Renewables Obligation (RO) Guidance

Sustainability Criteria

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This document is guidance for operators of generating stations using solid biomass, biogas or bioliquids to generate electricity. It explains how to demonstrate that you are complying with the Renewables Obligation sustainability.

Contents

Introduction

Overview

The Renewables Obligation (RO), the Renewables Obligation (Scotland) (ROS) and the Northern Ireland Renewables Obligation (NIRO) were designed to incentivise renewable electricity generation in the UK. The respective schemes are administered by the Gas and Electricity Markets Authority (the Authority), whose day-to-day functions are performed by Ofgem. The scheme puts an obligation on licensed electricity suppliers in England and Wales, Scotland and Northern Ireland to present a specified number of Renewables Obligation Certificates (ROCs) per megawatt hour of electricity supplied to their customers during each obligation period.

In 2009, the European Commission introduced a comprehensive and binding sustainability scheme for bioliquids. Under the European Renewable Energy Directive (RED),[1] operators using bioliquids must meet specified sustainability criteria to be eligible for support under national incentive schemes. The EC also committed to considering solid biomass and biogas sustainability and published a paper with recommendations member states should follow if they opted to implement sustainability criteria.[2] The UK government transposed the bioliquid sustainability requirements of the Renewable Energy Directive I (RED I)[3] as well as the solid biomass and biogas recommendations into the RO on 1 April 2011.

In 2013, the Department for Energy Security and Net Zero (DESNZ) consulted on further amendments to the RO sustainability criteria for implementation from 1 April 2014. They mainly affected the sustainability criteria and related reporting requirements for generating stations using solid biomass and biogas. In 2015, the Renewables Obligation Order was consolidated and the requirement for solid biomass and biogas stations to meet the sustainability criteria in order to receive support under the scheme was introduced. In Scotland and Northern Ireland, the requirement for solid biomass and biogas stations to meet the sustainability criteria was introduced in an amendment Order. The RO and ROS Orders came into effect on 1 December 2015 and the NIRO Order came into effect on the 1 March 2016.

In 2017, BEIS (which replaced the DECC), consulted on implementation of the European Union's new sustainability requirements. This was for bioliquids used for electricity

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN
[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0011:FIN:EN:PDF
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0028

generation under the RO and implementing new definitions for waste and processing residues that apply to bioliquids, and solids and gaseous biomass. The Government published legislation in 2019 to ensure that the scheme continues to operate in line with EU Regulations that will be retained in UK law following the UK's exit from the EU on 31 January 2020.

This guidance describes the sustainability criteria for solid biomass, biogas and bioliquid fuels in England, Wales, Scotland and Northern Ireland.

For more information about the scheme, visit our website.

Relevant guidance

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

- 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
- Fuelled stations and fuel measurement and sampling (FMS)

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.

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

Executive Summary

This document describes the sustainability requirements to operators of generating stations, independent auditors and other interested parties.

The sustainability criteria consider the land from which the biomass is sourced, as well as the life-cycle greenhouse gas emissions associated with the biomass. In addition, the Orders specify that the sustainability information must be gathered for each consignment of biomass. Where consignments are mixed, the operator will need to use a suitable method to track the individual consignments and their associated sustainability information. This document has more information on the criteria and the types of information and evidence which can support an operator's reporting.

The legislation requires operators of generating stations using bioliquids, and operators of generating stations with a total installed capacity of 1MW or more using solid biomass and biogas, to report against, and meet, the sustainability criteria to get support under the scheme. For generating stations with a declared net capacity greater than 50KW and total installed capacity of less than 1MW, using solid biomass or biogas, operators must report against the sustainability criteria, but this does not link to support under the scheme.

Once the operator has confirmed what information to report against the criteria, they must send this to us. Operators of all bioliquid stations, and solid biomass and biogas stations with a declared net capacity of 1MW or more will report each month whether the sustainability criteria have been met, as part of each certificate claim under the scheme. These operators will also have to provide further information at the end of each obligation year. This includes a sustainability audit report which verifies the information the operator has given us. There is another guidance document that explains more about the reporting requirements, and you can find more details about it in the Associated Documents section.

This document has been specifically created for the Renewables Obligation scheme. It is for guidance only and is not a legal guide.

1. Overview of sustainability requirements

Chapter summary

Here we explain and give more information on the requirements that certain generating stations need to report against the sustainability criteria.

Overview

1.2. Operators of generating stations using biomass are required to report sustainability information, unless one of the following applies:

- use sewage gas, landfill gas or municipal waste to generate electricity[4],
- use solid biomass or biogas, and have a declared net capacity (DNC) of 50kW or less (i.e. microgenerators)
- use solid biomass or biogas which does not meet the definition of biomass (i.e. biogenic content is less than 90%)[5].

1.3. Operators who are required to report on the sustainability criteria will need to provide certain information to us. For information on the reporting requirements and what needs to be submitted, please see RO: Sustainability Reporting guidance.

1.4. Throughout, this document refers to sustainability criteria. In order to be issued ROCs, fuelled stations that are not exempt from reporting are required to collect and submit information on the sustainability criteria. These criteria are:

- Land criteria: which focuses on the land from which the biomass is sourced, and
- Greenhouse Gas (GHG) criteria: which accounts for the life cycle GHG emissions of the biomass.

1.5. More information on what these criteria are and how they can be met can be found in Chapters 4 and 5.

[4] Note that there are other exemptions to the sustainability criteria, but some reporting is still required each month and/or year.
[5] Operators using bioliquids which do not meet the definition of biomass are required to fulfil some sustainability reporting requirements.

Sustainability considerations

1.6. When using a biomass fuel for electricity generation, there are a number of things an operator will need to consider so they can report against the sustainability criteria. These include fuel classification, consignments and mass balance.

1.7. Figure 1.1 summarises these considerations and the sustainability criteria. The chapters in this guidance have been designed so an operator can work through them step by step.

Figure 1.1: Overview of sustainability considerations

2. Fuel classification

Chapter summary

This chapter provides clarity on what what exemptions may be available for reporting against the sustainability criteria. This is achieved by claissifciation of the various fuels used, as well as defining certain key terms. We also show how an operator should go about classifying various fuels.

Overview

2.1. 'Fuel classification' determines whether biomass is a product/co-product, waste or a type of residue. This will help the operator understand how to report against the sustainability criteria. Table 2.1 summarises the reporting requirements for bioliquid, solid biomass and biogas. For biomass that is wood or derived from wood there are no exemptions to the land criteria, with the exception of 'waste'.

2.2. If the operator believes the fuel being used at the station is classifiable as a waste or a type of residue and so would benefit from an exemption, they will need evidence to demonstrate this to their independent auditor as part of their annual sustainability audit.

2.3. It is not necessarily the final fuel that needs to be considered as a waste or residue. It is also possible to claim the exemption if the material from which the final fuel was created was a waste or a type of residue. For example, a biodiesel made from used cooking oil would be exempt if the operator has evidence that the used cooking oil was a waste.

Table 2.1: Fuel classification reporting requirements under the Orders.

Fuel Category	**Bioliquid Land Criteria**	**Bioliquid GHG Criteria**	**Solid Biomass / Biogas Land Criteria**	**Solid Biomass / Biogas GHG Criteria**
Waste[6]	Exempt	Emissions during and from the process of collection only	Exempt	Exempt
Biomass wholly derived from waste[7]	N/A	N/A	Exempt	Exempt
Processing residues	Exempt	Emissions during and from the process of collection only	Not wood - exempt from land criteria Wood - must report against the land criteria for woody biomass	Emissions during and from the process of collection only
Residues from agriculture	Reporting required	Emissions during and from the process of collection only	Reporting required	Emissions during and from the process of collection only
Residues from forestry	Reporting required	Full life-cycle emissions	Reporting required	Emissions during and from the process of collection only
Residues from arboriculture[8]	N/A	N/A	If not wood - exempt from land criteria If wood - deemed sustainable and meets the land criteria for woody biomass	Emissions during and from the process of collection only

[6] This term is as per the definition set out in paragraph 3.7 which can be applied to fuel which meets the definition of biomass

[7] This term is not used in the legislation for bioliquid fuels for the purposes of reporting against the land and GHG criteria

[8] This term is not used in the legislation for bioliquid fuels for the purposes of reporting against the land and GHG criteria

Residues from aquaculture and fisheries	Reporting required	Full life-cycle emissions	Reporting required	Emissions during and from the process of collection only
Products, co-products	Reporting required	Full life-cycle emissions	Reporting required	Full life-cycle emissions

Additional exemptions

2.4. In addition to the exemptions associated with fuel classifications in Table 2.1, for solid biomass and biogas only;

- Excreta produced by animals used to generate electricity is also exempt from the land and GHG criteria. This is noted separately to the table above as it is an exception to the rules on fuel classification. This is because the RED I considers manure to be a processing residue, and so for bioliquids derived from manure the processing residue reporting requirements remain relevant as per Table 2.1.
- Wood that was removed for the purpose of creating, restoring or maintaining the ecosystem of an area (which was not a forest), is deemed sustainable under the land criteria for woody biomass.[9] Emissions during and from the process of collection will be required to report against the GHG emissions.

Definitions

2.5. This is a complex area. There is often not a definitive answer to the question of whether a substance is a waste or a residue. The sections below aim to give guidance that is as clear and consistent as possible. Do not treat it as legal guidance: seek your own legal or technical advice if you need to.

Definition of waste

2.6. The RO Orders state that waste has the meaning given to it in Article 3(1) of Directive 2008/98/EC of the European Parliament and of the Council on waste which states that "waste" means any substance or object which the holder discards or intends or is required to discard"[10] It also includes anything derived

[9] This term is not used in the legislation for bioliquid fuels for the purposes of reporting against the land and GHG criteria
[10] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098

from waste but does not include landfill gas or sewage gas. The changes introduced by the ILUC Directive exclude from that definition "substances that have been intentionally modified or contaminated to fall within the meaning of waste.[11] Further guidance on this definition was published in August 2012 by the Department for Environment, Food and Rural Affairs (DEFRA) titled 'Guidance on the legal definition of waste and its application'.[12]

2.7. The Environment Agency has an important role under the Waste Framework Directive (WFD), in determining whether a substance is a waste or is derived from waste. As far as possible, a consistent approach will be taken, but the RO biomass sustainability government response document[13] says that for sustainability reporting, the waste definition should be used with the broad intention of the RED I in mind. This may mean there are times when a material is classified as a waste by the Environment Agency but this is not definitive for the purpose of the Orders.

Wastes as 'dedicated biomass'

2.8. As stated above, there are certain exemptions from the sustainability criteria for biomass that is considered 'waste' or 'wholly derived from waste'. For such fuels, where they have a renewable energy content of at least 90% they would meet the definition of biomass and may still be eligible for 'dedicated biomass' ROCs. For example, used cooking oil that has no fossil-derived contamination would be considered 'biomass' for issuing ROCs but would be exempt from aspects of the sustainability criteria. For more information on the definition of biomass or waste for the purpose of ROC issue, refer to the Fuel Measurement and Sampling Guidance document.

Definition of residues

2.9. The RO defines residues from processing in line with the RED which was, in turn, amended by the EU directive to reduce indirect land use change for biofuels and bioliquids[14].

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[11] Directive 2015/1513, Article 2(1)(p), available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32015L1513
[12] Available from DEFRA's website at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69590/pb13813-waste-legal-def-guide.pdf
[13] Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/231102/RO_Biomass_Sustainability_consultation_-_Government_Response_22_August_2013.pdf
[14] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1513&from=EN

2.10. "Processing residue" means a substance that is not the end product(s) that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it.

2.11. "Agriculture, aquaculture, fisheries and forestry residues" means residues that are directly generated by agriculture, aquaculture, fisheries and forestry, and does not include residues from related industries or residues from processing".

2.12. This definition of residues from agriculture, aquaculture, forestry and fisheries can be interpreted to mean that such residues are those generated in harvesting the material being sought. Once the product has been harvested and further processing occurs, any residues generated from this are considered processing residues.

2.13. Residues from arboriculture are not defined in the legislative framework. However, in line with DECC's (now DESNZ) consultation response in August 2014[15] arboricultural residues are considered to be material from woody plants and trees planted for landscape or amenity value that are removed as part of tree surgery usually in gardens, parks or other populated settings, and utility arboriculture such as the verges of roads and railways. Residues from arboriculture should not include forestry residues.

Allocating emissions – process of collection

2.14. In calculating the GHG emissions, the Orders use the term 'process of collection' when setting out for certain materials that full lifecycle GHG calculations are not required.

2.15. 'Process of collection' includes all emissions involved in collecting the waste or residue, further processing and transport. This is not necessarily the same as the point of collection, which is considered to be the point where the material is collected by another party. For the 'process of collection' any emissions arising after the waste/residue was created but before it is collected should also be taken into account. For example, there may be emissions associated with machinery used to gather the waste/residue into storage containers ready for collection.

[15] https://www.gov.uk/government/consultations/biomass-sustainability

2.16. For example, used cooking oil may be collected from different restaurants and food processing plants, which are considered the starting point for the waste. The transportation of this used cooking oil will need to be calculated and allocated to the final bioliquid fuel.

Considering fuel classification

2.17. Appendix 3 has a list of common classifications for materials and a separate table for classifications of wood types. The list isn't exhaustive, so there may be something that is considered a waste or type of residue that it doesn't include.

2.18. We might periodically review and update this list, if sufficient evidence emerges to indicate that a substance should be treated differently. If this happens, we will discuss it with the Renewable Heat Incentive team and the scheme administrators such as the Renewable Transport Fuels Obligation (RTFO) administrators and re-assess if necessary.

2.19. We try to be as consistent as possible with other government departments, such as the Department of Transport and its view on biofuel classification under the RTFO. But sometimes our role and responsibilities under the Orders might lead us to a different approach on the same material.

2.20. Our view on whether a substance is a residue or a waste is relevant to the RO sustainability criteria only. It doesn't apply to the status of substances under the Waste Framework Directive, nor influence the Environment Agency when making decisions on substances. This applies both to the common classification tables in Appendix 3, and to any subsequent views we reach on wastes and residues for the RO.

Approach for the operator

2.21. When considering the classification of a fuel, we recommend that the operator of the generating station first refer to the common classification tables in Appendix 3. If the fuel is listed in the common classification tables, and the table description fits the fuel, the operator will need to gather evidence that it does. This evidence needs to be presented to the auditor as part of the annual sustainability audit report.

2.22. If the operator considers their biomass to be a waste or type of residue that is not covered in the common classification lists, as either the material is not listed or the way the material was produced does not correspond with the common classification, they should discuss this with us. This should be done before they use the biomass.

2.23. Discussions about fuel classification should happen when we are agreeing the fuel measurement and sampling (FMS) procedures for the fuel. We will only discuss this with the operator of the generating station intending to make use of the fuel when they have submitted FMS procedures. We will not comment on speculative approaches or approaches from people other than the operator of a generating station. Although operators often rely on the supply chain for information on fuel, we have focused this action on scheme participants.

Process for fuel classification discussions

2.24. Each FMS questionnaire will have questions about fuel classification. If the operator thinks the fuel is a waste or a type of residue not covered in the common classification tables, we will ask them to provide evidence of the fuel classification. Operators can also ask us for our view if they think the tables don’t cover the fuel classification for a particular material. This process has been specifically developed for operators of generating stations who have to meet the sustainability criteria in order to be issued ROCs[16].

2.25. To do this, we have questions to ensure the operator presents relevant information to support discussions. These questions will be made available to the operator in a standard template during the FMS approval process.

2.26. We will consider the information provided by the operator. We will seek input from relevant parties such as the RHI and RTFO administrators. The operator should be aware that the information they provide to us may be shared.

2.27. If any information is unclear or incomplete, we will ask the operator to give us more information so we can provide our view on fuel classification.

2.28. Any view from us on fuel classification is not ‘a decision’ or ‘official approval’. The operator’s independent auditor should consider all the evidence and seek further information if they need to, as part of the annual sustainability audit. It’s not enough for the auditor to rely solely on the correspondence between us and the operator as part of the fuel classification review.

[16] Generating stations using bioliquids and those using solid biomass or biogas where the TIC is greater than or equal to1MW

2.29. If the audit disagrees with the classification, or further information comes to light, we will review the case. If the additional evidence results in the classification being inappropriate, we will consider the impact this has on how the operator has reported and any ROCs they have claimed for that fuel.

2.30. We will give all our views case by case, based on the information from the operator. We will seek consistency with scheme administrators and other government departments, but in some cases, it may be appropriate for us to take a different view for the purpose of the RO.

Demonstrating compliance

2.31. If the operator is seeking to make use of an exemption associated with fuel classification, whether for a material specified on the common classifications list or otherwise, they must have evidence to demonstrate this.

2.32. If a voluntary scheme is not being used, or does not cover this scope, useful documentation may include:

- Permits and certificates (such as waste transfer notes or end-of-waste certificates) issued by the Environment Agency,
- process flow diagrams which explain how the material is created, and
- information regarding the uses of the material and its market value

2.33. This evidence will be verified by the annual sustainability audit report. This means that an operator must demonstrate to the auditor’s satisfaction that the biomass used for generation is as per the common classifications list or the separately established agreement with us. More information on what the auditor should verify for fuel classification is in the RO: Sustainability Reporting guidance.

3. Land criteria

Chapter summary

Operators must report against the land criteria. This chapter provides information on the criteria themselves and how to demonstrate compliance.

3.1. To be eligible for ROCs, all biomass fuels used for generating electricity will have to report against the land criteria.[17] The land criteria refer specifically to the production of the raw material, i.e. at the farm, forest or plantation. They do not apply to any other steps further down the supply chain.

3.2. There are two types of land criteria. These are the land criteria for woody biomass and the land criteria for non-woody biomass. Depending on the type of fuel used, will affect which type of land criteria to report against. Further explanation on the two types of land criteria is in this chapter.

Exemptions to the land criteria

3.3. A fuel that is not wood or derived from wood and is classified as a waste or a processing residue is exempt from the land criteria (more information on fuel classification is in Chapter 2). In this instance the operator will need to collect information to justify the applied fuel classification to demonstrate that it is correct to apply the exemption. When submitting their output data, the operator would select 'exempt' when reporting against the land criteria each month.

3.4. Aside from the fuel being waste or biomass wholly derived from waste there are no exemptions to the land criteria for woody biomass, based on fuel classification, for wood. However, arboricultural arisings and trees removed from an area for ecological reasons are deemed to be sustainable and therefore meet the land criteria for woody biomass.[18]

3.5. For biomass fuels that are not considered exempt, the operator must demonstrate compliance with the relevant criteria (either the wood or non-wood land criteria). Figure 3.1 is a diagram to identify the suitable criteria for reporting.

[17] See Schedule 3 of the ROO 2015 (as amended) and Schedule A2 to the RO(S) 2009 (as amended) and NIRO 2009 (as amended).
[18] See Schedule 3 paragraph 6 of the ROO 2015 (as amended) and Schedule A2 paragraph 6 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).

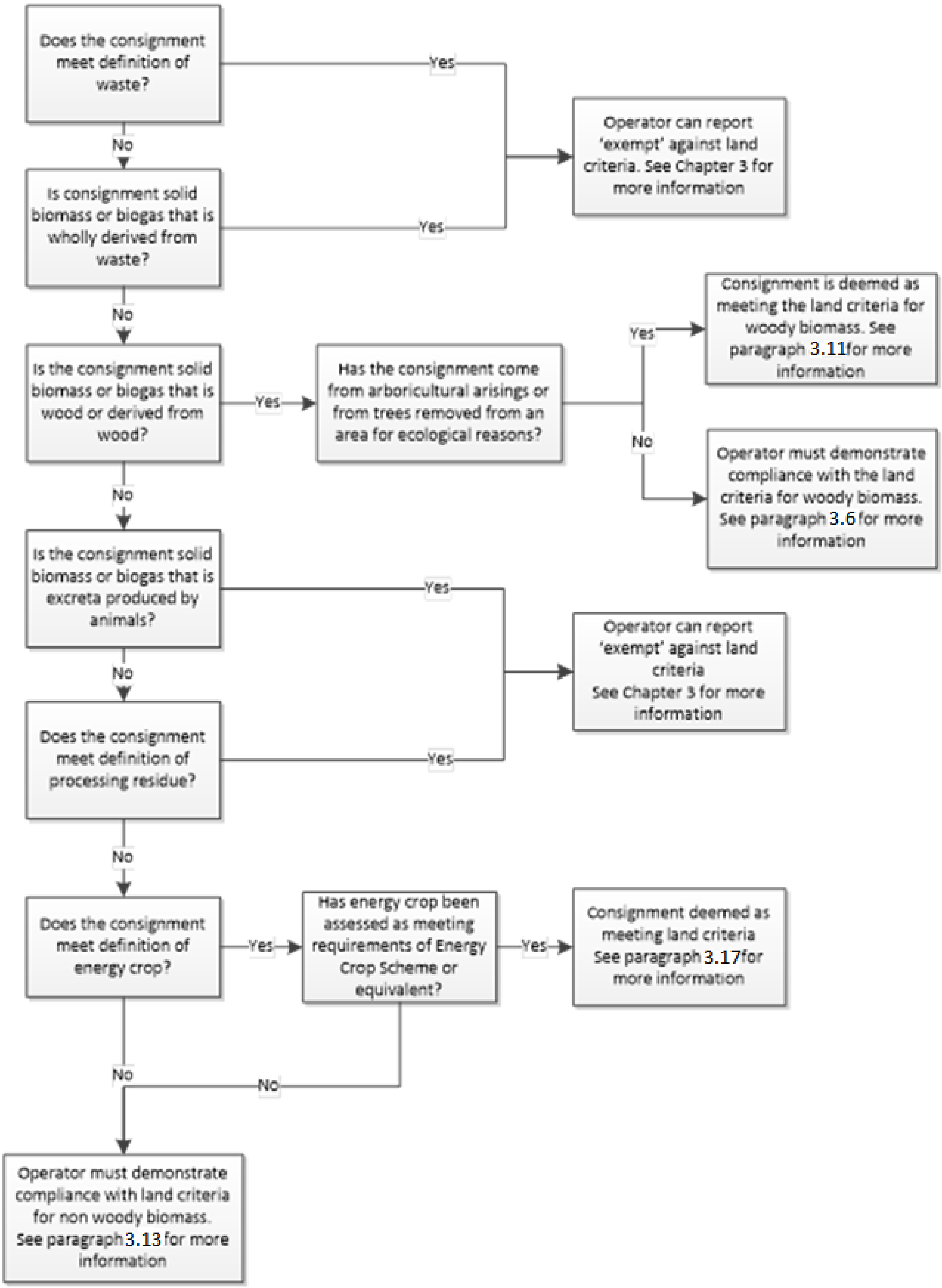

Figure 3.1 – Overview of land criteria requirements

Land criteria for woody biomass

3.6. If the biomass used to generate electricity was wood or derived from wood (other than an energy crop), the operator is required to report against the land criteria for woody biomass.[19]

3.7. The only exception to the land criteria for woody biomass is where the biomass is waste or wholly derived from waste. All other biomass that is wood or derived from wood (including processing residues, residues from forestry and residues from arboriculture) must report against the land criteria for woody biomass. There are two wood types that are 'deemed sustainable'. See paragraph 3.11 for more information.

