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

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S2Biom Guidelines

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About 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, 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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Overview of research aim and work within the S2Biom project

The overall aim of S2Biom project has been to:

'support 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" planning toolset (and respective databases) with up to date harmonized datasets for EU, western Balkans, Turkey, Moldova and Ukraine. The spatial level of analysis both for the toolset and the databases includes NUTS1 (country), NUTS2 (regional) and NUTS3 (local level).[1]

Research work has *covered the whole biomass delivery chain from primary biomass to end-use of non-food products and from logistics, pre-treatment to conversion technologies.* All these aspects together have been elaborated to facilitate the integrated design and evaluation of optimal biomass delivery chains and networks at European, national, regional and local scale to define synergies and potential conflicts at local/ regional level of application and further support the development of strategies for best ways to realise a biobased economy.

Key to the success, cost efficiency and value for money of this project has been the utilisation of up-to-date, relevant information and data, including the following:

i. drawing upon BEE, CEUBIOM, Biomass Futures, Biomass Trade Centres, CAPRI, Sector, and Bioboost projects;
ii. selecting, interpreting and undertaking validation case studies – such as those on-going within the Logistec, INFRES and Europrunning FP7 logistics research projects; and
iii. close collaboration with key stakeholders from policy, industry and market sectors.

Table 1 Progress research in S2Biom

Input from the other projects	How has it been used in the S2Biom research?
BEE (Biomass Energy Europe): This FP7 project focused on a methodological harmonization of the assessment of biomass for energy by analysing both existing available assessments, methodologies and input data as well as gaps and divergences in these three domains resulting in a	BEE results in form of the hand books have been used as a baseline for the assessment of the potential biomass supply both in form of statistics but as well as in form of maps for EU27 and Western Balkans, Moldova, Ukraine and Turkey. Methodologies described there have been further developed regarding

[1] See: http://en.wikipedia.org/wiki/Nomenclature_of_Territorial_Units_for_Statistics

methods hand book, a data handbook, a test of the methods described in a set of test cases and in recommendations for future improvements.	the gaps and development priorities identified by BEE. Moreover, they were integrated in data preparation tools in order to simplify future updates of supply data.
CEUBIOM (Classification on European Biomass Potential for Bioenergy using Terrestrial and Earth Observations): This FP7 project was a parallel project to the BEE project which complemented BEE research by focusing on the development of methods for gathering information on biomass potential by combining terrestrial and earth observations and disseminating information, best practices and methodology on using earth observations in the assessment of biomass potential.	CEUBIOM results are especially relevant for application in areas with extensive coverage with terrestrial data and / or LIDAR data. Parts of the developments of the S2Biom project have been based on methods resulting from CEUBIOM. As key partners of S2Biom also cooperated in the CEUBIOM project, they have provided input on methodological developments (e.g. pre-processing methods, methods for validation, estimation based on combined terrestrial / EO data) as well as terrestrial data and EO data for selected test sites.
Biomass Futures: The Intelligent Energy Project, Biomass Futures (2009-2012) estimated the role biomass can play to meet the 2020 RED targets at EU27 and MS through a demand-supply analysis and extensive consultation with stakeholders across Europe. To do so it developed a systematic Biomass cost supply Atlas for EU27 and the RESolve model to address the competition of biomass supply in the three energy markets (heat, electricity and transport). Furthermore, a set of sustainability criteria and indicators for bioenergy was developed which goes beyond the RED to address all bioenergy.	S2Biom has built on this and i) refined the cost supply Atlas for EU27 and increased the energy crop species included ii) extended the RESolve modelling capacity to include all the energy and biobased product markets (through biorefining) so that the role of biomass in the future bioeconomy can be estimated for different regional and temporal scales, and iii) extended the sustainability criteria and indicators to cover all lignocellulose biomass use.

Biomass Trade Centers: IEE Project Biomass trade centre II (2011-2014): »Development of biomass trade and logistics centres for sustainable mobilisation of local wood biomass resources« aims at increasing the production and the use of energy from wood biomass by organising motivation events that will engage identified target groups to invest in biomass business and biomass logistic and trade centres (BLTC) in 9 EU countries (Austria, Croatia, Germany, Greece, Ireland, Italy, Romania, Slovenia and Spain), by presenting clear, integrated and market orientated information to potential investors: farmers and forest owners, forest entrepreneurs, wood energy contractors and other stakeholders regarding business opportunities to produce and sell energy products and services to the market. It will also foster wood energy contracting between biomass providers and potential users. (www.biomasstradecentre2.eu).	In the frame of S2Biom project feasibility studies for selected cases have been prepared, taking in to account potentials in the regions, present users of biomass and all economical aspects. Input information has also been used in the S2biom logistics research work.
Bioboost: In the currently on-going Bioboost (www.BioBoost.eu) project costs of lignocellulosic biomass sources in EU-27 will be determined.	These data have been taken into account within the research work in S2Biom.

Atlas & databases for sustainable biomass cost supply in Europe

Aim of S2Biom research:

- Validate, update and improve the recent (2010-2012) datasets of BEE and Biomass Futures[2] projects on types and quantities of sustainable lignocellulosic biomass potentials at NUTS2 disaggregation level for EU.
- Use BEE harmonised methodological approach for biomass assessments to update respective information for EU and further estimate consistent data for the Western Balkans, Moldova, Ukraine and Turkey.
- Use and further develop CEUBIOM & BEE methodologies to generate spatially explicit data on biomass supply on large scale and by integrating LIDAR data on local scale.

Key output: Provision of comprehensive biomass cost supply data across fifty (50) lignocellulosic feedstock types from forestry, agriculture and wastes for 37 countries at NUTS2 & NUTS3 geographic disaggregation levels.

