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Renewables Obligation: template methodology for measuring fossil derived contamination within waste wood

Document Type: Guidance Note

Date of Publication: 12th November 2013

Target Audience: Generating stations using waste wood as a fuel source, who wish to claim Renewables Obligation Certificates.

Overview:

Under the Renewables Obligation Order 2009 (RO 2009), as amended, fuelled electricity generating stations that burn waste wood as a fuel to produce electricity are required to demonstrate on a monthly basis, the biomass and fossil derived portions of the fuel as a percentage of total energy content. Ofgem requires this information for the purpose of issuing Renewables Obligation Certificates. Generators are required to propose fuel measurement and sampling procedures to obtain these values, which are subsequently agreed with Ofgem.

This document provides a template methodology to demonstrate how the fossil derived energy content can be calculated. This document is not a definitive legal guide and fuel measurement and sampling methodologies submitted by operators will be considered by Ofgem on a case-by-case basis.

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Context

The Renewables Obligation, the Renewables Obligation (Scotland) and the Northern Ireland Renewables Obligation are designed to incentivise renewable generation into the electricity generation market. These schemes were introduced by the then Department of Trade and Industry (now the Department of Energy and Climate Change), the Scottish Executive and the Department of Enterprise, Trade and Investment respectively. The schemes are administered by the Gas and Electricity Markets Authority, whose day-to-day functions are performed by the Office of the Gas and Electricity Markets Authority (Ofgem). The schemes are provided for in secondary legislation.

The first Renewables Obligation Order came into effect in April 2002, as did the first Renewables Obligation (Scotland) Order. The first Renewable Obligation Order (Northern Ireland) came into effect in 2005. These Orders place an obligation on licensed electricity suppliers in England and Wales, Scotland and Northern Ireland to source an increasing proportion of electricity from renewable sources. Suppliers meet their obligations by presenting sufficient Renewables Obligation Certificates ("ROCs") to cover their obligations.

Where suppliers do not have sufficient ROCs to meet their obligation, they must pay an equivalent amount into a fund, the proceeds of which are paid back on a prorated basis to those suppliers that have presented ROCs. ROCs are issued to operators of accredited generating stations based on the net renewable electricity generated by such stations.

Generating stations that burn waste wood as a fuel to produce electricity are required to demonstrate, on a monthly basis, the biomass and fossil derived portions of the fuel as a percentage of total energy content. Ofgem requires this information for the purpose of issuing ROCs. Operators are required to propose fuel measurement and sampling (FMS) procedures to determine these values, which are then agreed with Ofgem. This document provides a suggested methodology to demonstrate how the fossil derived energy content, termed 'contamination', for an example station can be calculated.

This document is not a definitive legal or technical guide and any proposed FMS methodologies from operators will be considered by Ofgem on a case-by-case basis. This document should also be read in conjunction with other renewable obligation guidance documents, which can be found on Ofgem’s website.

Associated Documents

- Renewables Obligation: Fuel Measurement and Sampling guidance
- Renewables Obligation: Guidance for generators
- Renewables Obligation: template methodology for measuring fossil derived contamination within waste wood. Spreadsheet example.

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1. Introduction

Background

Operators of fuelled generating stations that burn waste wood[1] are required to determine the biomass and fossil derived fractions by energy content of the feedstock burnt in a given month. The determination of which should be based on accurate and reliable information. Operators using this fuel source are required to propose a suitable methodology to determine the relevant fractions. Each methodology proposed will be considered by Ofgem on a case-by-case basis.

To assist operators that are considering how to measure the fossil derived contamination percentage of a waste wood fuel source, this guidance note provides an example that could be adapted for use. This example is based on figures and techniques proposed by industry, and agreed by Ofgem. Ofgem encourages industry to lead the way in proposing FMS methodologies through sharing best practice and relevant data.

Methodology Overview

This guidance note outlines a methodology which can be adapted for use within a generating station where waste wood, containing fossil derived contamination, is used as a fuel source. The methodology includes calculations which can be undertaken to ascertain the overall percentage, by energy content, of fossil derived contamination within a representative fuel sample. This information is required by Ofgem for the purpose of issuing ROCs.

