Biodiesel and fossil-derived bioliquids

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This document gives guidance to generating stations using fossil-derived bioliquids. It covers the legislative requirements of the Renewables Obligation (RO) in England, Wales, Scotland and Northern Ireland.

This guidance was originally produced following the introduction of support for fossil-derived bioliquids under the Renewables Obligation. As ROCs are only issued for the biomass content of any fuel used, generating stations using such fuels will have to determine the proportion of the fuel that has come from biomass. This guidance explains how biodiesel generating stations can determine the fossil fuel and renewable derived content of biodiesel and other fossil-derived bioliquids.

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Introduction

Overview

The Renewables Obligation scheme closed to all new generating capacity 1 April 2017. More information on this can be found on the closure page and in the guidance on closure.

The Renewables Obligation (RO) scheme was designed to encourage generation of electricity from eligible renewable sources in the UK. The RO scheme came into effect in 2002 in Great Britain, followed by Northern Ireland in 2005.

The scheme places an annual obligation on electricity suppliers to present to Ofgem a specified number of Renewables Obligation Certificates (ROCs) per megawatt hour (MWh) of electricity supplied to their customers during each obligation period (1 April – 31 March). Suppliers can meet their annual obligation by presenting ROCs, making a payment into a buy-out fund or a combination of the two.

ROCs are issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Operators can trade ROCs with other parties or sell them directly to a supplier.

The administration cost of the scheme is recovered from the buy-out fund and the rest is distributed back to suppliers in proportion to the number of ROCs they presented to meet their individual obligation.

For more information about the scheme, visit our website.

Relevant legislation

All legislation can be found at www.legislation.gov.uk:

- The Renewables Obligation Order 2015
- The Renewables Obligation (Scotland) Order 2009
- The Renewables Obligation Order (Northern Ireland) 2009
- Their respective amendment Orders

Relevant guidance

All documents are available at www.ofgem.gov.uk/

- Renewables Obligation: Sustainability Criteria
- Renewables Obligation: Sustainability Reporting

- Renewables Obligation: Biodiesel and fossil-derived bioliquids guidance
- Renewables Obligation: Guidance for Generators
- Renewables Obligation: Guidance for suppliers
- Renewables Obligation: Fuel Classification Flow Diagram
- Renewables Obligation: Fuel Measurement and Sampling Guidance
- Renewable Electricity Register user guide

Contacts

If you would like to contact us, visit the schemes contact page.

Please note that we can only provide guidance on the legislation that is currently in place. Any queries about changes to the ROO for England and Wales, and wider policy should be directed to the Department for Energy Security and Net Zero (DESNZ). Contact details are at www.gov.uk/guidance/contact-desnz. For the ROS and NIRO Orders, contact details are available at www.scotland.gov.uk and www.economy-ni.gov.uk.

For queries related to the Quality Assurance for Combined Heat and Power (CHPQA) programme, please visit www.gov.uk/guidance/combined-heat-power-quality-assurance for contact details.

Executive Summary

This guidance explains how biodiesel generating stations can determine the fossil fuel and renewable derived content of their fossil-derived bioliquids. The purpose of this document is to focus on the Fuel Measurement and Sampling (FMS) procedures for FDBL fuels.

To determine the number of ROCs a generating station is eligible for month by month, fuelled generating stations need to distinguish between the amount of biomass and the amount of fossil fuel used to generate electricity. These amounts must be expressed as energy contributions, resulting from the Gross Calorific Value (GCV). We agree on how generating stations will calculate the biomass and fossil fuel content by approving a generating station's fuel measurement and sampling procedures.

Our FMS guidance sets out the eligibility for different biomass-related fuels under the RO and examples of how generating stations using such fuels could demonstrate the biomass to fossil fuel content on a monthly basis.

FDBLs are specifically defined within the RO. The most common of these fuels is expected to be biodiesel. Fossil-derived energy is an integral part of the combustion of FDBLs because of the process involved in their production. The contribution to overall energy content of this fossil-derived energy must be calculated as this is not eligible for ROC issue. It can however be complex to determine this fossil-derived contribution to the overall energy content.

This guidance document should be read alongside the FMS guidance, and answers specific questions on FDBLs.

- What is classified as a FDBL.
- How many ROCs are FDBLs eligible for.
- How to account for biodiesel in FMS methodology and procedures.

Operators of generating stations using FDBLs must also meet other RO requirements, such as the sustainability criteria. Our Renewables Obligation (RO) Guidance: Sustainability Criteria shows how to meet these criteria and evidence that they have been met. There is more general guidance on the eligibility of a generating station in our guidance for generators.

Terminology

When discussing the different components of biodiesel, the terminology can become quite complex. To differentiate between the various elements, we have used the following terms:

- **Biodiesel** means fuel suitable for use in diesel engines produced from vegetable oils or animal fat and alcohol, e.g. methanol. If made from methanol it primarily contains a mixture of Fatty Acid Methyl Ester (FAME) compounds.
- **Bioliquid** refers to the same term defined within the Electricity Act 1989: liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass.
- **FAME compound** refers to a particular FAME compound which includes a particular biomass-derived FAD group, e.g. 14:0. This only applies to biodiesel produced using methanol.
- **FAME mixture** includes all FAME compounds present in the biodiesel. This only applies to biodiesel produced using methanol.
- **Fatty Acid Derivative (FAD)** refers to the fatty acid part of the FAME compound, i.e. the biomass part of it. A particular FAD can be specified by the number of carbon atoms and double bonds it contains e.g. 14:0 has 14 carbon atoms and no double bonds.
- **Fatty Acid Methyl Ester (FAME)** refers to a chemical compound that is made up of a biomass (-R-CO) and fossil fuel derived ($-O-CH_3$) group.
- **Methanol** means an alcohol generally produced from natural gas and often used in the production of biodiesel.
- **Methoxy group** refers to the part of the FAME compound derived from methanol, i.e. the fossil fuel element where fossil fuel derived methanol has been used in the production process.

1. Eligibility

Chapter Summary

Provides background to the introduction of eligibility for fossil-derived bioliquids and a summary of the Renewables Obligation provisions.

Overview

1.2. Under the RO, generating stations can claim ROCs for eligible renewable generation. Since April 2011, FDBLs have become eligible for ROCs on their non-fossil fuel energy content.

1.3. One of the reagents used to produce biodiesel, methanol, is often obtained from the methane within natural gas (a fossil fuel). The use of methanol directly produced from natural gas implied that these fuels could be seen as being indirectly derived from a fossil fuel.

The introduction of FDBLs into the RO

1.4. In June 2008, the European Union Renewable Energy Directive was published. It contained renewable energy requirements to be fulfilled by each European Union Member State, including the 2020 renewable energy targets. There were many sustainability requirements relating to the use of biofuels and bioliquids, which referred specifically to their treatment under Member State support schemes. In the UK this included the RO.