3.8. At least 70% of all the woody biomass used in a month[20] must be obtained from a sustainable source.[21]

Demonstrating compliance

3.9. Evidence to demonstrate compliance with the land criteria for woody biomass should include evidence that traces the biomass from the source to the end user. There are two routes to doing this:

- Category A evidence: Through the use of Forest Stewardship Council (FSC) certificate scheme, the Programme for the Endorsement of Forest Certification (PEFC) certification scheme or the Sustainable Biomass Program (SBP) certification scheme.
- Category B evidence: Through collecting bespoke evidence that demonstrates compliance with the criteria.

3.10. We recognise that it is challenging to meet the criteria using Category B evidence, so to support this we have done a benchmarking exercise of certain certification schemes against the land criteria for woody biomass. This exercise was completed in 2015 with a further exercise completed in 2023. More information and the results are in Appendix 2.

[19] The land criteria for woody biomass have been transposed into the RO Order from the Timber Standard for Heat and Electricity. Available at: https://www.gov.uk/government/publications/timber-standard-for-heat-electricity
[20] By the RO capacity of a generating station.
[21] Schedule 3 of the ROO 2015(as amended), and Schedule A2 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).

3.11. If the wood is arboricultural arisings or from trees removed from an area for ecological reasons, they are deemed to be sustainable, and therefore meet the land criteria for woody biomass[22]. It is important that evidence is gathered to show that the wood has come from these types.

3.12. Guidance on the woody biomass land criteria has been provided by DESNZ.[23] This is split into three documents and explains how the land criteria for woody biomass can be met. These are;

- The woodfuel advice note[24]: provides a summary of the requirements and how to comply with these.
- Consignment and mass balance approach[25]: sets out how to operate mass balance systems and how to determine consignments.
- Risk based regional assessment: a checklist approach[26]: sets out how to use a checklist approach to operate a risk based regional assessment, and the types of evidence acceptable.

Land criteria for non-woody biomass

3.13. For biomass that is not wood or derived from wood, or exempt on the basis of fuel classification, the operator must demonstrate compliance with the land criteria. These criteria are derived from the RED and have been noted by the EC as being relevant for bioliquids, as well as solid biomass and biogas (other than wood). There is more information on the terms set out below.

3.14. The land criteria explain that biomass cannot be obtained from land that:

- at any time during or after January 2008 was primary forest,
- at any time during or after January 2008 was land designated for protecting nature (unless production of that biomaterial did not interfere with the purposes this land was designated for),
- at any time during or after January 2008 was a highly biodiverse grassland (unless the harvesting of the biomaterial was necessary to preserve the grassland status),

[22] See Schedule 3 Article 6 of the ROO 2015 (as amended) and Schedule A2 Article 6 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).
[23] Available at: https://www.gov.uk/government/publications/woodfuel-guidance-version-2
[24] The woodfuel advice note
[25] Consignment and mass balance approach
[26] Risk based regional assessment: A checklist approach

- at any time in January 2008 was peatland (unless cultivating and harvesting biomaterial did not involve draining previously undrained soil),
- at any time in January 2008 was a continuously forested area (unless that land is still a continuously forested area),
- at any time in January 2008 was a lightly forested area (unless that land is still a lightly forested area, or unless the biomass meets the GHG emission criterion when the GHG emissions from land use change are included using actual GHG values), and
- at any time in January 2008 was wetland (unless that land is still a wetland).

3.15. Where a land use change has occurred that is not permitted under the land criteria, the biomass has not met the land criteria.

3.16. If a land use change is permitted under the criteria (e.g. non-highly biodiverse grasslands to cropland, or lightly forested area to cropland), then a carbon stock calculation resulting from the land-use change will need to be performed. The associated GHG emissions will need to be calculated and added to the supply chain emissions. The relevant GHG threshold will still need to be met for the fuel to be compliant with the GHG criteria – see Chapter 4 for further details.

Energy crops

3.17. Energy crops, as defined in Article 2 of the Orders[27], are required to report against the land criteria for non woody biomass. When used as solid biomass and biogas these will be deemed to meet the land criteria where financial assistance has been paid under the Energy Crop Scheme, or equivalent.[28]

3.18. The Energy Crop Scheme is managed by Natural England and offers grants to farmers in England for establishing miscanthus and short rotation coppice for their own energy use or to supply power stations. The scheme closed to new applications on 31 August 2013.

3.19. There may be equivalents to the Energy Crop Scheme in other locations in the UK. If an operator is using an energy crop which is supported under such a scheme, they will need make a case that compares it to the requirements of the scheme against the Energy Crop Scheme.

[27] Article2(1) of the Renewables Obligation Order 2015(as amended)
[28] See Schedule 3 of the ROO 2015 (as amended) and Schedule A2 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).

3.20. Please refer to paragraph 3.51 for further information on suitable evidence for demonstrating compliance for energy crops.

Demonstrating compliance

3.21. To demonstrate compliance with the land criteria, the operator can use relevant voluntary schemes and/or collect evidence to support the land use from where the biomass was sourced.

3.22. We benchmarked a number of voluntary schemes against the land criteria in 2012. If the operator is using any of these schemes, they should refer to Appendix 2 for more information. More information on voluntary schemes can also be found in Chapter 6.

3.23. If the operator seeks to collect evidence to demonstrate compliance with the criteria, they should do this by collecting information on the land use of the farm/plantation in January 2008 (and after this date, where applicable).

3.24. Following the direction of an EC Communication about biofuels and bioliquids,[29] we suggest that these types of evidence could be useful in demonstrating compliance: aerial photographs, satellite images, maps, Land Register entries/databases,[30] and site surveys.

3.25. The evidence can be direct or indirect with regard to the format of the information supplied. For example, you could demonstrate compliance with the criterion about primary forest with evidence such as:

- An aerial photograph of the land, showing that it is planted with short rotation forestry (direct), or
- a map of all the primary forests in the region, showing the land to fall outside of them (indirect).

Other useful resources

3.26. It may be useful for operators to draw on other sources of guidance to help them determine the land use and gather evidence of this to demonstrate compliance with the land criteria.

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[29] Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:160:0008:0016:EN:PDF
[30] Note the Communication in footnote 13 lists the *Integrated Administration and Control System (IACS) for the EU's Common Agricultural Policy* as an example of a land register entry/database.

3.27. The EC has produced a guidance document to help identify the status of the land in January 2008 for demonstrating compliance with land criteria. This was produced for use with bioliquids and biofuels to demonstrate compliance with the RED land criteria, but is also useful for solid biomass and biogas where the same criteria are relevant. It is available on the Transparency Platform.[31]

3.28. For UK-sourced biomass, DEFRA is a useful source of information about land use. They have a list of evidence sources in the UK that might be useful for operators to demonstrate compliance with the land criteria. This list has been designed specifically for biofuels under the RTFO and is not exhaustive. Operators may need to draw on several sources as the work done by DEFRA was not done specifically to show compliance with the RO sustainability criteria.[32]

3.29. The European Committee for Standardization[33] (CEN) has published sustainability standards for bioliquids and biofuels, including one titled 'biodiversity and environmental aspects related to nature protection purposes' (published August 2012). This provides guidance on evidence that the production of raw material has not interfered with nature protection purposes for the land criteria.

3.30. The Forestry Commission, Forestry Commission Scotland, Natural Resources Wales and other countryside agencies may be able to help operators, as they have useful resources and guidance on providing evidence.

Land categories

3.31. To establish whether the land that the biomass comes from meets the criteria, the operator must consider what type of land it is, i.e. the land category. To help, we have included the following information that details some common land categories and indicates which land categories may comply with the land criteria.

[31] Inventory of data sources and methodologies to help identify land status. Available at: http://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria
[32] Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/2625/rtfo-supporting-claims-compliance.pdf
[33] CEN Sustainability criteria for biomass: http://www.cen.eu/cen/Sectors/Sectors/UtilitiesAndEnergy/Fuels/Pages/Sustainability.aspx

Categories of land and whether they comply with the land criteria

Cropland - non-protected

3.32. The Cropland is not in a nature protected area as defined in Schedule A2 of the Orders. This category includes cropped land, (including rice fields and set-aside[34]), and agro-forestry systems where the vegetation structure falls below the thresholds used for the forest land categories.[35]

- Complies

Cropland – protected

3.33. Same as above, but the Cropland is in a nature protection area as defined in Schedule A2 of the Orders.

- Complies if there is evidence that the production of the bioliquid raw material did not interfere with the nature protection purposes of the land. The evidence will depend on the specific nature protection purposes, but this might include evidence of actions taken to avoid damage to or maintain the nature protection purposes. Evidence could also be provided through reporting a voluntary scheme that meets the RED biodiversity criteria.

Grassland (and other wooded land not classified as forest) with agricultural use

3.34. This category includes rangelands and pasture land that are not considered to be Cropland, but which have an agricultural use. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category and which have an agricultural use. It includes extensively managed rangelands as well as intensively managed (e.g. with fertilisation, irrigation, species changes) continuous pasture and hay land.

- Complies if the GHG emissions of the resulting land use change are taken into account and the GHG threshold is still met (see Chapter 4).

Highly biodiverse grassland

3.35. Natural highly biodiverse grassland means grassland that:

[34] 'Set-aside' is a term related to the EU's Common Agricultural Policy (CAP). It refers to land taken out of production to reduce the risk of food surpluses, while increasing the opportunity for environmental benefits. From 2007 set-aside land has been abolished under the CAP.
[35] EC Communication 2010/C 160/02 considers that perennial crop plantations, including oil palm plantations, are classified as cropland.

- would remain grassland in the absence of human intervention and maintains the natural species composition and ecological characteristics and processes.

3.36. Non-natural highly biodiverse grassland means grassland that:

- would cease to be grassland in the absence of human intervention; and
- is not degraded, (i.e. characterised by long term loss of biodiversity); and
- is species rich

3.37. Habitats listed in Annex 1 to the Council Directive 92/43/EEC, habitats of significant importance for wild bird species listed Annex 1 to Directive 2009/147/EEC, and habitats of significant importance for wild bird species listed in Annex 1 to Directive 2009/147/EC will always be regarded as highly biodiverse grasslands.

- Complies only if the harvesting of the biomaterial was necessary to preserve the grassland status.

Grassland (and other wooded land not classified as forest) without agricultural use

3.38. This category includes grasslands without an agricultural use. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and bushes that fall below the threshold values used in the Forest Land category and which do not have an agricultural use.

- Complies if the GHG emissions of the resulting land use change are taken into account and the GHG threshold is still met (see Chapter 4).

Continuously forested area (forest greater than 30%)

3.39. Continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30%, or trees able to reach those thresholds in situ.

- Complies if the forest in question was not a primary forest (i.e. no signs of human disturbance such as logging), and that the land was not in a designated area.
- Complies only if the status of the land has not changed. Evidence of the nature and extent of the forest will need to be provided for January 2008 and the time the raw material was harvested.

Lightly forested area (forest 10-30%)

3.40. Land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10% and 30%, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of the area before and after conversion is such that, when the methodology laid down in part C of Annex V of the RED is applied, the conditions in paragraph 2 of Article 17 of the RED would be fulfilled.

- Complies if can demonstrate that the forest in question was not a Primary forest (i.e. no signs of human disturbance such as logging) and that the land was not in a designated area.
- Complies if the GHG emissions of the resulting land use change are taken into account and the GHG threshold is still met (see Chapter 4).

Wetland

3.41. Land that is covered with or saturated by water permanently or for a significant part of the year.

- Complies only if the wetland in question was not a primary forest or in a designated area.
- Complies only if the status of the land has not changed.
- Evidence of the nature and extent of the wetland will need to be provided for January 2008 and the date when the raw material was harvested.

Undrained peatland

3.42. Peatland that was not drained (either partially or completely) in January 2008.

- Complies only if the peatland in question was not a primary forest or in a designated area.
- Complies only if the land has not been drained.

Peatland

3.43. Peatland that was either partially or fully drained in January 2008.

- Complies only if can demonstrate that the peatland in question was not a primary forest, in a designated area.
- Complies only if the soil was completely drained in January 2008, or there has not been draining of the soil since January 2008. This means that for peatland that was partially drained in January 2008 a subsequent deeper

drainage, affecting soil that was not fully drained, would breach the criterion.

Degraded land

3.44. The land was not in use for agriculture or any other activity in January 2008 and falls into one of the following categories:

- 'severely degraded land', including such land that was formerly in agricultural use and that, for a significant period of time, has either been significantly salinated or presented significantly low organic matter content and has been severely eroded; or
- 'heavily contaminated land' that is unfit for the cultivation of food and feed due to soil contamination.

3.45. At the time of writing the EC has not published details on how degraded land should be further defined. This means it is not possible to say whether or not degraded land would always automatically comply with the RO land criteria. This guidance will be updated following the publication of the EC Decision, and any subsequent update of the ROO.

Settlement

3.46. All developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. Examples of settlements include land along streets, in residential (rural and urban) and commercial lawns, in public and private gardens, in golf courses and athletic fields, and in parks, provided this land is functionally or administratively associated with particular cities, villages or other settlement types and is not accounted for in another land use category.[36]

- Complies

3.47. Cropland specifically refers to land that is under the control of a farm or plantation. It is possible that the land at a single farm is not exclusively cropland but also includes other land uses (e.g. forestland). If the land cover does include forestland, the operator will have to demonstrate that there has been no conversion of that forestland after January 2008. However, if the land used to produce the feedstock is cropland, "cropland" should be reported.

[36] Definition from IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, 2006

3.48. The land category "cropland - non-protected" can be reported only if the land in question fully meets the land criteria. Similarly, the land category "cropland - protected" can be reported only if the operator has evidence that the production of the raw material, from which their biomass is sourced, did not interfere with the nature protection purposes of the land.

3.49. In some cases, the actual land cover may not be the same as the land category designated in a country's land registry. Operators who find themselves in this situation should report the actual land cover rather than that stated in the registry. For example, it is feasible that the land is or was designated for future agricultural purposes in a land registry, but the actual land cover (if you visit the site) is forestland. In this example, the land should be reported as forestland.

3.50. The categories "cropland", "grassland" and "forestland" specifically refer to the land cover. The categories "peatland" and "wetland" refer to other characteristics of the land, such as soil properties, that are not mutually exclusive with cropland, grassland or forest. For example, a forest may be on peatland, and grassland may be on a wetland. "Peatland", "wetland" and their variations should always be reported in precedence over the land types "cropland", "grassland" and "forestland" and their variations. For example, if a plantation is on peatland this should always be reported as peatland, irrespective of whether it had forest or grassland on it.

Energy crops

3.51. If an operator is generating electricity from an energy crop, it is possible that fuel can be deemed to have met the land criteria.

3.52. For the definition of ‘energy crop’ in Article 2(1) of the Orders, the operator would have already had to provide information to us to satisfy that it meets the definition for us to issue ROCs under the relevant ‘energy crop’ banding. If this is the case and in accordance with our FMS guidance, we will have written to the operator to confirm we were satisfied with the evidence of meeting the energy crop definition. However, not all crops require supporting evidence.

3.53. For more information on the types of evidence we review and the energy crops that don’t need evidence (and therefore there will be no subsequent confirmation email), refer to the FMS guidance.

3.54. In addition, suitable evidence will also need to be available to demonstrate that the energy crop meets the requirements of the Energy Crop Scheme, or equivalent, and to show that financial assistance has been paid. As with any of the evidential requirements, the operator may need to provide to their auditor several pieces of evidence rather than relying on a single document. Here are examples of what this might be:

- a copy of the offer letter signed by the energy crop grower,
- confirmation of the payment of the grant, or
- additional confirmation that the requirements set for the grower have not been breached, requiring the repayment of the grant.

3.55. If the operator needs to do an annual sustainability audit report, the evidence they have collated on the land criteria will be reviewed by their appointed auditor to satisfy them that the criteria has been met. For more information on the annual independent verification, please refer to the RO: Sustainability Reporting guidance.

4. Greenhouse gas (GHG) criteria

Chapter summary

Operators must report against the greenhouse gas criteria by one of the specified methods. This chapter describes the methodologies, and the thresholds that an operator should meet.

Overview

4.1. The Orders show the GHG criteria that the operator must report against per consignment of biomass, the methodology for calculations and the threshold that must be met.

4.2. As set out in Chapter 2, the classification of the biomass will determine how the operator reports against the sustainability criteria. Where the biomass used is exempt from the GHG emission criteria, or the operator only has to report emissions from the process of collection, they should gather evidence to demonstrate the correct fuel classification.

4.3. For some fuel classifications, operators are only required to calculate the GHG emissions from the 'process of collection'. Therefore, full life cycle GHG emission calculations are not required. Please refer to Table 2.1 for the relevant fuel classifications.

4.4. For those biomass fuels that need to determine whether they meet the GHG criteria, the operator will first need to determine which threshold they need to meet. Following this, the operator can consider how to demonstrate compliance either by the use of a voluntary scheme or by determining the GHG emissions of the biomass fuel.

4.5. Throughout this chapter we refer to GHG emissions of biomass as 'carbon intensity'. This is measured in terms of the lifecycle GHG associated with the biomass as carbon dioxide equivalent (CO_{2eq}). It therefore includes GHG other than carbon dioxide (e.g. methane and nitrous oxides).

GHG emission thresholds

4.6. The characteristics of the biomass fuel(s) used, and the type of station will determine which GHG threshold they need to meet. Figure 4.1 directs the operator to the relevant section in the chapter to identify the appropriate GHG threshold.

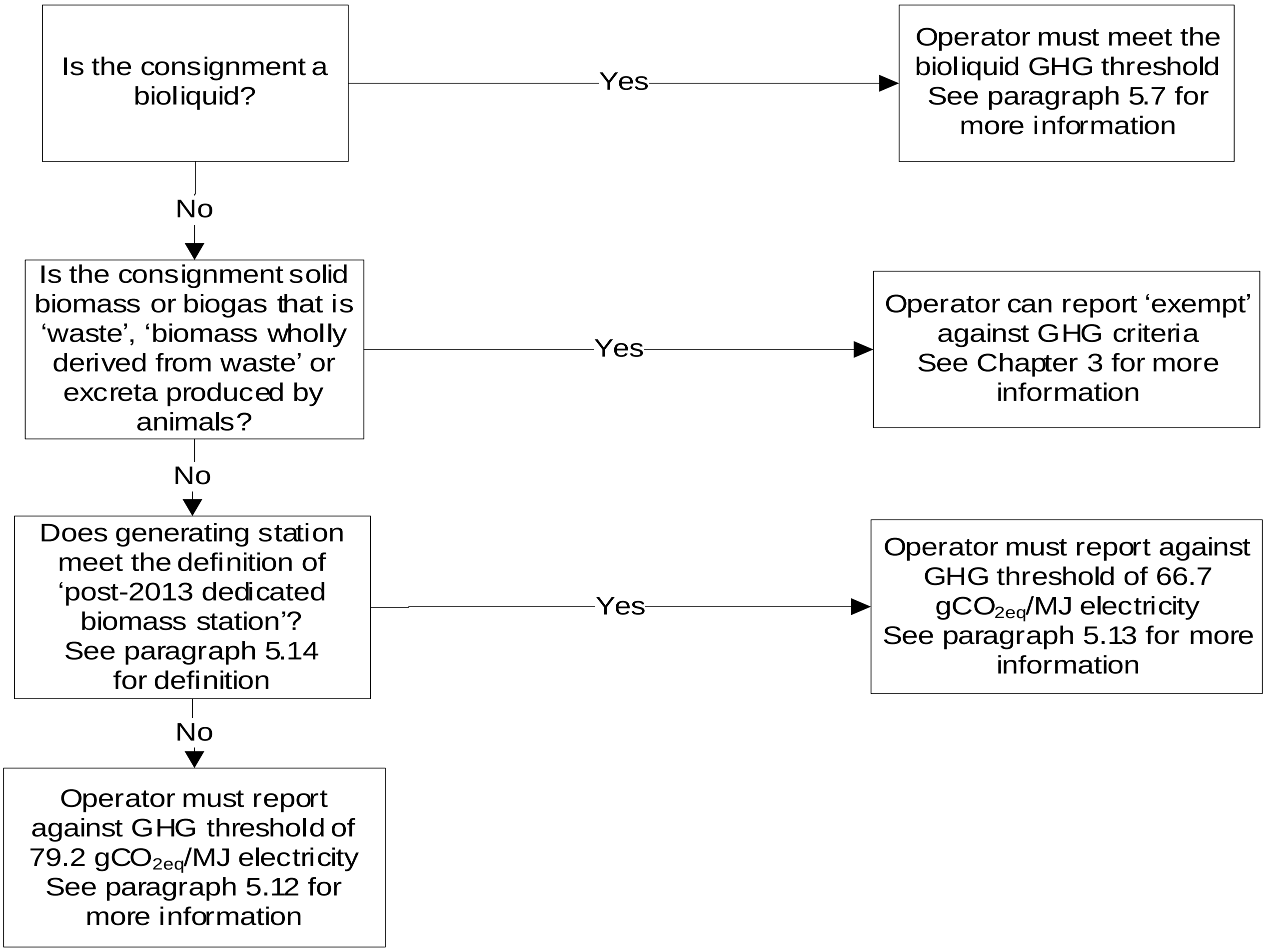


Figure 4.1: Overview of GHG thresholds

Bioliquid GHG threshold

4.7. If operators are reporting the GHG emissions for the use of a bioliquid they must report the GHG emission value as a saving against the fossil fuel comparator.[37] This means that once the operator has calculated the carbon intensity of their bioliquid fuel, they must calculate the percentage saving against the fossil fuel comparator. This gives them the GHG emission value they must report to us.

4.8. Table 4.1 shows the GHG emission threshold that must be met for the bioliquid to have complied with the GHG criteria.

