Co-firing of Biomass at UK Power Plant
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1. INTRODUCTION

The Government has set ambitious targets for the country regarding reduction of CO₂ emissions. One of the methods to reduce these emissions is co-firing of biomass with the considerable amount of coal that is currently burned by the UK power industry.

Biomass co-firing provides a relatively low-cost means of increasing renewables capacity, and an effective way of taking advantage of the high thermal efficiency of large coal-fired boilers. It is also recognised within the Government’s Renewables Obligation as an effective means of stimulating the development of a market for biomass fuels and energy crops within the UK.

The use of biomass as a renewable energy source is beneficial to the environment and can make a real contribution to the UK Government’s renewable targets and obligations. However, without economic and political incentives it would be difficult to commercially justify the on-going utilisation of biomass in the UK, since biofuels are generally much more expensive than conventional fuels, and have significantly different properties with respect to storage, bulk handling, volume flow, milling, combustion, slagging, corrosion, and gaseous emissions.

In the UK, such incentives have been provided through the issuing of Renewable Obligation Certificates (ROCs) and to a lesser extent Levy Exemption Certificates (LECs), for power produced by co-firing biomass. As a result, many of the utility companies in the UK have developed projects that take advantage of these incentives, as indicated by Table 1. Factors that will potentially influence the continued utilisation and further uptake of biomass co-firing in the future include higher fossil fuel prices and the value of carbon credits under the EU’s Emissions Trading Scheme (ETS).
This experience has raised issues in a number of areas which lead to complications during plant design, construction and commissioning. Consequently, there is a large amount of experience and information regarding combustion and co-combustion of biomass available in the UK, and through the links that have been developed with a range of organisations involved in these activities worldwide.

Through the DTI, the Government is also supporting a number of initiatives related to the co-firing of biomass at power stations. Although these projects include elements of dissemination, by themselves they are somewhat fragmented, with overall reporting timescales that are significantly longer than have been achieved with this brochure.

This Best Practice Brochure¹ summarises the experience derived from all the current biomass co-firing activities in the UK. It is designed to disseminate relevant information between all those involved in biomass co-firing activities, and to speed up the implementation of the most successful methods. It provides details of the solutions that have been adopted to the issues encountered, along with a commentary on those issues that still need to be resolved as further projects are developed, and the market drivers change towards the utilisation of energy crop and dedicated biomass combustion plant.

### 1.1 Co-firing vs Dedicated Biomass Plant

There are two main options available for utilising biomass as a renewable energy source in the generation industry: construction of ‘stand-alone’ dedicated biomass plant, or co-firing of biomass with other fuels in existing combustion plant.

Stand-alone or dedicated biomass plants are defined in the Renewables Obligation as those which have been commissioned since 1 January 1990 and are fuelled wholly by biomass in any month, although fossil fuel or

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¹ A comprehensive report (Report No. COAL R287, DTI/Pub URN 05/1160) is available from the DTI website (http://www2.dti.gov.uk/energy/coal/cfft/cct/pub/reports.shtml)
waste (eg residual fuel oil) can be used for certain purposes (eg ignition, stabilisation, emission control, stand-by) on a dedicated biomass plant. The Obligation also allows plant commissioned prior to 1 January 1990 to be used as dedicated biomass plant, provided that certain conditions are met with regard to current biomass utilisation.

It is possible to optimise a stand-alone biomass plant at the design stage, and therefore allow for any peculiarities specific to the fuel to be burned. In this way, dedicated plants present an advantage over co-firing biomass on an existing plant, where the plant design and systems will have been optimised for the primary fuel.

Planning, design, authorisation, construction and commissioning of new dedicated biomass power plants can take a number of years and involve significant costs. Capital and operating costs are typically orders of magnitude higher than for co-firing schemes of similar capacity and hence payback periods are significantly longer. This increases the reliance of dedicated biomass schemes on renewables support mechanisms and associated capital grant schemes. Investor confidence in the long-term security of such mechanisms is also clearly essential for dedicated biomass development. Only one dedicated biomass scheme developed in the context of the Renewables Obligation has to date entered construction. It is, however, noted that others, including E.ON’s 43MWe Lockerbie project, are in the final stages of development.