More information on:

http://s2biom.alterra.wur.nl/web/guest/biomass-cost

Username: demo

Password: helsinki

Key deliverables

(can be downloaded in http://www.s2biom.eu/en/publications-reports/s2biom.html)

- D1.1 Roadmap for regional end-users on how to collect, process, store and maintain biomass supply data
- D1.2 Draft of geoforced database
- D1.3 Draft of overview and description of relevant projects, sources and tools on biomass cost supply
- D1.4 Draft atlas with regional cost supply biomass potentials
- D1.5 Fully populated georeferenced database
- D1.6 Overview and description of relevant projects, sources and tools on biomass cost supply
- D1.7 Best practice guidelines on the maintenance and regular up-date of all the cost supply data

2 http://www.biomassfutures.eu/public_docs/final_deliverables/WP3/D3.3%20%20Atlas%20of%20technical%20and% 20economic%20biomass%20potential.pdf

- D1.8 Atlas with regional (NUTS2/3) cost supply biomass potentials for EU; Western Balkans, Ukraine, Turkey and Moldova.

Baseline from which the project started

Up to now, most of the recent research work on biomass availability and supply data has been driven by the high demand in the bioenergy and biofuels sectors. As the biobased economy evolves to cover a wider range of markets and end products it is important that future research and development work should carefully examine the synergies/ conflicts and interdependencies amongst the different feedstocks and develop coherent indicators for careful evaluation of their quantity and quality attributes and costs associated with their production/ collection.

Approach for biomass potentials: The most recent attempt to harmonise assumptions and provide a coherent methodology for biomass assessments in Europe has been in the framework of the Biomass Energy Europe (BEE) project (www.eu-bee.com/), which resulted (2010) in a set of harmonised methodologies for biomass resource assessments for energy purposes in Europe and its neighbouring countries in order to improve consistency, accuracy and reliability as well as serve the future planning towards a transition to renewable energy in the European Union itself.

Atlas on biomass feedstocks: The Biomass Futures project (http://www.biomassfutures.eu/) resulted (2012) in a coherent Atlas of sustainable biomass cost supply in EU27 with disaggregated data at NUTS2 level, for a variety of feedstocks including all lignocellulosic biomass types (from agriculture, forestry and waste sectors- including residual and cropped options). For the Atlas in combination with EEA (ETC-SIA) an assessment was also made of the sustainable potential and production cost for perennial biomass crops for EU-27. It estimated the potential on released land (assessed with the CAPRI model) in different scenarios taking account of sustainability criteria regarding no-go areas and minimal mitigation thresholds. This assessment was however only done using a limited suit of perennial crops (3 grassy crops and SRC willow) based on a limited number of EU wide field observations of attainable yields and costs.

Cost estimates: Estimates of biomass cost-supply for current and for different scenario situations in EU27 have been done in several projects of which an extensive inventory was made as part of BEE. In Biomass Futures, a further quantification of both cost and supply for current, 2020 and 2030 situation was also made from primary, secondary and tertiary resources from waste, forest and agriculture sector was made taking account of environmental constraints. As to the forest potential the Biomass Futures project build on the results from the EU-Wood project[3], but for the other sectors new quantified assessments were made. Also in the Bioboost (www.BioBoost.eu) project costs of lignocellulosic biomass sources in EU have been determined.

Regional coverage: The most recent datasets for lignocellulosic biomass feedstocks include only detailed analysis for the EU and the respective Member States. Still even the EU related assessments for lignocellulosic energy crop species were still fragmented and included only a limited number of species. Additionally, for the other countries covered in S2Biom (Western Balkans, Moldova, Ukraine and Turkey) only fragmented efforts and studies existed that do not of course use the most recent methodological concepts and tools.

Baseline from which the project started: This project has built on biomass assessments that have been performed in Biomass Futures project which produced a coherent Atlas of sustainable biomass cost supply in EU with disaggregated data at NUTS2. It also took the BEE harmonised methodology for biomass resource assessments for energy purposes in Europe as a starting point for the analysis.

Progress beyond the state of the art

Atlas for biomass in Europe: The Biomass Futures Atlas has been refined as follows: a) it took full account of the BEE harmonised methodology and b) it included a higher number of lignocellulosic perennial crop species assessed for their suitability in the different agro-ecological zones of Europe and c) it has higher resolution level (NUTS3) for all lignocellulosic feedstocks under study. S2Biom has focused on non-food lignocellulosic biomass feedstocks and provided improved and higher spatial and temporal resolution estimates for EU27 and expand the regional coverage to include Western Balkans, Ukraine, Moldova and Turkey considering the appropriate sustainability and demand criteria. The latter are more relevant from the perspective of resource efficient use of biomass and from the perspective of novel conversion and pre-treatment technologies. Collaboration with recent FAO in the non-EU region (Western Balkans, Moldova, Ukraine and Turkey) took place by i) inclusion in the partnership of a representative range of partners and national experts as well as CEI which represents most of these countries at policy level, ii) building on the recent research work in the region in the field of biomass resource assessments performed by the Scientific coordinator, Imperial College and University of Freiburg, iii) direct involvement in the Policy and Industrial Advisory Committee of the FAO responsible for the forest research work in the region and iv) extensive stakeholder consultations.

Remote sensing and spatial analysis: Furthermore, the project developed new approaches to making more accurate and spatially detailed estimates of biomass

[3] Mantau et al., 2010:
http://ec.europa.eu/energy/renewables/studies/doc/bioenergy/euwood_final_report.pdf

resources especially from forests, agricultural residues, perennial biomass crops and secondary and tertiary lignocellulosic waste resources. Attention has been paid to gap filling of biomass resources for which accurate estimates have not been produced until now. One of these was the potential from dedicated perennial crops to be grown on abandoned and/or marginal lands.

Methodology for projection of future biomass supply and LCA: The LCA results have been used to “screen” the biomass potentials for compliance with the sustainability criteria (GHG, land, etc.), and the projections for future biomass supply will be used also to define the LCA background data (future bioenergy shares in electricity, heat, transport) so that the results are consistent.

