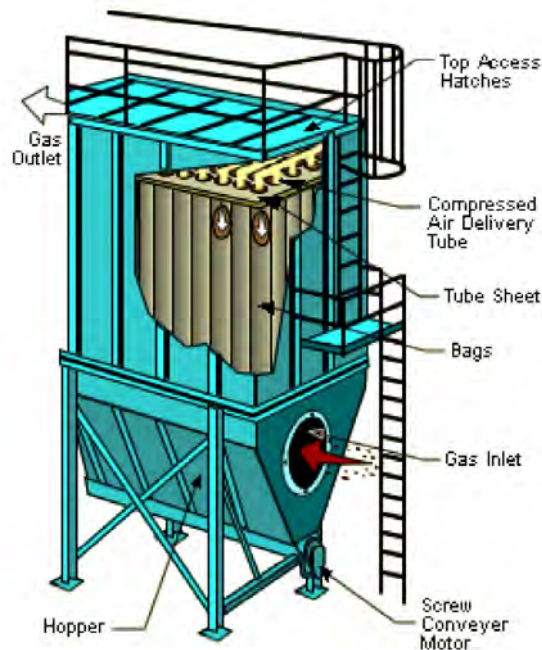


Figure 10.10: Fabric filter (baghouse)<sup>128</sup>

## Ceramic Filters

Ceramic filters consist of vertical, ceramic tubes to filter PM from flue gas – the ceramic tubes are located between the upstream and the downstream flows of flue gas to trap the particles<sup>124</sup>. Similar to fabric filters, particles build up on the ceramic tubes and subsequently contribute to the collection of further particles<sup>124</sup>. Ceramic filters are typically cleaned using pressurised air, with the collection of the particles which have built up facilitated by this cleaning process<sup>124</sup>. Ceramic filters can operate at higher temperatures than fabric filters<sup>65</sup>. Unlike fabric filters, ceramic filters pose a lower risk of fire<sup>124</sup>.

## Electrostatic Precipitators

Electrostatic precipitators (ESPs) make use of electric fields to remove PM from flue gases. They incorporate both a charging section and a collecting section – a negative charge is transmitted to the particles from electrodes in the charging (ionising) section, which results in the attraction and subsequent attachment of the particles to positively charged electrodes (collection plates) in the collection section<sup>124,128</sup>. Large combustion appliances may comprise numerous ESP zones which apply different electric fields, resulting in the collection of more PM<sup>124</sup>.

The majority of ESPs are dry systems. However, wet ESPs may be used. The flue gas in these systems has a high moisture content and is saturated prior to entry to the ESP, reducing the electrical charge of the PM, and consequently resulting in more efficient PM removal<sup>103,124</sup>.



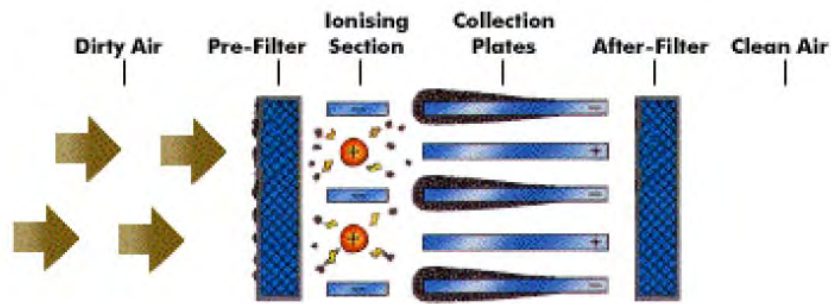


Figure 10.11: Principle of electrostatic precipitator operation

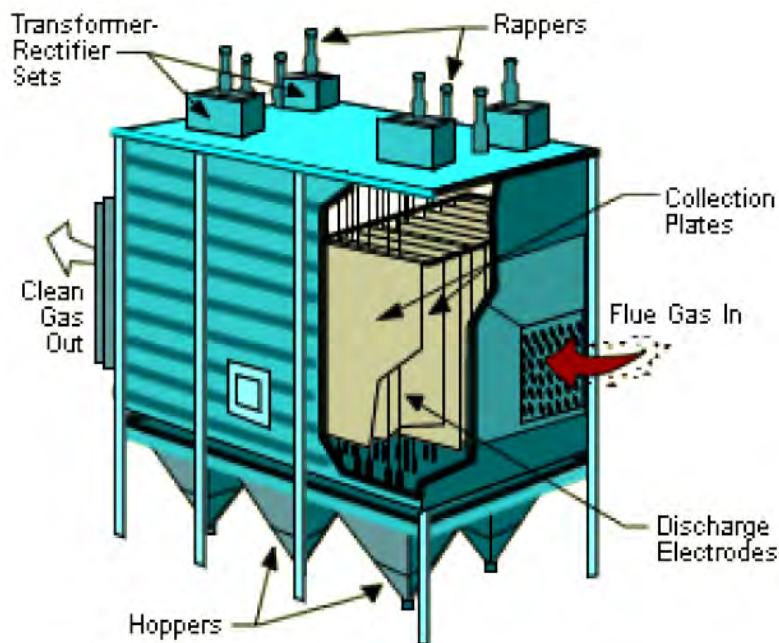


Figure 10.12: Electrostatic precipitator

### 10.6.2 Performance of PM Abatement Techniques

The effectiveness of the above abatement techniques in reducing PM levels of different sizes are identified in Table 10.4 and Figure 10.13.

Table 10.4: Reduction rates in PM<sub>10</sub> and PM<sub>2.5</sub> using different abatement techniques<sup>128</sup>

	PM <sub>10</sub>	PM <sub>2.5</sub>
Single cell cyclone	50%	5%
Multi cell cyclone	75%	10%
Core separator	29-56%	72-94%
Electrostatic precipitator	95%	90%
Fabric filter (Baghouse) with cyclone	99%	99%
Wet scrubber	99%	99%

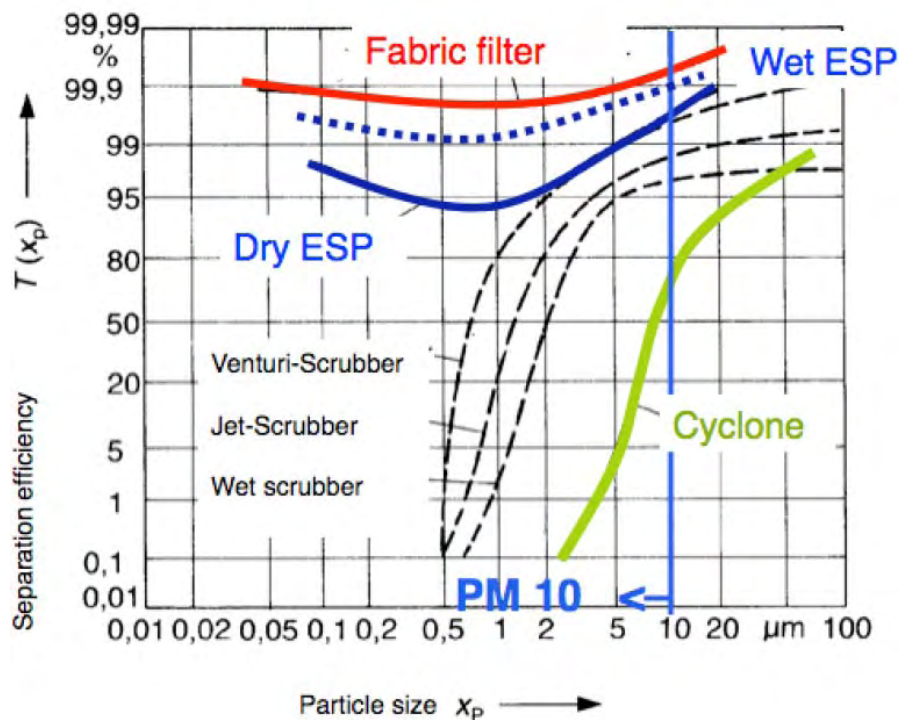


Figure 10.13: PM separation efficiency using different abatement techniques<sup>112</sup>

While there are noticeable differences in PM reduction rates achievable depending on the abatement technique adopted, it should also be noted that other factors such as the design, operation and installation of an appliance have a significant influence on reduction rates and should be taken into account. These factors are reviewed in Section 10.5 and Section 10.7.

In addition to providing an overview of the effectiveness of many of the abatement techniques in removing PM, Figure 10.14 also identifies the indicative capital and maintenance costs associated with the use of these techniques. It is important to note that these costs are indicative only and will vary considerably depending on the size of the appliance<sup>124</sup>.

	Effectiveness (Coarse particles)	Removal efficiency PM <sub>10</sub>	Removal efficiency PM <sub>2,5</sub>	Indicative Capital Cost	Indicative Maintenance Cost	Achievable final PM emission, g/GJ	Comment
Cyclone						30	Less effective for smallest particles
Multi- cyclone						30	Less effective for smallest particles
ESP						15	Removal efficiency and emission may be lower on smaller abatement plant
Fabric Filter						<15	Likely to require use of pre- separator to avoid damage/loss from hot embers. Final emission should be less than 5 g/GJ
Ceramic Filter						<15	Final emission should be less than 5 g/GJ
Key							
Effectiveness	<80%	Indicative Capital Cost	High	Indicative maintenance costs	High		
	80-90%		Medium- high		Medium-high		
	90-99%		Medium-low		Medium-low		
	>99%		Least expensive		Least expensive		

Figure 10.14: Matrix comparing PM removal effectiveness, capital costs and maintenance costs associated with different abatement techniques<sup>124</sup>

### 10.6.3 NOx Abatement Techniques

The abatement of NOx emissions using secondary measures is typically not required as the primary measures identified in Section 10.5 generally achieve sufficient levels of NOx emission reductions<sup>116</sup>. Nonetheless, NOx abatement is possible using one of the two processes outlined below. These secondary abatement techniques are generally utilised in large scale appliances at the community, commercial or industrial level only, as the costs associated with them are significant<sup>116</sup>.

#### Selective Non-Catalytic Reduction

The Selective Non-Catalytic Reduction (SNCR) technique of NOx abatement involves the injection of a reducing agent (either urea or ammonia) into the flue gas – the reducing agent will react with the NOx that has been produced from the combustion process to form nitrogen<sup>112,116</sup>. SNCR only generates appropriate NOx reduction levels within the temperature range of 820°C to 940°C – the reaction will not occur if the temperature is lower than this range, while separate reactions resulting in the formation of undesirable products such as HNCO, N<sub>2</sub>O, NH<sub>3</sub> and HCN, will occur if the temperature is higher than this range<sup>112,116</sup>.

Reduction rates of up to 90% may be achieved using the SNCR technique of NOx abatement<sup>112</sup>.

## Selective Catalytic Reduction

The Selective Catalytic Reduction (SCR) technique of NO<sub>x</sub> abatement operates according to the same principles of the SNCR technique, with the difference being that catalysts are used to speed up the reaction and keep temperatures lower<sup>116</sup>. Catalysts that are used may include platinum, tungsten, titanium or vanadium oxide based materials<sup>116</sup>.

The SCR technique generates appropriate NO<sub>x</sub> reduction levels within the temperature range of 250°C to 450°C – similar to the SNCR technique, the reaction will not occur if the temperature is lower than this range, while separate reactions resulting in the formation of undesirable products such as HNCO, N<sub>2</sub>O, NH<sub>3</sub> and HCN, will occur if the temperature is higher than this range<sup>112,116</sup>.