The methodology shows a series of calculations which can be undertaken to determine the contamination percentage, as a percentage of total energy content, for four fossil derived contaminants: plastics, resin binder, paint and varnish. The input data calculations use standard values alongside measured data obtained from lab analysis of a representative sample. The guidance note is accompanied by a waste wood contamination methodology spreadsheet which provides a worked example of the calculations.

Operators wishing to utilise this methodology will be required to demonstrate that it is fit for purpose given the specific waste wood fuel used on site. The list of four contaminants considered within the methodology is not exhaustive. Operators will still be required to account for the energy content of any other fossil derived contaminants present within the fuel stream. Furthermore, justification will need to be provided that the 'standard values' included within the methodology e.g. for Gross Calorific Value (GCV) figures, apply to the contaminants found within their specific fuel stream.

[1] Also referred to as recycled wood.

The units primarily used within the methodology, for energy and weight respectively, are megajoules (MJ) and kilograms (Kg). Operators can convert these to other units e.g. gigajoules (GJ) or tonnes (t), should this be desired. Providing the conversion is undertaken correctly and the units used in calculations are consistent this will not affect the results obtained from the methodology.

Status of Document

This document is not a definitive legal or technical guide and each FMS proposal submitted will be reviewed by Ofgem on a case-by-case basis, taking account of the provisions of the orders, specific fuels, fossil derived contaminants and generation technology stated within the application. Before Ofgem can approve FMS procedures it must be satisfied that they will deliver accurate and reliable results.

The determination of fossil derived contamination is only one factor within a generating station's wider FMS procedures. Operators choosing to adopt this methodology will still be required to complete a full FMS questionnaire document as part of the accreditation process, and have this approved by Ofgem.

2. Methodology

This chapter firstly explains the requirement to produce a representative sample. This is followed by the example methodology for calculating the energy content of fossil derived contaminants which may be found in waste wood fuel sources. The calculations required to establish the overall energy content of the sample contributed by these fossil derived contaminants are then presented.

Contaminants

2.1. The first step is for the operator to identify all the potential fossil derived contaminants within the waste wood fuel supply. The contaminants covered in this example methodology are:

- Plastics
- Resin binder
- Paint
- Varnish

The approach within the methodology for paint and varnish is the same and as such they are grouped. This list is not exhaustive and other contaminants may be present in waste wood feedstocks. Therefore each operator will need to identify the full range of fossil derived based contamination present within its fuel supply and then account for its contribution to energy content.

Producing a Sample

2.2. The operator is required to produce a representative sample of the fuel used within the month for analysis, based on a suitable number of increments[2] taken throughout the month. The approach used to produce a sample will compose part of the generating station's FMS procedures, as agreed by Ofgem. The sample is then tested to ascertain its energy content on a GCV basis e.g. in gigajoules per tonne (GJ/t), megajoules per kilogram (MJ/Kg) or kilojoules per gram (KJ/g).

2.3. Several sampling standards are available from the European Committee for Standardisation (CEN) which outlines suitable procedures to ensure an accurate sampling regime and therefore calculation results. These include:

- CEN/TS 14778-1:2005: Solid biofuels - Sampling - Part 1: Methods for sampling.
- CEN/TS 14780:2005: Solid biofuels - Methods for sample preparation.
- CEN/TS 14918:2005: Solid biofuels - Method for the determination of calorific value.

Best practice is for samples to be analysed in a laboratory accredited to ISO 17025:2005 by the United Kingdom Accreditation Service (UKAS).

[2] The operator will be required to demonstrate the number of samples required to deliver accurate results.

Calculating the energy content of individual contaminants

2.4. An example methodology for calculating the energy content of the contaminants set out in paragraph 2.1 of this document is outlined below.

