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The JRC-EU-TIMES model. Bioenergy potentials for EU and neighbouring countries.

Pablo Ruiz, Alessandra Sgobbi, Wouter Nijs, Christian Thiel

IET-JRC

Francesco Dalla Longa, Tom Kober

ECN

Berien Elbersen, Geerten Hengeveld

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Abstract
The JRC-EU-TIMES is a partial equilibrium energy system model maintained by the Institute for Energy and Transport (IET) of the Joint Research Centre (JRC) to analyse the role of energy technologies development and their potential contribution to decarbonisation pathways of the energy system. The technical potentials for renewable energies are a key input in models of this kind. In this context, it is important to ensure transparency in the assumptions: making available the underlying data to the public is thus an important step that can also further contribute to a scientific and transparent debate.
This report is the first in a series, and addresses the quantification of current and future biomass potentials for energy. As already identified in the 2011 European Commission's Communication Energy roadmap 2050, biomass is expected to play a key role in strengthening the Energy Union pillars by diversifying the energy supply, increasing the energy internal market, decarbonising the economy and boosting competitiveness. Estimating the technical potentials available in EU countries using state of the art methodologies and updated data is important to fully understand the implications of an increased used of biomass for energy. Acknowledging this relevance, much work has been carried to characterise and quantify biomass resources. Building on the initial effort from the European Environment Agency, followed by key projects like BEE and Biomass Futures, this report presents the results of extending and improving current methodologies and estimation to respond to energy system modelling needs.

Contents

List of Tables

List of Figures

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The JRC-EU-TIMES model is one of the models currently pursued in the JRC (http://midas.jrc.it/discovery/midas/#showmetadata/model/Model_2). The JRC-EU-TIMES model is designed for analysing the role of energy technologies and their innovation for meeting Europe's energy and climate change related policy objectives. It models technologies uptake and deployment and their interaction with the energy infrastructure in an energy systems perspective. It is a relevant tool to support impact assessment studies in the energy policy field that require quantitative modelling at an energy system level with a high technology detail.

The main objective of this report is to present the biomass potentials input currently used in the JRC-EU-TIMES model. The JRC-EU-TIMES model, as the majority of energy system models, uses very large data sets which subsequently require continuous update and improvement. One of the reasons for making this report public is to obtain constructive feedback aiming to improve the model's inputs. Suggestions, comments and more detailed data sets can be sent to JRC-EU-TIMES@ec.europa.eu

1 Executive summary

In the context of the strategy for an Energy Union as presented in the Communication of the European Commission COM/2015/080 final, "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy", five key dimensions are considered critical: **energy security, integrated European energy market, energy efficiency, decarbonising the economy** and **research and innovation** to foster competitiveness.

The **JRC-EU-TIMES** is a partial equilibrium energy system model maintained by the Institute for Energy and Transport (IET) of the Joint Research Centre (JRC) to analyse the role of energy technologies development and their potential contribution to decarbonisation pathways of the energy system. The technical potentials for renewable energies are a key input in models of this kind. In this context, it is important to ensure transparency in the assumptions: making available the underlying data to the public is thus an important step that can also further contribute to a scientific and transparent debate.

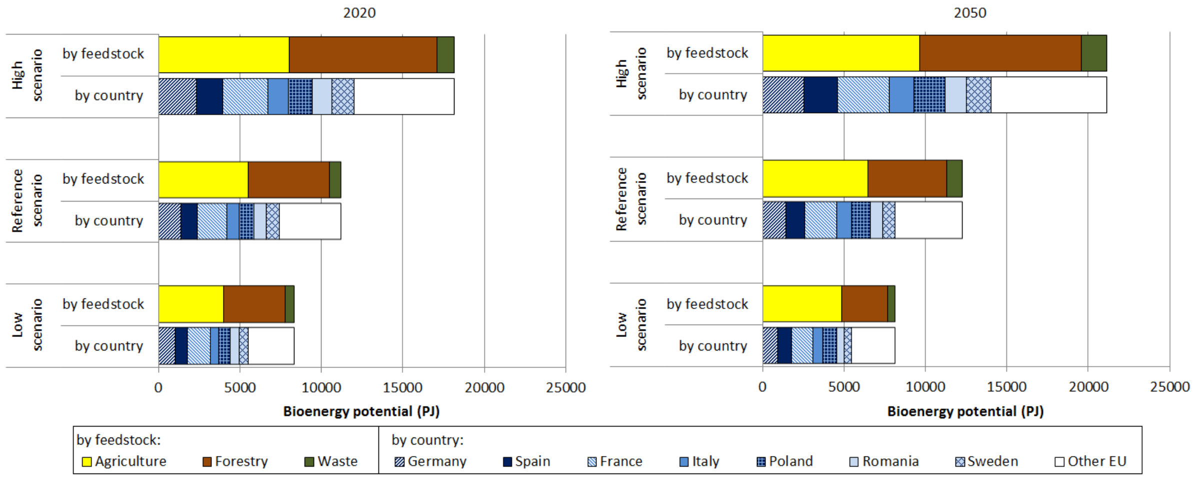
This report is the first in a series, and addresses the quantification of **current and future biomass potentials for energy**. As already identified in the 2011 European Commission's Communication *Energy roadmap 2050*, biomass is expected to play a key role in strengthening the Energy Union pillars by diversifying the energy supply, increasing the energy internal market, decarbonising the economy and boosting competitiveness. Estimating the technical potentials available in EU countries using state of the art methodologies and updated data is important to fully understand the implications of an increased used of biomass for energy. Acknowledging this relevance, much work has been carried to characterise and quantify biomass resources. Building on the initial effort from the European Environment Agency, followed by key projects like *BEE* and *Biomass Futures*, this report presents the results of extending and improving current methodologies and estimation to respond to energy system modelling needs, while extending the projections to 2050.