On the other hand, existing fossil fuel-fired power stations can quickly be modified for co-firing and achieve considerable levels of renewable generation, with lower capital costs and less commercial risk. The direct displacement of coal when co-firing plus the higher conversion efficiencies generally achieved also contribute to higher CO₂ reduction benefits from each co-fired tonne of biomass. Further modifications could be made to enable the use of a broader spectrum of less processed biomass fuels, if in the longer term financial incentives were sufficient to justify this.

Initially, off-site ‘pre-blending’ with coal (particularly at load ports or railheads) was favoured by many generators due to the investment required to install equipment for on-site blending. However, Ofgem has concerns regarding the ability of generators involved in pre-blending to fulfil the measurement and sampling requirements of the Renewables Obligation. In particular, these concerns relate to perceived risks of biomass fuels deteriorating in transit to the site, and the accuracy with which blends can be analysed to determine the biomass content at the generating station. Consequently, co-fired generators have been blending on-site or utilising direct injection routes.

Throughout the development of the legislation, the relatively short period of eligibility for co-firing under the Renewables Obligation has favoured low capital expenditure schemes with short lead times. For coal-fired plant, on-site blending of biomass with the primary fuel prior to co-milling has proved to be the least capital intensive approach, and is currently the most popular method for co-firing in use in the UK’s large coal-fired power stations listed in Table 1.

Figure 1. Ironbridge Power Station (courtesy of E.ON UK plc)
1.2 Descriptions of Relevant Plant

1.2.1 Introduction to Coal-fired Power Stations

In the UK, the term ‘coal-fired’ is used to refer to power stations which burn a range of solid fossil fuels in boilers to heat water, thereby producing high-pressure, high-temperature steam. The steam is used in turbine-generators to produce electricity, which is measured in units of megawatts (MW).

The typical layout of a large power station in the UK comprises a number of units, each consisting of a boiler, a turbine-generator set, and ancillaries (see Figure 2).

The range of fuels burned in modern coal-fired power stations vary widely in terms of chemical composition and physical properties.

Prior to combustion, fuel particle size is reduced in pulverising mills to a fine powder (‘pulverised fuel’) which is pneumatically conveyed to the furnace where it burns more rapidly, completely, consistently and controllably than could be achieved with the delivered feedstock.

The pulverised fuel is burned with controlled quantities of air to achieve the desired combustion behaviour necessary to achieve the required efficiency and environmental performance. The boiler walls are constructed from tubes in which water is heated to produce steam. ‘Superheat’ and ‘reheat’ sections of the boiler allow a range of temperatures and pressures to be achieved and maximise the efficiency of the steam raising process.

All coals contain organic and inorganic fractions. The non-combustible inorganic fraction (‘ash’) is collected from the base of the boiler (‘bottom ash’) and from the exhaust gas stream (‘fly ash’). Much of this ash is utilised in other industries, such as cement production and road surfacing.

At the high temperatures inherent with combustion in a boiler, the organic fraction of the fuel reacts with air to produce a range of gases (collectively termed ‘flue gas’) including oxides of nitrogen (NOX) and sulphur (SOX), and carbon dioxide. After passing through heat recovery stages and having the fly ash removed in electrostatic precipitators, the flue gas is exhausted from the boiler to the atmosphere via the chimney stack.

Most power stations have some form of emissions control equipment to mitigate their environmental impact. This may be in the form of optimised hardware, fuel additives, process control systems or exhaust gas treatment, which in a number of cases now includes flue gas desulphurisation (FGD) in addition to electrostatic precipitators.