Reduction rates of up to 95% may be achieved using the SNCR technique of NO<sub>x</sub> abatement<sup>112</sup>.

## 10.7 Appliance Installation

The installation of a biomass appliance also influences the impacts resulting from it, in terms of emission levels (and therefore air quality) encountered in the vicinity of the installation location. Its location in a rural or urban environment and its proximity to buildings (and hence potential receptors) influence the potential impacts resulting therefrom.

While not directly applicable to (non-waste) biomass combustion, Article 6 of the EU Waste Incineration Directive 2000/98/EC states that "*Incineration and co-incineration plants shall be designed, equipped, built and operated in such a way as to prevent emissions into the air giving rise to significant ground-level air pollution; in particular, exhaust gases shall be discharged in a controlled fashion and in conformity with relevant Community air quality standards by means of a stack the height of which is calculated in such a way as to safeguard human health and the environment.*"<sup>129</sup>

The principle outlined in the Directive applies equally to biomass appliances in term of utilisation of an appropriate stack (flue) height, such that emissions are dispersed in a manner that does not cause elevation of emission levels above relevant legislative values that are designed to protect human health.

As identified in Section 2.1.1, Ireland is divided into 4 zones in terms of air quality, with generally good air quality being evident across these zones. In 2014, no exceedance of applicable limit values were observed across 33 sites monitored – when compared to WHO guideline values (refer to Section 3.1.1), both PM<sub>10</sub> limit values and PM<sub>2.5</sub> limit values were exceeded at two monitoring sites<sup>3</sup>.

It is the non-exceedance of the ground level emission limit values, measured in Ireland annually by the EPA, that must be the objective of any biomass installation, through appropriate flue design and siting.

### 10.7.1 Guidance & Standards

There are numerous guidance documents published that address the issue of flue design related to biomass appliances, *inter alia*:

- CIBSE AM15 Biomass Heating<sup>69</sup>
- BFCMA Installation Guidelines for Wood Burning & Multi Fuel Appliances<sup>130</sup>
- BFMCA Guide to Flues & Chimney for Biomass Appliances<sup>131</sup>
- BFMCA General Guidance on the selection and installation of flues and chimneys for wood burning and multi fuel appliances in residential properties<sup>132</sup>
- Building Regulations (Part J Amendment) 2014

<sup>129</sup> Anzola, M. (2012) *Biomass boiler emissions and chimney height - A review of practice in the UK and other EU countries*. Thesis, University of Strathclyde, Department of Mechanical and Aerospace Engineering.

<sup>130</sup> BFMCA (2014) <http://www.bfcma.co.uk/siteFiles/resources/docs/BFCMAInstallationGuidelines27.07.15.pdf>

<sup>131</sup> BFMCA (2015) <http://www.bfcma.co.uk/siteFiles/resources/docs/BFCMABiomass12.08.15.pdf>

<sup>132</sup> BFMCA (2016) <http://www.bfcma.co.uk/siteFiles/resources/docs/BFCMAGeneralGuidance22.02.16.pdf>

These guidance documents refer to the requirements of the following standards:

- EN15287 - Chimneys — Design, installation and commissioning of chimneys
- EN13384 – Chimneys - Thermal and fluid dynamic calculation methods

While not attempting to identify specific detailed criteria for flue installation, the following section provides a summary of the principles of appropriate flue installation.

### 10.7.2 Appropriate Flue Installation Principles

Palmer<sup>133</sup> identifies the following factors as requiring consideration to ensure mitigation of potential impacts of ground level emission concentrations:

- Flue height
- Topography
- Proximity of nearby buildings
- Height of the flue relative to nearby buildings
- Flue gas dispersion

#### Flue Height

Two factors are identified as being relevant to flue height – the requirements to maintain a negative pressure within the appliance under all operating conditions including electrical failure and the need to ensure adequate dispersion of flue gas emission.

Flues work under negative pressure and draw the products of combustion from the appliance – a number of factors influence the maintaining of a negative 'draw':

- The difference in air pressure between the appliance and the top of the chimney (created by the height of the chimney)
- The difference in temperature between the appliance's exhaust gas and the outside temperature
- The quality of insulation along the length of the chimney
- The route of chimney

#### Topography & Proximity of Nearby Buildings

The topography of the locality and the proximity of nearby buildings naturally have an impact on the behaviour of flue emission upon release from the flue. Undulating topography influences air flow as does the presence of structures, as shown in Figure 10.15, which depicts the variation in airflow around a building and the potential for flue emission to 'downwash' around a building.

---

<sup>133</sup> Campbell Palmer Partnership Ltd.; Biomass Emission and the UK Emission Regime; presented to Project Steering Committee, 20<sup>th</sup> June 2016



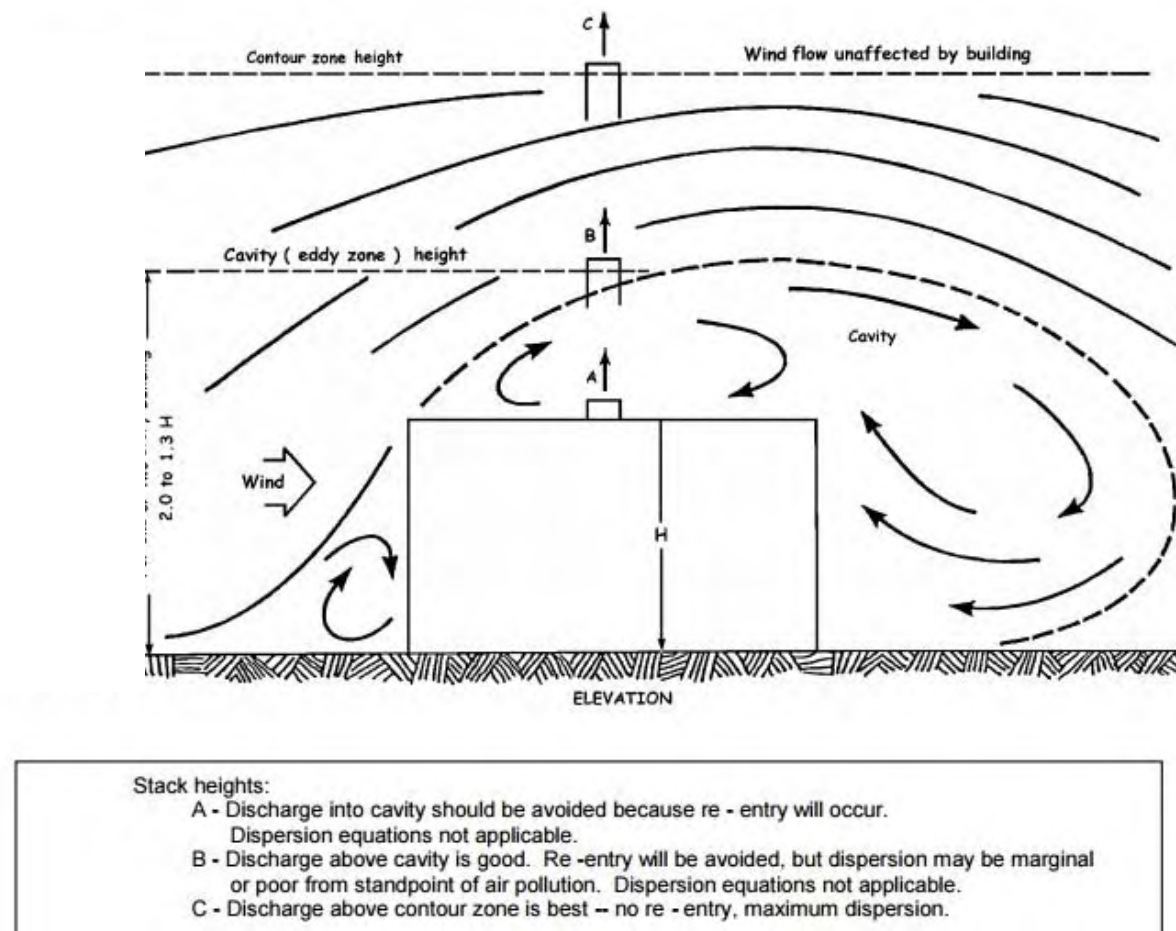


Figure 10.15: Airflow variation around building structure (indicative)<sup>134</sup>

### Height of Flue Relative to Nearby Buildings

The height of the highest building within 5 times the flue height is to be considered when identifying the 'effective' stack height, as per Palmer, where the effective stack height is:

$$1.66 \times (\text{flue height} - \text{building height})$$

In other words, the benefit or effectiveness of a flue is related not to its height from the ground but rather its height relative to the nearest building within 5 times its height from the ground. It should be noted that other obstacles or structures of height e.g. a treeline, should be considered as 'buildings', if located within the 5 times stack height radius.

### Flue Gas Dispersion

The objective of a flue of appropriate height is to ensure effective dispersion of flue emissions such that they are suitably diluted before falling to ground such that they will not impact on ground level emission limit values. The determination of potential for impact on ground level emission limit values must consider the existing background level of a particular emission.

DEFRA in the UK has developed a Biomass Calculator Tool<sup>135</sup> that identifies the maximum emission rate (target emission rate (TER)) permissible from a biomass appliance before the background limit values are exceeded i.e. the allowable emission rate from the appliance.

<sup>134</sup> <http://www.calpoly.edu/~rgordon/vent/windexh.pdf>

<sup>135</sup> <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#biomass>

In doing this, it considers the building height (i.e. height of the tallest building with 5 times the stack height), the stack diameter, the stack height, the geographic location of the appliance and the annual mean background concentration of a particular pollutant, in order to calculate the TER. This can then present the flue manufacturer or installer with a target value to attain when designing/installing a flue for a particular installation.

Figure 10.8 presents an example from the Tool, relating to PM<sub>10</sub>, for a building height of 8 m, a stack diameter of 0.3 m and a stack height of 16 m, located in Scotland. Utilising the principles previously outlined, in terms of effective stack height, a target emission rate of 0.0753 g/s is identified.

Review and Assessment Tool for PM <sub>10</sub> from biomass combustion stacks		
The maximum emissions of PM <sub>10</sub> in g/s from biomass combustion source emissions are calculated for your given stack details. Greater emission rates may result in exceedence of the 24 hour objective for PM10 in England, Wales and Northern Ireland or the annual mean objective in Scotland.		
Enter required information in Cream Cells Resulting Emission in Red Bold		
Building height	8	Height of the tallest building within 5 stack heights of the stack
Stack diameter	0.2	
Stack height	18	
Location (Scotland, Rest of UK)	Scotland	
PM <sub>10</sub> Annual mean background concentration (include roadside contribution at relevant receptors)	15	µg/m <sup>3</sup>
Calculated Effective stack height	16.7	m
Target Emission Rate	0.0753	g/s
If the maximum stack emission rate is less than the target above then it is not likely that the most stringent objective for PM <sub>10</sub> will be exceeded		

Figure 10.16: DEFRA Biomass Calculator Tool Example (PM<sub>10</sub>)



## 11 SUMMARY

Biomass is recognised as a positive, low carbon fuel option; its use as a fuel produces significantly lower levels of CO<sub>2</sub> emissions across its lifecycle when compared with the use of alternative fuels such as fossil fuels. While the benefits of using biomass as a fuel are evident, there is a need to take into account the potential negative impacts which may arise from its increased use. This report has identified the potential negative impacts on air quality, in the form of increased pollutant emissions, which may arise from further development of the biomass combustion industry.