The biomass production sectors relevant for renewable energy are **agriculture**, **forestry** and **waste**. For the JRC-EU-TIMES model, agriculture sector biomass resources are distributed between *energy crops, manure, and primary, secondary, and solid agricultural residues*. Energy crops cover those whose primary target is the production of end-use energy carriers: sugar, starch and oily crops, the energy maize silage for biogas, and lignocellulosic biomass. Primary residues refer mainly to dry and wet manure from the livestock industry. Secondary residues refer to solid residues, including residues from pruning of permanent crops, straw and stubble left from other main activities and olive pits. Biomass from the forestry sector is classified into *roundwood production* and *primary and secondary residues*. The roundwood used for energy purposes is considered. Primary residues can be logging residues and other pre-commercial thinnings; while the secondary residues can be woodchips and pellets, sawdust and black liquor coming mainly from the paper industry. Finally, the waste sector produces energy biomass in the *primary* and *tertiary residues* categories. The primary residues gather residues coming from landscape care management, roadside verges and abandoned lands. The tertiary residues cover biomass residues from different industries and municipal solid waste.

The main quantitative model used to derive biomass potentials for agriculture is *CAPRI*. CAPRI is an agricultural partial equilibrium model that covers from global to regional and farm type scale. The use of the CAPRI model is warranted as it is the only available model which projects the EU agriculture markets and production responses at the regional level for the whole EU28. Moreover, CAPRI ensures consistency in the scenarios and assumptions adopted across modelling exercises when estimating future land use and livestock production changes in the EU28, including land demand for domestic biofuels. The LUISA model was used to estimate the evolution of built up areas as input for the yields input to CAPRI. As for the forestry biomass resources, the *EFISCEN* model is used to evaluate the potentially harvestable stemwood. The current available wood is input to EFISCEN mainly based on the European Forest Sector Outlook Study II scenarios (United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations 2011), which provide data on the national forest inventories. Finally, the waste potential evaluation is based on *Eurostat statistics* on national waste generation. The evolution of the waste categories over time is built taking into account GDP and population growth assumed in the baseline.

Sustainability criteria are a key driver when assessing the final amount of biomass available for energy. While there is no agreed definition of what constitutes "sustainable biomass", in this exercise the maximum biomass potentials for energy is estimated under three scenarios. The *High, Medium* and *Low* bioenergy availability scenarios differ in assumptions related to land use, agricultural practices, and protected areas. The High bioenergy scenario is compatible with a situation where mobilisation measures are in place and/or demand for biomass is high and there is a willingness to pay a (higher) price for it. The Medium bioenergy scenario corresponds to a reference case, and specifies the most likely future development of bioenergy leading to a continuation of current trends. This implies that bioenergy use of types of biomass with high sustainability risks are avoided and that enough room is left for competing uses of biomass outside the energy sector. In the Low bioenergy scenario biomass use in the energy sector is not a key priority, but resource efficient use of biomass is.

For each biomass sector and each sustainability scenario, **potentials** and their related **costs** are derived for each EU28 country, Iceland, Switzerland, Norway and the Western Balkans countries at NUTS2 regional level for the years 2010 (taking into account current levels), 2020, 2030, 2040 and 2040. The resulting maximum potentials are summarised in the graph below.



As a summary, in the **agriculture** sector, for biofuel crops, in the reference year, France has already a total potential over 500 PJ. It is followed by Germany over 150 PJ and the rest of the countries are all bellow 50 PJ. This potential evolves to be more distributed. Other countries such as Spain, Italy, Poland or UK will increase their potentials to over 100 PJ. For **wood** based potentials, the main players in the reference year are Germany, France and Sweden, with a potential over 1000 PJ each. They are followed by Finland, Spain, Poland and Romania with over 400 PJ of potential. The total available current potential will be reduced from the current 9000 PJ down to close to 8000 PJ in 2050. The sustainability criteria has a remarkable influence in the future wood available potential, as it can reduce it around a 40% or increase it a 100% by 2050. Finally, for the different **waste** potentials, France and Germany have a potential over 200 PJ, while Spain, Italy and UK have more than 100 PJ each. It is expected that the total potential available will increase a 20% by 2050. The sustainability criteria can reduce or increase the estimated available potential for 2050 around a 40% in both directions.

The costs associated with the different biomass feedstocks for energy include both the cost of biomass production and or harvesting at the place of origin, transport, pre-treatment cost up-to the conversion gate (including the cost made after harvesting for pre-processing), and forwarding and transport to the place of collection. For biomass types that are already traded in the market, the market price is considered as a good proxy for cost levels. In line with the methodology used, the costs of converting biomass feedstock into useful energy are not included in the estimates given in this report. Each conversion technology has specific biomass input requirements, while the quality of biomass differs largely between the different biomass types, harvest and drying techniques, and pre-treatment technologies. Conversion technologies are modelled explicitly in the JRC-EU-TIMES, and the techno-economic parameters associated with each technological options are included in the model separately. Current technologies include from combustion (small/large heating and small/large CHP) to anaerobic digestion (small/large biogas, waste digestion, biomethane) or gasification.

As for the direct **CO_2 emissions**, energy system models generally only consider energy-related emissions. Therefore, biomass cultivation and harvesting are considered carbon-neutral from an energy system perspective, whereas the burning of biomass for electricity or as biofuels leads to process-related emissions. Nonetheless in this work emissions from cultivation of biomass feedstock that could be used in case of a whole-chain GHG emission analysis have been also calculated. Both direct and indirect and aggregated indirect emissions have been calculated. Specific direct land use emissions hypothesis are applied for each cropping process, differing strongly per EU-region and cropping system. For the calculation of emissions from crop cultivation and harvesting the MITERRA-Europe model was used.

