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

S2Biom Project Grant Agreement n°608622

D7.1
Extensive description of scenarios

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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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1. Scenarios for sustainable lignocellulosic biomass supply

1.1 Aim

The S2Biom project will support the sustainable delivery of non-food lignocellulosic biomass feedstock at local, regional and pan‑European level. The research work foreseen will cover the whole biomass delivery chain from primary biomass to end-use of non-food products and from logistics, pre-treatment to conversion technologies.

The aim of this report, prepared under Task 7.1, is to describe a number of scenarios - based on the modelling capacities and the data available to the project consortium- for which the potential lignocellulosic biomass flows in the under study geographical area will be further analysed.

Section 2 of this report summarises the existing information, models and modelling capacities that will be deployed in the project, and that will make use of the different scenarios. In section 3, we define and elaborate the scenarios themselves. Annexes on policies to be taken into account and on relevant technology pathways are also provided.

The scenarios will include both supply and demand side assumptions for energy and biobased products and cover EU28, western Balkans (WB), Moldova (MD), Ukraine (UKR) and Turkey (TR).

This report describes the background data and the rationale for the scenarios.

1.2 Key questions

The scenarios presented here are specifically designed to inform the ongoing discussions for the following set of questions from the industrial (A) and policy (B) perspectives:

A. How much indigenous (EU28, WB, MD, UKR, TR) lignocellulosic biomass can be made available in a sustainable manner for the 2020 and 2030 timeframes? is this best used at
    a. centralized biorefineries strategically located within Europe (Industry centralised Scenario)
    b. local/ regional decentralized units (Industry decentralised Scenario),

and what are the respective inputs (investment; logistics infrastructure, etc.) and outputs (tonnes of resources; tonnes of products; income flows; jobs; GHG savings, etc.).

B. Can Europe meet the 2020 & 2030 targets as set in the Renewable Energy Directive[1] and in the same time facilitate the vision for the European biobased economy[2] and assist to the development of the biobased industries[3]?
    a. what are the inputs required (land & water; costs; infrastructure; GHG emissions; carbon, improved policy package, etc.) so that the biobased industry sectors meet their targets set for 2020 and 2030 (Policy optimism Scenario),
    b. how much of the biobased industry products can be based on resource efficient lignocellulosic biomass value chains for the 2020 & 2030 timeframes? (Restricted policy Scenario)

Intra-trade options will be explored within both sets of scenarios.

1.3 Challenges

The work in S2Biom aims to perform detailed value chain analysis with harmonised approaches and datasets across a very large number of countries and regions (EU28 & WB, UKR, MD, TR) with distinct differences in biomass, industry and policy development.

Table 1 Challenges in S2Biom model analysis and sources of information

Issue	Constrains	Sources of information
Harmonised biomass potentials	There are recent datasets for EU27 but not for the rest of the countries	BEE project: Baseline for the assessments expanding in geography and sectors for bioeconomy. CEUBIOM project: Baseline methods as well as data (terrestrial and EO) for selected test sites. Biomass Futures project: 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). Extensive network of local partners for detailed data coverage in Western Balkans, Moldova, Ukraine and Turkey.
Fragmented policy frameworks	Integrated policies for the mobilisation of “resource efficient” indigenous biomass ‘value chains’	Biomass policies project: Baseline for resource efficiency in the bioenergy & biofuels sectors; harmonised assumptions & criteria to expand in terms of geography and the non-energy bioeconomy sectors.
Biomass competition	So far biomass competition has been modelled only among	The RESolve model has been extended for the purpose of the Biomass Futures project by merging several sub-models. RESolve serves as a ‘biomass allocation model’ determining

[1] Directive 2009/28/EC of the European Parliament and of the Council of 5 June 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
[2] http://www.biobasedeconomy.eu/
[3] http://www.bbi-europe.eu/

	the energy sectors (heat, electricity and transport fuels)	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 a number of biobased sectors for non-food lignocellulosic feedstocks.
Sustainability	So far sustainability criteria are l developed for the energy sectors and are only applied to liquid biofuels	Harmonized sustainability requirements for bioeconomy value chains will be elaborated. Environmental footprint approach
Resource efficiency	Minimum resource efficiency thresholds	Biomass policies project: will provide base information for resource efficient bioenergy and biofuel pathways
Biobased materials/ chemicals	No transparent cost or price information available for innovative biomass-based chemicals and materials	On the basis of the market review (Task 7.2), we will explore the impact of different ambition levels for biobased chemicals and materials, and explore their impact on the marginal costs for biomass. These marginal costs information will then be shared with industry for feedback on their business cases given these costs.

