Delivery of sustainable supply of non-food biomass to support a "resource-efficient" Bioeconomy in Europe

S2Biom Project Grant Agreement n°608622

S2Biom Deliverable D4.5

Bio2Match: a Tool for Matching Biomass and Conversion Technologies

15 August 2016




About the S2Biom project

The S2Biom project - Delivery of sustainable supply of non-food biomass to support a "resource-efficient" Bioeconomy in Europe - supports the sustainable delivery of non-food biomass feedstock at local, regional and pan European level through developing strategies, and roadmaps that will be informed by a "computerized and easy to use" toolset (and respective databases) with updated harmonized datasets at local, regional, national and pan European level for EU28, Western Balkans, Moldova, Turkey and Ukraine. Further information about the project and the partners involved are available under www.s2biom.eu.

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About this document

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Executive Summary

This report describes 'Bio2Match', the biomass and conversion technology matching tool that was developed in S2Biom in task 4.2.

With Bio2Match we aim to provide support for the development of strategies for the best ways to realise a bio-based economy in Europe. The tool is intended to be user-friendly to biomass and/or technology experts, but specifically also to other stakeholders in the bio-based economy, such as for example policy makers or entrepreneurs. Bio2Match brings together a large collection of data on both biomass properties and technology characteristics, in an interactive way. It should be able to help stakeholders in the bio-based economy to gain insight in bio-based value chains .Bio2Match compares data on both biomass characteristics and technology demands, in an interactive way to find suitable matches. The tool was built using a database of conversion technologies (D2.3) and a database of biomass properties (D2.4). It can be used to match biomass feedstocks to conversion technologies, in order to support stakeholders in the bio-based economy to identify opportunities for further exploitation of existing indigenous biomass resources (across borders).

The tool is accessible online, via the S2Biom website.[1] In this report the methodology that the tool uses to match biomass to technologies is described, as well as the way the Bio2Match works in practice.

[1] http://www.s2biom.eu/en/methodological-approaches/computerised-toolset.html

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1. Introduction

Work package 4 of the S2Biom project has multiple objectives. The fourth objective of WP4 relates to this report, and is the following:

'... 4. To provide technical support to end-user for identifying the best match between a given amount of biomass with specific characteristics and the conversion or pre-treatment technology. ...'

This D4.5 report provides background information on the development of the biomass and conversion technology matching tool 'Bio2Match', that was developed to meet the objective as described above. Bio2Match is an openly accessible online tool.[2] It is based on a method developed to match the available lignocellulosic biomass resources to the most suitable conversion technologies, taking into account the pyramid of end use applications (materials, chemicals, fuels, energy), which was described in deliverable D2.2. Each conversion technology has specific biomass input requirements (e.g. cellulose and lignin content, ash and moisture content, particle size, density, etc.), while the composition and characteristics of biomass at roadside varies widely. Some biomass types can be used in many different technology options, while others are difficult to process or will need extensive pre-treatment.

The conversion technologies database was described in D2.3, "Database of biomass conversion technologies" and the biomass properties database in D2.4, "Explanatory note accompanying the database for standardized biomass characterization (and minimal biomass quality requirement for each biomass conversion technology)". A list of the conversion technologies in the database can be found in appendix A, and a list of the biomass types in the database can be found in appendix B.

In this report the methodology of the matching tool will be described, followed by a detailed description of the matching tool itself: what are the functionalities, how does it work, and what information can be drawn from it.

[2] Accessible via the S2Biom website: http://www.s2biom.eu/en/methodological-approaches/computerised-toolset.html

2. Tool methodology

The fundamental biomass characteristics that determine the value or risk of a certain type of biomass for a certain type of conversion system were identified. That way it was possible to match different biomass types to different conversion technologies.

Figure 1 shows a simplified classification concept: each feedstock type has qualities that are relevant for different types of conversion processes. Some of these (physical) characteristics (e.g. moisture content and size) can easily be modified (against some cost) by a basic treatment such as drying or chipping. Other characteristics are more 'fundamental', in the sense that they cannot easily be modified, for example the lignin content. Only these fundamental characteristics will be taken into account for the matching tool, while the physical characteristics (notably moisture content and bulk density) are taken into account as a cost factor rather than a showstopper.

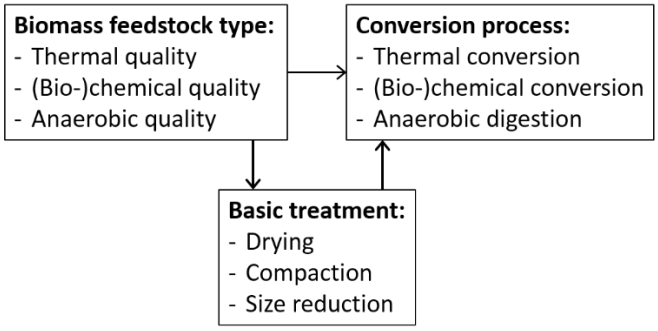


Figure 1. Simplified classification concept.

2.1 Conversion technology properties and their classification

For a **thermal conversion system**, the main feedstock-related challenges are related to corrosion, slagging & fouling, (higher) heating value, and NOx emissions. The chlorine content, ash deformation temperature, ash content, and nitrogen content were taken as the most important indicators for these potential issues.

A high ash content has a number of drawbacks: I) it does not contribute to energy production; II) it may increase wear of the machinery; III) it will generally cost money to discard ash; IV) stoves are generally designed to a limited ash amount. The nitrogen content is not so relevant for operation of the thermal conversion technology itself. But emission reduction measures make a conversion technology more expensive, and less economical to apply on a small scale (below 1 MWth). Therefore the nitrogen content is indeed relevant to take into account, especially for smaller conversion systems.