While increases in the emission levels of a range of pollutants are possible from the further development of the biomass combustion industry, it is the potential increases in both PM and NO<sub>x</sub> which are of most concern as these pollutants are considered to be the principal pollutants arising from biomass combustion. Both of these pollutants, but in particular PM, can contribute to respiratory and cardiovascular human health issues, while NO<sub>x</sub> emissions are also linked to environmental issues such as acid rain and climate change.

In an effort to protect both human health and the environment, legislation, guidelines and standards are in place which provide a range of emission limit values for the above pollutants. These have been reviewed in Section 2 and Section 3 of this report. General ambient air quality limit values are presented in both the EU CAFE Air Quality Directive and the ambient air quality guidelines set by the WHO, while air quality limit values for industrial plant are presented in both the Industrial Emissions Directive and the Medium Combustion Plant Directive. Emission limit values which are specific for biomass combustion appliances have also been set by both the EU Ecodesign Directive and the European Standard EN 303-5.

As the biomass combustion industry develops in the future, there will be a need to ensure that all types and sizes of combustion appliances meet the specific emission limit values that are relevant to them. While it is evident that the adverse impacts of biomass combustion, in the form of increased pollutant emissions, may not be completely avoided, these emissions may be kept at appropriate levels that meet the emission limit values set by the above mentioned legislation, guidelines and standards. A range of factors associated with biomass combustion influence emissions and should be taken into account so as to maintain emission levels at as low a level as possible. These factors have been reviewed in Section 10 of this report and are identified as:

- The type of fuel used for combustion
- The quality of fuel used for combustion
- The type of appliance used
- The design and operation of the appliance
- Abatement technologies used in the appliance
- The installation of the appliance

The use of an appropriate type and quality of fuel for combustion, that is in line with European fuel quality standards and quality assurance schemes such as the WFQA, may be seen as one of the first steps to be taken so as to ensure that emission levels produced from combustion appliances are maintained at low levels.

The specific type of appliance used and how it has been designed and is operated will also have significant impacts on emission levels. More modern appliances such as advanced and pellet stoves and boilers are generally known to produce lower levels of PM emissions than traditional appliances such as open fireplaces. Design and operational aspects to reduce emission levels include ensuring that appliances are operating under a full fuel load for as long as possible, that 'top-down' ignition and staged combustion occur within an appliance, where possible, that appliances are operated on a continuous basis, where possible, and that appliances are appropriately maintained at regular intervals.

Emission abatement technologies may also be utilised for biomass combustion so as to directly reduce the levels of emissions produced. In an effort to reduce PM emission levels, technologies such as cyclones, core separators, wet scrubbers, fabric filters, ceramic filters and ESPs may be employed, while the processes of SNCR and SCR may be employed so as to reduce NO<sub>x</sub> emission levels.

A final aspect which has an influence of emissions from biomass combustion is the installation of an appliance. All biomass combustion appliances should be installed appropriately so as to take into account the topography of the land, the proximity of nearby buildings, the height of the appliance flue and how it relates to nearby buildings, and the dispersion of gases from the flue. A thorough consideration of the above factors will help to reduce emission values recorded from appliances at ground levels.

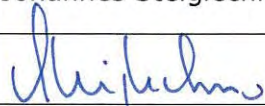
# Appendix 1

## UK RHI Emissions Certificate Example





This certificate provides evidence that the tested boiler meets the air quality requirements of the non-domestic Renewable Heat Incentive (RHI) – Reg 5A(3) and Schedule A1. It must be issued by a testing laboratory. Applicants applying for the RHI with biomass boilers must submit a certificate with their application, or alternatively, an environmental permit.

<b>1. TEST HOUSE</b>	
a) name and address of testing laboratory	TÜV SÜD Industrie Service GmbH Abteilung Feuerungs- und Wärmetechnik Ridlerstrasse 65 80339 München Germany
b) name and signature of the person authorised by the testing laboratory to issue the certificate	Name: Johannes Steiglechner
	Signature: 
c) date of issue of this certificate together with certificate reference number *Please see Note A	Date: 23/01/2014
	Ref: 14 01 91368 001
d) if testing laboratory is accredited to BS EN ISO/IEC 17025:2005, date of accreditation and accreditation number (note: if testing conducted after 24 September 2013, the testing laboratory <b>must be</b> BS EN ISO/IEC 17025:2005 accredited)	Date: 29/04/2013
	Accreditation number: initial date of accreditation 10/08/1992, accreditation number: ZLS-L-023/92, actual accreditation by DAkkS according to DIN EN ISO/IEC 17025:2005 (www.dakks.de), DAkkS accreditation number: D-PL-14153-04-00



<b>2. PLANT</b> <i>Please see Note B</i>	
a) name of the plant tested	ETA HACK VR BG2
b) model of the plant tested	ETA HACK VR BG2 Hackgut 333      Hack333 <sup>a</sup> ETA HACK VR BG2 Hackgut 350      Hack350 <sup>a</sup> ETA HACK VR BG2 Pellet 333      Pellet333 <sup>a</sup> ETA HACK VR BG2 Pellet 350      Pellet350 <sup>a</sup> ETA HACK VR BG2 Pellet 360      Pellet360 <sup>a</sup> <sup>a</sup> shortnames only in certificate
c) manufacturer of the plant tested	ETA Heiztechnik GmbH Gewerbepark 1 4716 Hofkirchen an der Trattnach Austria
d) installation capacity* of the <b>tested</b> plant in kilowatts (kW) *defined in the RHI Regulations as the total installed peak heat output capacity of the plant	Hack333      333 kW Hack350      350 kW Pellet333      333 kW Pellet350      350 kW Pellet360      360 kW
e) is the plant a <u>manually stoked, natural draught</u> plant? (that is, without a fan providing forced or induced draught)	no (all plants)
f) (i) the date the plant was tested*  (ii) please confirm that NO <sub>x</sub> and PM have been tested on the same occasion *This is in reference to the emissions testing for PM and NO <sub>x</sub> , not any wider range of tests. A specific date is required.	Hack333      23/10/2012 Hack350      23/10/2012 Pellet333      17/10/2012 Pellet350      17/10/2012 Pellet360      17/10/2012  yes (all plants)
g) list of all the plants in the type-testing range* of plants to which the certificate applies, if any <sup>1</sup> Please include the <b>installation capacity</b> of each model. <i>*This must follow the ratio rules:            If the smallest plant in the range is 500kW or less, the largest plant in the range can't be more than double the smallest.            If the smallest plant in the range is over 500kW, the largest plant in the range can't be more than 500kW greater than the smallest.</i>	-

<sup>1</sup> The type-testing approach enables testing laboratories to provide assurance that all boilers in a given range meet the air quality requirements, without needing to specifically test each boiler.

<b>3. FUELS</b>											
a) types of fuels used when testing	<p>chipped wood, B1 (EN 303-5, test of heating boilers Hack333 and Hack350)</p> <p>compressed wood, C1 (EN 303-5, test of heating boilers Pellet333, Pellet350 and Pellet360)</p>										
<p>b) based on the testing, list the range of fuels that can be used in compliance with the emission limits of 30 grams per gigajoule (g/GJ) net heat input for particulate matter (PM), and 150 g/GJ net heat input for oxides of nitrogen (NOx)</p> <p><i>(based if relevant on classifications from EN14961 or EN303-5)</i></p>	<p>chipped wood, B1 (EN 303-5, heating boilers Hack333 and Hack350)</p> <p>compressed wood, C1 (EN 303-5, heating boilers Pellet333, Pellet350 and Pellet360)</p>										
c) moisture content of the fuel used during testing	<table> <tr> <td>Hack333</td><td>w: 24 %</td></tr> <tr> <td>Hack350</td><td>w: 24 %</td></tr> <tr> <td>Pellet333</td><td>w: 6 %</td></tr> <tr> <td>Pellet350</td><td>w: 6 %</td></tr> <tr> <td>Pellet360</td><td>w: 6 %</td></tr> </table>	Hack333	w: 24 %	Hack350	w: 24 %	Pellet333	w: 6 %	Pellet350	w: 6 %	Pellet360	w: 6 %
Hack333	w: 24 %										
Hack350	w: 24 %										
Pellet333	w: 6 %										
Pellet350	w: 6 %										
Pellet360	w: 6 %										
<p>d) maximum moisture content* of the fuel which can be used with the certified plant(s) so as to ensure that the RHI emission limits are not exceeded.</p> <p><i>*This value may be obtained from ranges specified in EN 303-5 based on the fuel type(s) tested</i></p>	<p>w: 35 %, B1 maximum moisture content as value obtained from specification of fuel type according to EN 303-5</p> <p>w: 12 %, C1 maximum moisture content as value obtained from specification of fuel type according to EN 303-5</p>										



<b>4. TESTS</b>											
Confirm which requirements the emissions of NOx and PM have been tested in accordance with. <b><u>Either 4a or 4b should be confirmed, the other should be 'not applicable'</u></b>											
a) <b>if the testing was carried out in accordance with the provisions relevant to emissions of PM and NOx in either BS EN 303-5:1999 or BS EN 303-5:2012<sup>2</sup></b> , please confirm: - the test was conducted to whichever standard was current at the time of testing.	EN 303-5:2012: yes (all plants)										
b) <b>if the testing was carried out in accordance with the following requirements</b> , please confirm: (i) testing was carried out in accordance with: - EN 14792:2005 in respect of NOx emissions, and; - EN 13284-1:2002 or ISO 9096:2003 in respect of PM emissions <sup>3</sup> ; and  (ii) emissions of PM represent the average of at least three measurements of emissions of PM, each of at least 30 minutes duration; and  (iii) the value for NOx emissions is derived from the average of measurements made throughout the PM emission tests.	not applicable										
c) please confirm the plant was tested at $\geq 85\%$ of the installation capacity of the plant	yes (all plants)										
d) please confirm the test shows that emissions from the plant were no greater than 30 g/GJ PM and 150 g/GJ NOx	yes (all plants)										
e) measured* emissions of PM in <b>g/GJ</b> net heat input *this value should be from the test confirmed in 4c. Results from partial load tests are not required. This value must be in the specified units.	<table> <tr><td>Hack333</td><td>5</td></tr> <tr><td>Hack350</td><td>5</td></tr> <tr><td>Pellet333</td><td>13</td></tr> <tr><td>Pellet350</td><td>13</td></tr> <tr><td>Pellet360</td><td>13</td></tr> </table>	Hack333	5	Hack350	5	Pellet333	13	Pellet350	13	Pellet360	13
Hack333	5										
Hack350	5										
Pellet333	13										
Pellet350	13										
Pellet360	13										
f) measured* emissions of NOx in <b>g/GJ</b> net heat input *this value should be from the test confirmed in 4c. Results from partial load tests are not required. This value must be in the specified units.	<table> <tr><td>Hack333</td><td>54</td></tr> <tr><td>Hack350</td><td>54</td></tr> <tr><td>Pellet333</td><td>46</td></tr> <tr><td>Pellet350</td><td>46</td></tr> <tr><td>Pellet360</td><td>46</td></tr> </table>	Hack333	54	Hack350	54	Pellet333	46	Pellet350	46	Pellet360	46
Hack333	54										
Hack350	54										
Pellet333	46										
Pellet350	46										
Pellet360	46										

**Note A:** If details from a previously issued certificate are being transferred to this RHI emission certificate template, please note that this document must be **issued by the testing laboratory** as a separate certificate. So the issue date and certificate reference number should be in relation to *this* certificate using the RHI template, not the issue date and reference number of the original certificate.