1.5. Making these requirements part of the RO resulted in the following:

- Any energy produced from a bioliquid must meet the sustainability criteria of the RO to be eligible for support
- Any bioliquid that meets the sustainability criteria cannot be excluded from support on sustainability grounds.

1.6. The second of these changes meant that bioliquids manufactured from chemicals of fossil fuel origin, e.g. biodiesel, must be eligible for support under the RO, unless the reasons for excluding it are unrelated to sustainability. As a result, the UK government introduced eligibility for FDBLs into the RO in April 2011.

1.7. An FDBL is defined in the RO Order 2015 as follows: “bioliquid produced directly or indirectly from”:

- Coal

- Lignite
- Natural gas (within the meaning of the Energy Act 1976 (a))
- Crude liquid petroleum
- Petroleum products (within the meaning of the Energy Act 1976)

1.8. The fossil fuel used in the production process can either be purely fossil fuel e.g. natural gas, or a product derived originally from fossil fuel e.g. methanol. The legislation provides no minimum requirement for the proportion of the FDBL that comes from renewable sources. Table 1.1 below shows a list of examples of FDBLs.

Table 1.1: Examples of FDBLs used for electricity generation

Fuel	**Fossil element used in production process**
Biodiesel produced using fossil-derived methanol	Methanol
Hydro-treated vegetable oil	Hydrogen
Renewable diesel via Fischer- Tropsch synthesis	Hydrogen
Renewable diesel produced from pyrolysis oil using the hydrodeoxygenation process	Hydrogen

1.9. Bioliquids that do not include fossil fuel in the production process (e.g. uncontaminated vegetable oils or biodiesel produced using bioethanol) are not classified as FDBLs. For guidance on this, please refer to our FMS guidance.

1.10. The Orders show[1] the number of ROCs that should be awarded on generation by various fuelled and non-fuelled technologies. The legislation[2] also states that electricity generated in a way which is not described in the relevant Schedule should realise 1 ROC per MWh. When they were introduced into the Orders in 2011, FDBLs were supported in accordance with this article as none of the existing bands outlined in Schedule 5 provided support for FDBLs.

[1] Schedule 5 of the ROO 2015 (as amended), Schedule 2 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).
[2] Article 33(8) of the ROO 2015 (as amended) and Article 27(9) of the ROS Orders and Article 25 (5) of the NIRO Order.

1.11. From 1 April 2013 (or 1 May 2013 under the Northern Ireland Renewables Obligation) fuels which are FDBLs also meet the definition of biomass[3]. As such, from 1 April 2013 (or 1 May under the NIRO), generating stations using FDBLs are eligible to claim the same support as other bioliquids

1.12. The level of support will be determined based on the fuel mix and technology within the month of generation. The operator of the generating station will still need to determine to our satisfaction what proportion of the FDBL is derived from fossil fuel. Additionally, they must demonstrate that the biogenic portion of the FDBL meets the required sustainability criteria to be eligible for ROCs.

[3] Article 3 of the ROO, Article 4 of the ROS Order and NIRO Order.

2. Agreeing FMS procedures

Chapter Summary

Further information on the fuel measurement and sampling procedures. Generating stations using fossil-derived bioliquids must agree procedures with Ofgem to claim Renewables Obligation Certificates under the Orders.

Overview

2.1. An FMS procedure is the general term we use to describe the agreed procedures for the measurement and sampling of fuels at a generating station. This is done to determine the amount of fuel used in a month, the energy content of the fuel and the level of any fossil fuel derived contamination present in compliance with the Orders. Whilst the term 'FMS procedure' usually refers to the physical measurement and sampling processes, it may also refer to the provision of documentary evidence.

2.2. As with other fuels, generating stations using FDBLs had to agree FMS procedures with Ofgem before being accredited and issued with ROCs. As part of the process, the generating stations had to demonstrate to Ofgem's satisfaction how they will determine the proportion of the FDBL that is derived from fossil fuel.

2.3. In chapter 3, there is an example of how generating stations using biodiesel can demonstrate the biomass proportion of the fuel. Generating stations using other FDBLs can put forward proposals for determining the fossil-derived energy content to Ofgem. Alternative proposals can also be submitted for operators of generating stations using biodiesel who wish to use a different methodology than that outlined in chapter 3.

2.4. We can only issue ROCs for electricity generated from renewable sources in a given month. The Orders[4] show how to calculate the amount of electricity generated from renewable sources. In the case of a generating station fuelled partly by fossil fuel and/or waste and partly by another fuel or fuels, the amount of electricity generated from the fossil fuel fraction should be determined. The amount of electricity is determined according to the energy content of the fossil

[4] Articles 29 and 30 of the RO Order 2015 (as amended) and articles 25 and 26 of the RO(S) Order 2009 (as amended) and Articles 23 and 24 of the NIRO 2009 Order (as amended).

and biogenic fraction of each of the fuels used in a particular month. Operators of fuelled stations need to propose and agree FMS procedures with us, describing how they will get the values required for the ROC calculations.

2.5. We can only issue ROCs based on information provided to us which we consider is accurate and reliable. We will work with the generating station as closely as possible to do this, but the onus for the design of suitable FMS procedures ultimately lies with the operator.

The format of FMS procedures

2.6. We recognise that no two generating stations are identical, and that different generating stations can use different combinations and volumes of fuels, drawn from different sources. For these reasons, our approach is always to agree FMS procedures on a case-by-case basis, according to the specific setup and conditions at each generating station.

2.7. There is no set timeframe for agreeing FMS procedures, because the complexity of FMS procedures will vary greatly from one station to the next. Our aim is to agree procedures that will enable generating stations to meet the requirements of the legislation for fuel measurement and sampling to determine the energy content of fuels. We will work closely with generating stations to make the process as efficient as possible.

2.8. All procedures should be submitted using the appropriate FMS questionnaires. A range of questionnaires are available on our website[5]. Accompanying documentation can be provided alongside the FMS questionnaire if necessary. If you are unsure which questionnaire to complete, contact the Fuelling and Sustainability team at FuellingandSustainability@Ofgem.gov.uk (or call 0207 901 7310).

2.9. For more information on FMS, including general principles and their relationship to data submissions, please refer to our FMS guidance.

