UK Solid and Gaseous Biomass Carbon Calculator (B2C2)

User Manual for the Solid and Gaseous Biomass Carbon Calculator v2.0

Version for Participants Reporting Under the Renewable Heat Incentive

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E4tech
Strategic thinking in sustainable energy

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DEPARTMENT OF ENERGY & CLIMATE CHANGE

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Contents

Foreword

This document is the User Manual for version 2.0 of the *UK Solid and Gaseous Biomass Carbon Calculator* (known as the 'B2C2'), tailored for operators reporting under the **Renewable Heat Incentive (RHI)**. This is an adapted version of the generic User Manual for the B2C2[1], and provides some additional guidance to the different types of users who may be required to use the tool for sustainability reporting purposes under the RHI.

This manual will be of use to users wishing to assess the carbon intensity of **heat** generated from solid & gaseous biomass, and **grid-injected biomethane**. The B2C2 can also be used by operators generating electricity but this document does not provide any specific guidance for electricity generation and focuses on the B2C2 features relevant to users operating under the Renewable Heat Incentive[2].

How to use this manual

All users are advised to read sections 1 & 2 of this manual by way of introduction to the B2C2. **Section** 1 provides an introduction to the B2C2 and the initial steps to get started. **Section** 2 provides a basic walk-through for all types of operators reporting under the RHI, explaining what they are required to report. **Sections** 3**-**6 provide more detailed guidance on operating the B2C2. **Section** 7 provides a detailed description of every entry field[3] within the B2C2 and should serve as the first port of call for any questions about using the tool. **Section 8** is a Glossary of terms referred to in this user manual and within the B2C2. Finally, **Annex 1** provides details on the greenhouse gas calculation rules underpinning the tool.

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[1] Generic User Manual available from the Ofgem website: http://bit.ly/1BZl2Bc

[2] For operators generating heat from bioliquids the *UK Carbon Calculator* is also available to download to allow for the assessment of bioliquid fuel chains (see: https://www.gov.uk/government/publications/biofuels-carbon-calculator)

[3] See Glossary for definition

1 Getting Started

To download and install[4] the B2C2 go to https://www.ofgem.gov.uk/publications-and-updates/uk-solid-and-gaseous-biomass-carbon-calculator and click the link under 'Main document'. You will then be guided through the installation process.

1.1 Introduction

The *UK Solid and Gaseous Biomass Carbon Calculator* (known as the 'B2C2'[5]) is a greenhouse gas (GHG) calculator. It is designed to help companies and individuals to calculate the carbon intensity[6] of solid or gaseous biomass 'fuel chains'[7] (e.g. wood pellets from UK forestry residues) for the purpose of reporting under the Renewables Obligation (RO) and Renewable Heat Incentive (RHI) schemes. These fuel chains are represented in the tool by chains of 'modules'[8] covering each step of the fuel supply chain and appear like this:

The B2C2 uses the principles of Life Cycle Assessment (LCA) to evaluate the GHG emissions which result from the production, transport and combustion of solid & gaseous biomass fuels. The GHG calculation methodology applied is fully aligned with the requirements of the UK's Renewable Heat Incentive (RHI) and Renewables Obligation (RO), as well as relevant communications from the European Commission[9]. By using

[4] Note that the current B2C2 application is only compatible with Microsoft Windows operating systems

[5] 'Biomass & Biogas' = 'B2'; 'Carbon Calculator' = 'C2' hence 'B2C2'

[6] See Glossary

[7] See Glossary

[8] See Glossary

[9] The tool uses the GHG calculation methodology set out in the RHI regulations (Schedule 2A) which is an adaptation of the methodology set out for biofuels and bioliquids in the Renewable Energy Directive (*Directive 2009/28/EC* – See Annex V.C). This calculation methodology aligns with that set out by the European

the B2C2 to assess their fuel chains, operators can comply with this methodology as required by the GHG reporting components of the RHI.

The B2C2 is capable of calculating the carbon intensity of the following:

1. **Heat** produced from the combustion of solid or gaseous biomass, in units of $gCO_2e/MJ(heat)$
2. **Biomethane** injected into the natural gas grid, in units of $gCO_2e/MJ(biomethane)$
3. **Electricity** produced from the combustion of solid or gaseous biomass, in units of $gCO_2e/MJ(electricity)$

In addition, the tool can be used to determine the carbon intensity of the solid and gaseous biomass **fuels** (e.g. wood chips, energy grass pellets, biogas) before combustion or injection, in units of $gCO_2e/MJ(fuel)$ or $kgCO_2e/t(fuel)$. This version of the User Manual focuses on 1 and 2 above – calculating the carbon intensity of heat and grid-injected biomethane, in particular for users reporting under the RHI.

B2C2 users may calculate the carbon intensity of their fuel chains by either:

- Using a pre-defined **'default fuel chain'**[10] or
- Building their own **bespoke fuel chain** from scratch

The B2C2 contains a series of 'default fuel chains' (or 'default chain' for short). These are pre-defined fuel chains within the B2C2 which contains indicative data for the various fuel chain parameters (e.g. harvesting diesel use, pelleting electricity use, transport distances etc.). Default fuel chains are included in the tool for the most common solid and gaseous biomass fuel chains for heat and power. The user is free to adapt the 'default values' within these default fuel chains, as well as the overall structure of the chains, to reflect their own fuel chain. Alternatively the user can build their own unique fuel chain from scratch.

The B2C2 also provides details of how the total calculated GHG emissions for a fuel chain are split between the different supply-chain steps, helping

Commission in its communication on the sustainability of solid & gaseous biomass (SEC(2010)65-66).

[10] See Glossary

to indicate where further cost-effective GHG emissions reductions might be made.

For reporting under the RHI, operators are required to assess the GHG emissions associated with each consignment[11] of fuel they are reporting. Thus if an operator is using the B2C2 to calculate GHG emissions for multiple consignments they should build a separate fuel chain for each consignment.

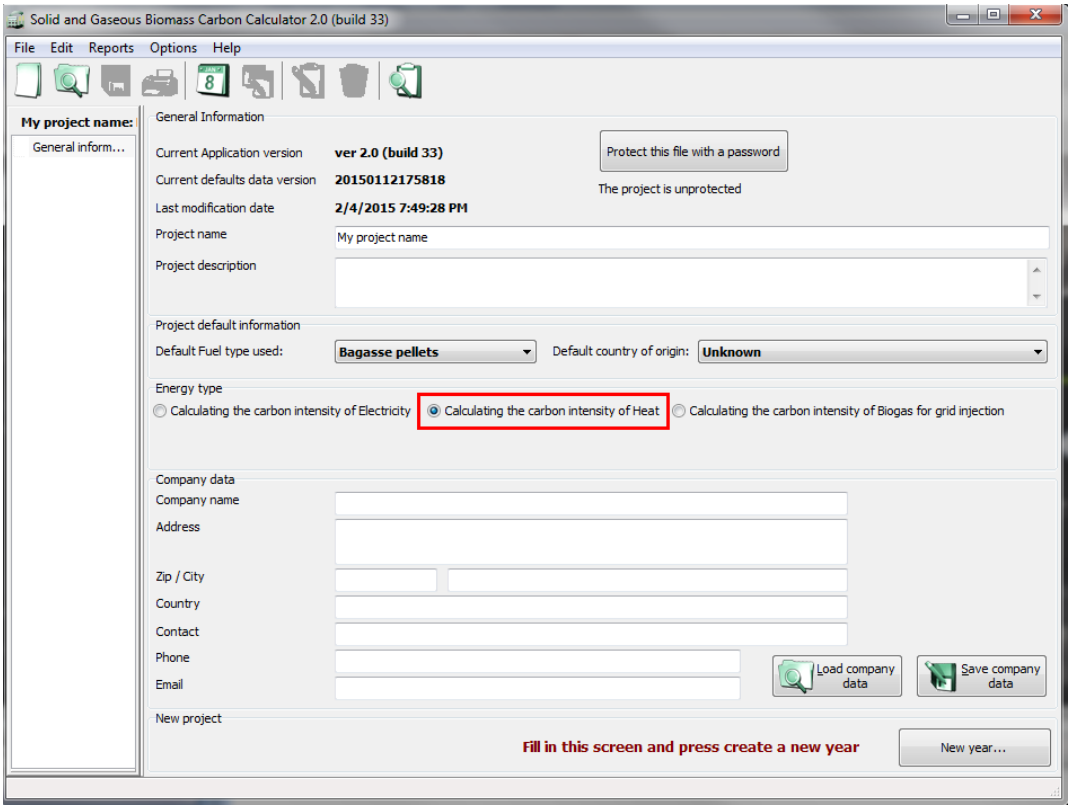
1.2 General information screen

The first screen upon opening the *UK Solid and Gaseous Biomass Carbon Calculator* is the general information screen. From this screen the user can go about setting up a **project file[12]**. Generic information about the company you are calculating the carbon intensities for can be entered here.

On this screen all users are required to select the **'energy type'**. All users operating under the RHI, except those producing biomethane for grid injection (see more detail in section 2.2.3), should select 'Calculating the carbon intensity of Heat' (see screen shot below).

[11] Whilst the RO and the RHI legislation do not define 'consignment', Ofgem have set out guidance on what constitutes a consignment. The guidance can be found here; http://bit.ly/1MAyzF9

[12] See Glossary



Most of the other fields[13] on this page are optional, but users submitting project files for reporting purposes (e.g. to the Biomass Suppliers List) are advised to fill in as much of this information as possible.

- Project name – a short description of the information can be entered for this project file.
- Project description – can include more detailed information relating to this project file (e.g. the scope of biomass types covered, whether the file is current or no longer being used etc.).
- Default fuel type used – select the type of biomass which you are likely to use most often within the B2C2 (you will still be able to assess the carbon intensity of other fuels).
- Default country of origin – select the country from which most of your biomass feedstock comes (e.g. the United Kingdom). If you receive feedstock from a wide range of countries or regions, select 'Unknown'. If the country of origin is not listed, select 'other.'

[13] See Glossary

- Company data – general contact details (you can save this data and reload it in other files by clicking the 'Save company data' button)

Users should then click 'New Year' in the bottom right corner. On the next screen users should select the year and month[14] for which the reporting applies. Click 'Create'[15].

This will bring the user to the main project screen within which it is possible to import default fuel chains or build bespoke fuel chains. Proceeding from this point will depend on what sub-category of RHI operator the user falls into. Guidance for each type of user is provided in the following section.

[14] Self-reporters should select the month in which the consignment of fuel was supplied

[15] Note: you can return to the general information screen at any time by clicking on 'General information' at the top of the left hand panel.

2 Walk-through for all types of operators reporting under the RHI

This section provides basic instructions to all types of users operating under the RHI on how they should use the B2C2. This section explains for each type of user:

- How to correctly structure your fuel chain
- How to extract the relevant information from the B2C2 for reporting

This section does not explain the details of manipulating and building fuel chains from scratch – detailed guidance on this is given in sections 3 and 4.

User Types

The first step is to establish what kind of user you are. There are two main types of operator who may wish / be required to use the B2C2 for greenhouse gas reporting under the RHI[16]:

1) Producers, producer-traders and traders applying to the Biomass Suppliers List[17] (BSL), and
2) Self-reporters

Within these user types there are various sub-categories of users. **Table 1** below identifies the different types of users and explains what each sub-category of user is required to determine from the B2C2 for reporting under the RHI.

You should determine which sub-category you fall into and read the instructions in the corresponding section that follows. You are advised to read section 1.2 initially to set up your project file.

Table 1: Overview of types of operators reporting under the RHI who may wish / be required to use the B2C2

Main types of B2C2 user	Sub-category	What needs to be determined from B2C2	Section in Manual
1. Producers, producer-traders and traders[18] applying to the BSL	A. Reporting on UK-produced fuel	gCO_2e/MJ[heat] up to the end of production of fuel, applying 70% conversion efficiency[19]	2.1.1
	B. Reporting on Non-UK-produced fuel	gCO_2e/MJ[heat] up to the point of entry of fuel into the UK, applying 70% conversion efficiency	2.1.2

[16] For information on the types of operators under the RHI and their sustainability reporting obligations see the Ofgem website: http://bit.ly/1vsOT5W

[17] The Biomass Suppliers List is a method which will be used to provide RHI participants with a simple way to demonstrate that their fuel complies with RHI standards. Not all suppliers applying to the BSL are required to use the B2C2 calculator. For detailed information regarding who is required to use the B2C2, please refer to the Biomass Suppliers List website: http://biomass-suppliers-list.service.gov.uk/

[18] This refers to traders who wish to add a producer who is not already on the BSL

[19] 'Conversion efficiency' is defined in Annex 1 point 3a)

2. Self-reporters	A. Reporting on heat where no electricity is co-produced	gCO_2e/MJ[heat] covering production, transport and combustion of fuel, applying the heat conversion efficiency of the users own installation	2.2.1
	B. Reporting on heat where electricity is also co-produced[20]	gCO_2e/MJ[heat] covering production, transport and combustion of fuel, applying Combined Heat and Power (CHP) calculation rules (explained in Annex 1) using the electrical and heat conversion efficiencies of the users own installation	2.2.2
	C. Reporting on biomethane injected into the grid	gCO_2e/MJ[biomethane] covering production and injection of fuel	2.2.3

2.1 Instructions for suppliers applying to the Biomass Suppliers List (BSL)

This sub-section addresses suppliers who are applying to the BSL through the BSL portal[21] but still need to use the B2C2 to complete the application, i.e. user categories 1A and 1B in Table 1.

The following instructions apply to producers, producer-traders and traders alike. For traders and producer-traders, the GHG emissions associated with transport of the fuel to the end-user will be reported within the BSL portal itself after the GHG emissions associated with fuel production have been extracted from the B2C2. GHG emissions associated with transport to customer are not relevant as these are reported by the trader not the producer.

Some additional instructions which may be relevant to those applying to the BSL are provided in the following sections of this manual:

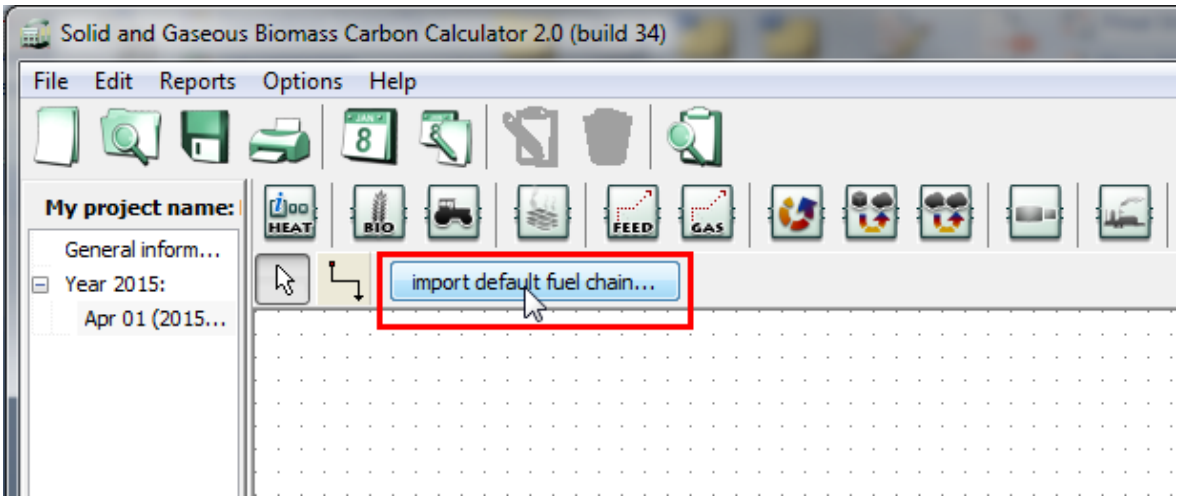
[20] This category covers generators who are using a CHP unit in the combustion of their final fuel

[21] http://bit.ly/1M3VwNY

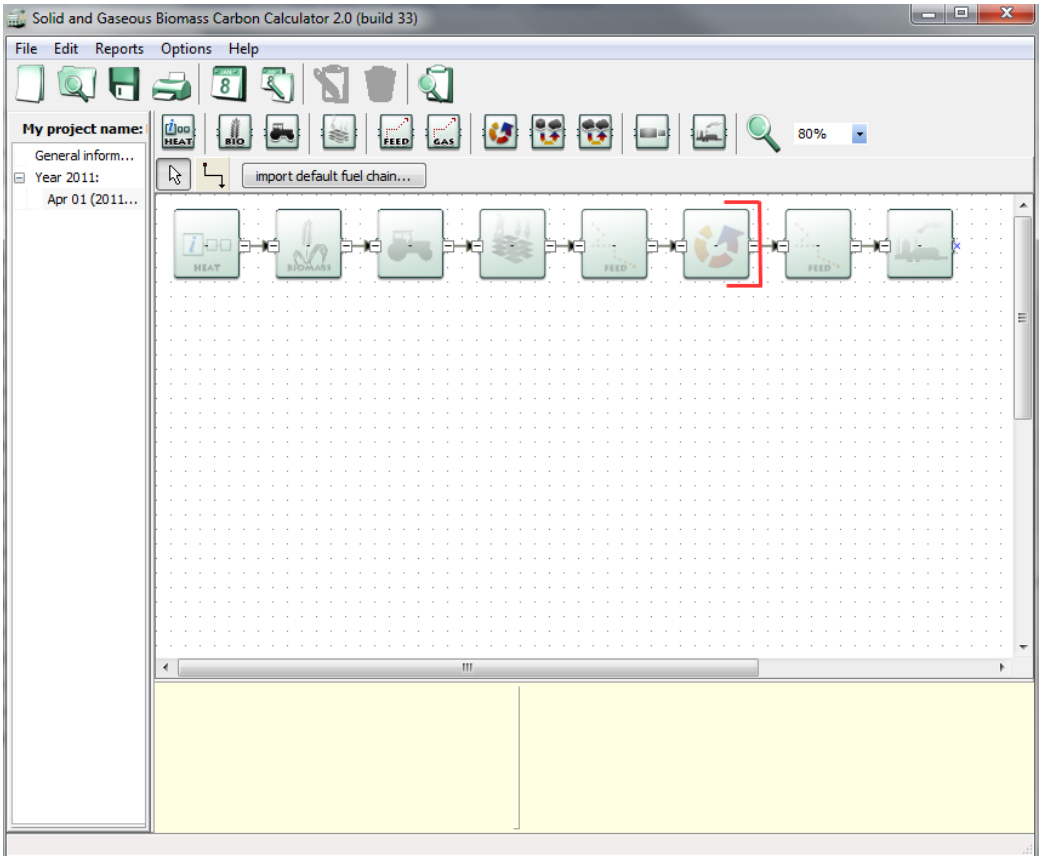
- For instructions on building a chain for 'firewood' or another biomass form not included in the B2C2 see section 3.3.1.
- For instructions on assessing a fuel which comprises multiple raw materials (e.g. wood pellets comprising sawdust and forestry residues) see section 3.4)

2.1.1 1A – Producers, producer-traders and traders reporting on UK-produced fuel

1) On the 'General information' screen select 'Calculating the carbon intensity of Heat' (as described in section 1.2) and click 'New Year'. Select the reporting year and month and click 'Create.' You will be directed to the main project screen.



2) Click 'Import default fuel chain' (see above). From the pop-up window choose the biomass form, feedstock type, process type and country/region of origin of the feedstock that corresponds closest to your fuel chain. Click 'Load' to import the relevant default fuel chain which will appear as in the image below (this example is the default fuel chain for UK wood chips from short rotation forestry with natural drying). If you wish to edit the default values in an imported fuel chain with your own data see section 3.1 for instructions on this. Alternatively, users can build their own fuel chain from scratch (see section 3.3 for instructions) rather than import a default fuel chain. In this case, the fuel chain should still be structured as described in steps 3-4 below.