4.9. From 1 January 2018, the threshold will be determined by when the bioliquid was used to generate electricity and the date that the installation that produced the bioliquid first started producing liquid fuels from biomaterial.

[37] The fossil fuel comparator is specified in Paragraph 19, Annex V, Part C of the RED as 91 gCO_{2eq}/MJ.

4.10. In this context, 'production of liquid fuels' refers to the first date that physical production of bioliquid took place, regardless of whether this was then sold for use in transport or electricity generation. This date will then determine which GHG emission threshold applies, based on whether it is 'before' or 'on or after' 6 October 2015.

GHG thresholds for bioliquids

4.11. For bioliquids produced by an installation that first started producing biofuels or bioliquids before 6 October 2015:

- Before 1 January 2017, any consignment of bioliquid produced by an installation that first started producing liquid fuel from biomaterial before 6 October 2015 will need to meet the current GHG threshold of 35%.
- From 1 January 2017, any consignment of bioliquid produced by an installation that first started producing liquid fuel from biomaterial before 6 October 2015 will need to meet the current GHG threshold of 50%.

4.12. For bioliquids produced by an installation that first started producing biofuels or bioliquids on or after 6 October 2015:

- **Before 1 January 2017**, any consignment of bioliquid produced by an installation that first started producing liquid fuel from biomaterial before 6 October 2015 will need to meet the current GHG threshold of 35%.
- **From 1 January 2017 and before 1 January 2017**, any consignment of bioliquid produced by an installation that first started producing liquid fuel from biomaterial before 6 October 2015 will need to meet the current GHG threshold of 50%.
- **From 1 January 2018**, any consignment of bioliquid produced by an installation that first started producing liquid fuel from biomaterial on or after 6 October 2015 will need to meet a GHG threshold of 60%.

Solid biomass and biogas GHG threshold

4.13. An operator of a generating station using solid biomass or biogas will need to report their GHG emission value in grams of CO_2 per MJ of electricity. For most operators, prior to 1 April 2020, the relevant GHG emission threshold is 79.2 gCO_{2eq}/MJ electricity.

4.14. Prior to 1 April 2020, an operator of a generating station which meets the definition of 'post-2013 dedicated biomass station' (as outlined below) was required to report against the GHG emission threshold of 66.7 gCO_{2eq}/MJ electricity. These stations are also able to use the GHG averaging mechanism.

4.15. A 'post-2013 dedicated biomass station' is defined in the Orders[38] as a generating station which was not accredited on or before 31 March 2013 and has, in any month after March 2013, generated electricity in the way described as 'dedicated biomass' (in accordance with Schedule 5 of the Orders[39]).

4.16. From 1 April 2020 until 31 March 2025, the threshold for all generating stations using solid biomass or biogas is 55.6 gCO_{2eq}/MJ electricity. These stations are also able to use the GHG averaging mechanism.

4.17. From April 2025 onwards, the threshold for all generating stations using solid biomass or biogas is 50 gCO_{2eq}/MJ electricity. These stations are also able to use the GHG averaging mechanism.

4.18. The GHG trajectory for solid biomass and biogas stations has been set out in legislation.

GHG annual averaging mechanism

4.19. The GHG annual averaging mechanism allows stations to meet the GHG criteria based on an annual average rather than an individual consignment basis for solid biomass and biogas. This means that the GHG criteria is met if the GHG emissions from its use are less than or equal to the relevant ceiling and that in an obligation year, the average GHG emissions are less than or equal to the relevant target.

4.20. Before 1 April 2020 this applied to the biomass used to generate electricity by a post-2013 dedicated biomass station only. After the 1 April 2020 this GHG annual averaging mechanism is open to all stations using relevant biomass.

4.21. The relevant target and the relevant ceiling thresholds change depending on the year they apply to. The targets and ceiling values, along with the definition of these terms, are in Table 4.1.

[38] Schedule 2, Part 1 of the ROO 2015 (as amended), Article 54 of the RO(S) (as amended) and Article 46 of the NIRO 2009 (as amended)
[39] Schedule 5 of the ROO 2015 (as amended), Schedule 1A1 of the RO(S) 2009 (as amended) and NIRO 2009 (as amended)

Table 4.1: GHG targets and ceiling values for solid and gas biomass

	Relevant Target	**Relevant Ceiling**
Definition	is the threshold for which the average GHG emissions of all the relevant biomass used in an obligation year should meet	is the maximum threshold for which relevant biomass can be issued ROCs
Post-2013 dedicated biomass stations before 1 April 2020	66.7 gCO2eq/MJ electricity	79.2 gCO2eq/MJ electricity
All solid biomass and biogas stations from 1 April 2020 to 31 March 2025	55.6 gCO2eq/MJ electricity	75 gCO2eq/MJ electricity
All solid biomass and biogas stations from 1 April 2025	50 gCO_{2eq}/MJ electricity	72.2 gCO_{2eq}/MJ electricity

4.22. Renewables Obligation Certificates (ROCs) are issued on a monthly basis and will be issued to electricity generated from those consignments that meet or are below the relevant GHG target that month. If any consignment of relevant biomass exceeds the relevant GHG ceiling value, no ROCs will be issued on the electricity generated from that consignment of biomass. For any consignment that is above the relevant target, but below the relevant ceiling value, the ROCs will be 'held' until the end of the obligation period pending the calculation of the annual GHG average.

4.23. At the end of the obligation period, the annual average GHG emissions from all of the consignments of solid and gaseous biomass will be calculated. If the annual average GHG emissions meet or is below the target, then the 'held' ROCs will be issued. If the annual average GHG emissions of all the consignments of biomass used is above the target, then the 'held' ROCs will not be issued, as those consignments of biomass would not meet the GHG criteria. This does not impact those individual consignments where ROCs have already been issued in a given month as these have independently met the GHG criteria.

4.24. The annual average GHG emissions figure will be calculated by us following the deadline for the final data submission for the obligation period (31 May each year) based on the GHG emission figures provided monthly by the operator in their ROC claims on the register. It is therefore important for the operator to ensure that data is reported accurately and on time.

4.25. Once calculated, we will share this with the operator and request that they provide a signed confirmation that they agree with the calculation and that there are no further emissions that need to be accounted for in this calculation.

4.26. Upon receipt of this confirmation, where the annual average GHG emissions calculated meet or is below the threshold then the 'held' ROCs will be issued. Any delay in receiving the confirmation from the operator or where it is confirmed that the calculation does not include all biomass will likely result in a delay to the issue of the 'held' ROCs.

Table 4.2

A	B	C	D	E	F	G	H
Month	Fuel	Quantity (T)	GCV (GJ/T)	Heat contribution value	Heat contribution	GHG emission figures (gCO_{2eq}/MJ electricity)	Weighted contribution
April	Woodchip	1324.72	15.3	20268.22	0.047	60.5	2.845287106
May	Woodchip (above target)	3282.71	12.78	41953.033	0.097	77.3	7.524853742
May	Saw dust (above target)	579.5	14.99	8686.71	0.020	69.5	1.400861098
June	Woodchip	1342.08	14.55	19527.26	0.045	50.12	2.270950444
July	Woodchip	5643	20.2	113988.6	0.2645	45.89	12.1376518
August	Woodchip (above target)	2382.16	10.965	26120.38	0.0606	79	4.78808501

August	Woodchip	800.9	10.965	8781.87	0.0204	60.3	1.228738423
September	Woodchip	4463	11.061	49366.14	0.11	60.55	6.935830585
October	Woodchip	644	11.061	7123.41	0.016	34.6	0.571899094
November	Woodchip	1876	12.4	23262.4	0.054	66.2	3.573285408
November	Saw dust	550.7	14.3	7875.01	0.018	49.3	0.900851551
December	Woodchip	3211	13.2	42385.2	0.099	66	6.491026311
January	Woodchip (above ceiling)	3457	11.45	39582.65	0.092	81	7.439522855
January	Woodchip	598	11.45	6847.1	0.016	57.1	0.907189419
February	Woodchip	700	13.3	9310	0.022	59.4	1.283191054
March	Woodchip	601	9.8	5889.8	0.014	66.5	0.908818984
			Total	430967.78		**Total Annual Average**	61.20804289

4.27. The annual average GHG emissions will be calculated based on a weighted average of the GHG emission figures reported. Please see Table 4.3 below for an example of this calculation for a solid biomass station for the 2021/22 period.

Table 4.3: This was calculated by:

A	B	C	D	E	F	G	H
Month	Fuel	Quantity (T)	GCV (GJ/T)	Heat contribution value	Heat contribution	GHG emission figures (gCO_{2eq}/MJ electricity)	Weighted contribution
Month	fuel name	value	value	= C1 * D1	E1/(Sum of E1:E12)	value	= G1 * F1
Month	fuel name	value	value	= C2 * D2	E2/(Sum of E1:E12)	value	= G2 * F2
…	…	….	…	…	…	…	…
Month	fuel name	value	value	= C12 * D12	E12/(Sum of E1:E12)	value	= G12 * F12
			Total	= sum of E1:E12		**Total**	= Sum of H1:H12

4.28. In the example above the annual average GHG emission is below the relevant target (66.7 gCO_{2eq}/MJ electricity), and therefore the ROCs that were 'held' for the months of May and August would be issued, as they were above the relevant target but below the relevant ceiling. The ROCs from January would not be issued as this was above the relevant ceiling.

4.29. If, in a month, a fuel does not meet the relevant GHG emissions target, it will have to be reported separately to the rest of that consignment (i.e. the month of August in the example above). If, in a month, there was a proportion of fuel above the relevant target, and a proportion of fuel above the relevant ceiling, these could not be averaged into one 'unsustainable consignment'. Instead, they would have to be reported as a consignment above the relevant target and a consignment above the relevant ceiling. The ROCs associated with the consignment above the relevant target, may be issued at the end of year if the annual average is below the relevant target. The ROCs associated with the consignment above the relevant ceiling threshold will never be issued.

4.30. The annual average GHG emission calculation will include all the biomass used by the station which results in generation of electricity, even where ROCs are not issued. This includes biomass that has exceeded the ceiling value.

4.31. In the circumstance where the GHG emission figure for a consignment is not known, the default value of 91g/CO2 eq/MJ of electricity will be used.[40] Figure 4.2 provides an overview of the monthly and annual process.

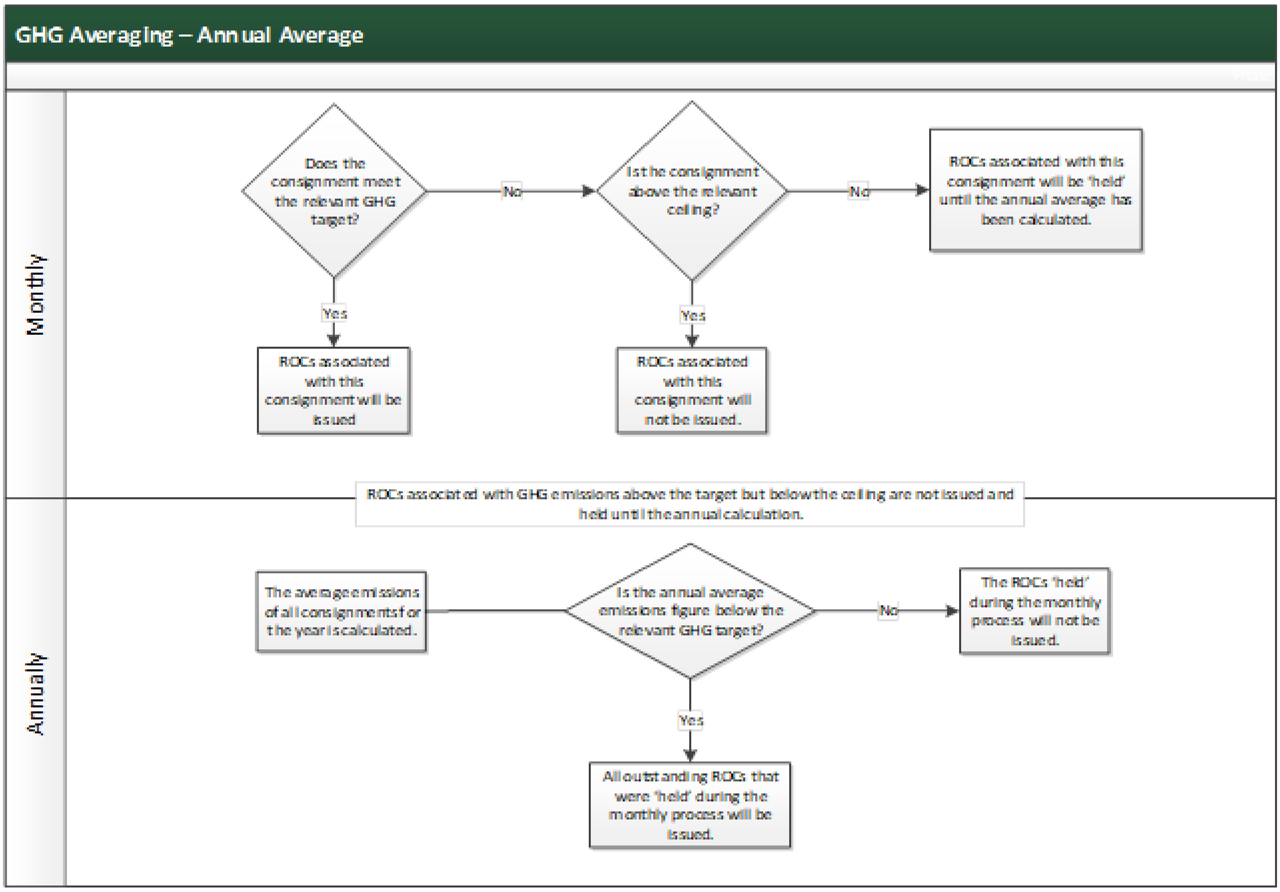


Figure 4.2: Overview of GHG averaging mechanism

Performing GHG calculations

4.32. If an operator is required to calculate the carbon intensity of their fuel, they can do so in the following ways:

- Default method – available to all fuel states – see paragraph 4.36.

[40] This is in line with the fossil fuel comparator for electricity production given in the RED.

- Actual Value method – available to all fuel states – see paragraph 4.43.
- Mixed Value method – available to bioliquids only – see paragraph 4.69.

4.33. For bioliquids, if an operator is making use of an EC-approved voluntary scheme, which is recognised for adequate certification of the GHG criteria, they are not required to calculate their GHG emissions. They are still required to report the carbon intensity of the bioliquid. A value will likely be specified on the sustainability certificate provided by the voluntary scheme.

4.34. The different calculation methods have conditions associated with them. Figure 4.3 is designed to help the operator identify which methods are available.

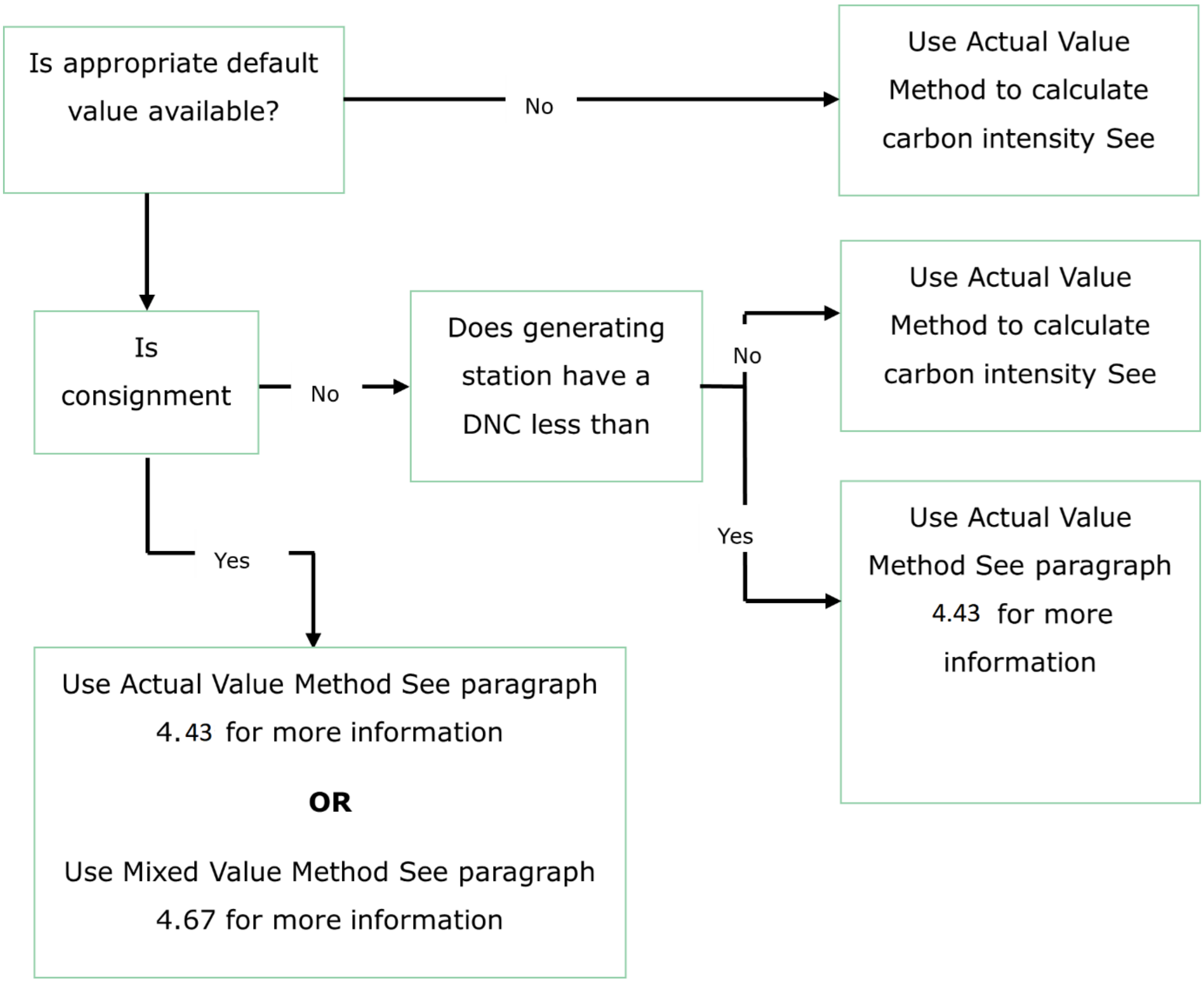


Figure 4.3: Overview of GHG calculation

N.B. Regardless of the calculation method selected, emissions associated with any land use change must be included within the final reported GHG emission figure.

4.35. If an operator of a generating station has a choice between the default value method and actual value method it will be up to them to determine their preferred approach. Please note:

- The actual value method can be time-consuming and may need a lot of verification. However, employing this method may allow the operator to understand more about their supply chain and where to make carbon savings.
- The default value method sets out default carbon intensities that are conservative, i.e. they are expected to be higher than the emissions calculated using the actual value method. This is especially relevant to the processing stage where the defaults are calculated by increasing typical emissions by approximately 40%.

Default method (all fuel states)

4.36. Operators using solid biomass, biogas and bioliquids can use default values to calculate the carbon intensity of their biomass. The fuels which have default values associated with them are set out in the legislation.

4.37. Using these default carbon intensities is subject to certain constraints:

- The party must prove that the carbon intensity reported corresponds to the actual fuel characteristics, including biomass type, feedstock and, if relevant, production process type. For example, it is not possible to use the default of 'waste vegetable and animal oil biodiesel' for used cooking oil (which has not been converted to biodiesel).
- The default carbon intensities may also only be reported if emissions from land use change are not greater than zero (see Appendix 5 for how to calculate these). For fuel chains in which land use has changed, the default value can only be used if combined with the emissions from the land use change.
- Solid biomass and biogas only: Generating stations using these fuels which have a TIC of 1MW or more will not be eligible to use the default value method. They must therefore use the actual value method.
    - Where the conditions above are not met, the operator cannot use the default method for that fuel. The operator therefore must use the actual value method.

4.38. Although the default value method is less time-consuming, the default values themselves are conservative. If an operator uses the default values, a higher carbon intensity may be generated than if they use actual values in the calculation. The use of defaults may also inhibit the operator's ability (and that of their upstream supply chain) to understand where cost-effective carbon reductions could be delivered.

Bioliquid default values

4.39. The default values currently available for bioliquids are in Parts A and B of Annex 5 of the RED and Appendix 4 of this document. These percentages already take into account the fossil fuel comparator and so can be reported by the operator for that particular bioliquid.

4.40. The EC may update the default values. It is therefore the operator's responsibility to make sure they are using the most up-to-date default carbon intensities published by the EC. We expect future updates to be published on the EC's online Transparency Platform.

Solid biomass and biogas default values

4.41. The default values for GHG emissions savings for the various biomass feedstocks are set out in an EC Report[41] and also in the Orders.[42] For ease of reference, the default values are replicated in Appendix 4 of this document.

4.42. The EC's default values for GHG emissions savings for the various biomass feedstocks only provide the carbon intensity of the fuel itself, and not the electricity produced, which is what needs to be reported to us. So before reporting to us, the operator must perform a single calculation using the default value and the actual conversion efficiency of the plant.[43] This calculation is in Step 11 of Table 4.5

[41] EC, Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling, Annex II: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC0011&from=EN
[42] Part 4 of Schedule 2 to the ROO (as amended); Part 2 of Schedule 3B to the RO(S) 2009 (as amended); Part 2 of Schedule 3B to the NIRO 2009 (as amended).
[43] DECC, ROO 2011 Statutory Consultation on the Renewables Obligation Order 2011 (July 2010), paragraph 52, http://www.decc.gov.uk/assets/decc/Consultations/Renewables%20Obligation/261-statutory-con-renewables-obligation.pdf

Actual value method (all fuel states)

4.43. Operators using solid biomass, biogas and bioliquids can use the actual measured values to calculate the carbon intensity of their biomass. The methodology for this calculation is set out in the legislation. For bioliquids the Orders refer to Part C of Annex 5 to the RED for the GHG calculation methodology. For solid biomass and biogas, the methodology in the Orders refers to an amended version of the bioliquid GHG calculation methodology.

4.44. The methodology specifies which GHG emissions must be accounted for when determining the carbon intensity of the biomass. In calculating emissions, the actual value method does not specify that all values must be actual data. An operator can use the actual data relevant to their specific supply chain alongside standard input data from relevant sources such as academic literature.[44]

4.45. According to the methodology, the total carbon intensity of biomass is the sum of the following, minus any emission savings:[45]

- Emissions from the extraction or cultivation of raw materials.
- Annualised emissions from carbon stock changes caused by land use change (if applicable).
- Emissions from processing.
- Emissions from transport and distribution.