The role of biomass in the energy system in the medium and long-term is estimated using the JRC-EU-TIMES model, taking into account the new and updated estimates for sustainable bioenergy potential in Europe, under two hypothetical climate and energy scenarios. Under the Current Policy Initiative Scenario (CPI), we assume that current EU energy and climate targets for 2020 are implemented. In addition, the proposed targets for 2030 as described in the 2011 European Commission's Communication "*A policy framework for climate and energy in the period from 2020 to 2030"* are also implemented. These include 2030 targets for GHG emission reduction of 40% compared to 1990 levels, and a minimum of 27% renewable energy. The alternative scenario is a long-term decarbonisation future (CAP), where by 2050 a CO_2 reduction of 80% compared to 1990 levels is achieved. Both scenarios are set to achieve a reduction in primary energy consumption (excluding non-energy) of 27% in 2030 (in line with the European Commission's Communication *Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy*).

The results obtained with the JRC-EU-TIMES model for the two scenarios are presented for the four main energy end-uses for biomass: biofuel crops, biogas, wood and waste. Biofuels crops follow a similar pathway in both CPI and CAP scenarios. There is a remarkable share of the available bioenergy potential that is used for the production of biofuels, in order to meet the targets to renewable energy in the transport. However, by 2030, biofuel production shifts to lignocellulosic based 2^{nd} generation technologies. Biogas results show a steady and constant development in all EU28 countries. Similar pattern is shown by the woody biomass, the most relevant resource in energy terms. There is a remarkable development from 2010 to 2030, increasing the medium usage share from over 30% to close to 70% under a CPI scenario. Under a CAP scenario, the wood resource available is almost fully used in 2050. The assumptions made for the cost of waste potential evaluation make it a very competitive option for 2010, so it is almost fully used.

The work and data presented in this report constitute and step forward in the existing framework to assess the possible role of biomass to contribute to a decarbonised energy system and to support the pillars of the future Energy Union.

2 Introduction

As highlighted in the Communication from the European Commission "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy" (European Commission 2015), the European Union imports 53% of its energy at a cost of around EUR 400 billion, making it the largest energy importer in the world. On the other hand, it is also remarked that "the European renewable energy businesses have a combined annual turnover of EUR 129 billion and employ over a million people". To face the open challenges identified, the European Commission has set the strategy to reach the European Energy Union. This strategy is based on five pillars:

- Energy security, solidarity and trust;
- A fully integrated European energy market;
- Energy efficiency contributing to moderation of demand;
- Decarbonising the economy, and
- Research, Innovation and Competitiveness

The important role that local biomass sources can play to help strengthen these pillars is evident. Domestic bioenergy sources can contribute to diversifying the energy supply, increasing the energy internal market, decarbonising the economy and boosting competitiveness.

Designing and implementing effective policies for the bioenergy sector requires characterising the bioenergy sources available in the European Union within a coherent and consistent framework, for all sources and Member States and for the time frame of the strategies and regulations. Moreover, it is important that the obtained data is made available to the public to further contribute to a scientific and transparent debate.

This report, as the first of a series on renewable energy potentials, is intended to contribute to the debate by providing transparent and coherent estimates on the availability of biomass for energy in Europe between now and 2050 under different, plausible, assumptions. This constitutes an essential input to the debate on the design of efficient and effective energy policies.

2.1 Bioenergy potentials evaluation in Europe

The European Environment Agency already started in 2006 characterising the biomass potential available taking into consideration environmental restrictions (European Environment Agency 2006). This report highlighted that by 2020 biomass could contribute 13% of the EU primary energy demand. The relevance of biomass for energy was confirmed in the Energy Roadmap 2050 (European Commission 2011). The Roadmap already identified a possible development path for the use of bioenergy sources, evolving from an initial phase based on harnessing existing resources, to a more optimised phase where new potential coming from agriculture could be mobilised.

Later on, the Biomass Energy Europe (BEE) project (Koch 2011) carried out a revision of existing estimates of biomass potentials, to identify the reasons behind divergences of methods and estimations and to propose a coherent approach for the whole of the EU. As a result of this extensive work it was identified that while forest resources will stay quite stable over time, the final amount of available biomass potential will depend on the capacity of agriculture to mobilise further unexploited potential. Therefore, it is clear that bioenergy-oriented agriculture development will be a key driver to determine the long-term potential available. The study also highlighted that sustainability criteria are a key driver in determining the final amount of biomass available for energy. Finally, the BEE study emphasised the need for a coherent and harmonized approach for the estimation of biomass types and potentials.

Building on the BEE project, the Biomass Futures project (Alterra B.V., Centre for Renewable Energy Sources et al. 2012) was launched with the aim "to use modelling frameworks in order to inform policy with quantitative information on the role biomass can play to meet the Renewable Energy Directive targets". The project targeted to fill some remaining gaps for biomass demand and supply analyses, sustainability, energy modelling and policy making. The project estimated biomass supply for 2009-2030, and the influence of sustainability criteria was later assessed. For the energy modelling, the PRIMES model was used to assess the impact and the configuration of effort sharing targets per Member-State according to the Renewable Energy Directive (European Union 2009) The Biomass Futures project, therefore, established a solid methodological framework to evaluate the biomass available for energy uses in the medium-term in the European Union.