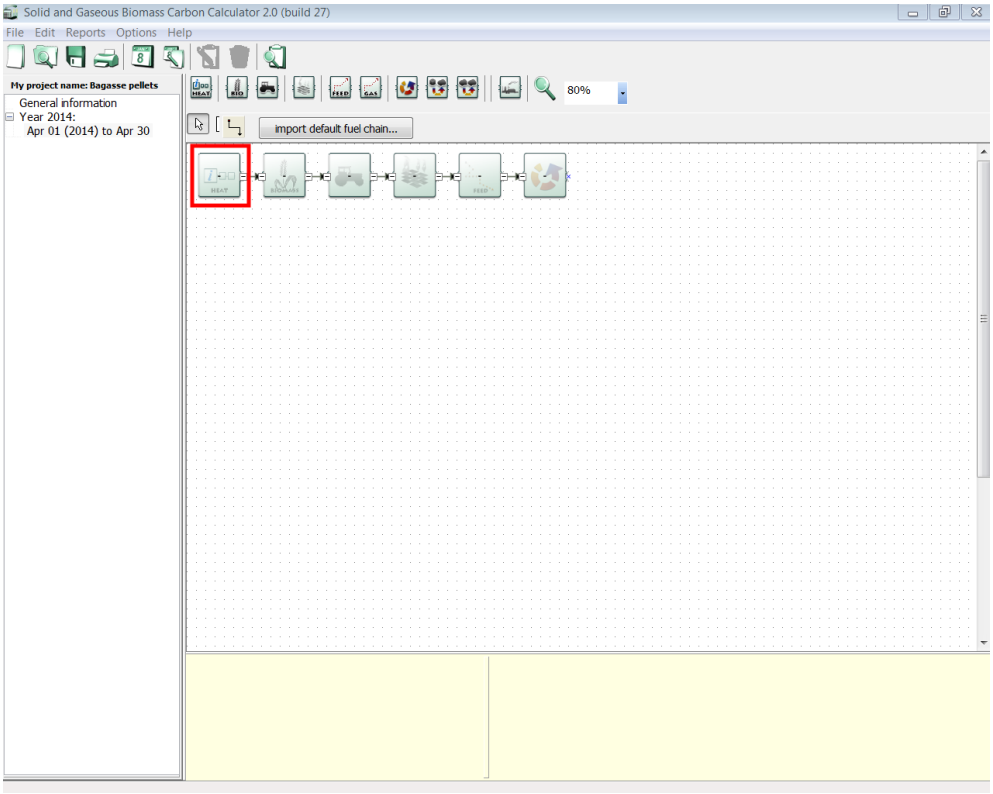
3) For entering data in the BSL, you are only required to report up to a certain point in the fuel chain. The default fuel chains thus need to be shortened (i.e. one or more modules need to be removed from the end of the chain). After loading the relevant default fuel chain, select and delete[22] all modules after the 'Biomass conversion' module[23] (see red bracket in above image), which represents the point of fuel production. This is the extent to which you are required by the BSL to report the GHG emissions associated with the fuel. The 'biomass conversion' module (see below) should always be the last module in your fuel chain.

4) After having deleted the necessary modules, and ensured the 'biomass conversion' module is the last in the fuel chain, double

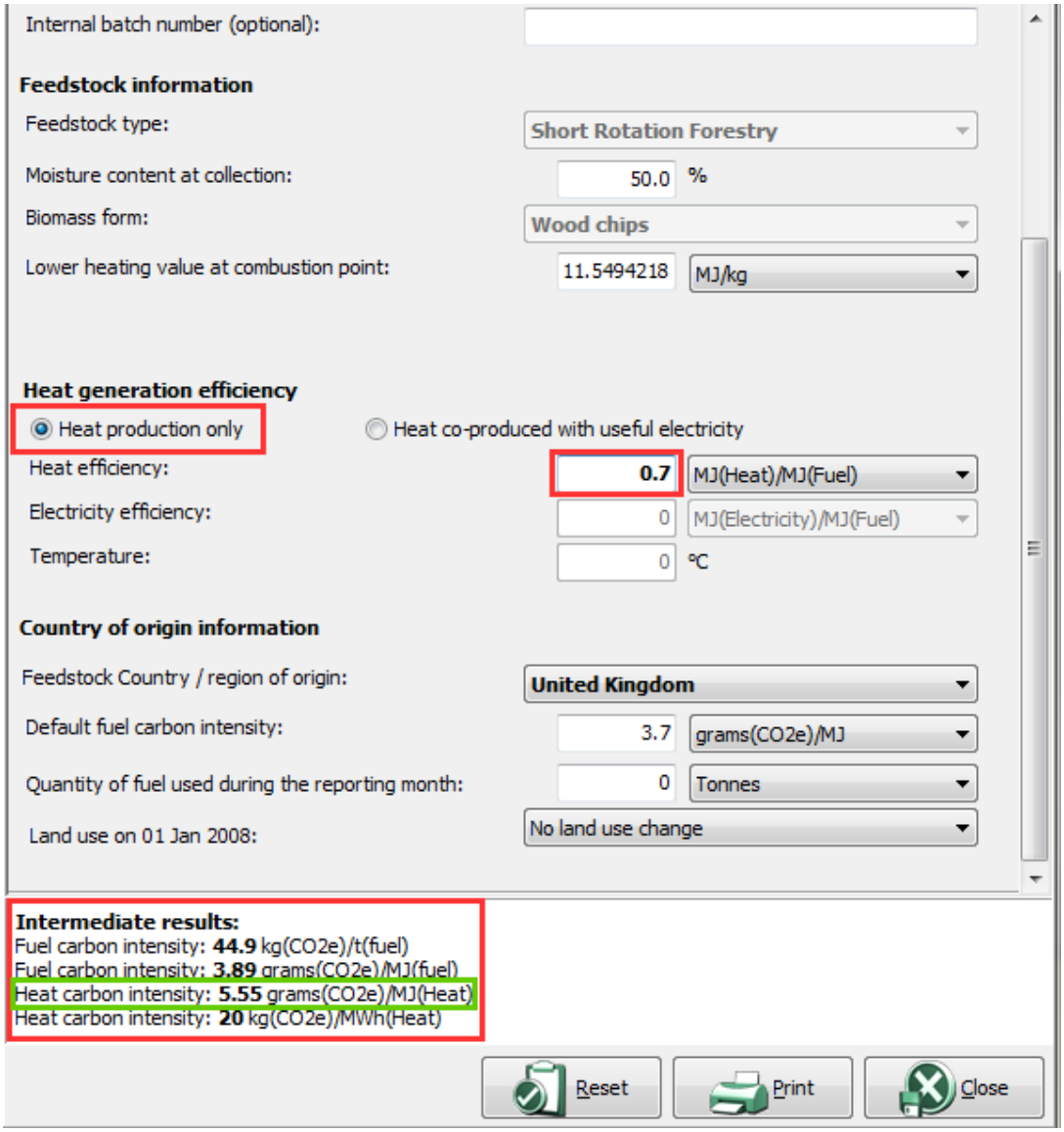
[22] Modules can be deleted by selecting the module and pressing the Delete key

[23] Each type of module is described in section 7

click on the ‘Fuel Chain Heat’ module (the first module in the fuel chain, indicated below).



You will then be taken to the following screen:



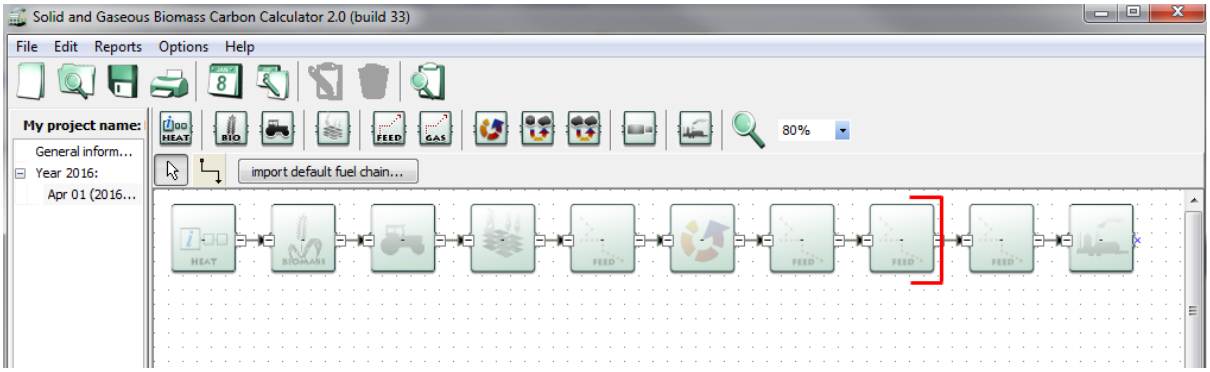
5) Inside the 'Fuel Chain Heat' summary module, you must ensure that 'Heat production only' is selected (see above) and that you enter the required default 'Heat efficiency' figure of 70% [0.7][24]. You will now see the 'Heat carbon intensity' of your fuel chain under the 'Intermediate results' heading. The relevant value which you should enter in the BSL portal is the 'grams(CO2e)/MJ(Heat)' figure (marked with a green box above) - this represents the GHG emissions associated with your fuel chain up to the point of production with a 70% conversion efficiency applied.

[24] See Annex 1 part 3a) for an explanation of 'heat efficiency'

The above steps apply to fuel produced in the UK for producers, traders entering a producer not already on the BSL list, and producer-traders alike. The distance travelled from production site to trader and from trader to customer will subsequently be entered in the BSL portal (once the user has extracted the 'grams(CO2e)/MJ(Heat)' figure associated with production from the B2C2).

2.1.2 1B - Producers, producer-traders and traders reporting on Non-UK-produced fuel

Those reporting on non-UK based fuels should first follow Steps 1-2 of section 2.1.1, before proceeding to step 3 below.



3) For entering data in the BSL, you are only required to report up to the point of entry of the fuel into the UK[25]. The default fuel chains thus need to be shortened (i.e. one or more modules need to be removed from the end of the chain). After loading the relevant default fuel chain, select and delete[26] all modules after the **transport step following which the fuel enters the UK** (see red bracket in above image). In other words, the final module in your fuel chain should be the transport step[27] which brings the fuel into the UK. In most cases this will be a 'shipping' transport step. This module represents the nearest point of entry to the UK. This is

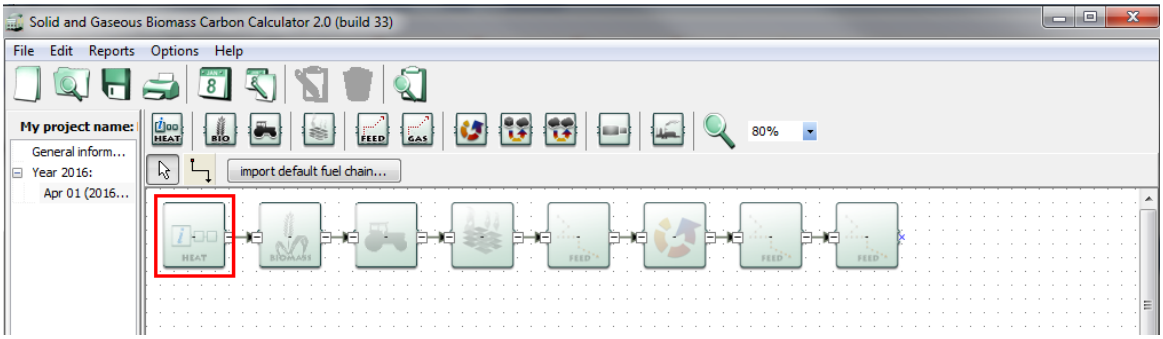
[25] Up to and including the arrival of the consignment at a UK port

[26] Modules can be deleted by selecting the module and pressing the Delete key

[27] Each type of module is described in section 7

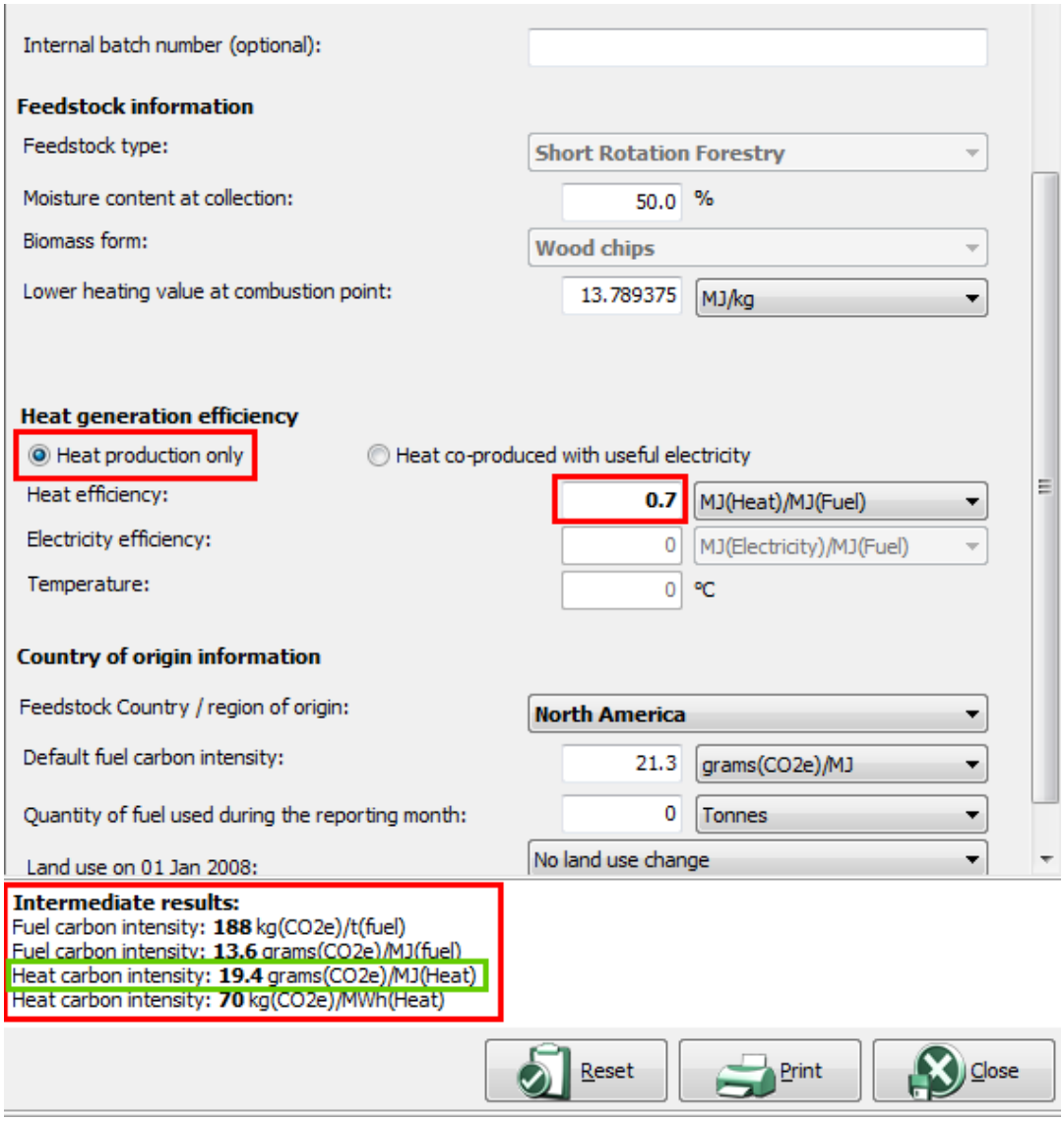
the extent to which you are required by the BSL to report the GHG emissions associated with the fuel. The 'feedstock transport'[28] module (see below) should always be the last module in your fuel chain.

4) After having deleted the necessary modules, and ensured the 'feedstock transport' module is the last in the fuel chain, double click on the 'Fuel Chain Heat' module (the first module in the fuel chain, indicated below).



You will then be taken to the following screen:

[28] Note that while this is labelled the 'feedstock transport' module, this module is also used to represent transport of fuel products (e.g. wood pellets)



5) Inside the 'Fuel Chain Heat' summary module, you must ensure that 'Heat production only' is selected (see above) and that you enter the required default 'Heat efficiency' figure of 70% [0.7][29]. You will now see the 'Heat carbon intensity' of your fuel chain under the 'Intermediate results' heading. The relevant value which you should enter in the BSL portal is the 'grams(CO2e)/MJ(Heat)' figure (marked with a green box above) - this represents the GHG emissions associated with your fuel chain **up to the point of entry to the UK** with a 70% conversion efficiency applied.

[29] See Annex 1 part 3a) for an explanation of 'heat efficiency'

2.2 Instructions for self-reporting operators

As set out in Table 1 there are three kinds of self-reporting operators under the RHI:

2A) Those producing heat directly with no co-produced electricity

2B) Those producing heat from a Combined Heat and Power (CHP) process (i.e. heat is co-produced with electricity)

2C) Those injecting biomethane into the gas grid.

Instructions for users under each subcategory are provided below.

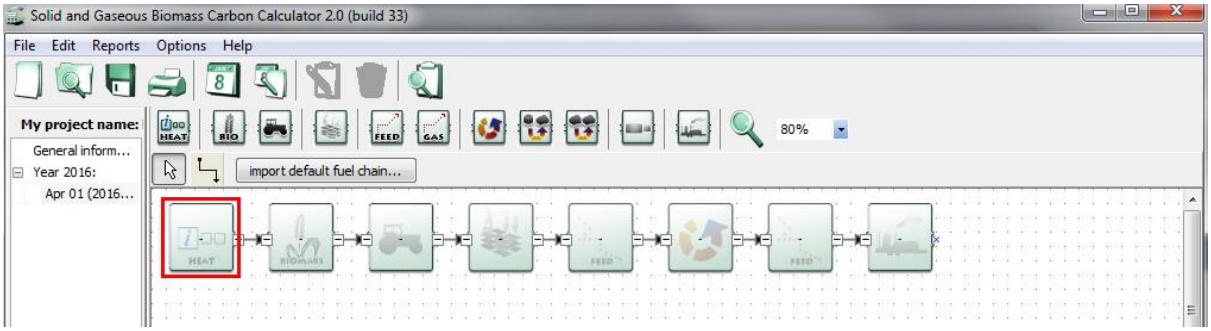
2.2.1 2A – Operators self-reporting on heat where no electricity is co-produced

Users falling under sub-category 2A should first follow Steps 1-2 of section 2.1.1, before proceeding to step 3 below.

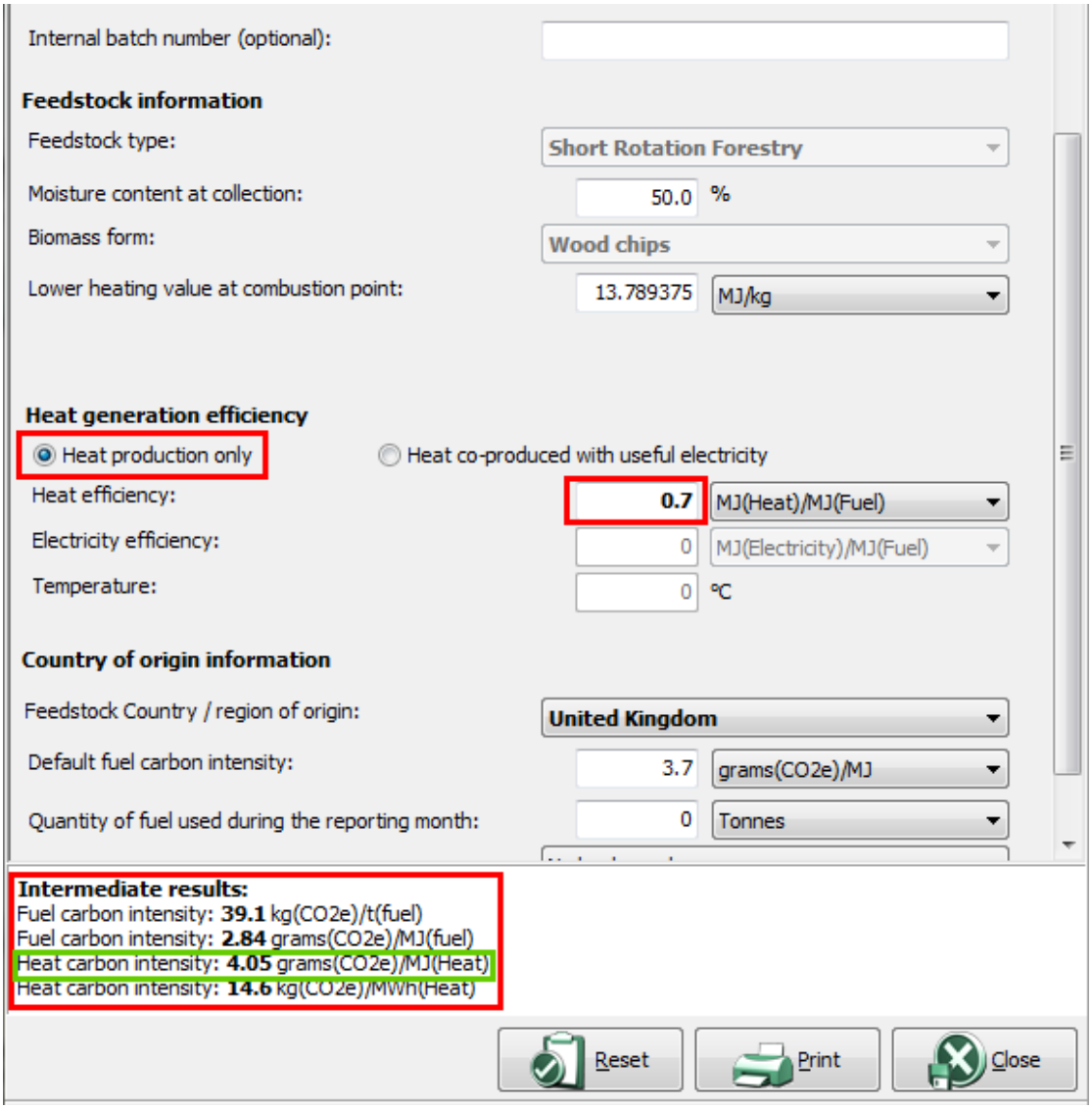
3) As a self-reporting operator, you are responsible for the GHG emissions associated with the entire fuel chain including combustion. Thus, the last module in your fuel chain should be a 'Power plant' module[30]. All imported default fuel chains will already end with a 'Power plant' module, so if you are importing a default fuel chain then the basic structure of the chain is already as required. The 'Power plant' module appears as below.