An inventory of key uncertainties, with regards to the development of the bio-economy until 2030, has been prepared. The following are the most important:

- The development of fossil fuel prices
- Technological developments for the creation of biomaterials/chemicals
- How much biomass there will be
- The price of the biomass feedstock
- Public perception of biomaterials (and whether they have a preference for these over conventional products)
- Development in competing sectors (using the same feedstock)
- Whether conversion will mainly happen thermochemically or biochemically
- The investment climate
- Whether conversion will take place in centralised or decentralised plants
- Whether conversion will be generic or specific, i.e. whether there will be a few generic vs. very strongly differentiated streams.
- Reduction in demand due to decrease material use (incl. recycling)
- Societal attention for environmental and climate related issues

The scenarios within the project will try to address the challenges described in this section based on the datasets and modelling capacities available to the team (see section 2 below). They will be based on a set of concrete, well aligned assumptions for the technical, economic, geographical and political parameters addressed within S2Biom which will further frame the model analyses and the translation of the their results to strategies and implementation plans.

2. Capacities within S2Biom (projects and modelling capacities)

2.1 Background

The research work planned in the project will cover 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 will be elaborated to facilitate the integrated design and evaluation of optimal biomass delivery chains and networks at European, national, regional and local scale in order to support the development of strategies for optimum ways to move forwards a biobased economy.

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

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

The projects/ modelling capacities presented in the next sub-chapter will play a fundamental role for the scenarios both in shaping the key assumptions, defining the research focus and providing the essential datasets.

2.2 Projects

2.1.1. Biomass Futures

The Biomass Futures Project assessed the role that biomass can play in meeting EU energy policy targets. The project defined the key factors likely to influence biomass supply, demand and uptake over the next twenty years (meeting the RED targets). This study made a comprehensive strategic analysis of biomass supply options and their availability in response to different demands in a timeframe from 2010- 2030. This was done according to the following steps:

- Identifying different biomass feedstocks and develop an inventory of data to quantify and map the technically constrained biomass potentials, including estimates of alternative uses of by- and waste in order to estimate the share that is available for bioenergy purposes and the share that competes with other uses.

- Map present technically constrained potentials of the different feedstock as spatially explicit at regional level
- Determine scenario specifications according to which future 2020 and 2030 potentials can be estimated.
- Quantify actual, 2020 and 2030 potentials according to scenarios.
- Identifying information on which basis cost levels for the different feedstocks can be established taking into account competing uses and costs for production, yielding and transport. It is aimed at estimating costs for biomass as received at the gate of the conversion/pre-treatment plant.
- Synthesizing the results in terms of economic supply estimates (cost-supply).

The study builds on the state-of-the-art overview of biomass assessment studies provided by BEE and the same biomass classification, definitions and conversions as in BEE are used. The biomass potentials and costs from the Biomass Futures project are currently the most recent and detailed data available for most biomass sources. The biomass potentials are also used by other energy and integrated assessment models, such as PRIMES, RESOLVE and GLOBIOM.

Biomass potentials and costs (technical and sustainable) are presented for EU-27 for biomass types from forest, waste and agricultural sectors. The following biomass types are distinguished: agricultural annual crops (cereals, maize, sugarbeet, sunflower, rapeseed and fodder maize) and perennial crops (woody and grassy perennials), agricultural residues (straw, manure (liquid and solid), prunings, abandoned grassland cuttings), wood, forest residues (primary, secondary and tertiary residues) and waste (MSW (land fill/no-landfill), animal waste, used fats and oils, post-consumer wood).

For all these biomass sources maps with their potential were made for 2008, 2020 and 2030 at national and regional level (mainly NUTS 2).

The *Biomass Futures* project, analysed scenarios and sensitivity cases to address the question “how and to what extent biomass can contribute to a sustainable energy future without causing negative impacts”.

- The reference scenario re-analysed bioenergy contributions to national renewable energy targets with a coherent supply dataset;

- The sustainability scenario considered a more sustainable energy system in which binding biomass sustainability criteria cover all energy sectors (electricity, heating and cooling, and transport sectors) and biofuel imports;
- The high biomass scenario built on the reference scenario bioenergy potentials and applies national policy measures that are stronger than the current ones. Thus, the sustainability criteria in line with the current RED directive are only applied to biofuels for transport.

2.2.2 Biomass Policies

The aim of the Biomass Polices project is to develop integrated policies for the mobilisation of “resource efficient” indigenous bioenergy ‘value chains’ in order to contribute towards the 2020 bioenergy targets set within NREAPs & 2030, and other EU27/ national policy measures. It will do so by capitalising on the knowledge of three recent studies (Biobench[4]; Biomass Futures[5] and a study for EEA[6]) and through concise collaboration with selected Energy Agencies (in the participating countries, i.e. AT, BE, DE, EL, ES, HR, IE, NL, PL, SK, UK) and key stakeholders from the policy and market fields.

In the framework of the project, scenarios and sensitivity cases will be analysed to address the question:

“How can we use biomass resources efficiently, facilitate the abatement of sustainability risks and at the same time deal with competition?”

Based on the scenario assumptions the Biomass Futures cost-supply estimates need to be further up-dated and use of these biomass resources in reaching NREAP targets and new mitigation targets towards 2030 will be assessed using the ReSolve model. In particular for forest biomass an update of the potentials taking into account C balance of forest bioenergy and biodiversity constrains will also be included.