Figure 2. Typical power station boiler system (courtesy of E.ON UK plc)
Table 2 provides typical technical data for coal-fired power plant in the UK:

| Table 2. Typical technical data for UK coal-fired power plant |
|---------------------|-----------------------------|
| **Unit sizes**      | MW | Up to 660 |
| **Unit efficiency** | %  | Up to 40% |
| **Emissions**       |    |           |
| NO<sub>x</sub>      | mg/Nm<sup>3</sup> | 500 to 650 |
| SO<sub>x</sub>      | mg/Nm<sup>3</sup> | ~500 (with FGD*) |
|                     |    | ~2000 (no FGD*, low S coal) |
| **CO<sub>2</sub>**  | tph | 280 to 580 |
|                     | tCO<sub>2</sub>/MWh | 0.88 to 0.99 |
| **Carbon-in-ash**   | %  | 2 to 20 |

*FGD = flue gas desulphurisation

### 1.2.2 Co-milling of Biomass

The approach that has currently been adopted to biomass co-firing in most coal-fired power stations in the UK is to pulverise the coal and biomass simultaneously in the existing pulverising mills. This approach has been termed ‘co-milling’, and it allows the simultaneous size reduction and drying of both the biomass and coal, prior to the two fuels being burned together in the furnace.

Where a co-milling approach is adopted, the biomass and coal may be blended before or after delivery to the power station. The former option is referred to as ‘off-site blending’, and results in a single fuel stream to the power station, which can be handled in a similar way to coal. The latter option is referred to as ‘on-site blending’; where two fuels are delivered to the power station, and require separate reception and handling facilities up until the point where the two fuel streams are blended into one. All stations that are co-milling biomass in the UK are using on-site blending to satisfy Ofgem’s audit requirements.

### 1.2.3 Direct Injection

‘Direct injection’ offers an alternative route for supplying co-fired biomass to a coal-fired boiler. It involves the introduction of the biomass to the boiler in a separate stream, through separate burners/injectors. This provides several advantages over co-milling, the most significant being that the biomass does not affect the flow, milling and classification of the coal, and it avoids the unit load limitations that can occur when co-milling with low calorific value coals or biomass. However, this type of installation is much more capital intensive than the limited modifications required for a co-milling approach.

The separate handling of biomass also allows co-firing to be carried out in a plant that has strict limits on volatile content in the coal. Biofuels typically contain around 80% volatile matter (on a ‘dry ash free’ basis), whereas coal-fired plant in the UK are designed to receive coals with dry ash free volatile contents of less than 45% for bituminous coals and 10% for anthracitic coals. This separate handling also has the advantage that problems that would occur when materials with bad milling properties are sent through the mill can be effectively bypassed.

Installations for direct injection schemes have ranged from a simple hopper feeding a pneumatic transport line leading directly into the furnace, to elaborate chipping/grinding plant feeding separate biomass burners with a complete burner control system.

### 2. LEGISLATION

All companies have an impact on the environment and as such are morally and legally responsible for managing these effects - and environmental legislation has been developed over the years to ensure that any impact stays within acceptable limits. Environmental legislation tends to be complex and constantly changing. In recent years, the volume of legislation concerned with the environment has also increased significantly, and an overview of this legislative framework and its implications for biomass co-firing is provided here.
There are now a number of EU Directives of direct relevance to the power industry. For example, the Integrated Pollution Prevention and Control (IPPC) Directive specifies that Best Available Techniques (BAT) for minimising pollution should be determined for various industry categories, including Large Combustion Plant. The European Pollutant Emission Register (EPER), established by a separate decision, under the umbrella of the IPPC Directive, requires Member States to report national emissions of listed pollutants.

In addition to the Renewables Obligation (RO), environmental legislation that has been enacted in the UK which makes specific reference to the use of biomass fuels in power stations includes the Large Combustion Plant Directive (LCPD), the Climate Change Levy (CCL), and the Waste Incineration Directive (WID).

Also, the alteration of activities in any industry can involve verification of local planning applications to ensure that all permissions are adhered to. Naturally, the same requirements exist for the power industry and, as such, the issues that have been raised as a result of co-firing activities are also considered here.