The involvement of integrated spatial assessment techniques and crop growth and environmental impact models and LCAs combining statistical, bio-physical and environmental information. This innovative approach facilitated the development of optimal land allocation maps (GIS) for lignocellulosic crops and enabled prioritisation at regional level.

Industrial conversion pathways for lignocellulosic biomass in Europe

Aim of S2Biom research

- To identify and extensively characterise existing and future non-food biomass conversion technologies for energy and bio-based products.
- To develop a standardized methodology according to which the different lignocellulosic biomass categories need to be characterised.
- To assess the optimal match of biomass categories of different quality with the existing and future non-food biomass conversion technologies.

Key outputs

- A conversion technology database was developed with, describing the characteristics of fifty (50) key biomass conversion technologies in detail.
- A biomass characteristics database was developed, describing the characteristics of fifty (50) key lignocellulosic biomass types in detail.
- A methodology was developed to find the optimal match between different types of biomass and conversion technologies, based on both their characteristics.
- This methodology was implemented in the Bio2Match tool, by which a user can establish which technologies match with which types of biomass, based on the collected information (databases) and the matching methodology.

Key deliverables

- D2.1: A method for standardized biomass characterisation and minimal biomass quality requirement for each biomass conversion technology.
- D2.2: A selection method to match biomass types with the best conversion technologies.
- D2.3: Database of conversion technologies.
- D2.4: Database for standardized biomass characterisation.

Baseline from which the project started

Biomass conversion technologies (including bio-refineries) form the essential link between the different available lignocellulosic biomass sources with their wide range of properties and the different identified end uses and markets. The European biorefinery sector will evolve from established biorefinery operations for products like food, biofuels, paper and board, to a broader, more mature sector. In 2030 biorefineries will use a wider range of feedstocks and will produce a greater variety of end-products than today.

Each conversion technology has specific biomass input requirements (i.e. cellulose, hemicellulose, lignin content, moisture content, minerals like chlorine, particle size etc.), while the quality of biomass differs largely between the different biomass types, harvest and drying techniques, and pre-treatment technologies. Also regionalised differences have to be taken into account (for instance increased chlorine content in coastal areas). Obviously, some biomass types can be used in many different technology options, while others are hard to process or will need extensive pre-treatment.

The project will describe the state of art of a wide range of existing and future (up to 2030) conversion technologies and build among others on EU projects like EMPYRO, Supra-Bio, SuperMethanol, BioCoup, Bioliquids-CHP, BioSynergy, Optima, Sector, BioBoost, etc.

Progress beyond the state of the art

In this project a database and method was developed to match the available non-food lignocellulosic biomass feedstocks with the most suitable conversion technologies, considering the pyramid of end use applications (materials, chemicals, fuels, energy). The method was built on the available information on the specifications from the various conversion technologies and on the biomass characteristics. An analytic tool was developed (Bio2Match) for viewing the characteristics of conversion technologies and guiding the user to find the optimal match between biomass sources of a certain quality with pre-treatment and conversion technologies.

By implementing the use of a "value chain" concept, a key gap that was covered is the systems integration of different technologies with different functions across the value chain such as densification, pre-processing, intermediates production and production and use of final energy vectors. Without such a representation, technologies are considered in isolation and it is very hard to identify the most promising technologies without understanding their role in the overall bio-based system.

European projects R&D and demonstration projects have investigated a wide variety of conversion pathways including those of heat & power, advanced (lignocellulosic) biofuels, biorefinery and bio-based products. Many of these projects have concluded that the techno-economic viability and/or sustainability could not be achieved yet. Important arguments were among others the difficulty to gather larger amounts of suitable and sustainable feedstock, at the envisaged location for acceptable cost. A variety of concepts like supply of energy crops, biomass hubs at central locations or several decentral pre-treatment plants towards an high energy density energy carrier which is then transported to a large scale facility for final processing have been developed. Common to all of them is the targeting of single issues in the supply chain.

In the case of biofuels both essential conversion technologies towards advanced biofuels like the fermentation of lignocellulosic feedstock to alcohols or gasification followed by synthesis to gasoline, DME or diesel demand large scale processing plants which are difficult to supply with feedstock of acceptable costs and good environmental performance from local or regional sources. Year-round availability, feedstock quality, flexibility and variability of the processes are further important issues not sufficiently solved yet. Similar gaps are associated to cofiring plants, the supply of CHP`s or biorefineries.

The information that was brought together by the S2Biom partners in both this work package and in work packages 1 and 3 on biomass availability and logistics are readily accessible in the form of tools and direct database access. In this way a stakeholder in the bioeconomy can easily obtain crucial information about the entire value chain that he or she envisages. The biomass characteristics and conversion technology information that was collected and made available in this work package (easily accessible via databases and the Bio2Match tool) provides a central and indispensable part of these potential value chains.

In this way S2Biom provides tools that allow for an optimized exploitation of existing feedstock sources across borders and frontiers as well as allowing local communities to identify domestic sustainable feedstocks.

Tools to evaluate promising logistics supply chains at local, regional and pan- European levels that will further inform the elaboration of implementation plans.

Aim of S2Biom research

The efficiency at which lignocellulosic biomass feedstock can be used for producing biobased (including bioenergy) services is very important. In this respect biomass feedstock poses a real logistical challenge as the quality and handling characteristics, and often also moisture content of biomass often restrict the available options for efficient logistics and of efficient conversion into bio-energy, biofuels, biochemicals and biobased products. The various factors that affect biomass feedstock quality for thermal and biochemical conversion need to be optimized through the optimal design of sustainable biomass feedstock supply chains.