[5] http://www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/FuelledStations/Pages/FS.aspx

3. Calculating the fossil fuel content of biodiesel

Chapter Summary

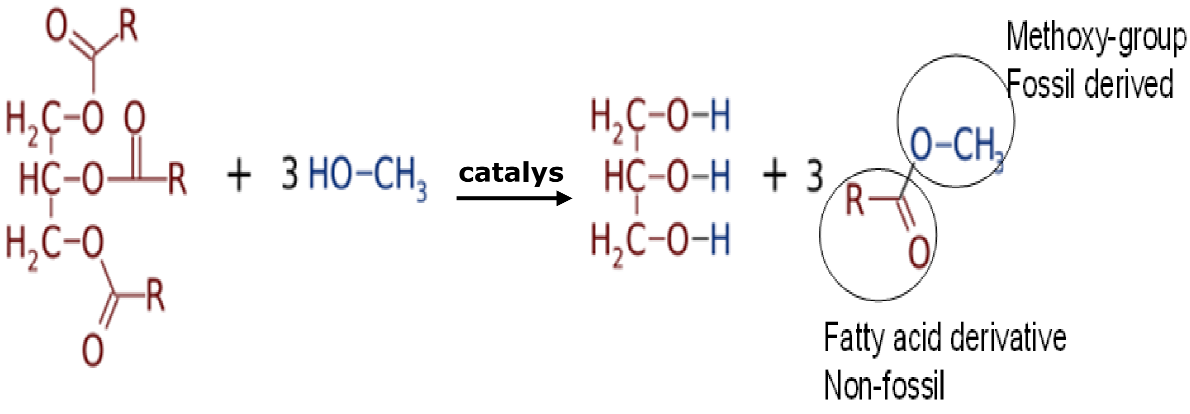
Describes a methodology operators may wish to use to determine the fossil fuel content of biodiesel.

Overview

3.1. This chapter focuses on a methodology for determining the relative biomass and fossil fuel energy content in biodiesel produced using fossil-derived methanol. The use of fossil-derived methanol in the production of biodiesel means that the fossil fuel and biomass aspects within the biodiesel are chemically bonded. Figure 1 below shows the chemical reaction that occurs in the typical biodiesel manufacturing process.

3.2. Vegetable oils or animal fats are reacted with methanol in the presence of catalysts to form glycerol and a FAME. The FAME is the desired component of biodiesel, and the glycerol is separated as a by-product.

Vegetable Oil/Animal **Methanol** **Glycerol** **Fatty Acid Methyl Ester**



Key: The RED part of the FAME shown in the diagram comes from the vegetable oil or animal fat. The BLUE part comes from the fossil-derived methanol. The R in the above diagram refers to hydrocarbon chains of varying lengths.

3.3. This leads to four problems which make the energy contribution of biomass in biodiesel difficult to determine:

- The vegetable oil or animal fat component of the biodiesel – the fatty acid derivative (FAD) – is chemically bonded to the methanol-derived component (methoxy group). This means it is not possible to separately measure the energy content of the fossil fuel and biomass within the biodiesel.
- The length of the hydrocarbon chains within the vegetable oil or animal fat varies as they are not uniform substances. This means it is not possible to simply determine the relative fossil fuel content in one FAME compound and apply it to all FAME compounds in the biodiesel.
- There are two main products from the process, glycerol and FAME, both taking differing amounts of energy from the methanol and biomass. This means it is not easy to determine what proportion of the reactants end up in the mix of FAME compounds without considering the mix of FADs making up the FAME compounds.
- There may be residual elements within the biodiesel, e.g. residual methanol, as a result of the production process.

3.4. To address these challenges, we have put forward an example methodology for calculating the energy content of biodiesel attributable to fossil fuel that a generating station can use in its FMS procedures. This is based on determining the FADs within the biodiesel, the bond energies within the FADs and using standard Gross Calorific Values (GCVs) to account for the residual elements in the biodiesel. Where this approach is used, the operator is still required to detail the procedures to collect the necessary input data as part of their FMS documentation.

The example methodology

3.5. An example methodology is included in this guidance to provide operators with an indication (rather than a prescriptive guide) to how the fossil fuel-derived energy content of biodiesel can be calculated. It does not preclude operators from proposing alternative procedures to determine the fossil-derived contribution to the energy content of biodiesel to Ofgem for consideration.

3.6. We recognise that sampling can be costly, especially for smaller generating stations. However, we are only able to issue ROCs to electricity generated by renewable sources. As a result, we have adopted a two-tier approach to the example methodology. This allows operators to choose between two options:

- **Minimal Sampling (Option 1):** This allows for minimal sampling information but uses conservative estimates of the biogenic content based on the biodiesel quality standard EN14214:2012 and a default fatty acid composition. Conservative values which can be used are found in the appendices to this document.
- **Full Sampling (Option 2):** When fuel is sampled and analysed, the test results can be used to determine the biogenic content of the FDBL. Details of the sampling and analysis must be outlined to Ofgem in the form of FMS procedures. This is necessary to demonstrate the sampling procedures will provide accurate and reliable results.

3.7. Much of the information required comes from fundamental thermodynamics and this is explained further in the appendices. Either conservative default values or figures obtained from sampling can be used for:

- The FAD composition of each FAME component in the biodiesel,
- The proportion of FAME in the biodiesel,
- The proportion of fossil-derived residues in the biodiesel.

3.8. Option 1 requires less sampling than Option 2, as it relies on conservative default figures (provided in this document). Therefore, Option 1 could potentially result in a lower qualifying percentage than Option 2. Apart from using one of these options, operators can also propose to Ofgem alternative methodologies to accurately determine the biomass content of biodiesel. We will review these case-by-case.

3.9. The information requirements under Options 1 and 2 are below. This is followed by a step-by-step explanation of each methodology. In chapter 4 there is an explanation of how the results from these steps are used to determine the fossil fuel-derived contamination percentage, and therefore biomass qualifying percentage.

Overview of the key steps of the example methodology

3.10. Figure 3.1 and Table 3.1 below give an overview of the two options described above. They identify where information is required either as a result of sampling or default values, depending on which option is chosen by the operator. The terminology used to refer to the different elements within biodiesel and calculations are explained in chapter 1.

Figure 3.1: An overview of the calculation and information requirements for determining the biomass contribution in fossil-derived biodiesel.