A **(bio-)chemical conversion system** was defined here as the pre-treatment of lignocellulosic biomass, followed by conversion of the polysaccharides into products like fuels or chemicals, but also as including processes from the pulp and paper industry. There are many fundamental characteristics that influence the potential success of (bio)chemical conversion of lignocellulose into fuels and chemicals. For our suitability approach we used the three most basic indicators: lignin content, carbohydrate (cellulose + hemicellulose) content, and ash content.

In **anaerobic digestion** a large part of the cost is determined by the size of the reactor. It is important that the yield per reactor volume per year is high enough. Therefore the methane yield per ton (or m^3) of substrate is very relevant. The cost of the disposal of the digestate is also relevant. Ttherefore the potential applicability of the digestate (e.g. as fertilizer) was also taken into account.

2.2 Biomass properties and their classification

The classification of the fundamental biomass properties is shown in Table 1.

Table 1. Biomass properties and their classification.

Property	*Unit*	Classification			
		1	2	3	4
Chlorine content	*wt-% d.m.*	<0.02	0.02-0.1	0.1-0.4	>0.4
Ash deformation temperature	*°C*	>1200	1000-1200	800-1000	<800
Ash content	*wt-% d.m.*	<1	1-3	3-10	>10
Nitrogen content	*wt-% d.m.*	<0.3	0.3-1	1-2.5	>2.5
Carbohydrates	*wt-% d.m.*	>65	50-65	30-50	<30
Lignin content	*wt-% d.m.*	<10	10-25	25-35	>35
Biogas yield	*m^3/ton a.r.*	>300	150-300	50-150	<50
Digestate has an application		Yes	n.a.	n.a.	No

For each technology, the minimum requirements were defined per property, in terms of which is the worst class that can be handled by that technology. Some processes will be able to handle only the highest quality (class 1) biomass, while others may be able to handle lower quality (e.g. class 3 or 4) biomass as well. Such a classification system should help to determine what type of conversion systems are needed to effectively utilise the available

biomass types in Europe under competitive conditions. For further details the reader is referred to deliverable D2.2, 'A selection method to match biomass types with the best conversion technologies'..

Biomass has physical properties as well, besides the types of fundamental properties that were described before. One can think of moisture content, particle size, bulk density, etc. These properties vary widely, and often depend on the method of harvesting with the end-use application already in mind. The physical properties that were taken into account for the matching tool are moisture content and bulk density. These are properties for which at roadside reliable data or estimates were available. They are quite important for the various conversion technologies, especially thermal conversion, given that the moisture content has a high impact on the lower heating value of a feedstock. For the physical properties threshold values rather than a classification system were used.

2.3 Matching methodology

The methodology for the Bio2Match tool was defined on the basis of the classification system described above, with fundamental characteristics (which cannot easily be modified) and physical characteristics (which can easily be modified). The procedure that the tool utilizes for matching each biomass and each technology is schematically shown in Figure 2.

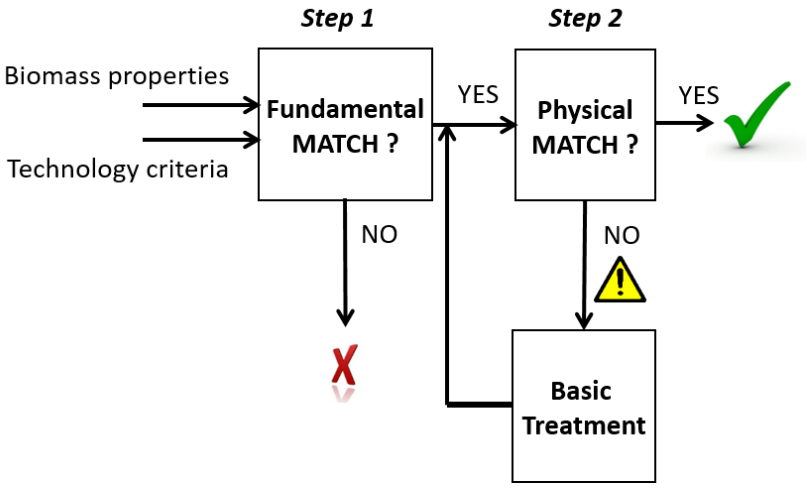


Figure 2. The Bio2Match tool methodology.

Depending on which type of technology is chosen (thermal, (bio-)chemical, anaerobic fermentation), the relevant fundamental properties of the biomass are first compared with the technology criteria (step 1). When each biomass property class has a lower or equal number than the technology criteria for those properties, there is a fundamental match, and the tool subsequently investigates the physical properties (step 2). When the values for the main

physical properties also match, the tool generates the answer “there is a match”, indicated by a green traffic light symbol. When there is a fundamental match but no physical match, the tool generates the answer “there is a match, if the biomass receives basic treatment”, indicated by a yellow exclamation mark. When there is no fundamental match, the tool does not proceed to step 2, but generates the answer “there is no match”, indicated by a red traffic light symbol.

The way this tool looks in practice and how a user can work with it, is described in the next section.