Key outputs

An integrated logistical toolset was built and applied to design and assess the logistics of lignocellulosic biomass values chains. This toolset is based on i) a newly designed logistical component database, ii) a formal description of logistical concepts that were identified in various EU-projects (like Bioboost, Biomass Trade Centers, LogistEC, Europruning and INFRES) and iii) both new and existing logistical assessment models (BeWhere, LocaGIStics and Witness Truck Transport Logistics). The integrated toolset was used to perform three regional case studies (Burgundy, Aragon and the Province of Central Finland) aimed at optimizing the logistics. Furthermore, an analysis was performed mainly with the BeWhere model to assess logistics on the national and EU level. These case studies show the importance of applying a variety of logistical concepts like an optimal combination of biomass types, multi-assortment collection systems, densification (pelletizing), biocommodities, intermediate collection points and small-scale versus large-scale conversion. However, it is recommended to always perform a dedicated regional assessment when setting up new projects, since there are many regional differences that influence the optimal set-up of a logistical chain.

Key deliverables

- D3.1 & D3.3 Database containing a description of about 230 logistical components.
- D3.2 Theoretical description of 6 main logistical concepts combining these logistical components.
- D3.5 A stepwise approach using an integrated toolset containing:

- a new tool to assess regional logistical biomass chains, called LocaGIStics;
- an existing tool, called BeWhere, aimed at the national and EU-level;
- a new detailed simulation model for woody biomass chains, called Witness Truck Transport Logistics;

- D3.4 & D3.6 Three regional case studies assessing various logistical concepts.

Baseline from which the project started

a) Ash content and –composition - Many biomass feedstocks contain larger amounts of inorganic components (generally referred to as ash) compared to the clean wood fuels that are currently being mobilised and used for (co-)firing. In addition, the composition of the ashes is such that the biomass fuels exhibit a poor quality for thermal combustion or gasification, as they lead to a relatively low ash melting point. It is anticipated that a larger number of biomass feedstocks will become suitable for energy conversion, if they first pass through a decentralised pre-treatment process e.g. at biomass hubs.

b) Heterogeneity of feedstocks - Many available biomass feedstocks are currently not used for energy conversion, as they are very heterogeneous in nature, which makes the large-scale conversion in energy conversion systems expensive. Thus, heterogeneous feedstocks are either not used for conversion, or they need to undergo costly pre-treatment, such as size reduction (milling), screening, and/or pelletisation. This makes the conversion of low cost biomass feedstocks often economically unfeasible.

c) Fragmented supply chains - In combination with the two previous quality aspects (ash quality, heterogeneity), the fragmented availability of many biomass feedstocks often leads to biomass feedstocks not being used for energy conversion, combustion for electricity generation. The fragmented supply results in high costs for collection and transportation, whereas it is often not feasible to develop optimized supply chain systems for every biomass feedstock. Although fragmented supply is an intrinsic quality of biomass, it is envisioned that decentral pre-treatment facilities that can accept a much wider group of biomass feedstock will also incur lower feedstock cost, for these fragmented feedstocks.

Progress beyond the state of the art

Logistics in an integrated value chain framework: The integration of new logistics concepts (e.g. storage and pre-treatment at intermediate biomass hubs) together with emerging near-farm pre-processing and densification technologies (e.g. pelletisation to produce bio- commodities) in an optimisation framework will facilitate the identification of new logistics systems. This will reduce the issues around trading off economies of scale in conversion with the logistics costs of feedstock supply, which have hampered the emergence of the bioenergy system to date.

A comprehensive list of properties of logistical components was drawn up based on the expert knowledge and experience of the partners in WP3 (see D3.1). These properties were divided in the following groups: general, technical, biomass input specifications, biomass output specifications, financial and economic and other. Then an overview was given of different main categories of logistical components. For each of these main categories further subcategories were given. This way a standardised method was developed that could be used to store information about logistical components that were found in literature, in European and national projects, through a market inventory and through consultation with scientific and industrial stakeholders. After two rounds of entering logistical components in the database, a total of 230 data records were present (see D3.3). The majority of records can be found in the main category comminution (size reduction), followed by transportation and harvesting/collecting. The other main categories feedstock handling, storage, drying and compaction are only little represented.

A logistical concept is broader and more general than a specific biomass value chain. A chosen logistical concept always still needs to be further specified and translated to obtain a specific biomass value chain (specify all the components). Often several possible biomass value chains fit within that general logistical concept. Several EU research projects are dealing with the logistics of biomass value chains. Examples were described of biomass value chains that were studied in these projects and that could be relevant for description of logistical concepts within the S2Biom project. This led to the identification of the following logistical concepts that were assessed on their advantages and disadvantages (see D3.2):