4) To extract the required GHG information from the B2C2, first double click on the 'Fuel Chain Heat' module (the first module in the fuel chain, indicated below).

[30] Each type of module is described in section 7



You will then be taken to the following screen:



5) Inside the 'Fuel Chain Heat' summary module, you must ensure that 'Heat production only' is selected (see above). In the 'Heat

efficiency' field you are required to enter the heat efficiency[31] **for your own installation**. In the above screen shot a figure of 70% [0.7] has been entered simply as an example. Having entered your own heat efficiency figure, you will now see the 'Heat carbon intensity' of your fuel chain under the 'Intermediate results' heading. The relevant value which you are required to report is the 'grams(CO2e)/MJ(Heat)' figure (marked with a green box above) - this represents the GHG emissions associated with your fuel chain covering production, transport and combustion of fuel, applying the heat conversion efficiency of your own installation.

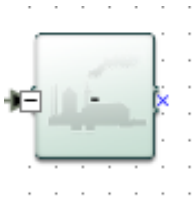
2.2.2 2B – Operators self-reporting on heat where electricity is also co-produced (CHP)

This category covers generating combined heat and power through the combustion of their final fuel. Users falling under sub-category 2B should first follow Steps 1-2 of section 2.1.1, before proceeding to step 3 below. For operators who fall into this category it is important to be conscious of the difference between co-produced electricity from the combustion of the final fuel (in the CHP plant), and co-produced electricity arising from a previous step in the supply chain. This is explained in more detail in section 4.2.

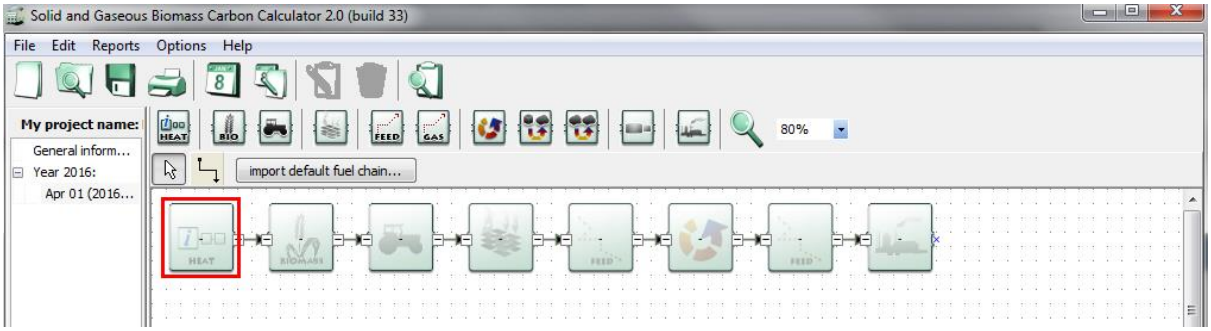
3) As a self-reporting operator, you are responsible for the GHG emissions associated with the entire fuel chain including combustion. Thus, the last module in your fuel chain should be a 'Power plant' module[32]. All imported default fuel chains will already end with a 'Power plant' module, so if you are importing a default fuel chain then the basic structure of the chain is already as required. The 'Power plant' module appears as below.

[31] See Annex 1 part 3a) for an explanation of 'heat efficiency'

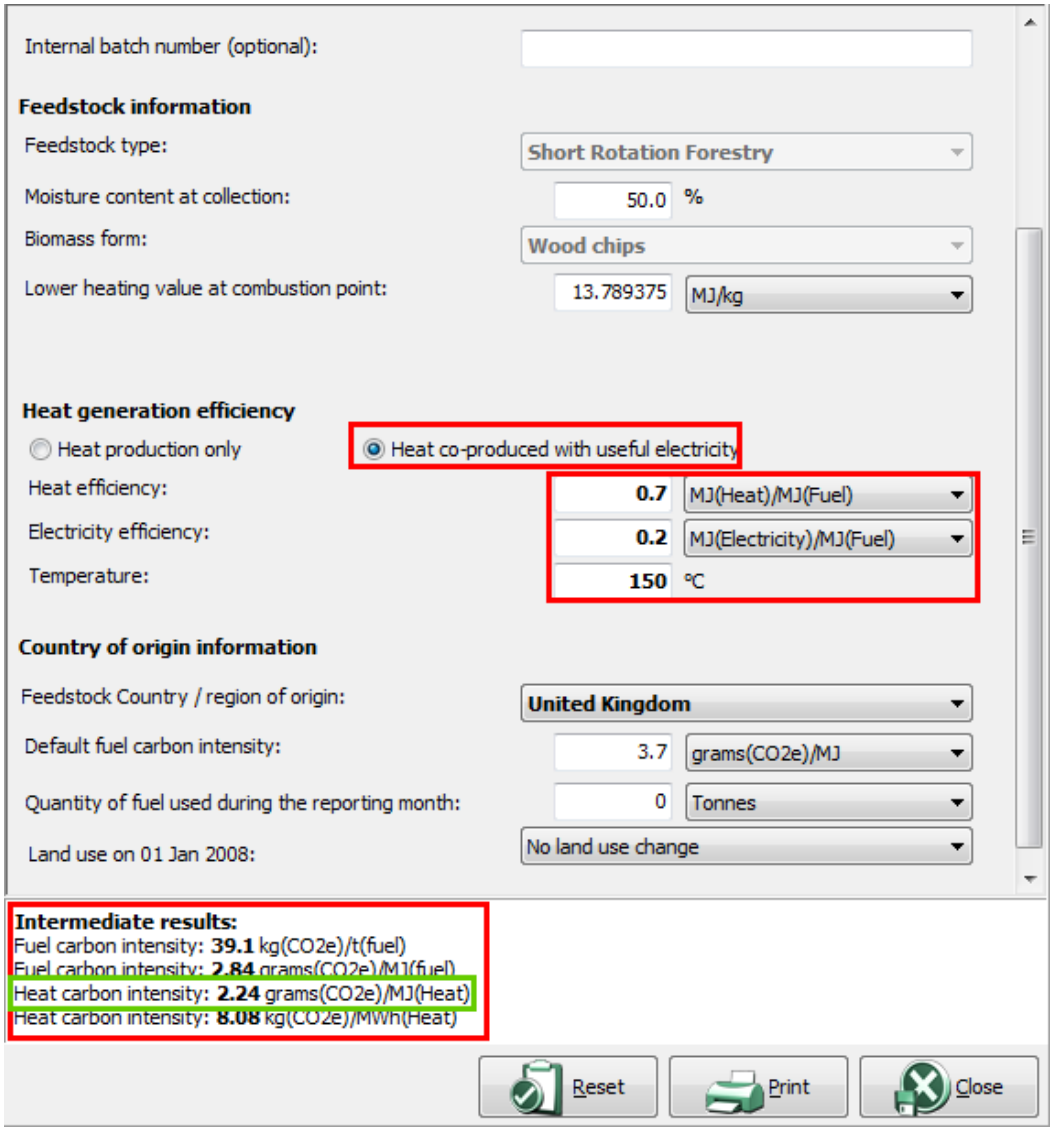
[32] Each type of module is described in section 7



4) To extract the required data from the B2C2, first double click on the 'Fuel Chain Heat' module (the first module in the fuel chain, indicated below).



You will then be taken to the following screen:



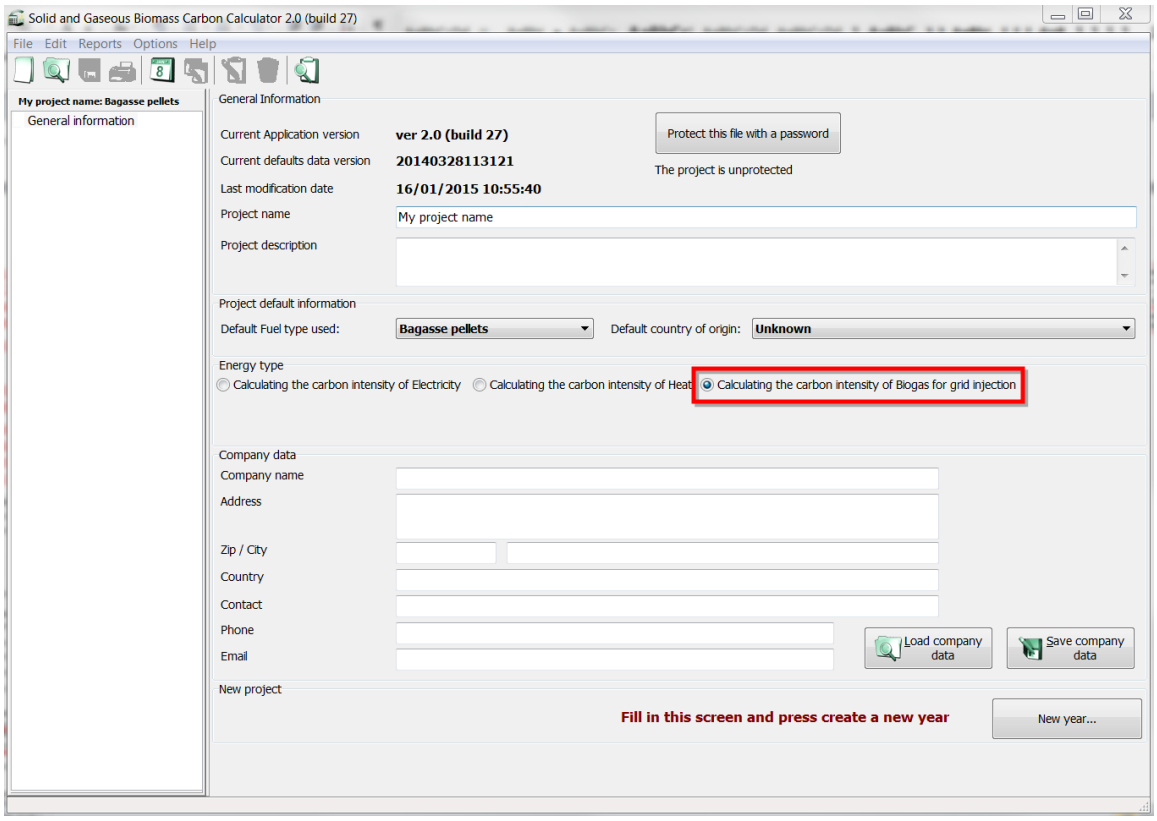
5) Inside the 'Fuel Chain Heat' summary module, you must ensure that 'Heat co-produced with useful electricity' is selected (see above). In the 'Heat efficiency' field you are required to enter the heat efficiency, electricity efficiency and heat temperature[33] **for your own installation**. In the above screen shot figures of 70% [0.7], 20% [0.2] and 150°C have been entered simply as an example. Having entered your own efficiency and temperature data, you will now see the 'Heat carbon intensity' of your fuel chain under the 'Intermediate results' heading. The relevant value which you are required to report is the 'grams(CO2e)/MJ(Heat)' figure (marked

[33] These terms are explained in Annex 1

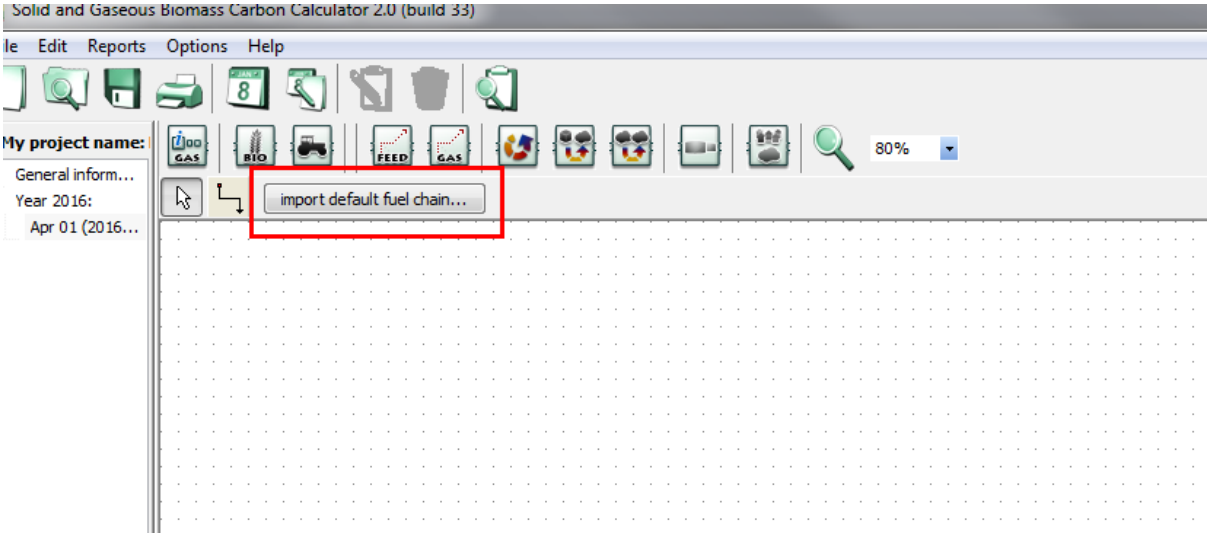
with a green box above) - this represents the GHG emissions associated with the production, transport and combustion of the fuel, applying the CHP calculation rules using the electrical and heat conversion efficiencies of your own installation. The details of the CHP calculation rules applied in the tool are explained in Annex 1.

2.2.3 2C – Self-reporters reporting on biomethane injected into the grid

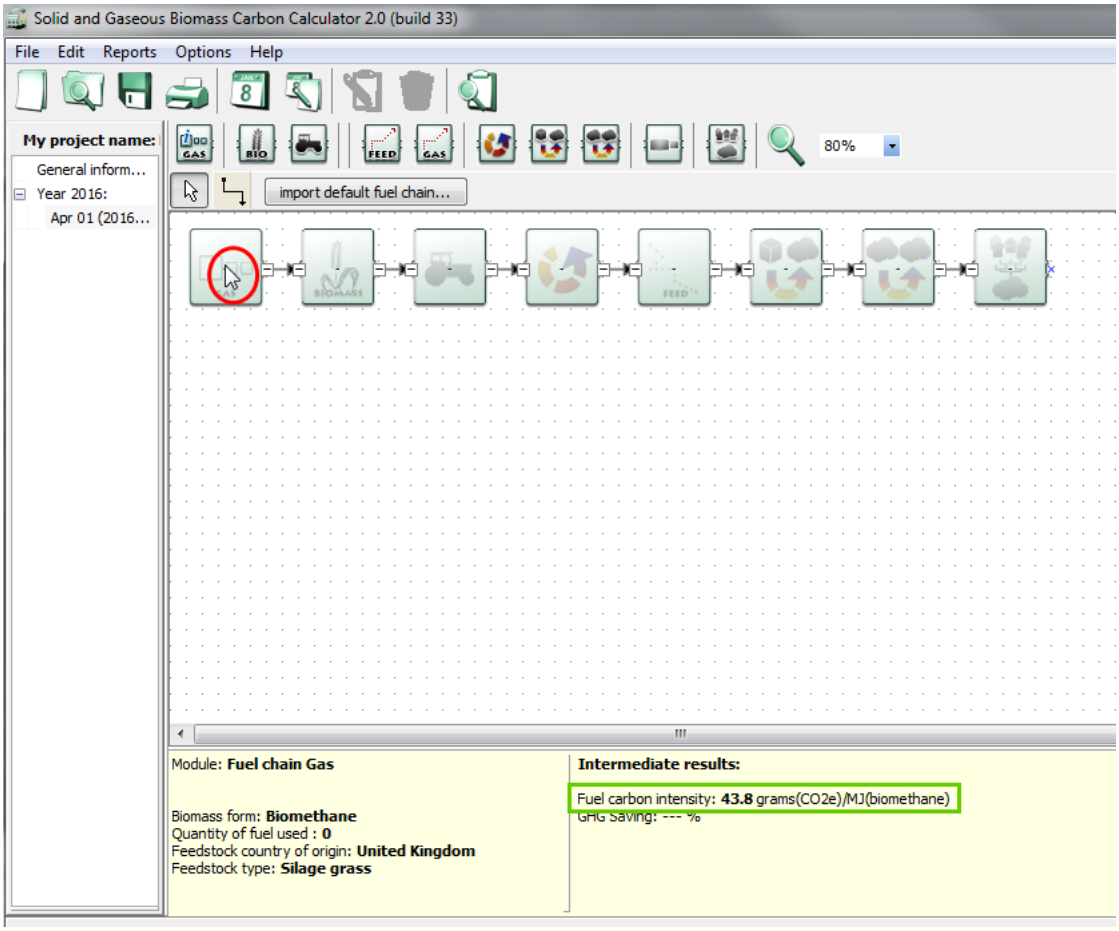
Users falling under sub-category 2C should follow these steps:



1) On the 'General information' screen select 'Calculating the carbon intensity of Biogas for grid injection' (see screen shot above) and click 'New Year'. Select the reporting year and month and click 'Create.' You will be directed to the main project screen.



2) Click 'Import default fuel chain' (see above). From the pop-up window choose the biomass form, feedstock type, process type and country/region of origin of the feedstock that corresponds to your fuel chain. Click 'Load' to import the relevant default fuel chain which will appear as in the image below (the example below is the default fuel chain for UK biomethane from silage grass via anaerobic digesation). Users can edit one of these existing default fuel chains to reflect their own fuel chain. Alternatively, users can build their own fuel chain from scratch (see section 3.3 for instructions). In both cases the instructions in step 3 below will still apply.

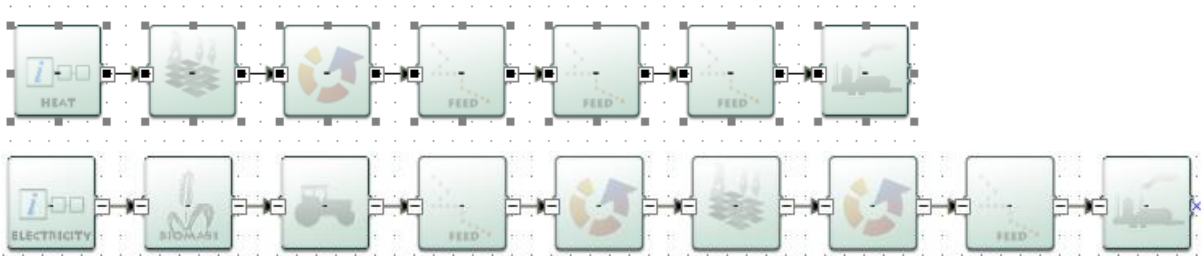


3) To extract the required data from the B2C2, hover the mouse cursor over the first module of the fuel chain (the 'Fuel Chain Gas' module[34]). The fuel carbon intensity associated with the injected biomethane will display at the bottom of the screen under 'Intermediate results.' This will appear in units of 'grams(CO_2e)/MJ(biomethane)'. This represents the emissions associated with the production and injection of the biomethane into the gas grid.