3. Using Bio2Match

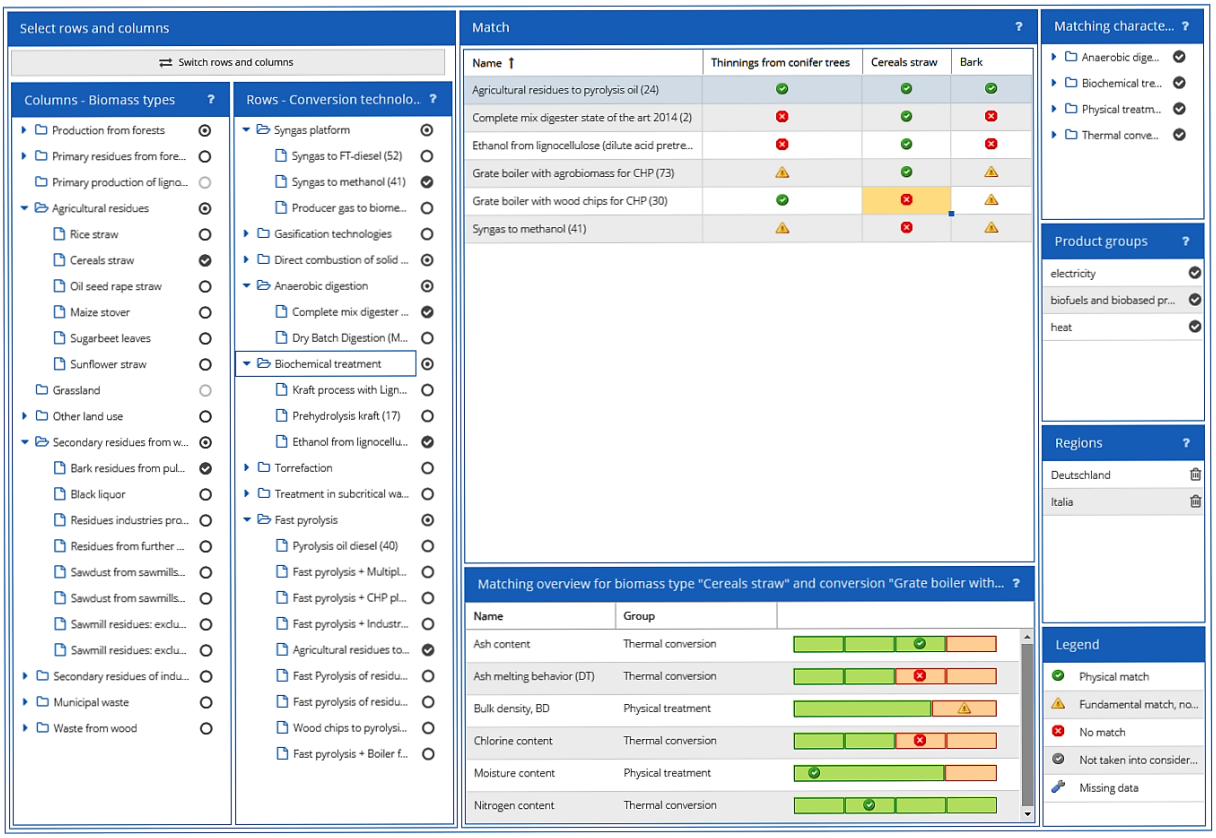


Figure 3. Screenshot overview of the user-interface of Bio2Match (details in the figures below).

The user-interface of Bio2Match is shown in Figure 3. The left two columns are for the selection of biomass types and technologies. The user can select any number of biomass types and conversion technologies that he or she is interested in. The central screen (Figure 4) then shows which technologies match to which types of biomass, based on the methodology that was described in section 2.2. A green check mark indicates a match, while a yellow exclamation mark indicates a fundamental but no physical match, and a red cross indicates that there is no match.

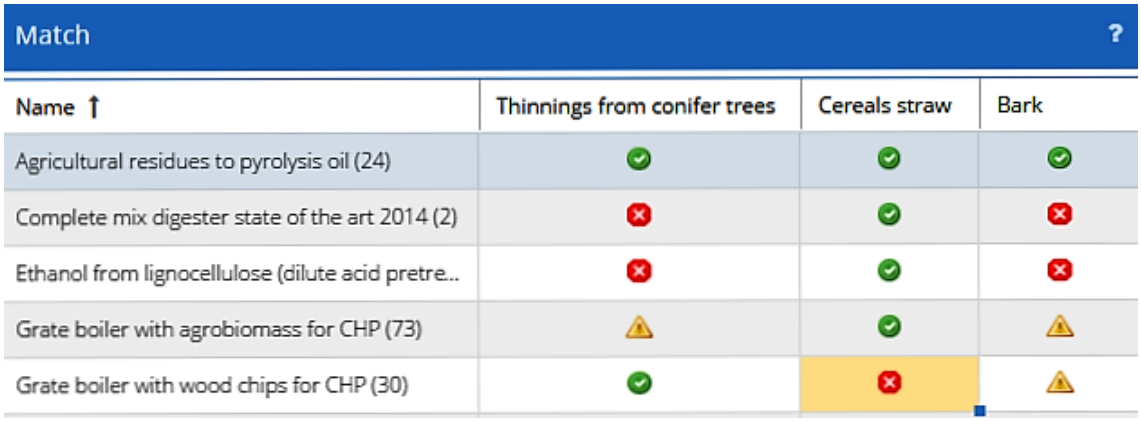


Figure 4. Detail of the 'Match' central screen. Clicking on one of the symbols will reveal more details in the screen below (Figure 5).

The user can then select a single biomass-technology combination to find out why a feedstock does or does not match to a certain conversion technology. The matching classification system is visualized in the screen below the central screen (Figure 5) with four blocks per property, in which green blocks represent the biomass quality that the technology can handle. When e.g. only the left block (class 1) is green, it means the technology can handle only feedstock of class 1 quality, when e.g. all four blocks are green the technology can handle all quality classes. The matching symbol (green ok sign or red cross) represents the actual quality of the selected biomass. If the symbol is positioned in a green block there is a match and the label turns green, if it is situated in a red block that means the technology cannot handle that feedstock quality and the label turns red in the case of a fundamental property or yellow in the case of a physical property.