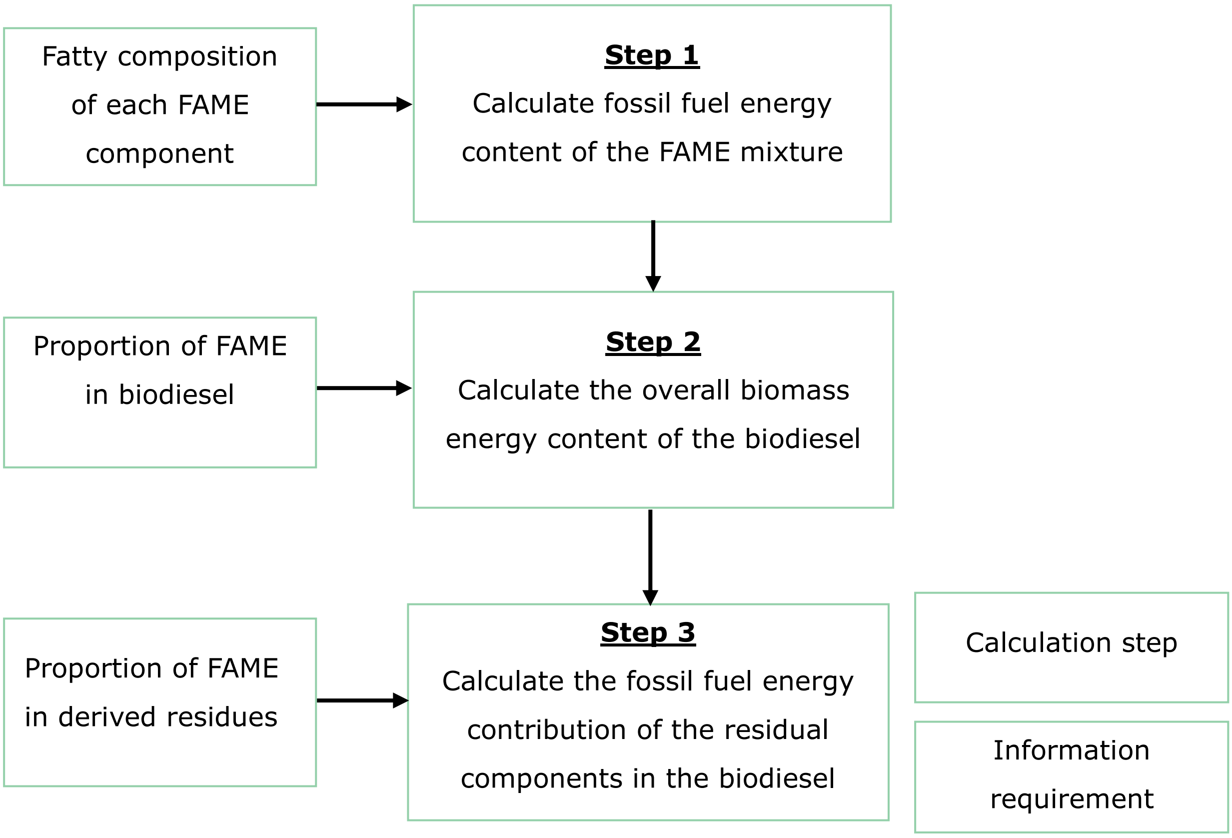


Table 3.1: Summary of sampling options

	Minimal sampling (Option 1)	**Full sampling (Option 2)**
Determining the FAD composition of each FAME component in the FAME mixture.	If the vegetable oil/animal fat used to make the biodiesel is known, then the default values listed in Appendix 1 for the FAD composition of the biodiesel can be used. If the vegetable oil/ animal fat is not listed in Appendix 1, a default value can be proposed to Ofgem based on evidence.	Direct measurement of the FAD composition of the biodiesel can be used e.g. using a mass spectrometer and gas chromatography. You will need to demonstrate to Ofgem how you plan to do this.

	Minimal sampling (Option 1)	**Full sampling (Option 2)**
Calculating the proportion of FAME in biodiesel	If the fuel meets the EN14214:2012 standard, then the minimum FAME content given in Appendix 4 can be used.	The biodiesel used at the generating station during the month can be sampled to determine the minimum FAME content.
Calculating the proportion of fossil fuel-derived residues.	If the fuel meets the EN14214:2012 standard, then the maximum percentage proportion and standard energy contents of potential fossil fuel-derived components can be used. These are given in Appendix 4.	The biodiesel used at the generating station during the month can be sampled for the breakdown of the FAME compounds comprising FAD. The standard energy contents (GCV values) for the fossil fuel-derived components given in Appendix 2 can then be used.

3.11. The next sections give more information on both the minimal and full sampling approaches for each of the sampling and calculation steps.

Option 1: minimal sampling with conservative estimates

3.12. If an operator does not wish to sample and instead wants to use conservative estimates to calculate the required elements in Table 3.1, they should use this three-step process.

Step 1: Determining the FAD composition of each FAME component in the FAME mixture

3.13. The FAD composition (also referred to as mass share) of FAME compounds will generally vary within a range according to the vegetable oil or animal fat used to produce the biodiesel. Appendix 1 details conservative FAD compositions of palm oil, soybean, rapeseed, sunflower and tallow. If operators are using biodiesel from any of these feedstocks, they can use these figures for the FAD composition of their biodiesel.

3.14. If the biodiesel production facility uses a feedstock that is not listed, then a conservative FAD composition can be proposed to Ofgem. It is likely that if the feedstock is a waste, e.g. used cooking oil, it will not be possible to estimate the composition and so the testing method under Option 2 would be needed.

3.15. The documents we need in support of the FAD composition will probably include:

- Evidence of fuel supply from the biodiesel production facility to the generating station, e.g. a fuel supply contract or formal letter from the fuel supplier. This should name the feedstock used to produce the biodiesel.
- Details of the sources of the FAD composition if the feedstock is not one listed in Appendix 1.

Step 2: Calculating the proportion of FAME in the biodiesel

3.16. **EN 14214:2012** is the European biodiesel standard commonly used to demonstrate the quality of biodiesel. The standard is outlined in Appendix 4. To meet the standard, a biodiesel needs to have a minimum FAME content of 96.5%. If an operator uses biodiesel that meets **EN 14214:2012** standards, then the FAME content of 96.5% can be assumed for that biodiesel.

3.17. The documents we need are likely to include:

- Evidence of fuel supplier(s) supplying the generating station with biodiesel e.g. a fuel contract or formal letter from the supplier.
- Evidence that the biodiesel meets the EN 14214:2012 standard on a monthly basis, e.g. copy of certifications or production facility sampling results.

3.18. Procedures should also be agreed with Ofgem to demonstrate that no contamination of the biodiesel occurs during fuel transportation.

Step 3: Calculating the proportion of fossil fuel-derived residues

3.19. The European biodiesel standard **EN 14214:2012** provides a lower and upper limit to the different components in biodiesel, which must be met for the fuel to comply with the standard.

3.20. The limits are given in the table in Appendix 4, and we have added a column to provide standard GCVs that can be assumed for each relevant component.

3.21. Unless evidence is presented for the composition of the residue, we will conservatively assume that any unallocated residue (i.e. that is not FAME) is derived from fossil fuel and is considered under the “other additives” column. A GCV for fossil diesel is assumed for "other additives".

Option 2: full sampling

3.22. If an operator wants to sample the FDBL themselves to provide the required elements in Table 3.1, they should use the following three-step sampling process. As with all FMS procedures, sampling needs to represent the biodiesel consumed within the month and they should agree with us how to do this. For more information on sampling, see our FMS guidance.

Step 1: Determining the FAD composition of each FAME compound in the FAME mixture

3.23. Fuel samples can be taken at the generating station and the FAD composition tested, for example by mass spectrometry or gas chromatography. Procedures for extracting samples and how these are tested will form part of FMS procedures which should be agreed with Ofgem. Documents required monthly are likely to include:

- A spreadsheet containing the sample results.
- Copies of the sampling results, e.g. a lab report.

Step 2: Calculating the proportion of FAME in the biodiesel

3.24. If using full sampling, operators will need to sample the fuel(s) used at the generating station for the FAME content of the biodiesel consumed within the month. The samples analysed should represent the fuel used in the month. The sample results should be averaged to give an overall sampling result for the month. We would normally expect a weighted average to be used based on the proportion of each fuel used in the month.

3.25. Documents required each month are likely to include:

- A spreadsheet containing the sample results.
- Copies of the sampling results, e.g. a lab report.