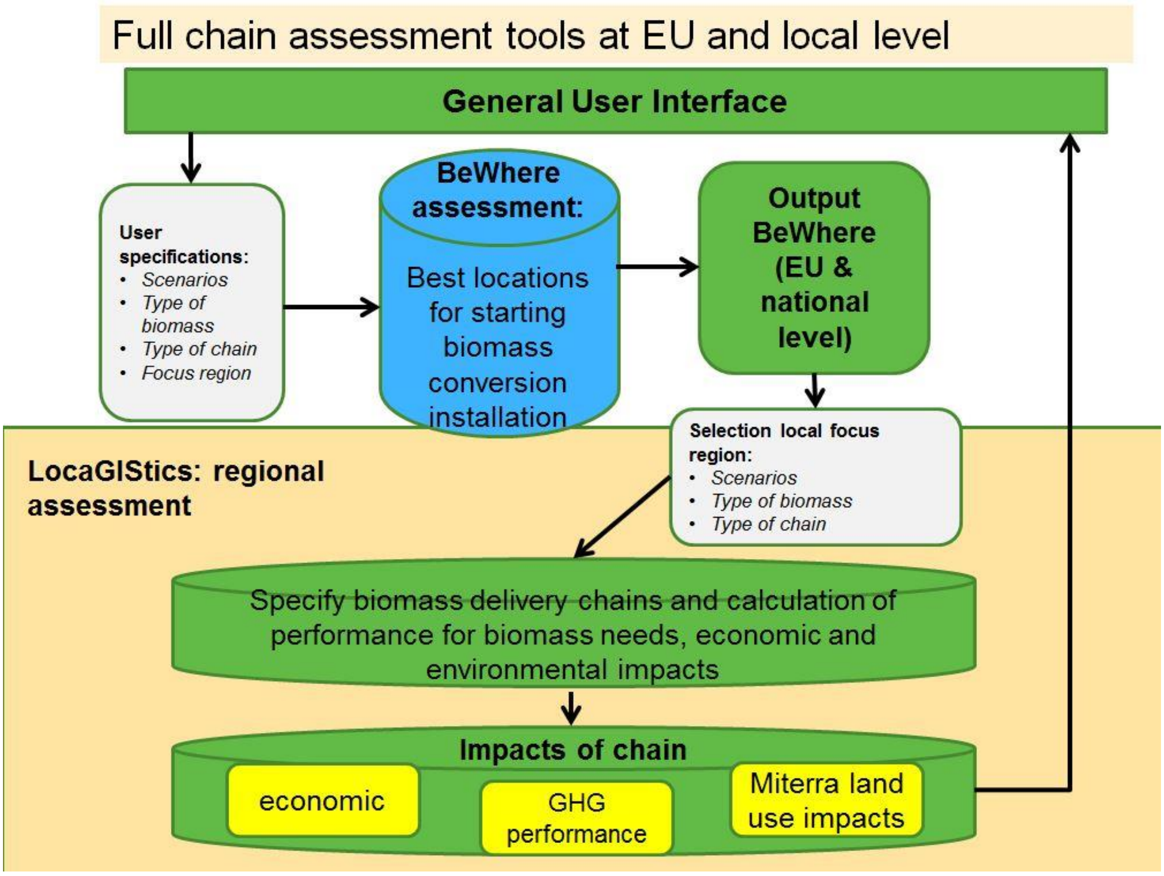
- pre-treatment (e.g. comminution and densification) integrated with harvesting/collecting versus stand-alone pre-treatment later on in the biomass value chain;
- indirect supply to the final conversion location through biomass yards (often in combination with intermediate storage and pre-treatment) versus direct supply from road-side;
- multi-modal transport (combination of different transport types) versus only one transport modality (road, water, rail);
- European/world-wide biomass value chains based on standardized biocommodities (e.g. wood pellets, ethanol or pyrolysis oil) versus regional biomass value chains based on locally sourced ‘raw’ biomass;
- ‘light’ pre-treatments (like comminution, densification, drying, etc.) and/or storage at a de-central (at road site), intermediate (at biomass yard) or central (at conversion site) location;

- 'intensive' pre-treatments like (catalytic-) pyrolysis, hydrothermal carbonisation, torrefaction in decentral plants with feedstock capacities up to several 100,000 t/a, efficient energy carrier transport (by railway) to central plants for upgrading to final energy product;
- many small-scale conversion plants versus only one large-scale conversion plant to meet product demand.

Three logistical assessment methods have been integrated in the toolset for assessments in the logistical case studies (see D3.5) viz.:

- BeWhere for the European & national level;
- LocaGIStics for the Burgundy and Aragón case study at the regional level;
- Witness simulation model for the Finnish case at the regional level .

BeWhere and LocaGIStics have been closely interlinked so that LocaGIStics can further refine and detail the outcomes of the BeWhere model and the BeWhere model can use the outcome of the LocaGIStics model to modify their calculations if needed. The relationship between BeWhere and LocaGIStics in the S2Biom project is given in the figure below.



Relation between BeWhere and LocaGIStics.

The Witness simulation model was only used for the Finnish case study. The *Truck Transport Logistics* -simulation model was compiled in Witness simulation software and combined with an Excel-spreadsheet environment. This enabled us to study the transport logistics of timber trucks from roadside storages to end-use facilities.

The logistical cases studies in WP3 follow a practical stepwise approach for the design and implementation of optimal sustainable biomass delivery chains as was described in D3.5. The logistical stepwise approach was used as basis for the development of a set of tools within WP4. A case based approach was followed, where optimal logistical concepts or conceptual designs were matched with the specific situation in three logistical case studies in cooperation with WP9 'Regional adaptation & application, user integration, testing, validation and implementation planning'. The chosen advanced regional case studies are (see D3.4+D3.6):

1. Small-scale power production with straw and Miscanthus in the Burgundy region (France)
2. Large-scale power production with straw and with woody biomass in the Aragon region (Spain)
3. Advanced wood logistics in the Province of Central Finland

Data on biomass availability (WP1) and technical demand specifications (WP2) in combination with data on logistical components and concepts (WP3) have been used to provide guidelines for the case study partners in WP9 to construct relevant cases. These advanced regional case studies can be seen as an example for most regions in the EU-27.

S2Biom computerised toolset

Aim of S2Biom research

Develop a user friendly computerised tool enabling easy access and integrated use of the SRT material developed in this project

Key outputs

An open access online computerised toolset. which facilitates the evaluation of optimal biomass delivery chains at European, national, regional and local scale and informs the development of strategies for best ways to realise a biobased economy.

Key deliverables

- D4.1 Draft structure of the database
- D4.2 Draft structure of the general user interface (GUI)
- D4.3 Fully populated database including all data accumulated in the project and used by the tools included in the Toolset
- D4.4 Final version of data viewer, download and analysis tool for biomass cost-supply
- D4.5 Final version of tool for viewing characteristics of technologies and matching biomass to pre-treatment and conversion technologies
- D4.6 Final Tool for viewing market demand and policies for biomass for bioenergy and biobased products
- D4.7 Validated tool for optimal design and evaluation of biomass delivery chains and network s at national and Pan-European scale
- D4.8 Validated tool for optimal design and evaluation of biomass delivery chains at regional and local scale
- D4.9 Comprehensive general user interface (GUI) that integrates different existing and new tools and datasets
- D4.10 A full technical description of the integrated toolset, central database and general user interface developed
- D4.11 A user guide for the integrated toolset, central database and general user interface (GUI)

Baseline from which the project started

Most tools developed till the beginning of the S2Biom project provided understanding and support in setting up biomass delivery chains by addressing and facilitating one of the many aspects that need to be addressed when setting up a biomass delivery chain. The facilitation on both the design of a biomass delivery chain and the assessment of the biomass delivery chain impacts in terms of spatial, environmental and economic implications had also already been integrated then in the BeWhere and the ME4 tools. These provide a very complete support to end-users, but are now still only applicable to a limited number of biomass delivery chains. Both tools work on a different scale as ME4 only does regional level designs and assessments and was developed for the Netherlands only and BeWhere works at national and EU wide scale.