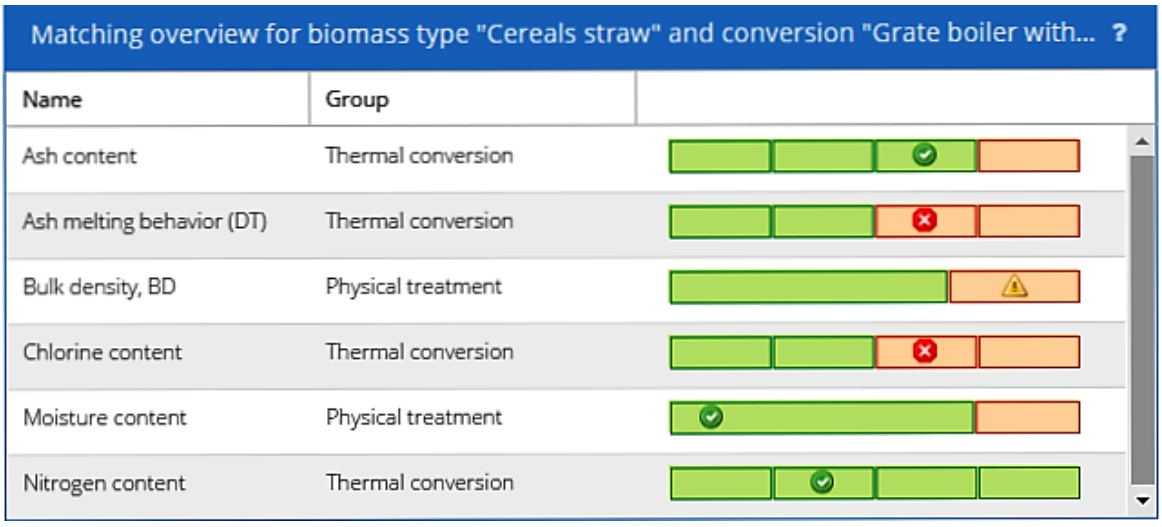


Figure 5. Detail of the 'Matching overview' screen, for the biomass-technology combination highlighted in Figure 4.

This way the user can quickly identify which biomass property is responsible for a mismatch between a biomass type and a technology type. In the example of a grate boiler that is designed for the combustion of wood chips, cereal straw does not match as a feedstock, as depicted in Figure 4 (the highlighted biomass-technology combination). It can be seen in Figure

5 that the chlorine content and the ash melting temperature are responsible for the fact that there is no match between this type of biomass and this conversion technology.

Another outcome could be the case of a match, in which a user may find in the matching overview screen that a certain biomass type is of such high quality that it would be less than optimal to use it for a certain technology, because another biomass type of lower quality could also be converted by that same technology. An example of such a case is shown in Figure 6, which shows the matching overview pane for the combination of conifer stemwood and hydrothermal carbonisation. Such findings may help to optimise the use of biomass in a region.

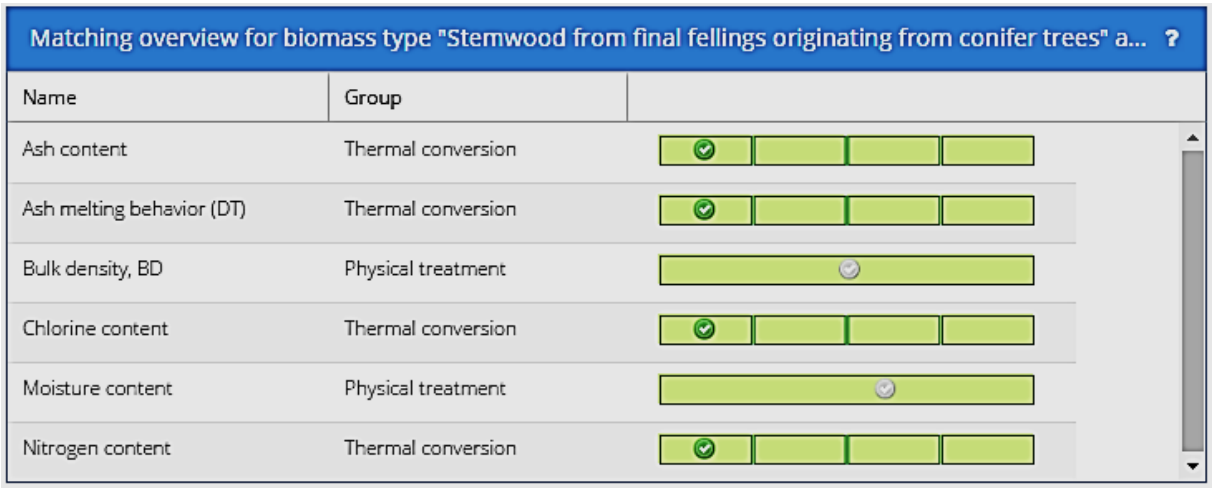


Figure 6. Detail of the 'Matching overview' screen, for the biomass-technology combination of stemwood from conifer trees and hydrothermal carbonization (overview not shown).

A feature of the tool is that the user can select which properties need to be taken into account for the matching. If an expert user finds that for his specific case (be it technology or feedstock) a certain property is not important, he or she can unselect that specific characteristic in the screen to the top right (detail in Figure 7), after which the tool recalculates which technologies match to which types of biomass without that property being taken into account.

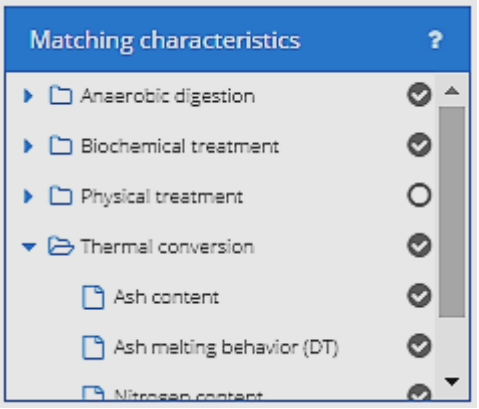


Figure 7. Detail of the 'Matching characteristics' selection screen.

