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Biomass and Air Quality Guidance for Local Authorities

England and Wales

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Environmental Protection UK's vision is of a cleaner, quieter, healthier world. We seek changes in policy and practice to minimise air, noise and land pollution, bringing together stakeholders to inform debate and influence decision making. We are a national membership based charity and have been playing a leading role in environmental protection in the UK since 1898.

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About LACORS

LACORS (the Local Authorities Coordinators of Regulatory Services) is the local government central body responsible for overseeing local authority regulatory and related services in the UK. Central to LACORS' work is the promotion of quality regulation, development of policy and dissemination of comprehensive advice, guidance and good practice for local authority regulatory services.

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Executive Summary

In common with other combustion appliances, emissions from biomass boilers and combined heat and power systems should be managed to ensure potential air quality impacts are controlled. Management of combustion appliances can include product and fuel standards, emissions abatement equipment, regulatory controls and/ or planning controls to restrict where certain appliances can be installed. This guidance aims to help local authorities understand and manage emissions from biomass combustion, with a focus on the most common biomass fuel – wood.

Biomass fuels are currently being encouraged to help the UK meet stringent targets under the Climate Change Act and the related Renewable Energy Strategy. Unabated climate change presents a major environmental and health hazard to the whole world, and de-carbonising our energy supply is therefore a priority. At the same time the UK is currently failing to meet legally binding EU air quality standards in many parts of the country, and public health is suffering as a result. Management of biomass emissions should therefore seek to encourage biomass use, whilst maintaining or improving air quality.

As a general rule of thumb biomass boilers fuelled by clean, new wood have lower emissions than coal, roughly equivalent emissions to oil, but higher emissions than equivalent gas fired boilers. The process of assessment should therefore follow a risk-based approach based upon:

- Where the boiler is, i.e. could it affect areas of poor air quality
- Whether the biomass plant is substituting for a boiler using a different fuel; i.e. if it's substituting for oil or coal, emissions might actually drop, if it substitutes for gas they may rise
- The likely emissions standard of the boiler
- The type of biomass fuel used.

The approach to assessment should therefore have a lighter touch where risk is low (for example in a rural area where air quality is good, and coal and oil are the realistic alternative fuels), and more rigorous where risk is high (for example in or adjacent to an Air Quality Management Area).

The declared view of the Department for Environment, Food and Rural Affairs (Defra) is that the air quality impacts of a major expansion in biomass heat can be controlled through the use of high quality, low emission plant and targeting rural areas off the gas grid where coal and oil fired plant are currently used. In urban areas, or where an Air Quality Management Area has been declared, they would expect biomass heat deployment to be less common, and larger (and therefore cleaner) biomass units to be more prevalent.

This guidance document contains information on the policy background to biomass, climate change and air quality, details of the technology used in biomass plant and their regulation, and finally advice on the management and mitigation of biomass emissions. Several tools have been developed alongside this guidance to help local authorities and their partners manage emissions. These are listed on the contents page, and are also available for download from www.environmental-protection.org.uk/biomass.

This guidance does not intend to be a complete guide to biomass, and suggested reading links have been placed in the text if more detailed information is needed about any of the policies, technologies and methodologies raised. This guidance is intended as a companion to the more general Environmental Protection UK planning guidance 'Development Control: Planning for Air Quality'. This was last updated in 2006, and at the time of writing is under review for a further update later in 2009.

Chapter 1 – Background

1.1 Biomass burning is perhaps the oldest method of providing heating and hot water; however in recent years pressure to reduce our reliance on fossil fuels such as coal, oil and gas has encouraged a large expansion in the use of biomass heat. Concerns, however, have been raised that this may have an adverse effect on air quality, particularly in densely populated urban areas.

1.2 Biomass can have a variety of meanings, but in the context of this guidance it refers to deriving energy from biological material through a transformation process. The energy provided may be heat, electricity or mechanical power. The biological material may come from animal or plant sources (including animal wastes and composts), whilst the transformative process may be direct combustion or perhaps involve gasification, fermentation or pyrolysis.

1.3 The status of biomass as a renewable low carbon fuel means there is growing interest in using it to help meet local and national targets for renewable energy. As a relatively mature renewable energy technology, biomass is often one of the most cost effective, and therefore attractive, technologies to use.

Types of Biomass

1.4 There is a wide range of original sources of biomass fuels, which can be broadly defined in terms of 'wet' and 'dry' sources. Under these two broad headings, they can be grouped into five categories:

Virgin wood
Dry – includes roundwood, harvesting residues (brash), bark, sawdust, crowns, needles and residues of tree surgery

Energy crops
Dry – includes woody energy crops (short rotation forestry, willow, eucalyptus, poplar), grassy energy crops (miscanthus and hemp), sugar crops (sugar beet), starch crops (wheat, barley, maize/corn), oil crops (rape, linseed, sunflower), and even hydroponics (lake weed, kelp, algae)

Agricultural residues
Wet – includes pig and cattle slurry, sheep manure, grass silage
Dry – poultry litter, wheat or barley straw, corn stover

Food residues
Wet – includes wastes from various processes in the distillery, dairy, meat, fish, oils, fruit and vegetables sectors

Industrial residues
Wet – includes sewage sludge
Dry – includes residues from sawmills, construction, furniture manufacturing, chipboard industries, pallets.

Scope of this Guidance

1.5 This guidance covers the burning of dry and seasoned woody fuels only, as this is the most popular form of biomass being deployed in the UK (e.g. wood chips, pellets and logs with up to 50% moisture content). The document is aimed at local authorities, and is intended to help officers and elected members with strategic planning and decisions on individual planning applications. Whilst this guidance relates to practice and the legislative position in England and Wales, the general approach will be of relevance to Scotland and Northern Ireland. At the time of writing Environmental Protection UK's Scottish Division were looking to produce a dedicated version of this guidance for Scotland in the near future.

1.6 The guidance focuses on assessing and managing the effects of biomass on air quality – specifically nitrogen dioxide (NO_2) and particulates (PM_{10} and $PM_{2.5}$). It does not cover sulphur dioxide (SO_2) in depth. Lifecycle CO_2 emissions from different biomass fuels are beyond the scope of this guidance, however the Environment Agency report 'Biomass – Carbon Sink or Carbon Sinner?' can provide more information on this subject (see Chapter 1 reading links).

1.7 Biomass does have other environmental and sustainability impacts surrounding its use. These are mentioned in this guidance, and links are given to sources of further information. Dry, woody fuels are most commonly burnt in a boiler to produce heat for space heating and/ or hot water, or in a Combined Heat and Power (CHP) unit to produce both heat and electricity. This guidance uses the term 'biomass boilers' to cover both boilers and CHP units.

1.8 The burning of waste wood may be subject to more stringent environmental regulation than the burning of clean, new wood. These issues are examined in Chapter 3.

1.9 At the time of writing this document, technology and legislation surrounding the air quality effects of biomass were developing quickly. Updates to this guidance will be posted at www.environmental-protection.org.uk/biomass, and we strongly recommend checking for updates when using this guidance.

1.10 The majority of installations of biomass plants will occur as part of a larger development, and will therefore need both to meet regulatory (pollution) conditions, and also gain planning approval. Both issues are looked at in Chapter 3 of this guidance. Wider air quality issues surrounding development control are considered in the guidance document 'Development Control: Planning for Air Quality' which is available to download from the Environmental Protection UK website.

1.11 An information leaflet for developers has been produced alongside this guidance document. This leaflet explains the issues surrounding biomass and air quality, the information that local authorities may need to assess the air quality impacts of a proposed biomass boiler, and the reasons why they may request this information.

Introduction to the Air Quality Impacts of Biomass Plant

1.12 In common with other combustion plant, the combustion of biomass for energy can affect air quality in a variety of ways. Emission levels of pollutants such as particulates (PM), polyaromatic hydrocarbons (PAHs) and carbon monoxide depend on the completeness of the combustion process. The temperatures in conventional biomass combustion are considered to be not sufficiently high to oxidise atmospheric nitrogen, and oxides are almost exclusively formed from fuel nitrogen (note that this may not be the case for newer biomass technologies such as gasification that have higher combustion temperatures). Emission levels of NO_x are therefore heavily dependent on the chemical composition of individual fuels, as are emissions of SO_x. Overall emissions will therefore be dependent on

- The design of the combustion plant
- The chemical and physical qualities of the fuel (fuel quality), and
- The presence of any emissions abatement equipment fitted to the plant.

1.13 In many cases the introduction of new biomass plant will displace heat and/ or power provided by other combustion appliances. In this case the relative contribution will depend on the type of fuel(s) and combustion technology displaced. For example, the sulphur and nitrogen content of wood biomass is low but higher than for gas, and hence displacement of gas may lead to a modest increase in SO_2 and NO_x emissions. Conversely, displacement of fuels such as coal may lead to an overall reduction in emissions.

1.14 The depth of the air quality assessment applied to a planning application containing a biomass boiler should follow a risk-based approach. Key questions to consider when making an initial broad assessment should include:

- Geography – what is the planned location of the biomass boiler, and could it potentially negatively affect any areas of poor air quality?
- Fuel substitution/ alternatives – will the biomass boiler be displacing a boiler running on a different fuel, and if so what fuel? If the development containing the boiler is on a new site, what other fuels might be available (and what would be their comparative effect on air quality)?
- What is the likely emissions performance of the boiler?
- What type of biomass fuel will the boiler be running on?

1.15 In 2008 the Department for Environment, Food and Rural Affairs (Defra) commissioned a biomass impact assessment study to help inform the development of the UK Renewable Energy Strategy, the results of which were communicated in May 2009 via a letter to all local authority Chief Executives in England from the then Defra and DECC Minister Lord Hunt of Kings Heath. The study modelled the potential air quality impacts of a large increase in biomass heat (installed capacities of 38 TWh and 50 TWh; total UK heat demand in 2005 was 844TWh). Results of Defra's analysis, and the Minister's key messages, are shown in Box 1.1.

1.16 Implementation of the Minister's key messages has implications for local planning policy, however some of the technical needs (for example product emission standards) are not yet in place. Many of the issues raised are, however, covered in this guidance including current technologies, standards and certification (Chapter 2) and risk based approaches to assessment (Chapter 4). Chapter 6 looks at some of the anticipated developments that will help implement the targeted approach outlined by the Minister, and updates to this guidance will be posted as new information becomes available.

1.17 Nuisance issues can also arise from the use of biomass, with the most common issues arising from smoke and odour. Emission of smoke in smoke control areas is in general an offence under the Clean Air Act and outside smoke control areas can either be addressed through nuisance or the Clean Air Act provisions prohibiting the emission of dark smoke. Odour is most likely to be associated with a combination of inadequate combustion and poor plume dispersion, or from fuel storage.

Box 1.1: Results from Defra Biomass Impacts Assessment, and Minister's Key Messages

Results of the Impact Assessment – 'where certain conditions are met … impacts can be reduced to a manageable level, and that no additional breaches of the current EU air quality directive's air quality limit values would occur. These conditions are:

- That all new biomass plant are of high quality, corresponding to the best performing units currently on the market;
- That the majority of biomass heat uptake replaces or displaces existing coal and oil fired heating;
- That the majority of uptake is located off the gas grid and therefore away from densely populated urban areas;
- That levels of uptake where the local authority has declared an Air Quality Management Area under section 83 of the Environment Act 1995 are substantially lower than other areas.

As conditions move away from this scenario, the modelled adverse/ negative impacts on air quality and public health increase significantly'.

Current Levels of Biomass in the UK – 'Biomass use in the UK is currently at a very low level; to achieve 7% of the UK heat market, the level of biomass use in the UK would have to increase 20 fold ….. The fact that the market penetration of biomass is very low is an advantage here rather than a drawback: by setting the right conditions now we can ensure almost all of the eventual installed capacity is of a high standard, and in locations unlikely to have air quality issues – meaning that early installations will not result in exceeding air quality limits'.

Key Messages for Local Planning Policies – 'In the development of local planning policy and the consideration of development planning applications, the evidence points toward the following key points:

- To meet the 2020 targets for renewable energy, the UK needs to increase very substantially the amount of renewable heat generated, and biomass heat is one of the key technologies;
- The potential conflicts between these goals and air quality can be avoided through the use of high quality, low emission plant. The replacement of old coal and oil fired plant with high quality wood fired plant located off the gas grid and away from densely populated urban areas may actually benefit air quality. In urban areas or where an Air Quality Management Area has been declared, we would expect biomass heat deployment to be less common and larger (and therefore cleaner) biomass units to be more prevalent.
- Encouraging the use of larger plant, for example in conjunction with the development of heat networks, will result in a system where air quality emissions are easier to control than from a larger number of small plant'.

The Policy Context (Biomass)

1.18 Policies to encourage the use of biomass have primarily been driven by climate change and the need to reduce greenhouse gases. Other relevant drivers include sustainability, energy security and rural employment. UK legislative drivers have developed within the framework of EU and other international policies, strategies and instruments such as the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC).

1.19 Carbon dioxide (CO_2) in the atmosphere is understood to have a warming effect. Since pre-industrial times the level of atmospheric CO_2 has increased from about 280 parts per million to 380 parts per million, largely due to emissions from the combustion of fossil fuels and human induced land use changes. Observations have shown that the world is now warming as a result, and modelling predicts that if we continue to emit carbon dioxide and other greenhouse gases at present rates there will be a significant change in climate over coming decades. The consequences of unabated climate change would be widespread, with increased temperatures, sea level rises and a greater frequency of extreme weather events having serious effects on the natural environment, and human health and wellbeing.

1.20 **The Climate Change Act 2008** – is now the UK's pre-eminent climate change framework legislation. The Act commits the Government to achieving an 80% cut in CO_2 emissions (from 1990 levels) by 2050. Under the Act the Government sets a series of 5-year carbon 'budgets', with three successive budgets always in legislation. The first three budgets were set alongside the (financial) budget in 2009 committing to cuts (from 1990 levels) of 22% by 2012, 28% by 2017 and 34% by 2022. The official Government advisory body for setting targets and budgets under the Act is the Committee on Climate Change.

1.21 **European Renewable Energy Targets** – The EU has adopted a target of 12% renewable energy in the EU by 2010 and has produced a range of implementation measures. These include Directives with targets for renewable use in electricity generation and transport fuels, and a Biomass Action Plan. Further to the 2010 target, the EU has agreed a 20% renewable energy target for 2020. This relates to all energy consumed, and thus for the first time includes heat as well as electricity. Under a burden sharing agreement the UK has agreed to a target of 15% of all energy to come from renewable sources by 2020.

1.22 **Current UK National Policy** – The **UK Energy White Paper**, released in May 2007, has acknowledged the role of biomass and its potential contribution to renewable energy in the UK. This follows the UK Government's **Biomass Strategy**, which acknowledges the role of biomass in helping to meet climate change and renewable energy targets, and brings together the various Government policies that encourage biomass. Whilst a UK document, it acknowledges that separate strategies have been, or are being, developed to address the specific conditions that apply in Scotland, Wales and Northern Ireland. It does not include any binding targets; instead its main aims are to:

- Realise a major expansion in the supply and use of biomass in the UK
- Facilitate the development of a competitive and sustainable market and supply chain
- Promote innovation and low-carbon technology development so biomass can deliver relatively higher energy yields
- Contribute to overall environmental benefits and the health of ecosystems through the achievement of multiple benefits from land use.

1.23 Currently the main mechanism for the Government to encourage renewable energy development is the **Renewable Obligation (RO),** which supports the generation of electricity from renewable resources through a system of Renewable Obligation Certificates (ROCs). As of 2009, larger biomass CHP systems will receive 'double ROCs' (i.e. twice as many certificates for every unit of energy generated), and a new feed-in tariff will provide benefits for smaller biomass CHP systems (up to 5 MW). At the time of writing, the Government was also preparing the details of a new **Renewable Heat Incentive**, which will become the main mechanism for encouraging deployment of renewable heat. Overall, these incentives are likely to make biomass more economically attractive.

1.24 **The UK Renewable Energy Strategy** – The Government launched a draft Renewable Energy Strategy for consultation during 2008; this strategy will aim to implement the 15% by 2020 UK target set by the EU. Although the strategy does not set sector targets, biomass heat is identified as one of the most promising available renewable technologies, and the strategy therefore foresees a major expansion of biomass use over current levels. The final strategy was expected during the first half of 2009. More detailed proposals for biomass are included in the Government's **Heat and Energy Saving Strategy**, which at the time of writing was available in a consultation draft.

1.25 The Forestry Commission's (England) **Woodfuel Strategy for England** aims to bring an additional two million tonnes of wood into the market, annually, by 2020. To achieve this target the strategy focuses on the potential wood resource available in the 60% of English woodlands that are currently under-managed.

1.26 **Planning and Biomass** – Regional (Regional Spatial Strategies) and local (Local Development Frameworks) plans must be developed in accordance with Government planning guidance. For biomass, relevant guidance is provided by:

- Renewable Energy – PPS 22 (England), SPP 6 & PAN 45 (Scotland) and TAN 8 (Wales), draft PPS 18 (Northern Ireland)
- Climate Change – PPS 1 (England)
- Pollution Control – PPS23 (England) and PAN 51 (Scotland)

Planning issues are looked at in more depth in Chapter 3.

1.27 **Local Climate Change and Renewable Energy Targets** – Many local authorities have adopted renewable energy targets for new developments in their area. These became known as the 'Merton Rule' after the London Borough of Merton, which was the first local authority to introduce such targets. The 2008 Energy and Planning Act formalised this approach by enabling local planning authorities to set requirements for energy use and energy efficiency in local plans.