2.2 *Analysing bioenergy contribution to the Future Energy System*

In the context of energy and climate policies, the Joint Research Centre of the European Commission develops and maintains tools and instruments for the analysis of energy and climate policies in the European Union in the medium and long term. One of such instruments is the JRC-EU-TIMES model (Simoes, Nijs et al. 2013). It is a bottom-up, technology-rich model of the energy system of the European Union, Iceland, Norway, and Switzerland designed for analysing the role of energy technologies and their innovation in meeting Europe's energy and climate change related policy objectives. The Balkans countries can also be added to the analysis. For a full list of countries and their ES-codes see Annex 1. The JRC-EU-TIMES is geared to support the follow-up of the Energy Technologies and Innovation Communication (European Commission 2013) and its Strategic Energy Technology Plan (European Commission 2007).

The JRC-EU-TIMES explicitly considers energy supply sector and transformation– primary energy supply, electricity and heat generation – and five energy demand sectors – industry; residential; commercial; agriculture; and transport.

One of the key assumptions on the supply side is the renewable energy potentials. To steer a transparent debate on the future energy strategies, it is essential to develop an EU-wide coherent and transparent approach across technologies to evaluate such potentials and their relative impact with an energy system point of view.

The amount of energy that can be produced from a certain renewable energy resource (RES) depends on several parameters. These range from the physical characteristics of the renewable resource to performance improvements due to technical development up to economic or regulatory framework in force.

Assumptions regarding the current and future availability of renewable energy potentials are critical drivers of modelling exercises and results. Two examples of renewables potential assessment studies are the "*RE-shaping*" project[1] supported by the Intelligent Energy for Europe Programme from the European Commission and the "*GIS-Based Analysis of the Renewable Energy Technical Potentials"* carried by the National Renewable Energy Laboratory from the U.S. Department of Energy[2].

In the JRC-EU-TIMES, a number of assumptions and sources are adopted to derive the renewable energy (RES) potentials in the modelled regions for wind, solar, geothermal, ocean and hydro (Table 1).

Table 1: Overview of the technical RES potential considered in JRC-EU-TIMES for the EU28

RES	Methods	Main data sources	Assumed maximum possible technical potential capacity / activity for EU28
Wind onshore	Maximum activity and capacity restrictions disaggregated for different types of wind onshore technologies, considering different wind speed categories	(RES2020 Project Consortium 2009) until 2020 followed by expert-based own assumptions	272 GW in 2020 and 382 GW in 2050
Wind offshore	Maximum activity and capacity restrictions disaggregated for different types of wind offshore technologies, considering different wind speed categories	(RES2020 Project Consortium 2009) until 2020 followed by expert-based own assumptions	75 GW in 2020 and 143 GW in 2050
PV	Maximum land surface available for different types of PV (mainly thinfilm and CiSi)	Adaptation from JRC-IET on (RES2020 Project Consortium 2009)	115 GW and 1970 TWh in 2020 780 to 2340 GW depending on the efficiency of the considered panels in 2050

[1] http://www.reshaping-res-policy.eu/, last accessed on 20 November 2015.

[2] http://www.nrel.gov/docs/fy12osti/51946.pdf, last accessed on 20 November 2015.

RES	Methods	Main data sources	Assumed maximum possible technical potential capacity / activity for EU28
CSP	Maximum capacity restrictions disaggregated	Adaptation from JRC-IET on (RES2020 Project Consortium 2009) for 2020, then (Scholz 2012)	9 GW in 2020 526 GW in 2050
Geothermal electricity	Maximum activity restriction disaggregated for different types of geothermal technologies	(RES2020 Project Consortium 2009) until 2020 followed by expert-based own assumptions	Geothermal dry-steam and flash power plants: 20 TWh in 2020 and 31 TWh in 2050 Geothermal ORC plants: 17 TWh in 2020 and 707 TWh in 2050 Geothermal EGS: 1.5 TWh in 2020 and 8798 TWh in 2050
Ocean	Maximum activity restriction, disaggregated for tidal and wave energy	(RES2020 Project Consortium 2009) until 2020 followed by JRC-IET expert-based own assumptions	Near-shore wave production: 782 TWh in 2020 and 1064 TWh in 20050 Off-shore wave production: 3127 TWh in 2020 and 4254 TWh in 2050 Tidal energy: 385 TWh in 2030 and 390 TWh in 2050
Hydro	Maximum restriction, disaggregated for run-of-river and lake plants	(RES2020 Project Consortium 2009)	22 GW in 2020 and 40 GW in 2050 for run-of-river. 197 GW in 2020 and 2050 for lake. 449 TWh generated in 2020 and 462 TWh in 2050

Bioenergy is also modelled explicitly in the JRC-EU-TIMES. In addition to endogenous production forestry residues can be imported. Cropping and harvesting biomass for bioenergy entails specific costs. Bioenergy conversion pathways include first, second and third generation biorefineries. The direct use of ligno-cellulosic biomass is also envisaged.

Previous bioenergy potential data for JRC-EU-TIMES already pointed to the relevance of bioenergy in the future energy system (Simoes, Nijs et al. 2013), reaching in 2050 a maximum of 18% of total electricity generated via RES in the reference scenario. However, as the bioenergy potential data sets used in this study are of proprietary nature, the full range of results related to the deployment of bioenergy in Europe could not be published. This is a critical drawback for the contribution to the ongoing Energy Union debate. Therefore, the Institute for Energy and Transport of the Joint Research Centre commissioned a study[3] to estimate updated, EU-wide coherent data set for such a critical input for energy system modelling. Improving the estimation and the transparency of current and future bioenergy potentials for Europe is of paramount importance. Related work is carried out by the JRC, assessing the status of the potential for renewable energy in Europe (for instance, the Photovoltaic Geographical Information System, PVGIS[4], and (Scarlat, Martinov et al. 2010))

This report summarises the key findings of the study, which constitute the input for the updated JRC-EU-TIMES model for biomass potentials and costs for the main biomass categories in the agricultural, forest and waste sectors, for the period from 2010 to 2050. Given the uncertainty regarding future availability, bioenergy maximum potentials are estimated under three different possible biomass availability scenarios. All bioenergy availability scenarios account for the impact of the sustainability criteria on the future biomass available for bioenergy. This takes into consideration the work of the JRC on sustainable biofuels and bioenergy[5].