Throughout the UK, ‘Integrated Pollution Control’ (IPC) is being phased out and replaced by the ‘Pollution Prevention and Control’ (PPC) regime. This implements the EU’s ‘Integrated Pollution Prevention and Control’ (IPPC) Directive within the UK, and builds on many of the same principles as IPC. Under PPC, power stations are classed as ‘Energy Industry Combustion Activities’ and fall within the Part A(1) process category. Permits issued under PPC must be based on the Best Available Techniques (BAT), taking into account the local environmental conditions, geographical location and technical characteristics of the specific installation.

PPC includes new issues not previously covered by IPC such as vibration, noise, waste minimisation and energy efficiency. This new system also requires that an effective management system is in place to ensure that all pollution prevention and control measures are taken.

Before burning biomass material, all combustion plant operating under IPC/IPPC need to apply for approval from the Environment Agency (EA). These applications are made through local EA Area Inspectors, and for the earliest biomass co-firing applications this led to some inconsistency in approach to the approvals given. The EA and the Joint Environmental Programme (JEP) subsequently worked together to produce a protocol for the approval process. This protocol has helped to standardise the approvals for operators and also allowed some streamlining of the process.

### 2.1 IPC Authorisations/IPPC Permits

The Environmental Protection Act 1990 and the Industrial Pollution Control (Northern Ireland) Order 1997 have created a UK-wide pollution control system for industry where any person carrying out a prescribed process must obtain authorisation from the environmental regulator which will contain conditions that they must adhere to.

The revised Large Combustion Plant Directive (LCPD) is particularly important since this establishes emission limit values (ELVs) for new and existing plant, in addition to making further provisions for pollution inventory reporting in support of the European Pollutant
Emission Register (EPER) requirements. However, it should be noted that it is necessary to satisfy the requirements of both the LCPD and the IPPC Directive.

Under this legislation, existing combustion plant must either observe lower emission limits, or achieve equivalent emission reductions via a national emissions reduction plan, by 2008, unless it is intended to close the plant after a further 20,000 operating hours between 2008 and the end of 2015. Plant that is upgraded to meet the Part A Emission Limit Values, defined in the Annexes of the Directive, is ‘opted in’. Plant that is designated for eventual closure is ‘opted out’.

The LCPD limit values for existing and new plant larger than 300MWth are given in Table 3. There are specific requirements for both monthly averages and 48-hour averages, and numerous caveats within the text of the Directive. Continuous emissions monitoring is required for all plant greater than 100MWth and the LCPD also requires compliance with CEN standards relating to the quality assurance of these monitoring systems.

Table 3. Nominal LCPD emission limit values for large plant (>300 MWth)

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Existing (Part A)*</th>
<th>New (Part B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solid</td>
<td>Liquid</td>
</tr>
<tr>
<td>SO₂</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>NOₓ</td>
<td>500</td>
<td>400</td>
</tr>
<tr>
<td>Dust</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Ref. O₂ dry</td>
<td>6%</td>
<td>3%</td>
</tr>
</tbody>
</table>

* Valid until 31 December 2015

Since 2004, each large combustion plant must also report an inventory of total annual SO₂, NOₓ and dust emissions and the total annual energy input and net calorific value by fuel type. Biomass is identified as a separate fuel category, in common with the provisions of the EU Guidelines for the Monitoring and Reporting of Greenhouse Gas Emissions.

The LCPD defines biomass as any product consisting of vegetable matter from agriculture or forestry which can be used as a fuel for the purpose of recovering its energy content. The LCPD also includes a list of biomass wastes that are exempt from the provisions of the Waste Incineration Directive (see Table 4).