1.28 In 2008 a **new framework for local authority performance indicators** was introduced in England and Wales, reducing the number of indicators to 198. Local authorities are required to monitor all of the indicators; however they are only required to set improvement targets for up to 35 indicators as part of multi agency Local Area Agreements. Relevant indicators for biomass are:

- *NI 185* CO_2 reduction from local authority operations
- *NI 186* Per capita CO_2 emissions in the LA area
- *NI 194* Level of air quality – reduction in NO_x and primary PM_{10} emissions through local authority's estate and operations.

1.29 **The Code for Sustainable Homes** is a system for rating the sustainability of new homes, including energy and water use performance. It replaces the EcoHomes standard in England. The Code measures the sustainability of a new home against categories of sustainable design, rating the 'whole home' as a complete package, using a 1 to 6 star rating system to communicate the overall sustainability performance of a new home. The Code sets minimum standards for energy and water use at each level. Since April 2007 the developer of any new home in England has been able to choose to be assessed against the Code, and a mandatory rating against the Code was implemented for new homes from 1st May 2008. Together with the Code, the Government has announced its plans to tighten the building regulations so that from 2016, all new homes will have to be zero carbon and meet level 6 of the Code. Level 3 will become compulsory in 2010 and level 4 in 2013.

1.30 **Support and Funding** – Funding to support the use and production of biomass is available from many organisations and schemes, including:

- The Bio-Energy Infrastructure Scheme
- Bioenergy Capital Grant Scheme
- Enhanced Capital Allowances
- EU funding for research, demonstration and Intelligent Energy Europe, which may fund information dissemination and study tours
- England Rural Development Programme Energy Crops Scheme
- Low Carbon Buildings Programme
- The Carbon Emission Reduction Target (for energy supply companies)
- The Carbon Trust.

The Policy Context (Air Quality)

1.31 Policies to reduce concentrations of pollutants in the air are a response to the negative effects of these pollutants on human health and ecosystems. Despite improvements in air quality over the past decades poor air quality still represents a major hazard to human health in many areas of the country, causing premature death and chronic illness. Air quality standards are still failing to be met in many parts of the UK, particularly in densely populated urban areas.

1.32 The most widespread air quality problems relate to concentrations of fine particles (PM), nitrogen dioxide and ozone, with particles being the pollutant most strongly associated with biomass combustion. Particles are normally referred to as PM_{10} or $PM_{2.5}$ with the number denoting their maximum size in micrometers. The smaller particles ($PM_{2.5}$) are understood to have the greatest effect on human health. Particles and nitrogen dioxide are strongly associated with combustion processes, with vehicles normally being the most significant source of both. Ozone is a product of polluted air reacting in strong sunlight; as a long-lived pollutant it can often build up to significant concentrations well away from the urban areas where it is formed.

1.33 Developments in air pollution policy during the 1990s resulted in the UK Government introducing the first **National Air Quality Strategy** in 1997, as a requirement of the Environment Act 1995. A series of national air quality standards and objectives were also established. The Act also established **Local Air Quality Management** (LAQM) as a way to address localised 'hot spots' of poor air quality, which could not be resolved effectively through national policy measures.

1.34 Since the development of the first UK Air Quality Strategy legally binding standards for several air pollutants have been set at a European level, including standards for PM_{10}, $PM_{2.5}$ and NO_2. These EU standards have been incorporated into revisions of the UK Air Quality Standards and the Air Quality Strategy, the most recent revision having taken place in 2007 (although note that standards for $PM_{2.5}$ are not as yet incorporated into the LAQM regime).

1.35 The 2007 revision introduced a target value and exposure reduction target for $PM_{2.5}$, the former to be achieved by 2020. The exposure reduction target calls for a 15% cut in urban background exposure between 2010 and 2020. Urban areas are defined as agglomerations with a population of over 250,000.

1.36 In 2008 a new **European Air Quality Directive** came into force. This tidied up existing legislation by merging several Directives into one, introduced standards for $PM_{2.5}$ and provided a means of addressing breaches in air quality standards by member states, by allowing them to apply for 'compliance flexibilities' (deadline extensions). The UK has applied for an extension to meet the PM_{10} standard and is in the process of doing so for NO_2. The applications will need to be accompanied by a robust plan for achieving the standards by the new deadlines.

1.37 The **Local Air Quality Management** (LAQM) Regime requires individual local authorities to periodically assess air quality and identify locations within their locality where the national air quality objectives may be exceeded by their target dates. Where any such exceedences are predicted, and where there is relevant public exposure, local authorities have a duty to declare Air Quality Management Areas following a process of consultation.

Such designations are a statutory requirement, and local authorities in England, Scotland, Wales and Northern Ireland have a duty to work towards achieving the national air quality objectives based upon standards for seven key pollutants. The legislative basis for LAQM in England, Scotland and Wales is the Environment Act 1995 and in Northern Ireland the Environment (Northern Ireland) Order 2002.

1.38 Following the designation of AQMAs, local authorities are required to develop **Air Quality Action Plans** (AQAPs) to identify and implement actions to improve air quality locally. Such plans require effective collaboration between authority departments and external agencies and stakeholders (such as the Environment Agency, Highways Agency and industry). Land-use planning and transport planning underpin the development of effective air quality action plans.

1.39 Local authorities have taken different approaches to establishing AQMAs. Some have declared only the exact areas where exceedences are expected to take place; this often leads to the declaration of multiple AQMAs in, for example, a city centre. Others have chosen to declare the whole area around where exceedences are found to form a single AQMA, or even make a whole district/borough declaration (these are especially common in London). It should therefore be noted that air quality standards might not be exceeded across an entire AQMA.

1.40 Local authorities have been provided with technical and policy guidance by Defra (England) and the Welsh Assembly Government (Wales) to assist them with their duties under LAQM. The technical guidance applies UK wide and was last updated in 2009. The policy guidance is issued by Defra or the relevant devolved administration, and was updated in 2009 in both England and Wales.

1.41 The Environment Act 1995 also forms the legislative basis linking the actions of the Environment Agency (the environmental regulator) and the Air Quality Strategy. The Act requires them to 'have regard to the Air Quality Strategy in discharging pollution control functions'. Broadly this means the regulators base permit conditions for applicable installations upon Best Available Techniques (BAT). This is covered in more depth in Chapter 3.

Chapter 1 Reading Links

- Environmental Protection UK Biomass Guidance Update Page (http://www.environmental-protection.org.uk/biomass)
- Environmental Protection UK Planning Guidance (http://www.environmental-protection.org.uk/assets/library/documents/Development_Control_planning_for_air_quality.pdf)
- Information on the Code for Sustainable Homes (http://www.communities.gov.uk/documents/planningandbuilding/pdf/803784.pdf)
- The UK Air Quality Archive (UK Air Quality portal) (http://www.airquality.co.uk/)
- Air Quality Strategy Objectives (http://www.airquality.co.uk/archive/standards.php#std)
- Defra LAQM Guidance (http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm)
- Welsh Assembly Government LAQM Guidance (http://new.wales.gov.uk/topics/environmentcountryside/epq/airqualitypollution/laqmguidance/?lang=en)
- Scottish Government LAQM Technical and Policy Guidance (http://www.scotland.gov.uk/Topics/Environment/waste-and-pollution/Pollution-1/16215/6148 and http://www.scotland.gov.uk/Topics/Environment/waste-and-pollution/Pollution-1/16215/6151)
- Environment Agency Report 'Biomass – carbon sink or carbon sinner?' (lifecycle emissions of CO_2 from biomass fuels) (http://www.environment-agency.gov.uk/business/sectors/32595.aspx)

Chapter 2 – Boilers, Fuels, Standards and Certification

2.1 The emissions performance of a biomass boiler will depend heavily upon the design of the boiler and the type of fuel used. The relationship between the boiler and the fuel is crucial – boilers are usually set up to burn fuel of a specific type and quality, and deviation from this fuel specification without adjustments to the boiler set up can lead to poor efficiency and increased emissions of air pollutants.

2.2 Current UK and EU wide emission standards for biomass boilers are largely inadequate as tools for setting demanding air quality conditions, as mostly they do not directly cover emissions of NO_x and $PM_{(10 \text{ and } 2.5)}$.

2.3 Emission standards and eco-labels have been developed in other European countries, and may be quoted in the information provided to local authorities. These standards are, however, difficult to apply to the UK due to a wide range of approaches used for testing cycles and emissions measurement.

2.4 This chapter provides a brief overview of boilers, fuels, standards and certification. More detailed information on boilers and fuels can be found in Appendixes A and B, and also in the Carbon Trust document 'Biomass heating: a practical guide for potential users'.

Biomass Boilers

2.5 Biomass appliances usually fall into two categories – batch fuelled or continuously fired. Batch fuelled appliances are usually small, <50kW output, units fuelled by logs or lump wood. They can be stoves, where the main output is by directly heating the room in which they are placed, or hot water boilers. Until the recent introduction of pellet stoves log fuelled batch units were the only type found in the domestic sector where they still make up the majority of sales. In a continuously fired boiler, or stove, fuel is added continuously to the combustion air in the correct proportion to give the desired heat output. Combustion air is regulated to match. Generally continuously fired appliances have lower emissions of pollutants than batch fuelled appliances.

2.6 In continuously fired appliances two main fuels are used – wood chips and pellets. Pellets are a modern form of manufactured biomass fuel that has many advantages. They are free flowing with a low moisture content and a consistent size and geometry. Designing efficient and effective combustion devices is therefore much simplified when compared with other fuels. Pellets can be a more expensive fuel than chips; however often the simplicity and convenience they offer outweighs the additional cost, particularly in smaller installations.

Table 2.1:– Broad factors affecting emissions
(note that these are generalisations only and emissions will vary significantly between different makes and models of boilers)
Appliance category Continuously fired appliances tend to have lower emissions than batch fired appliances, as the combustion conditions are more consistent.
System design Boilers that are on for long periods of time tend to have lower emissions than those that have to start up and shut down regularly. Unlike gas or oil boilers, biomass boilers do not 'like' to be stopped and started regularly, or vary their output significantly. A system designed correctly around the estimated heat load, with a heat store if necessary, should optimise efficiency and low emissions.
Automated maintenance Automated maintenance systems (e.g. de-ashing, heat-exchange cleaning) usually mean the appliance is cleaner and more efficient.
Fuel type Appliances burning wood pellets were thought to generally have lower emissions than those burning larger wood particles (i.e. chips and logs), however recent test data has shown that chip and pellet boilers can have similar emissions performance.

Table 2.2: Common wood fuel formats and their utilisation

Fuel format	Utilisation
Logs	Most commonly used in small-scale systems (<50 kW_{th} – domestic to light commercial scale) requiring daily input to load the system with fuel.
Bales	Generally either manually fed 'batch-firing' systems below 300 kW_{th} (as above, requiring daily input to load the system with fuel) or alternatively very large (multi-MW_{th}), automatically-fed heating/CHP plant.
Pellets	Most commonly used in smaller or urban systems (light commercial <150 kW_{th}) due to their greater energy density, although 1MW+ pellet fuelled systems are in use. Wood pellets are also used for 'co-firing' within existing electricity power stations.
Chipped/shredded wood	Typical fuel for most automated biomass systems (50 kW_{th} – multi-MW_{th} applications).
Woodworking off-cuts/ sawdust	Some biomass plant is specifically designed to burn co-products from the wood industries such as furniture off-cuts and sawdust.

2.7 In terms of emissions performance appliances vary significantly; however some generalisations can be drawn and are shown in Table 2.1.

2.8 More detailed information on biomass appliances and their operation is available in Appendix A and in the Carbon Trust document 'Biomass heating: a practical guide for potential users'.

Biomass (Wood) Fuels

2.9 Wood fuels are available in a variety of different formats and qualities. The most common formats for wood fuels are shown in Table 2.2.

2.10 Wood fuels will also vary in their characteristics. A detailed list of wood fuel characteristics is listed in Appendix B, however they can generally be described under three headings:

- Physical characteristics (including particle size, bulk density and energy density)
- Biological characteristics (including presence of any allergens and carcinogens)
- Chemical and combustion characteristics (including chemical make up and ash content).

2.11 Successful operation of a biomass heating system is strongly dependent on the use of properly specified fuel. To aid the matching of heating systems with fuel supplies, fuel standards have been introduced in several European countries. One of the best known sets of standards are the Önorm standards from Austria, which specify size, moisture content and various other important properties of solid biomass fuels. These standards are being used by some UK fuel suppliers in the absence of equivalent UK standards.

2.12 The CEN (European Committee for Standardisation) is developing a common methodology for specifying the key characteristics of all forms of solid biomass sold within the EU, and also methods for testing these properties. The CEN specifications will eventually be transposed into member states' standards systems (e.g. those of the British Standards Institute). At the time of writing, the specifications are available only in draft form, yet they are sufficiently well developed to be suitable for reference in fuel supply contracts, and the final versions are likely to be very similar. They can currently be downloaded from the Biomass Energy Centre – a 'one stop shop' for information on biomass fuels and associated conversion technologies (www.biomassenergycentre.org.uk).

2.13 Regardless of which set of standards are referred to, it is important that the site owner works closely with both the fuel supplier and system installer to ensure that the fuel purchased is suitable for the system, that the fuel supplier undertakes to deliver a consistent quality of fuel and that the fuel can be stored and handled at the site in the correct manner.

Emission Standards and Certification

EN Standards

2.14 Table 2.3 lists European EN standards for residential solid fuel appliances and for independent boilers with nominal heat output of up to 300 kW. The Standards include minimum requirements for efficiency, construction and safety of appliances. No EN Standards include NO_x

Table 2.3: Residential solid fuel appliance EN Standards

Standard	Harmonised	Title
EN 303 Pt 5	No	Heating boilers - Part 5: Heating boilers for solid fuels, hand and automatically stocked, nominal heat output of up to 300 kW - Terminology, requirements, testing and marking.
EN 12809	Yes	Residential independent boilers fired by solid fuel - Nominal heat output up to 50 kW - Requirements and test methods.
EN 12815	Yes	Residential cookers fired by solid fuel - Requirements and test methods.
EN 13229	Yes	Inset appliances including open fires fired by solid fuels - Requirements and test methods.
EN 13240	Yes	Room heaters fired by solid fuel - Requirements and test methods.
EN 14785	Awaiting formal publication	Residential space heating appliances fired by wood pellets - Requirements and test methods.
EN 15250	Awaiting formal publication	Slow heat release appliances fired by solid fuel - Requirements and test methods.
prEN 15281 (under development)	-	Sauna stoves fired by solid fuel - Requirements and test methods.
prEN 15544 (under development)	-	One off tiled/mortared stoves - Dimensioning.

Table 2.4: Summary of EN303 Pt 5 PM emission classes

Stoking	Nominal heat output	Emission limit, $mg.m^{-3}$ dry at STP (0°C, 101.3 kPa) and 10% O_2		
	kW	Class 1	Class 2	Class 3
Manual	≤50	200	180	150
	>50 to 150	200	180	150
	>150 to 300	200	180	150
Automatic	≤50	200	180	150
	>50 to 150	200	180	150
	>150 to 300	200	180	150

emission performance criteria and only EN 303 Pt 5, the independent boiler Standard, includes PM emissions criteria. EN Standards for residential appliances are harmonised[1] and mandatory across the EU; EN303 pt 5, however, is not a harmonised Standard.

2.15 Many of the heating appliances covered by the EN Standards for residential appliances can also include boilers in addition to the primary heating (or cooling) function. EN 12809 includes boilers that also provide a space-heating function. Boilers that do not provide a space heating function are covered by EN 303 pt 5, which applies to solid fuel boilers up to 300 kW output. This Standard defines an efficiency testing procedure and also assigns performance classes based on efficiency and emissions of PM, CO and 'OGC' (organic gaseous carbon) – classes for PM emission are summarised in Table 2.4 (see page 11).

2.16 Although EN303 Pt 5 includes PM limit values, it is not a harmonised Standard and the Standard indicates that national requirements in several member states (including the UK) differ from the Standard in terms of PM measurement protocols and permitted emissions.

2.17 In addition to the performance Standards there is a draft EN Technical Specification for measurement of gaseous emission components. A draft EN Technical Specification for particulate measurements has not been agreed.

UK Emission Standards

2.18 Solid fuel furnaces up to 20 MWth (thermal input) are generally regulated under the Clean Air Act (CAA). For combustion appliances above 20 MWth, the Environmental Permitting Regulations (EPR) will apply. Appliances smaller than 20 MWth can fall under EPR if they are (a) directly associated with another regulated activity or, (b) part of a larger (>50 MWth) combustion installation or, (c) a waste-burning process. Regulatory regimes are covered in more detail in Chapter 3.

2.19 The CAA was introduced to control air pollution arising from widespread use of coal and includes provision for creation of Smoke Control Areas, planning review of furnaces, general controls on smoke emissions and emission limits (for grit and dust) for larger solid fuel combustion installations.

2.20 Within a smoke control area appliances either must burn authorised 'smokeless' fuels or, the appliance needs to have been assessed and exempted by Defra for use in a smoke control area[2]. Emission limits for exempted appliances are detailed in BS PD 6434 covering residential combustion (< about 44kW output). Emission limits for 'grit and dust' are applied to larger appliances (> about 240 kW output) irrespective of whether they are located in a smoke control area. Assessment of emissions from appliances of more than about 44kW for CAA exemption is generally by interpolation between the BS PD 6434 limits and the grit and dust emission limits.

2.21 If an activity falls under EPR then controls on other pollutants (in addition to PM) can apply.

Other National Regulations

2.22 A number of countries apply emission controls to biomass/wood combustion appliances. For residential appliances, these are generally applied under 'type approval' arrangements under which the manufacturer undertakes tests on an example appliance to assess compliance with emission limits (and EN product Standards). Table 2.5 provides a summary of countries applying emission limit values for biomass combustion.