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[4] Benchmarking biomass sustainability criteria for energy purposes. Study for European Commission DG Energy (Sept 2010 - Dec 2011)

[5] Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders. www.biomassfutures.eu, IEE project (2009-2012)

[6] Review of the EU bioenergy potential from a resource efficiency perspective. An update of EEA report No 7/2006. Study for the European Environmental Agency.

2.3 Modelling

2.3.1 RESolve- B

Within the S2Biom project the RESolve-Biomass model will be expanded to cover the most promising biochemicals, bioplastics and biorefinery concepts. The pathways will be selected in collaboration with Work Package 2. Some early suggestions of criteria for the selection process are.

- Technical feasibility (this considers not only the technical feasibility based on expert view but also the feasibility in terms of ECN model architecture)
- Economic feasibility (as far as information is available about it)
- Environmental feasibility (an early assessment of CO2, water consumption, any other hazardous effects)
- Limiting the concepts in which bioenergy production is the starting point (thus, excluding biorefinery concepts in other industries, such as food industry, pulp and paper industry). We could consider including such concepts outside the model activity.

2.3.2 Land use modelling in JRC- Institute of Environment and Sustainability

The changes in the cover and use of the surface of the earth depend on natural processes, and are – at the same time - shaped by demographic, economic, cultural, political and technological drivers.

A land-use/cover model helps in understanding and interpreting the interactions between the bio-physical and human systems which are at the basis of the territorial dynamics. It can support explaining the consequences of “where” and “when” in addition to “what” and “how much”:

- Evaluate direct and indirect effects of policies over time;
- Determine the critical factors;
- Correlate and interconnect sectors;
- Compare and evaluate alternative scenarios (options);
- Locate impacts and effects (multi-scale analysis)

The Land Use Modelling Platform (LUMP) has been developed by the Institute for Environment and Sustainability of the European Commission Joint Research Center (JRC-IES) to support the policy needs of different services of the European Commission, such as exploration of future policies and impact assessment of specific proposals.

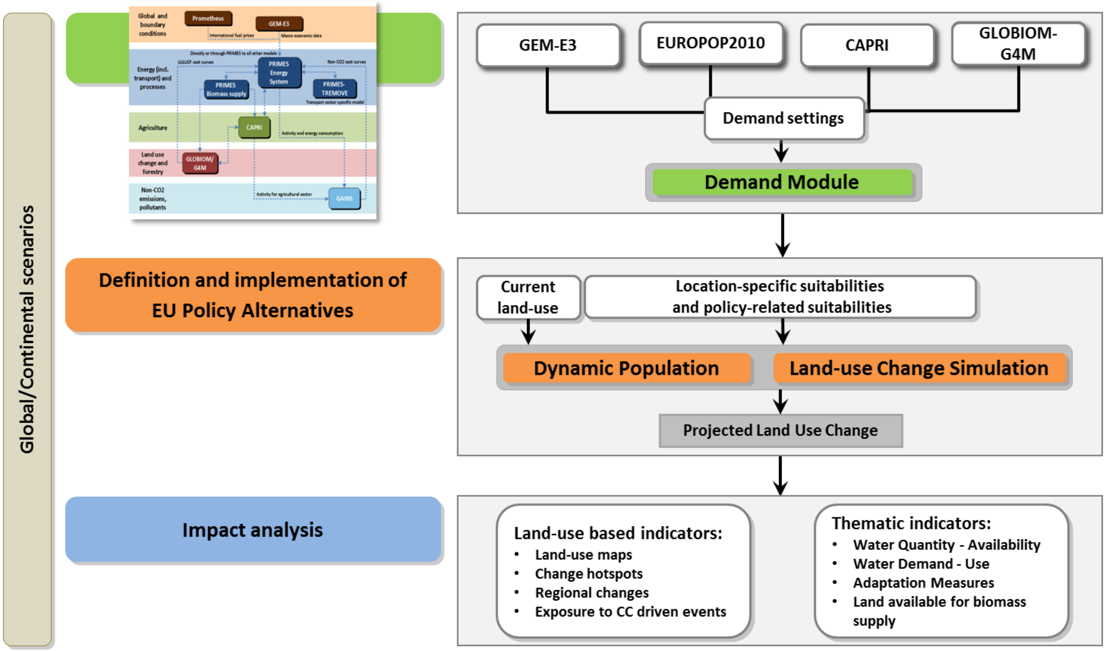

Figure 1 Configuration of LUMP for the Energy-Climate Reference Scenario – Components and Workflow

LUMP is a GIS-based platform that enables dynamic simulation of competing land uses based on pre-defined allocation rules (for example, land demand, neighbourhood characteristics, suitability factors, and scenario/policy-specific decision rules). LUMP is interoperable with numerous existing models/data sources (CBM, CAPRI, EUROP2008, LEITAP/IMAGE, TRANSTOOLS, GEM-E3, RHOMOLO, POLES, etc.) and impact assessment models (LISFLOOD, SOC-TOP, GUIDOS, GREEN/SWAT, EFDM, EDGAR, etc.), and can be used for the purpose of constructing spatially and temporally-specific models that combine environmental, social and economic indicator data[7] [8].