Another feature is a product filter, which is situated in the small screen on the middle right side of the interface (detail in Figure 8). Here the user can select which types of products he or she is interested in. For example only heat or electricity, or in fuels or bio-based products. This filter then automatically selects only the technologies that are able to produce those specific products.

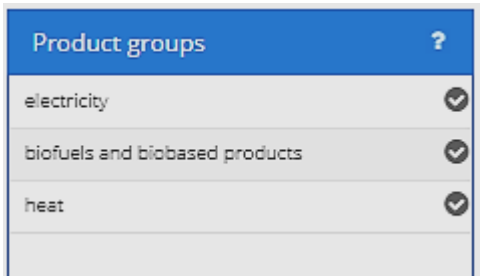


Figure 8. Detail of the 'Product groups' selection screen.

The last feature is the other small screen on the right side, which is a regions filter (Figure 9). This is a part of the tool that is linked to another tool on the S2Biom website, which is a biomass supply database (Figure 10). This database contains availability data of all the biomass categories that are in the Bio2Match tool as well. The user can select a certain region and then link to Bio2Match, which then automatically filters the biomass types that are relevant for that specific region.

Figure 9. Detail of the 'Regions' selection screen.

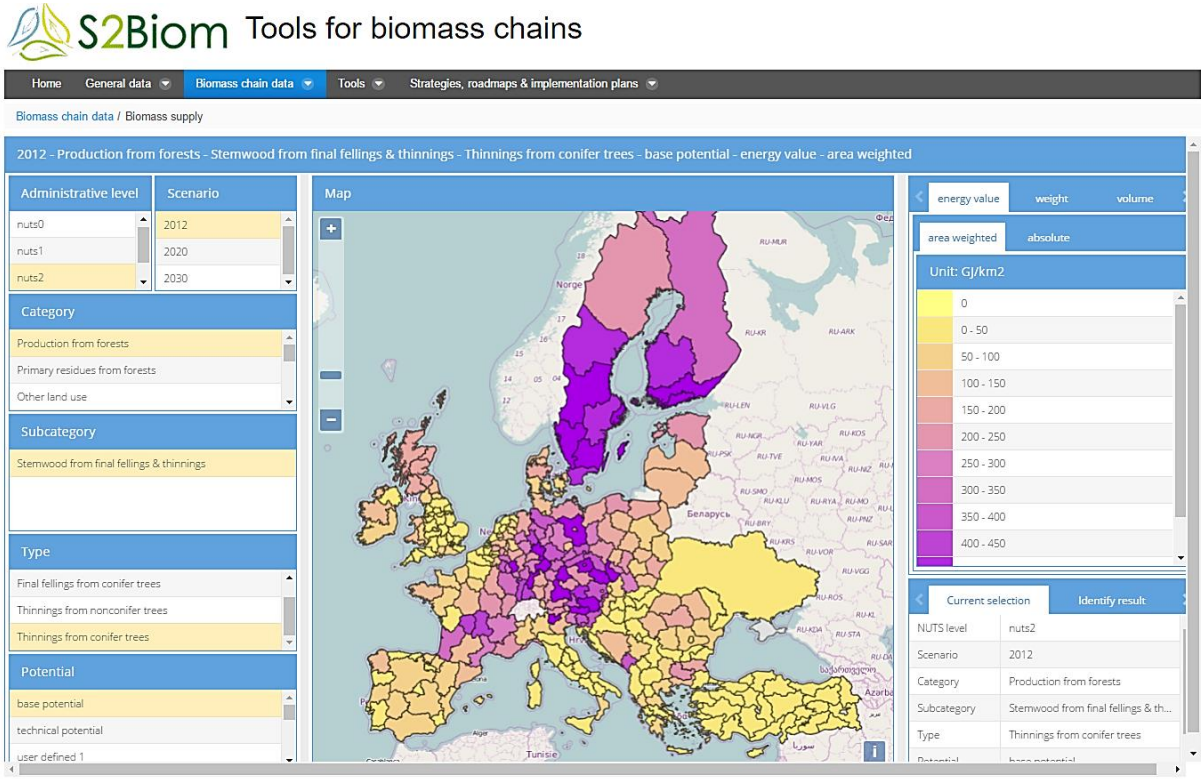
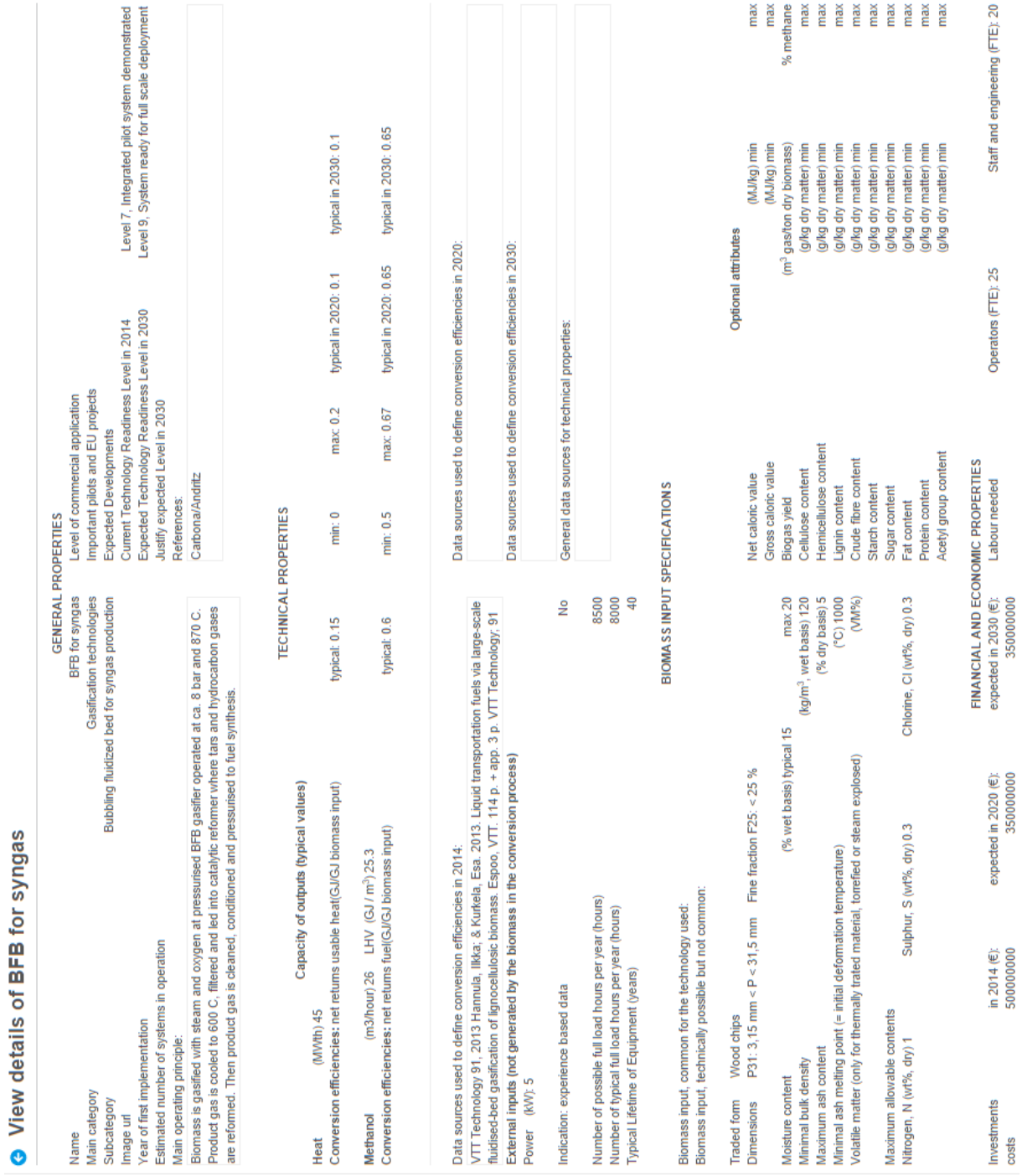