Step 3: Calculating the proportion of fossil fuel-derived residues

3.26. Sampling should provide the levels of fossil fuel or fossil fuel-derived components, for instance

- Methanol
- Other additives/miscellaneous

3.27. If not explicitly stated within test results 'Other additives / miscellaneous' can be calculated as one minus the percentage sum of FAME + methanol.

3.28. As in Option 1, we expect that the GCV of the components will be standard GCVs as specified in Appendix 4.

3.29. Glycerol is not considered a fossil fuel-derived component because the net contribution to the GCV of the fossil fuel-derived Oxygen-Hydrogen bond is zero (the bond is broken and reformed in a water molecule). If sampling indicates the presence of glycerol, the quantity of glycerol contamination in the biodiesel can be considered as a renewable proportion of the FDBL.

3.30. Documents required each month are likely to include:

- A spreadsheet with the sample results.
- Copies of the sampling results, e.g. a lab report.
- Any other evidence that bio-methanol or bio-hydrogen has been used instead of fossil fuel-derived reagent.

4. Calculating the Biomass content of FAME

Chapter Summary

Describes a methodology operators may wish to use to determine the biomass energy content of FAME.

Overview

4.1. Once the Fatty Acid Methyl Ester (FAME) and fossil fuel composition of the biodiesel have been determined (through either Option 1 or Option 2 described in the previous chapter) the energy content of the FAME and fossil fuel can be calculated. There are three steps to calculating the biomass content in the biodiesel that is eligible to claim ROCs:

- **Step 1: Calculating the fossil fuel energy content of the FAME mixture.** This is necessary to take account of the presence of energy derived from the fossil fuel methoxy group chemically bonded to the biomass Fatty Acid Derivative (FAD) in the FAME molecule.
- **Step2: Calculating the fossil fuel energy contribution of the residual components in biodiesel.** This is necessary to take account of any residual components within the biodiesel which are fossil fuel derived and contribute to the energy content of the fuel.
- **Step 3: Calculating the overall biomass energy content of the biodiesel.** Calculating the overall biomass content of the biodiesel brings together the fossil fuel element calculated in the FAME mixture and the residual fossil fuel elements to create an overall qualifying percentage for the biomass contribution that is eligible for ROC issue.

4.2. The following sections provide a worked example for doing the calculations in steps 1-3.

Step 1: Calculating the percentage fossil fuel energy content of the FAME mixture

4.3. The fossil fuel energy content within the FAME mixture depends on the fossil fuel energy content of each FAME compound and the relative proportion of each FAME compound within the FAME mixture.

4.4. Using fundamental thermodynamics, we have calculated the fossil fuel energy content of a range of FAME compounds likely to be present in biodiesel. These proportions are given in Appendix 2 with an explanation of how these proportions are arrived at in Appendix 5.

4.5. The proportion of each FAD within the feedstock's FAME mixture is also required (as a mass share). Either the default value relevant to the feedstock as given in Appendix 1, or the sampling results as discussed in the information requirements above can be used depending on whether you are using Option 1 (minimal sampling) or Option 2 (full sampling).

4.6. To calculate the fossil fuel energy contribution of each FAME compound, multiply the percentage fossil fuel energy content of the FAME compound by the percentage mass share of that FAD within the FAME mixture. Then sum the percentage fossil fuel contribution of each FAME compound to determine the percentage share of fossil fuel in the FAME mixture.

$$\%\ fossil\ fuek\ energy\ content\ of\ FAME\ mixture = \sum_{i=1}^{n} \%\ fossil\ fuuel\ energy\ content\ of\ FAME\ compound\ x\ mass\ share\ of\ FAD\ in\ feedstock$$

Where n= number of FADs in feedstock from appendix 1 or from lab analysis

Example 1

Step 1

4.7. This example uses the rapeseed default values given in Appendix 1.

Table 4.1: Mass and fossil fuel energy share of FAME in rapeseed

FAME compound (ordered by FAD)	Fossil fuel energy content of FAME compound (%)	Mass share of FAD in feedstock (%)
12:0	5.64	0
14:0	4.86	1.5
16:0	4.27	6
16:1	4.32	0
17:0	4.03	0

FAME compound (ordered by FAD)	Fossil fuel energy content of FAME compound (%)	Mass share of FAD in feedstock (%)
18:0	3.81	1
18:1	3.85	51.5
18:2	3.88	30
18:3	3.92	10

Fossil fuel energy content of FAME mixture = (5.64% x 0%) + (4.86% x 1.5%) + (4.27% x 6%) + (4.32% x 0%) + (4.03% x 0%) + (3.81% x 1%) + (3.85% x 51.5%) + (3.88% x 30%) + (3.92% x 10%)

Percentage fossil fuel energy content of FAME mixture = 3.91 %

Step 2: Calculating the fossil fuel energy contribution of the residual components in biodiesel

4.8. This step explains how to take account of the energy content of the fossil-derived residues present in the biodiesel.

4.9. To determine the percentage energy contribution that each residue makes to the biodiesel, it is necessary to know the energy content of the biodiesel as a whole. If the Gross Calorific Value (GCV) of the fuel is known as a result of sampling, then this GCV should be used. Please agree with us how a sample is extracted for GCV analysis.

4.10. If the GCV of the fuel is not known, the GCV of the FAME mixture, as the major component of the biodiesel, can be used as an approximation for the energy content of the biodiesel as a whole. To calculate the GCV of the FAME mixture, use the calculation in Step 2a below. The proportion of each component can then be determined as in Step 2b. If a GCV value produced from testing is available for the FAME mixture, this GCV value should be used in preference to the GCV value from the approximate calculation method described above.

Step 2a: Calculate the GCV of the FAME mixture (if GCV unknown)

4.11. The GCV of the FAME mixture depends on the GCV of each FAME compound present in the FAME mixture and the proportion of each FAD in the original feedstock.

4.12. Table 5.2 shows our calculated GCV of each FAME compound based on fundamental thermodynamics (an expanded table is given in Appendix 2. For an explanation of how these figures were arrived at, see Appendix 5).

Table 5.2: GCV of each FAME compound

FAME compound that is comprised of FAD group x:y	GCV of FAME compound (MJ/kg)
12:0	38.0
14:0	39.0
16:0	39.8
16:1	39.6
17:0	40.1
18:0	40.4
18:1	40.3
18:2	40.1
18:3	40.0

4.13. For the proportion of each FAME compound within the FAME mixture, you can either use the default value relevant to your feedstock as given in Appendix 1 for Option 1, or the results of sampling for Option 2.