[3] Contract notice 2013/S 150-260084

[4] http://re.jrc.ec.europa.eu/pvgis/, last accessed on 30 November 2015.

[5] https://ec.europa.eu/jrc/en/research-topic/biofuels-and-bioenergy, last accessed on 30 November 2015.

2.3 Report content

The report is organised as follows: Chapter 3 describes the methodological framework, covering the scope of the study, the description of the main models used and their inputs as well as the scenarios defined to analyse the effect of different sustainability criteria on the future biomass availability. The chapter also includes an approach to account for the available land for the different crop types.

Chapter 4 outlines the main assumptions used to evaluate the potentials available for each type of bioenergy commodity, while Chapter 5 summarizes the main results of the study, presenting the estimated bioenergy potentials available for each biomass type for 2010-2050 in the three sustainability scenarios implemented.

Chapter 6 presents the hypothesis and the results of the biomass harvesting costs. Related emission factors are given in Chapter 7.

Finally, Chapter 8 presents two potential bioenergy deployment scenarios in Europe, derived from the JRC-EU-TIMES model using the obtained potentials.

The detailed data sets can be found in the Annexes.

3 Methodology

There is already an extensive framework on renewable energy potential evaluation, resulting in a consensus around the *type of potentials* that can be analysed when trying to quantify the available amount of renewable resource.

The global study from (Resch, Held et al. 2008) already differentiated the *theoretical*, *technical* and the *realisable* potential. In the Biomass Futures project approach (Alterra B.V., Centre for Renewable Energy Sources et al. 2012), an extended set of definitions was used:

- Theoretical potential: refers to the maximum energy potential that can be harvested from a resource, given its physical constraints.
- Technical potential: is the share of the theoretical potential that can be harvested taking into account current harvesting technologies performance and other possible constraints not fully associated with the physical limiting factor of the targeted source.
- Economic potential: covers the part of the technical potential that can be realized under certain condition of profitability.
- Implementation potential: terms the economic potential that can actually be implemented given a certain set of social, legal or political conditions.

When applied to biomass resources, the first input for the theoretical potential is the land available and its characteristics –those needed to estimate the expected yield - for a given crop. Technical potentials account for the machinery performance and, in some studies, also for the road infrastructure available for a given unit of terrain and its slope. Therefore, evaluating the technical potential involves assuming a coupling of the available resource (land) with a given harvesting technology (machinery and fertilization). Usually this coupling is decided by an expert. Here lies the methodological challenge faced to build a coherent potential data base to be used as an input to an energy system model.

The economic potential has to account for the cost of the machinery, fertilization and labour and the implementation should also include policies like the Common Agricultural Policy (CAP) of the European Union.

Within an energy system model, the coupling resources-technologies is a result of the model itself, according to its underlying rationale and principles (cost minimization in the case of the JRC-EU-TIMES) and restrictions (energy policies, emission and energy efficiency targets, etc.). An energy system model, which is detailed enough in the energy sector to decide on the energy technologies, may not be detailed enough to model and to evaluate the agricultural potential available.

In order to leverage on the strengths of sectoral models, the approach followed in this study has been to use agricultural and forest biomass specific models to account for the non-energetic priority uses of land (food crops), as well as for other relevant restrictions (e.g. environmentally protected areas). The baseline assumptions and inputs used for the agricultural / forestry models are as coherent as possible with those used in the JRC-EU-TIMES model. Therefore the results of these sectoral models provide the theoretical potential for bioenergy crops that is coherent with the food crops and non-energy wood requirements in the baseline. The energy-related outputs of the agriculture and forestry models are then selected and aggregated to match the technology structure of the energy system model. The results of the energy system model will then in turn identify the level of exploitation of the technical and economic potential that minimises the costs of the energy system under different energy and climate policies scenarios.

In the following sections the energy biomass feedstocks under the scope of the project are outlined and described. The sectoral modelling framework description follows, before defining the scenarios considered for this work. These are mainly designed to account for different levels of sustainability criteria applied to bioenergy feedstock. Finally the modelling of the available land is described.

It is important to point out that uncertainty regarding the current and future availability of biomass for energy is pervasive, as it is dependent on many external factors, such as population, land use patterns, policies, energy prices and climate, to cite just a few. For this study, in order to address the uncertainty, a two-pronged approach is taken: on the one hand, different plausible scenarios are developed, as discussed in the next Sections; on the other hand, a thorough assessment of the reliability of the data and assumption used was carried out. The results of such analysis are summarised in Annex 2.

3.1 *Energy Biomass feedstocks*

Biomass resources can be classified from several points of view. Harmonization across countries, crops and criteria is essential to build a comprehensive and coherent data set, suitable to be input into an EU wide energy system model. Therefore this project builds on the classification established after the BEE project, whose target was "to improve the accuracy and comparability of future biomass resource assessments for energy by reducing heterogeneity, increasing harmonisation exchanging knowledge" (The BEE project 2010). The BEE project biomass classification scheme was further refined in the Biomass Future project (Alterra B.V., Centre for Renewable Energy Sources et al. 2012). From this starting reference, the current work adapts the biomass categories to ensure their compatibility with the classifications and technologies represented in the JRC-EU-TIMES.

In the scope of this report, biomass feedstocks are classified according to the following hierarchy, which is based on current and expected trends in the development of the supply and demand sectors from an energy perspective (Table 2).

- Production sector
- Biomass category
- Biomass type

The relevant biomass production sectors for renewable energy are *agriculture, forestry* and *waste*.