[7] Lavalle, C., Baranzelli, C., Mubareka,S., Rocha Gomes, C., Hiederer, R., Batista e Silva, F., Estreguil, C., 2011. Implementation of the CAP Policy Options with the Land Use Modelling Platform: A first indicator-based analysis. JRC Scientific and Technical Reports EUR 24909 EN doi: 10.2788/45131.

[8] Batista e Silva, F., Lavalle, C., Jacobs-Crisioni, C., Barranco, R., Zulian, G., Maes, J., Baranzelli, C., Perpiña, C., Vandecasteele, I., Ustaoglu, E., Barbosa, A., 2013. Direct and Indirect Land Use Impacts of the EU Cohesion Policy - Assessment with the Land Use Modelling Platform. JRC Scientific and Policy Reports EUR 26460 EN doi: 10.2788/60631.

Within S2Biom collaboration is foreseen between LUMP and the other project modelling capacities from DLO, IIASA and ECN both on aligning the baseline assumptions and on exchanging the required data.

Regarding the definition of a Baseline Scenario, it is worth-noting that the current configuration of LUMP is aligned to the definition of Reference scenario[9] as from the Energy Trends to 2030 publication by DG ENER and DG CLIMA[10], and the Impact Assessment, annex to the Energy Roadmap 2050[11], as well as the Roadmap itself[12]. Further updates are currently on-going.

2.3.3 Environmental impact modelling in JRC- Institute of Environment and Sustainability

In response to policy needs of the Roadmap to a Resource Efficient Europe (EC, 2011)[13], JRC-IES has developed a set of life-cycle based resource efficiency indicators, with the aim to quantify and monitor the overall environmental impact potentials of production and consumption in the EU-27 (taking into account internationally traded commodities). This indicator set provides an overall indicator of potential environmental impacts, by normalizing and weighting across multiple (14) environmental impact categories such as climate change, acidification, toxicity and energy resource depletion potentials.

The methodology builds on pilot case studies recently developed by JRC for life cycle indicators (EC, 2012a and 2012b) and will combine territorial emissions and resource extractions for each of the Member States and the EU27 in total with those related to imported and exported products, consistently to the requirements of the International Reference Life Cycle Data system (ILCD) (EC, 2010 and 2012c). This framework will also allow to cover the environmental impacts related to import and export activities, allowing to capture the environmental impact occurring outside the territory of the EU.

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[9] Lavalle, C., Mubareka, S., Perpina Castillo, C., Jacobs-Crisioni, C., Baranzelli, C., Batista e Silva, F., Vandecasteele, I. (2013). Configuration of a Reference Scenario for the Land Use Modelling Platform. EUR 26050 EN. Luxembourg: Publications Office of the European Union.

[10] European Commission (2010).EU energy trends to 2030 — UPDATE 2009. Luxembourg. ISBN 978-92-79-16191-9. doi:10.2833/21664.

[11] European Commission (2011). Impact Assessment accompanying the Energy Roadmap 2050

[12] European Commission (2011). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. Energy Roadmap 2050.

[13] European Commission (2011), Roadmap to a Resource efficient Europe, COM(2011) 571. http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf

The project outcomes will allow monitoring over time of overall consumption-related environmental impacts. The results will represent the actual pressures on the natural environment, human health and the availability of material, biomass, energy, water and land resources exerted by the European society consumption.

Within S2Biom collaboration is foreseen between JRC environmental modelling and the team in the respective work package.

2.4 Other sources

2.4.2 National Renewable Energy Action Plans

Article 4 of Directive 2009/28/EC on Renewable Energy requires Member States to submit national renewable energy Action Plans (NREAP) by 30 June 2010. These plans, to be prepared in accordance with the template published by the European Commission (EC), provide detailed roadmaps of how each Member State expects to reach its legally binding 2020 target for the share of renewable energy in their final energy consumption. Beurskens et al. (2011) collected all data from the NREAP documents and made them available in a report and database. The purpose of their study was to allow easy comparison of the National Renewable Energy Action Plan (NREAP) for further analysis. Based on their database the Biomass Futures project assessed the domestic biomass resource for energy per member state. Member states have recently up-dated their NREAP targets which are being reported currently to the EC in the bioenergy progress reports (DG-ENER). These up-dates will be used for the S2Biom scenario assessments.