4.46. These can be broadly categorised into three main stages, as shown in Figure 4.4.

Figure 4.4: Summary of key steps in GHG calculations

4.47. In an actual supply chain, there may be more than one transport or processing step. Figures 4.5 and 4.6 show some of typical biomass supply chains.

[44] There is some standard input data pre-built into the carbon calculators that operators can use.
[45] Emission savings may be related to soil carbon accumulation via improved agricultural practices, carbon capture and storage/replacement and excess electricity from co-generation

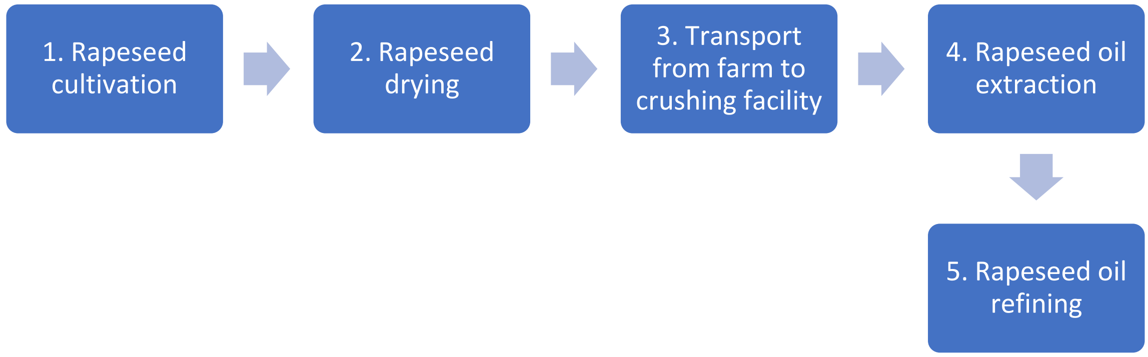


Figure 4.5: Example of a fuel chain structure using rapeseed biodiesel.

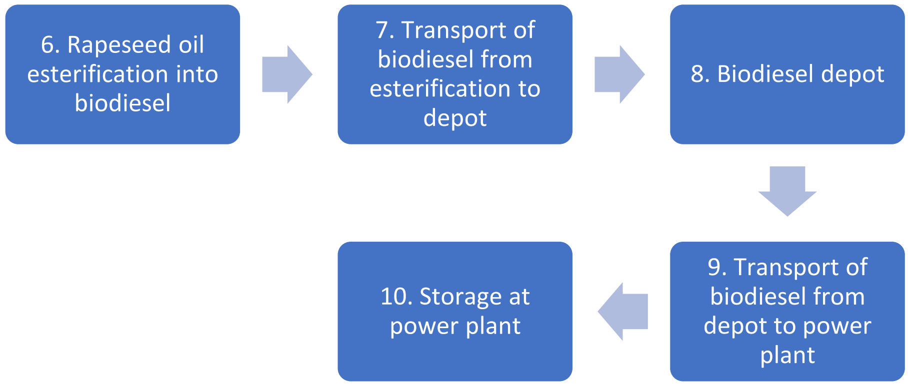
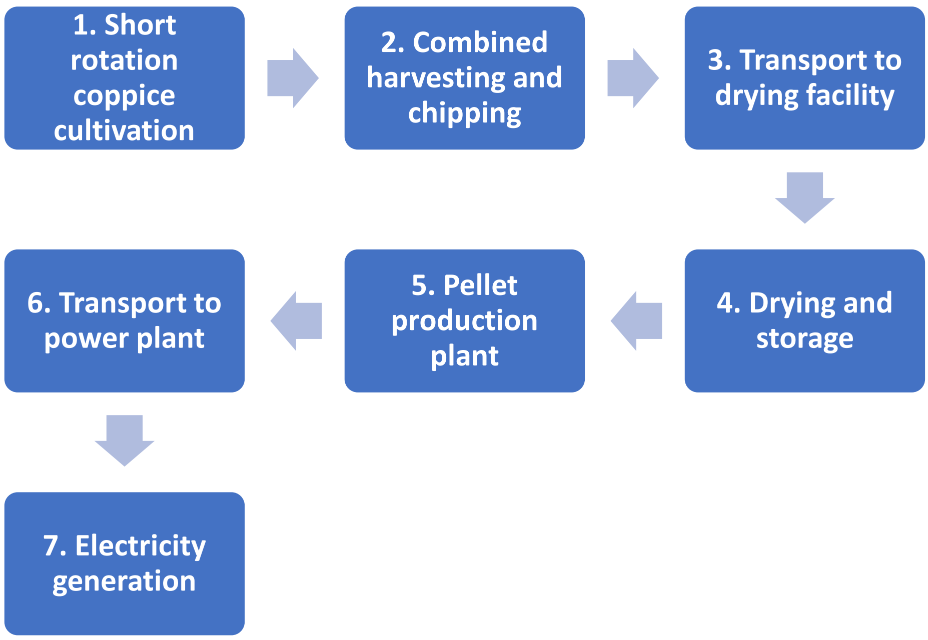


Figure 4.6: Example of a solid biomass to electricity supply chain: short rotation coppice pellets.



4.48. Where, due to a material's fuel classification, the emissions must be calculated 'from the process of collection', the methodology for calculation is the same except there will be no emissions associated with cultivation.

4.49. When performing this calculation, please keep in mind the UK government will use these values for analysis, statistics and future policymaking so they should reflect the supply chain.

Allocation factors, input data and emission factors

4.50. When working through the actual value method, you will likely make use of allocation factors for co-products, input data and emission factors. The following sections provide further information on these terms and how to use them.

Allocation factors

4.51. In some cases, when a feedstock is produced, other useful products are made at the same time. These are termed 'co-products'.

4.52. In these cases, it is important that all of the emissions at the point at which the co-products are made are split between the different co-products. For example, the emissions associated with rapeseed oil cultivation, transport to a crushing facility and pressing the seeds, should be split between the two co-products, the oil and the meal. This proportioning of emissions is referred to by the term 'allocation factor' which is determined by performing a calculation.

4.53. In most cases, the upstream emissions should be allocated between the different co-products based on the energy content of each one. However, the allocation factor needs to be calculated differently if one or more of the co-products is useful heat.

4.54. To calculate the emission factor when no heat is co-produced, follow these steps:

Step 1: Calculate or look up the calorific values of all products exported from the conversion plants (i.e. both the main exported product and all the co-products) – each of these values should be expressed in MJ/kg of product.

NOTE: calorific values of common co-products are part of the list of standard emission factors.

Step 2: Calculate the total energy in each product exported from the plant (the main product and the co-products) by multiplying the amount of product (expressed in kg of product/kg of main product) by its calorific value. This gives the energy content of each exported product per kg of main product (MJ/kg of main product).

Step 3: Sum of all values in Step 2 to give the total energy content of products exported from plant (expressed in MJ/kg main product).

Step 4: For a particular product, divide the amount of product per kg of main product (Step 2) by the total energy content of products exported from plant (Step 3). This gives the proportion of emissions which should be allocated to that product.

This can also be done for each of the co-products.

4.55. If one of the co-products during the production of the biomass is useful heat, then the emissions should be allocated between the different products by taking into account the energy content of all the co-products and the temperature of the useful heat based on this formula:

Allocating emissions when useful heat is co-produced

$$A_i = \frac{E}{\eta_i}\left(\frac{C_i\eta_i}{C_i\eta_i + C_h\eta_h}\right)$$

Where: A_i = Allocated GHG emissions at allocation point to co-product, *i*

E = Total GHG emissions up to allocation point

η_i = The fraction of co-product, measured in energy content, defined as the annual amount of co-product produced divided by the annual energy input

η_h = The fraction of heat produced together with other co-products, defined as the annual useful heat output divided by the annual energy input

C_i = Fraction of exergy in the energy carrier (other than heat), equal to 1

C_h = Carnot efficiency (fraction of energy in the useful heat)

The Carnot efficiency, C_h, is calculated as follows:

$$C_h = \frac{T_h - T_0}{T_h}$$

Where:	T_h	=	temperature of the useful heat, measures in Kelvin at point of delivery
	T_0	=	Temperature of surroundings, set at 273 Kelvin.

For $T_h < 150°C$, C_h is set to 0.3546.

4.56. If the co-product is excess electricity from co-generation, an emission saving should be calculated equivalent to the avoided emissions that the same amount of electricity would have produced when produced in an electricity-only power plant using the same fuel.

4.57. These steps explain how to calculate the emission savings from excess electricity co-generation.

Step 1:	Identify the amount of excess electricity being co-produced with the amount of heat used in the module.[46]
Step 2:	Determine the carbon intensity of electricity produced in an electricity-only power plant using the same fuel as the co-generation unit (identified in step 1) by looking up the appropriate emission factor for the electricity.
Step 3:	Give the output electricity a credit which is equal to the amount of exported electricity produced (per tonne of product), multiplied by the carbon intensity of power plant-produced electricity (GHG emissions per tonne of electricity). This credit should be negative (i.e. reduces the carbon intensity of the bioliquid).

[46] In accounting for that excess electricity, the size of the cogeneration unit will be assumed to be the minimum necessary for the cogeneration unit to supply the heat that is needed to produce the fuel

Input data

4.58. When using the actual value method, operators of generating stations should focus on parameters which have an impact on the overall results, i.e. inputs that change the carbon intensity by more than 1% when included. Data collection should especially focus on:

- nitrogen fertiliser application rate,
- crop yield,
- fuel consumption for cultivation,
- transport distances,
- process efficiency,[47]
- fuel type and demand,
- electricity demand, and
- co-product yield and energy content.[48]

4.59. When performing the actual value method for solid biomass and biogas fuels, the UK biomass sustainability government response document (paragraph 5.11)[49] notes government's preference for operators of generating stations with a TIC less than or equal to 1MW to use actual data for the type and amount of energy used in pelleting and transport distances. We recommend operators take this into account when calculating the carbon intensity of their fuel.

4.60. Aside from the points noted in paragraph 4.59, it is possible to use standard input data in place of actual data. When using standard input data the operator should be sure that values correspond to the type of biomass fuel being used at the generating station in terms of feedstock type, form, region of origin and if relevant, the drying technique.

4.61. For an operator using solid biomass and biogas, a similar exercise was performed in the UK by DESNZ, in the development of the carbon calculator. Appendix 4 sets out a number of these inputs. Where actual input data is being used, these are not required.

[47] i.e. tonnes of product (e.g. biodiesel) per tonne of input (e.g. rapeseed oil).
[48] The energy content of co-products should be based on their lower heating value (LHV). By convention, the LHV is considered to be the heat released during the combustion of a fuel, with starting temperature at 20°C and end-state temperature at 125°C for all products. For the purposes of the carbon intensity calculations laid out in this guidance, LHV can either be found in scientific literature or measured in calorimeters.
[49] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/231102/RO_Biomass_Sustainability_consultation_-_Government_Response_22_August_2013.pdf

4.62. There are some forms of input data which are heavily interdependent. Table 4.4 below shows these compulsory dependencies which operators should follow if they are using actual data for one of the inputs. For example, the yield of many crops is influenced heavily by the amount of nitrogen which has been applied, and as such, if actual data is provided for yield, actual data is also required for nitrogen input.

Table 4.4: Compulsory links between interdependent parameters

Input one	**Input two**
Crop production	**Crop production**
Crop yield[50]	Nitrogen fertiliser application rate
Nitrogen fertiliser application rate	Soil N_2O emissions[51]
Conversion	**Conversion**
Efficiency	Any co-product yield
Efficiency	Fuel or electricity use
Electricity or heat exported	Fuel use

Emissions factors

4.63. Emissions factors are used to calculate the GHG emissions of the production of an input material. For example, the emissions factor for nitrogen fertiliser is 5.88 $kgCO_{2eq}$ per kg of nitrogen ($kgCO_{2eq}/kgN$) applied, based on the emissions from producing and transporting the fertiliser. This factor is used in combination with the application rate of the fertiliser (in kg N/ha) and the yield of the crop (in t/ha) to give the contribution of the use of the nitrogen fertiliser to the overall carbon intensity of the production of the crop (in $kgCO_{2eq}$/t crop).

[50] This compulsory link does not apply to sugar beet.
[51] Note that actual input data does not need to be collected for soil N_2O emissions; the IPCC Tier 1 methodology can be used as described in Step 4 of the table in paragraph 5.66, which calculates N_2O emissions based N fertiliser input. If either of the Carbon Calculators is used, N_2O emissions are automatically calculated from the nitrogen fertiliser applied, using the same IPCC Tier 1 methodology.

4.64. If no appropriate emission factor or energy content can be found in this list, and actual data is unavailable, a value should be referenced from scientific literature. Give a copy of this literature or its reference to the auditor as part of the annual verification process. The value used must fulfil the following requirements:

- The standard emission factor should be obtained from independent, scientifically expert sources,[52]
- It should also be based on the most up-to-date reference available; and
- It should apply to what it is being used for.

4.65. When accounting for the consumption of electricity that is not co-produced in the biomass production plant, but which is imported from the grid, the emission factor for the electricity consumed should be equal to the average emission intensity of producing and distributing electricity in the region where the biomass is produced. The emissions intensity of production and distribution in different regions should be taken from an authoritative source, e.g. the latest version of the International Energy Agency CO_2 emissions from fuel combustion database.[53] A region may be a sub-national region, a country or a supra-national region. If electricity is co-produced, follow the steps in paragraph 4.55.

4.66. If the electricity comes from a power plant that is not connected to the electricity grid, generating station operators may use an emission factor equal to the emission intensity of the production of electricity in that specific power plant.

4.67. The electricity supplier may be able to provide an actual emission factor for this step in the calculation that is reliable. In this instance they should still keep evidence of the source of this value.

The step-by-step method

4.68. The following steps explain how to calculate the carbon intensity of the biomass using the actual value method. Once the carbon intensity of the biomass has been calculated (Steps 1 to 10) it must then be converted into the appropriate units for reporting to us as shown in Step 11:

- For bioliquids, this means taking the carbon intensity of the fuel and expressing this as a percentage saving against the fossil fuel comparator.

[52] In the first instance, we recommend you look to the EU Transparency Platform, as the EC may decide to upload acceptable input data there.
[53] Other sources may also be used.

- For solid biomass and biogas, the GHG emission value reported to us must take into account the electricity generated from the fuel. This necessitates that the final calculation with the carbon intensity of the fuel takes into account the efficiency of the generating station. For combined heat and power (CHP) generating stations[54] this calculation considers the thermal efficiency of the power plant. For non-CHP stations this calculation is based on its electrical efficiency.

Table 4.5: Step-by-step approach for actual value method

1 – Define the supply chain
Define the steps which occur during the production of the biomass. Each step in the supply chain is called a module, and therefore a supply chain is composed of a series of modules.
2 – Identify the output of each module
Identify the main product which is exported from each module (e.g. rapeseed oil, wood chips, biogas, etc). All emissions within a module should be calculated per unit of this product (i.e. in kg CO2eq/t product or kgCO2eq/MJ product if the product is a gas).
3 – Identify the inputs of each module
Within each module, identify all inputs (material and energy) which are likely to give rise to GHG emissions which will influence the final carbon intensity of the biomass by 1% or more. Each input must then be measured and expressed per unit of the exported product (ie in MJ or t input/t product).
4 – Identify appropriate emission factors
For each input, find an appropriate emission factor. The emission factor is a factor used to calculate the GHG emissions that occurred during the manufacture and

[54] As defined in Part 2, Schedule 2 of the ROO 2015 (as amended) and Schedule 3A to the RO(S) 2009 (as amended) and NIRO 2009 (as amended).

distribution of an input (in kg CO2eq/t input or kg CO2eq/MJ input). Paragraph 5.63 has more information on emission factors.
5 – Multiple inputs by emission factors
Within each module, multiply the inputs by their appropriate emission factors and sum the results. The summed total represents the total GHG emissions per unit of output for this module (i.e. the material that is transferred to the next module in the biomass chain). Any certified reductions of GHG emissions from flaring at oil production sites anywhere in the world should be deducted from the overall emissions from the production of the biomass.[55]
6 – Accounting for co-products in conversion modules
Within each conversion module, identify if there are co-products, i.e. products that are created (which are not wastes or residues) alongside the main product and to which some of the emissions generated should be allocated. If the co-product is a waste, the emission associated with disposing of that waste should be included in the calculation of the overall carbon intensity of the biomass used at the generating station. Differing allocation factors are applied if the co-product is useful heat or excess electricity.
7 – Identifying efficiency of modules
For all modules, the efficiency (in unit output/unit input) of the module has been collected, as this is needed to establish the contribution that upstream emissions make to the final carbon intensity of the biomass. Typical efficiencies are: • For conversion module – generally lower than 1 • For transport and distribution modules – can be 1 if no losses occur during transport For a module converting biomass into biogas (e.g. an anaerobic digestion plant), the unit of the efficiency should be in MJ output/t input, and the value will usually be much bigger than 1. Specifically for the cultivation module, make sure that the crop yield (in t product/ha.yr) has been collected. Please note that N_2O emissions, from soil, which

[55] European Commission, Annex V, Part C, paragraph 6, European Directive 2009/28/EC on the promotion of the use of energy from renewable sources, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

occur when nitrogen in the soil is converted to N_2O through natural processes, should also be included in the cultivation module.[56]
8 – Calculating carbon intensity of each module
For each module, the contribution of that module to the total carbon intensity now needs to be calculated (in gCO_{2eq}/MJ). This is done by taking: • The total GHG emissions per unit of exported product for this module (as calculated in step 5) • Any emission savings for that module (as calculated in step 6) • Any allocation factor of the module or any downstream modules (as calculated in step 6) • The efficiency of any downstream modules (as determined in step 7) For each module performing this calculation: $\frac{\text{((Total GHG emissions of exported product – emission savings for module) x allocation factor of module or any downstream modules)}}{\text{Efficiency of any downstream modules}}$
9 – Calculating carbon intensity of supply chain
The biomass carbon intensity can now be calculated by adding up the contribution of each module as calculated in step 8. This carbon intensity is expressed in $kgCO_{2eq}$/unit (unit is 'tonnes' for bioliquid and solid biomass or 'MJ' for biogas).
10 – Converting carbon intensity into relevant units
The carbon intensity has to be converted to gCO_{2eq}/MJ biomass. • For a bioliquid chain, this is done by dividing the results of step 9 by the energy content (in terms of lower heating value[57]) of the bioliquid (in MJ

[56] Biogeochemical models are the most sophisticated method for estimating these emissions from soils but are complex to use and require large amounts of data which are unlikely to be available. Instead, the RED recommends the use of the IPCC methodology for estimating both direct and indirect N_2O emissions when performing actual calculations. The use of Tier 1 of this methodology is recommended here because it simply correlates N_2O emissions with nitrogen fertiliser application rates. See 2006 IPCC guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf

[57] Where literature data is used for LHV's rather than actual input data, the operator would need to demonstrate to a verifier that they have used an appropriate LHV for the type of feedstock they are using.

bioliquid/kg bioliquid) and then multiplying by 1000 to convert the kg CO_{2eq} to gCO_{2eq}.

- For a solid biomass chain, this is done by dividing the results of step 9 by the energy content (in terms of lower heating value) of the biomass (in MJ biomass/kg biomass) and then multiplying by 1000 to convert the kg CO_{2eq} to gCO_{2eq}.
- For a biogas chain, this is done by multiplying the result of Step 9 by 1000 to convert the $kgCO_{2eq}$/MJ biogas to gCO_{2eq}/MJ biogas.

The energy content (i.e. lower heating value) of typical biomass types can be found in the standard emission factors list (see Appendix 4).

11 – Final calculation for value to report to Ofgem

The Orders require the carbon intensity to be reported in specific units in order to demonstrate whether the GHG threshold has been met.

For a bioliquid, the emissions are reported to us expressed as a percentage saving against a fossil fuel comparator of 91 gCO_{2eq}/MJ. The following calculation must therefore be performed with the result from step 10:

$$\textit{GHG emissions saving} = \frac{\textit{fossil fuel comparator - carbon intensity of bioliquid}}{\textit{fossil fuel comparator}}$$

For solid biomass or biogas, the value is reported in gCO_{2eq}/MJ electricity. This requires the operator to take into account the efficiency of the generating station.

For a non-CHP station, the following steps, using the value determined from step 10, are necessary to calculate the emissions from the use of the biomass to be reported to us:

$$\textit{GHG emission } (gCO_{2eq}/\textit{MJ electricity}) = \frac{\textit{emissions from production of biomass}}{\textit{electrical efficiency of power plant}}$$

The electrical efficiency of the power plant is determined by dividing the total amount of electricity generation by the generating station during the month (in MJ) by the energy content (based on lower heating value) of all the fuels used in generating that electricity during the month (in MJ).[58]

For a CHP station, the following steps, using the value determined from step 10, are necessary to calculate the emissions from the use of the biomass to be reported to us:

[58] Where appropriate the operator can use the annual average efficiency of their power plant.

GHG emission (gCO_{2eq}/MJ electricity) =

GHG emission (gCO2eq/MJ = electricity) Emissions from

production of biomass =

(GHG emission (gCO2eq/MJ = electricity) Emissions from

production of biomass / Electrical efficiency of power plant) x (Electrical efficiency of power plant / Electrical efficiency of power plant + Ch x thermal efficiency of power plant)

The electrical efficiency of the power plant is determined in the same way as for non-CHP stations above. The thermal efficiency of the power plant is determined by dividing the energy content (based on lower heating value) of all the heat supplied from the generating station to any premises[59] during the month[60] (in MJ) by the energy content (based on lower heating value) of all the fuels used in generating that electricity during the month (in MJ).

For 'C_h', if the temperature of the useful heat at delivery point is less than 423 Kelvin (K) the C_h is 0.3546. If it is greater than or equal to 423 K then subtract 273 from the temperature, and divide the answer by the temperature.

Mixed value method (bioliquid only)

4.69. For each bioliquid default value set out in the RED I, the values are also provided for the default carbon intensity into the following stages:

Figure 4.6: Disaggregated steps in supply chain

4.70. The GHG emissions values provided for each of these stages are called *disaggregated default values*. If all three disaggregated default values are added

[59] If several useful heat sources are produced, then the denominator in this calculation is: the electrical efficiency added to the sum of all the useful heat streams' thermal efficiencies multiplied by their respective Carnot efficiencies. Refer back to section 5.47 on allocation factors for more details.
[60] Where appropriate, it is acceptable to divide the annual heat figure from the previous year by 12 to get a monthly figure.

together, the result is the total carbon intensity of the bioliquid chain which is used for the default method (see paragraph 5.34).