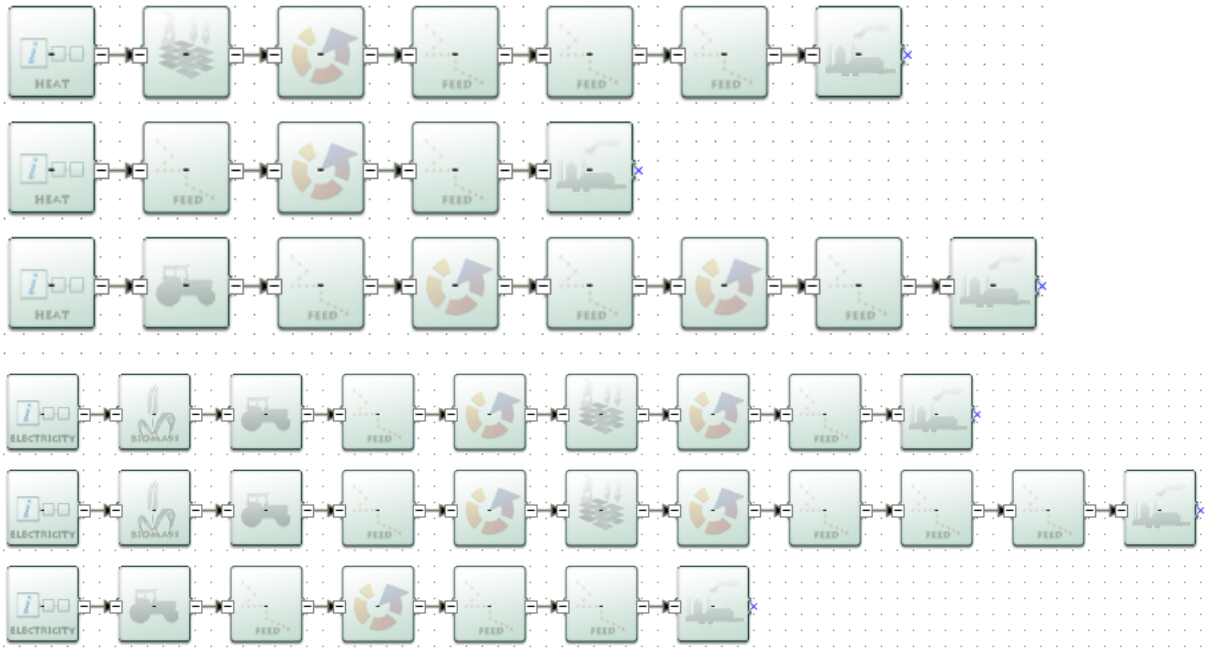
[34] Each type of module is described in section 7

3 Adding a new fuel chain

The information required to calculate the carbon intensity of a new type of biomass is entered using a graphical representation of a biomass supply chain.



These graphical fuel chains are made up of a set of pre-defined modules which contain all of the data needed to assess the GHG emissions from this step of the chain. When the tool is used for reporting purposes, a chain must be added for every consignment of biomass reported to Ofgem[35].



These chains can be expanded and/or reduced by clicking on the '+' / '-' sign as detailed below.

[35] For those reporting on a fuel comprising multiple types of raw materials (e.g. wood pellets consisting of a mixture of sawdust and forestry residues) a separate fuel chain must be made for each different 'consignment' (i.e. each different feedstock requires its own fuel chain). For reporting the GHG emissions of the final fuel product (e.g. the pellets) to the BSL a weighted average of the GHG emissions

On the right side of a module in the B2C2, you can see a small square containing either the sign '-' or '+', as is shown on the picture below.

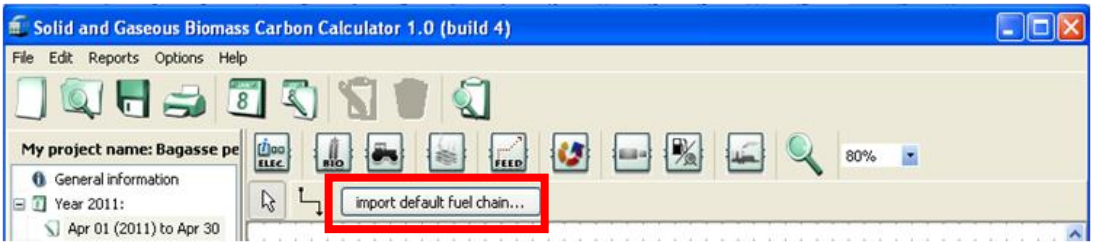
The '-' sign means that the chain is expanded – i.e. you can see all the modules contained in the chain after the specific module.

The '+' sign means that the chain is reduced – i.e. you cannot see any modules after the specific module. However these modules have not been deleted – they will reappear if you click on the '+' – they have been condensed into one single module.

3.1 Loading a default fuel chain and adding actual data

Pre-define default fuel chains[36] exist within the tool for the most common solid & gaseous biomass fuel chains[37]. Most users will begin by uploading one of these pre-defined default fuel chains. To import such a chain, follow the steps below.

Step 1 Click the 'import default fuel chain' button on the toolbar



Step 2 Select the form of biomass which will ultimately be produced (e.g., charcoal, wood pellets, straw bales, etc)[38], the type of feedstock from which that biomass form has been produced, (e.g., forestry residues, wheat, sugar cane, etc.), the type of process (e.g., natural drying, bulk drying, continuous drying) and the country/region of origin. Then click 'Load'.

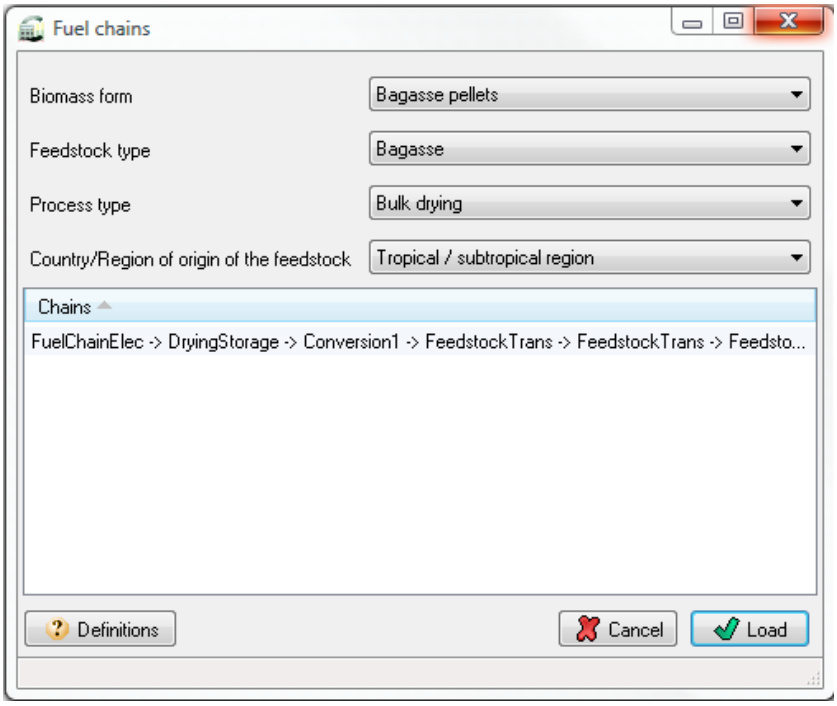
---

[36] See Glossary

[37] Default fuel chains do not exist for all possible biomass forms. For information on defining your own biomass form see section 3.3.1.

[38] If you are calculating the carbon intensity of biomethane for injection to the national grid, you will only have one choice of feedstock form, i.e. biomethane.

- If you cannot select the combination of fuel type, feedstock, and drying process that you require, it is because there is no default fuel chain currently defined for this supply chain. If this is the case, it is possible to create a new fuel chain from scratch (see section 3.3).
- If the structure of the default fuel chain for the combination you have selected does not represent your chain, it is possible to load a similar fuel chain and then adapt it using the different elements at the top of the tool bar (see section 3.2).
- A list of definitions of the terms used in the fuel chains is available by clicking 'Definitions'. [39]



Step 3 Open individual modules in the fuel chain by double-clicking on the desired module. The default values within each module can be adjusted to reflect the actual data from the users own fuel chain. See Section 0 for more details on entering actual data.

3.2 Adding or removing modules from an existing fuel chain

In some situations you may wish to add or remove a module from an existing fuel chain, for example:

[39] The definitions spreadsheet also indicates whether feedstock types are considered to be wastes or residues [W/R] or co-products [C].

- A default fuel chain might only include one module for feedstock transport (e.g., by truck); however, your fuel chain might involve two transport steps: firstly a short distance by truck, then a longer distance by rail.
- A default fuel chain might include a drying step that is not required in your fuel chain, and therefore needs to be removed.

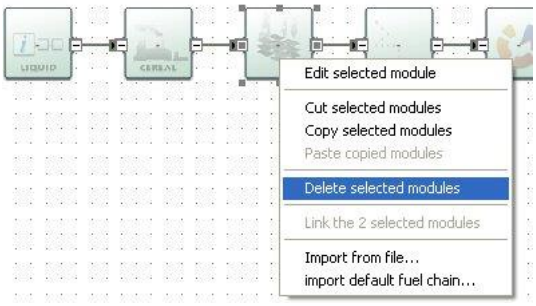
The following steps present how to add or remove a module from an existing fuel chain.

Step 1 Click the 'import default fuel chain' button on the toolbar.

Step 2 Select the form of biomass used, the feedstock from which the biomass has been produced, the type of drying process and the country/region of origin. Then click 'Load'.

If you want to delete a module:

Step 3 Select the module you want to delete by clicking on it once. Delete it either by using the 'Delete' key on your keyboard *OR* by right clicking on the module and selecting 'Delete selected modules'. Click 'yes' when asked if you really want to delete the selected elements.



Step 4 The fuel chain will now be broken – i.e. there will be two modules which are not connected by a small black arrow. You can reconnect these two modules in two ways:

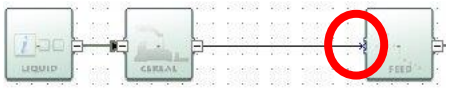
- by clicking on the small X (the 'connector') in the middle of the right hand side of the first module and, holding the mouse button down, drag the arrow to the connector on the second module to which you wish to connect.
- by selecting the two modules you wish to connect, right clicking on one of the modules and selecting the options "Link the 2 selected modules".

The connector will have an arrowhead if it is correctly formed. If no arrowhead appears, it is either because you have not dragged the line precisely to the connector on the second module, or because these two types of module are not allowed to connect (see Table in Section

3.3 for connection rules) – check that the fuel chain you are building is accurate and permitted.

Correct:

Incorrect:



Step 5 Check all downstream modules, particularly those of the same type to ensure that the default values provided are still representative of your chain. For example, transport modes and distances, countries in which conversion steps take place, etc.

If you want to add a new module:

Step 3 Create some space for the new module (e.g., by selecting and dragging to the right the modules which will be on the right of the new module).

Step 4 Delete the arrow which connects the two modules in between which you wish to insert a new module.

Step 5 On the toolbar, click once on the type of module you wish to add to the fuel chain (e.g., 'Feedstock transport') then click the main screen where you want the new module to appear.

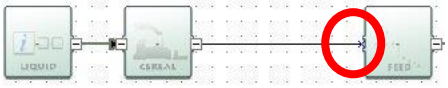
Step 6 Connect the new module to the remaining parts of the fuel chain. You can connect two modules in several ways:

- by clicking the small X (the 'connector') on the right hand side of the first module and, holding the mouse button down, dragging the arrow to the connector on the second module to which you wish to connect.
- by selecting the two modules you wish to connect, right clicking on one of the modules and selecting the options "Link the 2 selected modules".

The line will have an arrowhead if it is correctly formed. If no arrowhead appears, it is either because you have not dragged the line precisely to the connector on the second module, or because these two types of module are not allowed to connect (see Table in Section 3.3 for connection rules) – check that the fuel chain you are drawing is accurate.

Correct:

Incorrect:



Step 7 Enter the actual data you have for this module.

Step 8 Check all downstream modules, particularly those of the same type to ensure that the default values provided are still representative of your chain. For example, transport modes and distances, countries in which conversion steps take place, etc.

3.3 Constructing a completely new fuel chain

The B2C2 can be used to construct an entirely new fuel chain (e.g., for a new type of biomass such as firewood[40]), although it is almost always easier to edit an existing default fuel chain. This is because most of the data in the fuel chain would need to be provided from actual data sources, rather than default values (emissions factors for fertilisers, fuels, electricity and chemicals are some exceptions).

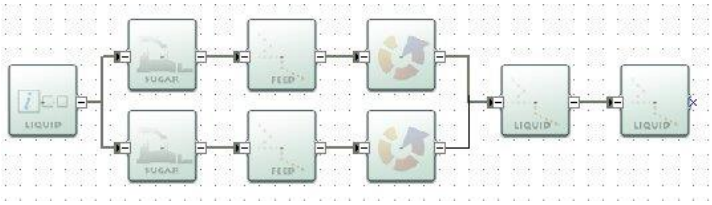
There are some rules which must be followed when adding completely new fuel chains:

- Each fuel chain must start with the 'Fuel Chain – Heat' or 'Fuel Chain – Gas' Module. For a new type of biomass not included in the B2C2, "other" should be selected for feedstock type and/or form in the fuel chain module.
- The modules must be mapped, from left to right in the same sequence as the different processing steps occur – e.g., starting with "crop production" (if applicable), followed by "harvesting, extraction and roadside processing" (if applicable), then feedstock transport, etc.
- All modules must be connected with a small black arrow. If these arrows are not present, the B2C2 will not be able to calculate the carbon intensity of the fuel chain.

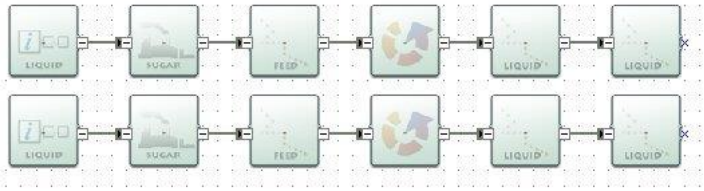
[40] See section 3.3.1

- It is not possible to have two parallel streams in a fuel chain, you could, however, represent this situation with two separate fuel chains.

Incorrect:



Correct:



- Not all modules can be connected to each other. This ensures simple errors cannot be made when building new fuel chains. The table below indicates which modules can be connected – when the module in column 1 is the first of two modules (i.e. the first in a sequence when reading from left to right) it can be connected to all of the modules listed in column 2.

First module…	…can be connected to these modules
Fuel chain – Heat	Crop production, Harvesting, Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power plant
Fuel chain – Gas	Crop production, Harvesting, Feedstock transport, Biomass processing, Biomass processing to gas
Crop production	Harvesting, Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power plant
Harvesting	Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power Plant
Drying and storage	Feedstock transport, Biomass processing, Biomass processing to gas, Power plant
Feedstock transport	Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power plant

Gas transport	Gas transport, Gas processing, Grid injection, Power plant
Biomass processing	Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power plant
Biomass processing to gas	Gas processing, Gas transport, Grid injection, Power plant
Gas processing	Gas processing, Gas transport, Grid injection, Power plant
Storage	Drying and storage, Feedstock transport, Biomass processing, Biomass processing to gas, Power plant
Grid injection	
Power Plant	

To add a new module to the screen, follow the steps below.

Step 1 On the toolbar, click once on the type of module you wish to add to the fuel chain (e.g., 'Feedstock transport').

Step 2 Click the main screen where you want the new module to appear.

To connect two modules, follow the steps below.

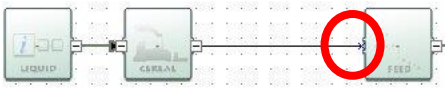
Step 1 Click the small X (the 'connector') on the right hand side of the first module and, holding the mouse button down, drag the arrow to the connector on the second module to which you wish to connect.

OR

Select the two modules you wish to connect, right click on one of the modules and select the options "Link the 2 selected modules".

Step 2 Check to see that the line you have added has an arrowhead. If no arrowhead appears it is either because you have not dragged the line precisely to the connector on the second module (try Step 1 again) or because you have tried to connect two modules which not allowed to be connected (see Table above) – check that the fuel chain you are drawing up is accurate.

Incorrect:

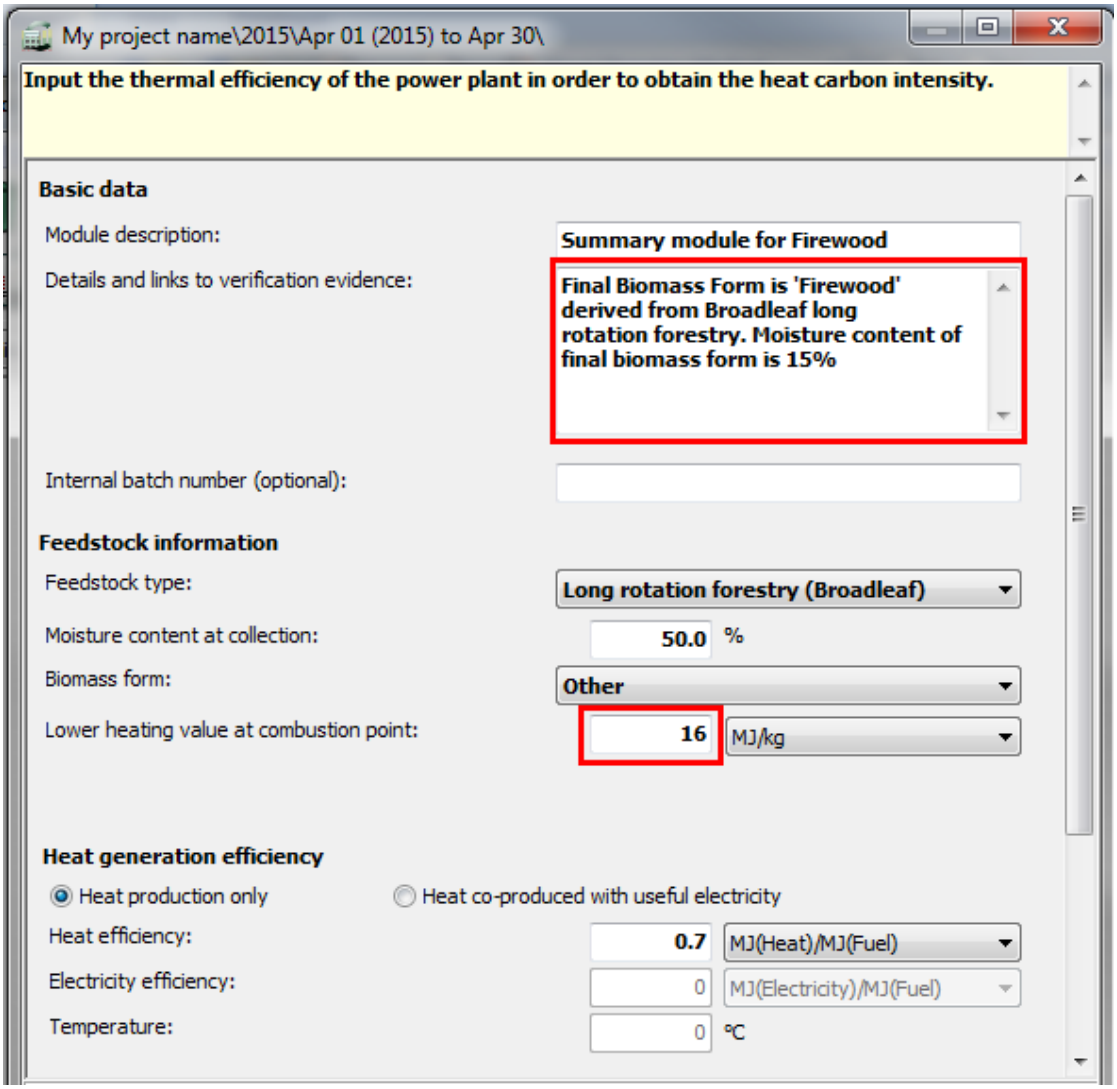


Correct:

Step 3 Once you have defined the whole fuel chain, you can begin entering actual data – see Section 0

3.3.1 Including a new biomass form

The B2C2 does not include an exhaustive set of final biomass forms / fuels – for example, 'firewood' is not included in the tool. Users can define their own biomass form when building a fuel chain from scratch. This can be done within the initial 'Fuel Chain Heat' or 'Fuel Chain Gas' module. Within this module users should select 'Other' for the field 'Biomass Form.' **Users must then define the lower heating value** of the biomass form at combustion point (for applications to the BSL this should be the LHV of the fuel delivered to the customer). If a new biomass form has been defined a description should be provided in the field 'Details and links to verification evidence' (see below).



3.4 Reporting to the BSL on fuels comprising multiple feedstocks

For those reporting to the BSL on a fuel comprising multiple types of feedstock (e.g. wood pellets consisting of a mixture of sawdust and forestry residues) a separate fuel chain must be made for each different 'consignment[41]' within the same project file (i.e. each different feedstock requires its own fuel chain). For reporting the GHG emissions of the final fuel product (e.g. the pellets) to the BSL a weighted average of the GHG emissions of each comprising

[41] See Glossary

consignment should be taken. For further information on how to do this, see the BSL website[42].

[42] http://biomass-suppliers-list.service.gov.uk/

4 Entering actual data

4.1 Entering values

Once you have loaded a fuel chain (see Section 3) you can begin entering actual data. See Section 7 for descriptions of the fields in each module.

In addition to the simple steps below, please also refer to the information given in Sections 4.2 to 4.5.