Table 2.5: Countries applying emission limits for biomass combustion

Country	Emission limit value (ELV)		Comment
	NO_x	PM	
Austria	X	X	ELVs applied to residential appliances and several size ranges of larger boilers including 50-100 kW, 100-350 kW. Different NO_x ELVs applied for different wood types.
Belgium		X	Proposed PM ELVs for residential appliances.
Denmark		X	PM ELVs for roomheaters and <300kW boilers.
Finland		X	Proposed PM ELVs for residential and <300 kW boilers but will distinguish between primary and secondary heat providers.
Germany		X	PM ELVs for residential and larger biomass boilers. Proposed to extend ELVs to cover roomheaters and other domestic appliances.
Sweden			VOC ELVs.
Switzerland		X	PM ELVs for roomheaters and boilers.
USA/Canada		X	Wood stove performance standards.
Australia		X	Selected areas only.
New Zealand		X	Wood burners on properties less than two hectares.

[1] A harmonised Standard is a European standard prepared by CEN/CENELEC under a mandate from the Commission, with a view to fulfilling a requirement of a specific Directive (in the case of residential heating appliances this is Directive 89/106/EEC the Construction Products Directive).

[2] For more information see http://www.uksmokecontrolareas.co.uk/

2.23 Several of these countries have emission measurement Standards or protocols; however a range of approaches are adopted which means that it can be difficult to compare results between countries. The differences in measurement procedure concern test cycles (for example whether to include start-up emissions) and emission measurement procedures. The differences in measurement procedure also include whether the procedure only looks at filterable material or filterable and condensable material and also whether measurements are undertaken directly on the chimney flue or through a dilution chamber.

Ecolabelling and Other Emission Controls

2.24 There are a number of ecolabel and biomass grant schemes in Europe that specify performance criteria that are typically higher than the minimum efficiency requirements of the EN product Standards and national regulations. A number of these ecolabel schemes recognise the importance of PM emission and include criteria for assessment. Table 2.6 provides a summary of ecolabelling criteria for biomass combustion with selected weblinks to further information. A number of products are available in the UK market with one or more ecolabels but note that compliance with an ecolabel scheme does not indicate that a product is an exempt appliance under the Clean Air Act.

Table 2.6 Ecolabelling criteria for biomass combustion

Ecolabel	Country	ELV		Comment
		NO_x	PM	
Blue Angel	Germany	X	X	Includes efficiency and limit values for wood pellet stoves and wood pellet boilers http://www.blauer-engel.de/en/index.php
Nordic Swan	Sweden, Norway, Denmark & Finland	(X)	X	Includes efficiency, PM and VOC limit values for various residential roomheater types and NO_x, PM and VOC limits for boilers <300 kW http://www.svanen.nu/Default.aspx?tabName=StartPage
EFA	European association of fireplace manufacturers		X	Higher efficiencies than product Standards and also PM ELVs for various residential roomheaters www.efa-europe.com
Umweltzeichen 37	Austria	X	X	Higher efficiency and more stringent emission criteria than legislative limits for boilers and roomheaters
Flamme Verte	France		X	Differs from other ecolabelling schemes in that criteria show an annual improvement. Efficiency criteria set for roomheaters, additional PM and VOC ELVs for boilers http://www.flammeverte.org/
DINplus	Germany	X	X	VOC limit also set and also covers certification of pellet fuels http://www.dincertco.de/en/about_us/our_marks_of_conformity/quality_mark.html
Housing grants	Denmark		X	Efficiency and PM ELVs for biomass boilers
P marking	Sweden		X	Efficiency and PM ELVs for pellet boilers, pellet stoves and wood-fired roomheaters

Chapter 2 Reading Links

- Biomass heating: a practical guide for potential users (the Carbon Trust) – this document includes a detailed introduction to the technicalities of fuel and plant operation (registration required to download) (http://www.carbontrust.org.uk/publicationdetail?productid=CTG012

Chapter 3 – Approvals and Consents

3.1 New biomass boilers will require regulatory approval, and in many cases planning consent too. The latter may be required for a development as a whole in cases where the boiler is part of a new building development, or for new buildings, stacks, etc where a biomass boiler is installed in an existing development.

3.2 This chapter provides only a brief description of biomass in the planning system and should be read alongside the Environmental Protection UK document 'Development Control: Planning for Air Quality'. Another useful source of guidance is the Beacon Councils' guidance 'Low Emission Strategies', which is likely to become incorporated into the Local Air Quality Management technical guidance at some stage in the future (see Chapter 3 reading links for both documents).

Biomass in the Planning System

3.3 In addition to meeting regulatory requirements, all but the smallest biomass installations will also require planning consent. The basic planning process for renewable energy is described on the BERR web site (see links).

3.4 Biomass energy proposals >50 MWe fall within Schedule 2 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (the EIA Regulations) and are subject to an Environmental Impact Assessment (EIA) if they are considered likely to have significant effects on the environment. Any 'thermal' biomass power stations with a heat output of at least 300 MW would fall under Schedule 1 of the EIA Regulations, which means an EIA would be mandatory (this also includes all heat plant that co-fire biomass and have an output over 300MW).

3.5 In November 2008 a new Planning Act was passed. This set the foundations for the establishment of an Infrastructure Planning Commission (IPC), which will decide on planning application for infrastructure of 'national significance'. The IPC's decisions will be based on National Policy Statements, which will be developed by the Government during 2009-11. In terms of energy projects, generation stations of more than 50MW will in the future receive planning approval from the IPC rather than the local authority and/ or the Secretary of State. Planning applications will be handled under the 'new' regime once the relevant National Policy Statements are in place. Until this time planning applications will continue to be handled under the 'old' system, and once started applications will not be transferred into the new system.

General Permitted Development

3.6 Certain types of changes to properties can be made without the need to apply for planning permission. These are called "permitted development rights" and derive from a general planning permission granted not by the local authority but by Parliament. In some areas of the country, known generally as 'designated areas', permitted development rights are more restricted. These areas may include conservation areas, National Parks, Areas of Outstanding Natural Beauty and the Norfolk and Suffolk Broads,

3.7 Local planning authorities can also remove permitted development rights by issuing an 'Article 4' direction. Article 4 directions are made when the character of an area of acknowledged importance would be threatened. They are most common in conservation areas. Planning departments can provide details of the status of permitted development in a local authority area.

3.8 When a biomass boiler or combined heat and power unit is installed in an existing property planning permission is not normally needed if all of the work is internal. If the installation requires a flue outside, however, it will normally be permitted development as long as it:

- does not exceed 1m above the roof height
- is not installed on the principal elevation and visible from a road.

3.9 If the project also requires an outside building to store fuel or related equipment the same rules apply to that building as for other extensions and garden outbuildings.

3.10 Further information about permitted development is available on the Planning Portal website (see Chapter 3 reading links).

Section 106 Agreements

3.11 Section 106 agreements are commonly known as 'planning gain'. They attach conditions to the grant of

Box 3.1: Examples of planning conditions

Assessment and certification conditions

An air quality assessment using dispersion modelling shall be carried out and submitted to the local authority to demonstrate that the stack height of the biomass boilers is sufficient to prevent emissions having a significant negative impact on the air quality objectives for nitrogen dioxide (NO_2) and particulate matter (PM_{10}). Where emissions are shown to result in an increase a full discussion of any potential breaches of air quality criteria shall be provided and an outline of how emissions will be mitigated.

With regards to energy use on site the biomass boiler must be certified as an exempt appliance in accordance with the Clean Air Act 1993. Evidence to demonstrate that the boiler has been tested and certified as an exempt appliance shall be provided to the local authority prior to installation. This shall be supplemented with the technical details of the biomass boiler.

Fuel quality conditions

The biomass boiler shall only be operated using clean wood pellets that comply with a recognised fuel quality standard (such as CEN/TS 14961:2005.) A written guarantee shall be submitted to the local authority prior to commencement of the development with a declaration that wood pellets conforming to a recognised fuel quality standard will be consistently used in the biomass boiler. A statement shall be submitted to the local authority specifying the quantity of wood pellets used in the biomass boiler, and the fuel specifications in accordance with CEN/TS 14961:2005 or a similar recognised standard. (The statement shall be obtained from the fuel supplier.)

Maintenance conditions

The biomass boiler shall be associated with a written schedule of maintenance, which shall include removal of ash, inspection and maintenance of particulate arrestment equipment, boiler servicing and stack cleaning. The maintenance schedule shall be submitted prior to installation.

planning consent, for example for the developer to fund new community facilities or road improvements. The legislative basis for planning obligations is Section 106 of the Town and Country Planning Act 1990.

3.12 Section 106 agreements can also be used to mitigate air quality impacts. PPS23 outlines the statutory basis for applying a combination of planning conditions and legal obligations to address the environmental impacts of proposed developments. In particular, it notes that 'Section 106 Agreements can be used to improve air quality, make other environmental improvements …. or offset the subsequent environmental impact of a proposed development.' The use of Section 106 agreements to mitigate transport impacts of development is extensively covered in the Beacon Councils' Guidance 'Low Emission Strategies'.

Regulation of Biomass Plant

3.13 In common with other combustion appliances, biomass boilers and combined heat and power systems are subject to a range of regulatory regimes. The regime that a system will fall into depends upon its size (based upon its rated thermal input), and the type of fuel it burns.

3.14 Biomass fuels generally fall into three categories, depending on whether the fuel is classified as waste, and whether it falls under the Waste Incineration Directive (WID):

- 'Virgin' fuels – e.g. fuels derived from fresh timber
- Waste or waste derived fuels, exempt from WID – e.g. agriculture residues
- Waste or waste derived fuels, covered by WID – e.g. treated wood waste.

3.15 The regulatory regime applicable to different biomass plant and fuels is shown in Table 3.1. Note that the regulatory thresholds apply to the cumulative total of the combustion plant on a site regulated under a single permit:

Regulatory Regimes

Environmental Permitting Regulations - Pollution Prevention and Control (PPC) and Local Authority Pollution Prevention and Control (LA-PPC)

3.16 Procedures, permit limits and conditions for the regulation of industrial pollution are broadly the same across the UK, however the systems and regulatory bodies differ between England and Wales, Scotland, and Northern Ireland. Whilst we have noted the main features of the regulatory environment across the UK below, this guidance is not intended for use in Scotland and Northern Ireland. At the time of writing a Scottish adaptation of this guidance was under development.

3.17 In England and Wales the Environmental Permitting Regulations came into force on 6 April 2008 (replacing 2000 PPC Regulations). Most installations (known as Part A1) are regulated by the Environment Agency, with a lesser number of smaller, or less complex, installations (known as Part A2) regulated by local authorities. Some smaller installations (Part B) are regulated by local authorities for emissions to air only.

3.18 Elsewhere in the UK the comparable regulatory system is referred to as Pollution Prevention and Control (PPC). In Scotland all installations are regulated by the Scottish Environmental Protection Agency (SEPA), with no local authority involvement. In Northern Ireland all Part A installations are regulated for IPPC by the Northern Ireland Environment Agency (NIEA), who also regulate Part B installations for emissions to air; district councils in Northern Ireland regulate some smaller less complex installations (Part C) also for emissions to air only under the PPC regime.

Best Available Techniques

3.19 Permit conditions are based on the use of Best Available Techniques (BAT), which balances the cost to the operators against benefits to the environment. The IPPC Directive requires competent authorities to ensure that "installations are operated in such a way that all the

Table 3.1: Regulation of biomass plant

Fuel Scenario	Plant size	Pollution regulation applicable	Regulator
1. Biomass fuels e.g. coppice willow, and fuel residues of a similar nature arising from the manufacture of these fuels	<20 MW_{th} 20 - 50 MW_{th} > 50 MW_{th}	Clean Air Act LA-PPC (Part B PPC) EPR (Part A1); PPC Part A Sc & NI LCPD also applies	Local authority Local authority; SEPA/NIEA Environment Agency/SEPA/NIEA
2. Waste or waste derived biomass exempted from WID, and fuel residues of a similar nature arising from their manufacture	<0.4 MW_{th} and <50 kg/hr 0.4 - 3 MW_{th} or 50 - 1000 kg/hr >3 MW_{th} and/ or 1000 kg/hr > 50 MW_{th}	Clean Air Act LA-PPC (Part B PPC) EPR (Part A1); PPC, Part A Sc & NI EPR (Part A1); PPC Part A Sc & NI. LCPD applies	Local authority; SEPA Local authority; SEPA/ NIEA Environment Agency/SEPA/NIEA Environment Agency/SEPA/NIEA
Waste or waste derived biomass to which WID applies	< 3 MW_{th} >3 MW_{th}	WID applies LA-PPC (Part A2) WID Applies. PPC (Part A)	Local Authority; SEPA; NIEA Environment Agency/SEPA/NIEA

Notes:
a) The above is true for stand-alone combustion plant and incinerators. However, if the combustion is associated with an activity that is subject to LA control, then the waste burning plant will remain under LA control provided it is below 50 MW.

b) All plant rating is thermal capacity.

appropriate preventive measures are taken against pollution, in particular through the application of best available techniques". In seeking through the application of BAT to balance costs to the operator against benefits to the environment, the Directive defines BAT as:

- "The most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole;
- "Available techniques" means those techniques which have been developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;
- "Best" means, in relation to techniques, the most effective in achieving a high general level of protection of the environment as a whole;
- "Techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned."

3.20 Where a breach of legally binding EU air quality limit values is caused by a particular industrial installation or sector the regulator must set emission limits or other conditions in the permit(s) to ensure the EU limit values are met, even if the permit conditions are beyond BAT.

Waste Incineration Directive (WID)

3.21 WID came into force in December 2000 and regulates plants incinerating both hazardous and non-hazardous waste. Incineration plants are defined as any mobile or stationary technical unit and equipment dedicated to the thermal treatment of waste with or without the recovery of the combustion heat generated. Clean, uncontaminated waste wood can be exempt from WID – the Environment Agency (in England and Wales) can provide more guidance on this matter.

3.22 The Directive requires strict emission limits, based on Best Available Techniques, as well as compliance with the IPPC Directive. Absolute limit values have also been set for emissions to air of several pollutants, including hydrogen chloride, hydrogen fluoride, heavy metals, sulphur oxides, nitrogen oxides, dioxins and furans (see Chapter 3 reading links).

The Large Combustion Plant Directive (LCPD)

3.23 The LCPD applies to combustion plant with a rated thermal input equal to, or greater than 50 MWth, irrespective of the fuel used – solid, liquid or gaseous. The Directive defines three categories of plant – with a group of boilers discharging through a single stack being counted as a single combustion plant:

- "New-new" plant which are subject to request for a licence on or after 27 November 2002; these must comply with the Directive and meet emission limit values (ELVs) from when they are brought into operation.
- "New" plant – licensed on or after 1 July 1987, but before 27 November 2002, or subject to a full licence request before 27 November 2002 and which came into operation before 27 November 2003; these must comply with the Directive and meet ELVs from 27 November 2002.
- "Existing" plant, licensed before 1 July 1987; for this category Member States may choose to meet required emissions reductions by 1 January 2008, either through ELVs or a National Emissions Reduction Plan (NERP).

3.24 The UK's NERP set a 2008 emissions 'bubble' for total emissions of SO_2 of 133,445 tonnes per year, 107,720 tonnes of NO_x per year and 9,659 tonnes per year of dust, and allows emissions trading between participating plants.

3.25 Individual operators of existing plant may alternatively choose not to be included in the ELV or national plan approach and instead undertake to close down after 20,000 operational hours beginning 1 January 2008 and ending 31 December 2015. Operators had to inform the competent authority (i.e. the Regulators) of their decision before 30 June 2004. Implementation of the LCPD is through IPPC permit conditions.

The Clean Air Act

3.26 The Clean Air Act 1993 (in NI: the Clean Air (Northern Ireland) Order 1981) is the primary regulatory legislation for smaller biomass burning plant that fall outside the Environmental Permitting/ PPC system. Local authorities are the regulating body for the conditions of the Act. The most commonly known parts of the Act are those that allow local authorities to set up Smoke Control Areas (section 18; NI: Article 17), where domestic premises are committing an offence if they emit smoke unless using an approved smokeless fuel, or an exempt (approved) appliance. The Act also contains other powers regarding the control of emissions from larger domestic and industrial boilers. Application of the Act to biomass plant is summed up in Chart 4.2 (see page 21), and described in more detail below.

3.27 When assessing which regulations apply to a particular biomass boiler, it is important to note the effect of the varied moisture content of biomass fuels. Increased moisture content leads to lower calorific values and lower thermal inputs for a given weight of fuel burnt. For example, a furnace burning fuel at 45.4 kg/h and fuel with a calorific value of 10 MJ/kg would represent 126 kW (input), and at 20 MJ/kg this would imply 252 kW (input). A unit conversion tool has been developed for this guidance – this is in the form of a spreadsheet which is available to download from the Environmental Protection UK website (see Chapter 3 reading links).

3.28 It is important to note the limitations of the Act, which was designed to control the coal smoke smogs of the 20th century. The Clean Air Act does not directly control emissions of the smaller particles (PM_{10} and $PM_{2.5}$) that are the subject of modern air quality legislation. The cumulative impacts of a large number of exempt appliances (for example) could therefore be significant. Assessing cumulative impacts is discussed in Chapter 4.

Smoke from domestic chimneys

3.29 The Clean Air Act allows local authorities to create smoke control areas (section 18; NI. Art.17) in which smoke emission is prohibited (section 20; NI. Art.17) unless arising from the burning of authorised fuel or from the use of an exempt appliance. Procedures for testing and approving authorised fuels and appliances have been established via powers given to the Secretary of State under sections 20 and 21 of the Act (NI: Department of Environment, Art 17). Details of currently authorised fuels and exempt appliances can be found on the UK smoke control areas website.