### 2.3 Levy Exemption Certificates

As part of a range of measures to help the UK meet its commitment to reduce greenhouse gas emissions and create a low carbon economy, the UK Government introduced the Climate Change Levy (CCL) on industrial and commercial (I&C) users in April 2001. Under this scheme, I&C users of electricity

Table 4. Biomass wastes that are exempt from the provisions of the Waste Incineration Directive

- Vegetable waste from agriculture and forestry
- Vegetable waste from the food processing industry (with heat recovery)
- Fibrous vegetable waste from virgin pulp and paper production from pulp, if it is co-incinerated at the place of production and the heat generated is recovered
- Cork waste
- 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 originating from construction and demolition

NB List limited to Renewables Obligation biomass likely to be co-fired in fossil fuel-fired plant. See the Waste Incineration Directive (Article 2, Paragraph 2) for the complete list.
must pay an additional £4.30/MWh for their electricity. Payments are made to HM Revenue & Customs (HMRC) and partly administered by Ofgem. These payments can be avoided by either investing in energy efficient machinery (80% rebate), or purchasing a Levy Exemption Certificate (LEC) as evidence of having consumed a unit of electricity (1 MWh) generated using renewables (100% rebate). It is generally thought that the I&C user is prepared to pay up to £4.00/MWh to the electricity supplier for an LEC which enables it to avoid paying £4.30/MWh to HMRC and that the electricity supplier in turn would pay up to £3.40/MWh for a renewable LEC to the generator, meaning that the electricity supplier is the essential link. The final value that the generator receives for renewable LECs is subject to negotiation and is market-based, and therefore unstable until contract completion.

In addition, the EU Emissions Trading Scheme (ETS) was launched on 1 January 2005. Both of these measures may award value to renewable generators, because renewable generation is exempt from the CCL and from the EU ETS.

The CCL exemption can be traded through LECs, whereas carbon values from the ETS are likely to be passed on through higher wholesale electricity prices.

### 2.4 Renewables Obligation

The Renewables Obligation was introduced on 1 April 2002, and extended to Northern Ireland in 2005. It is effective until 31 March 2027 and has the following goals:

- Increasing the amount of electricity generated from renewable energy sources to 15.4% of total supply in 2015
- Reducing carbon dioxide emissions
- Maintaining investor confidence in the development of renewable energy sources
- Development of an integrated UK biomass production and utilisation industry.

It requires all licensed electricity suppliers in the UK to supply a specified proportion of their electricity sales from a choice of eligible renewable sources, and provides a number of paths to compliance. This is the key instrument

Figure 4. A photo-montage of renewable energy projects (images courtesy of E.ON UK plc)
the Government is using to influence the growth necessary to reach the UK’s renewable energy targets in the power sector.

The Renewables Obligation defines a number of eligible renewable energy sources which include combustion of biomass in dedicated plant; co-firing of biomass and energy crops (subject to the restrictions detailed in Table 5); and pyrolysis, gasification & anaerobic digestion of biomass and biomass/waste blends (such plant can only claim Renewable Obligation Certificates (ROCs) for the biomass component of mixed waste). For the purposes of the Renewables Obligation, biomass is defined as a “fuel from which at least 98% of the energy content is derived from plant or animal matter”.

ROCs are awarded for eligible renewable generation from the above technologies. In order to limit the impact of large-scale co-firing on the ROC market, restrictions have been placed both on the fuels used at co-fired stations and on an electricity supplier’s ability to demonstrate compliance with the Renewables Obligation using co-fired ROCs (the ‘Co-firing Cap’).

An additional restriction on fuel type is that from 2009 onwards an increasing proportion of the fuel used for co-firing will have to be sourced from energy crops. This is also designed to encourage the development of indigenous supplies of this feedstock. Energy crops are defined as crops planted after 31 December 1989, and grown primarily for the purpose of being used for fuel.

Details of the other targets and restrictions on co-firing, as they are currently defined, are set out in Table 5.

The Government is currently reviewing the legislative framework that should be put in place beyond 2015. It has said that no major changes that will create uncertainty for project developers will be undertaken.