**Note B:** If you are including multiple tested plants on one certificate, please ensure that all sections are completed for each tested plant, and are laid out such that it is clear which details relate to which tested plant. If a type-testing range is included as well, please show clearly which type-testing range relates to which tested plant(s), following the type-testing range ratio rules outlined in 2g.

<sup>2</sup> BS EN303-5:1999 and 2012 explain what should be measured and when.

<sup>3</sup> These standards explain how to make the PM and NOx measurements.

# Appendix 2

Unit conversion factor tool





## Unit conversion factor tool developed for DEFRA

The below information is taken from the following publication which was produced for DEFRA:

AEA (2012) *Conversion of biomass boiler emission concentration data for comparison with Renewable Heat Incentive emission criteria*.

An emission concentration (i.e. mg/m<sup>3</sup>) may be converted to an emission factor (i.e. g/GJ) using the following formula:

$$EF = (\text{Conc.}) \times (\text{SDFGV}) \div 1000$$

Where:

EF = Emission Factor (g/GJ net heat input)

Conc. = Pollutant concentration (mg/m<sup>3</sup>; dry flue gas at 0°C, 101.3 kPa and at a defined oxygen concentration)

SDFGV = Specific Dry Flue Gas Volume Factor per GJ net heat input (m<sup>3</sup>/GJ; for dry flue gas at 0°C, 101.3 kPa and at the same defined oxygen concentration as the pollutant concentration)

÷ 1000 = to convert from milligrammes to grammes

The reference conditions involved in the above formula are key in determining its outcome. Typically, the reference oxygen content for wood combustion is 6, 10 or 11%.

The use of these reference oxygen contents and the SDFGVs that arise as a result of their use, as well as a formula which may be used should alternative reference oxygen contents present themselves, are presented in the below table.

Specific dry flue gas volumes for wood, m <sup>3</sup> /GJ (net heat input, dry gas at 0°C, 101.3 kPa)					
O <sub>2</sub> content % (dry)	0 (stoichiometric)	6	10	11	[N] (where [N] is the O <sub>2</sub> concentration)
Specific dry flue gas volume (m <sup>3</sup> /GJ)	253	354	483	531	$253 \times (21 \div (21 - [N]))$

Should the operator of the above tool wish to convert in the opposite direction (from an emission factor (i.e. g/GJ) to an emission concentration (i.e. mg/m<sup>3</sup>)), the above formula may be simply inverted as follows:















































$$\text{Conc.} = (EF) \times (1000) \div \text{SDFG}$$

It should be noted that while the above unit conversion factor tool was produced specifically so that RHI emission limit values could be converted to enable operators to demonstrate compliance with these values, it may also be used in a general sense for unit conversions.

















































# Appendix 3

## List of Biomass Appliances on the Triple E Products Register



































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO52913		ETA	ETA PEK 50	013049	Wood pellet boiler 50kW		<a href="#">Suppliers</a>	€ 11/06/2015	50	No	Yes		90	18
BBO53307		ETA	ETA PEK90	013085	90kW WOOD PELLET BOILER		<a href="#">Suppliers</a>	€ 11/06/2015	90	No	Yes		90	13
BBO64454		ETA	HACK 130	13130-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 130kW		<a href="#">Suppliers</a>	€ 22/12/2015	140	Yes	Yes	92	90	20
BBO64455		ETA	HACK 200	13200-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 199kW		<a href="#">Suppliers</a>	€ 22/12/2015	199	Yes	Yes	92	91	15
BBO64456		ETA	HACK 205	13205-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 205kW		<a href="#">Suppliers</a>	€ 22/12/2015	205	Yes	No	92		15
BBO64457		ETA	HACK 350	13350-T	Multi-fuel biomass boiler (wood chips and pellets) 333kW		<a href="#">Suppliers</a>	€ 22/12/2015	350	Yes	Yes	92	94	8
BBO64432		ETA	HACK 50	13049-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 50kW		<a href="#">Suppliers</a>	€ 22/12/2015	50	Yes	Yes	91	90	13
BBO64458		ETA	HACK 500	13500-T	Multi-fuel biomass boiler (wood chip and pellets) 499kW		<a href="#">Suppliers</a>	€ 22/12/2015	499	Yes	Yes	93	93	19
BBO64451		ETA	HACK 70	13075-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 70kW		<a href="#">Suppliers</a>	€ 22/12/2015	70	Yes	Yes	92	90	14
BBO64452		ETA	HACK 90	13085-T	Multi-fuel biomass boiler (wood chip, pellets, miscanthus) 90kW		<a href="#">Suppliers</a>	€ 22/12/2015	95	Yes	Yes	93	90	14
BBO64426		ETA	PC 50	12050	Wood pellet boiler 50kW		<a href="#">Suppliers</a>	€ 22/12/2015	50	No	Yes		90	18
BBO64427		ETA	PE-K 70	13075	Wood pellet boiler 70kW		<a href="#">Suppliers</a>	€ 22/12/2015	70	No	Yes		90	13
BBO48592		Firefox	Firefox 150i	TRR 150	150kW Biomass Boiler		<a href="#">Suppliers</a>	€ 10/04/2013	150	No	Yes		93	19
BBO48593		Firefox	Firefox 200i	TRR 200	200kW Biomass Boiler		<a href="#">Suppliers</a>	€ 10/04/2013	200	No	Yes		93	34
BBO48594		Firefox	Firefox 300i	TRR 300	300kW Biomass Boiler		<a href="#">Suppliers</a>	€ 10/04/2013	300	No	Yes		94	31
BBO48591		Firefox	Firefox 90i	TRR 90	90kW Biomass Boiler		<a href="#">Suppliers</a>	€ 10/04/2013	90	No	Yes		93	13
BBO62235		Froling	Fröling LM 1000	LM 1000 Woodchip	Fröling LM Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	980	Yes	No	90		23
BBO62234		Froling	Fröling LM 750	LM 750 Woodchip	Fröling LM Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	750	Yes	No	90		23
BBO60065		Froling	Froling P4 100	14010ATD	14010ATD Froling P4 100 Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 11/06/2015	99	No	Yes		90	13
BBO62216		Froling	Fröling P4 100	P4 100 Pellet	Fröling P4 Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	100	No	Yes		94	18
BBO60186		Froling	Froling P4 60	14008ATD	14008ATD Froling P4 60kW Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 11/06/2015	58	No	Yes		90	10
BBO62214		Froling	Fröling P4 60	P4 60 Pellet	Fröling P4 Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	58	No	Yes		92	17
BBO62215		Froling	Fröling P4 80	P4 80 Pellet	Fröling P4 Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	80	No	Yes		93	18




























































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO62221		Froling	Fröling T4 110	T4 110 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	110	Yes	No	93		19
BBO62222		Froling	Fröling T4 130	T4 130 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	130	Yes	No	93		15
BBO62223		Froling	Fröling T4 150	T4 150 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	150	Yes	No	94		18
BBO62217		Froling	Fröling T4 50	T4 50 Woodchip	Fröling P4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	50	Yes	No	93		15
BBO60239		Froling	Fröling T4 60	12845LTD	60kW combined wood chip and pellet boiler		<a href="#">Suppliers</a>	€ 11/06/2015	60	Yes	Yes	93	90	10
BBO62218		Froling	Fröling T4 60	T4 60 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	60	Yes	No	93		16
BBO62219		Froling	Fröling T4 75	T4 75 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	75	Yes	No	93		17
BBO60240		Froling	Fröling T4 90	12847LTD	90kW combined wood chip and pellet boiler		<a href="#">Suppliers</a>	€ 11/06/2015	90	Yes	Yes	92	90	13
BBO62220		Froling	Fröling T4 90	T4 90 Woodchip	Fröling T4 Woodchip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	90	Yes	No	93		18
BBO62227		Froling	Fröling TM 150	TM 150 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	150	Yes	Yes	91	91	13
BBO62228		Froling	Fröling TM 200	TM 200 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	199	Yes	Yes	91	91	11
BBO62229		Froling	Fröling TM 250	TM 250 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	250	Yes	Yes	91	91	9
BBO62230		Froling	Fröling TM 300	TM 300 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	300	Yes	Yes	93	93	18
BBO62231		Froling	Fröling TM 320	TM 320 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	320	Yes	Yes	93	93	18
BBO62232		Froling	Fröling TM 400	TM 400 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	400	Yes	Yes	94	94	15
BBO62233		Froling	Fröling TM 500	TM 500 Pellet/Chip	Fröling TM Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	500	Yes	Yes	94	94	18
BBO62224		Froling	Fröling TX 150	TX 150 Pellet/Chip	Fröling TX Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	150	Yes	Yes	92	91	24
BBO62225		Froling	Fröling TX 200	TX 200 Pellet/Chip	Fröling TX Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	199	Yes	Yes	93	93	18
BBO61215		Froling	Fröling TX 250	12870TD	Large capacity wood chip and pellet burning Biomass boiler		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	Yes	93	93	15
BBO62226		Froling	Fröling TX 250	TX 250 Pellet/Chip	Fröling TX Wood Pellet/Chip Boiler		<a href="#">Suppliers</a>	€ 22/12/2015	250	Yes	Yes	94	93	11
BBO47135		GILLES	GILLES HPK 0150	HPKI 0150	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G49		<a href="#">Suppliers</a>	€ 22/11/2012	150	Yes	Yes	94	95	21
BBO47136		GILLES	GILLES HPK 0180	HPKI 0180	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	180	Yes	Yes	90	91	20
BBO47144		GILLES	GILLES HPK 02000	HPKI 02000	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 60%, G100		<a href="#">Suppliers</a>	€ 22/11/2012	2000	Yes	Yes	95	95	46
BBO47137		GILLES	GILLES HPK 0240	HPKI 0240	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G51		<a href="#">Suppliers</a>	€ 22/11/2012	240	Yes	Yes	90	91	20






















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO47138		GILLES	GILLES HPK 0300	HPKI 0300	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G52		<a href="#">Suppliers</a>	€ 22/11/2012	300	Yes	Yes	94	95	17
BBO47139		GILLES	GILLES HPK 0360	HPKI 0360	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	360	Yes	Yes	91	92	30
BBO47140		GILLES	GILLES HPK 0450	HPKI 0450	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	450	Yes	Yes	94	93	29
BBO47141		GILLES	GILLES HPK 0550	HPKI 0550	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	550	Yes	Yes	91	92	29
BBO47142		GILLES	GILLES HPK 0700	HPKI 0700	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	700	Yes	Yes	91	92	29
BBO47143		GILLES	GILLES HPK 0900	HPKI 0900	GILLES HPKI-K Underfed Stoker /Pellets, Wood Chips, Residual wood, MC ? 50%, G50		<a href="#">Suppliers</a>	€ 22/11/2012	900	Yes	Yes	93	92	30
BBO47131		GILLES	GILLES HPKRA 0100	HPKRA 0100	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	100	Yes	Yes	95	95	28
BBO47132		GILLES	GILLES HPKRA 0120	HPKRA 0120	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	120	Yes	Yes	90	92	20
BBO47133		GILLES	GILLES HPKRA 0145	HPKRA 0145	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	145	Yes	Yes	94	94	23
BBO47134		GILLES	GILLES HPKRA 0160	HPKRA 0160	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	160	Yes	Yes	90	92	20
BBO47126		GILLES	GILLES HPKRA 060	HPKRA 060	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 (ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	60	Yes	Yes	94	94	19
BBO47127		GILLES	GILLES HPKRA 070	HPKRA 070	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	70	Yes	Yes	90	90	20
BBO47128		GILLES	GILLES HPKRA 075	HPKRA 075	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	75	Yes	Yes	90	90	20
BBO47129		GILLES	GILLES HPKRA 085	HPKRA 085	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	85	Yes	Yes	90	90	20
BBO47130		GILLES	GILLES HPKRA 095	HPKRA 095	Wood pellets/ industrial pellets, ONORM M7135 or DIN Plus and can operate on Log wood without modification. Wood chips (G30/G50 in accordance with ONORM M7133) with up to 50 % water content, wood pellets/ industrial pellets (dia=11mm), ONORM M7135 or DIN Plus and Log wood without modification, also Miscanthus and various biomass fuels.		<a href="#">Suppliers</a>	€ 22/11/2012	95	Yes	Yes	90	90	20
BBO50878		Guntamatic Gmbh	Blocom 100 Flex with 1.5m pellet feeder	SGP141	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	100	No	Yes		94	8
