Figure 10. Printscreen of the S2Biom biomass supply database.

The tool and the conversion technology database that was described in Deliverable D2.3 are linked. For all the technologies in the matching tool the user can find more specific data in the database. An example of which is shown in Figure 11. So when a user identified an interesting technology for his or her case, he or she can easily look up that same technology in the database to find more detailed information on for example technology readiness level, investment costs, labour requirements, etc.


View details of BFB for syngas

GENERAL PROPERTIES

Name: BFB for syngas
Main category: Gasification technologies
Subcategory: Bubbling fluidized bed for syngas production
Image url:
Year of first implementation:
Estimated number of systems in operation:
Main operating principle:
Biomass is gasified with steam and oxygen at pressurised BFB gasifier operated at ca. 8 bar and 870 C. Product gas is cooled to 600 C, filtered and led into catalytic reformer where tars and hydrocarbon gases are reformed. Then product gas is cleaned, conditioned and pressurised to fuel synthesis.

Level of commercial application: Level 7, Integrated pilot system demonstrated
Important pilots and EU projects: Level 9, System ready for full scale deployment
Expected Developments
Current Technology Readiness Level in 2014
Expected Technology Readiness Level in 2030
Justify expected Level in 2030
References: Carbona/Andritz

TECHNICAL PROPERTIES

Capacity of outputs (typical values)

Heat	(MWth) 45				
Conversion efficiencies: net returns usable heat(GJ/GJ biomass input)	typical: 0.15	min: 0	max: 0.2	typical in 2020: 0.1	typical in 2030: 0.1
Methanol	(m3/hour) 26 LHV (GJ / m3) 25.3				
Conversion efficiencies: net returns fuel(GJ/GJ biomass input)	typical: 0.6	min: 0.5	max: 0.67	typical in 2020: 0.65	typical in 2030: 0.65

Data sources used to define conversion efficiencies in 2014:
VTT Technology 91, 2013 Hannula, Ilkka; & Kurkela, Esa. 2013. Liquid transportation fuels via large-scale fluidised-bed gasification of lignocellulosic biomass. Espoo, VTT. 114 p. + app. 3 p. VTT Technology: 91
External inputs (not generated by the biomass in the conversion process)
Power (kW): 5

Data sources used to define conversion efficiencies in 2020:

Data sources used to define conversion efficiencies in 2030:

Indication: experience based data: No
General data sources for technical properties:

Number of possible full load hours per year (hours): 8500
Number of typical full load hours per year (hours): 8000
Typical Lifetime of Equipment (years): 40

BIOMASS INPUT SPECIFICATIONS

Biomass input, common for the technology used:
Biomass input, technically possible but not common:

Traded form	Wood chips				
Dimensions	P31: 3.15 mm < P < 31.5 mm Fine fraction F25: < 25 %				
Moisture content	(% wet basis) typical 15	max 20	Net caloric value	(MJ/kg) min	max
Minimal bulk density		(kg/m3, wet basis) 120	Gross caloric value	(MJ/kg) min	max
Maximum ash content		(% dry basis) 5	Biogas yield	(m3 gas/ton dry biomass)	% methane
Minimal ash melting point (= initial deformation temperature)		(°C) 1000	Cellulose content	(g/kg dry matter) min	max
Volatile matter (only for thermally trated material, torrefied or steam explosed)		(VM%)	Hemicellulose content	(g/kg dry matter) min	max
Maximum allowable contents			Lignin content	(g/kg dry matter) min	max
Nitrogen, N (wt%, dry) 1	Sulphur, S (wt%, dry) 0.3	Chlorine, Cl (wt%, dry) 0.3	Crude fibre content	(g/kg dry matter) min	max
			Starch content	(g/kg dry matter) min	max
			Sugar content	(g/kg dry matter) min	max
			Fat content	(g/kg dry matter) min	max
			Protein content	(g/kg dry matter) min	max
			Acetyl group content	(g/kg dry matter) min	max

Optional attributes

FINANCIAL AND ECONOMIC PROPERTIES

Investments costs	in 2014 (€): 500000000	expected in 2020 (€): 350000000	expected in 2030 (€): 350000000	Labour needed	Operators (FTE): 25 Staff and engineering (FTE): 20

Figure 11. Excerpt of the datasheet of one technology entry in the database.