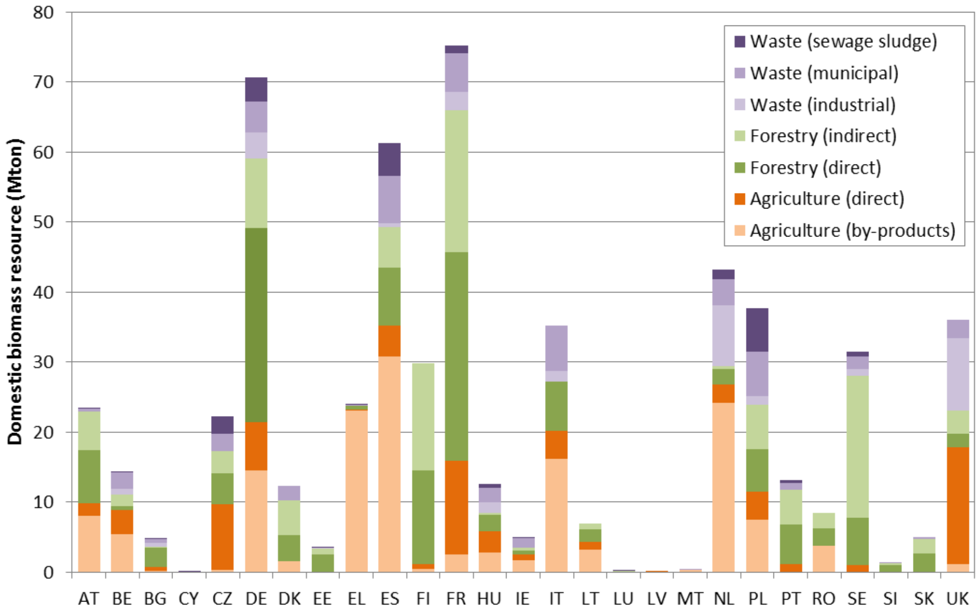

Figure 2.Domestic biomass resources in 2020 according to the NREAPs

Western Balkans, Moldova and Ukraine (as member countries of the Energy Community) also adopted the RES Directive on 18 Oct 2012, with mandatory national RES target for each country - calculated using the EU methodology, and with equal level of ambition as the targets set for other EU Member States.

They should have submitted National Renewable Action Plans (NREAP) based to a template published by the European Commission by 30 June 2013; however, only Serbia and Kosovo* actually adopted the NREAP and submitted it until the end of 2013. All other countries have started to draft the NREAP, with the exception of Bosnia and Herzegovina. When submitted, NREAPs will be used for further analysis.

The biomass consumption in respective countries is assessed based on the findings of the survey (biomass consumption for electricity, heating and cooling) conducted by CRES in 2011 and 2012 (Biomass consumption survey for energy purposes in the Energy Community, February 2012).

3. Scenarios overview

The following table and Figure present an overview of the S2Biom scenarios and their main characteristics

Table 2 Overview of S2Biom scenarios and their main characteristics

How much indigenous (EU28, WB, MD, UKR, TR) lignocellulosic biomass can be

made available in a sustainable manner for the 2020 and 2030 timeframes?	
<u>Centralised Europe scenario</u> <u>Large biorefineries within Europe</u>	<u>Decentralised local scenario</u> <u>Local/ regional decentralized units</u>
Role of macro-actors: cooperatives, investment funds, international companies, etc. processing activities concentrated near transport platform (e.g. ports, hubs, etc.) central planning of bio-based activities for Europe (energy, materials, products, carbon..) strong EU policies/ strategies & financing mechanisms are in place	Biomass "hot- spots" creation of added-value through SMEs re-organisation of the biomass supply sectors with new players payments for carbon credits and recreation services emphasis on regional/ local support mechanisms and policies
B. Can Europe meet the 2020 & 2030 targets as set in the Renewable Energy Directive and in the same time facilitate the vision for the European biobased economy and assist to the development of the biobased industries?	
<u>Policy active scenario</u> What are the inputs required (land & water; costs; infrastructure; GHG emissions; carbon, etc.) so that the biobased industry sectors meet their targets for 2020 and 2030	<u>Policy passive scenario</u> How much of the biobased industry targets can be met under strict resource efficiency constraints for the 2020 & 2030 timeframes?
Biobased industries vision and strategy is accomplished; Technology advances in the harvesting and processing of biomass; Sustainability issues resolved through improvements in land productivity and crop efficiency; Biobased products are very cost-competitive with fossil fuel counterparts – buying bio is a natural choice economically.	Climate change disrupts biomass production, and so in the food vs. fuel debate, food wins; Engine efficiency, electrification, and public transit drive down overall demand for fuel; 1st gen biofuels decline; dismissed as viable alternatives, but advanced biofuels grow in importance; Renewable and nuclear energy play a larger role, with policy supports; biobased materials and chemicals find a strong niche market.