Step 1	Double click on the module in which you want to enter actual data.
Step 2	Click the field in which you want to enter actual data.
Step 3	Replace the default value with your actual data (changing the units, if appropriate, by selecting the new units from the units drop down box).
Step 4	Enter any other actual data for this module and then click 'Close' to return to the main fuel chain screen.
Step 5	Include any references to entered data in the 'Details and links to verification evidence' field[43]

Points to note about entering actual data:

- Tables of data such as the fertiliser inputs, fuel inputs, chemical inputs, etc. can be edited using the same process as outlined above. However, if you wish to add or delete a row, you will need to use the buttons which appear above the table (the green plus symbol adds a new row, and the red cross deletes the selected row).
- If a warning symbol appears after you have entered some actual data, hover the mouse over it to see the warning message. The message may say 'The input you have provided is different from the default value by more than xx%. Please check that your value is correct' (where xx is a number), which is an indication that the value you have entered is smaller or larger than what might

[43] This is particularly relevant to suppliers applying to the BSL. Including references will assist with the verification process

normally be expected. **This does not lead to any program error** – i.e. the program will still perform the usual calculations. However, you may want to double check the value entered is correct.

- The message may also say 'please also provide actual data for [name of another field]' – this is known as a compulsory linkage, see Section 4.2 for further details.
- You can reset a field to the default value by right clicking on the field and selecting 'Reset to default value'. If you want to reset a table to its original default value, use the circular arrow button above the table. Note that you can only reset the whole table, not an individual row. You can reset **all** data in a module by clicking on the 'Reset' button which appears at the bottom of each module.
- Actual data stored in a module is shown in bold text.

4.2 Co-product treatment rules

In any given module of a fuel chain one or more co-products could be produced alongside the primary output product. Rather than attribute 100% of the fuel chain GHG emissions to the primary product, a share of the emissions are allocated to these co-product(s). Furthermore, some co-products are eligible for a 'credit' which can improve the GHG balance of the fuel chain.

The approach for accounting for co-products is explained in Annex V.C (16-18) of the Renewable Energy Directive[44]. When considering co-products it is important to distinguish between **two categories** of co-product:

- Co-products from combustion of the *final* fuel (e.g. co-produced electricity in the case of useful heat produced in a CHP plant)
- Co-products from processing steps in the fuel supply chain (e.g. digestate produced in an anaerobic digester)

4.2.1 Co-products from combustion of final fuel

In the context of the RHI this refers to useful electricity which is co-produced alongside the useful heat when the final fuel product is combusted in a CHP plant. The fuel chain GHG emissions are split

[44] *Directive 2009/28/EC* – See Annex V.C. http://bit.ly/1FDzVK4

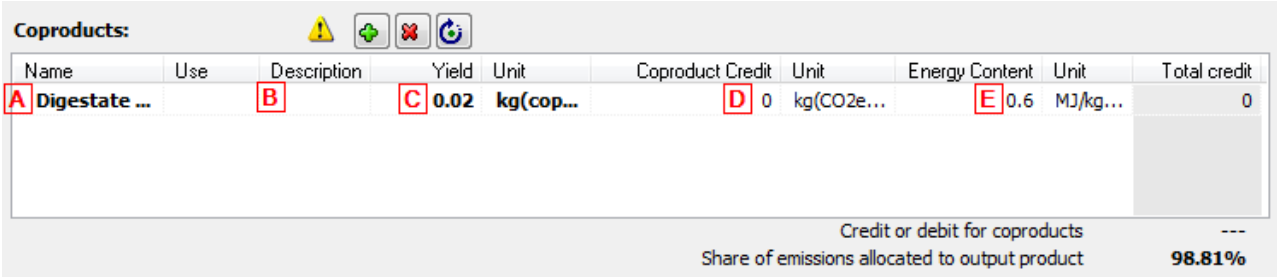
between both the heat and electricity generated. The instructions for entering the required information to calculate this split for a fuel chain are given in section 2.2.2 (see step 5). The rules around allocation of emissions are set out in Annex 1 of this manual.

4.2.2 Co-products from processing steps in the fuel supply chain

Often in fuel processing modules one or more co-products will be produced alongside the primary product. GHG emissions will be allocated between the product and various co-products. The allocation method depends on the type of co-products and is explained in detail below in section 4.2.2.3.

The B2C2 will automatically allocate emissions between products and co-products when information is entered in the 'Coproducts' field which appears in the 'biomass conversion', 'biogas production' and 'biogas upgrading' modules. This image below shows how this field will appear. For all co-products users should first select the Name of the co-product in field A. If the desired co-product is not in the drop-down menu, users should select 'Other' and enter a description of the co-product in field B. For each co-product the B2C2 needs a 'Yield' (field C) and an 'Energy Content' (field E) in order to allocate emissions appropriately. 'Energy content' refers to the lower heating value of the product and this should appear in field E when a pre-defined co-product is selected. Users can edit this field as required.

Note that LHV should be entered regardless of whether or not the co-product is an output that will ultimately be combusted (e.g. digestate). Note also that paragraph 18 of Annex V.C of the RED[45] explains that products with negative energy content (e.g. digestate at very high moisture content) shall be considered to have an energy content of zero for the purpose of the calculation.



[45] *Directive 2009/28/EC* - http://bit.ly/1FDzVK4

Note that the 'Coproduct Credit' field (field D) should be set to zero for all co-products except for excess electricity from cogeneration using certain fuels (see section 4.2.2.1). For all other co-products this field is set to zero and the 'Total Credit' field will display as zero (see above image).

4.2.2.1 Unusual case for electricity as a co-product

There is one unusual co-product in this field to be conscious of and that is 'electricity.' This refers to excess electricity produced during a processing step and exported to the grid (as opposed to electricity produced from the combustion of the final biomass fuel – see section 4.2.1). Electricity as a co-product is treated differently depending on what feedstock was used to produce it. If the feedstock used is a co-product of the fuel chain being analysed (e.g. if some portion of wood chips are being diverted from the fuel processing chain for combustion to provide electricity for processing) then the usual co-product allocation approach (as described in section 4.2.2) is used. In the case of electricity, units of energy (MJ(electricity)/kg(output)) are used rather than mass, but the same allocation principles apply as with other co-products.

Annex V.C paragraph 16 of the RED identifies a unique case in which excess electricity can be eligible for a GHG credit. Only excess electricity from a local CHP plant can be eligible for such a credit, except where the fuel used in the cogeneration unit is a co-product other than an agricultural crop residue. In other words, the excess electricity is eligible for a credit if the fuel used is a) a fossil fuel, b) a biomass fuel which is not a co-product of the fuel chain being analysed, or c) an agricultural residue which is produced in the fuel chain being analysed. To account for such electricity in the 'Coproducts' field follow these instructions:

Step 1	Identify the amount of excess electricity being co-generated per MJ (or per kg) of output, based on the amount of heat used in the module[46]. This will be in units

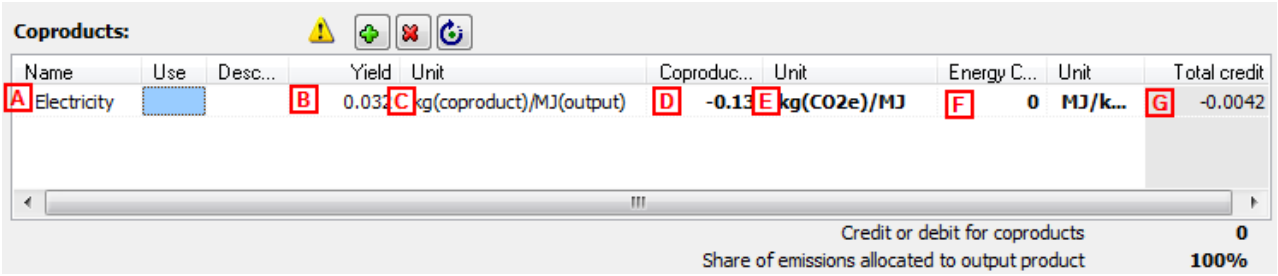
[46] In accounting for that excess electricity the size of the cogeneration unit shall be assumed to be the minimum necessary for the cogeneration unit to supply the heat that is needed to produce the fuel

of MJ(excess electricity)/MJ(output from that module) (or kg(output from that module).

Step 2 — Enter this value in the yield field (field B in image below). In field C select the units MJ(coproduct)/MJ(output) (or kg(output))

Step 3 — Determine the carbon intensity of electricity produced in a power plant burning the same fuel as the co-generation unit in units of kg(CO_2e)/MJ(electricity). Enter the carbon intensity of this electricity in field D preceded by a minus sign (e.g. if the carbon intensity of the electricity is 0.13 kg(CO_2e)/MJ(electricity) enter -0.13. In field E select the units kg(CO_2e)/MJ.

Step 4 — Set the Energy Content field (field F) to zero

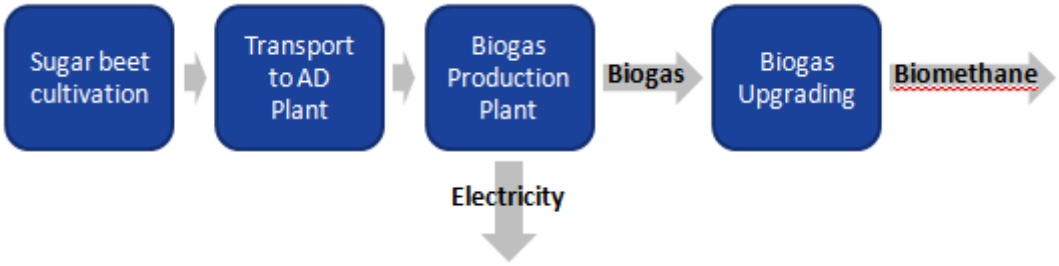


The total credit will now be displayed in field G in units of kg(CO_2e)/MJ(output) (or kg(CO_2e)/kg(output) if you have been working on a mass basis). This credit is now subtracted from the overall total for the module.

4.2.2.2 A unique case for biomethane for grid injection

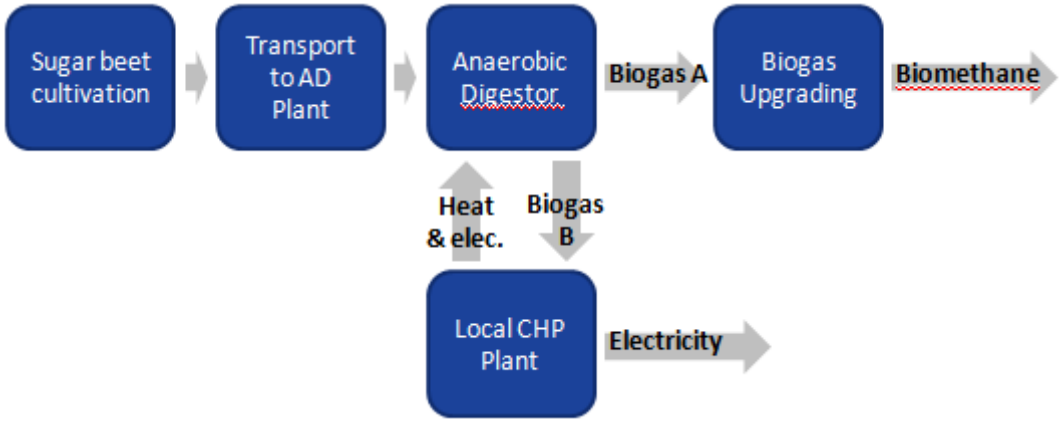
In cases where biogas is produced via Anaerobic Digestion (AD) and subsequently upgraded to biomethane, often some of the biogas is burned in a local CHP plant to produce the heat and electricity required in the AD process. Usually the CHP unit produces more electricity than needed by the system, and thus some electricity is exported back to the grid. The following paragraphs explain two different ways to calculate the carbon intensity of the final biomethane in cases where some of the biogas is used to power the production process itself.

There are two ways of visualising this process, as represented below.



This first figure shows the 'biogas production plant' as a black-box, from which exit both biogas and electricity. In this view, there is no heat co-produced (assuming all heat is utilised on site); the only co-product is electricity. Following the approach set out in section 4.2.2.3, upstream GHG emissions should then be allocated between biogas and electricity based on their energy contents.

However the process could also be visualised as follows:



In this second figure, the 'biogas production plant' is deconstructed into 2 separate components:

- one pure AD biogas production component which produces 2 streams of biogas: biogas-A which exits the anaerobic digestion module and is transferred to the next upgrading step; and biogas-B which is used in the local CHP for heat and electricity production, and
- one local CHP component which produces the heat used in the AD biogas production module and some electricity from biogas-B.

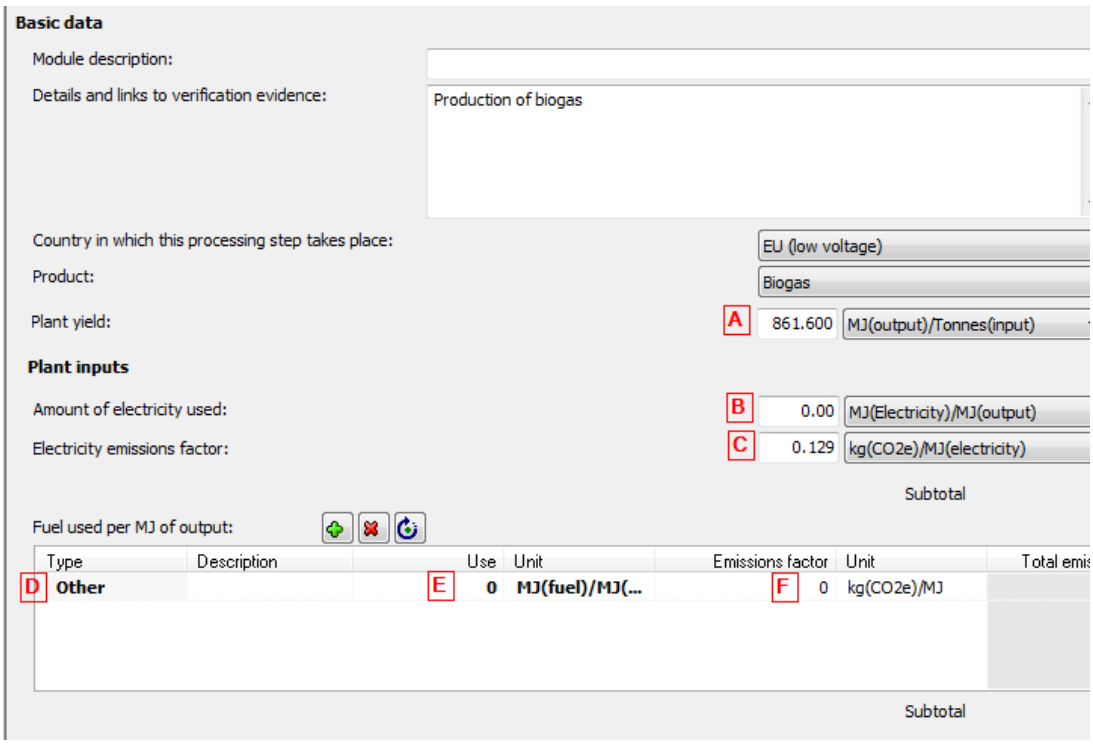
In this case, the AD unit has two outputs: biogas-A and biogas-B, and two energy inputs: heat and electricity from the biogas CHP unit. In terms of co-product treatment, upstream GHG emissions should be allocated between biogas-A and biogas-B on an energy content basis

and the heat and electricity inputs should be taken into account through the use of their emission factors.

The default values included in the UK Solid and Gaseous Biomass Carbon Calculator for such chain configurations are calculated based on the **first approach** set out above (i.e. biogas production = black box). The treatment of the co-products is thus to allocate emissions between biogas and electricity on an energy content basis as described in section 4.2.2.3. Under these assumptions the 'amount of electricity used' is zero since there is no external electricity input to the fuel chain.

However, for generators who wish to calculate their actual carbon intensity based on the **second approach**, the steps to follow have been laid out below.

Step 1	Build or load a biomethane chain.
Step 2	Open the Biogas production plant module, by double clicking on it.
Step 3	Insert the plant yield (i.e. the amount of biogas that is being transferred to the next supply chain step) in the 'Plant yield' field (field A in the screen shot below).



Step 4 Enter the amount of electricity used by the biogas production unit in the 'Amount of electricity used' field (field B in the screen shot below)

Step 5 In the 'Fuel used per MJ of output' (field C) select 'Other' and enter the amount of heat used in the biogas production unit.

Step 6 You now need to calculate the electricity and heat emission factors, i.e. the GHG emissions associated with the production of the electricity and heat used. This calculation cannot be performed in the B2C2 itself.

In an Excel spreadsheet, enter:

the default value for the biogas used to produce the electricity (in g CO2e / MJ biogas) – ***E***
the electricity efficiency of the CHP unit (in MJ electricity / MJ biogas) – η_e
the thermal efficiency of the CHP unit (in MJ heat / MJ biogas) – η_h
the temperature of the useful heat at delivery point (in Kelvin) – T_h
the temperature of the surroundings (in Kelvin) set at 273 Kelvin – T_0

Step 7 In the Excel spreadsheet, perform the following calculation to generate the emission factors in units of kg(CO2e)/MJ(electricity)

$$Electricity\ emission\ factor = \frac{E}{\eta_e} \times \frac{\eta_e}{\eta_e + \frac{T_h - T_0}{T_h} \times \eta_h}$$

$$Heat\ emission\ factor = \frac{E}{\eta_h} \times \frac{\frac{T_h - T_0}{T_h} \times \eta_h}{\eta_e + \frac{T_h - T_0}{T_h} \times \eta_h}$$

Step 8 In the B2C2, enter the electricity emission factor in the field 'Electricity emission factor' (field C) and the heat emission factor in the column 'Emissions factor' in the fuel information table (field F).

Step 9	Fill in any other field that you need to take into consideration (e.g., methane losses). If the data has been entered correctly, the 'subtotal' fields should be nonzero.

Either of these approaches is acceptable when considering the system boundaries of the fuel chain.

4.2.2.3 Co-product allocation methodology

For more information, please refer to Annex V.C (16-18) of the RED and to the RHI regulations[47].

Where a fuel production process produces, in combination, the energy carrier for which emissions are being calculated and one or more other products ("coproducts"), greenhouse gas emissions shall be divided between the energy carrier or its intermediate product and the co-products in proportion to their energy content. For the accounting of useful heat as co-product, the allocation between the useful heat and other co-products shall be made using the Carnot efficiency (C), where all other co-products than heat has a C equal to 1. The following formula applies:

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

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 or product, measured in energy content, defined as the annual amount of co-product or product produced divided by the annual energy input

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

[47] See Schedule 2A: http://www.legislation.gov.uk/uksi/2015/145/contents/made

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

C_h = Carnot efficiency (fraction of exergy 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, Ch is set to 0.3546.

4.3 Compulsory linkages

If a warning symbol appears after you have entered some actual data, which says 'please also provide actual data for [name of another field]' then you have entered some data for a field which has a 'compulsory linkage'.

Compulsory linkages are defined between two inputs which are often linked in some way – for example, a crop yield is often linked to the rate of nitrogen fertiliser application, so if a higher crop yield is reported then there is a reasonable chance more nitrogen fertiliser has been applied. To prevent 'cherry-picking' (i.e. selective use of actual data and single default values) the B2C2 warns the user when they have entered actual data for a field which has a compulsory linkage. When this occurs, make sure that actual data is also entered for the second field.

The following table summarises the current compulsory linkages.

Input one	**Input two**
Crop production	
Crop yield	Nitrogen fertiliser application rate
Nitrogen fertiliser application rate	N_2O emission rate from agricultural soils
Conversion	
Efficiency	Any co-product yield

Efficiency	Fuel or electricity use
Electricity or heat exported	Fuel use

The compulsory linkage between nitrogen fertiliser application rate and soil N_2O emissions is not signalled by a warning sign but automated in the program. For all fuel chains the N_2O emission rate was calculated using the IPCC Tier 1 methodology[48] based on the nitrogen fertiliser application rate. For all chains, when the fertiliser input table is edited in the B2C2, the N_2O emission rate is automatically recalculated based on the IPCC Tier 1 approach and the 'new' N fertiliser application rate.

4.4 Conservative factor for processing steps

In the methodology for calculating default values for fuels derived from biomass, the European Commission takes a conservative approach by multiplying the GHG emissions resulting from each processing step by a factor of 1.4[49]. This conservative approach to the processing step of default values is continued in the B2C2. This is included to encourage users to use their own actual data for processing steps where possible.

In the case of biomass to energy, the processing step refers to any chipping, pelleting or briquetting steps and any drying and storage steps that do not happen at cultivation or harvesting site (i.e. the processing modules are usually separated from the 'Crop production' and/or 'Harvesting' modules by a 'Feedstock transport' module). However, if actual data is used for the modules in the processing step, it is possible for this conservative multiplier to be removed.