4. Conclusion

With Bio2Match we aim to provide support for the development of strategies for the best ways to realise a bio-based economy in Europe. The tool is intended to be user-friendly to biomass and/or technology experts, but specifically also to other stakeholders in the bio-based economy, such as for example policy makers and entrepreneurs. Bio2Match brings together a large collection of data on both biomass properties and technology characteristics, in an interactive way. It should be able to help stakeholders in the bio-based economy to gain insight in bio-based value chains.

5. References

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W. Elbersen, R. Bakker, P. Harmsen, M., E. Alakangas, **S2BIOM Deliverable D2.2**, *A selection method to match biomass types with the best conversion technologies* (2015).

T. Lammens, M. Vis, R. te Raa, D. van den Berg, J. Kärki, A. Uslu, H. Mozaffarian, P. Harmsen, H. de Groot, **S2BIOM Deliverable D2.3,** *Database of biomass conversion technologies* (2016).

W. Elbersen, E. Alakangas, B. Elbersen, E. Annevelink, J. Ramirez Almeyda, T. Lammens, **S2BIOM Deliverable D2.4,** *Explanatory note accompanying the database for standardized biomass characterization (and minimal biomass quality requirement for each biomass conversion technology)* (2016).

Appendix A. Overview of conversion technologies in the database

The rationale behind the selection of the conversion technologies was described in deliverable D2.1, "A method for standardized biomass characterization and minimal biomass quality requirements for each biomass conversion technology", as well as which technologies were selected. Table A1 summarizes the conversion technologies that were taken up in the database.

In order to be able to match the technology requirements with biomass characteristics, the different technologies were categorized into three main categories, all with a different set of specifications, as described in deliverable D2.2, "A selection method to match biomass types with the best conversion technologies". The first category contains thermal conversion technologies, with requirements for corrosion, ash agglomeration (fouling), ash content, and NO_x emissions. The second category contains both chemical and biochemical processes that have requirements on the lignin, (hemi-) cellulose and ash content. The third category specifically contains anaerobic digestion, and has requirements for digestibility and biogas yield.

Each category is further split down into three levels, in order to provide sufficient level of detail to distinguish each technology. An example of this is for thermal conversion processes: one category (level 1) is 'direct combustion of solid biomass', with subcategory (level 2) 'fluidized bed combustion', and process name (level 3) Circulating Fluidized Bed direct combustion'.

Table A1 Conversion technologies described in the database.

Category	Subcategory	Process name
Thermal conversion technologies		
Direct combustion of solid biomass	Fluidised bed combustion for CHP (steam cycle)	BFB direct combustion
		CFB direct combustion
	Fixed bed combustion for heat	Grate boiler for heat
	Fixed bed combustion for CHP (steam cycle)	Grate boiler with wood chips for CHP
		Grate boiler with agrobiomass for CHP
	Direct co-combustion in coal fired power plants	Co-firing in PC
	Waste incinerators with energy recovery	Grate fired waste incinerator
	Domestic pellet burners for heat	Pellet boiler for heat
	Domestic residential batch fired stoves for heat	Batch stove for heat
Gasification technologies	Circulating Fluidized bed for CHP (gas engine)	CFB for CHP
	Circulating Fluidized bed for IGCC	CFB for IGCC
	Bubbling fluidized bed for CHP (gas engine)	BFB for CHP
	Circulating Fluidized bed for syngas production	CFB for syngas
	Dual Fluidized bed for CHP (gas engine)	DFB for CHP
	Dual Fluidized bed for syngas production	DFB for syngas
	Entrained flow for syngas production	Entrained flow for syngas
	Fixed bed (downdraft) for CHP (gas engine)	Fixed bed for CHP

	Fixed bed (updraft), direct combustion	Fixed bed, direct combustion
	Bubbling fluidized bed for IGCC	BFB for IGCC
	Bubbling fluidized bed for syngas production	BFB for syngas
Syngas platform	Fluidised bed gasification for methanol production	Syngas to methanol
	Indirect gasification for SNG production	Producer gas to biomethane
	Fluidised bed gasification for FT-fuels production	Syngas to FT-diesel
Fast pyrolysis	Pyrolysis plus boiler for heat and steam	Fresh wood chips to pyrolysis oil
		Agricultural residues to pyrolysis oil
		Pyrolysis oil to heat
		Pyrolysis oil to steam
	Pyrolysis and hydrogenation for diesel fuel	Pyrolysis oil diesel
	Pyrolysis oil and diesel engine for electricity	Pyrolysis combustion engine (compression-ignition)
		CHP Gas Turbine
	Pyrolysis plus boiler for heat and steam	Pyrolysis plus boiler for heat, integrated
	Pyrolysis plus boiler for heat and steam	Pyrolysis plus boiler for steam, integrated
	Pyrolysis oil and diesel engine for electricity	Pyrolysis plus combustion engine, integrated
	Pyrolysis oil and diesel engine for electricity	Pyrolysis plus CHP, integrated
Torrefaction	Moving bed reactor	torrefaction and pelletisation (TOP)
(Bio-)chemical conversion technologies		
Techniques from pulp and paper industry	Kraft process with LignoBoost process	Kraft process with Lignoboost
	Prehydrolysis Kraft process in water phase	Prehydrolysis kraft
Chemical pretreatment	Alkaline hydrolysis	Alkaline hydrolysis
	Dilute acid hydrolysis	Dilute acid hydrolysis
Biochemical hydrolysis and fermentation	Enzymatic hydrolysis	Enzymatic hydrolysis alkaline pretreated
		Enzymatic hydrolysis acid pretreated
	Fermentation	Fermentation alkaline pretreated
		Fermentation acid pretreated
Biochemical ethanol and biobased products	Ethanol production	Ethanol from lignocellulose (dilute acid pretreatment)
		Ethanol from lignocellulose (alkaline pretreatment)
Treatment in subcritical water	Aqueous Phase Reforming	Aqueous Phase Reforming
Anaerobic digestion technologies		
Anaerobic digestion	Complete mix digester	Complete mix digester state of the art 2014
Anaerobic digestion	Plug flow digester	Dry Batch Digestion (MSW)