4.71. If a bioliquid default carbon intensity (i.e. via the default value method) for the production pathway exists but actual data on the production chain is available and the operator of a generating station wishes to use it, a combination of disaggregated default values for some parts of the supply chain and actual values for the other parts may be used. This is the mixed value method.

4.72. As with the default percentage, the mixed value method can only be used if there is an appropriate production pathway.[61] The operator has to be able to prove that the carbon intensity reported does correspond to the actual bioliquid characteristics (which includes bioliquid type, feedstock and, if relevant, production process type).

Using the disaggregated default for the processing stage

4.73. The disaggregated default value for processing is a conservative value. The disaggregated default value for all the processing stages for the different bioliquids was calculated using typical inputs to the processing modules, and then the resulting emission was increased by 40%.

4.74. However, if actual values are used to calculate emissions from the processing step, the 40% conservative factor does not apply if actual data is used for all of the following parameters within the same module:

- conversion efficiency,
- co-product yields,
- quantity of fuel used,
- electricity consumption, and
- chemicals consumption.

4.75. This removal of the conservative factor can be illustrated through an example. If a bioliquid chain is composed of three processing modules: oil extraction, oil refining and esterification;

- If an operator of a generating station reports actual data only on chemicals consumption for the oil extraction, the conservative factor will not be removed.

[61] See Parts D and E of Annex V of the RED

- If an operator of a generating station reports actual data on conversion efficiency, quantity of fuel used, electricity consumption and chemicals consumption for oil extraction, then the conservative factor will be removed for the oil extraction. It will, however, remain for the oil refining and esterification.
- If an operator of a generating station reports actual data on conversion efficiency, quantity of fuel used, electricity consumption and chemicals consumption for all three processing modules, then the conservative factor will be removed totally.

Land use change emission calculation

4.76. As set out in Chapter 4, where there is a land use change, regardless of the fuel type, the emissions associated with this must be included within the GHG lifecycle emissions calculation. As the calculations will be required only in certain instances, they have been included in Appendix 5.

4.77. Further to this, the EC Transparency Platform has published an annotated example of such emissions calculations which can be downloaded from their website.[62]

4.78. All calculations for land use change at present refer to *direct* land use changes. There are currently no requirements on operators of generating stations to report or include in their carbon intensity calculations, emissions from *indirect* land use change.

Soil carbon accumulation via improved agricultural management

- The land use change may not necessarily result in a loss of carbon to the atmosphere. It is possible that emission savings can be created from the soil carbon accumulation via improved agricultural practices and be accounted for within the GHG calculation. This calculation is available for use in all supply chains, regardless of the fuel state.
- Specifically, for bioliquid fuels, this is an area that the audit must comment on in the annual audit report. See guidance RO:

[62] https://ec.europa.eu/energy/sites/ener/files/2010_bsc_example_land_carbon_calculation.pdf

Sustainability Reporting guidance for more information. Note that this is not a requirement for solid biomass or biogas.

Degraded land bonus

- A bonus[63] of 29 gCO_{2eq}/MJ will be attributed if there is evidence that the land on which the bioliquid feedstock was grown:

- was not in use for agriculture or any other activity in January 2008, and
- falls into one of the following categories:
    - severely degraded land including such land that was formerly in agricultural use,
    - heavily contaminated land.

- The bonus will apply for ten years from the date of conversion of the land to agricultural use, provided that a steady increase in carbon stocks as well as a sizable reduction in erosion for land falling under the first category are ensured and that soil contamination for land falling under the second category is reduced.
- The EC is currently working on a refined definition of severely degraded and heavily contaminated land. Until further guidance is issued, no biomass used for electricity generation will be eligible to claim the degraded land bonus. When appropriate, we will aim to update this guidance accordingly.
- Specifically, for bioliquid fuels, this is an area that the audit must provide comment on within the annual audit report. Please see our guidance on sustainability reporting for more information. Note that this is not a requirement for solid biomass or biogas.

Useful tools and sources of information

4.79. It is up to the operator to determine which tool they will use to calculate their GHG emissions. For performing the actual value method, or the actual calculations within the mixed value method (bioliquid only), the operator may wish to use a calculation tool.

[63] As set out in the RED - Annex V, Part C, Para 8.

Carbon calculators

4.80. There are two tools available to download from our website[64] which support the GHG emission calculations: the UK Bioliquid Carbon Calculator (for bioliquid supply chains) and the UK Biomass and Biogas Carbon Calculator (for solid biomass and biogas supply chains).

4.81. The RO aspects of both tools are owned by BEIS and were developed in accordance with the methodology as set out in the Orders. They were designed to facilitate the implementation of the life cycle calculation methodology for reporting the carbon intensity of fuels under the RO.

4.82. Both calculators automatically work out the total emissions of the module being edited, and the contribution of that module to the overall fuel chain. They also identify the key inputs required for any particular module, depending on what type of module it is (e.g. cultivation, transport and distribution, etc). Furthermore, accepted default emission factors are included in the calculators.

4.83. Both calculators are published alongside user manuals which lay out the steps on how to build a new fuel chain and how to calculate its carbon intensity.

Other tools

4.84. Other tools are available which an operator can use when calculating the GHG emissions for their supply chain. It is also possible to use databases or spreadsheets. If an operator wishes to use a tool other than the UK Carbon Calculators, they should ensure that it meets the methodology as set out in the Orders and that any in-built standard input data is appropriate.

4.85. Where a tool other than the UK Carbon Calculators are used to calculate the GHG emissions, it is important it follows the methodology as set out in legislation. The operator should ensure they have evidence to demonstrate this to their independent auditor.

Sources of information

4.86. In January 2013, CEN published a standard (EN 16214-4) titled 'Methods of the greenhouse gas emission balance using a life cycle analysis'[65] which operators

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[64] Available at https://www.ofgem.gov.uk/environmental-programmes/renewables-obligation-ro/information-generators/biomass-sustainability
[65] Available at https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT:33585&cs=167F20DC2C57835A5751EA8A3B653C522

may find useful in calculating emissions for bioliquids. Although the document has been published specifically for biofuels and bioliquids, it will likely contain information useful for solid biomass and biogas supply chains also.

4.87. There is further information published on the EC transparency platform[66] which operators may find useful for calculating GHG emissions, particularly land use change emissions, including:

- EC decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC.
- The climate region and soil type data layers.
- An annotated example of land use change emission calculations.

Common queries

4.88. The legislation does not necessarily provide practical direction to support operators (and parties within the supply chain) in calculating the carbon intensity of their fuel. Below are our recommendations to operators on some common queries.

4.89. This is recommended guidance only. How suitable the operator's approach to calculating the carbon intensity of their fuel will be subject to independent verification as part of the annual sustainability audit. This will determine whether the method is satisfactory.

- In accounting for transport emissions, the operator will likely consider the emissions associated for the single journey from 'A' to 'B', on the basis that the transport vehicle (lorry, ship, etc) will be returning to 'A' or onto another destination with further separate cargo. In the event that the transport vehicle is returning empty, and therefore the journey has been solely for transporting the biomass then it would be appropriate for the operator to factor in the emissions for the return journey. The values within the Carbon Calculators for energy intensity of transport are set up to account for an empty return journey.
- In accounting for transport emissions, the operator may wish to consider whether the biomass is the full cargo or whether this is only an aspect of what is being transported. In the event that the lorry, ship (or other

[66] http://ec.europa.eu/energy/renewables/transparency_platform/transparency_platform_en.htm

transport mode) is carrying other cargo, the operator should seek to apportion the emissions accordingly.

- When a generating station is accredited under the RO, the generating station boundary, and therefore what is considered to contribute to 'input electricity' is determined. To avoid double-counting, the operator does not need to take account of any emissions associated with equipment at the generating station that is considered associated with input electricity.

5. Consignment and mass balance

Chapter summary

The Orders specify that operators must report per consignment in relation to the sustainability criteria. This chapter provides information on how to determine a consignment and what steps the operator should take if consignments are mixed.

5.1. The Orders require operators to report per consignment of biomass.[67] To report accurately against the sustainability criteria for each consignment of biomass, and for the information to be independently verified, the sustainability information must be able to be traced through the supply chain. This concept of traceability from raw material to end product is known as the 'chain of custody'.

5.2. For ease of reporting, the most straightforward chain of custody system is 'physical segregation'. This is where the consignment of biomass is not mixed with any other consignment and so the biomass, and its associated sustainability characteristics, can be easily traced through the supply chain from start to end.

5.3. For bioliquids, where consignments are mixed, the Orders specify that a 'mass balance' chain of custody system must be used.[68] A mass balance system requires generators to account for their biomass fuel on an input equals output basis but does not require physical separation of certified/uncertified biomass.

5.4. For solid biomass and biogas, the Orders do not expressly state that operators must use a mass balance system. However, we recommend this method as a useful way to ensure that accurate sustainability information passes through the supply chain (thereby ensuring operators are able to provide accurate sustainability information to us).[69]

5.5. To identify whether a mass balance chain of custody system is required, the operator must first determine the number of consignments they are using and whether these are being mixed at the generating station or elsewhere in the supply chain. We recognise that the operator may not necessarily be aware of

[67] For solid biomass and biogas; Article 82 of the RO Order, Article 54of the ROS Order, and Article 46 of the NIRO Order. For bioliquids; Article 61 of the ROO 2015 (as amended) and Article 22A of the RO(S) 2009 (as amended) and NIRO 2009 (as amended).
[68] Article 61 of the ROO (as amended) and Article 22A of the RO(S) 2009 (as amended) and NIRO 2009 (as amended) which requires that a mass balance chain of custody system is to be used.
[69] Article 80(6)(b), 82 and 84 of the ROO 2015 (as amended). Article 36(4)(b), 54 and 54B of the RO(S) (as amended) . Articles 34(4)(b), 46 and 46B of the NIRO 2009 (as amended).

every detail of the supply chain. However, they should ensure that they are seeking the relevant information from their supplier to understand whether they are receiving biomass that is a single consignment or a mix of consignments.

Determining a consignment

5.6. The Orders do not define 'consignment'. However, they are clear that a determination of what constitutes a consignment must be based on the 'sustainability characteristics' of the material.[70]

5.7. For practical reasons, we consider these sustainability characteristics should be taken into account:

- feedstock type,[71]
- biomass form (solid biomass only),
- country of origin,[72]
- classification of the fuel (waste, residue, product etc.),
- compliance with land criteria,
- compliance with GHG criteria, and
- date the installation that produced the bioliquid started production (bioliquids only).

5.8. This list is not a definitive legal guide.

5.9. Compliance with the GHG criteria will be determined as having been applied by considering the portion of the material with the largest emissions and whether this meets the relevant GHG emission threshold. If it does not, even if all other characteristics are the same, it cannot be considered the same consignment. This will need to split out as an unsustainable consignment and reported separately. If the operator is making use of the GHG annual averaging mechanism, please see chapter 4 for more information.

5.10. There isn't a 'timeframe' for a consignment. It is for the operator to determine what consignments of biomass should be reported to us each month as part of their output data submission, based on the biomass that they had available for combustion.

[70] Article 61 of the RO Order and Article 22A of the ROS and NIRO Orders.
[71] This is to ensure that different biomass fuels are not grouped together, eg, wood cannot be considered the same as sunflower pellets or rapeseed oil cannot be considered the same as used cooking oil.
[72] UK can be considered as a single country of origin.

5.11. Provided materials have identical sustainability characteristics (as listed above), these can be considered as a single consignment for data collection and reporting under the RO. For instance, a number of deliveries of a material, over a number of months could all be classed as the same consignment as long as the sustainability characteristics are the same.

5.12. If there are several source locations in the same country of origin (e.g. used cooking oil from numerous locations in the UK) and the sustainability characteristics are the same, the overall carbon intensity for aggregated consignment is given by calculating a weighted average (by quantity) of all the carbon intensities.[73]

5.13. Many biomass pellets contain biomass binders which will not necessarily have the same characteristics as the rest of the pellet. In this case, where the binder is <2% by weight, it will be considered to have the same sustainability characteristics as the pellet. In all other cases the sustainability characteristics of the binder, in its entirety, will have to be reported separately to the rest of the pellet.[74]

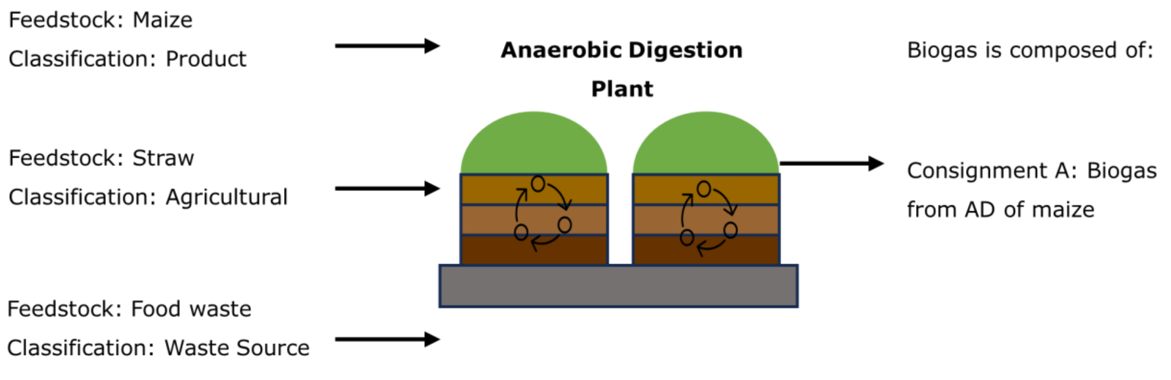
5.14. To assist operators, Figures 5.1–5.3 provide examples of determining consignments following the bullets in paragraph 5.7.

Biogas is composed of:

Consignment A: Biogas from AD of maize

Consignment B: Biogas from AD of straw

Consignment C: Biogas from AD of food waste



[73] We note here the UK government's preference to have data with a reasonable level of accuracy
[74] See Schedule 3 of the RO Order and Schedule A2 to the ROS and NIRO Orders

Figure 5.1: Example of determining a consignment for biogas from AD

5.15. The example in Figure 5.1 is of a UK-based AD plant. In this example, all feedstock inputs are from the same country of origin, and each satisfies the land and GHG criteria. The main determining factors here as to the number of consignments within the biogas are based on the fact that the feedstocks and their fuel classifications differ.

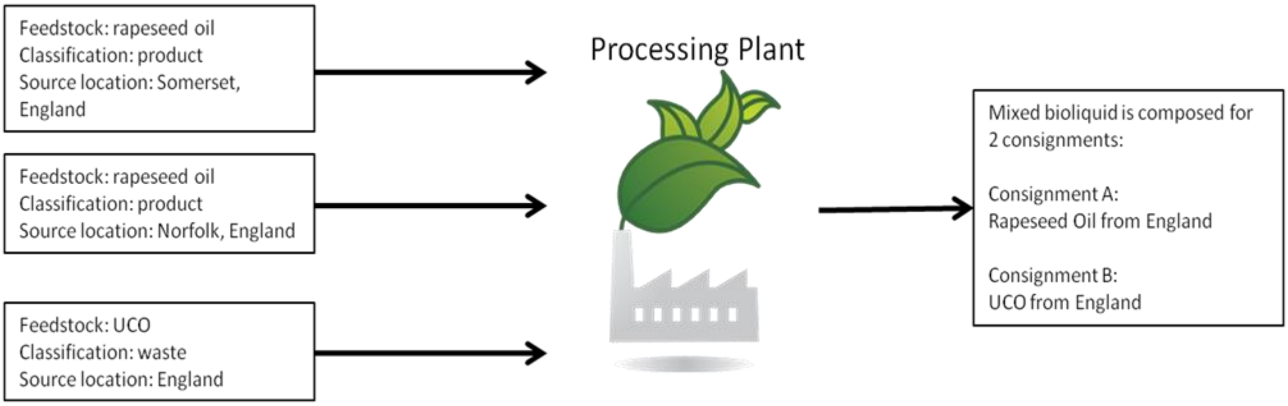


Figure 5.2: Example of determining a consignment for bioliquid mix

5.16. The example in Figure 5.2 is of a bioliquid processing facility which processes and blends bioliquids for sale to the bioenergy industry. In this example, all bioliquids delivered to the processing plant are from the same country of origin, and each satisfies the land and GHG criteria. Consignment A within the bioliquid mixture includes rapeseed oil from Somerset and Norfolk. If taken individually, both would meet the GHG criteria within this particular example and so can be grouped together. The main determining factors here as to the number of consignments within the bioliquid mixture are based on the fact that the feedstocks and their fuel classifications differ. In addition, if the installations that produced the bioliquid started production within different applicable date ranges, then these would need to be split into separate consignments.

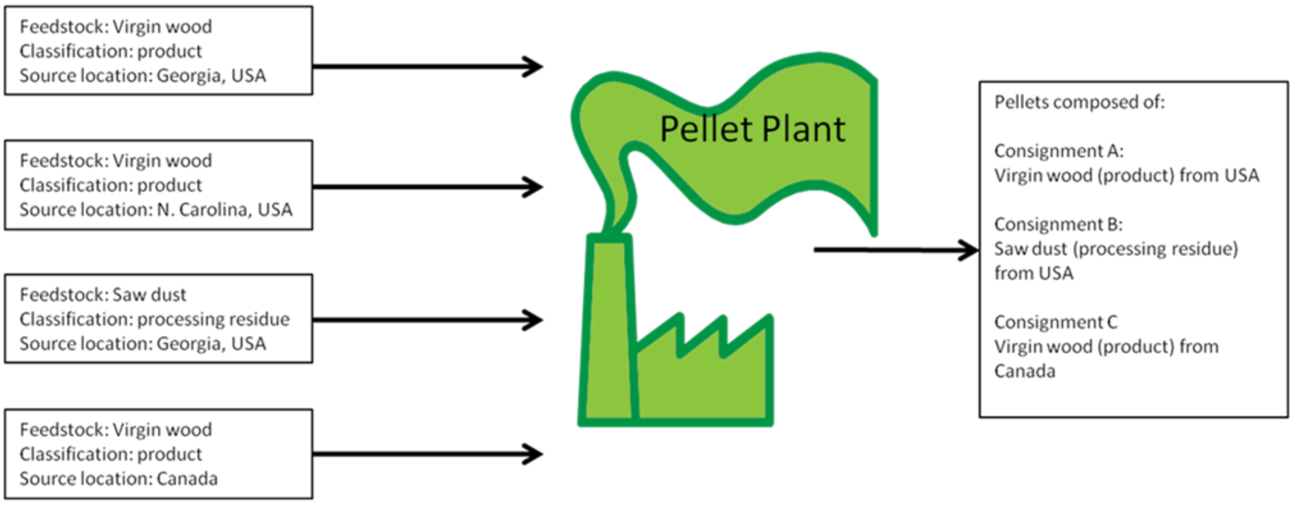


Figure 5.3: Example of determining a consignment for wood pellets

5.17. The example shown in Figure 5.3 outlines a pellet plant which is taking in different materials from different locations in North America. In this example, the biomass used at the generating station is wood in pelleted form. Each biomass input into the pellet satisfies the land and GHG criteria. Consignment A within the pellet includes the virgin wood from both Georgia and North Carolina as both, if taken individually, are considered to meet the GHG criteria within this particular example. The main determining factors here as to the number of consignments within the wood pellets are based on the fuel classification and country of origin.

5.18. We recognise that biomass pellets can be made from multiple types of biomass with differing sustainability characteristics, in particular with different fuel classifications. The legislation is clear on the need to report per consignment. We will work with operators during the FMS review process to develop appropriate procedures to report on a consignment basis. For more information on this, please see the FMS guidance.

5.19. Once the number of consignments has been determined, the operator will need to establish whether the consignments are mixed at the generating station or elsewhere in the supply chain. Where they are, a mass balance system will need to be used to trace the biomass and its associated sustainability characteristics.

5.20. Where the operator and parties in the supply chain are making use of a voluntary scheme, as per the guidance in Chapter 6, they should follow the scheme rules for tracking sustainability information associated with each consignment of biomass.

5.21. If a mass balance system is required, and the operator and parties in the supply chain are not using a voluntary scheme recognised in this respect, this chapter has more guidance on the types of mass balance and the best ways to set up a system.

Overview of mass balance

5.22. A mass balance system is a system in which sets of sustainability characteristics remain assigned to consignments. The sum of all consignments withdrawn from the mixture is described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture. A party in the chain of custody cannot sell more output with certain biomass data than its sourced input with the same biomass data.

5.23. Mass balance systems should be used[75] where a mixing of consignments takes place, either at the operator's site or down the supply chain. This is to ensure that the biomass and its associated sustainability data are verifiable. It is the operator's responsibility to implement the appropriate process and procedures.

5.24. Although consignments with different sustainability information can be physically mixed, sustainability information cannot be mixed between different consignments of biomass. For example, if an operator has two types of biomass in a single storage container, 'short rotation forestry from Canada' and 'thinnings from Germany', the information could not be swapped between the consignments. An operator could therefore not assign the outgoing consignment as 'short rotation forestry from Germany'.

5.25. For the parts of the supply chain where biomass is traded as a single feedstock, outgoing consignments of feedstock must be sold with information consistent with that feedstock. For example, if a site contains separate silos of tall oil pitch and rapeseed oil, tall oil pitch sold as a single feedstock from that site must be sold with tall oil pitch data.

Types of mass balance systems

5.26. There are typically two ways of reporting claims through mass balance systems.

- When using **proportional mass balance**, any quantity of fuel removed from a mixture containing different consignments must be assigned the sustainability characteristics in the same proportions as the original

[75] Note for bioliquid fuels the legislation prescribes this is a mandatory requirement

mixture. For example, if a bioliquid mixture is 400 litres of 'A' and 600 litres of 'B' when you extract a volume of bioliquid from the mixture you apply these proportions to the extracted amount (i.e. 40% is 'A' and 60% is 'B'). See Figure 14 for an example.