Progress beyond the state of the art

In S2Biom both BeWhere and the ME4 tools have been used as a basis for further work to ensure local, regional and national level coverage options. The current tools can be applied at the moment to a limited number of conversion technologies but in the framework of the project they will be further developed for covering:

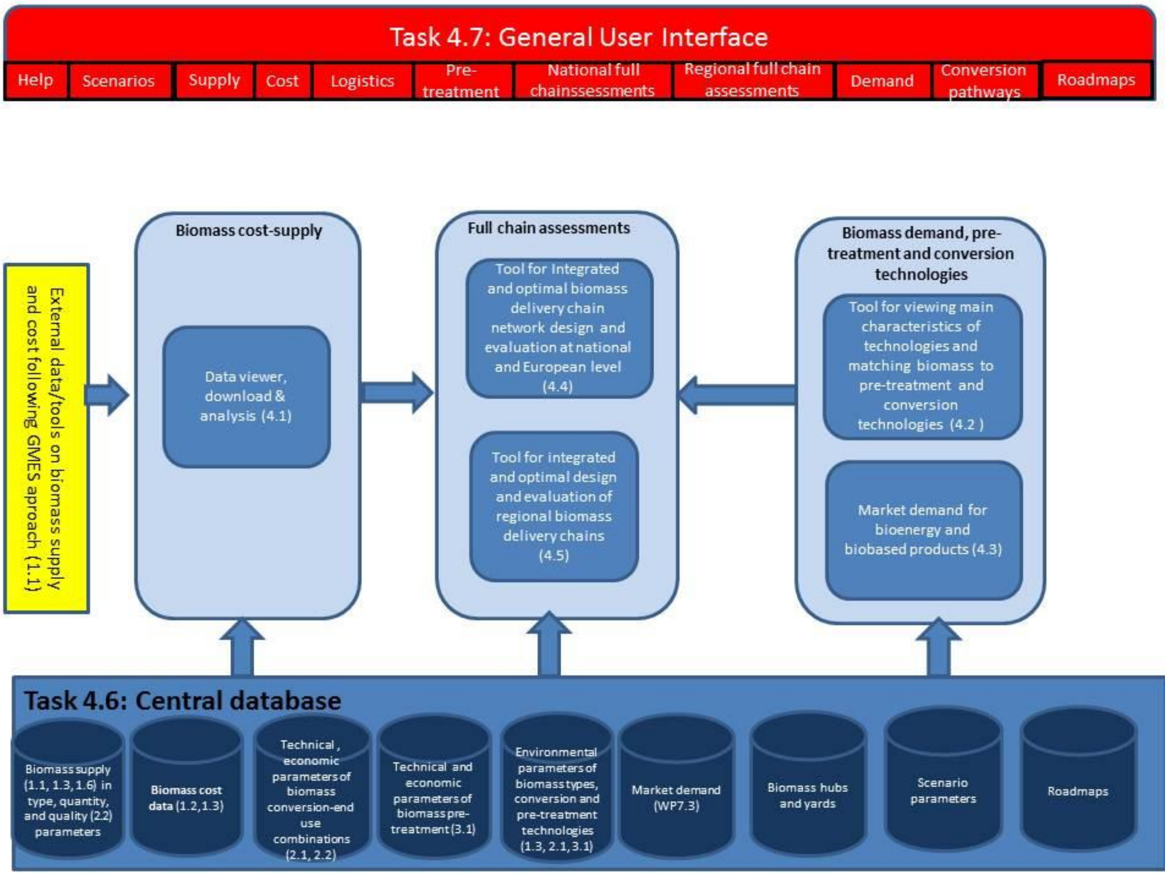
- a broader territory at local, regional and national level and a wider number of conversion technologies- expanding to bio-based products
- including pre-treatment and logistical concepts such a hubs and yards taking account of the 4) up-dated and improved biomass cost-supply,
- sustainability constraints and resource efficient optimisation
- demand from markets and influenced by policies and
- end-user requirements (WP9) for such an integrated tool.

The S2Biom toolset provides functionalities which include:

i. Display and download of all parameters contained in the databases and generated in the different WPs related to the delivery of sustainable non-food biomass feedstocks in Europe.
ii. Provision of selection and conversion functionality to choose and switch units/currencies, select desired biomass feedstocks, zoom in desired areas and perform simple user-weighted analyses of the sustainability of the quantities shown in a variety of units exceeding energy and related to the biobased products as well (e.g., tonnes dry mass, tonnes/ha, kJ, in €/tonne d.m., €/GJ).
iii. Quantified and objectively scaled sustainability performance of the biomass supply in relation to key sustainability criteria

In addition, a general user interface (GUI) has been developed to provide easy use and access through the internet to all the strategies, roadmaps and tools developed within this project. It also enables linking the output generated by one tool as the input for the assessment of another tool.

A schematic overview of the S2Biom toolset is presented in the following figure.



Overview of Toolset to be developed in S2Biom

Sustainability

Aim of S2Biom research

Provide clarity - for industry, investors and other stakeholders - on sustainability requirements for the different value chains addressed in the project and to support the future development of an agreed methodology for the calculation of environmental footprints, e.g. using life cycle assessments.

Key outputs

Harmonized sustainability requirements for bioeconomy value chains, including guidelines for methodologies to determine sustainability performance.