Table 5. Targets and restrictions on co-fired renewable generation

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated UK sales by licensed suppliers (TWh)</th>
<th>Suppliers’ obligation (% renewables)</th>
<th>Total obligation (TWh)</th>
<th>Co-firing cap (%)</th>
<th>Predicted maximum co-fired ROCs (TWh)</th>
<th>Proportion of co-firing to be energy crop (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001/2002</td>
<td>310.9 *</td>
<td>3.0</td>
<td>9.4</td>
<td>25</td>
<td>2.4</td>
<td>-</td>
</tr>
<tr>
<td>2002/2003</td>
<td>313.9 *</td>
<td>4.3</td>
<td>13.5</td>
<td>25</td>
<td>3.4</td>
<td>-</td>
</tr>
<tr>
<td>2003/2004</td>
<td>316.2 *</td>
<td>4.9</td>
<td>15.6</td>
<td>25</td>
<td>3.9</td>
<td>-</td>
</tr>
<tr>
<td>2004/2005</td>
<td>318.7 *</td>
<td>5.5</td>
<td>17.7</td>
<td>25</td>
<td>4.4</td>
<td>-</td>
</tr>
<tr>
<td>2005/2006</td>
<td>320.6 *</td>
<td>6.7</td>
<td>21.5</td>
<td>10</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td>2006/2007</td>
<td>321.4 *</td>
<td>7.9</td>
<td>25.4</td>
<td>10</td>
<td>2.5</td>
<td>-</td>
</tr>
<tr>
<td>2007/2008</td>
<td>322.2 *</td>
<td>9.1</td>
<td>29.4</td>
<td>10</td>
<td>2.9</td>
<td>-</td>
</tr>
<tr>
<td>2008/2009</td>
<td>323.0 *</td>
<td>9.7</td>
<td>31.5</td>
<td>10</td>
<td>3.2</td>
<td>25</td>
</tr>
<tr>
<td>2009/2010</td>
<td>323.8 *</td>
<td>10.4</td>
<td>33.6</td>
<td>10</td>
<td>3.4</td>
<td>50</td>
</tr>
<tr>
<td>2010/2011</td>
<td>324.3 †</td>
<td>11.4</td>
<td>37.1</td>
<td>5</td>
<td>1.9</td>
<td>75</td>
</tr>
<tr>
<td>2011/2012</td>
<td>325.2 †</td>
<td>12.4</td>
<td>40.4</td>
<td>5</td>
<td>2.0</td>
<td>75</td>
</tr>
<tr>
<td>2012/2013</td>
<td>326.7 †</td>
<td>13.4</td>
<td>43.8</td>
<td>5</td>
<td>2.2</td>
<td>75</td>
</tr>
<tr>
<td>2013/2014</td>
<td>327.5 †</td>
<td>14.4</td>
<td>47.2</td>
<td>5</td>
<td>2.4</td>
<td>75</td>
</tr>
<tr>
<td>2014/2015</td>
<td>328.2 †</td>
<td>15.4</td>
<td>50.5</td>
<td>5</td>
<td>2.5</td>
<td>75</td>
</tr>
</tbody>
</table>

* Source = DTI † = Extrapolated data
2.5 Renewables Obligation Auditing

Under the Renewables Obligation Order, Ofgem is only authorised to issue ROCs once it is satisfied that a number of relevant criteria have been met. Consequently, as well as operating routine checks and controls, Ofgem carries out audits each year on a sample of generating stations. Ofgem carried out 20 audits of accredited generating stations during the first obligation period. The sample size has been increased in subsequent years and will be maintained at a level deemed necessary to ensure the integrity of the scheme. Whilst most of the outcomes were satisfactory, some recurring issues did arise, mainly with regard to interpretation of terms used within the Renewables Obligation and the methods used for calculating the numbers of ROCs claimed.

The requirements that need to be met to claim for co-fired ROCs are contained in the Renewables Obligation Order 2005. This replaced the Renewables Obligation Order 2002 and the Renewables Obligation (Amendment) Order 2004. The updates to the legislation were designed to address unforeseen operational difficulties and to ensure the Renewables Obligation delivers its renewable targets.

Generators are advised to read these documents with care. To avoid misinterpretation, Ofgem encourages the submission of a proposed ROC claims procedure prior to commencing co-firing, and is willing to meet with generators to discuss how the biomass measurement requirements can be fulfilled at each station. It is noted that due to concerns regarding commercial confidentiality, RO procedures operating at existing biomass sites are not transparent.