- When using **non-proportional mass balance**, any quantity of fuel removed from a mixture containing different consignments does not require the sustainability characteristics to be assigned based on the proportions of the mixture. Instead, it allows the sustainability characteristics to be assigned freely, as long as what is being assigned is not in greater amount than in the original mixture. For example, if a bioliquid mixture is 400 litres of 'A' and 600 litres of 'B' when you extract a volume of bioliquid you are free to set out whether it composes all of 'A', 'B' or a combination of both. However, you should not declare that you have more volume of either 'A' or 'B' than the mixture in the first instance. See Figure 5.5 for an example.

5.27. Generally, we are content for the operator to determine which mass balancing system to use within their supply chain. However, we note the following constraints that the operator, and parties within their supply chain, should follow:

- Since ROCs can only be issued on electricity generated from renewable sources, consignments containing any fossil fuel or fossil-derived contamination will need to be subject to proportionate mass balancing.
- When using the non-proportionate method, we recommend that data assigned to a quantity of biomass should be done on a 'first in first out' (FIFO) basis. This reduces the risk that there is an amount of unsustainable biomass within the mix which is never assigned to an extracted quantity of biomass. If a party does not follow a FIFO approach the independent auditor may wish to consider this risk as part of the annual verification process.
- Where possible, when determining the 70/30 threshold for sustainable wood burnt in a month, the proportionate mass balance method should be used.

5.28. There may be other examples of where the use of one particular method should be followed, such as the use of the proportionate method where there are technical reasons for a quantity to be a specific blend.

5.29. In general, the feedstock reported by parties should represent the feedstock mixture, and parties should have a consistent and transparent reporting process.

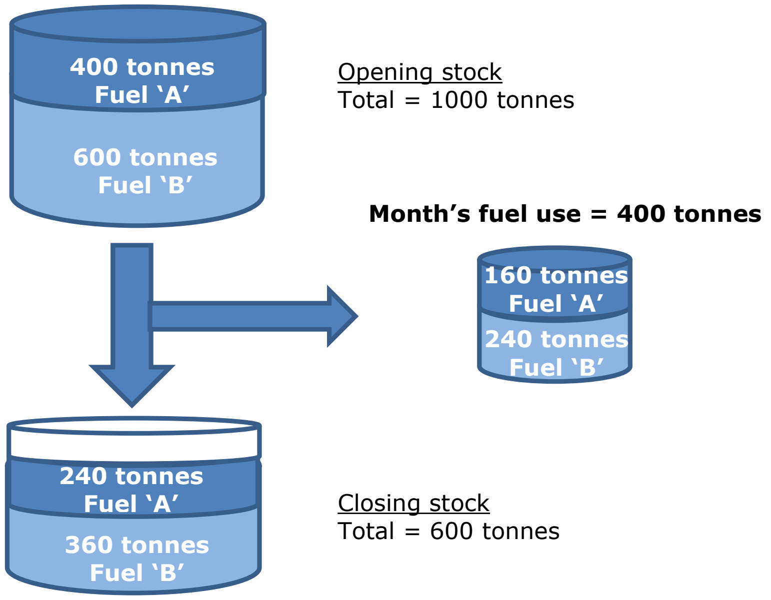


Figure 5.4: Example of proportional mass balance

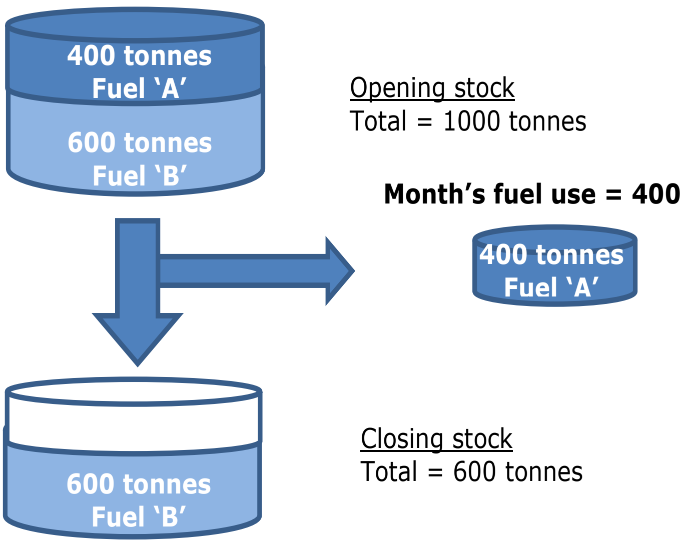


Figure 5.5: Example of non-proportional mass balance

The operation of a mass balance system

5.30. Each party in the supply chain, which is at any point the legal owner of the product, will need to have the administration necessary to maintain the mass balance chain of custody.

Level at which the mass balance should take place

5.31. The mass balance should be operated at the level of a 'site' that a company owns/operates. For the purposes of mass balance sustainability requirements, a 'site' is defined by the EC as 'a geographical location with precise boundaries within which products can be mixed'.[76] A site can include multiple silos or tanks, as long as they are at the same physical site.

5.32. If a party wishes to manage the data at a more detailed level, then this is also acceptable. For example, a company could operate mass balance at the level of individual storage containers within a site. The mass balance however is not recommended to be operated over multiple physical sites that a company owns.

Timeframe for conducting mass balance

5.33. We recommend that parties in the supply chain periodically review site-level sustainability data every month at least.

5.34. When doing this, parties may not have sold more sustainability data than they have taken in. They should also not have more sustainability data than they have actual physical feedstock/product.

5.35. Due to the way the supply chain currently operates, it may be challenging for some parties to do a monthly mass balance review, particularly at the agricultural end of the supply chain. Therefore the maximum period over which the mass balance has to be achieved, can be longer than one month but must not exceed one year.[77]

5.36. Parties using a certified voluntary scheme must use the mass balance timeframe of that scheme.

[76] Defined in 'Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme'. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:160:0001:0007:EN:PDF
[77] Operators should note that lengthy balancing timeframes may add a layer of complexity and thus hinder the ability of verifiers to confirm whether the sustainability criteria have been met

Passing information through the supply chain

5.37. Using a mass balance chain of custody system promotes information about a particular consignment of biomass being passed down the supply chain. Although the physical evidence does not need to move through the supply chain with the biomass, we recommend that there is enough information with the operator for them to be confident about reporting to us against the sustainability criteria each month. Any information or evidence should be kept and made available if we need to verify it.

5.38. It is good practice if operators let parties earlier in the supply chain know what is required to demonstrate compliance with the sustainability criteria. This will ensure that relevant information moves along the supply chain.

5.39. Records of commercial transactions should let parties in the supply chain (and the verifier appointed by the operator of a generating station) trace back through the supply chain to verify any sustainability data claims made. A company that sells biomass should specify certain information on the invoice or documentation they share with the buyer.

5.40. Many operators will seek additional information from their biomass supplier in order to be confident that the biomass they are buying meets the RO sustainability criteria.

Demonstrating compliance and record-keeping

5.41. If an operator is not mixing consignments, they do not need to demonstrate compliance with the mass balance requirements. They must, however, be able to demonstrate to the auditor’s satisfaction that the biomass is traceable through the supply chain.

5.42. If consignments are being mixed, an operator should demonstrate they have a suitable mass balance in place to allow for traceability of the biomass and its associated sustainability characteristics.

5.43. As shown in Chapter 6, if the operator is using a voluntary scheme to demonstrate compliance with mass balance, they should ensure they have the certification documentation to demonstrate this to their auditor.

5.44. If an operator is using a mass balance chain of custody which is not covered by a voluntary scheme, they must collect information to demonstrate compliance with the mass balance requirements.

5.45. This will require not just the operator, but also parties within the supply chain to maintain suitable evidence. Clear, detailed and transparent records are vital to support sustainability reporting under the RO and for the annual sustainability audit.

5.46. We recommend that each party in the supply chain keeps, for a minimum of six years[78], records that should concur with the information on the invoices. This will let sustainability data claims be traced back through the supply chain. Table 6.1 sets out the recommended records to maintain. Example formats for these records are illustrated in Appendix 6.

Record type

Input and output records of biomass data and sustainability information

5.47. Input records refer to the biomass and sustainability related information for products purchased from a supplier. Output records refer to the biomass and sustainability related information for products sold to a buyer.

Information to record

- An invoice reference(s).
- Description of the physical product to which the biomass data refer.
- Volume of physical input/output to which the biomass data refer.
- Supplying/receiving company.
- Transaction date.
- Any biomass and sustainability information.

Conversion factor records

5.48. These records refer to the conversion factor of inputs to outputs and associated actual input data. Each party in the supply chain can maintain records of its own conversion factors. A party may have more than one conversion factor.

5.49. If no records are kept for the conversion factor a standard input value must be used.

Information to record

- To which input product it refers.

[78] Six years is recommended as this is the period in which we can revoke a ROC

- To which output product it refers.
- The units in which the conversion factor is expressed.
- The value of the actual conversion factor.
- When the specific conversion factor was valid.
- The calculation and supporting documentation that determines the conversion factor.

Periodic inventory of biomass data

5.50. These records provide an insight into the balance of biomass and sustainability information. Besides helping companies to manage their input-output balance, these records also assist in the verification of a party's mass balance records. Periodic inventories are recommended to be conducted on a monthly basis.

Information to record

- Inventory of biomass and sustainability information at the beginning of the respective period. It must be clearly specified whether this is expressed in input-equivalents (before conversion factor) or output-equivalents (after conversion factor).
- Volumes of inputs with identical biomass and sustainability information in the respective period. These volumes must coincide with the input records described above.
- Volume of outputs with identical biomass and sustainability information in the respective period. These volumes must coincide with the output records described above.
- Conversion factor(s) used in the respective period.
- Inventory of biomass and sustainability information at the end of the respective period (including the carbon intensity of the stock). It must be clearly specified whether this is expressed in input-equivalents (before conversion factor) or output-equivalents (after conversion factor).
- Purchase and sales invoices should be retained.

6. Demonstrating compliance and voluntary schemes

Chapter summary
This chapter sets out how voluntary schemes can be used to demonstrate compliance and the different types of recognised voluntary schemes.

Demonstrating compliance with the criteria

6.1. If the operator is reporting that they meet the criteria, or are using exemptions, they must retain the relevant evidence which demonstrates their compliance.[79]

6.2. For generating stations using bioliquids, and stations with a TIC of 1MW or more using solid biomass and biogas, meeting the sustainability criteria and having the evidence to demonstrate compliance is a condition for receiving support in the form of ROCs. These stations must also provide an annual independent sustainability audit report to us to verify what they have reported each month. There is more information about this in the RO: Sustainability Reporting guidance.

6.3. Operators can show that they comply with the sustainability criteria, by collecting information and/or using voluntary schemes as evidence.

6.4. Other people in the supply chain may have some of the evidence (e.g. evidence for meeting land criteria). The operator should have enough information to be confident about reporting sustainability information to us. For this, the operator may be relying on contractual agreements.

6.5. Any information or evidence should be kept by the relevant party and made available if needed for verification, even if it is held by the supply chain. This does not need to be in paper copy – electronic format is acceptable.

6.6. If you want to read more about the type of information and data which may be considered relevant evidence to demonstrate compliance refer to Chapters 2 to 5 of this document.

[79] Compliance must be with the criteria set out in the Orders. Compliance with another member state's requirements may not provide sufficient evidence to demonstrate compliance with the Orders.

6.7. Aside from the option to collect evidence, it is also possible to use voluntary schemes to demonstrate compliance.

Recognised voluntary schemes

6.8. Voluntary schemes are certification schemes that are a way to assure us that a fuel meets part or all of the RO sustainability criteria.

6.9. Voluntary schemes typically have a specific scope for which they are recognised. The operator of a generating station may use more than one voluntary scheme, or a combination of a voluntary schemes and collect other information.

6.10. If all or part of the supply chain is covered by a voluntary scheme, the operator can use this as evidence for demonstrating compliance with the relevant aspects of the RO sustainability criteria. If there is a break in the voluntary scheme certification in the supply chain, the certification cannot be used as automatic compliance and instead the operator's independent auditor would need to view this as part of the evidence provided.

6.11. To be registered with a voluntary scheme, the relevant party will typically be audited by an independent third party to ensure compliance with the scheme rules, before they can obtain certification by that voluntary scheme. Further audits will normally be needed to maintain certification, according to the requirements of the voluntary scheme.

6.12. The operator may make use of voluntary schemes recognised by the UK government to demonstrate compliance with the RO sustainability criteria (see Appendix 2). As parties will have been audited by the voluntary scheme, an operator's independent auditor may be able to rely on the audit conclusion/assessment result when providing assurance within the RO sustainability audit report. For more information on the role of voluntary schemes in the annual sustainability audit report please refer to RO: Sustainability Reporting guidance.

6.13. Any voluntary schemes which are not recognised by the UK government may still be used to demonstrate compliance with aspects of the RO sustainability criteria, but these will be considered alongside other evidence as part of the annual independent sustainability audit. The independent auditor will need to review the voluntary scheme to consider which aspect(s) of the RO sustainability criteria the scheme rules correspond with. Using UK-recognised voluntary schemes

6.14. For more information on using the voluntary schemes benchmarked by us for demonstrating compliance with the land criteria, refer to Chapter 3 and Appendix 2.

6.15. We will consider benchmarking further voluntary schemes in future if we think it's appropriate. In this instance, the operator making use of the scheme or a representative of the scheme itself can approach us directly to talk about it.

Schemes not benchmarked by the UK

6.16. Other schemes may still be useful evidence to support compliance with the RO sustainability criteria alongside other evidence collected by the operator to present to their independent auditor for the annual sustainability audit. Operators are welcome to get in touch with our Fuelling and Sustainability team to discuss the application of voluntary schemes.

Appendices

Appendix 1– Ofgem's role as RO administrator

A1.1. The Renewables Obligation Order 2015 (as amended) and the Renewables Obligation (Scotland) Order 2009 (as amended) detail our powers and functions for the Renewables Obligation in England and Wales and in Scotland respectively. Those functions include:

- issuing ROCs and Scottish Renewables Obligation Certificates (SROCs),
- establishing and maintaining a register of ROCs and SROCs,
- revoking ROCs and SROCs where necessary,
- monitoring compliance with the requirements of the Orders,
- calculating annually the buy-out price resulting from adjustments made to reflect changes in the Retail Price Index,
- receiving buy-out payments and redistributing the buy-out fund,
- receiving late payments and redistributing the late payment fund,
- publishing an annual report on the operation of and compliance with the requirements of the Orders, and
- forwarding to the Secretary of State a summary of the sustainability information submitted during the obligation period.

A1.2. We administer the Northern Ireland Renewables Obligation (NIRO) on behalf of the Northern Ireland Authority for Utility Regulation (UR) under an Agency Services Agreement. Under this agreement the Authority is required to carry out the functions listed above for Northern Ireland Renewables Obligation Certificates (NIROCs). However, the UR continues to retain responsibility under the legislation for administering the NIRO.

A1.3. We cannot properly act beyond the scope of the powers laid down in the Orders. For example, we have no remit over the operation or regulation of the ROC market itself. Amendments to the relevant legislation for the Renewables Obligation are a matter for the Secretary of State, Scottish Ministers and the Secretary of State for Northern Ireland.

Legislative and administrative changes

A1.4. As the legislation continues to evolve and our administrative processes are developed further, we aim to inform operators of generating stations of the changes and the impact they are likely to have by revising relevant guidance documents or publishing other communication, such as open letters, on our website.

A1.5. It should be appreciated, however, that the onus is on operators of generating stations to ensure that they are complying with the RO legislation. Operators of generating stations who are in any doubt as to whether the legislative requirements are being met may wish to seek independent technical and legal advice, as appropriate.

Our approach

A1.6. As the RO evolves, we continue to work in partnership with industry to develop our administrative processes, produce clear and consistent guidance for operators of generating stations and promote good practice. This is achieved by:

- The publication and updating of this guidance document, providing operators of generating stations with guidance and examples of good practice.
- Engagement with stakeholders on key issues, allowing us to gauge industry opinion and shape our guidance and administrative processes accordingly.

Appendix 2 – UK recognised voluntary schemes

A2.1 As set out in Chapter 6, in 2012 we benchmarked a number of voluntary schemes against the land criteria for non woody biomass. An overview of the results of the exercise is in the Table A2.1 below.

Table A2.1: Summary of 2012 benchmarking exercise against the land criteria for non-woody biomass

		Land Criteria	**Land Criteria**	**Land Criteria**	**Land Criteria**	**Land Criteria**		
Scheme Name	Benchmarked Version	Conservation of primary forest and other wooded land	Conservation of protected areas	Conservation of wetlands	Conservation of continuously forested areas	Conservation of "10% to 30%" forested areas	Conservation of peatlands	Audit Criteria
American Tree Farm System (ATFS)	2010-2015 Standard	No reference date	No reference date	No reference date, No specific reference to conversion of wetlands	No reference date	No reference date	Not covered	Yes
Canadian Standards Association (CSA)	CAN/CSA Z809-08	No reference date, Conversion permitted if "ecologically	No reference date	No reference date, Criteria focus on water quality and quantity	No reference date	No reference date	Not covered	Yes
Green Gold Label	GGL v2010.1	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Natural England Energy Crop Scheme	2009	No reference date, no specific reference to primary forest (relies on protected areas)	No reference date	No reference date, no specific reference to wetlands (relies on protected areas)	Not covered	Not covered	Not covered	3rd party verification required Annual surveillance audits required

Programme for the Endorsement of Forest Certification (PEFC)	PEFC ST 1003:2010	Reference date of 31 Dec 2010, Conversion permitted under "justified circumstances"	No reference date	No reference date	No reference date	No reference date	Not covered	Yes
Sustainable Forestry Incentive (SFI)	2010-2014 Standard	No reference date	No reference date	No reference date	No reference date	No reference date	Not covered	Yes
UK Woodland Assurance Scheme (UKWAS)[80]	Second Edition, Nov 2008	Yes	No reference date for non-wooded areas	No reference date, No specific reference to wetlands (relies on protected areas)	No reference date	No reference date	Not covered	Yes

A2.2 In 2015 we did benchmarking exercises of voluntary schemes against the land criteria for woody biomass. In 2023, we re-benchmarked these schemes as well as 2 additional schemes. The schemes benchmarked as part of these exercises were:

- FSC Controlled Wood (Company)
- FSC Controlled Wood (FME)
- PEFC Controlled Sources
- Sustainable Biomass Program (SBP)
- SFI Fibre Sourcing
- KZR IniG
- Sustainable Resources (SURE)

A2.3 Of these schemes, only SBP was found to be suitable as Category A evidence of compliance with the land criteria for woody biomass.

[80] UKWAS 2nd edition (2008) was the version benchmarked. We understand UKWAS 3rd edition has been publicly available since 1 December 2011.

A2.4 In undertaking these benchmarking exercises, a number of the schemes did not cover some of the areas specified within the Orders. We understand that this is likely to be because other primary legislation in the relevant country may set robust requirements which are relevant to the aspects of the criteria which the scheme does not cover, e.g. for the conservation of certain ecosystem types, such as high biodiversity areas, wetlands, peatlands or protecting soil, water and biodiversity in forests. In such cases, the voluntary schemes therefore may not include particular criteria as the requirement is already catered for in the primary legislation of the country in which the biomass is sourced, which takes precedence over the voluntary schemes. Compliance with all laws (and standards, manuals, programmes and policies) is the basis for voluntary scheme certification in these countries.

A2.5 Our benchmarking exercises focused on the principles and criteria covered by the schemes themselves, but, when sourcing biomass, operators may wish to take into account the national context for which a voluntary scheme was created. Notably, some schemes in the 2012 benchmarking exercise did not cover areas specified in the land criteria (e.g. they are silent on the conversion of a wetland or peatland). This could be because these aspects of the RO land criteria are not relevant in the respective environments for which the schemes are tailored.

A2.6 Where the recognised scope of a voluntary scheme covers only part of the RO sustainability criteria, operators should seek additional information to demonstrate full compliance with the criteria under the Orders. For wetlands and peatlands, the purchaser needs proof from the supplier that applicable legislation and policy, as well as the accompanying standards and programmes of the particular province from which the biomass is sourced, assure sustainability of wetlands and peatlands. For the land criteria for woody biomass, DESNZ has published further guidance on how to demonstrate compliance.[81]

A2.7 The 2012 benchmarking exercise was done before the land criteria for woody biomass was introduced and therefore makes reference to some forestry-related schemes. For transparency and completeness, these schemes have not been removed from Table A2.1, although it is recognised they may be less relevant to reporting against the non-woody biomass land criteria.

[81] https://www.gov.uk/government/publications/woodfuel-guidance-version-2

Appendix 3 – Common fuel classifications

A.3.1. These tables provide guidance on when substances should be considered products, residues or wastes, only for the purposes of the sustainability criteria under the RO.

A.3.2. It is not possible to lay down definitive or absolute rules for when particular materials will be considered waste, residues or products. A judgement has to be made taking into account the circumstances of each case, and applying the legislation, case law principles and other relevant indicators.

A.3.3. This is an indicative and not an exhaustive list. There may be further wastes or residues that are not on the list that still qualify as wastes or residues. As described in Chapter 2, we may periodically review and update this list on our website, if sufficient evidence emerges to indicate that a substance should be treated differently.

A.3.4. For more information on fuel classification, including definitions and reporting requirements please see Chapter 2.

Table A3.1: Products

Material	Description
Virgin oils, including but not limited to: • palm • soy • rape • sunflower	Including, but not limited to, oils derived from palm, soy, rape and sunflower. The treatment of these materials and of the meal produced as part of the same process in the RED GHG calculations makes clear that these are to be treated as products.
High oleic acid rape seed oil	A product if grown as a fuel, or if grown as a product and diverted to use as a fuel. If used as fuel after being used for cooking then it will be a waste (as used cooking oil).
Short rotation coppice (SRC)	Short rotation coppice is grown specifically for use as a fuel and, as such, it is a product.
Short rotation forestry (SRF)	Short rotation forestry grown specifically for use as a fuel is a product.