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO50877		Guntamatic Gmbh	Blocom 100 Flex with 1m pellet feeder	SGP140	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50880		Guntamatic Gmbh	Blocom 100 Flex with 2.5m pellet feeder	SGP143	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50879		Guntamatic Gmbh	Blocom 100 Flex with 2m pellet feeder	SGP142	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50882		Guntamatic Gmbh	Blocom 100 Flex with 3.5m pellet feeder	SGP145	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50881		Guntamatic Gmbh	Blocom 100 Flex with 3m pellet feeder	SGP144	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50884		Guntamatic Gmbh	Blocom 100 Flex with 4.5m pellet feeder	SGP147	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50883		Guntamatic Gmbh	Blocom 100 Flex with 4m pellet feeder	SGP146	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50885		Guntamatic Gmbh	Blocom 100 Flex with 5m pellet feeder	SGP148	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	No	Yes		94	8
BBO50860		Guntamatic Gmbh	Blocom 50 Flex with 1.5m pellet feeder	SGP121	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50859		Guntamatic Gmbh	Blocom 50 Flex with 1m pellet feeder	SGP120	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50862		Guntamatic Gmbh	Blocom 50 Flex with 2.5m pellet feeder	SGP123	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50861		Guntamatic Gmbh	Blocom 50 Flex with 2m pellet feeder	SGP122	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50864		Guntamatic Gmbh	Blocom 50 Flex with 3.5m pellet feeder	SGP125	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50863		Guntamatic Gmbh	Blocom 50 Flex with 3m pellet feeder	SGP124	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50866		Guntamatic Gmbh	Blocom 50 Flex with 4.5m pellet feeder	SGP127	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50865		Guntamatic Gmbh	Blocom 50 Flex with 4m pellet feeder	SGP126	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50867		Guntamatic Gmbh	Blocom 50 Flex with 5m pellet feeder	SGP128	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		94	19
BBO50869		Guntamatic Gmbh	Blocom 75 Flex with 1.5m pellet feeder	SGP131	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50868		Guntamatic Gmbh	Blocom 75 Flex with 1m pellet feeder	SGP130	Guntamatic Blocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13











































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO50871		Guntamatic Gmbh	Biocom 75 Flex with 2.5m pellet feeder	SGP133	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50870		Guntamatic Gmbh	Biocom 75 Flex with 2m pellet feeder	SGP132	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50873		Guntamatic Gmbh	Biocom 75 Flex with 3.5m pellet feeder	SGP135	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50872		Guntamatic Gmbh	Biocom 75 Flex with 3m pellet feeder	SGP134	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50875		Guntamatic Gmbh	Biocom 75 Flex with 4.5m pellet feeder	SGP137	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50874		Guntamatic Gmbh	Biocom 75 Flex with 4m pellet feeder	SGP136	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50876		Guntamatic Gmbh	Biocom 75 Flex with 5m pellet feeder	SGP138	Guntamatic Biocom is a pellet boiler complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	No	Yes		93	13
BBO50902		Guntamatic Gmbh	Powerchip 100 with 1.5m agitator + 2m feed	SGP030	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50904		Guntamatic Gmbh	Powerchip 100 with 2.5m agitator + 2.5m feed	SGP032	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50903		Guntamatic Gmbh	Powerchip 100 with 2m agitator + 2.25m feed	SGP031	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50906		Guntamatic Gmbh	Powerchip 100 with 3.5m agitator + 3m feed	SGP034	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50905		Guntamatic Gmbh	Powerchip 100 with 3m agitator + 2.75m feed	SGP033	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50908		Guntamatic Gmbh	Powerchip 100 with 4.5m agitator + 3.5m feed	SGP036	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50907		Guntamatic Gmbh	Powerchip 100 with 4m agitator + 3.25m feed	SGP035	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50909		Guntamatic Gmbh	Powerchip 100 with 5m agitator + 3.75m feed	SGP037	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	100	Yes	No	92		21
BBO50886		Guntamatic Gmbh	Powerchip 40/50 with 1.5m agitator + 2m feed	SGP010	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50888		Guntamatic Gmbh	Powerchip 40/50 with 2.5m agitator + 2.5m feed	SGP012	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42



















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO50887		Guntamatic Gmbh	Powerchip 40/50 with 2m agitator + 2.25m feed	SGP011	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50890		Guntamatic Gmbh	Powerchip 40/50 with 3.5m agitator + 3m feed	SGP014	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50889		Guntamatic Gmbh	Powerchip 40/50 with 3m agitator + 2.75m feed	SGP013	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50892		Guntamatic Gmbh	Powerchip 40/50 with 4.5m agitator + 3.5m feed	SGP016	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50891		Guntamatic Gmbh	Powerchip 40/50 with 4m agitator + 3.25m feed	SGP015	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50893		Guntamatic Gmbh	Powerchip 40/50 with 5m agitator + 3.75m feed	SGP017	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	Yes	No	92		42
BBO50894		Guntamatic Gmbh	Powerchip 75 with 1.5m agitator + 2m feed	SGP020	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50896		Guntamatic Gmbh	Powerchip 75 with 2.5m agitator + 2.5m feed	SGP022	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50895		Guntamatic Gmbh	Powerchip 75 with 2m agitator + 2.25m feed	SGP021	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50898		Guntamatic Gmbh	Powerchip 75 with 3.5m agitator + 3m feed	SGP024	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50897		Guntamatic Gmbh	Powerchip 75 with 3m agitator + 2.75m feed	SGP023	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50900		Guntamatic Gmbh	Powerchip 75 with 4.5m agitator + 3.5m feed	SGP026	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50899		Guntamatic Gmbh	Powerchip 75 with 4m agitator + 3.25m feed	SGP025	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50901		Guntamatic Gmbh	Powerchip 75 with 5m agitator + 3.75m feed	SGP027	The Guntamatic Powerchip is a multi-fuel biomass boiler which can burn wood chips, pellets, miscanthus or grain. It is complete with auger and vacuum pellet transfer system.		<a href="#">Suppliers</a>	 10/12/2013	75	Yes	No	93		22
BBO50851		Guntamatic Gmbh	Powercorn 12-50 with 1.5m agitator + 2m feed	SGP040	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	 10/12/2013	50	No	Yes		93	18



















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO50853		Guntamatic Gmbh	Powercorn 12-50 with 2.5m agitator + 2.5m feed	SGP042	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50852		Guntamatic Gmbh	Powercorn 12-50 with 2m agitator + 2.25m feed	SGP041	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50855		Guntamatic Gmbh	Powercorn 12-50 with 3.5m agitator + 3m feed	SGP044	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50854		Guntamatic Gmbh	Powercorn 12-50 with 3m agitator + 2.75m feed	SGP043	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50857		Guntamatic Gmbh	Powercorn 12-50 with 4.5m agitator + 3.5m feed	SGP046	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50856		Guntamatic Gmbh	Powercorn 12-50 with 4m agitator + 3.25m feed	SGP045	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO50858		Guntamatic Gmbh	Powercorn 12-50 with 5m agitator + 3.75m feed	SGP047	The Guntamatic Powercorn is a biomass boiler that can burn grain (barley and triticale) or 6 mm pellets, complete with auger and vacuum transfer system.		<a href="#">Suppliers</a>	€ 10/12/2013	50	No	Yes		93	18
BBO59999		Guntamatic Gmbh	PRO 1000 c/w 3.5m Agitator	SGP554	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	Yes	No	93		30
BBO59998		Guntamatic Gmbh	PRO 1000 c/w 3m Agitator	SGP553	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	Yes	No	93		30
BBO60001		Guntamatic Gmbh	PRO 1000 c/w 4.5m Agitator	SGP556	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	Yes	No	93		30
BBO60000		Guntamatic Gmbh	PRO 1000 c/w 4m Agitator	SGP555	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	Yes	No	93		30
BBO60002		Guntamatic Gmbh	PRO 1000 c/w 5m Agitator	SGP557	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	Yes	No	93		30
BBO60057		Guntamatic Gmbh	PRO 1000 Flex c/w 2.5m Flex	SGP648	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO60059		Guntamatic Gmbh	PRO 1000 Flex c/w 3.5m Flex	SGP650	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO60058		Guntamatic Gmbh	PRO 1000 Flex c/w 3m Flex	SGP649	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO60061		Guntamatic Gmbh	PRO 1000 Flex c/w 4.5m Flex	SGP652	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO60060		Guntamatic Gmbh	PRO 1000 Flex c/w 4m Flex	SGP651	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO60062		Guntamatic Gmbh	PRO 1000 Flex c/w 5m Flex	SGP653	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	1000	No	Yes		94	30
BBO59954		Guntamatic Gmbh	PRO 175 c/w 3.5m Agitator	SGP506	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	Yes	No	95		25
BBO59956		Guntamatic Gmbh	PRO 175 c/w 4.5m Agitator	SGP508	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	Yes	No	95		25



















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO59955		Guntamatic Gmbh	PRO 175 c/w 4m Agitator	SGP507	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	Yes	No	95		25
BBO59957		Guntamatic Gmbh	PRO 175 c/w 5m Agitator	SGP509	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	Yes	No	95		25
BBO60003		Guntamatic Gmbh	PRO 175 Flex c/w 2.5m Flex	SGP594	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO60005		Guntamatic Gmbh	PRO 175 Flex c/w 3.5m Flex	SGP596	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO60004		Guntamatic Gmbh	PRO 175 Flex c/w 3m Flex	SGP595	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO60007		Guntamatic Gmbh	PRO 175 Flex c/w 4.5m Flex	SGP598	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO60006		Guntamatic Gmbh	PRO 175 Flex c/w 4m Flex	SGP597	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO60008		Guntamatic Gmbh	PRO 175 Flex c/w 5m Flex	SGP599	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	188	No	Yes		96	23
BBO59959		Guntamatic Gmbh	PRO 250 c/w 3.5m Agitator	SGP511	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	Yes	No	93		30
BBO59958		Guntamatic Gmbh	PRO 250 c/w 3m Agitator	SGP510	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	Yes	No	93		30
BBO59961		Guntamatic Gmbh	PRO 250 c/w 4.5m Agitator	SGP513	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	Yes	No	93		30
BBO59960		Guntamatic Gmbh	PRO 250 c/w 4m Agitator	SGP512	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	Yes	No	93		30
BBO59962		Guntamatic Gmbh	PRO 250 c/w 5m Agitator	SGP514	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	Yes	No	93		30
BBO60009		Guntamatic Gmbh	PRO 250 Flex c/w 2.5m Flex	SGP600	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO60011		Guntamatic Gmbh	PRO 250 Flex c/w 3.5m Flex	SGP602	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO60010		Guntamatic Gmbh	PRO 250 Flex c/w 3m Flex	SGP601	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO60013		Guntamatic Gmbh	PRO 250 Flex c/w 4.5m Flex	SGP604	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO60012		Guntamatic Gmbh	PRO 250 Flex c/w 4m Flex	SGP603	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO60014		Guntamatic Gmbh	PRO 250 Flex c/w 5m Flex	SGP605	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	200	No	Yes		94	30
BBO59964		Guntamatic Gmbh	PRO 250.1 c/w 3.5m Agitator	SGP519	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	No	93		30
BBO59963		Guntamatic Gmbh	PRO 250.1 c/w 3m Agitator	SGP518	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	No	93		30
BBO59966		Guntamatic Gmbh	PRO 250.1 c/w 4.5m Agitator	SGP521	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	No	93		30
BBO59965		Guntamatic Gmbh	PRO 250.1 c/w 4m Agitator	SGP520	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	No	93		30
BBO59967		Guntamatic Gmbh	PRO 250.1 c/w 5m Agitator	SGP522	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	Yes	No	93		30











































