Plastics

2.5. For this methodology, the plastic contamination within the sample must firstly be manually separated and weighed. The weight of plastics in the sample, as determined by manual separation, is then multiplied by a GCV value to give the energy content of plastics within the sample. A 'standard value'[3] GCV of 45 MJ/Kg[4] is utilised in this methodology.

$$W\ p \times GCV\ p = EC\ p$$

W p = Weight of plastics in sample (Kg)
GCV p = Standard GCV Plastics (45 MJ/Kg)
EC p = Energy content of plastics in sample (MJ)

Resin binder

2.6. To calculate the resin binder content within the waste wood sample, it must first be analysed for nitrogen content percentage (on an 'as received' basis[5]). This forms part of the required laboratory analysis of the representative sample submitted. This nitrogen content is then used alongside the nitrogen content of virgin wood and the nitrogen content of resin within the methodology calculations.

2.7. A standard value of 0.36%[6] ('dry and ash free') is used for the nitrogen content of virgin wood. This should then be converted to an as received basis in order to be comparable to the waste wood sample. This involves the subtraction of the ash and moisture content by weight. Ash and moisture content should be determined by laboratory analysis. Within this methodology a standard value of 39%[7] is used for the nitrogen content of resin (again on an as received basis). Determining the resin content of the sample by energy content is now a three step processes, as outlined on the following page.

[3] A standard value is a value used in a calculation that has not been directly measured but has been accepted based on evidence.
[4] A generator has proposed this standard value to Ofgem and it was agreed. This is the highest figure from the following sources: Ullmann's Encyclopaedia of Industrial Chemistry, vol. A21, pg 45 (1981), Polymer Flammability (R.E. Lyon and M.L. Janssens, US Dept Transportation FAA), Heats of Combustion and Potential Heat in Heat Release in Fires (V. Babrauskas and S.J. Grayson eds. Chapter 8 pp 207-223 Elsevier, London 1992), Heats of Combustion of High Temperature Polymers (R.N. Walters, S.M Hackett and R.E. Lyon US FAA).
[5] Test data evaluated relative to moisture in samples without conditioning.
[6] This value is based on initial testing of six samples of clean wood by the generator from their fuel supply
[7] This is based on five samples carried out internally and confirmed by the calculation: urea-formaldehyde monomer has the molecular formula $C_2H_4N_2O$. This gives the formula mass of the monomer as 72.0536 g/mole, and the elemental composition as follows: C 33.3%, H 5.6%, N 38.9% and O 22.2%.

2.8. Step 1: Calculate the resin content of the sample by weight using the following calculation:

$$(NC\ s\ -\ NC\ vw) \div (NC\ r\ -\ NC\ vw)* = RC\ s\ (\%)$$

*All Nitrogen Contents should be expressed on an as received basis.

NC s = Nitrogen content of sample (%)
NC vw = Nitrogen content of virgin wood (%)
NC r = Nitrogen content of resin (%)
NC vw = Nitrogen content of virgin wood (%)
RC s = Resin content of sample (%)

2.9. Step 2: To calculate the resin content of the sample by weight, the total weight of the waste wood sample must be multiplied by the % resin content of the sample (as calculated in Step 1).

$$W\ s \times RC\ s = WRC\ s$$

W s = Sample weight (Kg)
RC s = Resin content of sample (%)
WRC s = Resin content of sample by weight (Kg)

2.10. Step 3: To calculate the resin content of the sample by energy content the resin content by weight is multiplied by the GCV of resin. This methodology uses a standard value for resin GCV of 16 MJ/Kg[8].

$$WRC\ s \times GCV\ r = EC\ r$$

WRC s = Resin content of sample by weight (Kg)
GCV r = Standard resin GCV (16 MJ/Kg)
EC r = Energy content of resin in sample (MJ)

Paint and varnish

2.11. Determining the paint and varnish content of the sample by energy content is a three step process, as explained below.

2.12. Step 1: The sample should be assessed in order to determine the area in cm^2 of the sample that is covered in paint or varnish. A standard value of 0.0246 g/cm^2[9] can then be applied to determine the overall weight of paint or varnish in the sample. This is calculated by multiplying the surface coverage by this figure.

$$A\ pv \times WA\ pv = W\ pv$$

A pv = Area of waste wood sample covered in paint or varnish (cm^2)
WA pv = Weight of paint or varnish per cm^2 (0.0246 g/cm^2)
W pv = Paint or varnish in sample by weight (g)

[8] This figure was based on the average GCV of analysed resins and agreed with Ofgem.
[9] Figure determined by an operator through laboratory based experimentation and agreed with Ofgem.