Abbreviations:

BFB: bubbling fluidized bed; CFB: circulating fluidized bed; CHP: combined heat and power; DFB: dual fluidized bed; FT: Fischer-Tropsch; IGCC: integrated gasification combined cycle; MSW: municipal solid waste; PC: pulverized coal-fired boiler; SNG: synthetic natural gas.

Appendix B. Biomass categories in the biomass properties database

Table B1 Subcategories of first level category 1 "Forestry"

Second level subcategories		Third level subcategories		Final level subcategories	
ID	Name	ID	Name	ID	Name
11	Production from forests	111	Stemwood from final fellings &thinnings	1111	Stemwood from final fellings originating from nonconifer trees
				1112	Stemwood from final fellings originating from conifer trees
				1113	Stemwood from thinnings originating from nonconifer trees
				1114	Stemwood from thinnings originating from conifer trees
12	Primary residues from forests	121	Logging[1] residues from final fellings &thinnings	1211	Logging residues from final fellings from nonconifer trees
				1212	Logging residues from final fellings from conifer trees
				1213	Logging residues from thinnings from nonconifer trees
				1214	Logging residues from thinnings from conifer trees
		122	Stumps from final fellings &thinnings	1221	Stumps from final fellings originating from nonconifer trees
				1222	Stumps from final fellings originating from conifer trees
				~~1223~~	~~Stumps from thinnings originating from nonconifer trees~~
				~~1224~~	~~Stumps from thinnings originating from conifer trees~~

[1] In the sense of "Standard" logging residues, thus excluding stamps, on second level 121 and 122 are both "logging residues.

Table B2 Subcategories of second level category "21 Primary production of lignocellulosic biomass crops

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
211	Energy grasses, annual & perennial crops	2111	Sweet and biomass sorghum (Annual grasses)
		2112	Miscanthus (Perennial grass)
		2113	Switchgrass (Perennial grass)
		2114	Giant reed (Perennial grass)
		2115	Cardoon (Perennial crop)
		2116	Reed Canary Grass (Perennial grass)
212	Short rotation coppice	2121	SRC Willow
		2122	SRC Poplar
		2123	Other SRC

Table B3 Subcategories of second level category "22 Agricultural residues"

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
221	Straw/stubbles	2211	Rice straw
		2212	Cereals straw
		2213	Oil seed rape straw
		2214	Maize stover
		2215	Sugarbeet leaves
		2216	Sunflower straw
222	Woody prunning & orchards residues	2221	Residues from vineyards
		2222	Residues from fruit tree plantations (apples, pears and soft fruit)
		2223	Residues from olives tree plantations
		2224	Residues from citrus tree plantations
		2225	Residues from nuts plantations

Table B4 Subcategories of second level category "23 Grassland"

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
231	Grassland	2311	Unused grassland cuttings (abandoned grassland, managed grasslands not used for feed)

Table B5 Subcategories of "3 Other Land use"

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
311	Biomass from other areas under landscape maintenance	3111	Grassy biomass from landscape maintenance (recreational and nature protection areas, dykes)
		3112	Woody biomass from landscape maintenance (landscape elements)
312	Biomass from road side verges	3121	Grassy biomass from road side verges
		3122	Woody biomass from road side verges

Table B6 Subcategories of second level category 41 "Secondary residues from wood industries"

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
411	Saw mill residues	4111	Sawdust from sawmills from conifers
		4112	Sawdust from sawmills from nonconifers
		4113	Sawmill residues: excluding sawdust, conifers
		4114	Sawmill residues: excluding sawdust, nonconifers
412	Other wood processing industry residues	4121	Residues from industries producing semi -finished wood based panels
		4122	Residues from further wood processing
413	Secondary residues from pulp and paper industry	4131	Bark residues from pulp and paper industry
		4132	Black liquor

Table B7 Subcategories of "42 Secondary residues of industry utilising agricultural products

Third level subcategories		Final level subcategories	
ID	Name	ID	Name
421	By-products and residues from food and fruit processing industry	4211	Olive-stones
		4212	Other by-products and residues from food and fruit processing industry
422	Other industry by-products utilising agricultural products	4221	Cotton_acorn
		4222	Other industry by-products utilising agricultural products

Table B8 Subcategories of "Waste"

Second =Third level subcategories		Final level subcategories	
ID	Name	ID	Name
51/511	Biodegradable municipal waste	5111	Biowaste as part of integrally collected municipal waste: Biodegradable waste of not separately collected municipal waste (excluding textile and paper)
		5112	Separately collected biowaste: Biodegradable waste of separately collected municipal waste (excluding textile and paper)
52/521	Post consumer wood	5211	Hazardous post consumer wood
		5212	Non hazardous post consumer wood