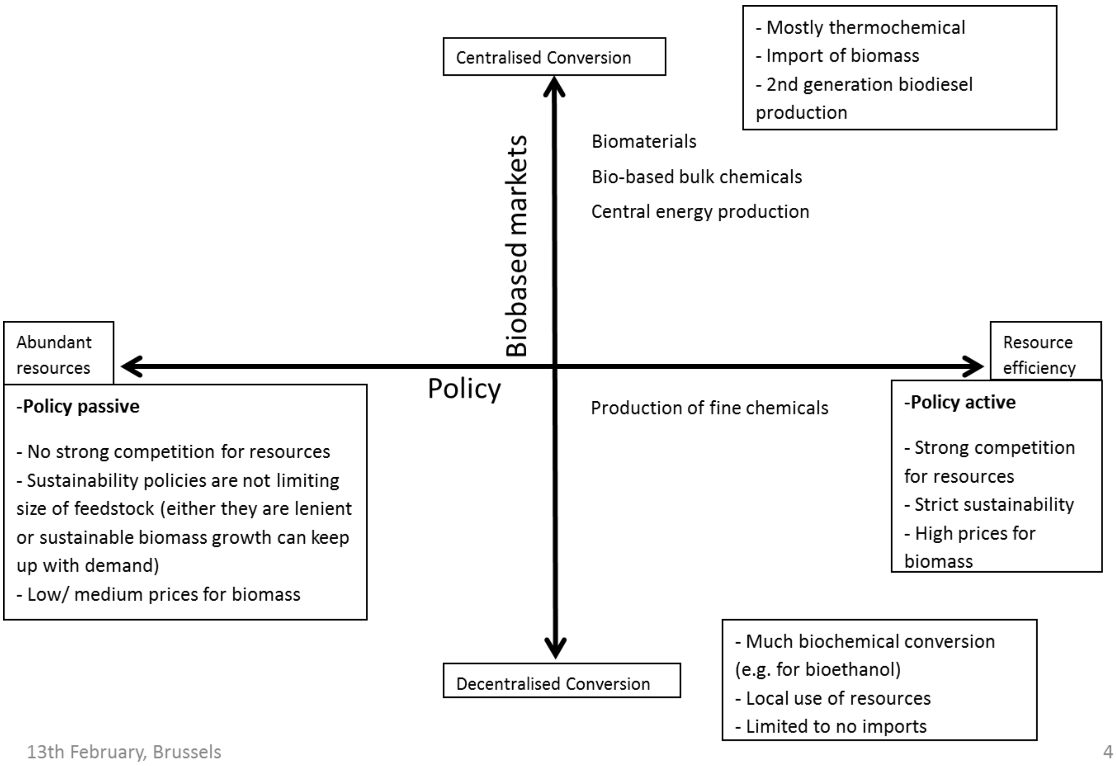

Figure 3 S2Biom scenario structure

3.1 Biobased markets scenario axis: European and local/ regional biomass supply chains

The rationale of this scenario axis is to exploit which are the optimal biobased market organisation structures to use the available biomass in all the under study countries.

The key differentiating question among the two scenarios is whether this supply is best exploited in large scale centralised biorefineries (more focus on thermochemical processes) or in decentralised units (more focus on biochemical ones). Other important ones include:

Centralised scenario: i) Mostly large-scale thermochemical processes; ii) Import of biomass and iii) - 2nd generation FT-diesel production.

Decentralised scenario: i) More biochemical conversion processes (e.g. for bioethanol); ii) local use of resources and iii) limited to no imports.

Key characteristics for both scenarios

- Indigenous biomass supply and ex-EU imports will be separated. Depending on the scenario assessments will be performed on the basis of only indigenous supply. Intra-trade is expected to present increasing trends in the European scenario while it will be limited in the local/regional one;
- EU 28: In this scenario there is relatively low bioenergy consumption, but (up-dated) NREAP targets are reached by 2020 and the emissions targets are accomplished for 2030, mainly domestic production of biomass from waste, forest residues and only very limited use of non food crops. Part of the bioenergy is produced from imports. The current sustainability criteria for biofuels are implemented; Western Balkans, MD, UKR: Information from update NREAPs (Energy Community).
- No radical changes from today;
- Petroleum products still domineering;
- Technologies advancements help improve both biomass harvesting and processing;
- Policy and market support for bioeconomy is still fragmented and not harmonised;
- 1st gen biofuels still in market but low shares due to BAU sustainability concerns;
- Sustainability criteria from RED will be applied to both scenarios

3.2 Policy scenarios: active and passive

The rationale of these two scenarios is to inform the policy agenda and target setting for the biobased targets for 2020 and 2030.

The differentiating question is how much input (land & water; costs; infrastructure; GHG emissions; carbon, improved policy package, etc.) is required to meet the current targets fully and how much of the targets can actually be met under a strictly sustainable and resource efficient supply within Europe.

Key characteristics for both scenarios

- Public policy plays a large role in shaping the market deployment patterns;
- Intra trade will be considered in both scenarios while international biomass imports will only be considered in the policy optimism one;
- EU 28: In the “active” scenario there is high biomass consumption, (up-dated) NREAP targets are reached, both imports and domestic production of biomass from waste, forest residues and non -food crops. The current

sustainability criteria for biofuels are implemented; On the contrary in the "passive" scenario there is low biomass consumption, NREAPs targets are abandoned, mainly domestic biomass from wastes and residues with marginal non- food crop production. For Western Balkans, MD, UKR: Information from update SREAPs (Energy Community); TR?