The conservative factor can only be removed from the conversion modules for which actual data is provided for *all* of the following parameters:

- Plant Yield/Module Efficiency
- Electricity consumption
- Fuel consumption (if applicable)

[48] http://bitly.com/UOrnag

[49] See European Commission Communication on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01)

- Chemical inputs (if applicable)
- Co-product yield (if applicable)

The conservative factor can only be removed from the drying and storage modules that form part of the processing step and for which actual data is provided for *all* of the following parameters:

- Module efficiency
- Electricity consumption (if relevant)
- Fuel consumption (if relevant)
- Moisture content after drying

This rule applies to each conversion, drying and storage module individually in the case that there is more than one.

Follow the steps outlined below to remove the conservative factor from a conversion module.

Step 1 Double click on a 'Biomass conversion', 'Biogas production plant', 'Biogas upgrading to biomethane', 'Drying and storage', or 'Storage' module that you consider to be part of the processing step.

Step 2 Provide actual values for all the relevant input data required in the module. Refer to the list of relevant inputs described in the paragraph above.

Step 3 At the end of the module, click on 'All data reported in this module are actual data'.

The conversion factor of 1.4 will then be removed.

Please note that if the conversion factor was already showing '---' before you clicked on 'All data reported in this module are actual data', then the module you have opened is not considered part of the processing step.

4.5 Land use change emission calculations

The B2C2 implements the land use change emissions calculations as described in the RED and the European Commission Decision of June 2010 on guidelines for the calculations of land carbon stock[50]. If there has been a change of use on the land from which the biomass feedstock is sourced, the emissions associated with this land use

[50] Commission 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 (2010/335/EU)

change should be taken into consideration in the calculation of the carbon intensity of the consignment of biomass.

As a default, the B2C2 assumes that no land use change has taken place, except in the case that clear felled virgin forest is used as the feedstock[51]. However, if you are reporting a land use change, you must include the emissions due to that land use change in your carbon intensity and GHG emission saving calculations.

To determine whether there has been a change in the use of the land from which the biomass feedstock is sourced, you must determine:

- The land cover in January 2008 within the following categories: forest land, grassland, annual cropland, wetlands, settlements and perennial cropland
- The current land cover within the same categories as above

If there is a change in category, land use change emissions must be included in the carbon intensity calculations.

In the 'crop production' module of the B2C2 there are two different approaches to calculating emissions from land use change (where land use change has occurred):

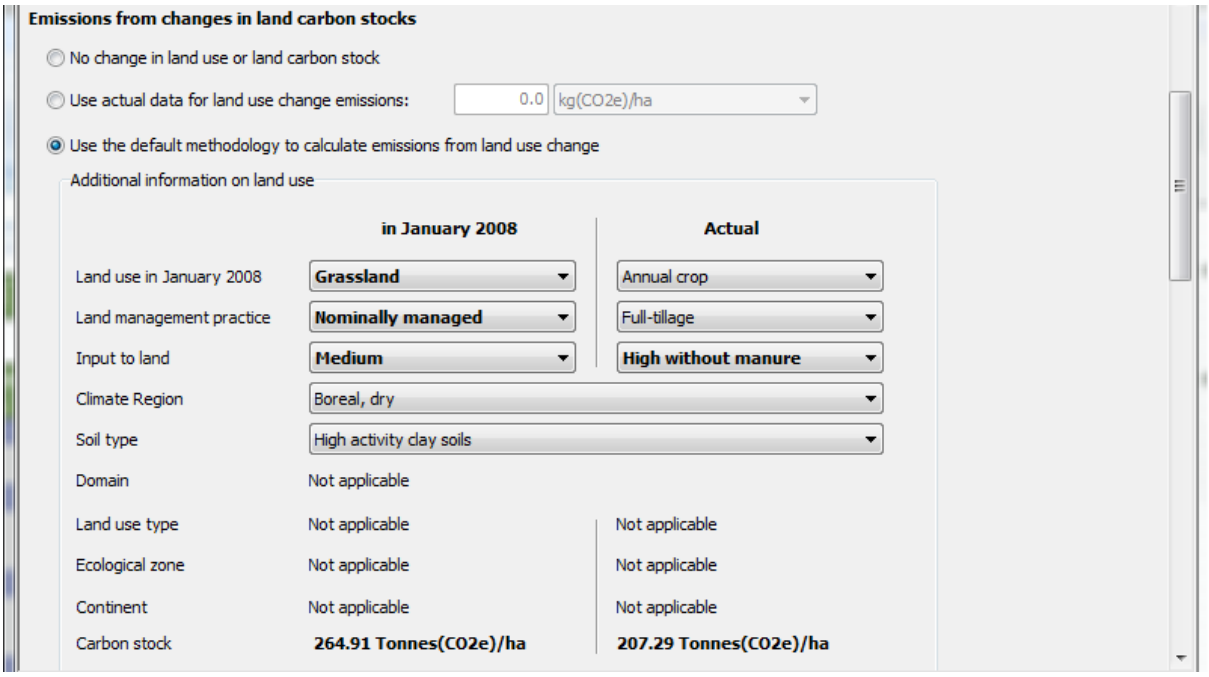
- Provide actual data for annualised land-use change emissions (in units of kgCO2e/ha.yr) by entering a value in the field 'Use actual data for land use change emissions.'
- Use the default approach set out in the European Commission Decision 2010/335/EU[52] by providing information under the heading 'Use the default methodology to calculate emissions from land use change.'

Carbon stocks are estimated as the total of soil organic carbon and above and below ground vegetation carbon stock. These are determined based on information on land management practice, inputs to land, climate region, soil type, domain, land use type, ecological zone and continent from look-up tables provided in the EC decision. Depending on the land use, not all of these information

[51] For clear felling, land use change emissions will always take place and so the default will be that the land was forested area on 1 Jan 2008.

[52] Commission Decision on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC http://bit.ly/1Ffyp0l

pieces are necessary, and B2C2 will take you through the pieces of information you need to provide depending on the previous information selected. See the screen shot below for an example. The tool will apply the approach set out in the Commission Decision and automatically calculate the land use change impact on the GHG emissions.



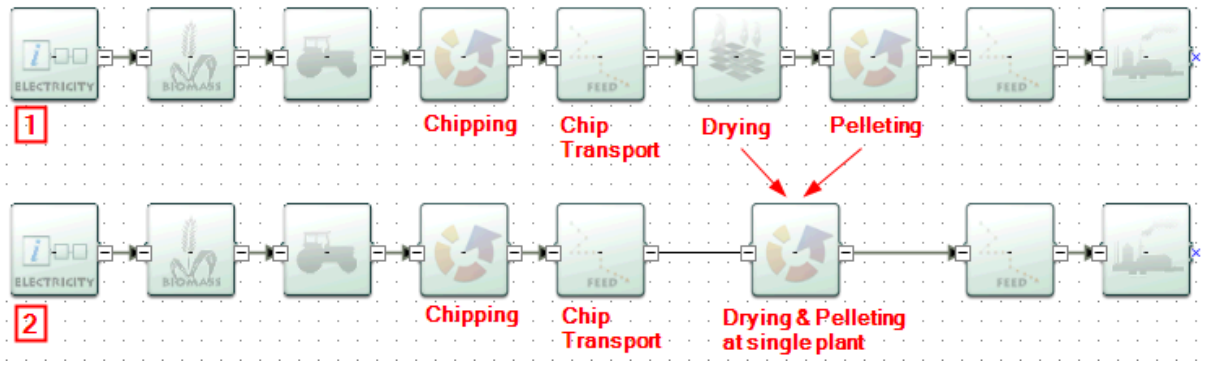
4.6 Adapting existing default fuel chains

Default fuel chains are provided for many common biomass feedstock/fuel supply routes. Each default chain is deconstructed into modules which represent the principle stages of typical supply chains (e.g. cultivation > harvesting > chipping > chip transport > drying > pellet production > etc). However, not all supply chains for the same fuel will follow the same configuration of modules, and users are encouraged to adapt the default fuel chains as appropriate to reflect their own supply chains (or alternatively, build a supply chains from scratch).

For instance, a fuel chain may be adapted by a user to reflect a supply chain in which several processing steps are combined into a single plant (e.g. chipping, drying and pelleting), and only aggregated fuel use data is available. In this case it is acceptable for users to adapt an existing default chain to include a single, aggregated 'biomass conversion' module for the plant which accounts for all inputs. An example of this is presented below.

4.6.1 Wood pellet chains

The default fuel chains for wood pellets separate the principle stages of the supply chain into disaggregated modules (see fuel chain 1 below). This means that, for example, the default value for 'amount of electricity required' in the pelleting module represents only the electricity requirements for grinding, pelleting and cooling (i.e. no drying inputs are included in this module). It is recognised that often a generator will only have access to aggregated data on energy inputs to a single processing plant, which may combine drying, pelleting and other processes. If this is the case, the user can adapt the chain as shown in fuel chain 2 below. In this way they can enter the aggregated data into the 'drying and pelleting at single plant' module. When adapting fuel chains in this way however, users must ensure that the actual moisture content of the incoming feedstock is specified in the previous 'biomass conversion' module (the 'chipping' module in this example), and all process inputs are accounted for.



5 Interpreting the results

5.1 Module results

All modules, except for the 'Fuel chain' modules, the 'Power plant' module and the 'Gas injection to the grid' module (i.e. the first and last modules in a fuel chain), show four intermediate results:

- **Total for the module** in $kgCO_2e$ / t output if the output product is solid or gCO_2e / MJ output if the output product is gaseous

  This is the total GHG emissions of the module alone, after multiplication by any allocation factor and conservative factor. Note that 'output' in this case refers to *tonnes of output of* ***the product from that particular module*** rather than *tonnes of final fuel product*. For example, for a chipping module the 'Total for this module' is in units of $kgCO_2e$ / t(wood chips).

- **Contribution of the module to the fuel chain** in $kgCO_2e$ / t fuel if the output product is solid or g CO_2e / MJ fuel if the output product is gaseous

  This is the total GHG emissions of the module as integrated into the chain. 'Fuel' in this context represents the *final* 'biomass form' that the fuel chain is built to assess. It is calculated by taking the 'total for this module' and dividing it by any subsequent module efficiency, plant yield and allocation factor.

- **Percentage contribution to chain**

  This represents the contribution of the module to the total fuel chain GHG emissions.

- **Total emissions up to the module** in $kgCO_2e$ / t output if the output product is solid or gCO_2e / MJ output if the output product is gaseous

  This is the total GHG emissions of all the modules upstream of the specific module and including the specific module. It is calculated by dividing the 'total emission up to this module' of the previous module by the module efficiency or plant yield of the module looked at, multiplying it by the allocation factor of that module is relevant, and adding the 'total for this module' of the module looked at. Note that once again 'output' in this case refers to *tonnes of output of* ***the product from that particular module*** rather than *tonnes of final fuel product*.

5.2 Fuel chain results

The 'Fuel Chain Gas', 'Fuel chain Heat' and 'Power plant' modules show the final results[53] of a fuel chain, including:

- **The fuel carbon intensity** in $kgCO_2e$ / t fuel if the fuel is solid and in g CO_2e / MJ fuel in all cases

  The fuel carbon intensity is the GHG emissions associated with the biomass fuel (before combustion).

- **The heat carbon intensity** in gCO_2e / MJ heat or $kgCO_2e$ / MWh heat.

  The heat carbon intensity is the GHG emissions associated with the heat produced from the biomass fuel.

  Please note the following:

  - No heat carbon intensity will be calculated unless the heat efficiency has been provided in the 'Fuel chain Heat' module.
  - The heat carbon intensity only considers GHG emissions associated with the production and transport of the biomass fuel. No GHG emissions are associated with the combustion of the biomass[54].

- **GHG saving**

  This field is blank for heat chains as no fossil fuel comparator figure is currently contained within the B2C2 (as there is for the electricity chains).

5.3 Generating reports

Report creation functions have also been included in the B2C2, allowing users to generate annual reports, as well as reports on individual projects. These functions are primarily for the use of operators reporting under the Renewables Obligation and can thus be ignored by most operators under the RHI. However, some users may wish to use the reporting function as a means of maintaining a record

[53] Note that while the heading in these modules reads 'Intermediate Results,' the results summarised here are in fact the final results for that fuel chain.

[54] This aligns with the approach set out in the European Commission Communication *SEC(2010)65-66*

of the fuel chains reported on. For instructions on how to use the reporting functions within the tool, please consult to full B2C2 user manual[55].

[55] https://www.ofgem.gov.uk/publications-and-updates/uk-solid-and-gaseous-biomass-carbon-calculator

6 Updates to software and default values

If opened when online, the B2C2 will check (via the internet) to see whether there are any updates of the program or of the default values available. If updates are found, you will receive a message shortly after opening the B2C2, asking you whether you would like to download the latest version of the B2C2 or default values.

You can also manually check to make sure you have the most up-to-date version and users are advised to check this regularly.

Follow the steps below to manually check for updates.

Step 1 In the 'Help' menu, select either 'Check for default value updates' or 'Check for software updates'.

Step 2 If your network uses a proxy server to access the internet, you will need to complete the proxy parameters by clicking on the 'Proxy parameters' button. You may need to check this with your system administrator. Once this has been completed, click the 'Next' button.

Step 3 If there are any updates available for the B2C2, a new screen will appear indicating which version it is, click 'Next' and follow the installation instructions.

7 Module descriptions

In this section a detailed summary of every field in every fuel chain module is presented. If a user is in doubt about what information to enter into a particular field in the B2C2, this section should be the first point of reference.

Beside each quantitative information field in the B2C2, the user can select the unit in which the data is provided. The most used units are unit of mass (tonne, kilogramme, gram), energy (megajoule) and area (hectares).

When there is uncertainty around what product the units refer to, the units are provided with the product in parenthesis. For example, agricultural yields are usually expressed in tonnes (feedstock)/ha, i.e. in tonnes of agricultural feedstock per hectare. The products most often referred to in the B2C2 are:

- Feedstock – this is the primary harvested product from which the biomass feedstock used in the power plant derives, e.g., sugar cane, forestry residues;
- Output – this stands for the product coming out of a module;
- Input – this stands for the product going into a module;
- CO_2e – this stands for the greenhouse gas emissions expressed in CO_2 equivalents.

7.1 Fuel chain – Heat

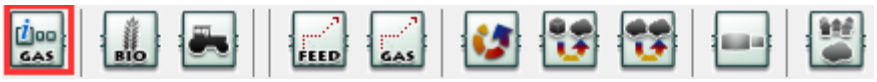
Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example links to any evidence which supports the actual data used within this module. This field is optional.
Feedstock information	
Feedstock type	The primary harvested product from which the biomass feedstock used in the power plant derives. This field is compulsory.

Moisture content at collection	The moisture content of the biomass collected. This field is automatically filled with a default value by the B2C2. Users can replace this value with actual data if appropriate. Note that if the default value in this field is changed manually in an existing default fuel chain, the energy requirements for any drying step will automatically update. This field is compulsory.
Biomass form	The format of the biomass used in the power plant. This field is compulsory.
Lower heating value at combustion point	The energy content of the biomass fuel used in the power plant. This is given in units of MJ/kg where kg is fresh kg (i.e. kg of fuel at final moisture content of fuel). The default LHVs given for wood pellets and wood chips are for wood fuel at 10% and 25% moisture content respectively. This field is automatically filled with a default value by the B2C2. Users can replace this value with actual data if appropriate. Note that if a fuel chain is producing a fuel with a moisture content different to the default moisture content for that fuel (e.g. if pellets are dried to 8% moisture content rather than the 10% default value) then the LHV should be updated to reflect this. This field is compulsory.
Process type	The process used for producing the biomass form (if applicable). This field is compulsory but 'Unknown' or 'n/a' can be selected if relevant.
Heat generation efficiency	
Heat production only	Select this option if the biomass was burned in a power plant / boiler that only exports heat. This field is compulsory.
Heat co-produced with electricity	Select this option if the biomass was burned in a power plant / boiler producing both electricity and heat. This field is compulsory.
Heat efficiency	This is the net thermal efficiency of the power plant, i.e. the heat leaving the fuel chain per unit biomass input (MJ[heat]/MJ[biomass]). Any heat generated which is used in a process step of the same fuel chain (i.e. parasitic losses) should be deducted from this figure. This should be given as a decimal. This field is compulsory.

Electricity efficiency	If the option 'Heat co-produced with electricity' is selected, it is also necessary to insert the efficiency of electricity production. In such case, this field is compulsory.
Temperature	If the option 'Heat co-produced with electricity' is selected, the temperature of the heat also needs to be provided. The temperature is used to calculate the proportion of emissions that should be allocated to the heat vs. the electricity. This field is compulsory if 'Heat co-produced with electricity' is selected.
Country of origin information	
Feedstock country / region of origin	The country or region from which the feedstock is sourced.
Default fuel carbon intensity	This is the default carbon intensity for the Feedstock type / Biomass form / Process type / Country combination. If this field shows a value of 0 g CO_2e / MJ, then it means that no default value for the selected combination exists. For the purposes of RHI reporting this field can be ignored.
Quantity of fuel used during the reporting month	In this field you can record the amount of biomass used in the power plant in a particular month or reporting period. This field is optional but you may wish to use it for your own records.
Land use on 01 Jan 2008	The land use, on 1st January 2008, for the land from which the biomass feedstock is sourced. This field is compulsory. n/a may be selected if the feedstock is an agricultural or processing residue. If there has been a change of land use between 1st January 2008, and when the biomass was harvested, it will be necessary to include in the carbon intensity calculations the emissions associated with that land use change. These calculations are performed in the 'Crop production' module.
Intermediate results	
Fuel chain carbon intensity	The carbon intensity of the consignment, measured in units of kilograms of CO_2 equivalent released per tonne of biomass fuel and as grams of CO_2 equivalent per MJ of biomass fuel or biogas used in the power plant.

Heat carbon intensity	The carbon intensity of the heat produced from the biomass fuel, measured in units of grams of CO_2 equivalent released per megajoule (unit of energy) of heat produced. Please note that the heat carbon intensity will only be calculated if you have provided the relevant information under the 'Heat generation efficiency' section.
GHG saving	No GHG saving is currently calculated for heat

7.2 Fuel chain – Gas



Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example links to any evidence which supports the actual data used within this module. This field is optional.
Feedstock information	
Feedstock type	The primary harvested product from which the biomass feedstock used in the power plant derives. This field is compulsory.
Moisture content at collection	The moisture content of the biomass collected. This field is automatically filled with a default value by the *B2C2*. Users can replace this value with actual data if appropriate. Note that if the default value in this field is changed manually in an existing default fuel chain, the energy requirements for any drying step will automatically update. This field is compulsory.
Biomass form	The format of the biomass used in the power plant. This field is compulsory.
Process type	The process used for producing the biogas. This field is compulsory but 'Unknown' or 'n/a' can be selected if relevant.
Country of origin information	
Feedstock country / region of origin	The country or region from which the feedstock is sourced. This field is compulsory.

Default fuel carbon intensity	This is the default carbon intensity for the Feedstock type / Biomass form / Process type / Country combination. If this field shows a value of 0 g CO_2e / MJ, then it means that no default value for the selected combination exists. This field is automatically filled by the *B2C2*.
Quantity of fuel used during the reporting month	In this field you can record the amount of biomass used in the power plant in a particular month or reporting period. This field is optional but you may wish to use it for your own records.
Land use on 01 Jan 2008	The land use, on 1st January 2008, for the land from which the biomass feedstock is sourced. This field is compulsory. n/a may be selected if the feedstock is an agricultural or processing residue. If there has been a change of land use between 1st January 2008, and when the biomass was harvested, it will be necessary to include in the carbon intensity calculations the emissions associated with that land use change. These calculations are performed in the 'Crop production' module. If the biomass being used is a virgin forest that is being clear-felled, there will always be a land use.
Intermediate results	
Fuel carbon intensity	The carbon intensity of the consignment, measured in units of kilograms of CO_2 equivalent released per MJ of biomethane injected to the national gas grid.
GHG saving	No GHG saving is currently calculated for biomethane as the fossil fuel comparator is not defined yet.

7.3 Crop production

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.