Agriculture sector biomass resources are distributed between *energy crops, manure, primary*, *secondary*, and *solid agricultural* residues. Energy crops cover those whose primary target is the production of energy: sugar, starch and oily crops, the energy maize silage for biogas, and lignocellulosic biomass. Primary residues refer mainly to dry and wet manure coming from the livestock industry. Secondary residues refer to olive pits and finally the solid agricultural residues category gathers residues from pruning of permanent crops, straw and stubble left from other main activities.

Biomass from the forestry sector is classified into roundwood production and primary and secondary residues. The roundwood adds the production from roundwood and thinnings. Primary residues can be logging residues and other pre-commercial thinnings; while the secondary residues can be woodchips and pellets, sawdust and black liquor coming mainly from the paper industry[6].

Finally, the waste sector produces energy biomass in the primary and tertiary residues categories. The primary residues mainly group residues coming from landscape care management, roadside verges and abandoned lands. The tertiary residues group biomass residues from different industries and municipal solid waste.

The agro-energetic results per biomass type from the agricultural model are therefore grouped according to their possible energy use within the energy system model. Biomass technologies and end-uses within the JRC-EU-TIMES are aggregated in line with the POLES model. Detailed description can be found in (Simoes, Nijs et al. 2013).

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[6] While the potentials for black liquors is also estimated as part of this study, it is not included as an input into the JRC-EU-TIMES model. The paper industry is modelled explicitly in the JRC-EU-TIMES model and, therefore, the availability of black liquor is endogenous.

Table 2: Biomass categories, definitions and energy uses

Sector	Biomass category	Biomass type	Definition	Energy End-Use	Energy Commodity	JRC-EU-TIMES code
Biomass from agriculture	Energy crops	Sugar, starch & oil crops	Crops dedicated to the production of bioenergy, mainly biofuels of first generation bioethanol and biodiesel. Sugar and starch crops feed fermentation processes to produce bioethanol and oily crops feed transesterification process to produce biodiesel	Biofuels for transports End uses in the JRC-EU-TIMES allow different blending options for biofuels and fossil fuels to feed the transport fleet	Bioethanol sugar beet	MINBIOCRP21
					Oil crops other than rape seed	Added to MINBIORPS1
					Rape seed	MINBIORPS1
					Starchy crops	MINBIOCRP11
		Dedicated perennials-woody/ lignocellulosic biomass	Biomass from agricultural production activities of perennial crop, including short rotation forests (SRF): willow, poplar and other grassy crops	Wood suitable for combustion in different demand sectors: agricultural, commercial, electricity production, industry and residential. Biomass gasification processes and hydrogen production	Grassy crops	MINBIOAGRW1
					Willow	MINBIOCRP41
					Poplar	MINBIOCRP41a
		Energy maize / silage	Grassy crops producing lignocellulosic biomass	Crops residues mainly sent for combustion applications	Wet / silage	MINBIOCRP31
	Agricultural primary residues	Dry manure	Dry manure (poultry, sheep & goat manure)	Biomass from agricultural production activities that is gasified. Possible combustion and electricity production downstream	Biogas	MINBIOGAS1
		Liquid/wet manure	Wet manure (pit and cattle manure)	Biomass from agricultural production activities that is gasified. Possible combustion and electricity production downstream		
	Secondary residues	Olive pits	Biomass from olive pitting	Combustion based energy production downstream	Wood-like fuel	MINBIOAGRW1
	Solid agricultural residues	Pruning and straw/stubble	Residues from agricultural cultivation, harvesting and maintenance activities. Other solid agricultural residues (pruning, orchards residues), straw and stubbles			

Sector	Biomass category	Biomass type	Definition	Energy End-Use	Energy Commodity	JRC-EU-TIMES code
Biomass from forestry	Stemwood production	Stemwood	Sustainable extracted forests biomass Includes tree plantations	Wood suitable for combustion in different demand sectors: agricultural, commercial, electricity production, industry and residential. Biomass gasification processes and hydrogen production	Wood-like fuel	MINBIOVOO
		Additionally harvestable stemwood	Woodchips and pellets			MINBIOWOOa
	Primary forestry Residues	Logging residues	Aggregated fuelwood and chips from primary residues. Forest biomass residues additionally harvestable from forest (top, branches, stumps and early pre-commercial thinnings)			MINBIOFSR1
		Landscape care	Potentials outside agricultural permanent cropland			MINBIOFRSR1a
	Secondary forestry residues	Woodchips, pellets, sawdust and black liquor	Cultivation and harvesting / logging activities in forests, like branches and roots and other wooded biomass.			MINBIOWOO1
			Saw dust			MINBIOWOO1a
			Other industrial woody residues		Black liquor	The amount of black liquor available is given by the model as a result of the industry production (INBLQ)
Biomass from waste	Primary residues	Biodegradable waste	Public greens (road side verges)	Cogeneration and electric generation applications mainly in the industry and residential sectors	Solid fuel	MINBIOMUN1
	Tertiary residues	Biodegradable waste	Municipal Solid Waste (renewables), other waste (abandoned grass cuttings, vegetable waste, shells/husks)	Cogeneration and electric generation applications mainly in the industry and residential sectors		
		Other waste	Sewage sludge, paper and cardboard waste, dredging spoils	Cogeneration and gasification mainly in the industrial and residential sectors	Biogas substrate	MINBIOSLU1

3.2 Modelling framework

This section provides the methodological framework for the analysis, describing the overview of the main modelling blocks, their inputs and outputs. The detailed assumptions and modelling approaches adopted for each biomass type are discussed in Chapter 4 and Chapter 6.