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO60015		Guntamatic Gmbh	PRO 250.1 Flex c/w 2.5m Flex	SGP606	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO60017		Guntamatic Gmbh	PRO 250.1 Flex c/w 3.5m Flex	SGP608	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO60016		Guntamatic Gmbh	PRO 250.1 Flex c/w 3m Flex	SGP607	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO60019		Guntamatic Gmbh	PRO 250.1 Flex c/w 4.5m Flex	SGP610	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO60018		Guntamatic Gmbh	PRO 250.1 Flex c/w 4m Flex	SGP609	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO60020		Guntamatic Gmbh	PRO 250.1 Flex c/w 5m Flex	SGP611	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	250	No	Yes		94	30
BBO59969		Guntamatic Gmbh	PRO 350 c/w 3.5m Agitator	SGP524	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	Yes	No	95		25
BBO59968		Guntamatic Gmbh	PRO 350 c/w 3m Agitator	SGP523	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	Yes	No	95		25
BBO59971		Guntamatic Gmbh	PRO 350 c/w 4.5m Agitator	SGP526	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	Yes	No	95		25
BBO59970		Guntamatic Gmbh	PRO 350 c/w 4m Agitator	SGP525	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	Yes	No	95		25
BBO59972		Guntamatic Gmbh	PRO 350 c/w 5m Agitator	SGP527	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	Yes	No	95		25
BBO60021		Guntamatic Gmbh	PRO 350 Flex c/w 2.5m Flex	SGP612	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO60023		Guntamatic Gmbh	PRO 350 Flex c/w 3.5m Flex	SGP614	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO60022		Guntamatic Gmbh	PRO 350 Flex c/w 3m Flex	SGP613	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO60025		Guntamatic Gmbh	PRO 350 Flex c/w 4.5m Flex	SGP616	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO60024		Guntamatic Gmbh	PRO 350 Flex c/w 4m Flex	SGP615	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO60026		Guntamatic Gmbh	PRO 350 Flex c/w 5m Flex	SGP617	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	376	No	Yes		96	23
BBO59974		Guntamatic Gmbh	PRO 425 c/w 3.5m Agitator	SGP529	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	Yes	No	94		30
BBO59973		Guntamatic Gmbh	PRO 425 c/w 3m Agitator	SGP528	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	Yes	No	94		30
BBO59976		Guntamatic Gmbh	PRO 425 c/w 4.5m Agitator	SGP531	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	Yes	No	94		30
BBO59975		Guntamatic Gmbh	PRO 425 c/w 4m Agitator	SGP530	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	Yes	No	94		30
BBO59977		Guntamatic Gmbh	PRO 425 c/w 5m Agitator	SGP532	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	Yes	No	94		30
BBO60027		Guntamatic Gmbh	PRO 425 Flex c/w 2.5m Flex	SGP618	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27
BBO60029		Guntamatic Gmbh	PRO 425 Flex c/w 3.5m Flex	SGP620	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27



Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO60028		Guntamatic Gmbh	PRO 425 Flex c/w 3m Flex	SGP619	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27
BBO60031		Guntamatic Gmbh	PRO 425 Flex c/w 4.5m Flex	SGP622	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27
BBO60030		Guntamatic Gmbh	PRO 425 Flex c/w 4m Flex	SGP621	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27
BBO60032		Guntamatic Gmbh	PRO 425 Flex c/w 5m Flex	SGP623	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	438	No	Yes		95	27
BBO59979		Guntamatic Gmbh	PRO 500 c/w 3.5m Agitator	SGP534	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	Yes	No	93		30
BBO59978		Guntamatic Gmbh	PRO 500 c/w 3m Agitator	SGP533	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	Yes	No	93		30
BBO59981		Guntamatic Gmbh	PRO 500 c/w 4.5m Agitator	SGP536	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	Yes	No	93		30
BBO59980		Guntamatic Gmbh	PRO 500 c/w 4m Agitator	SGP535	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	Yes	No	93		30
BBO59982		Guntamatic Gmbh	PRO 500 c/w 5m Agitator	SGP537	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	Yes	No	93		30
BBO60033		Guntamatic Gmbh	PRO 500 Flex c/w 2.5m Flex	SGP624	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO60035		Guntamatic Gmbh	PRO 500 Flex c/w 3.5m Flex	SGP626	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO60034		Guntamatic Gmbh	PRO 500 Flex c/w 3m Flex	SGP625	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO60037		Guntamatic Gmbh	PRO 500 Flex c/w 4.5m Flex	SGP628	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO60036		Guntamatic Gmbh	PRO 500 Flex c/w 4m Flex	SGP627	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO60038		Guntamatic Gmbh	PRO 500 Flex c/w 5m Flex	SGP629	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	500	No	Yes		94	30
BBO59984		Guntamatic Gmbh	PRO 600 c/w 3.5m Agitator	SGP539	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	Yes	No	93		30
BBO59983		Guntamatic Gmbh	PRO 600 c/w 3m Agitator	SGP538	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	Yes	No	93		30
BBO59986		Guntamatic Gmbh	PRO 600 c/w 4.5m Agitator	SGP541	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	Yes	No	93		30
BBO59985		Guntamatic Gmbh	PRO 600 c/w 4m Agitator	SGP540	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	Yes	No	93		30
BBO59987		Guntamatic Gmbh	PRO 600 c/w 5m Agitator	SGP542	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	Yes	No	93		30
BBO60039		Guntamatic Gmbh	PRO 600 Flex c/w 2.5m Flex	SGP630	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	No	Yes		94	30
BBO60041		Guntamatic Gmbh	PRO 600 Flex c/w 3.5m Flex	SGP632	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	No	Yes		94	30
BBO60040		Guntamatic Gmbh	PRO 600 Flex c/w 3m Flex	SGP631	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	No	Yes		94	30
BBO60043		Guntamatic Gmbh	PRO 600 Flex c/w 4.5m Flex	SGP634	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	€ 11/06/2015	599	No	Yes		94	30















































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO60042		Guntamatic Gmbh	PRO 600 Flex c/w 4m Flex	SGP633	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	599	No	Yes		94	30
BBO60044		Guntamatic Gmbh	PRO 600 Flex c/w 5m Flex	SGP635	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	599	No	Yes		94	30
BBO59989		Guntamatic Gmbh	PRO 750 c/w 3.5m Agitator	SGP544	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	Yes	No	93		30
BBO59988		Guntamatic Gmbh	PRO 750 c/w 3m Agitator	SGP543	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	Yes	No	93		30
BBO59991		Guntamatic Gmbh	PRO 750 c/w 4.5m Agitator	SGP546	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	Yes	No	93		30
BBO59990		Guntamatic Gmbh	PRO 750 c/w 4m Agitator	SGP545	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	Yes	No	93		30
BBO59992		Guntamatic Gmbh	PRO 750 c/w 5m Agitator	SGP547	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	Yes	No	93		30
BBO60045		Guntamatic Gmbh	PRO 750 Flex c/w 2.5m Flex	SGP636	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO60047		Guntamatic Gmbh	PRO 750 Flex c/w 3.5m Flex	SGP638	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO60046		Guntamatic Gmbh	PRO 750 Flex c/w 3m Flex	SGP637	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO60049		Guntamatic Gmbh	PRO 750 Flex c/w 4.5m Flex	SGP640	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO60048		Guntamatic Gmbh	PRO 750 Flex c/w 4m Flex	SGP639	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO60050		Guntamatic Gmbh	PRO 750 Flex c/w 5m Flex	SGP641	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	750	No	Yes		94	30
BBO59994		Guntamatic Gmbh	PRO 850 c/w 3.5m Agitator	SGP549	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	Yes	No	93		30
BBO59993		Guntamatic Gmbh	PRO 850 c/w 3m Agitator	SGP548	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	Yes	No	93		30
BBO59996		Guntamatic Gmbh	PRO 850 c/w 4.5m Agitator	SGP551	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	Yes	No	93		30
BBO59995		Guntamatic Gmbh	PRO 850 c/w 4m Agitator	SGP550	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	Yes	No	93		30
BBO59997		Guntamatic Gmbh	PRO 850 c/w 5m Agitator	SGP552	Biomass wood chip/pellet boiler, including agitator, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	Yes	No	93		30
BBO60051		Guntamatic Gmbh	PRO 850 Flex c/w 2.5m Flex	SGP642	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30
BBO60053		Guntamatic Gmbh	PRO 850 Flex c/w 3.5m Flex	SGP644	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30
BBO60052		Guntamatic Gmbh	PRO 850 Flex c/w 3m Flex	SGP643	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30
BBO60055		Guntamatic Gmbh	PRO 850 Flex c/w 4.5m Flex	SGP646	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30
BBO60054		Guntamatic Gmbh	PRO 850 Flex c/w 4m Flex	SGP645	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30
BBO60056		Guntamatic Gmbh	PRO 850 Flex c/w 5m Flex	SGP647	Biomass pellet boiler, including flex feed system, which can be used in modulation up to 1000kW.		<a href="#">Suppliers</a>	 11/06/2015	849	No	Yes		94	30











