3.30 The acquisition or delivery of a non-approved solid fuel in a smoke control area, other than to be used in an exempt appliance, is an offence (section 23; NI SR 1998/328).

3.31 Smoke control areas are relatively common across the UK, primarily in urban areas that have had a concentration of industry and/ or coal fired dwellings. Unfortunately, due to the passage of time and the age and number of the individual orders passed to establish smoke control areas there are no easily accessible records of the location of smoke control areas in some authorities (although the local authority can re-designate if necessary).

3.32 Knowledge of the conditions of smoke control areas under the Clean Air Act can be low amongst the general public and also, in some cases, amongst installers of smaller wood burning appliances. Some people may be simply unaware that they are committing an offence by burning wood in non-exempt appliances (e.g. open grate fires). Awareness raising can therefore be an effective tool, with information for the general public available on the UK Smoke Control Areas and Environmental Protection UK websites (see Chapter 3 reading links).

Emissions from commercial premises

3.33 Clean Air Act provisions for commercial and industrial premises apply everywhere, i.e. not just in designated smoke control areas.

3.34 Under section 1 of the Act (Art.3 of NI Order) it is an offence to emit dark smoke from industrial/ commercial chimneys unless within the limited periods allowed by the dark smoke permitted periods regulations. Sources of dark smoke can include chimneys, bonfires, skip fires and waste disposal/ demolition fires. ‘Dark smoke’ is defined using a Ringlemann smoke chart; British Standard approved versions of these are available to purchase online.

3.35 Under section 4 of the Act (Art. 5 of NI Order) all new furnaces installed should be capable of operating without emitting smoke, and should be notified to the local authority. Domestic boilers are excluded from these conditions – these are furnaces of less than 16.12kW output (defined as domestic furnaces).

3.36 Larger furnaces fall under the so called ‘grit and dust’ provisions of the Act. Here the use of a furnace burning solid fuel at 45.4 kg/h or more or liquid and gas fuels at 366.4 kW or more (other than a domestic furnace) is prohibited unless it has grit and dust arrestment plant fitted which has been agreed by the local authority, or unless the local authority has been satisfied that the emissions will not be prejudicial to health or a nuisance (section 6; NI Art. 10). Emission limits on grit and dust from furnaces (other than domestic furnaces) are prescribed by the Secretary of State under section 6.

Approval of chimney (stacks and flues) heights

3.37 Local authorities are required to approve the chimney heights of furnaces which burn pulverised fuel and solid fuel at 45.4 kg/h or more, or liquid and gas fuels at 366.4 kW of more (sections 14 & 15; NI Arts. 14 & 15). It is an offence to use the furnace if the chimney heights are not approved, unless the local authority did not respond within 4 weeks (or a longer time if mutually agreed) following the provision of relevant information by the applicant.

Powers to request monitoring and information

3.38 A local authority may request that monitoring of emissions from furnaces be carried out. Where the furnace is burning pulverised fuel or solid fuel at 45.4 kg/h or more or, liquid and gas fuels at 366.4 kW or more, the local authority may direct that measurements of the dust emissions are made by the occupiers of the building (section 10; NI. Art. 11). However, if the furnace is burning solid matter at less than 1.02te/h or liquid or gas at 8.21 MW or less then the local authority can be required to carry out the monitoring at its own expense. Section 36 of the Act adds to this by requiring occupiers of buildings other than private dwellings or caravans to return estimates (not necessarily monitored) of the emission of pollutants from the premises when requested by the local authority.

3.39 Section 12 of the Act (Art.11 of NI Order) gives local authorities the power to request information on the furnaces in a building, and the fuels or wastes burnt in them, in order to properly perform their functions under sections 5-11 of the Act. Notice must be served in writing and the occupier must reply within fourteen days (or such longer time as may be limited by the notice). Note that whilst this applies to both domestic and commercial premises, it is unlikely that any domestic premises will fall under sections 5-11. This power could be used where local authorities suspect breaches of regulations are taking place, for example where there is a suspicion that waste derived fuels are being burnt in an appliance designed for clean, new wood.

3.40 Under section 4 of the Act, before installing a furnace (except a domestic furnace) in a building or fixed boiler, the local authority must be informed; any such furnace must be capable of being operated continuously without emitting smoke when burning fuel of a type for which the furnace was designed. There is no definition of “furnace”, but a practical interpretation of this word whenever it appears in clean air legislation is usually taken as “any enclosed or partly enclosed space in which liquid, solid or gaseous matter is burned, or in which heat is produced”. Domestic furnaces are defined as those with a maximum heating capacity of less than 16.12 kilowatts.

Chapter 3 Reading Links

Planning

- Beacon Councils Low Emission Strategy Guidance (http://www.cenex.co.uk/uploaded-documents/LES_Consultation_draft.pdf)
- Climate Change Northwest Biomass Guides for Planners (http://www.climatechangenorthwest.co.uk/news/archive/new-guidance-available-for-householders-developers-and-planners-on-using-biomass-wood-fuel-heating.html)
- Planning Portal - the UK Government's online planning and building regulations resource for England and Wales (http://www.planningportal.gov.uk)
- Planning and Renewable Energy on the BERR website (includes policy developments) (http://www.berr.gov.uk/whatwedo/energy/sources/renewables/planning/page18405.html)

Regulation

- BERR website (http://www.berr.gov.uk/whatwedo/energy/sources/renewables/planning/page18405.html)
- UK Smoke Control Areas website (http://www.uksmokecontrolareas.co.uk)
- Domestic smoke on the Environmental Protection UK website (http://www.environmental-protection.org.uk/neighbourhood-nuisance/domestic-smoke/
- Unit conversion tool can be downloaded from www.environmental-protection.org.uk/biomass

Chapter 4 – Assessing and Mitigating Potential Impacts

4.1 Once a local authority receives notification that a biomass boiler is planned for a particular location a number of steps need to be followed to assess whether the potential air quality impacts are significant. The first, and probably most important step, is to collect basic information about the proposed boiler to enable a quick risk based assessment to be made. This may be followed by the collection of more detailed information, a screening assessment, and proceeding to a more detailed assessment if screening suggests that there may be a significant impact. Factors to consider within an initial quick risk based assessment are shown in Table 4.1.

4.2 Note that even if this quick assessment suggests that there is very little risk to air quality the proposed boiler should still be checked to ensure it is compliant with the Clean Air Act and/ or whether it needs a permit to operate (see Charts 4.1 and 4.2 on pages 20 and 21). Suitable conditions can then be added to planning permission if necessary to ensure regulatory conditions are met (e.g. that the boiler is certified as an exempt appliance in accordance with the Clean Air Act 1993, or that a permit is gained from the appropriate regulator).

4.3 If the quick assessment suggests that the biomass boiler may pose a risk to air quality then more detailed information about the biomass boiler will be required. Collecting this at the earliest stage possible is key to making a good assessment, but is a step that many local authorities have found to be difficult. There are several reasons for this:

- Decisions on which renewable energy technologies to use are often left until after outline planning permission has been granted;
- The costs of the technical consultants and air quality assessments that may be needed to specify a biomass boiler can be high, and developers may want to secure planning permission before incurring such costs;
- Planners and developers are often unaware that biomass boilers have air quality impacts, and also that different boilers can vary significantly in their emission rates.

Flagging up air quality issues with planning colleagues and developers at the earliest stage possible is therefore extremely important. The developers' information leaflet produced alongside this guidance can be used for this purpose.

4.4 A biomass boiler information request form has also been produced alongside this guidance, which local authorities can tailor and use to request information from developers. Again, it is good practice to vary the depth of the information requested according to the risk to air quality suggested by the initial quick assessment. Where the developer is unable to supply information on their proposed appliance(s) generic figures may be available to use in screening assessments; however if this assessment suggests that air quality impacts may be significant developers should be allowed the opportunity to supply more detailed information on their proposed appliance to enable a more accurate assessment to be made.

4.5 Once basic information has been collected a screening tool can be used to make an initial assessment. If this shows that the impact may be significant the developer can then be asked to use more detailed dispersion modelling to make a more detailed assessment of emissions and stack heights. If the impact is still judged to be significant the developer can be asked to use abatement technology, choose a cleaner boiler or, if none of these are suitable, use a different renewable energy technology. A simple flow diagram of the process is shown in Chart 4.1. The process for checking Clean Air Act compliance is shown in Chart 4.2 (see pages 20 and 21).

4.6 There is no specific Government guidance on determining the significance of air quality impacts within an air quality assessment, and the definition of what is a significant impact therefore ultimately lies with the judgement of the individual local authority. The Environmental Protection UK document 'Development Control: Planning for Air Quality' contains guidance on assessing significance which can assist in this area.

4.7 To support local authorities' duties under LAQM three help desks have been established –

Table 4.1 – Factors to consider in a quick risk based assessment
Geography The potential risk of a breach of air quality standards is increased if the boiler is in or near (and could potentially affect) an Air Quality Management Area. If air quality in the area around the boiler is marginal there is a risk that emissions from the boiler could trigger a new AQMA.
Fuel substitution/ alternatives If the biomass boiler is displacing a similar appliance running on a 'clean' fuel such as gas then it could negatively affect air quality. Conversely if the boiler displaces 'dirtier' fuels such as coal or oil there may be little, or even a positive, effect on air quality. If the boiler is being installed on a site with no current combustion appliances some consideration of alterative fuels available should be made – i.e. are 'clean' fuels such as mains gas available, or are the realistic alternatives coal and oil?
Emissions performance Although a detailed assessment of the emissions performance of the boiler is unlikely to be available at this stage some simple questions can be asked, e.g. is it an exempt appliance, how does is compare against the general criteria in Table 2.1 (page 10).
Fuel Emissions performance for smaller appliances depends heavily on the fuel used. Clean, virgin wood fuels are likely to provide the best emission performance. Appliances burning wood pellets were thought generally to have lower emissions than those burning larger wood particles (i.e. chips and logs); however recent test data has shown that chip and pellet boilers can have similar emissions performance.

- Monitoring, Modelling and Emissions Inventories (0870 190 6050);
- Review and Assessment (0117 328 3668);
- Action Planning (0870 190 6050).

4.8 Smaller biomass boilers installed in existing dwellings may be fitted without notification to, or involvement of, the local authority. It is important to note that the provisions of the Clean Air Act in its existing form may not be enough to ensure that localised increases of PM_{10} and $PM_{2.5}$ concentrations do not occur if a number of small biomass boilers are installed in a particular geographical area.

Energy Statements and Basic Information about a Biomass Boiler

4.9 If a local authority has introduced a local renewable energy target, developers submitting affected planning applications should include an Energy Statement to detail how the renewable energy target will be achieved. There is no Government guidance on what a local authority should ask developers to include in these statements; however a common series of steps within a statement would be:

- A description of measures taken to reduce carbon emissions through energy efficiency (therefore reducing the total amount of renewable energy needed to meet the target);
- A calculation of the predicted energy demand and carbon emissions for the development, and the amount of renewable energy provision needed to meet the target;
- A consideration of the technologies that could be used to generate the renewable energy requirement, and their advantages and disadvantages for the particular development in question;
- A decision on the type of renewable energy system(s) to be installed and a calculation of their size to comply with the energy demand.

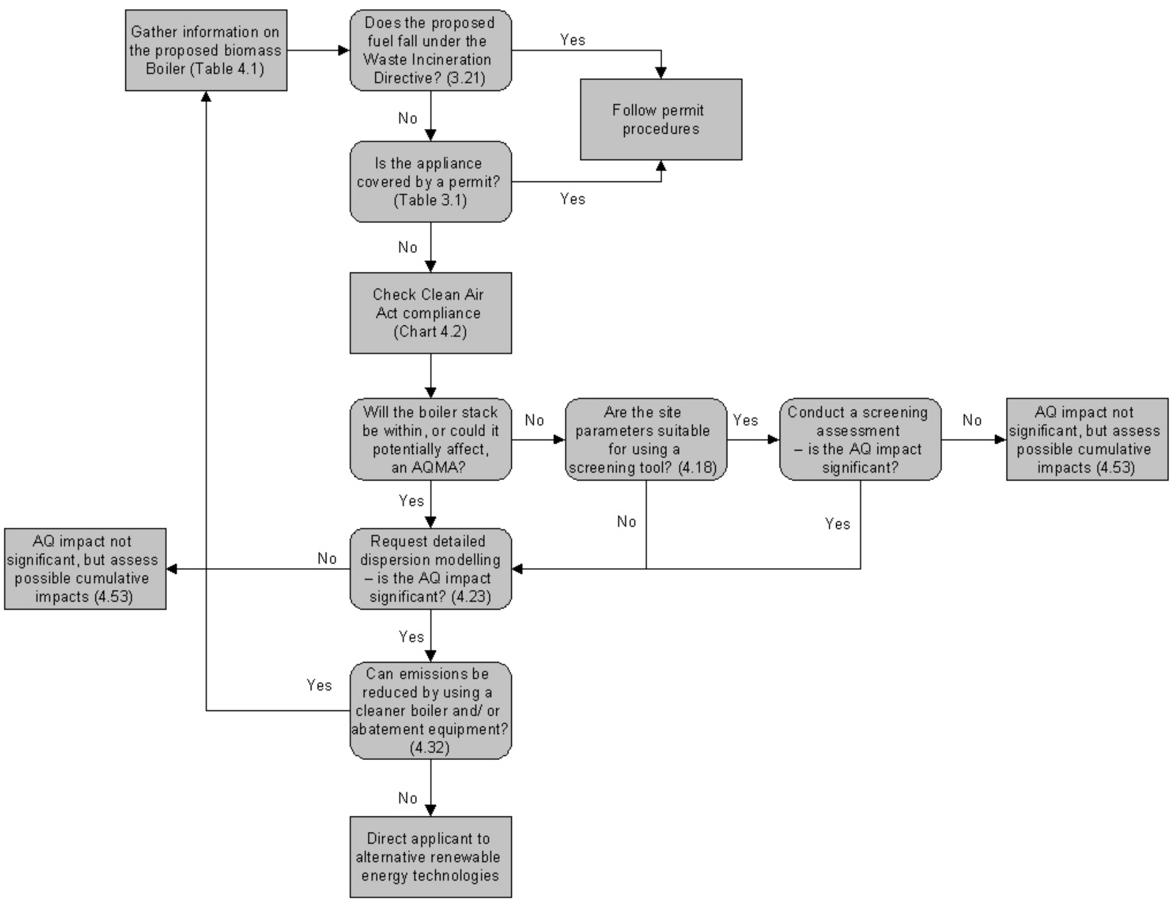
4.10 If a biomass boiler is proposed in the Energy Statement basic information should be requested about the proposed system to enable an initial assessment to be made. As a minimum, this should include:

- The thermal capacity of the proposed boiler, and if possible its make and model;
- The type of fuel to be used;
- If the boiler is covered by the Clean Air Act, confirmation that it will be an approved appliance;
- The precise location of the proposed stack(s).

4.11 To avoid time-consuming conversations for both sides, it is advisable that guidance on air quality issues and the type of basic information needed to make an assessment should be provided to developers early in the planning process. It is essential that developers are informed of, and understand, the need to supply this basic information

Chart 4.1:– An air quality assessment in the planning process for biomass boilers

(numbers in brackets refer to relevant sections of this guidance)



at the earliest stage possible.

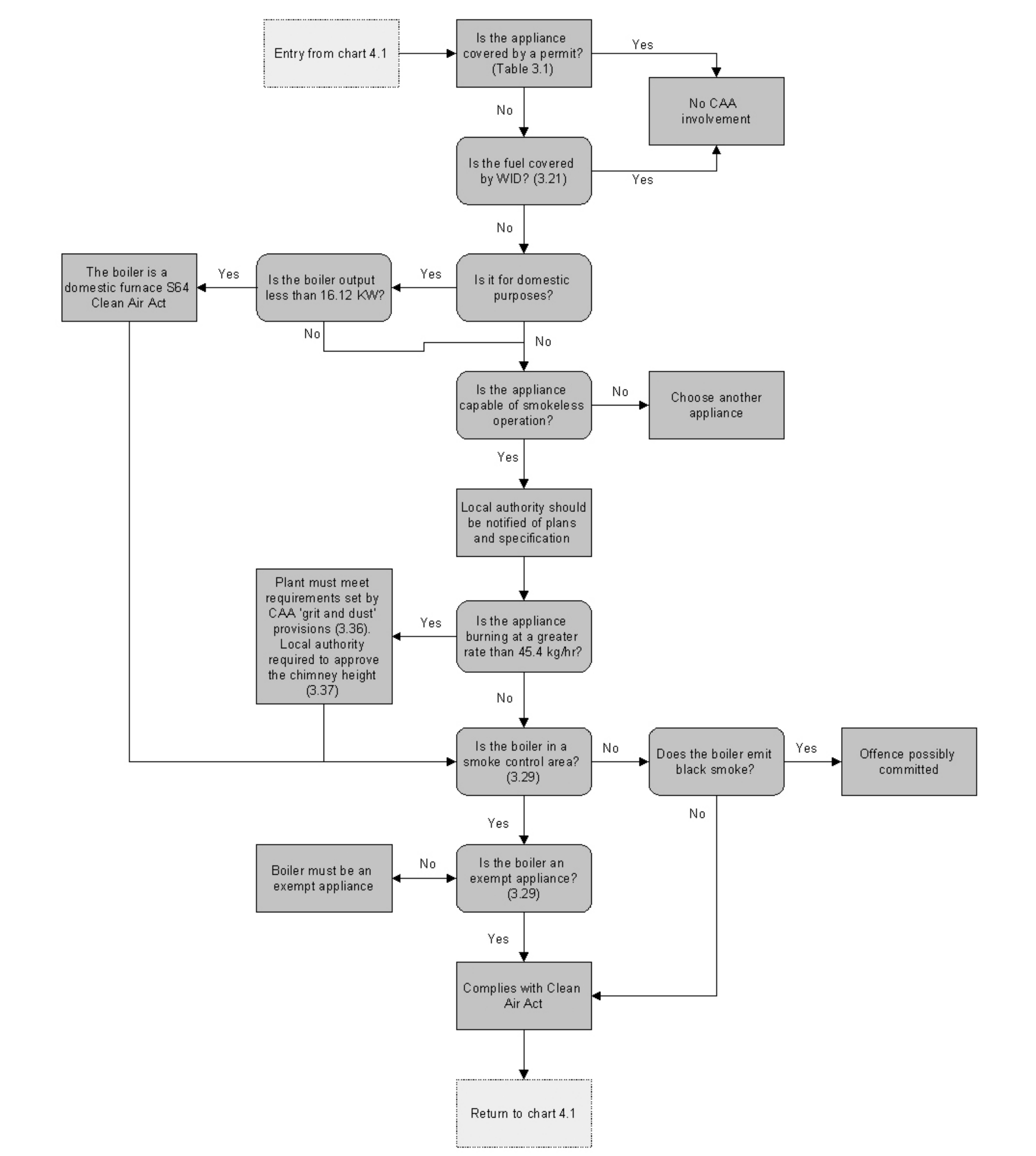
4.12 If an Energy Statement is required the planning department should provide guidance to the applicant regarding the format of the statement and the information that they would like to see included. Information regarding biomass and air quality can be provided to developers alongside (or integrated into) this guidance. The developers' information leaflet produced as a companion to this guidance document may be used for this purpose.