Crop yield	The quantity of feedstock produced per unit area. The percentage moisture of crops can vary, and this will affect the yield achieved. The yield reported here should be for the moisture content reported in the fuel chain module as the moisture content at the point of collection. This field is automatically filled by the *B2C2* but can be updated with actual data if it is available. This field is compulsory. Note that the yield values provided in default chains with a rotation >1 year are annualised. Users can enter either total or annualised yields if they wish, provided data entered under the 'farming inputs' fields (e.g. fertiliser inputs) represents total or annualised input accordingly.
Emissions from changes in land carbon stocks	
No change in land carbon stock	This option should be selected if the cultivation of biomass did not lead to any change in land carbon stocks between the actual land use and land use on January 1st, 2008.
Use actual data for land use change emissions	This option should be selected if the user wishes to report land use change emissions based on actual data or another methodology than the default calculation methodology outlined in EU Decision 2010/335/EU. The actual emissions should be put in the blank data field.
Use the default methodology to calculate emissions from land use change	This option should be selected if the user wishes to use the default methodology to calculate emissions from land use change.
Land use	Land use in January 2008 or current land use. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected, in which case it is mandatory. If clear-felled virgin forestry (lightly forested) is used as a feedstock, there will always be land use change. For "current land use" the management of the land following felling should be selected. If the land is unmanaged, "scrubland" should be selected from the drop-down list. If the land is managed as something else, e.g. a crop or a forest plantation, this should be selected from the drop-down list.
Land management practice	Land management practice in January 2008 or actual land management practice. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory.

Input to land	Input to land in January 2008 or actual input to land. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory.
Climate region	Climate type of the region where the land used to grow the biomass feedstock is located. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected, in which case it is mandatory.
Soil type	Soil type of the land use to grow the biomass feedstock. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected, in which case it is mandatory.
Domain	Climate domain of the region where the land used to grow the biomass feedstock is located. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory.
Land use type	Further information on the land use type for the land use in January 2008 or for the actual (current) land use. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory.
Ecological zone	Ecological zone where the land used to grow the biomass feedstock is located. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory.
Continent	Continent on which the land used to grow the biomass feedstock is located. This field is only available if the option 'Use the default methodology to calculate emissions from land use change' is selected and is only applicable for certain types of land use, in which case it is mandatory. If forest plantation has been selected as the land use type, there may be an option to select the continent with either <= 20 years or >20 years. In the case that the land use change is from virgin forest to forest plantation, the option <= 20 years should be selected (i.e. a plantation that has been growing for less than or equal to 20 years).

Carbon stock	Carbon stock of the land as used in January 2008 and actual (current) carbon stock. This field cannot be changed by users but is calculated based on the previous information.
Subtotal	Emissions from land use change in kilograms of CO_2 equivalent per tonne of feedstock.
Emissions from cultivation	
Rate of nitrous oxide emissions per hectare	The rate at which nitrous oxide (N_2O) emissions are produced from the soil on which the feedstock was grown. The N_2O emission rate is calculated using the IPCC Tier 1 methodology based on the nitrogen content and application rate of fertilisers entered in the 'Fertilisers' field below. Most users will not enter their own values in this field. However, if an N_2O value has been calculated according to a method consistent with the rules set out in the IPCC Guidelines for National Greenhouse Gas Inventories, then it can be entered here.
Subtotal	Emissions of nitrous oxide in kilograms of CO_2 equivalent per tonne of feedstock.
Farming inputs	
Fertilisers	All information relating to the use of fertilisers during feedstock growth can be entered in this table.
Type	The type of fertiliser used.
Application rate	The rate at which the fertiliser was applied. Note: this is measured in the industry standard kilograms of 'nutrient' per hectare. Note that this rule means that the figure entered here when digestate is applied as fertiliser should represent the amount of Nitrogen applied rather than the total mass of digestate applied. Note that the values provided in default chains with a rotation >1 year are annualised figures. Users can enter either total or annualised inputs if they wish, provided that yield data represents total or annualised input accordingly.
Emissions factor	The emissions which are produced during manufacture and transport of every kilogram of fertiliser (that is kg of nutrient, not of product). Most users will not need to manually change this field, as the B2C2 will automatically select the correct default emission factor based on the fertiliser 'Type' selected.

Nitrogen content	The nitrogen content of the fertiliser applied. Most users will not need to manually change this field, as the B2C2 will automatically select the correct value based on the fertiliser 'Type' selected. Nitrogen content is measured in units of kilograms of nitrogen per kilogram of the main nutrient. If nitrogen is the main nutrient, then the nitrogen content will be 1. If there is negligible nitrogen in the fertiliser or if nitrogen is not the main nutrient then the nitrogen content will be 0.
Subtotal	Emissions due to fertiliser production and application in kilogram of CO_2 equivalent per tonne of feedstock.
Pesticide application rate	The quantity of all pesticides applied (measured in kilograms of active ingredient, not kilograms of product) per hectare. Note that the values provided in default chains with a rotation >1 year are annualised figures. Users can enter either total or annualised inputs if they wish, provided that yield data represents total or annualised input accordingly.
Pesticide emissions factor	The emissions which occur during manufacture and transport of every kilogram of pesticide (that is kg of active ingredient, not of product). Most users are expected to rely on the default value.
Subtotal	Emissions due to pesticide production and application in kilogram of CO_2 equivalent per tonne of feedstock.
Other input	All information relating to products used during feedstock farming other than fertilisers, pesticides and fuel. Note that the values provided in default chains with a rotation >1 year are annualised figures. Users can enter either total or annualised inputs if they wish, provided that yield data represents total or annualised input accordingly.
Type	Type of other input – e.g. seeding materials.
Use	The quantity of the other input used.
Emissions factor	The emissions resulting from the production and use of each unit of other input. Most users are expected to rely on default values that will be automatically selected by the B2C2 based on the 'Type' of other input chosen.
Subtotal	Emissions due to production and input of other materials in kilograms of CO_2 equivalent per tonne of feedstock.

On-farm fuel use	All information relating to the on-farm use of fuels such as diesel, with the exception of fuel used during harvesting activities. Note: more than one type of fuel can be entered into this table Note that the values provided in default chains with a rotation >1 year are annualised figures. Users can enter either total or annualised inputs if they wish, provided that yield data represents total or annualised input accordingly.
Type	Type of fuel used – e.g., diesel for tractors, electricity to power pumps for irrigation, etc.
Use	The quantity of fuel used (Note: this is the quantity of fuel used in cultivation of this crop, not total on-farm fuel use and excluding fuel used for harvesting activities).
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Almost all users will rely on the default value selected by the B2C2.
Subtotal	Emissions due to fuel production and on-farm use in kilograms of CO_2 equivalent per tonne of feedstock.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.4 Harvesting, extraction and roadside processing

Basic data	
Module description	A brief description of the module. This field is optional.

Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Module efficiency	The efficiency with which the feedstock is harvested. Any losses should be included in this field. Note that this will typically have a value of 1 since the yield recorded in the cultivation module by the user will in most cases be equivalent to the amount of biomass harvested.
Farming inputs	
Fuel information	All information relating to the on-farm use of fuels such as diesel for harvesting, extraction and/or roadside processing activities. Note: more than one type of fuel can be entered into this table
Type	Type of fuel used – e.g., diesel for harvesters.
Use	The quantity of fuel used (Note: this is the quantity of fuel used for the harvesting of the feedstock itself).
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Almost all users will rely on the default value selected by the B2C2.
Subtotal	Emissions due to fuel production and on-farm use in kilograms of CO_2 equivalent per tonne of feedstock.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.5 Drying and storage

Basic data

Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country in which this processing step takes place	The country in which this drying and/or storage occurs. This information is needed for the B2C2 to select the appropriate emissions factor for electricity if required (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Module efficiency	The efficiency with which the feedstock is dried. Any raw material losses should be included in this field. For example if 20% of the feedstock is "lost" during the drying phase, 0.8 should be inserted into this field. Measured in units of dry tonnes(output)/dry tonnes(input)
Moisture content after drying	The moisture content of the biomass after this particular drying phase. Updating this field will cause the fields 'amount of electricity used' and 'fuel information' to automatically update to reflect the estimated energy requirements. This field is compulsory.
Amount of electricity used	The total quantity of electricity used during this drying and storage step.
Electricity emissions factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions due to electricity production and consumption in kilograms of CO_2 equivalent per tonne of feedstock.
Fuel information	
Type	Type of fuel used – e.g., diesel used in burners to provide heat for drying, etc.
Use	The quantity of fuel used during this drying and storage step.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions due to fuel production and consumption in kilograms of CO_2 equivalent per tonne of crop.
Conservative factor	

All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'Drying and storage' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.6 Feedstock transport

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country	The country in which this transport step begins. This is currently an optional field.
Transport mode	The mode of transport used – e.g., truck, rail, etc. Changing the entry in this field will automatically update the 'Type' of fuel in the 'Fuel Information' field to correspond to the transport mode.

Density of dry product	Density of the product transported at 0% moisture content. Note that this field is not compulsory and will only impact the calculation if a very low density is entered.
Energy intensity of transport	The energy intensity of this transport mode. Most users will rely on the B2C2 to select the appropriate default value on the basis of the mode of transport selected. This energy intensity depends on the transport mode and the product density (if a very low density is entered). The default values in the B2C2 factor in an empty return voyage. Note that if this field is changed manually, the B2C2 overrides the entry in the 'Density of dry product' field. Changing the density field subsequently will not affect the calculation, unless the Reset button is pressed.
Distance transported	The distance over which the product is transported by the selected mode.
Module efficiency	Efficiency of the transport step in tonnes of output feedstock per tonne of input feedstock – this is to account for any feedstock losses during transport.
Fuel information	
Type	Type of fuel used. If several fuels are entered, it will be necessary to know how much of each fuel is used (see next field). Note that if the default fuel type (i.e. Diesel) is changed
Use	The quantity of fuel used during this transport step – this value is automatically calculated based on the 'Energy Intensity of Transport' and the 'Distance transported.' If more than one fuel is used you can specify how much of each fuel type is used in this field. Note that if the 'Use' figure is changed manually, this overrides the values entered in the above fields (Transport mode, Density of dry product, Energy intensity of transport, and Distance transported) in calculating the CO_2 emissions. The entry in the 'Distance transported' field is however still used in the calculation of CH_4 and N_2O emissions. To revert back to using the calculation based on the aforementioned fields, press the Reset button.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field. Note that as with the 'Use' field, changing this figure manually will override the values entered in the field above.

Subtotal	Emissions due to fuel production and consumption in kilograms of CO_2 equivalent per tonne of output from this module (this subtotal excludes the exhaust gas emissions).
CH_4/N_2O exhaust gas emissions	This field accounts for exhaust gas emissions of other greenhouse gases. A default value is presented in this field based on the transport mode selected. This default emission value is multiplied by the distance transported in order to estimate non-CO_2 GHG emissions.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.7 Gas transport

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country	The country in which this transport step begins. This is currently an optional field.
Transport mode	The mode of transport used – e.g., pipeline etc.
Distance transported	The distance over which the product is transported by the selected mode.

Energy intensity of transport	The energy intensity of this transport mode. Most users will rely on the B2C2 to select the appropriate default value on the basis of the mode of transport selected. The default values in the B2C2 factor in an empty return voyage. Note that if this field is changed manually, the B2C2 overrides the entry in the 'Density of dry product' field. Changing the density field subsequently will not affect the calculation, unless the Reset button is pressed.
Module efficiency	Efficiency of the transport step in tonnes of output feedstock per tonne of input feedstock – this is especially to account for grain losses during transport.
Fuel information	
Type	Type of fuel used. If several fuels are entered, it will be necessary to know how much of each fuel is used (see next field). No default fuel information is included in the gas transport modules.
Use	The quantity of fuel used during this transport step. Any fuel used for gas transport should be entered here.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions due to fuel production and consumption in kilograms of CO_2 equivalent per tonne of output from this module (this subtotal excludes the exhaust gas emissions).
CH_4/N_2O exhaust gas emissions	This field accounts for exhaust gas emissions of other greenhouse gases. A default value is presented in this field based on the transport mode selected. This default emission value is multiplied by the distance transported in order to estimate non-CO_2 GHG emissions.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of grams of CO_2e) per MJ of gas produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of grams of CO_2e) produced from this stage of the fuel chain, per MJ of biogas.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.

Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of grams of CO_2e) per MJ of gas.

7.8 Biomass processing (chipping, briquetting, pelleting)

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country in which this processing step takes place	The country in which this plant is located. This information is needed by the B2C2 to select the appropriate emissions factor for electricity (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Product	Product produced by this module – e.g., wood pellets, energy grass chips, etc.
Plant yield	Quantity of output per quantity of input measured in units of dry tonnes(output)/dry tonnes(input), e.g., tonnes energy grass pellets (at 0% moisture content) per tonne energy grass chips (at 0% moisture content)
Moisture content of output product	Moisture content of the product produced by this module (measured in %).
Plant inputs	
Amount of electricity used	The total quantity of electricity used (per tonne of output) during this conversion step. For information on this field specific to wood pellet chains, please consult section 4.6.1.
Electricity emissions factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions from the production and consumption of electricity in kilograms of CO_2 equivalent per tonne of output from this module.
Fuel used per tonne of output	
Type	Type of fuel used – e.g. natural gas burnt in a boiler to provide process heat, etc.

Use	The quantity of fuel used during this conversion step, per tonne of output.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of fuel in kilograms of CO_2 equivalent per tonne of output from this module.
Chemicals	
Type	Type of chemical used – e.g., n-hexane used to produce rapeseed oil and rapeseed meal from oilseed rape, etc.
Use	The quantity of chemical used during this conversion step, per tonne of output.
Emissions factor	The emissions resulting from the production and use of each unit of chemical. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of chemicals in kilograms of CO_2 equivalent per tonne of output from this module.
Co-products	
Name	The name of the co-product produced by this conversion process.
Use	The market in which the co-product is used – e.g. for animal feed, for fertiliser etc. (optional field)
Description	If the 'Name' and/or 'Use' of a particular co-product are not specified in the B2C2, they can be recorded in the description field.
Yield	Quantity of co-product produced per tonne of output from this conversion module. Note the unusual case for electricity as a co-product which is explained in section 4.2.2.1.

Co-product credit	The credit attributed to the use of the selected co-product. This value should be negative if the impact of the credit is to reduce the overall fuel chain GHG emissions. Note: if the 'Co-product credit' is a value other than zero, then the 'Energy Content' (see below) **must** be set to zero. See the Renewable Energy Directive Annex V.C paragraph 16-18 for the rules to follow to determine whether a co-product is eligible for a credit or should be taken into account through the allocation factor. In general, only excess electricity from a local CHP plant can be eligible for a credit, except where the fuel used in the cogeneration unit is a co-product other than an agricultural crop residue.
Energy Content	The lower heating value (LHV) of this co-product. This is required in order to allocate a portion of the fuel chain GHG emissions to the co-product. Note that for co-products with a negative LHV (e.g. digestate at very high moisture content) a LHV of zero should be used. For electricity a value of 1 MJ/MJ(co-product) is used.
Credit or debit for co-products	This value shows the total impact of the co-products in units of kgCO2e/MJ(output) or kgCO2e/tonne(output). If the value is negative, then the co-products have the effect of reducing the overall carbon intensity of the fuel chain. If the value is positive, then the co-products have increased the carbon intensity of the fuel chain. In most cases relevant to the RHI this field will be zero
Share of emissions allocated to the output product	The value shows the allocation factor for the main output products. The tool calculates this by combining each co-product LHV with its yield to determine what share of emissions should be allocated co-products – the remaining share is allocated to the main output product. If the value is 100%, it means that all GHG emissions up to this point in the chain are allocated to the output of the module. If it is less than 100%, it means that only a portion of the emissions are allocated to the output.
Carbon Capture & Replacement / Storage	
Carbon Capture & Replacement / Storage	This field accounts for any avoided greenhouse gas emissions through carbon capture & replacement, or carbon capture and storage where applicable. Units are kgCO2e/tonne(output).
Conservative factor	

All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'Biomass processing' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.9 Conversion of biomass feedstock to biogas

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country in which this processing step takes place	The country in which this plant is located. This information is needed by the B2C2 to select the appropriate emissions factor for electricity (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Product	Product produced by this module – e.g., biogas or biomethane.

Plant yield	Quantity of biogas per quantity of input (measured in units of MJ output per (fresh) tonne input).
Plant inputs	
Amount of electricity used	The total quantity of electricity used (per MJ of output) during this conversion step.
Electricity emissions factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions from the production and consumption of electricity in kilograms of CO_2 equivalent per MJ of output from this module.
Fuel used per MJ of output	
Type	Type of fuel used – e.g. natural gas burnt in a boiler to provide process heat, etc.
Use	The quantity of fuel used during this conversion step, per MJ of output.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of fuel in kilograms of CO_2 equivalent per MJ of output from this module.
Chemicals	
Type	Type of chemical used – e.g., n-hexane used to produce rapeseed oil and rapeseed meal from oilseed rape, etc.
Use	The quantity of chemical used during this conversion step, per MJ of output.
Emissions factor	The emissions resulting from the production and use of each unit of chemical. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of chemicals in kilograms of CO_2 equivalent per MJ of output from this module.
Co-products	
Name	The name of the co-product produced by this conversion process.
Use	The market in which the co-product is used – e.g. for animal feed, for fertiliser etc. (optional field)
Description	If the 'Name' and/or 'Use' of a particular co-product are not specified in the B2C2, they can be recorded in the description field.

Yield	Quantity of co-product produced per tonne of output from this conversion module. Note the unusual case for electricity as a co-product which is explained in section 4.2.2.1
Co-product credit	The credit attributed to the use of the selected co-product. This value should be negative if the impact of the credit is to reduce the overall fuel chain GHG emissions. Note: if the 'Co-product credit' is a value other than zero, then the 'Energy Content' (see below) **must** be set to zero. See the Renewable Energy Directive Annex V.C paragraph 16-18 for the rules to follow to determine whether a co-product is eligible for a credit or should be taken into account through the allocation factor. In general, only excess electricity from a local CHP plant can be eligible for a credit, except where the fuel used in the cogeneration unit is a co-product other than an agricultural crop residue.
Energy Content	The lower heating value (LHV) of this co-product. This is required in order to allocate a portion of the fuel chain GHG emissions to the co-product. Note that for co-products with a negative LHV (e.g. digestate at very high moisture content) a LHV of zero should be used. For electricity a value of 1 MJ/MJ(co-product) is used.
Credit or debit for co-products	This value shows the total impact of the co-products in units of kgCO2e/MJ(output) or kgCO2e/tonne(output). If the value is negative, then the co-products have the effect of reducing the overall carbon intensity of the fuel chain. If the value is positive, then the co-products have increased the carbon intensity of the fuel chain. In most cases relevant to the RHI this field will be zero
Share of emissions allocated to the output product	The value shows the allocation factor for the main output products. The tool calculates this by combining each co-product LHV with its yield to determine what share of emissions should be allocated co-products – the remaining share is allocated to the main output product. If the value is 100%, it means that all GHG emissions up to this point in the chain are allocated to the output of the module. If it is less than 100%, it means that only a portion of the emissions are allocated to the output.
Other	
Methane losses	Methane losses during the conversion step, measured in grams of methane per MJ of output from this module. The methane losses are accounted as GHG emissions from the module, assuming a Global Warming Potential for methane of 25.
Carbon Capture & Replacement / Storage	

Carbon Capture & Replacement / Storage	This field accounts for any avoided greenhouse gas emissions through carbon capture & replacement, or carbon capture and storage where applicable. Units are kgCO2e/tonne(output).
Conservative factor	
All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'Biomass processing' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of grams of CO_2e) per MJ of biogas produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of grams of CO_2e) produced from this stage of the fuel chain, per MJ of biogas produced.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of grams of CO_2e) per MJ of output of this module.

7.10 Biogas upgrading

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.

Country in which this processing step takes place	The country in which this plant is located. This information is needed by the B2C2 to select the appropriate emissions factor for electricity (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Product	Product produced by this module – e.g., biomethane.
Plant yield	Quantity of output per quantity of input (measured in units of MJ output per MJ input).
Plant inputs	
Amount of electricity used	The total quantity of electricity used (per MJ of output) during this conversion step.
Electricity emissions factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions from the production and consumption of electricity in kilograms of CO_2 equivalent per MJ of output from this module.
Fuel used per MJ of output	
Type	Type of fuel used – e.g. natural gas burnt in a boiler to provide process heat, etc.
Use	The quantity of fuel used during this conversion step, per MJ of output.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of fuel in kilograms of CO_2 equivalent per MJ of output from this module.
Chemicals	
Type	Type of chemical used – e.g., n-hexane used to produce rapeseed oil and rapeseed meal from oilseed rape, etc.
Use	The quantity of chemical used during this conversion step, per MJ of output.
Emissions factor	The emissions resulting from the production and use of each unit of chemical. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of chemicals in kilograms of CO_2 equivalent per MJ of output from this module.