Material	Description
Virgin wood	Virgin wood is timber from whole trees and the woody parts of trees including branches and bark derived from forestry works, woodland management, tree surgery and other similar operations. It does not include clippings or trimmings that consist primarily of foliage (though these may be forestry residues)
Miscanthus	This is commonly grown as a fuel crop and in these circumstances will be a product. If it is put to another use first, e.g. as animal bedding, before being used as fuel then it will be a waste.
Palm oil olein	The refined liquid fraction of palm oil is a product. If used for cooking before being used as fuel then it will be a waste (as used cooking oil).
Palm kernel oil	Palm kernel oil is a product. If used for cooking before being used as fuel then it will be a waste (as used cooking oil).
Acid ester	Esters are produced intentionally and are therefore a product.
Molasses	This material arises from the processing of sugar cane and sugar beet into sugar. It arises on the basis of a technical decision, and is considered a product.
Glycerol from virgin oils	The treatment of glycerol from virgin oils in the RED GHG calculations makes clear that it is to be treated as a product.
Crude tall oil	Crude tall oil arises from the process of pulping coniferous wood. The pulping process involves cooking woodchip in a chemical mixture and this gives rise to a soapy material which is separated from the pulp and liquor. It is then acidified and heated to convert it into crude tall oil. Crude tall oil is a product of the pulping process.
Brown liquor	This material arises during the pulping of wood. As for tall oil, it is considered a product.
Meal from virgin oil production	These materials' treatment in the RED GHG calculations makes clear that they are to be treated as products.
Sugar beet sludge	This is the pulp left over following sugar extraction. Its treatment in the RED GHG calculations makes clear that it is to be treated as a product.

Material	Description
Corn or wheat dried distillers grain (DDGS)	This material's treatment in the RED GHG calculations makes clear that it is to be treated as a product.
Palm Stearin	Palm stearin is produced alongside palm olein from the fractionation of crude palm oil. After the fractionation process, the mixture is filtered to separate stearin (solid form) and olein (liquid).
Palm fatty acid distillate	The treatment of PFAD in the RED GHG calculations indicates that it is to be treated as a product.
Tallow – Animal By-Product Category 3	Tallow, also called rendered animal fat, is the hard fat obtained from the whole or part of any dead animal through the process of rendering. It is then used as feedstock for the production of biodiesel or bioliquid as fuels. Annex V, Part D of the RED makes clear that animal oil produced from animal by-product classified as category 3 should be treated as product. A revised Animal By-Products Regulation 1069/2009 took effect on 4 March 2011 . Although the revised regulation does not appear to change this definition, no decisions have yet been made by a court or other panel on the basis of the new regulation. There is the possibility that once a decision is made, the status of tallow could change. The Environment Agency have further information on the process of producing biodiesel from rendered animal fat.[82] Note that the approach we have taken for category 3 tallow is that the operator does not have to make a response to the land criteria as the feedstock is neither cultivated nor obtained from land, as such the land criteria is considered not-applicable. The operator should therefore select 'exempt' in monthly reporting. GHG emissions should be considered from the starting point of the material when it is generated at the abattoir/rendering plant.

[82] Further information can be found: https://www.gov.uk/government/organisations/environment-agency

Table A3.2: Processing residues and residues from agriculture, aquaculture, forestry and fisheries

Material	Description
Forestry residues	Forestry residues are identified explicitly by the RED I as residues. Following statements from the EC[83] and the Environment Agency,[84] we consider forestry residues to be derived from "virgin wood" and to include all raw materials collected directly from the forest, whether or not as a result of thinning or logging activities. This may include (but is not limited to) materials such as tree tops, branches, brash, clippings, trimmings, leaves, bark, shavings, woodchips and saw dust from felling. Forestry residues do not include any residues from related industries, or residues associated with processing the virgin wood/raw material (for example sawdust from saw mills). These may be classed as processing residues (see below).
Arboricultural residues	Residues from arboriculture are not defined by the Orders or existing EC communications but can be considered to be biomaterial such as that which is removed as part of tree surgery, management of municipal parks and verges of roads and railways. Residues from arboriculture should not include forestry residues.
Straw	Straw is specifically named as an agricultural crop residue in the RED. Depending on whether the material was created during harvesting or processing will determine whether it must meet the land criteria or is exempt. Straw is deemed to have zero GHG emissions prior to the process of collection.

[83] European Commission, Report From The Commission To The Council And The European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC0011&from=EN

[84] Statement from the Environment Agency: http://www.forestry.gov.uk/pdf/eng-yh-ea-wastewoodstatement.pdf/$FILE/eng-yh-ea-wastewoodstatement.pdf

Material	Description
Bagasse	Bagasse results from crushing sugarcane or sorghum. Bagasse is specifically named as an agricultural crop residue in the RED. Depending on whether the material was created during harvesting or processing will determine whether it must meet the land criteria or is exempt. Bagasse is deemed to have zero GHG emissions prior to the process of collection.
Nut shells	Nut shells are specifically named as an agricultural crop residue in the RED. Depending on whether the material was created during harvesting or processing will determine whether it must meet the land criteria or is exempt. Nutshells are deemed to have zero GHG emissions prior to the process of collection.
Husks	Husks are specifically named as agricultural crop residues in the RED. Depending on whether the material was created during harvesting or processing will determine whether it must meet the land criteria or is exempt. Husks are deemed to have zero GHG emissions up to the point of collection.
Cobs	Cobs are specifically named as agricultural crop residues in the RED. Depending on whether the material was created during harvesting or processing will determine whether it must meet the land criteria or is exempt. Cobs are deemed to have zero GHG emissions up to the point of collection.
Tall oil pitch	Tall oil pitch is the remaining fraction of the fractional distillation process of crude tall oil. Tall oil pitch cannot be further refined. No matter which technical decisions are made in the fractional distillation, this fraction will remain. Tall oil pitch is therefore a residue of this process.
Manure	Manure is specifically named as a processing residue in the RED.

Material	Description
Crude glycerol from processing of waste oils	Crude glycerol (from processing of waste oils) is specifically named as a residue from processing in the RED. The RED treats of glycerol from processing of virgin oils as a product – see above.
Vinasse	Vinasse results from the processing of sugar cane or sugar beet. The treatment of vinasse in the RED GHG calculations makes clear that it is to be treated as a processing residue.
Palm processing residues: empty palm bunches fibre and shell from palm oil production palm oil mill effluent (POME)	These materials' treatment in the RED GHG calculations makes clear that they are to be treated as processing residues.
Saw dust from saw mills	This is a processing residue. Note that any deliberate change to the production process to increase the volume of sawdust resulting from processing would make the resulting material a product rather than a residue

Table A3.3: Wastes

Material	Description
Waste wood	Any waste wood, including "non-virgin" wood, will be considered a waste. Following statements from the Environment Agency, waste wood may include non-virgin timber off-cuts, shavings, chippings and sawdust from the processing of non-virgin timbers (whether clean or treated). The phrase "non-virgin" wood refers to materials such as post-consumer waste and construction and demolition waste.

Material	Description
Used cooking oil (UCO)	Commonly called "UCO" or "WCO" (waste cooking oil), this is purified oils and fats of plant and animal origin. These have been used by restaurants, catering facilities and kitchens to cook food for human consumption. They are wastes as they are no longer fit for that purpose and are subsequently used as either feedstock for the production of biodiesel as fuel for automotive vehicles and heating or as a direct fuel. The Environment Agency have further information on the process of producing biodiesel from UCO.[85]
Brown grease (ex USA)	Brown grease is the grease that is removed from wastewater sent down a restaurant's sink drain. This is a waste.
Tallow – Animal By-Product Category 1	Tallow, also called rendered animal fat, is the hard fat obtained from the whole or part of any dead animal through the process of rendering. It is then used as feedstock for the production of biodiesel or bioliquid as fuels. Annex V, Part D of the RED makes clear that animal oil produced from animal by-product classified as category 1 should be treated as waste. A revised Animal By-Products Regulation 1069/2009 took effect on 4 March 2011. Although the revised regulation does not appear to change this definition, no decisions have yet been made by a court or other panel on the basis of the new regulation. There is the possibility that once a decision is made, the status of tallow could change. The Environment Agency have further information on the process of producing biodiesel from rendered animal fat.[86]
Municipal Solid Waste	This is a waste.
Construction and demolition wastes	For the purposes of generation, this category will be mainly waste wood.
Meat/bone meal	This is a waste.
Food waste	Whether from manufacturers, retailers or consumers, this will be a waste.
Waste pressings from production of vegetable oils	When a vegetable material such as olives is pressed to produce vegetable oil, the pressed material consisting of pips, skins, flesh etc. remains. This may be used as a fuel. The purpose of the process is to produce oil; the pressings are therefore wastes.

[85] Further information can be found: https://www.gov.uk/government/organisations/environment-agency
[86] Further information can be found: https://www.gov.uk/government/organisations/environment-agency

Material	Description
Olive pomace	As above.
Soapstocks	From oil de-acidification; again an output from vegetable oil refining that will be waste.
Distillation residues	Distillation residues are what are left over following the distillation of products such as biodiesel so will be wastes.
Food crops affected by fungi during storage	These are wastes.
Food crops that have been chemically contaminated	These are wastes.

A.3.5. Following the introduction of the land criteria for woody biomass we undertook some work to provide guidance on how certain types of wood should be classified.

A.3.6. As with the common classification tables, it is not possible to lay down definitive or absolute rules for when particular wood types will be considered waste, residues or products. A judgement has to be made taking into account the circumstances of each case, and applying the legislation, case law principles and other relevant indicators. This is not a definitive list and there may be some wood types not covered.

Table A3.3 – Default values and standard input data

Material	Description	Classification
Bark	Tough outer surface of tree trunks and other woody plants	Forest residue, arboricultural residue or processing residue (depending on where and to what purpose the residue is generated)
Clippings/trimmings	Primarily leaves and the stems on which the leaves grow	Forest residue or arboricultural residue (depending on where the residue is generated)
Construction and demolition waste wood (sometimes called recycled wood)	Woody material from construction or demolition sites that is no longer used in its primary function.	Waste

Material	Description	Classification
Diseased wood	Wood that has been felled due to damage from insect nests or blight which damages the tree and/or may spread disease to other trees/organisms and is of little value other than for energy	Forestry residue (unless from arboriculture)
End of life timber	Standing trees from plantations for non-timber products (e.g. coconut, rubber, palm trees) which have reached the end of their useful life	Agricultural residue
Fire damaged wood	Wood that has been damaged by fire and therefore has no other market than for energy.	Forestry residue (unless from arboriculture)
Leaves	Leaf matter arising directly from the forest as a result of harvesting or management activities	Forestry residue or arboricultural residue (depending on where the residue is generated)
Long rotation coppice	Plantation felled after a growing period of 15+ years and then replanted	Product
Non-sawmill lumber	Woody material that has been felled but does not meet the specifications for lumber for the sawmill due to its size or shape	Co-product
Post-consumer waste wood (Sometimes called recycled wood, e.g. pallets, packaging etc.)	Woody material in a product that has been considered past its useful life by the consumer	Waste
Saw dust from felling	Saw dust produced during felling of trees	Forestry residue or arboricultural residue (depending on where the residue is generated)

Material	Description	Classification
Sawmill residue	Saw dust produced during the processing of wood at the sawmill	Processing residue However, some parties may say co-product if the value from this stream is material to ongoing profitability
Sawmill residue	Woody material produced during the processing of wood at the sawmill, may include small offcuts or also bark that has been stripped from the wood	Processing residue
Shavings	Wood shavings produced in the mill during timber processing	Processing residue
Short rotation coppice	Varieties of poplar and willow grown in wood plantations and managed through coppicing. Harvesting takes place every 2-5 years.	Product
Short rotation forestry	Tree plantations with short harvest rotations typically every 8-15 years. This can include agro-forestry (where trees are grown around or among crops or pastureland to optimise use of the land)	Product
Slab wood	An outsize piece cut from a log when squaring it for lumber. This takes place in the forest.	Forestry residue if removed in a forest, sawmill residue if removed in a sawmill.
Storm salvage wood	Wood from trees that have been uprooted or damaged during hurricanes or storms and is of little value other than for energy	Forestry residue or arboricultural residue (depending on where the residue is generated)
Stumps	The basal portion of a tree remaining after the rest has been removed	Forestry residue

Material	Description	Classification
Thinnings	Wood from a silvicultural operation where the main objective is to reduce the density of trees in a stand, improve the quality and growth of the remaining trees and produce a saleable product.	Co-product in the situation where alternative markets are available and the value of the thinnings is material to forest profitability. In other circumstances, forestry residue
Virgin Forestry	An area forested with virgin trees (i.e. non plantation) from which felled trees have been extracted.	Product
Woodchips from tops and branches	Typically comprised of chipped tops and limbs of trees that have been left behind following the harvesting of stem wood. This category should not include wood chips from stem wood or thinnings. May sometimes be called brash, which is the collective term for foliage, branches and tops of the tree.	Forestry residue
Wood residues from arboriculture	Biomaterial that is removed as part of tree surgery, management of municipal parks and verges of roads and railways. Also called arboricultural arisings	Arboricultural residue

Appendix 4 – Default values and standard input data

A4.1 Table A4.1 sets out the default GHG saving for bioliquids fuels for use with the default method. It also provides the disaggregated default values for use with the mixed value method. These values are taken directly from Annex V of the RED.

A4.2 Table A4.2 sets out the default values for solid biomass and biogas fuels for use in the default method as defined in Part 3 of Schedule 2 of the Orders[87].

A4.3 Tables A4.3 and A4.4 provide standard input data that can be used by operators when calculating their GHG emissions. These values have been determined by DESNZ and are pre-built into the Carbon Calculator.

Table A4.1: Bioliquid default carbon intensities and disaggregated default values

Ethanol pathways

Bioliquid production pathway	**Default carbon intensity (CI)** **[gCO_{2eq}/MJ]**	**Disaggregated default values [gCO_{2eq}/MJ]**	**Disaggregated default values [gCO_{2eq}/MJ]** **Processing**	**Disaggregated default values [gCO_{2eq}/MJ]** **Transport and distribution**	**GHG saving[88]** **[%]**
Corn ethanol, community produced (natural has as process fuel in CHP plant)	43		21	2	49%
Farmed wood ethanol	25		17	2	70%
Sugar beet ethanol	40		26	2	52%
Sugar cane ethanol	24		1	9	71%

[87] Part 2 of Schedule 3B of the ROS and NIRO Orders.

[88] As set out in Tables A and B from Annex V, Part C of the RED.

Bioliquid production pathway	**Default carbon intensity (CI)** **[gCO_{2eq}/MJ]**	**Disaggregated default values [gCO_{2eq}/MJ]**	**Disaggregated default values [gCO_{2eq}/MJ]** **Processing**	**Disaggregated default values [gCO_{2eq}/MJ]** **Transport and distribution**	**GHG saving[88]** **[%]**
Waste wood ethanol	22		17	4	74%
Wheat ethanol (process fuel not specified)	70		45	2	16%
Wheat ethanol (lignite as process fuel in CHP plant)	70		45	2	16%
Wheat ethanol (natural gas as process fuel in conventional boiler)	55		30	2	34%
Wheat ethanol (natural gas as process fuel in CHP plant)	44		19	2	47%
Wheat ethanol (straw as process fuel in CHP plant)	26		1	2	69%
Wheat straw ethanol	13		7	2	85%

Bioliquid production pathway	**Default carbon intensity (CI) [gCO$_{2eq}$/MJ]**	**Disaggregated default values [gCO$_{2eq}$/MJ]**	**Disaggregated default values [gCO$_{2eq}$/MJ] Processing**	**Disaggregated default values [gCO$_{2eq}$/MJ] Transport and distribution**	**GHG saving[88] [%]**
Part from renewable sources of Ethyl tert-butyl ether (ETBE)	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used
Part from renewable sources of Tertiary amyl-ethyl ether (TAEE)	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used
Methanol Pathways					
Farmed wood methanol	7		0	2	91%
Waste wood methanol	5		0	4	94%
Part from renewable sources of methyl tert-butyl ether (MTBE)	Equal to that of the methanol production pathway used	Equal to that of the methanol production pathway used	Equal to that of the methanol production pathway used	Equal to that of the methanol production pathway used	Equal to that of the methanol production pathway used
Biodiesel Pathways					
Palm oil biodiesel (process not specified)	68		49	5	19%

Palm oil biodiesel (process with methane capture at oil mill)	37		18	5	56%
Rape seed biodiesel	52		22	1	38%
Soybean biodiesel	58		26	13	31%
Sunflower biodiesel	41		22	1	51%
Waste vegetable or animal biodiesel	14		13	1	83%

Hydrogenated Vegetable Oil Pathways

Hydrogenated vegetable oil from palm oil (process not specified)	62		42	5	26%
Hydrogenated vegetable oil from palm oil (process with methane capture at oil mill)	29		9	5	65%
Hydrogenated vegetable oil from rape seed	44		13	1	47%
Hydrogenated vegetable oil from sunflower	32		13	1	62%

Pure Vegetable Oil Pathways

Pure vegetable oil from rape seed	36		5	1	57%

Fischer-Tropsch Diesel Pathways

Farmed wood Fischer-Tropsch diesel	6		0	2	93%
Waste wood Fischer-Tropsch diesel	4		0	3	95%

Dimethyl Ether (DME) Pathways

Farmed wood DME	7		0	2	92%
Waste wood DME	5		0	4	95%

Table A4.2: Solid biomass and biogas default carbon

Biomass production pathway	**Default carbon intensity (CI) [gCO_{2eq}/MJ feedstock]**
Wood chips from forest residues (European temperate continental forest)	1
Wood chips from forest residues (tropical and subtropical forest)	25
Wood chips from short rotation forestry (European temperate continental forest)	4
Wood chips short rotation forestry (tropical and subtropical e.g. eucalyptus)	28
Wood briquettes or pellets from forest residues (European temperate continental forest) – using wood as process fuel	2
Wood briquettes or pellets from forest residues (tropical or subtropical forest) – using natural gas as process fuel	20
Wood briquettes or pellets from forest residues (tropical or subtropical forest) – using wood as process fuel	17
Wood briquettes or pellets from forest residues (European temperate continental forest) – using natural gas as process fuel	35

Wood briquettes or pellets from short rotation forestry (European temperate continental forest) – using wood as process fuel	4
Wood briquettes or pellets from short rotation forestry (European temperate continental forest) – using natural gas as process fuel	22
Wood briquettes or pellets from short rotation forestry (tropical and sub-tropical e.g. eucalyptus) – wood as process fuel	22
Wood briquettes or pellets from short rotation forestry (tropical and sub-tropical e.g. eucalyptus) – natural gas as process fuel	40
Charcoal from forest residues (European temperate continental forest)	41
Charcoal from forest residues (tropical and sub-tropical forest)	50
Charcoal from short rotation forestry (European temperate continental forest)	46
Charcoal from short rotation forestry (tropical and subtropical e.g. eucalyptus)	57
Wheat straw	2
Bagasse briquettes – wood as process fuel	17
Bagasse briquettes – natural gas as process fuel	35
Bagasse bales	20
Palm kernel	27
Rice husk briquettes	28
Miscanthus bales	7
Biogas from wet manure	8
Biogas from dry manure	7
Biogas from wheat and straw (wheat whole plant)	21
Biogas from maize as whole plant (maize as main crop)	34
Biogas from maize as whole plant (maize as main crop) – organic agriculture	19

Table A4.3: Standard Input Data

Factor	Value
Global warming potentials	**Global warming potentials**
CO_2	1 gCO_2eq / g
CH_4	23 gCO_2eq / g
N_2O	296 gCO_2eq / g
Agricultural inputs GHG emission coefficients	**Agricultural inputs GHG emission coefficients**
N-fertiliser (kg N)	4567.8 gCO_2-eq/kg
P_2O5-fertiliser (kg P_2O5)	1176.0 gCO_2-eq/kg
K_2O-fertiliser (kg K_2O)	635.6 gCO_2-eq/kg
CaO-fertiliser (kg CaO)	89.6 gCO_2-eq/kg
Pesticides	13894.6 gCO_2-eq/kg
Seeds- rapeseed	794.0 gCO_2-eq/kg
Seeds- soy bean	0.0 gCO_2-eq/kg
Seeds- sugarbeet	3820.5 gCO_2-eq/kg
Seeds- sugarcane	4.9 gCO_2-eq/kg
Seeds- sunflower	794 gCO_2-eq/kg
Seeds- wheat	289.9 gCO_2-eq/kg
Short rotation coppice cuttings	0.0 [kg CO_2eq / cutting]
Short rotation coppice setts	0.0 [kg CO_2eq / sett]
Factor	**Value**
Emissions due to transport of filter mud cake	0.0 [kg CO_2eq / kg filter mud cake]
Emissions due to transport of vinasse	0.0 [kg CO_2eq / kg vinasse]
Manganese	0.8 [kg CO_2eq / kg Mn]
Rhizomes	0.3 [kg CO_2eq / kg rhizome]
Forage maize seeds	0.3 [kg CO_2eq / kg seeds]
Urea silage additive	9.8 [kg CO_2eq / kg additive]

Propionic acid silage additive	1.3 [kg CO_2eq / L additive]
Digestate	0.0 [kg CO_2eq / kg digestate]
Farm yard manure	0.0 [kg CO_2eq / kg FYM]
Fuels GHG emission coefficients	**Fuels GHG emission coefficients**
Natural gas (4000 km, Russian NG quality)	66.20 gCO_2-eq/MJ
Natural gas (4000 km, EU Mix quality)	67.59 gCO_2-eq/MJ
Diesel	87.64 gCO_2-eq/MJ
HFO	84.98 gCO_2-eq/MJ
HFO for maritime transport	87.20 gCO_2-eq/MJ
Methanol	99.57 gCO_2-eq/MJ
Hard coal	111.28 gCO_2-eq/MJ
Lignite	116.98 gCO_2-eq/MJ
Wheat straw	1.80 gCO_2-eq/MJ
Electricity GHG emission coefficients	**Electricity GHG emission coefficients**
Electricity EU mix MV	127.65 gCO_2-eq/MJ
Electricity EU mix LV	129.19 gCO_2-eq/MJ
North America	145 gCO_2-eq/MJ
Latin America	55 gCO_2-eq/MJ
Russia	237 gCO_2-eq/MJ
Conversion inputs GHG emission coefficients	**Conversion inputs GHG emission coefficients**
n-Hexane	80.53 gCO_2-eq/MJ
Hydrogen (for HVO)	94.35 gCO_2-eq/MJ
Phosphoric acid (H_3PO_4)	3040.6 gCO_2-eq/kg
Fuller's earth	199.8 gCO_2-eq/kg
Hydrochloric acid (HCl)	1375.4 gCO_2-eq/kg
Sodium carbonate (Na_2CO_3)	1267.6 gCO_2-eq/kg
Sodium hydroxide (NaOH)	764.4 gCO_2-eq/kg
Potassium hydroxide (KOH)	626.1 gCO_2-eq/kg