4.14. To calculate the GCV of the FAME mixture, you should first work out the energy contribution of each FAME compound. This is calculated by multiplying the GCV of each FAME compound by the percentage share of the FAD within the FAME mixture. The GCV contribution of each FAME compound is then summed to reach the total GCV of the FAME mixture.

$$\sum_{i=1}^{n} \text{CGV of FAME compound } \times \text{mass share of FAD in feedstock}$$

(where n = number of FADs in feedstock from Appendix 1 or from lab analysis)

Example 2 - Step 2a

4.15. This example uses the rapeseed default values in Appendix 1.

Table 4.3: mass distribution of FADs from rapeseed

FAME compound (ordered by FAD)	GCV of FAME compound (MJ/kg)	Mass share of FAD (%)
12:0	38.0	0
14:0	39.0	1.5
16:0	39.8	6
16:1	39.7	0
17:0	40.1	0
18:0	40.4	1
18:1	40.3	51.5
18:2	40.2	30
18:3	40.1	10

GCV of FAME = (38.0 x 0%) + (39.0 x 1.5%) + (39.8 x 6%) + (39.7 x 0%) + (40.1 x 0%) + (40.4 x 1%) + (40.3 x 51.5%) + (40.2 x 30%) + (40.1 x 10%) = 40.2 MJ/kg

Step 2b: Calculate the energy content contributions of residual fossil fuel derived components

4.16. The energy contribution of the components is dependent on the proportion by mass of that component in the biodiesel, the energy content of that component and the energy content of the biodiesel as a whole. The GCV of the biodiesel from sampling results or the outcome of Step 2a can be used for the energy content of biodiesel as a whole.

4.17. Either the default values given in Appendix 4 or sampling results as discussed in the information requirements above can be used to determine the proportion by mass of each component. As the GCVs of the components cannot be measured, standard GCVs can be used. These are in Appendix 4 and discussed further in the information requirements above.

4.18. To work out the energy contribution of a residual component the proportion by mass of the component is multiplied by the GCV of the component to determine its energy contribution. This is then divided by the GCV of the biodiesel to get a percentage contribution.

***Energy composition of Component** = (proportion of component in biodiesel ×GCV of component) ÷ GCV of biodiesel*

Example 3 – Step 2b

4.19. This example assumes no sampling has been carried out and uses the default proportion of residual fossil fuel components (3.5%) and a standard GCV for fossil diesel (47.9 MJ/kg) as given in Appendix 4. Energy contribution of residual components = (3.5% x 47.9)/40.2 = 4.17

Step 3: Calculate the overall biomass energy content of the biodiesel

4.20. Step 3a below shows how to calculate the fossil fuel energy contribution to the biodiesel as a whole. This fossil fuel energy content comes from both the methoxy group within the FAME compounds that make up the FAME mixture and the fossil fuel contribution of each contamination component in the biodiesel. An overall fossil fuel and biomass proportion of the biodiesel is calculated in step 3b. The total percentage of fossil fuel contamination figure is entered on the RER system each month as it is not eligible for ROC issue.

Step 3a: The fossil fuel energy content of biodiesel from the FAME mixture

4.21. The fossil fuel content within the FAME mixture as a proportion of the fossil fuel content in the biodiesel is dependent on:

- The fossil fuel energy content of the FAME mixture, and
- The proportion of FAME mixture in the biodiesel.

4.22. The fossil fuel energy content of the FAME mixture is calculated in step 1. For the proportion of FAME in the biodiesel you can either use the default value of 96.5%

(if your fuel meets the standard **EN14214:2012**) or the results of sampling as in the information requirements above.

4.23. The fossil fuel energy content attributable to the FAME mixture is a multiple of the proportion of FAME mixture in the biodiesel and the fossil fuel energy content in the FAME mixture.

Fossil fuel energy content attributable to FAME mixture = proportion of FAME mixture in biodiesel × fossil fuel energy content in FAME mixture

Example 4 – Step 3a

4.24. This example uses the outcome of example 1 for the average fossil fuel energy content of the FAME mixture in rapeseed oil (3.91%) and the minimum FAME mixture content from the EN14214:2012 biodiesel standard given in Appendix 4 (96.5%). Fossil fuel energy content attributable to rapeseed FAME mixture = 3.91% x 96.5% Fossil fuel energy content attributable to rapeseed FAME mixture = 3.77%.

Step 3b: biomass energy content of biodiesel

4.25. To determine the overall fossil fuel energy content of the biodiesel, expressed as a percentage, add the fossil fuel energy content from the FAME mixture to the fossil fuel energy content of the other components. This can then be subtracted from 100 to give a biomass energy contribution to the biodiesel.

$$\text{\% fossil fuel energy content of biodiesel} = \text{\% fossil fuel energy content attributable to FAME mixture} + \sum_{i=1}^{n} \text{\% fossil fuel energy content of each potential fossil fuel component}$$

% biomass energy content of biodiesel = 100% -% fossil fuel energy content of biodiesel (where n = number of fossil fuel components)

Example 5 – Step 3b

4.26. This example uses the outputs of example 3 (0.11% and 3.63%) and example 4 (3.77%) for the fossil fuel content of the FAME and the fossil fuel content of the components (glycerol is excluded from the fossil fuel percentage as it is considered biogenic).

Fossil fuel energy content of rapeseed biodiesel (%) = 0.11% + 3.63% + 3.77% = 7.51% (This is the contamination value which would be stated within your fuel submission on the RER).

Biomass energy content of rapeseed biodiesel = 100% – 7.51% = 92.49%

Appendices

Appendix 1: Default FAD composition values

Table A1.1: A breakdown of FAD compositions by mass according to the least favourable share in commonly used vegetable oils/ animal fats

FAD composition by mass share (%)

(carbon chain length: number of double bonds)

Palm	2.4	46.3	6.3	0	0	37.0	8.0	0	0
Soyabean	0	0	11.0	0	0	2.4	23.1	53.0	10.5
Rapeseed	0	1.5	6.0	0	0	1.0	51.5	30.0	10.0
Sunflower	0	0	6.5	0	0	1.3	23.5	68.7	0
Tallow	0	4.0	27	4.0	0	13.0	48.0	4.0	0

Appendix 2: FAME energy values

Table A2.1: The energy content and fossil fuel derived energy content in FAME compounds derived from different FADs.

FAD component in FAME compound	GCV of FAME (MJ/kg)	Fossil fuel energy share in FAME (%)
6:0	32.5	10.85
8:0	35.0	8.30
10:0	36.7	6.72
12:0	38.0	5.64
14:0	39.0	4.86
16:0	39.8	4.27
16:1	39.6	4.32
17:0	40.1	4.03
18:0	40.4	3.81
18:1	40.3	3.85
18:2	40.1	3.89
18:3	40.0	3.93
20:0	40.9	3.44
20:1	40.8	3.47
20:2	40.7	3.50
20:3	40.6	3.53
22:0	41.4	3.13
22:1	41.3	3.16

22:2	41.2	3.19
22:3	41.0	3.21
24:0	41.7	2.88
24:1	41.6	2.90
24:2	41.5	2.92
24:3	41.4	2.94

Appendix 3: Default values for the biomass energy content of FAME

Table A3.1: Default values for different biodiesel feedstocks based on Fatty Acid Derivative compositions according to the least favourable share