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO45953		HDG Bavaria	HDG Compact 100	C100	Wood Chip/Pellet boiler		<a href="#">Suppliers</a>	€ 22/11/2012	100	Yes	Yes	91	92	36
BBO45954		HDG Bavaria	HDG Compact 150	C150	Wood Chip/Pellet boiler		<a href="#">Suppliers</a>	€ 22/11/2012	150	Yes	Yes	90	91	42
BBO45955		HDG Bavaria	HDG Compact 200	C200	Wood Chip boiler		<a href="#">Suppliers</a>	€ 22/11/2012	190	Yes	No	90		69
BBO54575		KOZLUSAN	Propel 100	P100	99KW Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 11/06/2015	99	No	Yes		95	16
BBO54574		KOZLUSAN	Propel 70	P70	70KW Wood Pellet Boiler		<a href="#">Suppliers</a>	€ 11/06/2015	70	No	Yes		95	14
BBO32292		KWB Biomass Heating Systems	KWB Multifire USV100_P	USV 100 Wood Pellets	The KWB Multifire system runs on wood pellets dia=6 mm / dia=8 mm in accordance with ONORM M 7135 or DIN Plus and industrial pellets dia=11 mm in accordance with ONORM M 7135 HP2.		<a href="#">Suppliers</a>	€ 20/10/2010	100		Yes		92	19
BBO32291		KWB Biomass Heating Systems	KWB Multifire USV100_W	USV 100 Wood Chips	The KWB Multifire system runs on G30/W30 wood chips in accordance with ONORM M 7133 or B1 in accordance with CEN TC 335.		<a href="#">Suppliers</a>	€ 20/10/2010	100	Yes		91.1		23
BBO32286		KWB Biomass Heating Systems	KWB Multifire USV50_P	USV 50 Wood Pellets	The KWB Multifire system runs on wood pellets dia=6 mm / dia=8 mm in accordance with ONORM M 7135 or DIN Plus and industrial pellets dia=11 mm in accordance with ONORM M 7135 HP2.		<a href="#">Suppliers</a>	€ 20/10/2010	50		Yes		90.7	19
BBO32285		KWB Biomass Heating Systems	KWB Multifire USV50_W	USV 50 Wood Chips	The KWB Multifire system runs on G30/W30 wood chips in accordance with ONORM M 7133 or B1 in accordance with CEN TC 335.		<a href="#">Suppliers</a>	€ 20/10/2010	50	Yes		90.9		19
BBO32288		KWB Biomass Heating Systems	KWB Multifire USV60_P	USV 60 Wood Pellets	The KWB Multifire system runs on wood pellets dia=6 mm / dia=8 mm in accordance with ONORM M 7135 or DIN Plus and industrial pellets dia=11 mm in accordance with ONORM M 7135 HP2.		<a href="#">Suppliers</a>	€ 20/10/2010	60		Yes		91.4	19
BBO32287		KWB Biomass Heating Systems	KWB Multifire USV60_W	USV 60 Wood Chips	The KWB Multifire system runs on G30/W30 wood chips in accordance with ONORM M 7133 or B1 in accordance with CEN TC 335.		<a href="#">Suppliers</a>	€ 20/10/2010	60	Yes		91.1		20
BBO32290		KWB Biomass Heating Systems	KWB Multifire USV80_P	USV 80 Wood Pellets	The KWB Multifire system runs on wood pellets dia=6 mm / dia=8 mm in accordance with ONORM M 7135 or DIN Plus and industrial pellets dia=11 mm in accordance with ONORM M 7135 HP2.		<a href="#">Suppliers</a>	€ 20/10/2010	80		Yes		92.9	18
BBO32289		KWB Biomass Heating Systems	KWB Multifire USV80_W	USV 80 Wood Chips	The KWB Multifire system runs on G30/W30 wood chips in accordance with ONORM M 7133 or B1 in accordance with CEN TC 335.		<a href="#">Suppliers</a>	€ 20/10/2010	80	Yes		91.3		21
BBO32293		KWB Biomass Heating Systems	KWB Powerfire TDS130	TDS 130 Multifuel	The KWB Powerfire operates on wood chips (G30/G50 in accordance with ONORM M7133) with up to 45 % water content, as well as wood pellets/ industrial pellets (dia=11mm) in accordance with ONORM M7135 or DIN Plus.		<a href="#">Suppliers</a>	€ 20/10/2010	130		Yes		91.9	27
BBO32294		KWB Biomass Heating Systems	KWB Powerfire TDS150	TDS 150 Multifuel	The KWB Powerfire operates on wood chips (G30/G50 in accordance with ONORM M7133) with up to 45 % water content, as well as wood pellets/ industrial pellets (dia=11mm) in accordance with ONORM M7135 or DIN Plus.		<a href="#">Suppliers</a>	€ 20/10/2010	150		Yes		91.5	18
BBO32295		KWB Biomass Heating Systems	KWB Powerfire TDS240	TDS 240 Multifuel	The KWB Powerfire operates on wood chips (G30/G50 in accordance with ONORM M7133) with up to 45 % water content, as well as wood pellets/ industrial pellets (dia=11mm) in accordance with ONORM M7135 or DIN Plus.		<a href="#">Suppliers</a>	€ 20/10/2010	240		Yes		92.7	14
BBO32296		KWB Biomass Heating Systems	KWB Powerfire TDS300	TDS 300 Multifuel	The KWB Powerfire operates on wood chips (G30/G50 in accordance with ONORM M7133) with up to 45 % water content, as well as wood pellets/ industrial pellets (dia=11mm) in accordance with ONORM M7135 or DIN Plus.		<a href="#">Suppliers</a>	€ 20/10/2010	300		Yes		93.5	21
BBO51608		Schmid AG	UTSK-1200	UTSK1200	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range:180 - 1600 kW. Capacity control: modulating. Fuel:10 - 50 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	1200	Yes	No	87		120
BBO51609		Schmid AG	UTSK-1600	UTSK1600	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range:180 - 1600 kW. Capacity control: modulating. Fuel:10 - 50 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	1600	Yes	No	87		120
BBO51600		Schmid AG	UTSK-180	UTSK180	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range:180 - 1600 kW. Capacity control: modulating. Fuel:10 - 50 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	180	Yes	No	93		25
BBO51601		Schmid AG	UTSK-240	UTSK240	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range:180 - 1600 kW. Capacity control: modulating. Fuel:10 - 50 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	240	Yes	No	93		25


































































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO51602		Schmid AG	UTSK-300	UTSK300	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	300	Yes	No	91		18
BBO51603		Schmid AG	UTSK-360	UTSK360	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	360	Yes	No	91		18
BBO51604		Schmid AG	UTSK-450	UTSK450	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	450	Yes	No	90		31
BBO51605		Schmid AG	UTSK-550	UTSK550	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	550	Yes	No	90		31
BBO51606		Schmid AG	UTSK-700	UTSK700	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	700	Yes	No	87		120
BBO51607		Schmid AG	UTSK-900	UTSK900	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:180 - 1600 kW, Capacity control: modulating, Fuel:10 - 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	900	Yes	No	87		120
BBO51628		Schmid AG	UTSL-110	UTSL110	7 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	110	Yes	No	85		150
BBO51629		Schmid AG	UTSL-150	UTSL150	8 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	150	Yes	No	85		150
BBO51630		Schmid AG	UTSL-199	UTSL199	9 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	199	Yes	No	86		130
BBO51631		Schmid AG	UTSL-250	UTSL250	10 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	250	Yes	No	86		130
BBO51625		Schmid AG	UTSL-50	UTSL50	4 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	50	Yes	No	85		150
BBO51626		Schmid AG	UTSL-65	UTSL65	5 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	65	Yes	No	85		150
BBO51627		Schmid AG	UTSL-80	UTSL80	6 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to 50 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	80	Yes	No	85		150
BBO51621		Schmid AG	UTSL-P-110	UTSL110P	7 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	110	No	Yes		90	150
BBO51622		Schmid AG	UTSL-P-150	UTSL150P	8 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	150	No	Yes		90	150
BBO51623		Schmid AG	UTSL-P-199	UTSL199P	9 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	199	No	Yes		91	130
BBO51624		Schmid AG	UTSL-P-250	UTSL250P	10 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	250	No	Yes		91	130
BBO51618		Schmid AG	UTSL-P-50	UTSL50P	4 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	50	No	Yes		90	150
BBO51619		Schmid AG	UTSL-P-65	UTSL65P	5 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	65	No	Yes		90	150
BBO51620		Schmid AG	UTSL-P-80	UTSL80P	6 pass heat exchanger, Rotating grate burner, Operating medium: water, . Operating range: 50 - 250 kW, Capacity control: modulating, Fuel: up to <10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	80	No	Yes		90	150
BBO51610		Schmid AG	UTSP-180	UTSP180	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:up to 900 kW, Capacity control: modulating, Fuel:< 10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	180	No	Yes		94	31
BBO51611		Schmid AG	UTSP-240	UTSP240	Underfeed stoker, Operating medium: water, Garte cooling: air, Operating range:up to 900 kW, Capacity control: modulating, Fuel:< 10 %MC,		<a href="#">Suppliers</a>	€ 14/05/2014	240	No	Yes		94	31



























































Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BB051612		Schmid AG	UTSP-300	UTSP300	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	300	No	Yes		93	26
BB051613		Schmid AG	UTSP-360	UTSP360	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	360	No	Yes		93	26
BB051614		Schmid AG	UTSP-450	UTSP450	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	450	No	Yes		91	130
BB051615		Schmid AG	UTSP-550	UTSP550	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	550	No	Yes		92	120
BB051616		Schmid AG	UTSP-700	UTSP700	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	700	No	Yes		92	120
BB051617		Schmid AG	UTSP-900	UTSP900	Underfeed stoker. Operating medium: water. Garte cooling: air. Operating range: up to 900 kW. Capacity control: modulating. Fuel: < 10 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	900	No	Yes		92	120
BB051564		Schmid AG	UTSR-100	UTSR100	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	100	Yes	No	85		76
BB051574		Schmid AG	UTSR-1200	UTSR1200	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	1200	Yes	No	90		120
BB051565		Schmid AG	UTSR-150	UTSR150	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	150	Yes	No	91		150
BB051575		Schmid AG	UTSR-1600	UTSR1600	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	1600	Yes	No	87		120
BB051566		Schmid AG	UTSR-180	UTSR180	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	180	Yes	No	86		61
BB051576		Schmid AG	UTSR-2000	UTSR2000	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	2000	Yes	No	87		120
BB051567		Schmid AG	UTSR-240	UTSR240	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	240	Yes	No	86		54
BB051577		Schmid AG	UTSR-2400	UTSR2400	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	2400	Yes	No	87		120
BB051568		Schmid AG	UTSR-300	UTSR300	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	300	Yes	No	92		130
BB051578		Schmid AG	UTSR-3200	UTSR3200	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	3200	Yes	No	87		120
BB051569		Schmid AG	UTSR-360	UTSR360	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	360	Yes	No	92		130
BB051579		Schmid AG	UTSR-4200	UTSR4200	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	4200	Yes	No	87		120
BB051570		Schmid AG	UTSR-450	UTSR450	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	450	Yes	No	91		130
BB051580		Schmid AG	UTSR-5000	UTSR5000	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	€ 14/05/2014	5000	Yes	No	87		120



Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO51571		Schmid AG	UTSR-550	UTSR550	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	 14/05/2014	550	Yes	No	91		120
BBO51572		Schmid AG	UTSR-700	UTSR700	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	 14/05/2014	700	Yes	No	91		120
BBO51573		Schmid AG	UTSR-900	UTSR900	Moving grate furnace. Operating medium: water, steam, thermal oil. Grate cooling: air/water. Operating range: 100 - 5000 kW. Capacity control: modulating. Fuel: 10 - 60 %MC.		<a href="#">Suppliers</a>	 14/05/2014	900	Yes	No	91		120
BBO51595		Schmid AG	UTSW-1200	UTSW1200	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	1200	Yes	No	87		120
BBO51596		Schmid AG	UTSW-1600	UTSW1600	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	1600	Yes	No	87		120
BBO51597		Schmid AG	UTSW-2400	UTSW2400	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	2400	Yes	No	87		120
BBO51589		Schmid AG	UTSW-300	UTSW300	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	300	Yes	No	86		130
BBO51598		Schmid AG	UTSW-3200	UTSW3200	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	3200	Yes	No	87		120
BBO51590		Schmid AG	UTSW-360	UTSW360	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	360	Yes	No	86		130
BBO51599		Schmid AG	UTSW-4200	UTSW4200	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	4200	Yes	No	87		120
BBO51591		Schmid AG	UTSW-450	UTSW450	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	450	Yes	No	86		130
BBO51592		Schmid AG	UTSW-550	UTSW550	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	550	Yes	No	87		120
BBO51593		Schmid AG	UTSW-700	UTSW700	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	700	Yes	No	92		120
BBO51594		Schmid AG	UTSW-900	UTSW900	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 4200 kW. Capacity control: modulating. Fuel: up to 40 %MC.		<a href="#">Suppliers</a>	 14/05/2014	900	Yes	No	92		120
BBO51587		Schmid AG	UTSW-P-1200	UTSW1200P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	1200	No	Yes		92	120
BBO51588		Schmid AG	UTSW-P-1600	UTSW1600P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	1600	No	Yes		92	120
BBO51581		Schmid AG	UTSW-P-300	UTSW300P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	300	No	Yes		91	130
BBO51582		Schmid AG	UTSW-P-360	UTSW360P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	360	No	Yes		91	130
BBO51583		Schmid AG	UTSW-P-450	UTSW450P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	450	No	Yes		91	130
BBO51584		Schmid AG	UTSW-P-550	UTSW550P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	550	No	Yes		92	120
BBO51585		Schmid AG	UTSW-P-700	UTSW700P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	700	No	Yes		92	120