As represented in Figure 1, the CAPRI model (W. Britz and P. Witzke 2014) is the core modelling element for the agriculture sector. CAPRI is a partial equilibrium model for the agricultural sector ranging from global to regional and farm type scale. The use of the CAPRI model is warranted as it is the only available model which predicts the EU agriculture markets and production responses at the regional level for the whole EU28. It is therefore the only source of information available that gives a plausible overview taking account of the specific diverse regional circumstances in the EU, what land-use changes can be expected by 2050 and the extent to which they can be related to dedicated bioenergy cropping and other renewable energy activities on farms. Moreover, CAPRI is part of the modelling suit used by the European Commission in assessing energy and climate policies: it thus ensures consistency in the scenarios and assumptions adopted across modelling exercises. In this study we therefore build on the CAPRI model results, which forecast future land use and livestock production changes in the EU28, including land demand for domestic biofuels.

The core data sets for each biomass type are built from the most recent 2010-2050 baseline runs. The baseline for CAPRI runs have been aligned with the GDP and population assumptions in the Reference Scenario 2013 (European Commission 2013). Similarly, demand for biofuels, both first generation (1G) and second generation (2G), derive from (European Commission 2013). The total demand for 1G biofuels (bioethanol and biodiesel), which comes from rotational arable crops also used for food and feed purposes (e.g. oil seed rape, sunflower, wheat, barley, maize, sugar beet), is added to the total market demand in the CAPRI market module. The CAPRI module then determines the match between the total biomass demand needs and the best mix of biomass crops and distribution over production countries according to several production and market constraints internal to the CAPRI model. These are not necessarily consistent with the PRIMES assumptions in terms of exact conversion efficiencies, but are consistent with the totals for bioethanol and biodiesel demand. The reason is that CAPRI needs to take account of the farm production realities. So the CAPRI model ensures that the total biofuel demand from PRIMES for domestic sources is reached, in terms of totals at an EU and national scale, but the mix of biofuel crops making up the total bioethanol and biodiesel could be different from the PRIMES demands.

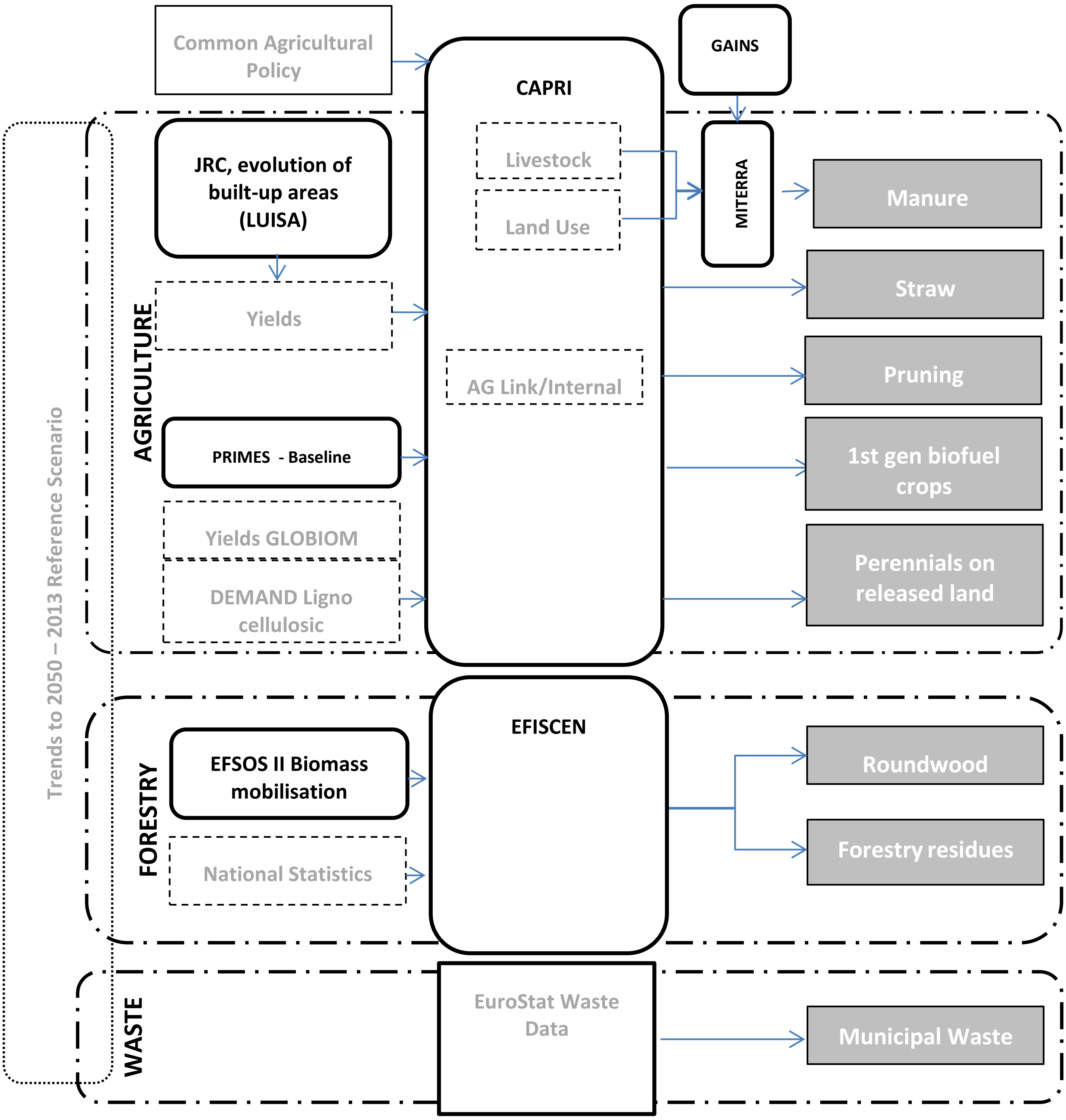

Figure 1 Energy Biomass Potentials modelling framework

For the agricultural crops, yields are derived from existing results of the AgLINK modelling system (OECD 2007). AgLINK is a dynamic supply-demand model of world agriculture, developed by the OECD Secretariat in cooperation with Member countries which is used as evaluation tool for the yearly OECD-FAO Agricultural Outlook. Other specific yield factors are input into CAPRI. Other policies and external factors like the Common Agricultural Policy or the demand for biofuels are input as exogenous to the model runs.