- Sustainability criteria from RED will be applied to the policy optimism while stricter ones – beyond RED – will be applied in the restricted policy scenario. At least 70% (2020) and 80% (2030) GHG mitigation for all RES-energy; ILUC included;
- Technologies efficiencies advance rapidly;
- Biobased materials and chemicals find a strong niche market;
- Use of abandoned land is strengthened

Table 3 Detailed scenario specifications according to policy, resources, technology and market parameters

Scenario	Main characteristics	Policies			Resources			
		Energy/ Fuel/ bioeocnomy	Agriculture	Sustainability	Type	Land (tbf from CAPRI)	Efficiency	Local/ global
Centralised Europe	Low bioenergy consumption, limited domestic production;	RED Biobased sector targets	CAP 2013	50 % (2020, 2030) for biofuels only, No ILUC included. No use of highly biodiverse land, peat land, permanent grassland for biofuels as specified in RES Directive.	Woody biomass Pellets Limited cultivation of non food crops	Agricultural land Abandoned land	BAU in efficiency improvements	global
Decentralised local	Refined biomass potentials for all under study countries	RED Biobased sector targets	CAP 2013		Woody biomass Pellets Limited cultivation of non food crops **Agro residues** **wastes**	Agricultural land Abandoned land	BAU in efficiency improvements	Local; limited intra-trade
Policy Optimism	Opportunity & laissez faire Biobased sectors meet their targets; Technology advances in the harvesting and processing of biomass; Sustainability issues resolved through improvements in land productivity and crop efficiency; biobased Products are very cost-competitive with fossil fuel counterparts – buying bio is a natural choice economically.	strong support measures for biobased & RES	Stronger support for residual biomass mobilisation and non food crop production in CAP and…? Strong incentives at local/ regional level		Woody biomass Pellets Agro residues Wastes **Non food crops**	Agricultural land Abandoned land	Increased yields and machinery efficiency	Increased intra- trade International trade
Restricted policy		No support for 1st gen biofuels		at least 70%(2020) and 80% (2030) GHG mitigation for all RES-energy; ILUC included.	Woody residues, Agro residues Wastes Marginal non food crop production	Only abandoned land	BAU in efficiency improvements	Local; limited intra-trade

Existing policies
Minimise support
Maximise support

Annex I. Policies

Agriculture

Common Agricultural Policy- ***to be completed*** (accounting for the update CAPRI assumptions as well)

Resource efficiency policy measures for maintenance of ecosystem services

In the “Restricted” policy scenario more policy measures are taken in the field of resource efficiency to limit the use of scarce resources such as water and counter the loss of biodiversity and related ecosystems services. This is not only done by limiting the removal of biomass from high biodiversity areas or lands with a high carbon stock (e.g. peat lands). In this scenario the stricter criteria go together with an overall global sustainability concern which leads to an overall ban on deforestation. As a result land for food production can no longer increase either which makes land an even scarcer resource then it is already. Land based biomass resources therefore become more scarce and the only way to obtain enough woody biomass is from domestic dedicated biomass cropping on land that is not suitable for food and feed production. Furthermore other additional criteria for resource efficiency are applied which involves an obligation to only use the most energy efficient pathways (>50% energy efficiency) and prevent the depletion of valuable resource such water and forest ecosystems. There is also more stimulation of technological developments in biorefinery and cascading use technologies. Constraints are also applied on the use of irrigation water in energy cropping as this is also seen as an increasingly scarce resource particularly in arid regions. This implies that dedicated non- food cropping in arid regions that have large marginal/abandoned land potentials are limited, as it becomes more complicated to produce enough biomass per hectare to reach the relatively high mitigation and energy efficiency levels.

The criteria will apply to all biomass used for energy and non-energy pathways

RES/Bioenergy targets

The bioenergy production is encouraged by setting consumption targets. In the industry scenarios these targets are set at the levels of the 2020 NREAP targets or the up-dated targets from the 2013 national progress reports for bioenergy consumption share as specified at national level. These targets are assumed to remain stable until 2030 for both scenarios. For Western Balkans, MD, UKR: Information from NREAPs (Energy Community) - for 2020 targets, and same assumptions as EU MS for the period 2020-2030;

Table 4 Policy targets for biomass in the Energy Community for 2020 and 2030

	2020 biomass targets	Source / NREAP status	2030 biomass targets	Source
Albania	Primary energy production - 3,739.68 ktoe from biomass; biofuels target - 105.42 ktoe	Draft NREAP - under preparation		
Bosnia and Herzegovina		not started		Energy Strategy of Republic of Srpska until 2030 (2012) - no targets set
Kosovo*	Primary energy production - 83.96 ktoe from biomass; biofuels target - 36.33 ktoe	RES Transparency platform for the Energy Community; NREAP adopted		
FYR Macedonia		NREAP under preparation		Strategy for the Exploitation of Renewable Energy Resources and the Strategy for Energy Development until 2030 - adopted in 2010, but not revised in accordance with mandatory 2020 RES targets
Moldova	Overall RES target only: to reach 20% share or energy consumption from RES in 2020, and to ensure a 10% share of biofuels in the total fuels by 2020	Energy Strategy until 2030 ; NREAP - under preparation		Energy Strategy until 2030 - adopted - specific targets for bioenergy not set (until 2020 only)
Montenegro	Primary energy production - 91.72 ktoe; biofuels target - 24.48 ktoe	NREAP - under preparation	Primary energy production - 133.62 ktoe; biofuels target - 21.7 ktoe	Current Energy Strategy covers the period until 2025 - Ministry of Economy has drafted a new Energy Strategy for the period until 2030 and published it for a public hearing
Serbia	Primary energy production - 1,673 ktoe from biomass; biofuels target - 246 ktoe	RES Transparency platform for the Energy Community; NREAP adopted	Primary energy production - 1,786 ktoe; biofuels target - 195.6 ktoe	Draft Energy Strategy until 2025 - with projections up to 2030 (2013) - not adopted yet - bioenergy targets set until 2030 (Scenario with EE measures)
Ukraine		under preparation		Energy Strategy of Ukraine until 2030 - adopted - planned share of renewables in the energy balance was not specified. March 2013 draft indicated that RES share could reach 18% by 2030 (and 10% of the power mix)