Pure CaO for processes	1099.9 gCO_2-eq/kg
Sulphuric acid (H_2SO_4)	268.8 gCO_2-eq/kg
Ammonia	2554.7 gCO_2-eq/kg
Cycle-hexane	723.0 gCO_2-eq/kg
Lubricants	947.0 gCO_2-eq/kg
Emissions from steam production (per MJ steam or heat)	**Emissions from steam production (per MJ steam or heat)**
CH_4 and N_2O emissions from NG boiler	0.39 gCO_2-eq/MJ
CH_4 and N_2O emissions from NG CHP	0.00 gCO_2-eq/MJ
CH_4 and N_2O emissions from Lignite CHP	3.79 gCO_2-eq/MJ
CH_4 and N_2O emissions from Straw CHP	0.00 gCO_2-eq/MJ
CH_4 and N_2O emissions from NG gas engine	1.23 gCO_2-eq/MJ
Electricity production (reference for credit calculation)	**Electricity production (reference for credit calculation)**
Electricity (NG CCGT)	124.42 gCO_2-eq/MJ
Electricity (Lignite ST)	287.67 gCO_2-eq/MJ
Electricity (Straw ST)	5.71 gCO_2-eq/MJ
Factor **Density**	**Value** **Density**
Diesel	832 kg/m3
Gasoline	745 kg/m3
HFO	970 kg/m3
HFO for maritime transport	970 kg/m3
Ethanol	794 kg/m3
Methanol	793 kg/m3
FAME	890 kg/m3
Syn diesel (BtL)	780 kg/m3
HVO	780 kg/m3
Lower Heating Values	**Lower Heating Values**
Manure	10 MJ/kg

Methane	50 MJ/kg
Diesel	43.1 MJ/kg
Gasoline	43.2 MJ/kg
HFO	40.5 MJ/kg
HFO for maritime transport	40.5 MJ/kg
Ethanol	26.81 MJ/kg
Methanol	19.9 MJ/kg
FAME	37.2 MJ/kg
Syn diesel (BtL)	44.0 MJ/kg
HVO	44.0 MJ/kg
PVO	36.0 MJ/kg
Hard coal	26.5 MJ/kg
Lignite	9.2 MJ/kg
Corn	18.5 MJ/kg
FFB	24.0 MJ/kg
Rapeseed	26.4 MJ/kg
Soybeans	23.5 MJ/kg
Sugar beet	16.3 MJ/kg
Sugar cane	19.6 MJ/kg
Sunflower seed	26.4 MJ/kg
Wheat	17.0 MJ/kg
Waste vegetable / animal oil	37.1 MJ/kg
Bio Oil (by-product FAME from waste oil)	21.8 MJ/kg
Crude vegetable oil	36.0 MJ/kg
DDGS (10 wt% moisture)	16.0 MJ/kg
Glycerol	16.0 MJ/kg
Palm kernel meal	17.0 MJ/kg
Palm oil	37.0 MJ/kg
Rapeseed meal	18.7 MJ/kg

Soybean oil	36.6 MJ/kg
Soy bean meal	-
Sugar beet pulp	15.6 MJ/kg
Sugar beet slops	15.6 MJ/kg
Wheat straw	17.2 MJ/kg
n-hexane	45.1 MJ/kg
Wood @ 50% moisture content	8.4 MJ/kg
Wood @ 25% moisture content	13.8 MJ/kg
Wood @ 15% moisture content	16.0 MJ/kg
Wood @ 10% moisture content	17.0 MJ/kg
Bagasse @ 50% moisture content	11.8 MJ/kg
Bagasse pellets (10% moisture content)	15.1 MJ/kg
Olive cake	19.3 MJ/kg
Factor	**Value**
Grass at 10% MC	14.4 MJ/kg
Grass at 15% MC	13.6 MJ/kg
Grass at 25% MC	11.9 MJ/kg
Charcoal	30.0 MJ/kg
RDF	15.5 MJ/kg
Biological fraction of MSW	5.8 MJ/kg
Straw @ 15% moisture content	15.2 MJ/kg
Biogas (52% methane)	21 MJ/Nm3
Biomethane	34 MJ/Nm3
Methane	36 MJ/Nm3
Fuel efficiencies	**Fuel efficiencies**
Truck for dry product (Diesel)	0.81 MJ/t.km
Truck for liquids (Diesel)	0.87 MJ/t.km
Truck for FFB transport (Diesel)	2.24 MJ/t.km
Tanker truck MB2318 for vinasse transport	2.16 MJ/t.km

Tanker truck with water cannons for vinasse transport	0.94 MJ/t.km
Dumpster truck MB2213 for filter mud transport	3.60 MJ/t.km
Ocean bulk carrier (Fuel oil)	0.20 MJ/t.km
Ship /product tanker 50kt (Fuel oil)	0.12 MJ/t.km
Local (10 km) pipeline	0 MJ/t.km
Rail (Electric, MV)	0.21 MJ/t.km
Transport exhaust gas emissions	**Transport exhaust gas emissions**
Truck for dry product (Diesel)	0.0034 gCH_4/t.km
Truck for dry product (Diesel)	0.0000 gN_2O/t.km
Truck for liquids (Diesel)	0.0036 gCH_4/t.km
Truck for liquids (Diesel)	0.0000 gN_2O/t.km
Truck for FFB transport (Diesel)	0.0002 gCH_4/t.km
Truck for FFB transport (Diesel)	0.0000 gN_2O/t.km
Tanker truck MB2318 for vinasse transport	0.000 gCH_4/t.km
Tanker truck MB2318 for vinasse transport	0.000 gN_2O/t.km
Tanker truck with water cannons for vinasse transport	0 gCH_4/t.km
Tanker truck with water cannons for vinasse transport	0 gN_2O/t.km
Dumpster truck MB2213 for filter mud transport	0 gCH_4/t.km
Dumpster truck MB2213 for filter mud transport	0 gN_2O/t.km
Ocean bulk carrier (Fuel oil)	0 gCH_4/t.km
Ocean bulk carrier (Fuel oil)	0.0007 gN_2O/t.km
Ship /product tanker 50kt (Fuel oil)	0 gCH_4/t.km
Ship /product tanker 50kt (Fuel oil)	0 gN_2O/t.km
Local (10 km) pipeline	0 gCH_4/t.km
Local (10 km) pipeline	0 gN_2O/t.km
Rail (Electric, MV)	0 gCH_4/t.km

Rail (Electric, MV)	0 $gN_2O/t.km$

Table A4.4: IPCC Default Values for calculation of soil N2O emissions

Factor **IPCC default values for calculation of soil N2O emissions**	**Value** **IPCC default values for calculation of soil N2O emissions**
Direct N_2O emission factor (calculated from IPCC references given in italics below)	4.65 kg CO_2eq / kg N
Indirect N_2O emission factor from inorganic fertiliser (calculated from IPCC references given in italics below)	1.51 kg CO_2eq / kg N
Indirect N_2O emission factor from organic fertiliser (calculated from IPCC references given in italics below)	1.98 kg CO_2eq / kg N
IPCC Tier 1 default emission factor for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised form mineral soil as a result of loss of soil carbon	0.01 [kg N_2O-N / (kg N)]
IPCC Tier 1 default emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces	0.0100 [kg N_2O-N / (kg NH_3-N + NOx-N volatilised)]
IPCC Tier 1 default fraction of AN fertiliser that volatilises as NH3 and NOx	0.1000 [(kg NH_3-N + NOx-N) / kg N applied]
IPCC Tier 1 default fraction of urea that volatilises an NH3 and NOx	0.2000 [(kg NH_3-N + NOx-N) / kg N applied]
IPCC Tier 1 default emission factor for N2O emissions from N leaching and runoff	0.0075 [kg N_2O-N / (kg N leached and runoff)]
IPCC Tier 1 default fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff	0.3000 [kg N / kg N additions]
N_2O emissions / N_2O-N emissions	1.5714 [kg N_2O / kg N_2O-N]
IPCC Tier 1 default fraction of organic fertiliser that volatilises as NH_3 and NOx	0.2000 [(kg NH_3-N + NOx-N) / kg N applied]
Nitrogen content of digestate	2.1000 [kg N / t]

Nitrogen content in farm yard manure	6.5000 [kg N / t]

Appendix 5 – Land use change calculations

A5.1 This section sets out how to calculate emissions due to land use change. The EC transparency platform has published an annotated example of these emissions calculations. This can be downloaded from its website[89].

A5.2 Equation 1 is taken directly from the RED GHG calculation methodology.[90] Equations 2-5 are from the EC decision[91] regarding guidelines for the calculation of land carbon stocks. The EC decision was published to establish the rules for calculating land carbon stocks, for both the reference land use (CSR) and the actual land use (CSA). Please refer to the EC decision for further information on the similarities required when establishing the extent of an area for which the land carbon stocks are to be calculated.

A5.3 The same method should be applied for the calculation of emission savings from soil carbon accumulation via improved agricultural practices.

A5.4 All calculations in this section refer to direct land use changes. Operators of generating stations do not need to report against, or include in their carbon intensity calculations, emissions from indirect land use change.

A5.5 Land use change-related emissions should be calculated based on the difference in carbon stocks of the land between its current and previous use (on 1 January 2008), as shown in Equation 1.

Equation 1: Land use change emission

$$\mathbf{e_l = (CS_R - CS_A) \times 3.664 \times (1/20) \times (1/P) - e_B\ (*)}$$

Where:

e_l is the annualised GHG emissions from carbon stock change due to land use change (measured as mass of (grams) of CO_2–equivalent per unit of bioliquid energy (MJ)). Cropland** and perennial cropland*** shall be regarded as one land use.

CS_R is the carbon stock associated with the reference land use (ie the land use in January 2008 or 20 years before the feedstock was obtained, whichever the later) (measured as mass (tonnes) of carbon per unit area, including both solid and vegetation)

[89] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria
[90] Annex V, Part C, Para 7.
[91] 2010/335/EU - Commission Decision of 10th June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC – available on the EC Transparency Platform.

CS_A is the carbon stock per unit area associated with the actual land use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to CS_A shall be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earlier.

P is the productivity of the crop (measured as energy per unit area per year)

e_B is a bonus of 29gCO_{2eq}/MJ is the bioliquid feedstock is obtained from restored degraded land under the conditions set out in the paragraphs below

***** The quotient obtained by dividing the molecular weight of CO_2 (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) is equal to 3,664.

****** Cropland will be as defined by IPCC: 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories - volume 4 at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

******* Perennial crops are defined as multi-annual crops, the stem of which is usually not annually harvested such as short rotation coppice and oil palm.

A5.6 The EC decision defines the calculation of the carbon stocks as:

Equation 2: Carbon stock

$$CS_i = (SOC + C_{VEG}) x A$$

Where:

CS_i is carbon stock of the area associated with the land use *i* (measured as mass of carbon per unit area, including both soil and vegetation)

SOC is the soil organic carbon (measured as mass of carbon per hectare)

C_{VEG} is the above and below ground vegetation carbon stock (measured as mass of carbon per hectare)

A is the factor scaling to the area concerned (measured as hectares per unit area)

A5.6 The key part of the land use change calculation is therefore an estimation of the change in carbon stocks. This is based on the difference between the carbon stock now and the carbon stock either in January 2008 or 20 years before the feedstock was obtained, whichever is later.

A5.7 Carbon stock estimates are based on:

- previous land use,
- climate and in some cases ecological zone,
- soil type,
- soil management (for both previous and new land use), and

- soil input (for both previous and new land use).

A5.8 The location and nature of the land use change must be known by the operator of a generating station reporting land use change. When the change is known, it is possible to use the look-up tables in the EC decision for the different parameters listed above to estimate the change in carbon stock.

A5.9 Climate, ecological zone and soil type can be taken from maps and data provided in the EC decision and on the EU Transparency Platform

A5.10 Soil management (whether full-till, reduced-till or no-till) and soil inputs (low, medium, high-with manure, and high–without manure) are factors that would need to be reported by the operator of a generating station reporting that land use change has taken place.

A5.11 There are two land types (settlements[92] and degraded land) for which the carbon stock has not yet been defined in the existing EC decision. In the absence of specified carbon stock for settlements, we advise that the carbon stock of the settlement should be measured. We also advise measuring that the carbon stock of any land claimed to be degraded land.

Soil organic carbon

Mineral soils

A5.12 Operators may use several methods to determine soil organic carbon, including measurements.[93] As far as the methods are not based on measurements, they should take into account climate, soil type, land cover, land management and inputs.

A5.13 As a default method, this equation can be used:

[92] Based on the 2006 IPCC Guidelines for National GHG inventories (Vol. 4), a settlement includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
[93] Soil organic carbon levels can traditionally be measured using mass loss on ignition or wet oxidation. However, newer techniques are being developed, which can either be carried out in the field or remotely (near infrared reflectance spectrometry, remote hyperspectral sensing).

Equation 3: Soil organic carbon

$$SOC = SOC_{ST} x F_{LU} x F_{MG} x F_{I}$$

Where:

SOC is soil organic carbon (measured as mass of carbon per hectare)

SOC_{ST} is the standard soil organic carbon in the 0 – 30 cm topsoil layer (measured as mass of carbon per

F_{LU} is the land use factor reflecting the difference in soil organic carbon associated with the type of land use compared to the standard soil organic carbon (no unit)

F_{MG} is the land use factor reflecting the difference in soil organic carbon associated with the principle management practice compared to the standard soil organic carbon (no unit)

F_{I} is the land use factor reflecting the difference in soil organic carbon associated with different levels of carbon input to soil compared to the standard soil organic carbon (no unit)

A5.14 SOC_{ST} can be located in Table 1 of the EC decision depending on climate region and soil type. The climate region can be determined from the climate region data layers available on the EC transparency platform.[94] The soil type can be determined by following the flow diagram on page 12 of the EC decision or following the soil type data layers also available from the transparency platform.

A5.15 F_{LU}, F_{MG} and F_{I} can be located in Tables 2 to 8 of the EC decision depending on climate region, land use, land management and input.

A5.16 If an operator of a generating station does not report a land use change but wishes the carbon intensity calculation to take into consideration an increase in soil carbon resulting from improved agricultural practices, the same calculations are performed but only F_{MG} or F_{I} will change between CS_{R} and CS_{A}.

1. Organic soils (histosols)

A5.17 There is no default method available for determining the soil organic carbon (SOC) value of organic soils. The method used by parties should, however, take into

[94] The climate region and soil type data layers are available online from http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy/

account the entire depth of the organic soil layer as well as climate, land cover and land management and input. An appropriate method could be to measure the SOC of the soil.

A5.18 Where carbon stock affected by soil drainage is concerned, losses of carbon following drainage shall be taken into account by appropriate methods, potentially based on annual losses of carbon following drainage.

Above and below ground vegetation carbon stock

A5.19 For some vegetation types, C_{VEG} can be directly read in Tables 9 to 18 of the EC decision.

A5.20 If a look-up value is not available, vegetation carbon stock should be determined using the following equation:

$CVEG = CBM + CDOM$

A5.21 This takes into account both above and below ground carbon stock in living stock (CBM) and above and below ground carbon stock in dead organic matter (CDOM). See Equations 4a-d for calculating CBM and CDOM. For CDOM the value of 0 may be used, except in the case of forest land (excluding forest plantations) with more than 30% canopy cover.

Equations 4a, b, c and d: Above and below ground carbon stock in living stock

$C_{BM} = C_{AGB} + C_{BGB}$ [a]

Where:

$C_{AGB} = B_{AGB} \times CF_B$ [b]

And:

$C_{BGB} = B_{BGB} \times CF_B$ [c]

Or

$C_{BGB} = C_{AGB} \times R$ [d]

Where:

C_{BM} is the above and below ground carbon stock in living biomass (measured as mass of carbon per hectare)

C_{AGB} is the above ground carbon stock in living biomass (measured as mass of carbon per hectare)

C_{BGB} is the below ground carbon stock in living biomass (measured as mass of carbon per hectare)

B_{AGB} is the weight of above ground living biomass (measured as mass of carbon per hectare)

B_{BGB} is the weight of below ground living biomass (measured as mass of carbon per hectare)

CF_B is the carbon fraction of dry matter in living biomass (measured as mass of carbon per hectare)

R is the ratio of below ground carbon stock in living biomass to above ground carbon stock in living biomass

A5.22 The values for Equation 4a-d are determined as follows:

- For cropland, perennial crops and forest plantations, the value of B_{AGB} shall be the average weight of the above ground living biomass during the production cycle.
- For CF_B the value of 0.47 may be used.
- For cropland, perennial crops and forest plantations, the value of B_{BGB} shall be the average weight of the above ground living biomass during the production cycle.
- R can be read in Tables 11 to 18 of the EC decision.

Equation 5a, b and c: Above and below ground carbon stock in dead organic matter

$C_{DOM} = C_{DW} + C_{LI}$ [a]

Where:

$C_{DW} = DOM_{DW} \times CF_{DW}$ [b]

And

$C_{LI} = DOM_{LI} \times CF_{LI}$ [c]

Where:

$\mathbf{C_{DOM}}$	is the above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare)
$\mathbf{C_{DW}}$	is the carbon stock in dead wood pool (measured as mass of carbon per hectare)
$\mathbf{C_{LI}}$	is the carbon stock in litter (measured as mass of carbon per hectare)
$\mathbf{DOM_{DW}}$	is the weight of dead wood pool (measured as mass of carbon per hectare)
$\mathbf{CF_{DW}}$	is the carbon fraction of dry matter in dead wood pool (measured as mass of carbon per hectare)
$\mathbf{DOM_{LI}}$	is the weight of litter (measured as mass of carbon per hectare)
$\mathbf{CF_{LI}}$	is the carbon fraction of dry matter in litter (measured as mass of carbon per hectare)

A5.23 These values for Equations 5a to c are determined as follows:

- For CF_{DW} the value of 0.5 may be used
- For CF_{LI} the value of 0.4 may be used

Appendix 6 – Example templates for mass balance chain of custody records

A6.1 This appendix provides several tables with examples of mass balance records that parties in the supply chain could use. The examples mention several steps in the supply chain. However, there may be other steps, for example for a biodiesel plant.

Table A6.1: Example of an output record from a farm supplying certified rapeseed to crusher C1

Consignment no.	Transaction date	Receiving Company	Product	Quantity (tonnes)	Country of origin	Voluntary Scheme	Land Use on 1 January 2008	Crop yield (t/ha)[95]	Nitrogen fertiliser (kg/ha) Error! Bookmark not defined.
22001	6-1-2022	C1	Rape seed	1,000	UK	LEAF	Cropland - non protected	30	180

Table A6.2: Example of an input record from a rapeseed crusher

Consignment no.	Transaction date	Receiving Company	Product	Quantity (tonnes)	Country of origin	Voluntary Scheme	Land Use on 1 January 2008	Carbon intensity (g CO2e/ MJ)
22001	16-1-2022	F1	Rapeseed	1,000	UK	LEAF	Cropland -	30

[95] Farmers/plantation owners can also report on carbon intensity but the key data are crop yield and use of nitrogen fertiliser.

							non protected	
22002	16-1-2022	F2	Rapeseed	1,000	UK	LEAF	Cropland - non protected	30

This crusher receives certified rapeseed from farms F1 and F2

Table A6.3: Example record of crusher conversion factor.

Conversion parameters	Rapeseed to rapeseed oil
Input	Rapeseed
Output	Rapeseed oil
Unit	kg rapeseed oil / kg rapeseed
Value	0.40
Valid from	1-1-2022
Valid until	1-6-2022

Table A6.4: Example of an output record from a crusher

Consignment no.	Transaction date	Receiving Company	Product	feedstock	Quantity (tonnes)	Country of origin	Voluntary Scheme	Land Use on 1 January 2008	Carbon intensity (g	Bonus degraded land	Factor soil carbon	Installation in
23001	20-1-2022	G	Rapeseed oil	Rapeseed	400	UK	LEAF	Cropland - non protected	32	N	N	Y
23002	20-1-2022	G	Rapeseed oil	Rapeseed	800	UK	LEAF	Cropland - non protected	36	N	N	Y

This crusher supplies operator of a generating station G with rapeseed oil

Table A6.5: Example of an input record from an operator of a generating station

Consignment no.	Transaction date	Supplying Company	Bioliquid type	Feedstock	Production process	Quantity (tonnes)	Country of origin	NUTS 2 compliant region	Voluntary Scheme	Land Use on 1 January 2008	Carbon intensity (g	Bonus degraded land	Factor soil carbon	Installation in operation
33001	20-1-2022	B1	HVO	CPO	Methane capture	900	Indonesia	-	RSPO	Cropland - non protected	29	N	N	Y
33002	20-1-2022	B2	HVO	CPO	-	300	Malaysia	-	RSPO	Cropland - non protected	62	N	N	Y

This operator of a generating station receives palm oil based HVO from bioliquid producers B1 and B2

Appendix 7 – Glossary

A

ASTM	American Society for Testing and Materials

B

BEIS	Department for Business, Energy and Industrial Strategy
BS	British Standard

C

CHP	Combined Heat and Power
CO_{2eq}	Carbon dioxide equivalent
CPET	Central Point of Expertise on Timber

D

DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
DME	Dimethyl ether
DNC	Declared Net Capacity

E

EC	European Commission
EN	European Norm (Standard)
ETBE	Ethyl tert-butyl ether
EU	European Union

F

FMS	Fuel Measurement and Sampling

FSC	Forest Stewardship Council
G	
GHG	Greenhouse gas
I	
ISO	International Organisation for Standardisation
L	
LUC	Land use change
K	
kg	Kilogram
M	
MBS	Mass Balance system
MJ	Megajoule
MTBE	Methyl tert-butyl ether
N	
NIAUR	Northern Ireland Authority for Regulation
NIRO	Northern Ireland Renewables Obligation
NIROC	Northern Ireland Renewables Obligation Certificate
NUTS	Nomenclature of Territorial Units for Statistics
O	
Ofgem	Office of Gas and Electricity Markets

P

PEFC	Programme for the Endorsement of Forest Certification

R

RED	Renewable Energy Directive
RFA	Renewable Fuels AgencyRHI
RHI	Renewable Heat Incentive
RO	Renewables Obligation
ROS	Renewables Obligation Scotland
ROC	Renewables Obligation Certificate
RTFO	Renewable Transport Fuels Obligation

S

SoS	Secretary of State
SROC	Scottish Renewables Obligation Certificate

T

TAEE	Tertiary amyl-ethyl ether
TIC	Total Installed Capacity

U

UK	United Kingdom
UK-TPP	UK Timber Procurement Policy

V

VS	Voluntary scheme

W

WFD	Waste Framework Directive