Making an Initial Assessment

4.13 Once sufficient information is available a basic assessment on the suitability of the boiler can be made. Initially this can be a simple checklist:

- Does the boiler require a permit?
- Will the boiler be installed in a Smoke Control Area?
- If the boiler is to be installed in a Smoke Control Area, is it an exempt appliance[4]?
- Is the boiler to be installed in or close to an Air Quality Management Area?
- Is air quality likely to be a material consideration in this planning application?

Chart 4.2: The application of the Clean Air Act to biomass boilers [3]



[3] Adapted from a chart produced by AEA Technology for London Councils
[4] See Chart 4.2

4.14 Any air quality consideration that relates to land use and its development is capable of being a 'material' planning consideration. However, the weight given to air quality in deciding the application will depend on such factors as:

- The severity of the impacts on air quality;
- The air quality in the area surrounding the proposed development;
- The likely use of the development, i.e. the length of time people are likely to be exposed at that location; and
- The positive benefits provided through other material considerations.

4.15 Ultimately the decision on whether air quality is a material consideration comes down to the significance of the effects of the development (and biomass boiler) on air quality. Whether the impact is 'significant' is a judgement made by the local authority, and assessing significance can be a difficult process is some cases. The issue of significance of the air quality impacts of a development, and the likely outcome in terms of planning decisions, is explored in detail in the Environmental Protection UK Guidance 'Development Control: Planning for Air Quality' (Chapters 6 and 7).

4.16 If air quality is judged to be a material consideration for the application, planning can be conditional on stricter conditions than minimum compliance with the applicable regulatory regime and in certain cases permission for a biomass boiler to be installed can even be refused. Before these decisions are taken, however, further information about the proposed system should be obtained, and a more detailed assessment made.

Technical Information to Obtain on a Biomass Boiler/ CHP System

4.17 Table 4.2 shows the type of information that should be collected to enable a more detailed assessment to be made. A template information request form has been produced alongside this guidance document and is available to download. Note that this form is a template, and the amount of information requested should be considered against the likely risk the biomass boiler poses to air quality.

Screening Assessment – LAQM Technical Guidance Nomographs

4.18 As part of the 2008/9 review of Local Air Quality Management Technical Guidance, nomographs were developed to help local authorities screen the potential impact of both individual and multiple biomass boiler

Table 4.2 – Typical information to obtain on a biomass boiler

Item	**Details of the proposed boiler**
Detail	This should include the make, model and capacity of the boiler, its combustion system, fuel feed system, emissions rates, whether it is fitted with an accumulation tank, and details of any emissions abatement equipment fitted. If the boiler is to be installed in a Smoke Control Area its status as an exempt appliance under the Clean Air Act should also be confirmed.
Reasoning	This information on the basic design of the system will help to assess the emissions performance. Biomass boilers often produce relatively high emissions when lightly loaded, hence the need to ask about an accumulation tank (heat store), which can even out load.
Item	**Procedures for Boiler Operation and Maintenance**
Detail	This will include the maintenance schedule associated with the boiler, stack and abatement equipment (if fitted). Plans for identifying and rectifying system failures should also be requested.
Reasoning	System efficiency and emissions performance greatly depends upon regular maintenance.
Item	**Stack Details**
Detail	This will include the height and diameter of the stack, and details of the methodology used to calculate this. The grid reference of the stack should also be requested to help monitor possible cumulative impacts.
Reasoning	The design of the stack greatly affects how pollutants produced in the boiler disperse over the surrounding area. Where the area is heavily built up, or has existing air quality issues, dispersion becomes more complicated.
Item	**Fuel Details**
Detail	This will include details of the type of fuel used (including fuel standards), its compatibility with the proposed boiler and procedures in place to ensure consistent fuel quality. Arrangements for fuel storage and delivery should also be requested.
Reasoning	Emissions from a biomass boiler depend greatly on the type and quality of the fuel used. Reasonable guarantees are therefore needed that the fuel is compatible with the boiler, is of a high quality and that quality will be assured for a reasonable period of time.
Item	**Building Details**
Detail	This will include the height of the building the stack is attached to, and details of neighbouring buildings.
Reasoning	The height and distance of neighbouring buildings will determine their exposure to emissions from the biomass boiler, and therefore the height of the stack needed
Item	**Plans**
Detail	This will include a site plan of the development and the biomass infrastructure (boiler, stack, fuel stores and delivery routes).
Reasoning	These details can be used to ensure that fuel storage, reception and delivery areas are adequate.

installations. These nomographs should be used for screening purposes only, and should not be used 'in reverse' to calculate stack heights. As part of the development of this guidance spreadsheet versions of the nomographs have been produced and can be downloaded for use (see chapter 4 reading links).

4.19 To use the nomographs a minimum level of information will be required:

- Height of stack above ground;
- Diameter of stack;
- Dimensions of buildings within a distance from the stack of five times the stack height above ground;
- Description of the combustion appliance;
- Maximum rates of emission of particulate matter (PM_{10} and $PM_{2.5}$) and oxides of nitrogen when operating at capacity.

4.20 If the maximum rates of emission of the appliance are unavailable, thermal capacity can be used instead. Local authorities may then estimate rates of emission based on the Clean Air Act exemption limits or on the basis of emission factors provided by the EMEP/CORINAIR Emission Inventory Guidebook – 2006 (included in the technical guidance). It should however be noted that these may overestimate the impact of the boiler in many circumstances, and if this assessment shows an unacceptable air quality impact then the planning applicant should be allowed the chance to commission a more detailed assessment.

4.21 Other screening assessment tools are also available; a list is available in Appendix C.

4.22 Assessment using screening models is likely to be appropriate for biomass combustion installations that are not regulated under the Environmental Permitting Regulations provided that the limitations of screening models are not exceeded. For example, most screening models are not applicable in areas where there are steep hills (>1:10) close (<10 stack heights) to the stack.

Dispersion Modelling and Stack Height Assessment

4.23 Screening assessments are designed to be inherently conservative – they use worst-case scenarios to ensure that the worst-cases (in terms of emissions and dispersion) are captured by the tool. If the screening tool shows a significant impact then more detailed assessment is required. This is usually achieved by dispersion modelling of emissions from the boiler to ascertain if they are significant, and calculating the stack height needed to ensure that emissions are sufficiently dispersed. Dispersion modelling is also used to calculate the stack height necessary to ensure adequate dispersal of pollutants (note however that stack heights may be restricted by other considerations within the planning regime).

4.24 Most local authorities will require the developer to commission and fund the dispersion modelling. The modelling itself is usually carried out by a private consultant, as the costs of software and training are significant. Local industry knowledge is usually enough to select a competent consultant, however Environmental Protection UK carry a directory of specialists on their website if signposting to a consultant is needed.

4.25 The detailed dispersion models most widely used in the UK for assessing the impact of stack emissions on local air quality are ADMS 4.1 and AERMOD.

4.26 ADMS 4.1 has been developed by Cambridge Environmental Research. It is a new generation air dispersion model, which means that the atmospheric

Table 4.3: Input data typically required for detailed modelling

Data class	Input required	Units	Note
Emissions	Rate of emission of pollutant	g/s	
Discharge characteristics	Stack height above ground	m	
	Stack diameter	m	
	Discharge temperature	°C	
	Discharge velocity	m/s	
	OS grid coordinates	m	
Building characteristics	Height	m	
	Length	m	
	Width	m	
	Orientation	degrees	
	OS grid coordinates	m	
Terrain	Height above datum	m	Data usually required on a regular grid
	Surface roughness	m	Constant value usually applied, but possible varying across grid
Meteorological data	Wind speed	m/s	Hourly sequential data, typically for 3 years. Data is typically purchased from the Met. Office or other data suppliers
	Wind direction	degrees	
	Cloud cover	oktas	
	Boundary layer height	m	
Receptor grid	OS grid coordinates	m	Receptors on a regular grid or at specific locations

boundary layer properties are described by two parameters – the boundary layer depth, and the Monin-Obukhov length – rather than in terms of the single parameter Pasquill Class. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution.The model takes account of the plume rise resulting from the thermal buoyancy and upwards momentum of the discharge. ADMS 4.1 has a number of model options including the ability to take account of hills and buildings. It includes an in-built meteorological preprocessor that allows the user to input a range of meteorological data.

4.27 AERMOD has been developed by the US Environmental Protection Agency. AERMOD is also a new generation dispersion model. The model operates with a range of data preprocessors:

- AERMET, a meteorological data preprocessor;
- AERMAP, a terrain data pre-processor;
- AERSURFACE, a surface characteristics pre-processor; and
- BPIPPRIME, a multi-building dimensions program.

4.28 Various companies have integrated the AERMOD models in proprietary modelling packages, including BEE-Line Software, BREEZE and Lakes Environmental.

4.29 Older models used a simpler representation of the atmospheric boundary layer. Examples of these models were ISC3 from the US EPA and various models based on the National Radiological Protection Board R91 model. These models are no longer widely used.

4.30 Table 4.3 (page 23) summarises the input data typically required for detailed dispersion modelling.

4.31 HMIP Technical Guidance Note (Dispersion) D1, or 'D1' is not suitable for assessing the impact of particle or nitrogen oxide emissions from biomass boilers. The reasons for this are covered in Appendix C.

Mitigating Impacts

4.32 If dispersion modelling suggests that air quality impacts would be significant and/ or the stack height needed to adequately disperse emissions is unacceptable then mitigation options should be looked at.

4.33 Mitigation of emissions can involve addressing emissions from the boiler itself by choosing a cleaner boiler, or making a requirement for emissions abatement equipment to be fitted. It should be noted though that emissions abatement equipment is currently costly, and is therefore impractical on cost grounds for smaller biomass boilers. Alternatively mitigation measures can involve offsetting via addressing emissions elsewhere in the development or the wider areas, e.g. through a Low Emission Strategy. The main options are summarised in Table 4.4. It should be noted that whilst potential mitigation measures are discussed below, specialist advice should be sought to assess which mitigation measures may be suitable for a particular site and biomass installation.

4.34 If the air quality impacts are still judged to be significant even after mitigation measures have been applied, or if mitigation measures are impractical, local authorities can ask developers to consider alternative renewable energy technologies (e.g. solar, wind, heat pumps, etc).

Abatement of nitrogen oxides

4.35 NO_x control on combustion plant can be achieved using primary or secondary methods but, in general, these are not currently applied to biomass combustion except for combustion plant burning wastes or at very high capacity plant (that is regulated by EPR).

Abatement of particulate matter

4.36 Primary measures (combustion management) provide effective control of products of incomplete combustion that can cause PM emission. Residential appliances often employ natural draught[5] to provide the required combustion air supply. However, this provides limited opportunity for combustion control. Fan assisted combustion air supplies are applied to boilers larger than about 50kW and also to some residential pellet stoves

Table 4.4: A Summary of Potential Mitigation Measures

Measure	Description	Paragraph
	Boiler and Flue Measures	
Cleaner boilers	Different boilers and fuels will have varying emissions performance, and cleaner options may be available	n/a
Abatement equipment	'End of pipe' abatement equipment may be available, but this is normally only cost effective on larger boilers	4.35
Automatic heat exchanger cleaning	Sophisticated heat exchanger cleaning systems can reduce PM emissions	4.45
Accumulator tank or buffer tank management	Heat stores can improve boiler efficiency and reduce the number of stop-start cycles, improving emissions performance	4.37
Fan assisted dispersion	Discharge point fanned flue systems can help to maintain stack efflux velocities under a wider range of conditions, potentially improving dispersion of emissions	4.49
	Other Measures	
Design optimisation	Optimisation of the flue design and placement can assist in dispersion of emissions	4.51
Wider or offset measures	Low emission strategies secured through Section 106 agreements can offset emissions from the biomass boiler(s)	4.52

[5] Air is drawn into the fireplace by the draught (suction) provided by the chimney and buoyancy of the hot flue gases.

and residential boilers. Use of a fan in conjunction with a 'Lambda' (oxygen) sensor and mechanical dampers allows active control of combustion air and air distribution.

4.37 In addition, management of boiler load to avoid excessive cycling operation can help reduce PM emissions. For example, use of an accumulator tanks and/or advanced buffer tank management is recommended for biomass boilers to allow longer, more efficient operation of the boiler with fewer start-up/shut-down periods.

4.38 End of pipe abatement is also possible for particulate control. Such devices include:

- Cyclone (and multicyclones)
- Electrostatic precipitator
- Fabric filter
- Ceramic filter
- Catalytic insert.

4.39 The catalytic insert is a device which can be fitted into a residential stove to reduce emission of products of incomplete combustion and hence PM emission. However, although these devices have been used in North America they have generally not been popular in Europe due to issues of catalyst life and blocking of the catalyst.

4.40 Larger (>50kW) boilers often incorporate a cyclone or multi-cyclone to provide emission control for particulate, although in many instances these are optional. Several boilers exempted for use in UK smoke control areas include cyclone abatement equipment and it should be noted that if the exemption is for a boiler with a cyclone, installation and operation of the boiler in a smoke control area without the cyclone is an offence.

4.41 Cyclones can occupy a small space, tolerate high temperatures and are very good at collecting coarse particles (they can often be used as a first stage gas cleaning device in industrial application) but are much less effective at smaller particle sizes ($PM_{2.5}$).

4.42 There is considerable research into application of electrostatic precipitator (ESP) technology for PM abatement from wood boilers down to perhaps 100 kW output. An ESP requires electricity to maintain the electrical field but flow resistance is low (that is no additional electrical energy is needed to power larger fans). They tend to require a large volume to minimise gas velocity and hence increase opportunity for particle collection. They are effective across all particle sizes and can be tolerant of high temperatures.

4.43 Fabric or 'bag' filters are commonly used in industrial and in local exhaust ventilation. They provide highly effective particle collection across all particle sizes but may require a pre-cleaning device (a cyclone) if significant carbon is present in the particulate as this can pose a fire risk. A range of fabrics are available which allow operation at high temperatures and in highly corrosive flue gases. Fabric filters can be affected by moisture (they may need preheating or use of material which is not clogged by moisture). They require a large volume and require additional fan power due to the high-pressure drop across the bags.

4.44 Ceramic filters have similar features to fabric filters but can operate at very high temperatures.

Automatic Heat Exchanger Cleaning

4.45 Certain boilers have advanced heat exchanger cleaning mechanisms, which can give similar PM abatement as multicyclones.

Abatement efficiencies and costs

4.46 Karvosenoja et al (see Chapter 4 Reading Links) reviewed measures for reducing PM emissions in Finland by 2020 including domestic combustion. Table 4.5 summarises the abatement options and costs considered for domestic biomass boilers. However, it should be noted that ESP for residential boilers are not yet commercially available.

4.47 Nussbaumer (see Chapter 4 Reading Links) has compared the availability and costs of ESP and fabric filters for automatic biomass boilers and determined that ESP and fabric filter technology is available and proven for boilers of 500 kW to 2 MW thermal capacity. Both techniques are capable of operating within an emission limit value of 20 $mg.m^{-3}$ at 11 or 13% O_2 dry and STP - 0°C, 101.3 kPa (<15 $g.GJ^{-1}$). ESP technology has a higher investment cost and fabric filters have a higher operation cost but total cost is similar with an additional 6-12% in heat production cost. Application to 100 kW boilers is possible but the cost of equipment rises below 500 kW, and application may make the boiler installation un-economic. It is however noted that there is cost reduction potential for technology <500 kW.

4.48 Gunczy et al (see Chapter 4 Reading Links) have reported PM emission reductions of about 80% on a 150-300 kW wood chip boiler and 80-90% on a residential 25 kW wood log boiler using prototype ESP systems. In both instances outlet PM concentrations were <10 $mg.m^{-3}$ (at 13% O_2).