For the policy "optimism" scenario higher biomass consumption targets are expected to be set in line with the levels assumed in the de-carbonisation scenarios of the Energy Roadmap 2050 for 2020 and 2030.

In the "Restricted" policy scenario even the NREAP bioenergy targets for 2020 are abandoned after 2020 and the bioenergy consumption is expected to decrease into the future.

Biobased industries

Biobased industries aim in particular, to ascertain the availability of reliable biomass supply taking into account other competing social and environmental demands, and support the development of advanced processing technologies, large scale demonstration activities and policy instruments, thus reducing the risk for private research and innovation investment in the development of sustainable and competitive bio-based products and biofuels[14].

No specific targets have been formed so far, but there are some figures indicating the vision from certain industries, as described in the table below.

Table 5 Current volumes and future market prospects for several bio-based products in Europe

Bio-product category	Bio-products	Market volume "Bio" 2010 [15]	Projected market volume "Bio" 2020 [16]
Bio-based plastics (European Bioplastics)	Short-life/ disposable applications (PLA, PHA, Starch Blends, Cellulosics)	110.000	1.280.000
	Durable applications	150.000	
	Engineering Polymers		740.000
	Modified PLA, Cellulosics		
	Polyolefines (2012)		530.000
	Starch based alloys	Not marketed	260.000
	TOTAL	**260.000**	**2.810.000**
Biodegradable and bio-based plastics (BASF SE)	Waste & shopping bags	30.000	260.000
	Tableware	3000	33.000
	Bio mulch for agriculture	2.000	40.000
	TOTAL	**35.000**	**333.000**
Bio-lubricants (2008) (Fuchs Petrolub AG)	Hydraulic Fluids	68.000	230.000
	Chainsaw Lubricants	29.000	40.000
	Mould Release Agents	9.000	30.000
	Other oils	31.000	120.000
	TOTAL	**137.000**	**420.000**
Bio-composites (nova-Institut, 2012)	Compression moulding:		
	- with natural fibres	40.000	120.000
	- with cotton fibres	100.000	100.000
	- with wood fibres	50.000	150.000
	Extrusion and injection moulding		
	Wood Plastic Composites:	167.000	450.000
	- with natural fibres	5.000	100.000
	TOTAL	**372.000**	**920.000**
Bio-solvents[17]	(2012)	630.000	[18]
Bio-surfactants [12]	(2012)	**1.520.000**	[13]
Biofuels total	(2011)	12.414.000	[19]

Source: Busch & Wittmeyer, Current market situation 2010 and market forecast 2020.

[14] - See more at: http://www.bbi-europe.eu/about/mission#sthash.D8VJ7cjL.dpuf
[15] In tons
[16] In tons; All figures for 2020 are based on estimations
[17] Figures by Industries & Agro-Ressources IAR
[18] To be estimated by respective CEFIC sector groups
[19] http://www.sustainablebiofuelsforum.eu/images/ESBF_Biofuels_Production_in_the_EU_MetricTonnes.pdf

Sustainability criteria in relation to GHG mitigation

In the both industry scenarios and in the policy "optimism" the sustainability criteria applied are the ones in RED.

In the "restricted" policy scenario the sustainability and resource efficiency criteria are stricter. GHG mitigation should be 70% in 2020 and 80% in 2030 above the fossil alternative. They also apply globally, which implies that other non-EU countries have also set similar sustainability criteria to consumption of biomass for energy. This in combination with the stricter overall mitigation and efficiency levels of biomass delivery chains, makes sustainable biomass sources more scarce and expensive in this scenario, which is acceptable since there is a global level playing field for biomass. As a result the imports of biomass from outside the EU, particularly of the most resource efficient biomass sources (e.g. waste and forest and agricultural residues) become more scarce and expensive. The biomass consumption therefore needs to be based more strongly on domestic biomass sources and dedicated perennial biomass is likely to become more attractive particularly where it can be produced on marginal and abandoned lands. Also, the criteria apply to all solid and gaseous biomass pathways in addition to the biofuel pathways. In the mitigation, ILUC emissions should also be compensated, which in turn encourages ILUC free bioenergy use.

Annex II. Technology pathways

to be completed