2.13. Step 2: Once the total weight of paint and varnish in the sample is determined in grams, it can then be converted to kilograms.

$$W\ pv\ (g) \div 1000 = W\ pv\ (Kg)$$

W pv = Paint or varnish in sample by weight

2.14. Step 3: The paint or varnish in waste wood sample by weight (Kg) is then multiplied by the standard value GCV of paint and varnish used within the methodology of 45 MJ/Kg[10] to give the energy content of the paint and varnish found within in the sample.

$$W\ pv \times GCV\ pv = EC\ pv$$

W pv = Paint or varnish in sample by weight (Kg)
GCV pv = Standard GCV of paint or varnish (45 MJ/Kg)
EC pv = Energy content of paint or varnish in sample (MJ)

NB: Whilst paint or varnishes are explicitly mentioned within this section, other related coating substances found within the waste wood sample could also be calculated using this methodology. Should the operator wish to apply the standard value energy content of 45 MJ/Kg for paint and varnish to other related coating substances they would need to demonstrate, to Ofgem's satisfaction, that it is applicable to the coatings in question.

Calculating overall fossil derived contamination within the sample

2.15. Calculating the overall fossil derived contamination percentage of the sample in terms of energy content, the figure required by Ofgem for undertaking ROC issue calculations, is now a two step process, as shown below.

2.16. Step 1: The energy content of each of the three contaminant groupings has been calculated. These can then be summed in order to give the total contamination content of the sample in terms of energy content (in MJ).

$$EC\ p + EC\ r + EC\ pv = EC\ c$$

EC p = Energy content of plastics in sample (MJ)
EC r = Energy content of resin in sample (MJ)
EC pv = Energy content of paint or varnish in sample (MJ)
EC c = Total energy content of contamination in sample (MJ)

[10] This corresponds to the GCV of polyethylene.

2.17. Step 2: To then calculate this as a percentage of the total energy content of the sample as a whole, the total energy content of the sample (in MJ) is needed. This will have been supplied though laboratory analysis as mentioned previously. Through dividing the total energy content of contaminants in the sample by the total energy content of the sample, and multiplying by 100, the overall fossil derived contamination by energy content is given as a percentage.

$$(EC\ c \div EC\ t) \times 100 = EC\ cs$$

EC c = Total energy content of contamination in sample (MJ)
EC t = Total energy content of sample (MJ)
EC cs = Energy content of contamination within the sample (%)

2.18. This percentage figure (EC cs), for the representative sample is then reported to Ofgem on a monthly basis via the Renewables & CHP Register. This figure is subsequently applied to waste wood fuel use within that month and used in the calculation of ROCs to be issued.

Waste wood contamination methodology spreadsheet

2.19. To accompany these calculations Ofgem has published a waste wood contamination methodology spreadsheet, 'Renewables Obligation: template methodology for measuring fossil derived contamination within waste wood. Spreadsheet example'. This shows a worked example of how the methodology can be used. The spreadsheet includes all the standard values and formulas for the calculations outlined within this guidance note.

NB: This spreadsheet will need to be adapted to the specific fuels used within each generating station.

Appendices

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Appendix 1 – The Authority's Powers and Duties

1.1. Ofgem is the Office of Gas and Electricity Markets which supports the Gas and Electricity Markets Authority ("the Authority"), the regulator of the gas and electricity industries in Great Britain. This appendix summarises the primary powers and duties of the Authority. It is not comprehensive and is not a substitute to reference to the relevant legal instruments (including, but not limited to, those referred to below).

1.2. The Authority's powers and duties are largely provided for in statute (such as the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998, the Enterprise Act 2002 and the Energy Acts of 2004, 2008 and 2010) as well as arising from directly effective European Community legislation.