Fan assisted dispersion

4.49 Fan assisted dilution systems – these introduce fresh air into the boiler's discharge flue duct, diluting the flue gases. They are usually employed to reduce the height of the stack/ flue when this is desirable on either aesthetic and/ or costs grounds. Total emissions of pollutants will of course be the same as a standard flue system; dispersion

Table 4.5: Finnish data on costs and ESP abatement efficiency for residential boilers

Boiler type	Em. factor without ESP ($mg\ MJ^{-1}$)	ESP removal eff. (%)	Em. factor after the ESP ($mg\ MJ^{-1}$)	Unit cost (€ Mg $(PM_{2.5})^{-1}$)	Unit cost (€ PJ^{-1})
Manual feed log boiler with accumulator tank	100	90	10	3700	333
Manual feed log boiler without accumulator tank	800	95	40	419	318
Automatic feed wood chip boiler	60	85	9	6960	355
Automatic feed pellet boiler	30	80	6	15300	368

may however be enhanced due to the higher discharge velocity. Note that as a general principle of Clean Air Act and Environmental Permitting legislation, it is forbidden to introduce excess air in order to achieve an emission limit.

4.50 Discharge point systems – These are systems with a fan mounted at the end of the flue to ensure a constant negative pressure in the whole stack. With biomass boilers these systems are usually employed to meet the efflux velocities recommended by the Clean Air Act Memorandum in conditions where other options (for meeting efflux velocities) would involve an undesirable (i.e. too high or narrow) stack design, or compromising the efficient running of the boiler (e.g. through introducing excess air flow into the boiler). They are also used to reduce the height of the stack/ flue when this is desirable on either aesthetic and/ or cost grounds.

Design optimisation

4.51 In addition to measures addressing the boiler and flue systems, mitigation options can also include looking at building and stack design to optimise dispersion of emissions. Measures can include optimisation of stack placement within the development site and, where multiple boilers are in use, consideration of multiple or single flue systems.

Mitigation through wider measures

4.52 If reducing emissions from the boiler itself is impractical, wider mitigation measures can be attached to the development containing the biomass boiler to effectively offset emissions. Potential measures are considered in the Environmental Protection UK guidance 'Development Control: Planning for Air Quality', whilst the Beacon Councils' guidance 'Low Emission Strategies' examines transport measures in detail.

Assessing Cumulative Impacts

4.53 Assessment of potential cumulative air quality impacts of multiple biomass boiler installations will become increasingly important as a greater number of biomass boilers are installed over coming years. At the present time it would be very difficult to set an overall 'acceptable level' of biomass deployment in terms of air quality, as technology and regulation is subject to change. It is, however, important to consider individual planning applications for developments containing biomass boilers in the context of current and planned biomass deployment.

4.54 Whilst a single biomass boiler is unlikely to affect air quality outside of its immediate vicinity, the cumulative effect of a number of biomass boilers could potentially add to localised air quality exceedences, and raise background levels of air pollutants. Steps should therefore be taken to ensure that biomass deployment is monitored, and screening assessments are made to ensure that any significant issues are flagged up. Steps that local authorities should take include:

- Logging of information on biomass boiler installations;
- Conducting screening assessments to flag up any potential impacts;
- Establishing common systems with neighbouring local authorities where necessary to assess any transboundary cumulative impacts;
- Monitoring the uptake of smaller (single house) biomass systems.

Logging information

4.55 When planning approval is given for developments containing a biomass boiler the information collected on the boiler should be logged in a systematic fashion. It is helpful to use a common template to do this, so that information can be collected and shared with neighbouring local authorities. A suitable template with essential and desirable information is available to download from Environmental Protection UK's website (see Chapter 4 reading links).

Conducting screening assessments

4.56 As part of the 2008/9 review of Local Air Quality Management Technical Guidance, nomographs were developed to help local authorities screen the potential impact of multiple biomass boiler installations. The nomographs provide a method of screening emissions from a number of biomass boilers in a 1km by 1km square. As part of the development of this guidance spreadsheet versions of the nomographs have been produced and can be downloaded for use (see Chapter 4 reading links). Instructions on how to use the nomographs are also provided.

Transboundary assessments

4.57 Biomass installations in neighbouring local authorities may have an effect on air quality in your own area, and it is therefore useful for local authorities to share information on biomass installations close to local authority boundaries.

4.58 In order to make the sharing of information as easy as possible it is recommended that a common format is used to record information on biomass installations. A suitable template for recording information with essential and desirable information has been developed alongside this guidance and is available to download from Environmental Protection UK's website (see Chapter 4 reading links). Many local authorities take part in county or metropolitan area air quality/ environmental health groups, which are an excellent opportunity to flag up developments with potential transboundary effects and swap information. If you do not have contact details for air quality officers in neighbouring local authorities, organisations such as Environmental Protection UK and LACORS can help you identify whom to contact.

Monitoring uptake of smaller (single house) biomass systems

4.59 Whilst larger biomass installations will be notified to the local authority, smaller systems installed in existing properties can in many cases be installed without any local authority involvement. These systems include stoves, room heaters and boilers that could potentially affect air quality if installed in large enough numbers. It is therefore useful to monitor the prevalence of biomass heating in a local authority area and any trends in installation rates.

4.60 Individuals do not need to notify the local authority if they are installing a biomass system outside of a Smoke Control Area, or if they are installing an exempt appliance within a Smoke Control Area. Installations of biomass burning appliances to existing dwellings do not require planning consent, unless the installation requires alterations to the existing building to accommodate a stack, fuel store, etc. Permitted Development Rights also cover the installation of some stacks for household scale biomass boilers.

4.61 Installations can require Building Control approval. In England and Wales Building Control consent is needed unless a 'Competent Person' carries out the work. This is defined as a member of a suitable industry scheme, such as HETAS (Heating Equipment Testing and Approval Scheme), APHC (Association of Plumbing and Heating Contractors) or BESCA (Building Engineering Services Competence Accreditation).

4.62 Whilst notification of individual installations will not be possible, there are sources of data available for estimating the overall level of biomass heating in a particular local authority area:

- Housing Condition Surveys – local authorities with a housing responsibility will periodically undertake private sector housing condition surveys. Survey questions will usually include the main heating fuel used in a house.
- Home Energy Efficiency Officers (HECA Officers) – Under the Home Energy Efficiency Act 1995 local authorities were required to report annually on the energy efficiency of housing in their area. Although there is no prescribed monitoring methodology many local authorities have used snapshot postal surveys, often in partnership with Energy Efficiency Advice Centres. The questions asked will usually include the main heating fuel used. Although HECA is now being revoked, local authorities are likely to continue working on domestic energy efficiency via their climate change commitments.
- Energy Efficiency Advice Centres/ Local Energy Saving Trust Advice Centres – The Energy Saving Trust funds a network of Energy Efficiency Advice Centres (EEACs), which are now being rationalised and rebranded as Local Energy Saving Trust Advice Centres. A core activity for EEACs has been to distribute and process Home Energy Check forms, which include questions on the main heating fuel used in dwellings within a local authority area. They therefore have a great deal of data on the types of heating used in a local authority area. Many EEACs have close working relationships with the local authorities in their area, which in many cases contract services and project management to them.

4.63 A useful first port of call within a local authority would therefore be to meet with colleagues in private sector housing and/ or domestic energy efficiency to establish what sources of data are available. Although this level of data cannot be used to estimate emissions or biomass contributions to pollutant concentrations it can help identify whether biomass is more or less prevalent than average in a local authority area (by comparing with others), and also the level of new installations.

Chapter 4 Reading Links

- LAQM Helpdesk information (http://www.airquality.co.uk/laqm/helpline.php)
- Examples of Air Quality Supplementary Planning Guidance on the University of the West of England website (http://www.uwe.ac.uk/aqm/review/mplanspd.html)
- List of local authorities with 10% (or greater) renewable energy targets (http://www.themertonrule.org/list-of-boroughs)
- Environmental Protection UK Planning Guidance (http://www.environmental-protection.org.uk/assets/library/documents/Development_Control_planning_for_air_quality.pdf)
- Biomass boiler information request template for local authorities (http://www.environmental-protection.org.uk/biomass)
- Environmental Protection UK Directory of Specialists (http://www.environmental-protction.org.uk/contact/directory/)
- HETAS Guide (http://www.hetas.co.uk/public/hetas_guide.html)

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Chapter 5 – Anticipated Progress

5.1 At the time of writing this guidance a number of initiatives were under way that will impact on how local authorities deal with biomass boilers. The draft UK Renewable Energy Strategy put forward a number of suggestions that would assist developers in specifying suitable biomass boilers, and local authorities to understand, plan and control the deployment of biomass boilers in their area.

5.2 The measures proposed are outlined below. As confirmation and/ or implementation of these measures will come after publication of this guidance we have set up an updates page on the Environmental Protection UK website (www.environmental-protection.org.uk/biomass). These updates should be read alongside this guidance.

Research and Modelling

5.3 The research base on emissions from biomass boilers continues to expand. The 2008 report 'Measurement and Modelling of Fine Particulate Emissions (PM_{10} and $PM_{2.5}$) from Wood-Burning Biomass Boilers' (see Chapter 5 reading links) presented the results of a study that measures emissions from several biomass boilers in Scotland, and modelled their likely effects on air quality. Whilst the report concluded that emissions were far from the 'worst case scenario', emissions between the different boilers studied varied, and could be significant in some locations. Further research is therefore needed to clarify potential impacts and abatement opportunities.

Emission Standards

5.4 There are currently no UK emission standards for biomass boilers beyond those detailed in Chapter 2. European emission standards vary in their testing procedures, meaning that they are difficult to compare with UK standards for other heating appliances. Emission standards were therefore proposed in the draft Renewable Energy Strategy. One option could be to apply a two-tier standard, with the top tier reflecting the 'best possible' in terms of emissions. This top tier could then be used as a specification standard for areas where air quality is being, or may be, compromised. There is also the option to apply standards in two stages, with a standard which allows only high quality boilers applying from, for example, 2010, and a second stage 'stretch target', which allows only the very best performance applying from, for example, 2014.

5.5 A type approval and enforcement scheme would have to be introduced to implement emission standards on biomass boilers. This could be achieved by modifying the Clean Air Act.

Regulatory Controls

5.6 Local authorities may be given more powers to control biomass installations in areas where air quality is poor (i.e. in Local Air Quality Management Areas). This would involve extending local authorities' current powers and duties under the Local Air Quality Management regime, either through new legislation or regulations made under the Environment Act 1995; it would also require the updating of current guidance to local authorities on LAQM.

Maintenance Requirements

5.7 Biomass boilers, stacks and emissions abatement equipment need regular maintenance to ensure efficiency is kept to a maximum, and emissions are kept to a minimum. In other countries, including Austria, Germany, Denmark and the United States, concerns over air quality deterioration caused by older style biomass boilers has led to the introduction of an MOT-type scheme, whereby the owners are required to have their boilers serviced on a regular (for example, annual) basis. A similar system may be applied to the UK. One concept is that documentation of maintenance checks should be needed to claim any subsidy provided by (for example) a Renewable Heat Incentive.

The Renewable Heat Incentive

5.8 The proposed Renewable Heat Incentive (RHI) will be the Government's main tool for encouraging a large increase in the deployment of renewable heat, such as biomass. The incentive will provide a payment per unit of renewable heat generated; with smaller plant this may be replaced with a one off payment when the plant is installed. The design of the RHI will strongly influence the size and shape of biomass deployment over the coming years. The RHI was expected to be the subject of a DECC consultation over summer 2009, with the scheme itself in place by April 2011.

Chapter 5 Reading Links

- Report - Measurement and Modelling of Fine Particulate Emissions (PM_{10} and $PM_{2.5}$) from Wood-Burning Biomass Boilers (http:www.scotland.gov.uk/Publications/2008/11/05160512/0)
- The draft UK Renewable Energy Strategy (http://renewableconsultation.berr.gov.uk/consultation/consultation_summary)

Appendix A – Biomass Boiler Technologies

A1 Boilers and appliances may be categorised according to the direction of the airflow through the fuel bed, the method of fuelling, the size of the appliance, the fuel type and the application. There are units that are fuelled by intermittently loading a batch of fuel, usually logs or lump wood, into the combustion chamber – batch fuelled; and those that are fuelled continuously with a steady flow of fuel logs, chips or pellets – continuous firing. Table A1 lists the main categories of appliance and the types of fuel used.

A2 Historically, wood was burned in open fireplaces, partially enclosed fireplaces and conventional enclosed stoves for domestic heating and the provision of hot water. These appliances were typically characterised by low efficiency and poor emissions performance.

A3 Modern biomass boilers minimise the emissions of unburned volatile compounds by optimising the design of the combustion zone of the appliance. This involves the way in which the biomass is introduced, the way in which air is introduced and the way in which the heat necessary to dry, vaporise and ignite the fuel is retained and transmitted. The following sections describe the main types of modern appliance and the design and operational factors that affect their performance.

Batch Fuelled Appliances

A4 These are usually small, <50kW output, units fuelled by logs or lump wood. They can either be stoves (roomheaters), where the main output is by radiation and convection to the room in which they are placed, or hot water boilers. There are fireplaces and stoves (and cookers) available, which also incorporate boilers. Until the recent introduction of pellet stoves, log-fuelled batch units were the only type found in the domestic sector where they still make up the majority of sales.

A5 It is in the nature of batch-fired units that there is always an excess of fuel in the combustion chamber. The only way to regulate output is by controlling the amount of combustion air. If this air is injected at just one point it will always give rise to a fuel rich zone that will create large quantities of unburned volatile matter and gases. This is unacceptable from an operational and environmental viewpoint and further air, 'secondary air', must be injected to ensure complete combustion. The influence of primary air (combustion air which is passed through the fuel bed) on emissions is significant but generally less important than the good management of secondary air. Most differences in stove design stem from the way this secondary air is injected to achieve complete combustion. The level of emissions depends on how well the design has succeeded in achieving this. Given these factors it is not surprising that emissions from unburned volatile organic compounds are the overriding concern for batch-fuelled appliances. Solid ash particles and volatile ash are present but of less concern.

A6 In most appliances the air is introduced in one of two ways; updraft where the air passes upwards through the batch of wood and the secondary air is introduced over the top of the fuel bed, and downdraft where it passes downwards through the fuel bed, with the secondary air being introduced in a separate combustion chamber. Updraft appliances are the most common, and the cheaper, but downdraft stoves give much better emissions performance because of the better combustion and control inherent in the use of a discrete secondary chamber.

Table A1: Types of biomass appliance

Capacity of appliance	Class of appliance	Type of appliance*	Fuel types
<50 kWth (mainly domestic or residential type applications)	Fireplace	Open fireplace, Partly closed fireplace	Log, lump wood and biomass briquettes
	Stove	Manual feed stoves	Log, lump wood and biomass briquettes
		Pellet stoves	Pellets
	Boiler	Over-fire	Log, lump wood and biomass briquettes
		Down draught wood boiler	Log, lump wood and biomass briquettes
		Pellet boiler	Pellets
>50 kWth and less than 20 MWth (mainly commercial, institutional, community or district heating and, industrial applications)	Manual feed boiler	Overfeed, under fire boilers	Lump wood
		Overfeed, upper fire boilers	Wood chips/fine coal mixture
	Automatic feed boiler	Moving bed combustion	Wood chips, sawdust Co-combustion with coal
		Underfeed boiler, upper fire	Wood chips, sawdust, pellets: particle size less than 50 mm
		Down draught wood boiler	Logs
		Gasification	Wood chips, pellets
		Pre-ovens combustion system	Wood chips
		Fluidised bed combustion	Sawdust, woodchips, pellets

* The types of appliance are described in EMEP/CORINAIR Emission Inventory Guidebook – 2007 Chapter B216

A7 Most of the smaller batch-fuelled appliances make use of natural draught generated by the increased buoyancy of the hot combustion gases. The use of fans to supply combustion air ensures a level of control that is not possible with simple natural draught. This is particularly true of the start phase where a cold flue will reduce the airflow significantly. Unfortunately fans are not usually provided with smaller appliances due to the increased cost and complexity. The current EN Standards for residential fireplaces, non-pellet roomheaters and cookers do not cover appliances with fan assisted combustion air supply (see Chapter 2 for details of Standards).

A8 High quality insulation installed around the combustion chamber retains heat where it is needed to encourage complete combustion of volatile compounds.

A9 The performance of boilers is improved if the appliance operates at a high and constant output. It is good practice to install a hot water storage tank, or accumulator, and fire a log boiler at maximum constant rating until the charge has been consumed. This is done two or three times per day with the connected heating system supplied from the accumulator. This configuration is so effective in reducing emissions that it is a legal requirement in Germany and Switzerland. It is bad practice to try to follow the heating load by controlling the air flow to the boiler because particulate formation is encouraged under conditions of restricted air flow.

A10 Tests have shown that emissions of unburned organic compounds are typically two orders of magnitude greater in the few minutes after the appliance is started or refuelled. They can be reduced significantly if the wood charge is ignited from the top of the charge.

A11 Good quality fuel with a consistent size and low moisture content will promote consistent air flow and prevent excessive heat loss from drying in the combustion zone. An ideal log fuel would be produced from small round hardwood, split in quarters with a moisture content of below 15%.

Continuously fired boilers

A12 In a continuously fired boiler, or stove, fuel is added continuously to the combustion air in the correct proportion to give the desired heat output. Combustion air is regulated to match.

A13 The processes of drying, devolatilisation, and combustion of volatile and char occur as in the batch fuelled appliances and the design must take this into account. An important difference is that the fuel rich situation does not occur and consequently the production of unburned volatile emissions will be to a large extent avoided. The particulate emissions will therefore be largely comprised of vaporised and physically entrained ash. In contrast to batch fuelled appliances the resulting level of emissions will be largely independent of the combustion conditions and be more a function of the type of equipment installed to clean the flue gas.

A14 The most common types of woody fuel used in continuously fired boilers are pellets and woodchips. There are automatic log boilers that apply downdraft gasification techniques to achieve very low particulate emissions but due to fuel handling constraints these tend to be smaller than 150 kW. At present, the relatively high cost of pellets (compared to wood chip) means that use of pellets tend to be rare in boilers larger than about 300 kW.