	Mass (kg)	Mass share (%)	Energy content (MJ/kg)	Energy share (%)
Palm	237.1	88.44	42.9	95.69
Methoxy group	31.0	11.56	14.8	4.31
Soy	260.7	89.37	43.1	96.08
Methoxy group	31.0	10.63	14.8	3.92
Rapeseed	261.7	89.41	43.2	96.10
Methoxy group	31.0	10.59	14.8	3.90
Sunflower	262.0	89.42	43.1	96.10
Methoxy group	31.0	10.58	14.8	3.90
Tallow	254.9	89.16	43.2	96.00
Methoxy group	31.0	10.84	14.8	4.00

Appendix 4: Specifications in EN14214:2012 standard and standard Gross Calorific Values for residual components

Table A4.1: Specifications in EN14214:2012 standard and standard Gross Calorific Values for residual components

Property	Unit	Lower limit	Upper limit	Test-Method	Potentially fossil fuel*	Energy content (MJ/kg)
FAME content	%(m/m)	96.5	-	EN 14103	Partially	
Density at 15°C	kg/m^3	860	900	EN ISO 3675 EN ISO 12185	N/A	
Viscosity at 40°C	mm^2/s	3.5	5.0	EN ISO 3104	N/A	
Flash point	°C	>101	-	EN ISO 2719 EN ISO 3679	N/A	
Sulphur content	mg/kg	-	10	EN ISO 20846 EN ISO 20884 EN ISO 13032	N/A	
Cetane number	-	51	-	EN ISO 5165	N/A	
Sulfated ash content	%(m/m)	-	0.02	ISO 3987	N/A	
Water content	mg/kg	-	500	EN ISO 12937	No	
Total contamination	mg/kg	-	24	EN 12662	N/A	
Copper band corrosion (3 hours at 50°C)	rating	Class 1	Class 1	EN ISO 2160	N/A	
Oxidation stability, 110°C	hours	8	-	EN 15751 EN 14112	N/A	

Acid value	mg KOH/g	-	0.5	EN 14104	N/A	
Iodine value	-	-	120	EN 14111 EN 16300	N/A	
Linolenic Acid Methyl ester	%(m/m)	-	12	EN 14103	Already accounted for**	
Polyunsaturated (≥4 double bonds) methyl esters	%(m/m)	-	1	EN 15779	Already accounted for**	
Methanol content	%(m/m)	-	0.2	EN 14110	Yes	22.6
Monoglyceride content	%(m/m)	-	0.7	EN 14105	No	
Diglyceride content	%(m/m)	-	0.2	EN 14105	No	
Triglyceride content	%(m/m)	-	0.2	EN 14105	No	
Free glycerol	%(m/m)	-	0.02	EN 14105 EN 14106	N/A	
Total glycerol	%(m/m)	-	0.25	EN 14105	No	
Group 1 metals (Na+K)	mg/kg	-	5	EN 14108 EN 14109 EN 14538	N/A	
Group 11 metals (Ca+MG)	mg/kg	-	5	EN 14538	N/A	
Phosphorus content	mg/kg	-	4	EN 14107 FprEN 16294	N/A	
Other additives	%(m/m)		3.5		Yes	47.9

* where N/A is entered the property does not have energy content.

** these esters are accounted for in the FAME content specified in the first row.

Appendix 5: Calculation of GCV and fossil fuel energy share of FAME compounds

A.5.1. The calculation to determine the GCV and fossil fuel content of each FAME compound is split into four steps:

- **Step A5.1:** Calculate the proportion by mass of biomass and fossil fuel in the FAME compound - this is necessary to apportion the energy from biomass and fossil fuel that can be expected in a particular unit of mass.
- **Step A5.2:** Calculate the bond energies of biomass and fossil fuel in the FAME compound - this is necessary to understand where the energy in the FAME compound has come from so that it can be attributed to biomass or fossil fuel.
- **Step A5.3:** Calculate the GCV of the FAME compound – this is calculated from the bond energies according to the proportion by mass of biomass and fossil fuel (as used in the calculation in chapter 3 and presented in Appendix 2).
- **Step A5.4:** Calculate the proportion by energy content of biomass and fossil fuel in the FAME compound - this uses the GCVs of the biomass component and fossil fuel component to calculate the proportion of biomass and fossil fuel given in Chapter 3 and Appendix 2.

A.5.2. The calculations for each of these steps are given below.

Step A5.1: Calculate the proportion by mass of biomass and fossil fuel in the FAME compound

A.5.3. This step begins with a calculation of the atomic mass of the biomass and fossil fuel in the FAD and methoxy group within each FAME compound in step A5.1a. Step A5.1b then uses the mass of the FAD and methoxy group to reach the relative proportions of the biomass and fossil fuel by mass within the FAME compound.

Step A5.1a: Molecular mass of FAD

A.5.4. The molecular mass of the FAD is calculated by multiplying the number of each type of atom by the atomic mass of the atom, then summing the mass calculated across all the types of atoms contained in the FAD.

A.5.5. Table A5.1 shows the number of each type of atom in the FAD within each FAME compound. The same steps have been completed for the methoxy group (first row in Table A5.1).

Table A5.1 – the number of atoms present in methoxy group and FADs commonly found in biodiesel

Fatty acid derivative	Carbon atoms	Hydrogen atoms	Oxygen atoms
Methoxy group	1	3	1
12:0	12	23	1
14:0	14	27	1
16:0	16	31	1
16:1	16	29	1
17:0	17	33	1
18:0	18	35	1
18:1	18	33	1
18:2	18	31	1
18:3	18	29	1

Example A

Atom type	Carbon	Hydrogen	Oxygen
Atomic mass	12	1	16

A.5.6. This example uses the makeup of FAD 14:0 and atomic mass of each atom as given in the table above.

Mass of FAD 14:0: (14 x 12) + (27 x 1) + (1 x 16)=211 kg/kmol

Step A5.1b: calculate the relative proportion of biomass and fossil fuel by mass

A.5.7. This step uses the mass of the FAD and the methoxy group calculated in step 1a to determine the relative proportions of biomass to fossil fuel by mass. The percentage mass of biomass is the mass of the FAD divided by the combined mass of the FAD and methoxy group multiplied by 100. The percentage mass of the methoxy group can then be calculated by deducting the percentage mass of the FAD from 100.

Percentage mass of biomass *= 100 x (mass of FAD/ mass of FAD + mass of methoxy group)*

Percentage mass of methoxy group *= 100 – percentage mass of FAD*

Example B

A.5.8. This example uses the mass of fatty acid derivative 14:0 as calculated in example A and the mass of the methoxy group which can be calculated as in step 1a

Mass of FAD (biomass) = 211 kg/kmol

Mass of the methoxy group (fossil fuel) = 31 kg/kmol

Percentage mass of the FAD = 100 x (211/(211 + 31)) = 87.19%

Percentage mass of methoxy group = 100 - 87.19 = 12.81%

Step A5.2: Calculate the bond energies of biomass and fossil fuel in the FAME compound

A.5.9. Steps A5.2a and A5.2b calculate the energy required to break the bonds in the FAME and the energy released when forming the products of combustion. The difference between the two gives the net energy content of the biomass and fossil fuel in the FAME compound (step A5.2c). A correction factor is then applied in step A5.2d to account for the difference between theoretical bond energies and experimental bond energies. Step A5.2e then calculates the net specific energy of the biomass and fossil fuel in the FAME compound.