Whilst the fundamental principles established within the legislation are clear, the implications of the detailed requirements for biomass sites are not immediately apparent. Additional guidance on Ofgem’s interpretation of these requirements is, however, available on its website.

Given the complexities of the Orders, it might be expected that biomass generators would experience some difficulties at the start of the scheme and the audit findings to date seem to bear this out. Where misunderstandings and disputes have arisen, the absence of an appeals mechanism under the Renewables Obligation and the lack of transparency have, in many cases, compounded issues experienced by generators.

Where a claim satisfies Ofgem’s requirements for accuracy and reliability, ROCs will be issued approximately one month after the deadline for submission (three months after the month of burn). However, the administrative requirements of the Renewables Obligation for biomass utilisation and the complexity of the processes involved should not be underestimated. The requirements may also change with time, and the onus is on the generator to monitor for these changes and respond accordingly.

Where there are problems with a ROC claim procedure this may not come to light until after the ROC claim is processed (up to three months after generation), and it may be some considerable time before the issue can be resolved to Ofgem’s satisfaction. Consequently, in a number of cases, generators have built up large financial liabilities with respect to their ROCs claims.
2.6 Waste Incineration Directive

The Waste Incineration Directive (WID) has applied to all new waste incineration installations since 28 December 2002 and applies to all existing installations co-firing certain wastes from 28 December 2005.

The purpose of the directive is to limit or prevent, as far as practicable, negative effects on the environment, in particular, pollution by emissions into the air, soil, surface water and groundwater, and minimise the resulting risks to human health from the incineration and co-incineration of waste. The directive will require the setting and upholding of stringent operational conditions, technical requirements and emission limit values for plants incinerating and co-incinerating waste throughout the European Union, to achieve a high level of environmental and health protection.

Generating stations may fire unadulterated, plant-derived, biomass products and by-products without reference to the WID. They may also fire plant-derived biomass waste that is WID exempt (see Table 4 and Article 2, Paragraph 2 of the Directive). Both are eligible for ROCs. However, if a biomass waste is not WID exempt, the station would be subject to some of the additional requirements specified by the WID, eg much more stringent air emission limit values, reduced flexibility with regard to operating conditions, additional measures relating to water discharges from exhaust gas cleaning, ash recycling, plant control and monitoring, and public access to information. It is, therefore, generally uneconomic for an existing generating station to burn biomass that is not WID exempt.

Figure 6. A wall-fired burner flame (courtesy of E.ON UK plc)

The Environment Agency has confirmed that all of the plant-derived biomass materials co-fired in the UK to date are exempt from the WID even if these could be classified as waste under some circumstances.

Given the broad EU definition of a waste as “any substance... which the holder discards or intends or is required to discard”, there is a concern that certain biomass types that may not be traditionally viewed as such, could be classified as wastes, requiring compliance with the Waste Management Regulations. This could, therefore, apply to some materials that are exempt from the provisions of the WID.

Classification of biomass as a waste, even when WID exempt, may result in substantially increased costs arising from compliance with the Waste Management Regulations, and individual organisations will have to verify their Duty of Care requirements for the transportation of such biomass fuels. This may have a significant negative impact on the supply of biomass as a renewable energy source.

Under the Renewables Obligation, ‘biomass’ is defined as a material in which at least 98% of its energy content is derived from plant or animal matter when it is used as a fuel. This may include the co-firing of waste (eg municipal solid waste fractions) to produce ROCs – as long as the waste materials meet this definition.
2.7 Local Authority (Planning Consents)

Development consent for new electricity generating stations over 50MWe is required under Section 36 of the Electricity Act 1989.

To date, experience of biomass co-firing in the UK suggests that the Department of Trade and Industry does not consider these changes sufficient to require Section 36 Consent under the Electricity Act 1989, despite all such schemes involving some extension of power station facilities and some change in operation. However, operators should satisfy themselves that Section 36 Consent exists or is not required for their schemes.