Triple E Code	Programme/s	Manufacturer	Product Name	Product Code	Short Description	Link To Tech. Description	Suppliers	Valid From	Boiler Rating	Chip fuel	Pellet fuel	Thermal Efficiency - Chip	Thermal Efficiency - Pellet	Dust Emissions
BBO51586		Schmid AG	UTSW-P-900	UTSW900P	Moving step grate furnace. Operating medium: water. Grate cooling: water. Operating range: 300 - 1600 kW. Capacity control: modulating. Fuel: 8 - 10 %MC.		<a href="#">Suppliers</a>	 14/05/2014	900	No	Yes		92	120
BBO66783		Viessmann	Pyrotec 720/Vitoflex 300-UF	7423676	Vitoflex 300-UF Fully automatic wood boiler with grate combustion For pellets, woodchips, shavings and mixed wood Moisture content: max. M50 390 to 1250 kW		<a href="#">Suppliers</a>	 19/07/2016	720	Yes	Yes	92	92	35
BBO66785		Viessmann	Pyrotec 1250/Vitoflex 300-UF	7423678	Vitoflex 300-UF Fully automatic wood boiler with grate combustion For pellets, woodchips, shavings and mixed wood Moisture content: max. M50 390 to 1250 kW		<a href="#">Suppliers</a>	 19/07/2016	1250	Yes	Yes	92	92	50
BBO66781		Viessmann	Pyrotec 390 /Vitoflex 300-UF	7423674	Vitoflex 300-UF Fully automatic wood boiler with grate combustion For pellets, woodchips, shavings and mixed wood Moisture content: max. M50 390 to 1250 kW		<a href="#">Suppliers</a>	 19/07/2016	390	Yes	Yes	92	92	23
BBO66782		Viessmann	Pyrotec 530/Vitoflex 300-UF	7423675	Vitoflex 300-UF Fully automatic wood boiler with grate combustion For pellets, woodchips, shavings and mixed wood Moisture content: max. M50 390 to 1250 kW		<a href="#">Suppliers</a>	 19/07/2016	530	Yes	Yes	92	92	30
BBO66784		Viessmann	Pyrotec 950/Vitoflex 300-UF	7423677	Vitoflex 300-UF Fully automatic wood boiler with grate combustion For pellets, woodchips, shavings and mixed wood Moisture content: max. M50 390 to 1250 kW		<a href="#">Suppliers</a>	 19/07/2016	950	Yes	Yes	92	92	35
BBO66762		Viessmann Ltd	Viessmann100	100	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	100	Yes	Yes	92	92	17
BBO66763		Viessmann Ltd	Viessmann150	150	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	150	Yes	Yes	92	92	6
BBO66764		Viessmann Ltd	Viessmann220	220	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	220	Yes	Yes	92	92	36
BBO66765		Viessmann Ltd	Viessmann3	3	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	300	Yes	Yes	92	92	26
BBO66766		Viessmann Ltd	Viessmann400	400	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	400	Yes	Yes	92	92	20
BBO66767		Viessmann Ltd	Viessmann540	540	Innovative wood boiler with rotation combustion For pellets, woodchips and shavings Moisture content: max. M35 150 to 540 kW		<a href="#">Suppliers</a>	 19/07/2016	540	Yes	Yes	92	92	14
BBO62665	 	Wood Energy Solution (WES)	E-Compact 100kW	99110001	100kW wood pellet boiler		<a href="#">Suppliers</a>	 22/12/2015	100	No	Yes		91	26
BBO62669	 	Wood Energy Solution (WES)	E-Compact 125kW	99112001	125kW wood pellet boiler		<a href="#">Suppliers</a>	 22/12/2015	125	No	Yes		91	26
BBO62668	 	Wood Energy Solution (WES)	E-Compact 150kW	99115001	150kW wood pellet boiler		<a href="#">Suppliers</a>	 22/12/2015	150	No	Yes		90	19
BBO62667	 	Wood Energy Solution (WES)	E-Compact 55kW	99105501	55kW wood pellet boiler		<a href="#">Suppliers</a>	 22/12/2015	55	No	Yes		90	21
BBO62666	 	Wood Energy Solution (WES)	E-Compact 85kW	99108501	85kW wood pellet boiler		<a href="#">Suppliers</a>	 22/12/2015	85	No	Yes		93	27



= Triple E



= ACCA



# Appendix 4

Biomass Appliance Products available in Ireland



## List of known biomass appliance products in Ireland

Alpha-InnoTec	Linka
Anselmo Cola	MCZ
ARCE	Mescoli Caldaie Termocucine
Ariterm	Multikalar
Artel Clima & Depura	Nibe
Atmos	Nordic Bioenergy
Attack S.r.o.	Okofen
Benekov	OlympOEM Werke GmbH
Biocom	OPOP spol sro
Biotech Energietechnik GmbH	Palazzetti
Biotherm Pelletheizung	Paradigma Energie und Umwelttechnik GmbH
Biovarme Aps	Passat Energi A/S
Calimax	PC 50
Caminetti Montegrappa	PE-K 70
Central Boiler	Perhofer
Cichewicz Kotly	Ponast
CN Maskinfabrik A/S	Powerchip
CT Pasqualicchio Termotecnica	Powercorn
D'Alessandro Termomeccanica	Primdal & Haugesen Energy
E-Compact	PRO
Ecoteck	Pro Solar Energietechnik
Ecowood	Propel
Edilkamin S.p.A.	PWTK TERMOTECH Sp.
EkoVimar Orlanski	Pyrotec
Endress	Quadrafire (Hearth and Home technologies Inc.)
ETA	Refo Energi
ETA Heiztechnik GmbH	Rika
ETA PEK	Royal s.r.l
Evotherm	Rozell
Extraflame	Sahlins Ecotec
Firebird	Sherwood Industries
Firefox	SHT
Froeling	Sicalor S.p.A.
Geostar Engineering Ltd.	Sideros spA.
Gerco	Smedegarden
Gerkros	Solarbayer GmbH
Gilles	Solarfocus
GILLES HPKRA	SOLARvent BiomasseHeizsysteme GmbH
Guntamatic	Solimpeks
HACK	Stanley
Harman Stove Company	Stocksbro Energi AB
HDG Bavaria	Tecno Cover Srl.
HDG Compact	Thermorossi
Heizomat	Twinheat
Herlt SonnenEnergieSysteme	Ulrich Brunner GmbH
HERZ Armaturen GmbH	UTSK Schmid
Hoval Ltd.	UTSL Schmid
Industrie Olivieri s.p.A.	UTSP Schmid
Innovating Concepts in Biomass	UTSR Schmid
IRLEH	UTSW Schmid
Janfire AB	Varnebaronen
JollyMec	Veljekset Ala Talkkari Oy
Kalor	Verner
KC Stoker	Viadrus
Kedco Energy	Viessmann
Koeb Schaefer	Wamsler Hausund Kuchentechnik
KSM Karby	Wikora
Kuenzel	Windhager
KWB	Wodtke
Ladan	Woodpecker Energy
Lincar Spa	Zaklady GórniczoMetalowe

# Appendix 5

Emissions Test Data for Biomass Appliances between  
50kW and 20MW



Emissions test data for commercially available biomass combustion appliances  
50 kW – 20 MW

Appliance make/type	Year of test	Appliance size (kW)	Fuel type	PM emissions (g/GJ)	NOx emissions (g/GJ)
Buderus Logano SH 50	2007	50	Pellet	12	68
BIOTECH HZ 50	2007	50	Chip	14	69
Ecotherm HS 50	2006	50	Chip	14	69
HMS HP 50	2003	50	Pellet	17	63
HEIZOMAT RHK-AK 50	2005	50	Chip	8	88
Rennergy HSV 50	2001	55	Chip	20	113
Pyrogrande PMT 55	2004	55	Pellet	13	82
Classic 60 Lambda	2007	58	Pellet	25	107
Turbomatic 55	2000	55	Chip	29	111
Turbomatic 55	2000	55	Pellet	13	82
UTSS 60.30	2000	60	Chip	12	74
Pelletstar biocontrol 60	2006	60	Pellet	24	83
SOLARFOCUS therminator 60 kW	2006	60	Pellet	19	106
PELLEMATIC PE64	2007	64	Pellet	9	97
Type PV 80	2002	80	Pellet	21	127
SL 80T	1999	80	Chip	15	95
RennergyHSV 80S	2001	80	Chip	13	79
KWB Multifire 80	2006	82	Chip	15	108
KWB Multifire 80	2006	82	Pellet	12	96
HSV80S WTH80	2004	85	Pellet	23	75
Buderus Logano SH 90	2005	93	Pellet	14	71
Buderus Logano SH 90	2005	93	Chip	27	116
Buderus Logano SP90	2007	95	Pellet	16	69
ETA PE-K 90	2006	95	Pellet	16	69
Kapelbi PE-K 95	2007	95	Pellet	16	69
SL 99 T	1999	99	Chip	9	104
UTSS 100.21	2000	100	Chip	22	77
Rennergy HSV 100S	2001	100	Chip	14	80
KWB Multifire 100	2006	101	Pellet	12	87
KWB Multifire 100	2006	101	Chip	15	100

Appliance make/type	Year of test	Appliance size (kW)	Fuel type	PM emissions (g/GJ)	NOx emissions (g/GJ)
Ecotherm HS 100 ECO	2007	105	Chip	20	112
EVOTHERM P 100 ECO	2007	105	Pellet	7	71
HSV100S WTH100	2004	109	Pellet	13	74
Pyrogrande PMT 110	2004	110	Pellet	3	46
Turbomatic 110	2002	110	Chip	18	78
SL 110T	1999	110	Chip	18	114
ETA HACK 130	2007	140	Pellet	11	69
SL150T	1999	150	Chip	17	113
Ecotherm HS 200 ECO	2009	200	Chip	25.35	82.55
Binder RRK 130 – 250	2006	250	Mixed	15.6	74.75
Kolhbach Metnitz	2009	632	Chip	11.61	63.64
Hoval STU 800 Wood pellet boiler	2006	800	Pellet	25	90
Binder RRK 640 – 850	2005	840	Chip	16.9	65.65
Gilles HPK-UTSK 550	2006	550	Chip	32.5	52
Gilles HPK-UTSK 900	2005	900	Pellet	32.5	93.6
Kohlbach K8-5000	2008	5325	Chip	2.6	76.05
Gilles HPK-UTSK 1600	2005	1600	Chip	42.25	64.35
Binder RRK 2500-3000	2005	3000	Chip	48.75	82.55
Kohlbach K8-1600	2008	1600	Chip	50.7	63.7