Step A5.2a: calculate the total input energy required for combustion of FAD

A.5.10. The total input energy required to combust the FAD is the energy within each bond multiplied by the number of that type of bond. The bond energies for each FAD are then summed separately. The calculation also takes into account the energy required to break the bonds in oxygen molecules needed for combustion.

$$\text{total input energy needed for combustion of FAD} = \sum_{i=1}^{n} \text{number of bonds} \times \text{bond energy}$$

Where n = number of bond types in FAD or oxygen)

Example C

A.5.11. The example uses FAD 14:0.

Table A5.2: Bonds within FAD 14:0 and oxygen required for combustion

Bond type	Number of bonds	Bond energy (MJ/kmol)
C-C	13	346
C-H	27	411
C=O	1	799
O=O	20.25	498
C=C	0	611

Total input energy: (13 x 346) + (27 x 411) + (1 x 799) + (20.25 x 498) = 26478.5 MJ/kmol

Step A5.2b - calculate the total energy released from combustion of FAD

A.5.12. This is the same calculation as 2a but is performed on the products of combustion of the FAD: carbon dioxide and water.

$$\textbf{Total energy released on combustion of FAD} = \sum_{i=1}^{n} \text{number of bonds in products of combustion} \times \text{bond energy}$$

Where n = number of bond types in FAD or oxygen.

Example D

A.5.13. The example uses FAD 14:0

Table A5.3: bonds within combustion products of FAD 14:0

Bond type	Number of bonds	Bond energy MJ/kmol
C=O	28	799
H-O	27	459

Energy released on combustion: (28 x 799) + (27 x 459) =34,765 MJ/kmol

Step A5.2c - calculate net energy released from the FAD

A.5.14. This simply deducts the total input energy from the energy released on combustion to give the net energy content of the FAD.

Theoretical biomass energy content of FAD = total energy released from FAD on combustion – total input energy required for combustion of FAD

Example E

A.5.15. This example uses the calculated input energy used and energy released in examples C and D for FAD 14:0.

Energy content in FAD 14:0 = 34,765 – 26,478.5=8,286.5 MJ/kmol

Step A5.2d - apply correction factor

A.5.16. The theoretical bond energy is multiplied by the correction factor of 1/0.923 (1.0834) to make it comparable with results observed through experimentation.

Corrected energy content of FAD = theoretical energy content of FAD × correction factor

Example F

A.5.17. The example uses the energy content of the FAD 14:0 as calculated in example D and the correction factor given above.

Corrected energy content in FAD 14:0: 8,286.5 x 1.0834=8,977.6 MJ/kmol

Step A5.2e: calculate the GCV of the FAD

A.5.18. This step divides the corrected energy content of the FAD by the molecular mass calculated in step 1a to provide the GCV of the biomass in the FAME compound (MJ/kg).

GCV of FAD = corrected energy content of FAD/ molecular mass of FAD

Example G

A.5.19. This example uses the corrected energy content of FAD 14:0 calculated in example F and the molecular mass of FAD 14:0 calculated in Example A.

GCV of FAD = 8,977.6/211 = 42.5 MJ/kg

Step A5.3: Calculate the GCV of the FAME compound

A.5.20. To calculate the energy from the biomass in 1 kg of FAME compound, the GCV of the FAD is multiplied by the mass share of the FAD in the FAME compound. The same calculation is performed to calculate the energy from fossil fuel (the methoxy group) in the FAME compound. The energy from biomass and fossil fuel can then be added together to get an overall GCV of the FAME compound.

A.5.21. The energy content of the FAD is as calculated in step A5.2. The GCV of the methoxy group to be used is 14.8 MJ/kg. This is calculated from the bond energies in the methoxy group and the ester C-O bond between the methoxy group and the FAD (348 MJ/kmol).

Energy from FAD in FAME compound = percentage mass of FAD × energy content of FAD

Energy from methoxy group in FAME compound = percentage mass of methoxy group × energy content of methoxy group

GCV of FAME compound = energy from FAD in FAME compound + energy from methoxy group in FAME compound

Example H

A.5.22. This example uses the energy content of FAD 14:0 calculated in example G and the energy content of the methoxy group calculated as 14.8 MJ/kg. It also uses the mass share of the FAD and methoxy group in the FAME compound calculated in example B.

Energy from FAD 14:0 = 87.19% x 42.5 = 37.1 MJ/kg

Energy from methoxy group = 12.81% x 14.8 = 1.9 MJ/kg

GCV of FAME compound = 37.1 + 1.9 = 39.0 MJ/kg

Step A5.4: Calculate the proportion of biomass to fossil fuel energy in the FAME compound

A.5.23. The energy from the FAD is divided by the GCV of the FAME compound and multiplied by 100 to give the percentage of biomass within the FAME compound. This can then be deducted from 100 to give the percentage of fossil fuel within the FAME compound.

Percentage of biomass energy = 100 x (energy from FAD/ GCV of the FAME compound)

Percentage of fossil fuel energy = 100 – percentage of biomass energy

Example I

A.5.24. This example uses the energy in FAD 14:0 and the GCV of the FAME compound comprising FAD 14:0 calculated in example H.

Proportion of biomass energy in FAD 14:0 = 100 x (37.1/39.0) = 95.14%*

Proportion of fossil fuel energy in FAD 14:0 = 100 - 95.14 = 4.86%*

*Note: the percentages presented are slightly different to those calculated from the preceding numbers due to rounding.

Appendix 6: Glossary

B

BS	British Standard

C

C	Carbon

D

DESNZ	Department for Energy Security and Net Zero

E

EN	European Norm (Standard)
EU	European Union

F

FAD	Fatty Acid Derivative
FAME	Fatty Acid Methyl Ester (main component of biodiesel)
FDBL	Fossil-Derived Bioliquid
FMS	Fuel Measurement and Sampling

G

GCV	Gross Calorific Value
GHG	Greenhouse Gas

H

H	Hydrogen

I

ISO	International Organisation for Standardisation

K

kg	Kilogram
kmol	Kilomole
KOH	Potassium hydroxide

M

MJ	Megajoule
MWh	Megawatt hour

N

NIRO	Northern Ireland Renewables Obligation
NIROC	Northern Ireland Renewables Obligation Certificate

O

O	Oxygen
Ofgem	Office of Gas and Electricity Markets

R

RED	Renewable Energy Directive
RER	Renewable Electricity Register
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
ROO	Renewables Obligation Order
RO(S)	Renewables Obligation Scotland

S

SROC	Scottish Renewables Obligation Certificate

U

UK	United Kingdom
UR	Utility Regulator in Northern Ireland