A15 A key feature of larger (>50 kW) boilers will be the need for automatic fuel handling from a storage area to the boiler (residential boilers will typically have a small hopper beside or as part of the appliance which the user will fill at intervals). Similarly larger boilers need to incorporate equipment for ash handling (and storage). Residential boilers generally incorporate a small bin that can be removed at intervals by the user however this is not practical for large units. Fuel tends to be moved by screw conveyors, which can be of varying length to suit the distance to, and design of, the storage area.

A16 Accumulation of deposits on heat transfer surfaces reduces efficiency and modern boilers tend to incorporate cleaning devices. Cleaning is either mechanical or, for larger boilers, by use of sootblowers.

A17 Most modern boilers incorporate automatic fuel ignition, which allows fully automatic operation.

A18 The performance of continuously-fired boilers is improved if the appliance operates at a high and constant output. It is good practice to install a hot water storage tank, or accumulator where there is a variable demand for hot water. In this way, a smaller boiler may be specified to meet the variable heat demand.

Pellet boilers

A19 Pellets are a modern form of manufactured biomass fuel that has many advantages. Pellets are free flowing with a low moisture content and a consistent size and geometry. Designing efficient and effective combustion devices is therefore much simplified when compared with other fuels. Pellets can, however, be an expensive fuel when compared with chips and they are usually confined to smaller domestic and commercial units where the simplicity and convenience they offer outweighs the additional cost.

A20 Pellet combustion appliances, whether stove or boiler, are sold in three variants, underfeed where the fuel is pushed up into the combustion chamber by a screw feeder; overfeed where the fuel falls down a chute into the combustion chamber and horizontal firing where the fuel is burned in the end section of a screw feeder. The choice depends largely on the manufacturer and there seems not to be any overwhelming advantage in one over the others.

A21 Almost all pellet-fired appliances use a fan powered supply for the combustion air so accurate control is possible. This is often complemented by a control circuit including an oxygen sensor in the flue gas to determine excess air level. Both of these measures improve the emissions performance of pellet-fired appliances.

Wood log boilers

A22 Automatic log boilers are sold for residential use and small commercial/institutional use (they tend to be smaller than 150 kW output). Modern appliances incorporate internal storage hoppers (filled at intervals by the users) and are based on the downdraft principle where logs are slowly heated and evolved vapours are burned in a secondary combustion chamber. The process resembles gasification and as a consequence they tend to have very low particulate emissions.

Continuous firing of woodchips

A23 Equipment for chip firing is supplied in a wide variety. Smaller units designed to burn dry (<35% moisture) chip with a top size below 50mm are similar to the overfeed and horizontal pellet burners: indeed many pellet burners were developed from these.

A24 Higher moisture content chips require more time in the combustion chamber to dry the fuel and an arrangement to recycle heat from combustion to drying. This is usually achieved by spreading the fuel on a grate that conveys the burning fuel bed slowly through the appliance. Heat for drying is usually supplied by radiation from a firebrick arch mounted over the feed end of the grate. The grate is moved forwards by one of many different mechanisms depending on the manufacturer. The combustion air is supplied partly under the grate and partly above the grate, to ensure complete burn out of the volatile compounds.

A25 To guarantee complete combustion of volatile compounds all biomass boilers are built with very well insulated combustion chambers that maintain a high temperature for several seconds.

Factors influencing boiler efficiency

A26 The aim of biomass combustion is to convert the energy stored chemically within the fuel to useful heat. There are no ideal processes of energy transformation, and it is impossible to transform energy into another form with 100% efficiency. Energy losses arise as the result of the following:

- ***Chemical loss in exhaust gas***: as a result of incomplete combustion, the exhaust gas contains combustible substances, like CO and hydrocarbons. These substances contain energy in chemical bonds which can be released in a combustion process and are a cause of energy loss. The methods for minimising this loss are to design the combustion chamber so as to maximise the combustion efficiency of the intended fuel.

- ***Thermal or physical loss in exhaust gas***: exhaust gases from combustion contain energy since they are at a higher temperature than the ambient temperature. Thermal losses are increased as the temperature of the exhaust gas from chimney increases or if additional ‘tramp’ air is passed through the chimney. Such losses can be minimised by design measures that improve heat recovery in the heat exchanger (where fitted), or measures that increase the emission of heat into the room and that control the air supply.

- ***Chemical loss in ash***: solid residues from the combustion process (ash including fly ash) may contain carbon that was not burnt in the combustion chamber. Insufficient combustion time of fuel particles, fuel dimension and fuel composition are reasons for chemical loss in ash.

- ***Physical loss in ash***: the ash, which is removed from the lower part of the appliance, also has a temperature above the ambient one. This means that some part of released energy during combustion process was not passed to the other medium, thus this energy may also be lost (if material is removed while hot).

- ***Heat loss from the surface of the appliance***: the surfaces of the appliance will be greater than the ambient air and so there will be transfer of heat from the appliance by radiation or convection. In many domestic applications this heat is usually considered a useful transfer of heat to the room but in larger installations for steam or hot water generation, the heat is considered to be lost. The heat loss from the surface area is minimised by means of effective insulation and the reduction of the surface area.

A27 Awareness of energy losses allows designers to design appliances that minimise these losses.

A28 A substantial part of the emissions of unburnt organic matter occurs when there is an excess of fuel in the combustion chamber. It follows that the efficiency of the boiler should be improved if the appliance operates at a constant load. Most modern biomass boiler designs are intended to operate over a range of heat outputs with little loss of efficiency. Recently reported tests on a range of modern log wood, pellet and wood chip boilers with capacity greater than 50 kW indicated that the efficiency remained at approximately 91% when operating at a third of the boiler capacity. Nevertheless, correct sizing of the plant is essential if efficiency is to be maintained over the full range of operating conditions.

Combined heat and power

A29 With a conventional boiler, the aim is to collect as much of the heat generated as possible in the boiler in order to provide a supply of hot water or steam for process heating, space heating or hot water. With a combined heat and power (CHP) plant, part of the heat produced is used to generate electricity.

A30 Electricity generation is a relatively low efficiency use for biomass, except where there is a high level of heat demand throughout the year, for example an industrial application requiring process heat, or a hotel or hospital requiring a constant supply of hot water. Above about 1-2 MWe, conventional superheated steam turbine technology can be used with reasonable efficiency. Alternatively, biomass gasification used with a gas turbine in a number of configurations may also be appropriate at high output levels. However, at lower output requirements neither of these options is likely to make efficient use of the fuel. Several technologies suitable for smaller scale applications are under active development: these include:

- Organic Rankine Cycle systems using a low boiling point organic compound to replace the heat transfer medium;
- Gasification combined with an internal combustion engine;
- Reciprocating steam engine;
- Stirling engine;
- Gas microturbine.

Appendix B – Fuel Specification

Introduction

B1 The term "biomass" covers a range of materials of biological origin, some of which may also be regarded as wastes.

B2 The most frequently used term to define biomass is the one included in the Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. This defines biomass as "the biodegradable fraction of products, waste and residues from agriculture (including vegetable and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste". This definition remains the same in the new Renewable Energy Directive that will repeal Directives 2001/77/EC and 2003/30/EC.

B3 Biomass fuels are characterised according to their chemical and physical properties. Paragraph B5, B6 and Table B2 examine the types of biomass fuels that are commonly proposed for biomass heat and power in the UK and the impact of biomass properties on combustion. Paragraph B7 and Table B3 provide an overview of the characteristics of wood fuels and paragraph B8 onwards and Tables B4 and B5 provide an overview of standards.

An overview of the effects of fuel specification on operational and emissions performance

B4 Biomass fuels represent a variety of different materials. For fuel use these are typically characterised according to their physical and chemical properties, particularly those that impact combustion. Table B1 summarises how these properties affect the operational and emissions performance of combustion systems.

Biomass fuel types

B5 Table B2 (pages 34-36) describes the main types of biomass fuel, sets out the most important issues relating to their handling and storage, and also summarises the relative advantages and disadvantages of each type of fuel.

B6 The most common fuels used for heat and power at present are wood fuels and agricultural residues. For small-scale heat or CHP in urban areas, most stand-alone applications use some form of wood fuel. However, specific plant may use agricultural residues if there is a local source, for example in conjunction with local production of food, drink or biofuels.

Specific characteristics of wood fuels

B7 The most common fuels used in urban areas for heat and power are wood fuels. Table B3 (page 37) provides a summary of the properties of typical wood fuels.

Standards for biomass fuels

B8 The European Standards Agency (CEN) has worked (or is working) on a number of standards that are relevant to biomass fuels. Table B4 (page 38) provides an overview of the contents and status of the most relevant standards.

B9 CEN 335 includes solid biofuels originating from the following sources:

- Products from agriculture and forestry;
- Vegetable waste from agriculture and forestry;
- Vegetable waste from the food processing industry;
- Wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originated from construction and demolition waste;
- Continued-fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and heat generated is recovered;
- Cork waste.

B10 Table B5 (page 39) provides a summary of the grades of woody fuels specified in CEN335.

B.11 The British BioGen code of good practice for biofuel pellets (Version 2.3) specified issues related to pellets' raw materials, physical and chemical attributes, and quality assurance and miscellaneous. The code was voluntary but all members of the industry were strongly encouraged to comply with it. The code was an interim measure, whilst no other standards exist in the UK, and has been superseded by the European Standard for solid biofuels.

References

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- SWS 2002. Heating large buildings with wood fuels. www.bioheat.info
- Transport Information Service 2008. www.tis-gdv.de/tis_e
- Cox, A. 2002. Low carbon heating with wood pellet fuel. www.bioenergy.org/downloads/PelletReport.pdf

Table B1 Impact of properties of biomass fuels on combustion

Sources: Hahn (2004); Transport Information Service (2008); Supergen WP2, Cox (2002). SWS (2002)

Characteristic	Issue
Physical characteristics	
Bulk density	Storage space and capacity of materials handling equipment and boilers.
Energy density	Storage space and capacity of materials handling equipment and boilers.
Particle size	Flow of particles in materials handling equipment including their tendency to bridge in storage. Combustion efficiency and consequent production of smoke.
Presence of fines	Dust explosion risk. Dust emissions from handling operations.
Durability of pellets	Poor quality pellets are liable to break up on physical handling and in storage. This will result in poor handling, flow, loss of fuel and production of dust.
Biological characteristics	
Allergies	Some biomass fuels, e.g. peanut husks are known allergens.
Carcinogens	Some tropical and North American hardwoods are carcinogenic.
Chemical and combustion characteristics	
Water content, hygroscopicity	Influences calorific value from specific weight of fuel. Self heating and fire risk. Flow properties in materials handling equipment. Tendency to bridge. Mould formation and associated health risks from dispersion of spores.
Calorific value	Storage space and capacity of materials handling equipment and boilers.
Chlorine	Corrosion. Dioxin and furan production during combustion. Formation of clinker deposits in ash and reduced ash melting temperatures. Hydrogen chloride emissions.
Sulphur	Sulphur dioxide emissions. Fouling of heat transfer surfaces. Corrosion of exhaust ductwork.
Nitrogen	NO_x, HCN and N_2O emissions.
Potassium	Corrosion in superheaters. Reduction of ash melting point (which may result in slagging and fouling). May affect mechanism of pyrolysis, decrease oil quality and increase char.
Mg, Ca, P	Raising of ash melting temperature, effect on pollutant retention in ash and the use of the ash. May affect mechanism of pyrolysis, decrease oil quality and increase char.
Si	Alkaline silicates can be formed with low melting or softening temperatures.
Heavy metals	Use or disposal of ash. Pollutant emissions.
Ash content	Particulate emissions. The quantities of ash for disposal.
Ash softening behaviour	Operational safety, level of pollutant emissions.

Table B2 Biomass fuel types

Description	Supply Source	Storage	Handling	Advantages	Disadvantages
WOOD BASED FUELS **Round wood and logs** Logs are the traditional source of fuels. Today logs are usually obtained from timber or trees unsuitable or unwanted for building or construction. Logs are usually seasoned for up to two years to decrease moisture content.	Forestry - UK	During seasoning – store under cover with good air circulation. Keep dry.	Few issues in handling.	Familiar fuel, which can be used on domestic fires, stoves and wood burners. Can be stored outside with minimal shelter. Growing demand stimulating supply.	Expensive to transport and store at large scale. Generally used at small scale only. Automatic feed not possible at this scale. Log burners require regular de-ashing.
Chips from fresh wood The term woodchips refers to mechanically processed wood particles. Depending on the moisture the chips can be: - *wet*: moisture content > 30% - *dry*: moisture content < 30%.	UK or imported Usually saw mill or other wood processing residues or short rotation coppice	Keep dry. Store as loose piles. Open air storage is possible, but permeable water shedding cover must be used to reduce re-watering.	Loss of dry matter may occur. There is a potential for self heating that can lead to fires. Dust – may be explosive hazard. Emission of organic compounds during drying. Degradation may result from fungal growth, which produces spores.	More suited to automatic handling than logs. More efficient combustion than logs. Lower risk of dust explosions than sawdust due to large particle size. Extensive experience of production, handling and storage from associated sectors including timber and paper industries. Minimal requirements for storage; can be stored outside with limited shelter. Growing demand and market stimulating increased international trade. Cheaper than pellets.	Further processing may be required (e.g. milling) depending on plant design. Moisture content in virgin wood chip (c. 30-60% of dry mass), results in a lower net calorific value. Long term storage: high moisture wood degrades quickly which can result in risk of self heating and potential spontaneous combustion. Low moisture wood can be stored longer. Wood stack height should be less than 10m to prevent composting and spontaneous combustion. Mitigation: "turning over" of stockpiles to avoid build-up of heat within stockpiles.
Waste wood The main source of wood waste is the untreated wood from processing / manufacting facilities (potential sources include: joinery works, planning mills, furniture manufacturers, pallet manufacturers, timber kit frame manufacturers etc).	UK – some may be imported from the EU.	Sheltered storage to maintain low moisture content. Storage as loose piles.	Loss of dry material.	Extensive experience of production, handling and storage from associated sectors (e.g. timber and paper industries). Typically lower moisture content than virgin wood chip. Generally low bark content.	Difficult to separate contaminated wood in some waste streams. Combustion may need to be compliant with Waste Incineration Directive. Quantity available limited by supply. May require further processing (e.g. milling). Contamination in wood can directly affect emissions from combustion process and ash content. Needs to be separated and collected.
Saw mills residues - sawdust Saw mills residues - sawdust Sawdust is either sourced from sawmills or from wood processing plants using un-treated timber.	UK	Best to keep all sawdust under dry cover, with good air circulation. This prevents the potential for degradation and self heating and will keep low moisture content sawdust dry.	Dust hazard Potential for loss of dry matter in storage. Need to avoid self heating that can lead to fires.	Needs minimal further processing in order to be used.	Low bulk density = large transport and storage requirements. Can become air borne in even low wind conditions - should be sheltered/covered and tipped carefully. Self heating and loss of dry matter in storage. There are often large quantities of dust, representing a health hazard. Some hardwood dusts are carcinogenic.

Description	Supply Source	Storage	Handling	Advantages	Disadvantages
Saw mills residues – wood pellets Wood pellet fuel is made from compressed sawdust, shavings and fines from the processing trees for timber and other wood products. At a pellet mill the material is dried, compressed, and formed into small uniform sized pieces. They should be clean, pleasant smelling and smooth to touch. Wood pellets are usually approximately cylindrical because they are made by forcing wood particles through a sieve with circular holes. They are usually referred to by the diameter of the chips, typically between 4-10mm.	UK or imported (from EU, Russia or North America)	Keep dry. Store under cover, preferably in enclosed areas. Should be kept away from other fuels with higher moisture content	Careful handling needed to prevent mechanical damage of the pellets (break down of the structure). Pellets absorb water and are liable to degradation if wet.	Higher bulk (and energy) density than sawdust material: reduced transport and storage volume requirements. Generally good storage characteristics. Less dust generated in mechanical handling compared to sawdust (with exceptions, see disadvantages). Good flow characteristics compared to sawdust. Low moisture content. Available in increasing quantities. Can be shipped in bulk. Good experience of combustion; good combustion characteristics. Should be able to be sustainably sourced. However, source of material may be obscure.	Hygroscopic, must be kept dry. Exposure to water will break down pellets and cause them to swell considerably. Can degrade to sawdust as a result of excessive, or poorly designed, mechanical handling processes. Tendency to be formed from very fine wood particles. If breakage of pellets does occur levels of dust can rise dramatically. In the most severe cases this has the potential to create a dust explosion hazard. Expensive (due to processing cost and competition). Sustainability: there may be issues with contaminated wood in some pellets, poor quality pellets in peak market conditions and environmental sustainability for pellets made from tropical timber in the Far East.
AGRICULTURAL RESIDUES **Dry residues** *Straw* is a by-product of the production of grain or seed and, if it is to be sold, is baled following the harvest of the primary crop.	UK	Major storage issues due to its bulk and short harvest period. Store in bales in stacks in field or under cover in barn. The latter is more expensive but will decrease spoilage.	Chopping, handling and feeding are difficult. Can deteriorate in storage (e.g. it can rot). Fire hazard.	There is no need to develop a new crop with which farmers may be unfamiliar. Techniques for harvesting, storage and transport are already available. Supply limited by production, particularly in poor harvest conditions and by competition for straw when there are poor harvests.	Bulky and expensive to transport over long distances. Contains trace components such as potassium chloride and silicates that cause corrosion in boilers at high temperatures.
Poultry litter is the bedding material from broiler chickens. Usually it consists of materials like wood shavings, shredded paper or straw and chicken droppings.		Strong odour – needs to be stored under conditions that prevent release of odour.	Main impacts: feedstock transport, odour and noise.	Poultry litter is an existing "fuel". The supply chain is relatively straightforward Low moisture. Combustion of poultry litter well proven in UK.	Require emissions clean up for atmospheric emissions. Combustion falls under the Waste Incineration Directive.
Meat and Bone Meal		Often burnt under special licence.	Health hazard during handling.	Low moisture. Co-combustion of MBM with coal has been demonstrated in EU. Combustion demonstrated in UK.	Combustion falls under the Waste Incineration Directive. High content of Ca and ash. Relatively low volatile matter. Supply limited by production.