In addition, the Town and Country Planning Order permits certain developments for electricity generating purposes by generation licence holders, and a biomass co-firing scheme can often be installed under these permitted development rights without specific planning permission.

If these rights are used, the height of any new building or structure must not exceed 15 metres above ground level or the height of any structure replaced, and a number of other restrictions also apply. It should always be checked that the local authority agrees that construction as part of a co-firing scheme is a permitted development.

Permitted development rights do not apply if a project needs an environmental impact assessment (EIA). If the area involved is over 0.5ha or the site is in a ‘sensitive area’ then the biomass scheme will be a ‘Schedule 2 development’ under the Planning EIA Regulations, for which EIA may be required at the discretion of the local planning authority.

3. COMMERCIAL ISSUES

3.1 Fuel Compatibility

The economic benefits of biomass co-firing can easily be outweighed by the commercial implications of any adverse impacts on load capability, particularly where there is a need to achieve flexibility with respect to overall plant operation. This makes assessing the compatibility of any particular biomass fuel an extremely important aspect of the fuel procurement process.

The impact that a biomass fuel has on plant operation will be dependent on the type of plant involved, especially the configuration of the milling plant if the biomass is to be co-milled, and the range of coals with which the biomass is to be co-fired.

Basic assessment of any new biomass material proposed for a particular plant is typically carried out through a combination of standard fuel analysis techniques, single mill testing and full unit trials. In this way, the following aspects of each fuel are assessed with respect to the co-firing approach to be utilised for commercial biomass co-firing operations:

- Fuel analysis, particularly the calorific value of the fuel, its moisture content, its volatile matter content (used to provide a measure of the reactivity of the fuel and the level of risk associated with blending it with higher volatility coals), and its trace element content (which must lie within limiting levels agreed with the EA).
- Bulk handling characteristics in terms of dust generation, mechanical stability and odour.
● Compatibility with existing plant, particularly the bunkers, feeders and milling plant (where the biomass is to be co-milled), taking into account the impact that each biomass fuel has had on mill throughput, and how this varied with the proportion of biomass blended with the coal.

● Combustion characteristics, particularly fuel burn-out, due to the adverse impact poor burn-out has on electrostatic precipitator performance, fly-ash sales, and overall plant efficiency.

Completion of this evaluation process will often result in a very limited range of fuels being considered suitable for any particular biomass co-firing application. Experience has, however, shown that the range of fuels selected will be plant specific and dependent on a number of factors including the required co-firing levels, the operating regime at the plant, the design and general condition of the fuel handling and milling systems, and the range of coals with which the biomass is to be co-fired.

Clearly, such limitations can restrict the flexibility of biomass co-firing operations. Where this is seen as a limiting factor in the potential commercial success of co-firing, there are a number of improvements which can be made to increase the co-firing capability and widen the range of biomass fuels that can be successfully co-fired on a commercial basis. In many cases, however, these improvements result in higher capital and revenue costs, particularly where there is HSE involvement in the resolution of occupational health and safety issues associated with these operations.

3.2 Fuel Logistics

Typical fuel choices for co-firing have been ‘clean’, plant-derived biomass (eg wood pellets, palm kernel, pelletised cereal co-product). Fuels of this type have been selected to be WID exempt and to satisfy Ofgem’s requirements with respect to verification of fuel purity.

In addition, the selection of fuels for a specific site is governed by fuel consumption rates, security of supply issues, stocking policies, reserve stocks, and transportation issues. Having considered these issues, the value of each selected biomass fuel can then be assessed. This assessment will depend on a number of factors, including relative price, availability, achievable blend ratio, calorific value, additional handling and blending costs, and technical or health and safety risks.

Evaluation of these factors is likely to further reduce the range of biomass fuels that can be utilised at a particular site, and in many cases has led to the identification of one preferred fuel, or even eliminating co-firing as an option without additional capital investment to improve the systems and increase fuel flexibility.