Co-products	
Name	The name of the co-product produced by this conversion process.
Use	The market in which the co-product is used – e.g. for animal feed, for fertiliser etc. (optional field)
Description	If the 'Name' and/or 'Use' of a particular co-product are not specified in the B2C2, they can be recorded in the description field.
Yield	Quantity of co-product produced per tonne of output from this conversion module. Note the unusual case for electricity as a co-product which is explained in section 4.2.2.1
Co-product credit	The credit attributed to the use of the selected co-product. This value should be negative if the impact of the credit is to reduce the overall fuel chain GHG emissions. Note: if the 'Co-product credit' is a value other than zero, then the 'Energy Content' (see below) **must** be set to zero. See the Renewable Energy Directive Annex V.C paragraph 16-18 for the rules to follow to determine whether a co-product is eligible for a credit or should be taken into account through the allocation factor. In general, only excess electricity from a local CHP plant can be eligible for a credit, except where the fuel used in the cogeneration unit is a co-product other than an agricultural crop residue.
Energy Content	The lower heating value (LHV) of this co-product. This is required in order to allocate a portion of the fuel chain GHG emissions to the co-product. Note that for co-products with a negative LHV (e.g. digestate at very high moisture content) a LHV of zero should be used. For electricity a value of 1 MJ/MJ(co-product) is used.
Credit or debit for co-products	This value shows the total impact of the co-products in units of kgCO2e/MJ(output) or kgCO2e/tonne(output). If the value is negative, then the co-products have the effect of reducing the overall carbon intensity of the fuel chain. If the value is positive, then the co-products have increased the carbon intensity of the fuel chain. In most cases relevant to the RHI this field will be zero
Share of emissions allocated to the output product	The value shows the allocation factor for the main output products. The tool calculates this by combining each co-product LHV with its yield to determine what share of emissions should be allocated co-products – the remaining share is allocated to the main output product. If the value is 100%, it means that all GHG emissions up to this point in the chain are allocated to the output of the module. If it is less than 100%, it means that only a portion of the emissions are allocated to the output.
Other	

Methane losses	Methane losses during the conversion step, measured in grams of methane per MJ of output from this module. The methane losses are accounted as GHG emissions from the module, assuming a Global Warming Potential for methane of 25.
Carbon Capture & Replacement / Storage	
Carbon Capture & Replacement / Storage	This field accounts for any avoided greenhouse gas emissions through carbon capture & replacement, or carbon capture and storage where applicable. Units are kgCO2e/tonne(output).
Conservative factor	
All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'Biomass processing' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of grams of CO_2e) per MJ of biogas produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of grams of CO_2e) produced from this stage of the fuel chain, per MJ of biogas produced.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of grams of CO_2e) per MJ of output of this module.

7.11 Storage

Basic data	
Module description	A brief description of the module. This field is optional.

Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Country in which this processing step takes place	The country in which this storage occurs. This information is needed for the B2C2 to select the appropriate emissions factor for electricity if required (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Module efficiency	Any raw material losses should be included in this field. For example if 1% of the feedstock is "lost" while loading/unloading the feedstock, the figure here should be 0.99. Measured in units of dry tonnes(output)/dry tonnes(input)
Amount of electricity used	The total quantity of electricity used during this storage step.
Electricity emissions factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions due to electricity production and consumption in kilograms of CO_2 equivalent per tonne of feedstock.
Fuel information	
Type	Type of fuel used if any
Use	The quantity of fuel used during this storage step.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions due to fuel production and consumption in kilograms of CO_2 equivalent per tonne of output.
Other	
Methane losses	Methane losses during the storage step, measured in kilograms of methane per tonne of output from this module. The methane losses are accounted as GHG emissions from the module, assuming a Global Warming Potential for methane of 25.
Conservative factor	

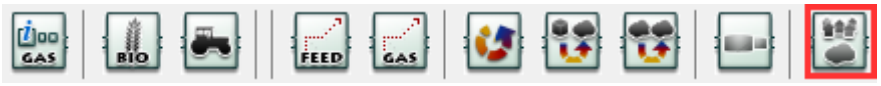
All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'storage' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of kilograms of CO_2e) per tonne of feedstock produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of kilograms of CO_2e) produced from this stage of the fuel chain, per tonne of final biomass type used.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of kilogram of CO_2e) per tonne of output of this module.

7.12 Heat production

Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.
Heat generation efficiency	
Heat production only	Select this option if the biomass was burned in a power plant that only exports heat and no electricity. This field is compulsory but can only be changed in the 'Fuel chain – Heat' module.
Heat co-produced with electricity	Select this option if the biomass was burned in a power plant producing both electricity and heat. This field is compulsory but can only be changed in the 'Fuel chain – Heat' module.

Heat efficiency	This is the thermal efficiency of the power plant, i.e. the ratio of heat produced by biomass input. This should be given as a decimal and reflect the units of energy in the heat produced per unit of energy in the biomass used. This field can only be changed in the 'Fuel chain – Heat' module.
Electricity efficiency	If the option 'Heat co-produced with electricity' is selected, it is also necessary to insert the efficiency of electricity production. In such case, this field can only be changed in the 'Fuel chain – Heat' module.
Temperature	If the option 'Heat co-produced with electricity' is selected, the temperature of the heat also needs to be provided. The temperature is used to calculate the proportion of emissions that should be allocated to the heat vs. the electricity. This field can only be changed in the 'Fuel chain – Heat' module.
Intermediate results	
Fuel chain carbon intensity	The carbon intensity of the consignment, measured in units of kilograms of CO_2 equivalent released per tonne of biomass fuel used in the power plant and as grams of CO_2 equivalent per MJ of biomass fuel or biogas used in the power plant.
Heat carbon intensity	The carbon intensity of the heat produced from the biomass, measured in units of grams of CO_2 equivalent released per megajoule (unit of energy) of heat produced.
GHG saving	The percentage saving the heat achieves relative to its fossil fuel equivalent. The fossil fuel equivalent of heat is taken from the European Commission report on sustainability requirements for solid and gaseous biomass sources in electricity, heating and cooling and has a value of 87 g CO_2e / MJ heat.

7.13 Gas injection to the national natural gas grid



Basic data	
Module description	A brief description of the module. This field is optional.
Details and links to verification evidence	Any further details can be added here, including, for example, links to any evidence which supports the actual data used within this module. This field is optional.

Country in which this processing step takes place	The country in which the injection takes place. This information is needed by the B2C2 to select the appropriate emissions factor for electricity (see below). This drop down list may also contain a few non-country options (e.g., local CCGT, EU (medium voltage), etc.). Select these options if the electricity used is not taken from the national grid.
Efficiency (methane losses during injection)	Efficiency of the injection, taking into account the possible methane losses during injection.
Plant inputs	
Amount of electricity used	The total quantity of electricity used (per MJ of output) during this conversion step.
Electricity emission factor	The emissions resulting from the production and use of each unit of electricity.
Subtotal	Emissions from the production and consumption of electricity in kilograms of CO_2 equivalent per MJ of output from this module.
Fuel used per MJ of output	
Type	Type of fuel used – e.g. natural gas burnt in a boiler to provide process heat, etc.
Use	The quantity of fuel used during this conversion step, per MJ of output.
Emissions factor	The emissions resulting from the production and use of each unit of fuel. Most users are expected to rely on the default value based on information provided in the 'Type' field.
Subtotal	Emissions from the production and consumption of fuel in kilograms of CO_2 equivalent per MJ of output from this module.
Other	
Methane losses	Methane losses during the conversion step, measured in grams of methane per MJ of output from this module. The methane losses are accounted as GHG emissions from the module, assuming a Global Warming Potential for methane of 25.
Conservative factor	

All data reported in this module are actual data	This option should be selected if all the data reported in the module are actual data (see Section 4.4 for details). This field is only relevant if the 'Biomass processing' module is part of the processing step (i.e. not part of the cultivation step – see Section 4.4 for more information). If it is selected, the conservative factor (factor by which the 'Total for this module' will be multiplied before the contribution of the module to the entire fuel chain is calculated) will be removed.
Intermediate results	
Total for this module	The total GHG emissions of this module (measured in units of grams of CO_2e) per MJ of biogas produced.
Contribution of this module to fuel chain	The total GHG emissions (measured in units of grams of CO_2e) produced from this stage of the fuel chain, per MJ of biogas produced.
Percentage contribution to chain	The percentage contribution this module makes to the total GHG emissions of the fuel chain. This value may be greater than 100% because there may be a very large co-product credit in another step which reduces the total chain GHG emissions to less than the emissions from this step alone.
Total emissions up to this module	The total GHG emissions of this module and all the previous ones (measured in units of grams of CO_2e) per MJ of output of this module.

8 Glossary

8.1 Terms used in this user manual

Carbon Intensity: in the context of this User Manual this means the life cycle Greenhouse Gas Emissions (measured in gCO_2-equivalents per mass of product or per energy content, e.g. gCO_2e/kg or gCO_2e/MJ) associated with the production of biomass fuels and end products

Consignment: Whilst the RO and the RHI legislation do not define 'consignment', Ofgem have set out guidance[56] on what constitutes a consignment. For practical reasons the definition of a consignment for GHG criteria and for meeting the woodfuel land criteria are the same. Each consignment should constitute the same **characteristics** in terms of:

- Feedstock types
- Biomass form (solid biomass only)
- Country of origin
- Classification of the fuel
- Compliance with the woodfuel land criteria
- Compliance with GHG criteria

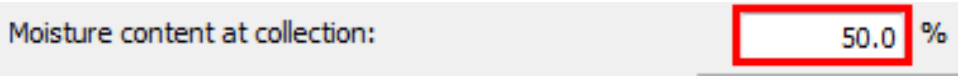
Default Fuel Chain: a default fuel chain (or 'default chain' for short) is a pre-defined fuel chain within the B2C2 which contains indicative data for the various fuel chain parameters (e.g. harvesting diesel use, pelleting electricity use, transport distances etc.). Default fuel chains are included in the tool for the most common solid and gaseous biomass fuel chains for heat and power. The user is free to adapt the 'default values' within these default fuel chains, as well as the overall structure of the chains, to reflect their own fuel chain.

[56] http://bit.ly/1MAyzF9

Default Value: the data fields within default fuel chains are populated with indicative data. These indicative values are known as 'default values.'

Emission Factor: this is a measure of the carbon intensity of a fuel or other process input per unit of that input. In most cases, emission factors for inputs used in the B2C2 have been taken from the Biograce II tool[57].

Field: in the context of this user manual, a 'field' refers to a box in which data or information can be entered within the various fuel chain modules. An example is indicated below in the red box.



Fuel Chain: a supply chain for a consignment of a solid or gaseous biomass fuel covering the cultivation and extraction of raw materials, transport of raw materials, fuel production and fuel transport.

Module: a visual representation of a step in a fuel supply chain. In the B2C2 a module is represented by a box. An example of one particular type of module, the 'biomass conversion' module, is shown below.

Project File: a working file within which a user builds and adapts fuel chains. These files can be saved in '.bcc' format (bcc stands for 'biomass carbon calculator').

[57] http://www.biograce.net/biograce2/

8.2 Feedstock types in the B2C2

Feedstock type is the type of biomass from which the final fuel is produced. N.B. [W/R] next to a feedstock in the list below indicates the feedstock is a waste or residue; whereas [C] indicates the feedstock is a co-product.

Bagasse [W/R]:

Fibrous processing residue produced when juice is extracted from sugarcane.

Bark [W/R]:

The tough outer surface of trunks of trees, and other woody plants.

Branch wood [W/R]:

Woody portions of a tree excluding the stem and roots.

Clear-felled virgin forestry (lightly forested) [C]:

An area lightly forested (i.e. 10-30% canopy cover) with virgin trees (i.e. non-plantation) and clear-felled for biomass. As this is a virgin forest, rather than a plantation, there are no inputs associated with the cultivation stage (e.g. no fertiliser has been applied). However, there will be emissions associated with the change in land use from virgin forest to whatever the forest is managed as subsequently. These land use change emissions need to be taken into consideration in the cultivation module of the B2C2. If using the default methodology for calculating emissions from land use change, and the forest is left unmanaged after felling, the land use following felling should be assumed to be "scrubland". If trees are replanted, "forest plantation" should be selected as the "current land use", if annual crops are grown, this should be selected, etc.

Diseased wood and storm salvage [W/R]:

Timber that is diseased or has been damaged during a storm and is subsequently of little value other than for energy.

End of life non-timber plantations [W/R]:

Standing trees from plantations for non-timber products (e.g., coconut, rubber, palm trees) which have reached the end of their useful life. Only tropical/sub-tropical locations have been considered to fall into this category so far.

Energy grass [C]:

Generic grouping of non-miscanthus energy grasses, e.g., switchgrass, reed canary grass, giant reed, etc. Users can adapt this generic chain with actual data for their specific energy grass if they have data available.

Husks/Shells [W/R]:

The outer shell or coating of a seed.

Forestry residues [W/R]:

Branch wood, tops, bark and stump collected from forests or plantations.

Long rotation forestry (broadleaf) [C]

Broadleaf tree plantations felled after a growing period of several decades, and then replanted

Long rotation forestry (conifer) [C]

Conifer tree plantations felled after a growing period of several decades, and then replanted

Manure [W/R]:

Wet manure is mainly produced by intensive pig farms, while dry manure results from more environmentally-aware farming practices.

Miscanthus [C]:

Species of energy grass called *Miscanthus x giganteus*.

Municipal Solid Waste [W/R]:

Urban, predominantly household, waste.

Olive cake [W/R]:

Co-product of olive oil production.

Palm kernel meal [C]:

Co-product of palm oil production.

Saw dust [W/R]:

Powdered particles of wood produced by sawing.

Sawmill residues [W/R]:

Any wood residue in the form of chip, bark, sawdust, etc. that is produced at a sawmill.

Short rotation coppice (combined harvesting and billeting) [C]:

Short Rotation Coppice (SRC) refers to varieties of poplar and willow grown in wood plantations managed through coppicing. Harvesting was assumed to take place every 2 to 5 years. SRC can be harvested using three different techniques. Combined harvesting and billeting refers to a harvest using machines that cut coppice stems into shorter lengths (5-10 cm), called billets.

Short rotation coppice (combined harvesting and chipping) [C]:

SRC refers to varieties of poplar and willow grown in wood plantations managed through coppicing. Harvesting was assumed to take place every 2 to 5 years. SRC can be harvested using three different techniques. Combined harvesting and chipping refers to a harvest in which the crop is cut and chipped in a single pass.

Short rotation coppice (stick harvesting) [C]:

SRC refers to varieties of poplar and willow grown in wood plantations managed through coppicing. Harvesting was assumed to take place every 2 to 5 years. SRC can be harvested using three different techniques. Under stick harvesting, the crop is cut as whole stems.

Short rotation forestry [C]:

Short Rotation Forestry (SRF) refers to tree plantations with short harvest rotations (typically every 8 to 15 years). For tropical/sub-tropical regions, eucalyptus is used as a representative type of short rotation forestry crop.

Silage grass [C]:

Forage grass typically harvested and fermented for use as winter fodder for cattle and sheep. It is also suitable as a biomass feedstock.

Slab wood [W/R]:

An outsize piece cut from a log when squaring it for lumber.

Sugarbeet [C]:

Plant with a tuber with a high concentration of sucrose. Grown commercially for sugar production.

Straw [W/R]:

This includes wheat straw, corn stover and other types of straw that may be harvested for use in power plants.

Tree Stumps [W/R]:

The basal portion of a tree remaining after the rest has been removed.

Thinnings [W/R]:

Roundwood from a forest or plantation thinning, as long as this practice does not change the land use status of the area.

Tree tops [W/R]:

The topmost part of a tree.

Waste wood [W/R]:

This category includes clean or treated waste wood, chipboard, MDF, etc. As the wood is considered to be a "waste", no emissions are assumed to be associated with its production. This category is only for wood that does not need to be pre-treated prior to its use.

8.3 Biomass forms in the B2C2

Biomass form is the form of the biomass used as fuel in the power plant

Bagasse pellet:

A small, densely packed mass of dried bagasse. Pelleting facilitates bagasse storage and its utilisation as a fuel.

Biogas:

Gas produced by anaerobic digestion containing about 55% methane and 45% carbon dioxide.

Biomethane:

Gas mixture that is predominantly methane, which meets the UK natural gas grid requirements, and is sourced from organic material (biomass).

Biopropane:

An alkane with identical properties to fossil propane, whose carbon atoms are of biogenic origin. Often a co-product of Hydrogenated Vegetable Oil production.

Briquette:

Briquettes are similar to pellets in that the biomass is processed into a denser and uniform format. However, they are larger in size, typically >25mm in diameter.

Charcoal:

A material formed from the incomplete combustion of organic material in a kiln or retort.

Chip:

Less uniform in size than pellets, and typically larger (in the range 20-50mm in size)

Crop processing residue pellets:

Husks or shells resulting from the processing of crops.

Draff:

The co-product resulting from the fermentation of the grains used in brewing, used as animal feed.

Olive cake:

Co-product of olive oil production.

Pellet:

Densified, biomass processed into uniform size, typically 5-10mm in size and <10% moisture content

Rapeseed meal:

Residue left over when oil is extracted from rapeseed. Commonly used as animal feed.

Refuse derived fuel:

Fuel derived from the non-biodegradable component of municipal solid waste (MSW).

Straw bales:

A bundle of straw tightly packed and bound.

Sweet sorghum DDGS:

The protein containing co-product resulting from the production of bioethanol from sweet sorghum.

Torrefied biomass:

Biomass that has been subject to a thermal process in which the material is exposed to high temperature, in the absence of oxygen, and so without the oxidation that typically occurs during combustion. This improves hydrophobicity, grindability and energy density.

Wheat DDGS:

The protein containing co-product resulting from the production of bioethanol from wheat.

8.4 Process types in the B2C2

Aerobic processing and dry stabilisation:

Process to produce refuse derived fuel in which the heat from the composting of the biological component of the waste is used to dry the input MSW, thereby easing the separation process and resulting in a higher yield of fuel than a straight aerobic process in which the MSW is not dried prior to sorting.

Aerobic processing:

Process to produce refuse derived fuel in which the MSW is not dried using heat from composting prior to mechanical sorting, and the biological component of the MSW is not anaerobically digested to produce biogas.

Anaerobic digestion:

Series of processes in which microorganisms break down biodegradable material in the absence of oxygen to produce biogas.

Anaerobic processing:

Process to produce refuse derived fuel in which the biological component of the waste is anaerobically digested to produce biogas, which is used on site to generate heat and power; some of which is used in the production of fuel from the non-biological component of waste (i.e. the shredding, screening and separation).

Bulk drying:

Drying with low volume ventilation using electrical fans.

Continuous drying and storage:

Drying with continuous grain flow driers - inputs required include electricity and some type of fuel to produce heat (e.g., diesel, natural gas, biomass, etc.).

Gasification:

The process used to convert a biomass into a gas.

Natural drying:

Drying of feedstock without any additional external energy inputs

Annex 1. Greenhouse gas calculation

1. Solid biomass, biogas or biomethane meets the greenhouse gas criteria if the life cycle greenhouse gas emissions associated with each consignment of that solid biomass, biogas or biomethane are less than or equal to 34.8g of $CO_{2\ eq}$ per MJ of heat generated (in the case of solid biomass or biogas) or biomethane injected.

2. Life cycle greenhouse gas emissions shall be calculated as follows—

   (a) where heat and power is generated from solid biomass or biogas, the following formula shall be used—

$$\frac{E}{\eta_h}\left(\frac{C_h \times \eta_h}{\eta_{el} + C_h \times \eta_h}\right)$$

   (b) where heat is generated from solid biomass or biogas, the following formula shall be used—

$$\frac{E}{\eta_h}$$

   (c) where biomethane is produced from biogas, lifecycle greenhouse gas emissions shall be E.

3. For the purposes of paragraph 2—

   (a) η_h is the efficiency of the plant in which the heat is generated, calculated as $\frac{H}{F}$ where—

      (i) H is the heat produced by the plant in the form of liquid or steam from all fuels used in that plant, and

      (ii) F is the energy content of all those fuels;

(b) η_{el} is the efficiency of the plant in which electricity is generated, calculated as $\frac{A}{F}$ where—

(i) A is the total amount of electricity generated by the plant from all the fuels used by that plant, and

(ii) F is the energy content of all those fuels;

(c) C_h is equal to—

(i) where the temperature (T) is less than 423 kelvin, 0.3546, and

(ii) in any other case, $\frac{T-273}{T}$ where *T* is temperature measured in kelvin of the heat produced by the plant in the form of liquid or steam;

(d) E is the greenhouse gas emissions expressed in grammes of CO2 eq per MJ of heat produced, from the production of the biomass, biogas or biomethane and calculated—

(i) using the actual value method in the case of participants producing biomethane for injection or using heat for a process in an accredited RHI installation with an installation capacity of 1MWth or above; or

(ii) in all othere cases, using the actual value method or the default value method.