Key deliverables

- D5.1 Report on benchmark and gap analysis of criteria and indicators (C&I) in legislation, regulations and voluntary schemes at international, European and MS level
- D5.2 Report on final version of Environmental Footprint methods for non-food biomass supply chains
- D5.3 Summary report on how sustainability aspects of introducing bioeconomy value chains are currently considered
- D5.4 Report on consistent sustainability requirements for bioeconomy value chains, including guidelines for harmonized methodologies to determine sustainability performance
- D5.5 Guidelines on assessing bioeconomy value chain sustainability performance

Baseline from which the project started

The sustainability of bioenergy has been a key issue in the formation of the legally binding criteria of the RED and FQD since 2005, but EU legislation at the start of S2Biom (2013) only addressed biofuels and liquid bioenergy carriers. Since 2008, several communications from the Commission and EU-funded projects and studies (4FCrops, BioBench, BiomassFutures, BioTop, Crops2Industry, EEA and JRC reports), as well as national (e.g. by Austria, Germany, Sweden, The Netherlands, UK) and international bodies (IEA, IEA Bioenergy, FAO, GBEP, UNEP, among others) broadened the view to cover the sustainability of *all bioenergy*, with a respective report (including possibly a proposal for regulation) of the Commission pending. Further work in the EU and beyond began addressing the sustainability of the *overall biomass* use for non-food purposes, i.e. including biomaterials, and biorefineries. As a part of that, significant improvement of knowledge on the sustainability issues of forest bioenergy has been achieved in various fora both within the EU, and internationally, but also questions such as the carbon neutrality of forest bioenergy and biodiversity impacts of intensified extraction of agricultural and forestry residues are still controversial.

Thus, there has been *no consensus or harmonised approach* on how to “frame” the sustainability of the bioeconomy, neither in its environmental nor its economic dimension, and adequate considerations of social aspects such as access to land and water, and food security are lacking, especially regarding feedstock provision impacts in developing countries.

Progress beyond the state of the art

S2Biom has built on the existing knowledge available on the Member State and EU levels, integrated the JRC capabilities on the sustainability domain as well as the international domain (through IEA Bioenergy, and GBEP), collected and compiled respective approaches especially regarding the broader biobased economy, and has developed integrated sustainability criteria for bioeconomy value chains based on lignocellulosic biomass. Furthermore, guidelines for harmonized methodologies to measure and assess respective impacts have been suggested and included in the project toolset. Emphasis has been given to the environmental and social dimensions, while economic issues will be addressed more broadly.

Economic and regulatory framework for the biobased economy in Europe

Aim of S2Biom research

Provide a structured overview of all elements of economic and regulatory frameworks that relate to the sustainable delivery of non-food biomass at different levels of governance across Europe (i.e. local, regional and pan-European), and to develop coherent policy guidelines (with a set of indicators) that will allow policy makers from the respective levels of policy determination to quickly appreciate the support frameworks that exist and the most efficient ways to apply them for the future use of biomass in a sustainable manner.

Key outputs

A database on EU and national level, for all thirty-seven (37) counties analysed in the S2Biom project, and policy guidelines in relation to the mobilization of sustainable non-food biomass for the biobased economy.

Key deliverables

- D6.1 Database on EU level and national level regulatory and economic framework in relation to the mobilization of sustainable non-food biomass for the biobased economy.
- D6.2 Report on benchmarking of country policy approaches.
- D6.3 Report on policy options, with a discussion of pros, cons, points of attention and guidelines.
- D6.4 Advisory document on fields of cooperation and potential synergies between countries and at international level.

Baseline from which the project started

The biobased economy is considered as one of the key elements to achieve a smart and green Europe (EU 2020 Strategy; Bioeconomy Strategy to 2030, etc.). To develop a bioeconomy for energy, fuels and biobased products several challenges need to be addressed, e.g. the competing uses of biomass, and securing a reliable and sustainable supply of biomass feedstock. Over the last decade, various policies in the form of regulations, financing and information provision mechanisms have been put in place to tackle some of these challenges. But we also must consider that various policies (e.g. in relation to agriculture, forestry, waste, environment, energy, trade) on EU, national and regional level exist and are also playing a role in the future implementation of bioeconomy. Some may be contradictory and cause confusion and market barriers, thereby prohibiting the efficient development of the bioeconomy.

The sustainability of bioenergy has been legally addressed in the RED and FQD by establishing mandatory criteria, especially for GHG emissions, biodiversity, and carbon stocks, but these regulations are restricted to biofuels and liquid bioenergy carriers[4]. Important other sustainability issues such as access to land and water, food security etc. are subject only to reporting requirements by economic operators, and the Commission.

Regarding to the non-EU countries under study in the project, it is worth mentioning that in October 2012, Energy Community contracting parties[5] adopted the obligation to implement RED Directive. However, Contracting Parties did not develop specific policies or targets for biomass yet, and there are no specific policies on sustainability of production and use of biomass as well.

Progress beyond the state of the art

Within the EU Member States there is a clear need to give a structured overview of which regulatory and economic frameworks exist at different levels, to benchmark the effectiveness of different approaches and develop coherent policy guidelines to support the sustainable development of the biobased economy.

At the same time, for Western Balkans, Ukraine, Moldova and Turkey it is very important to develop a biomass and biofuels policy that is aiming at fulfilling the EU requirements and more importantly, to provide the emerging bioenergy sector with regulations required for their sustainable growth and performance.

[4] See footnote **Error! Bookmark not defined.**.

[5] Albania, Bosnia & Herzegovina, Croatia, FYROM, Moldova, Montenegro, Serbia, UNMIK, Ukraine/ Turkey is an observer.

Integrated Assessment-Optimisation of biomass supply chains to satisfy the demand

Aim of S2Biom research

Define the optimal pathways (by employing the RESolve model[6]) towards a low-carbon bio-based economy that focuses on stimulating the prioritised biomass applications from 2020 up to 2030.