1.3. References to the Gas Act and the Electricity Act in this appendix are to Part 1 of those Acts.[11] Duties and functions relating to gas are set out in the Gas Act and those relating to electricity are set out in the Electricity Act. This appendix must be read accordingly.[12]

1.4. The Authority's principal objective is to protect the interests of existing and future consumers in relation to gas conveyed through pipes and electricity conveyed by distribution or transmission systems. The interests of such consumers are their interests taken as a whole, including their interests in the reduction of greenhouse gases and in the security of the supply of gas and electricity to them.

1.5. The Authority is generally required to carry out its functions in the manner it considers is best calculated to further the principal objective, wherever appropriate by promoting effective competition between persons engaged in, or commercial activities connected with,

- the shipping, transportation or supply of gas conveyed through pipes;
- the generation, transmission, distribution or supply of electricity;
- the provision or use of electricity interconnectors.

1.6. Before deciding to carry out its functions in a particular manner with a view to promoting competition, the Authority will have to consider the extent to which the interests of consumers would be protected by that manner of carrying out those functions and whether there is any other manner (whether or not it would promote competition) in which the Authority could carry out those functions which would better protect those interests.

1.7. In performing these duties, the Authority must have regard to:

- the need to secure that, so far as it is economical to meet them, all reasonable demands in Great Britain for gas conveyed through pipes are met;
- the need to secure that all reasonable demands for electricity are met;

11 Entitled "Gas Supply" and "Electricity Supply" respectively.
12 However, in exercising a function under the Electricity Act the Authority may have regard to the interests of consumers in relation to gas conveyed through pipes and vice versa in the case of it exercising a function under the Gas Act.

- the need to secure that licence holders are able to finance the activities which are the subject of obligations on them[13]; and
- the need to contribute to the achievement of sustainable development.

1.8. In performing these duties, the Authority must have regard to the interests of individuals who are disabled or chronically sick, of pensionable age, with low incomes, or residing in rural areas.[14]

1.9. Subject to the above, the Authority is required to carry out the functions referred to in the manner which it considers is best calculated to:

- promote efficiency and economy on the part of those licensed[15] under the relevant Act and the efficient use of gas conveyed through pipes and electricity conveyed by distribution systems or transmission systems;
- protect the public from dangers arising from the conveyance of gas through pipes or the use of gas conveyed through pipes and from the generation, transmission, distribution or supply of electricity; and
- secure a diverse and viable long-term energy supply,

and shall, in carrying out those functions, have regard to the effect on the environment.

1.10. In carrying out these functions the Authority must also have regard to:

- the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed and any other principles that appear to it to represent the best regulatory practice; and
- certain statutory guidance on social and environmental matters issued by the Secretary of State.

1.11. The Authority may, in carrying out a function under the Gas Act and the Electricity Act, have regard to any interests of consumers in relation to communications services and electronic communications apparatus or to water or sewerage services (within the meaning of the Water Industry Act 1991), which are affected by the carrying out of that function.

1.12. The Authority has powers under the Competition Act to investigate suspected anti-competitive activity and take action for breaches of the prohibitions in the legislation in respect of the gas and electricity sectors in Great Britain and is a designated National Competition Authority under the EC Modernisation Regulation[16] and therefore part of the European Competition Network. The Authority also has concurrent powers with the Office of Fair Trading in respect of market investigation references to the Competition Commission.

13 Under the Gas Act and the Utilities Act, in the case of Gas Act functions, or the Electricity Act, the Utilities Act and certain parts of the Energy Acts in the case of Electricity Act functions.
14 The Authority may have regard to other descriptions of consumers.
15 Or persons authorised by exemptions to carry on any activity.
16 Council Regulation (EC) 1/2003.

Appendix 2 - Glossary

C

CEN	European Committee for Standardisation

F

FMS	Fuel Measurement & Sampling

G

GJ	Gigajoule
GCV	Gross Calorific Value

K

Kg	Kilogram
KJ	Kilojoule

M

MJ	Megajoule

R

ROC	Renewables Obligation Certificate

T

t	Tonne

U

UKAS	United Kingdom Accreditation Service