Description	Supply Source	Storage	Handling	Advantages	Disadvantages
FOOD PROCESSING AND AGRICULTURAL PROCESSING RESIDUES/CO-PRODUCTS					
Dry residues Such as: palm kernel expeller, olive nuts, shea nuts, cereal co-products, sun flower co-products, corn kernels, coffee grounds, etc.	UK and internationally traded	Need specific temperature, humidity, ventilation conditions. Degrades rapidly (forms dust, mould spores), so some residues must be used rapidly.	Relatively good handling characteristics due to their consistency (granular, power-like or pellets). Potential for spontaneous combustion.	Good availability: both from UK and traded internationally. Some food processing residues are relatively dry, so they store well.	Many residues have alternative use as animal feed – this is a high value market where increased demand leads to increased prices. High volatile prices dependent on multiple variables (harvest, food and feed prices). Variable content (some of them with high ash content). Some residues can cause respiratory problems if not stored and handled properly.
INDUSTRIAL SLUDGE **Paper sludge**	UK			Good availability Low cost waste fuel.	Can be high in moisture content and bulky to transport. Consequently many paper mills are considering their own use. Variable composition (can be very high in ash and other metals). Explosion hazard for dry paper sludge.
Tall oil	Imported (usually from Nordic countries)	Strong smell. Stores well (up to 1 year).		Liquid fuel; can be used as a replacement for heavy fuel oil in oil or pulverised fuel-fired boilers with minimal modifications. History of use in Scandinavia.	Use of tall oil has been linked to potential boiler corrosion issues in the past. Mixture of chemicals, variable composition.
ENERGY CROPS **Short rotation coppice** SRC are trees planted primarily as a fuel for renewable energy production. The main species in the UK are willow and poplar, but eucalyptus is also being proposed.	UK or imported	Keep dry – store as loose piles in covered (but well-aired) storage if possible.	Potential for self heating in storage. Potential for emission of organic compounds. Potential for fungal growth and release of spores.	Wood fuel and energy crop. Sustainable source of wood and should be easy to audit source.	Shortage of planting material and harvesting equipment in UK. Low quantities available at present. Proposed use of eucalyptus as an energy crop is raising concern (deep tap roots impact on water table and it may be invasive).
Energy grasses (miscanthus, switch grass, reed canary grass) Are grasses grown specifically for energy production; include reed canary grass, switch grass, spartina, miscanthus	UK or imported	Store under cover to keep dry. Will rot if kept in the open air and in the rain.	Handling problems might occur due to morphology of material. Loss of dry material.	Available in a variety of forms. Energy crops. Annual crops that can have high yield.	Relatively high ash content. Relatively low bulk density.
RESIDUES FROM BIOFUELS PRODUCTION Dried distillers grains with soluble – DDGS (residue from alcohol or bioethanol production)	UK	Keep dry.	Explosion hazard.	Low calcium in ash. Low moisture content providing it is dried.	High silica, potassium and phosphorus content in ash. Relatively low fusion temperature. May have issues with corrosion and fouling.

Table B3: Summary of data on the combustion characteristics of wood fuels					
	Round wood logs	**Chips from fresh wood**	**Sawdust**	**Wood pellets**	**Waste wood**
Particle size	100mm to 1000mm[1]	1 - 100 mm (can be graded)	1-5mm[1]	0<25 mm[1]	Heterogeneous – usually chipped as specified
Moisture content (%)	20-65%	10 - 50	10 - 65	8 - 10	5 - 8
Gross Calorific value (MJ/kg) , dry ash free	20 (18.5-20.8)	20 (18.5-20.8)	18 - 21.8	18 - 21.8	17.6 (15 - 17)
Ash (dry basis)	0.2-2%[2]	0.2 - 1.98	0.1 - 4.9 (usually < 1.5)	0.5	0.1 - 0.8 (to 2)
Volatile Matter weight%	75-85	75 - 85	43 - 76	72	70 - 73
Sulphur (%dry basis)	0.01-0.05	0.01 - 0.05	< 0.08	> 0.08	0.02 - 0.04
Chlorine (%dry basis)	0.01-0.03[6]	0.01 - 0.03	0.04	0.01 - 0.36	0.01
Na_2O in ash (%)	0.02-0.77	0.02 - 0.77	0.77- 2.3	0.9 - 2.3	0.7 - 2.3
K_2O in ash (%)	0.05-12	0.05-11.9	7.6 - 11.9	5.2 - 8.5	7.6 - 11.9
Heavy metals	Typically low (< 35mg/kg, depending on the metal)				Levels of Pb, Cu and Zn may be significantly higher than uncontaminated wood.

1. Definition from CEN/TS 14961:2005 (CEN 335)
2. The content of bark will influence some of these values, e.g. ash content, level of chlorine, levels of heavy metals.

Sources of information:
- Phyllis database: www.ecn.nl/phyllis
- Biobib database: www.vt.tuwien.ac.at/biobib
- APAS project
- WRAP – Project WOO0036 Identification and assessment of types and levels of chemical contamination in wood wastes; August 2006, available at www.wrap.org.uk
- CEN 335: Solid biofuels – Fuel specifications and classes CEN/TS 14691:2005.

German standard DIN51731 specifies limits on specific metals contents of pellet fuels as follows:

Arsenic <0.8 mg/kg
Cadmium <0.5 mg/kg
Chromium <8 mg/kg
Copper <5 mg/kg
Mercury <0.05 mg/kg
Lead <10 mg/kg
Zinc <100 mg/kg

[6] Chlorine content varies depending on wood and land it is grown on. Values have been observed between: 10-200mg/kg

Table B4 : Overview of standards for biomass fuels

CEN Committee	What does the standard cover?	Additional comments
335	Standard for all forms of **solid biofuels** in Europe, including wood chips, wood pellets, briquettes, logs, sawdust and straw bales. These standards allow all relevant properties of the fuel to be described, and include both normative information that must be provided about the fuel, and informative information that can be included but is not required. As well as the physical and chemical characteristics of the fuel as it is, CEN 335 also provides information on the source of the material. **STATUS**: All Technical Specifications[7] for CEN 335 have now been published.	The Work Programme for TC 335 contains 30 Work Items, which are allocated to 5 Working Groups (WGs): • WG 1 Terminology, descriptions and definitions; • WG 2 Fuel specifications, classes and quality assurance; • WG 3 sampling and sample preparation; • WG 4 Physical and mechanical test methods; • WG 5 Chemical test methods.
343	Standards for **'solid recovered fuels'**. These are defined in the mandate for this standardisation work as: "fuels prepared from non-hazardous waste to be utilised for energy recovery in waste incineration or co-incineration plants regulated under Community environmental legislation". **STATUS**: All Technical Specifications for CEN 343 have now been submitted to the formal vote.	The Work Programme for TC 343 is allocated to 5 Working Groups: • WG1 Terminology and Quality Assurance; • WG2 Fuel specifications and classes; • WG3 Sampling, sample reduction and supplementary test methods; • WG4 Physical/Mechanical tests; • WG5 Chemical Tests.
383	Standard for **sustainability of biofuels** This Committee has only recently been established. It will develop standards to allow the measurement of the sustainability of biofuels as indicated in the Renewable Energy Directive.	It is not clear whether these standards will be updated for solid biomass in 2010 or if they will include solid biomass from the start.

[7] A Technical Specification is published by CEN but is not a full Standard; it provides a mechanism to publish a pre-Standard where, for example, there is a need gather information for a Standard.

Table B5: Summary of woody fuel categories specified in CEN 335		
Fuel type	**Property**	**Categories**
Pellets	**Origin and Source**	
	Dimensions	5 grades in range <6<Diameter<25+ mm Length less than 4 or 5 x Diameter
	Moisture content	3 grades in range up to 20%+ by weight
	Ash content	5 grades in range up to 6%+ by weight
	Sulphur content	4 grades in range up to 0.2%+ by dry weight
	Mechanical durability	3 grades in range 90%->97.5% by weight after testing
	Amount of fines	3 grades in range 0-2%+ weight per cent less than 3.15 mm at factory gate
	Additives	Weight % of pressing mass
	Nitrogen content	5 grades in range up to 3%+ by dry weight
	Net calorific value or energy density	Stated in MJ/kg as received
	Bulk density	Stated in kg/m^3 loose if traded by volume
	Chlorine content	4 grades in range up to 0.1%+ by dry weight
Wood chips	**Origin and Source**	
	Dimensions	4 grades of particle size with 80% of particles in range <16<particle size<100+ mm
	Moisture content	5 grades in range up to 65%+ by weight
	Ash content	5 grades in range up to 10%+ by weight
	Nitrogen content	4 grades in range up to 3%+ by dry weight
	Net calorific value or energy density	Stated in MJ/kg as received
	Bulk density	Stated in kg/m^3 loose if traded by volume
	Chlorine content	4 grades in range up to 0.1%+ by dry weight
Log woods	**Origin and Source**	
	Dimensions	5 grades in range <200<Length<1000 mm <20<Diameter<350+ mm
	Moisture content	4 grades in range up to 65%+ by weight
	Wood type	Deciduous, coniferous or mixed
	Energy density	Stated in kWh/m^3 loose or stacked
	Proportion of split volume	
	Cut-off surface	Even or smooth
	Mould and decay	If greater than 10% by weight
Sawdust	**Origin and Source**	
	Moisture content	5 grades in range up to 65%+ by weight
	Ash content	4 grades in range up to 6%+ by weight
	Nitrogen content	4 grades in range up to 3%+ by dry weight
	Net calorific value or energy density	Stated in MJ/kg as received
	Bulk density	Stated in kg/m^3 loose if traded by volume
	Chlorine content	4 grades in range up to 0.1%+ by dry weight

Properties printed in **bold** are normative: provision of this information is a requirement of the standard.

Properties printed in *italics* are normative only for chemically treated biomass

Properties printed as normal text are informative: it is recommended that the information is provided.

Appendix C – Screening Models

Several screening models are available that may be useful in assessing the impact of biomass combustion installations.

- **ADMS-Screen** is available from the developers, CERC. It is based on the detailed ADMS model but makes use of a number of pre-defined meteorological datasets.

- **AERSCREEN** is the screening model for AERMOD. The model will produce estimates of regulatory design concentrations without the need for meteorological data and is designed to produce concentrations that are equal to or greater than the estimates produced by AERMOD with a fully developed set of meteorological and terrain data. The US EPA is currently working on a beta version of the code that will be released to the public as soon as possible.

- **The third edition of the 1956 Clean Air Act Memorandum**: Chimney Heights "The Clean Air Act Memorandum" provides simple numerical formulae for assessing chimney heights. It was developed based on a simple dispersion algorithm. Separate formulae are used for very low sulphur fuels (less than 0.04% by weight) and for other fuels, i.e. containing sulphur. Most forms of biomass may be considered to be very low sulphur fuels except where the biomass has been chemically treated. The method is applicable for fuel burning plant with gross heat input in the range 150 kW to 150 MW. The method seeks to determine the minimum height for a chimney that will ensure adequate dispersal of pollutants produced in normal combustion; these include oxides of nitrogen. It does not deal with grit and dust emissions. The calculations assume that an adequate efflux velocity for the flue gas will be achieved to prevent the plume of gas flowing down outside of the chimney. For boilers up to 2.2 MW input, the target velocity should not be less than 6 m/s at full load although it is recognised that many existing designs of small installations cannot achieve this. For boilers equipped with induced draught fans, higher velocities are required. The Chimney Heights Memorandum provides a simple algorithm for taking account of the effect of nearby buildings on dispersion. The Chimney Heights Memorandum is widely used for assessing the height of discharge stacks for gas boilers: local authorities should consider whether it is reasonable to apply a more stringent criterion for biomass combustion than gas combustion when considering the impact of oxides of nitrogen emissions. The formulae for very low sulphur fuels have been included in the Unit Conversion Tool workbook available at www.environmental-protection.org.uk/biomass.

- **HMIP Technical Guidance Note (Dispersion)** D1 provides a simple set of formulae for assessing the short-term impact of pollutant emissions. It was developed by systematically running a dispersion model based on the NRPB R91 model for a range of discharge conditions. It is not appropriate for assessing the impact of oxides of nitrogen and particulate matter emissions from biomass boilers. D1 was developed in 1993 and addresses short term impacts, typically 15-30 minutes. Current air quality objectives for PM are associated with annual mean and 24-hour mean objectives. D1 is not applicable to the longer-term objectives. D1 should only be used where the discharge velocity exceeds 10 m/s: the discharge velocities for natural draught biomass boilers are often considerably less.

- **Environment Agency Guidance** for estimating the air quality impact of stationary sources (GSS) was a chart-based system for calculating the maximum impact of pollutant releases from a process stack. It was developed using results from systematic application of the ADMS2 model for a range of geographical and discharge situations.

- **Industrial nomographs** are provided in Technical Guidance for Local Authority Review and Assessment LAQM.TG(03) for the assessment of NO_x and PM_{10} emissions against the Air Quality Strategy objectives. The nomographs were based on the GSS charts. The method takes account of the effect of the height of nearby buildings using the approach adopted for the Chimney Heights Memorandum. The method is limited to effective stack heights greater than 10 m and assumes a discharge temperature of 100°C. The method in LAQM.TG(09) is intended to identify emissions sources that create a potential risk of locally exceeding the Air Quality Strategy objectives. The assessment criteria for development control decision-making are different from those for Local Authority Review and Assessment. The method has therefore been adapted for this study and a spreadsheet tool to calculate maximum annual mean ground level concentrations has been included in the Unit Conversion Tool workbook available at www.environmental-protection.org.uk/biomass.

- **Biomass nomographs** were developed for inclusion in Technical Guidance for Local Authority Review and Assessment LAQM.TG(09). The nomographs were developed using results from systematic application of the ADMS4 model for a range of discharge situations appropriate for biomass combustion installations. The method takes account of the effect of the height of nearby buildings using the approach adopted for the Chimney Heights Memorandum. The method was intended to identify biomass emissions sources that create a potential risk of locally exceeding the Air Quality Strategy objectives. The assessment criteria for development control decision-making are different from those for Local Authority Review and Assessment. The method has therefore been adapted for this study and a spreadsheet tool to calculate maximum annual mean ground level concentrations has been included in the Unit Conversion Tool workbook available at www.environmental-protection.org.uk/biomass.

Appendix D – The Air Quality Standards for England and Wales

UK Objectives not included in regulations

D1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (the UK Air Quality Strategy) also contains a number of objectives, which are not included in regulations for the purposes of LAQM. They are intended as drivers for UK air pollution policy, as are the other objectives, but it is not thought appropriate for local authorities to assess against them at this time. The main reasons for this are that local authorities lack the necessary policy instruments to address the pollutant in question, or that the pollutant is regional in nature and therefore not suitable for local control (e.g. ozone).

Table D1: Objectives for the Purposes of Local Air Quality Management (included in the Air Quality Regulations, as amended)

Pollutant	Objective	Measured as	To be achieved by
Benzene	16.25 µg/m^3	Running Annual Mean	31 December 2003
	5 µg/m^3	Annual Mean	31 December 2010
1,3-Butadiene	2.25 µg/m^3	Running Annual Mean	31 December 2003
Carbon monoxide	10.0 mg/m^3	Maximum daily running 8 Hour Mean	31 December 2003
Lead	0.5 µg/m^3	Annual Mean	31 December 2004
	0.25 µg/m^3	Annual Mean	31 December 2008
Nitrogen Dioxide	200 µg/m^3 Not to be exceeded more than 18 times per year	1 Hour Mean	31 December 2005
	40 µg/m^3	Annual Mean	31 December 2005
Particles (PM_{10}) (gravimetric)	50 µg/m^3 Not to be exceeded more than 35 times per year	24 Hour Mean	31 December 2004
	40 µg/m^3	Annual Mean	31 December 2004
Sulphur dioxide	266 µg/m^3 Not to be exceeded more than 35 times per year	15 Minute Mean	31 December 2005
	350 µg/m^3 Not to be exceeded more than 24 times per year	1 Hour Mean	31 December 2004
	125 µg/m^3 Not to be exceeded more than 3 times per year	24 Hour Mean	31 December 2004

Table D2: National Objectives not included in the AQ Regulations

Pollutant	Objective	Measured as	To be achieved by
Objectives for the protection of human health			
Ozone	100 µg/m^3 Not to be exceeded more than 10 times per year	Daily maximum of running 8 hr mean	31 December 2005
Particles ($PM_{2.5}$) (gravimetric)	25 µg m^3 (target)	Annual Mean	2020
	15% cut in urban background exposure	Annual Mean	2010-2020
PAHs (Benzo(a)pyrene)	0.25 ng/m^3	Annual Mean	31 December 2010
Objectives for the protection of vegetation and ecosystems			
Nitrogen Oxides	30 µg/m^3	Annual Mean	31 December 2000
Sulphur dioxide	20 µg/m^3	Annual Mean	31 December 2000
	20 µg/m^3	Winter Mean (01 October - 31 March)	31 December 2000
Ozone	18 µg m^{-3}	AOT40+, calculated from 1h values May-July	Mean of 5 years, starting 01 January 2010

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England and Wales

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