Key outputs

Integrated cross sector modelling to understand to what extent the additional biomass demand for chemicals and materials could be sufficiently significant to:

- influence lignocellulosic biomass prices and
- induce scarcity and competition issues with energy and fuel applications.

Key deliverables

- D7.1 Extensive description of scenarios in the S2Biom project
- D7.2: Market analysis for lignocellulosic biomass as feedstock for bioenergy, biobased chemicals & materials in Europe; A quantitative estimate of biomass demand in 2020 and 2030
- D7.3: Integrated Assessment of biomass supply chains and conversion routes under different scenarios

Baseline from which the project started

Several integrated assessments on the role of biomass for energy have been conducted in the past decade or so. Integrated assessment models such as TIAM, Green-X and RESolve-Biomass have analysed the role of biomass in the future energy system in various levels of detail. However, a more in-depth system analysis of the possible role of biobased chemicals and materials, and the interactions between energy and chemical/material routes was lacking.

[6] The RESolve model has been extended for the purpose of Biomass Futures by merging several sub-models. RESolve serves as a ‘biomass allocation model’ determining the amount of bioenergy feedstocks going to the different sectors ‘Renewable heat’, ‘Renewable electricity’ and ‘Transport’. There is a sub-model for each of these three sectors, whereby RESolve-T, the transport model, provides the overarching structure and actually integrates the sub-models for heat and electricity as two additional demand segments. RESolve-T is a cost minimisation model, whereas the sub-models for heat and electricity are simulation models. **In this project the RESolve model will be expanded to all biobased sectors for non-food lignocellulosic feedstocks.**

Progress beyond the state of the art

- Scenarios reflecting realistic futures for lignocellulosic biomass as feedstock for biobased economy.
- A better indication of the role that biomass demand from biobased chemicals routes can generate in the period 2020-2030, and the corresponding biomass demand.
- A better understanding of the interactions between pathways for bioenergy and biochemical/materials: to what extent do they compete for resources, to what extent does feedstock limitation influence technology optima, and to what extent do synergies occur between e.g. biofuels and biochemical
- Further understanding of the policy dilemmas for all biobased routes, including e.g. biofuels. Particularly potential ambition levels for advanced biofuels were studied further, and related insights were translated into policy recommendations.
- Based on the S2Biom research and results from the Biomass Policies project (www.biomasspolicies.eu), the resource and technology databases of RESolve-Biomass were expanded and updated.

Vision, strategies, implementation plans and an R&D roadmap

Aim of S2Biom research

Develop a vision, strategies, implementation plans and an R&D roadmap for the sustainable delivery of non-food biomass feedstocks at pan-European level.

Key outputs

Vision for one billion tonnes dry lignocellulosic biomass to supply the biobased economy for 2030.

Strategies to achieve the Vision Statement including the goals, identifying policy and regulatory priorities in the short, medium and longer term as well as appropriate implementation plans at Pan European and regional level.

Thirty-seven country roadmaps with policy recommendations for the development of a lignocellulosic biobased economy by 2030.

Key deliverables

- D8.1 Overview report on the current status of biomass for bioenergy, biofuels and biomaterials in EU, Western Balkans, Ukraine, Turkey and Moldova
- D8.2 Vision document for the future development of the sustainable delivery of non-food biomass feedstock at pan-European level
- D8.3 Strategies and implementation plans identifying policy & regulatory priorities in the short, medium and longer term as well as appropriate implementation plans at Pan European and regional level
- D8.4 Roadmap for sustainable biomass supply at pan European level in order to promote and develop environmentally desirable bio-based materials, power and fuels.
- D8.5 Report on the ex-ante assessment of the key findings and recommended strategies of the project at pan-European and regional level

Baseline from which the project started

The setting up of a Vision for the uptake of biomass in EU has primarily taken place within the respective Technology Platforms (European Biofuels Technology Platform/ EBTP, Renewable Heating and Cooling Platform/ RHCP) and the most recent EC (http://ec.europa.eu/research/bioeconomy /pdf/201202_innovating_sustainable_growth.pdf) and industrial initiatives for the Biobased economy (http://www.cepi.org/node/653)

Though the abovementioned initiatives have successfully set the path towards placing targets for energy, fuels and biobased products in Europe up to 2030, it is widely understood that the wide variety of supply & logistics value chains, the complex interactions of the key market sectors involved - especially expanding from bioenergy and biofuels to the bio-based economy- and the expectations from the advanced pathways, which when fully commercial will facilitate the success of the policy targets, fully justifies the development of a new, coherent and technically substantiated Vision with a respective R&D roadmap.

Progress beyond the state of the art

The S2Biom project has built on the above initiatives; further capitalised on all the project deliverables and developed a coherent and technically substantiated Vision with a respective R&D roadmap for the delivery of non-food sustainable biomass supply in Europe to meet the policy targets and the industrial demand for 2030.

To do this the work has also capitalised on the substantial involvement of a number of partners in the Technology Platforms (FNR holds the Secretariat of EBTP and is involved in the technical groups; Imperial College is the Scientific Coordinator of the Biomass Supply and Logistics working group in EBTP and VTT is the respective Scientific Coordinator of the Biomass Supply and Logistics working group in RHCP), the contribution of CEI and JRC as strategic institutional capacities for Southeast Europe and the European Commission respectively and the PPP for Biobased industry.

To ensure the project strategies and implementation plans are applicable at local level as well, the development of specific local ones is also foreseen as follows, linked to the case studies:

- Strategies with step plan from local renewable energy targets, local biomass availability, current initiative mapping, to action plan for policy development.
- National Roadmaps with policy recommendations & local biomass occurrence mapping details as they stem out of the S2Biom cost supply tool.

Finally, to ensure appropriate regional coverage in terms of strategies and policy formation, exchange of information, stakeholder involvement and input has taken place through the participation in the respective Energy Community Ministerial and technical meetings.