For the assessment of forestry biomass resources, the EFISCEN model (Verkerk, Anttila et al. 2011) is used to evaluate the potentially harvestable stemwood. The European Forest Sector Outlook Study II (EFSOS II) scenarios (United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations 2011), which provide data on the national forest inventory, are a main input category for the EFISCEN model.

Finally, the waste potential evaluation is carried out based on Eurostat statistics on national waste generation. The evolution of waste over time is estimated based on the GDP and population growth assumed in the baseline.

As for the cost assessment a more pragmatic approach is followed. A distinction is made between different types of cost and price estimates specific per biomass type:

1) Market prices for already traded biomass types;
2) Road-side-cost for biomass for which markets are (practically) not developed yet; and
3) At-gate-cost which covers the cost at roadside, transport and pre-treatment cost until the biomass reaches the conversion plant gate.

For biomass streams that are already traded on a market at large quantities and which can be regarded as (near to) a commodity the cost level will be similar to a price level. For the other biomass categories cost estimates are made taking account of national specific labour and machinery cost for production (in case of crops), harvesting and collecting of the biomass up to the roadside. Where relevant, logistic costs have also been calculated, based on an ad-hoc model that allows estimating the country-specific cost of transporting feedstock. Further details on cost calculation are given in Chapter 6.

3.3 Scenarios

Sustainability criteria play a major role in determining the final total amount of biomass available for energy production. Therefore the evaluation of bioenergy potentials has been carried under three scenarios with different sustainability assumptions: High, Medium and Low bioenergy availability.

The High bioenergy scenario is compatible with a situation where stimulation measures are in place and/or demand for biomass is high and there is a willingness to pay a (higher) price for it. This enhances the mobilisation of biomass production and harvesting opportunities and stimulates the use of biomass above alternative uses.

The Medium bioenergy scenario corresponds to a reference case, and specifies the most likely future development of bioenergy leading to a continuation of current trends. There is stimulation of bioenergy production, but taking account of sustainable and resource efficient use of biomass. This implies that bioenergy use of types of biomass with high sustainability risks are avoided and that enough room is left for competing uses of biomass outside the energy sector. The mobilisation of biomass production and harvesting is not as strongly stimulated as in the High scenario. Stimulation and policy measures can be assumed to be in line with currently agreed policies and targets.

In the Low bioenergy scenario biomass use in the energy sector is not a key priority, but resource efficient use of biomass is. This implies that there are fewer stimulation measures in place for mobilisation of domestic biomass supply and sustainability criteria are strict putting limits to the removal of residues from forests and the production of dedicated cropping potential both for biofuels and ligno-cellulosic crops. Competing uses for material conversion of biomass have higher priority than the use of biomass residues and waste in energy because of stricter policy guided by overall resource efficiency.

Further details on how the scenario assumptions are applied to each type of biomass feedstock is provided in Table 3 to Table 5: Summary of scenarios considered for the Table 5. The scenario dependant calculation steps for land availability are summarized in Table 6

Table 3: Summary of scenarios considered for the agriculture sector

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW
ENERGY CROPS	Sugar starch & oil crops	-	Available Land	An extra 10% land area available for biofuel and energy maize as compared to predicted by CAPRI baseline	Consistent with Capri	Consistent with Capri	Biofuel crops grow in competition for land with food and feed crops but this is no impediment for their use for energy. Their share can be even 10% above the land use share as predicted by CAPRI	Biofuel crops grow in competition for land with food and feed crops as assessed by CAPRI	Biofuel crops grow in competition for land with food and feed crops as assessed by CAPRI 2) No irrigation in biofuel crops 1) Biofuel crops cannot be sourced from HNV farmland
			Irrigation	Yes	Yes	No			
			Yield [% Increase per year]	Consistent with CAPRI yield increases Available					
	Energy maize/silage (for biogas)	-	Available Land	Yes	Yes	No	As for biofuel crops	As for biofuel crops	As for biofuel crops
			Irrigation	Yes	Yes	No			
			Yield [% Increase per year]	As in CAPRI+10%	CAPRI+10%	CAPRI+10%			
	Woody/ ligno-cellulosic biomass	-	Available Land	Consistent with Capri land release between 2008 and analysis year (2020, 2030, 2040 or 2050)	Consistent with Capri land release between 2008 and analysis year (2020, 2030, 2040 or 2050)	Consistent with Capri land release between 2008 and analysis year (2020, 2030, 2040 or 2050)	1) high yield factor increases per year for dedicated bioenergy crops as result of improved technological developments in perennial breeds and farm management systems	1) Medium increase per year in yield factors for dedicated bioenergy crops as result of improved technological developments in perennial breeds and farm management systems	1) Low increase per year in yield factors for dedicated bioenergy crops as no investments in technological developments in perennial breeds and farm management systems

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW
						but excludes protected areas and high nature value farmland	2) Growing energy crops (perennials) on marginal and fallow lands, such as highly erodible lands, poor soils, which have been released from agriculture already long time ago 3) Dedicated cropping can take place in High biodiversity lands 4) Irrigation is allowed	2) Growing energy crops (perennials) on marginal lands 3) no crops on biodiversity rich land and on land (e.g. High Nature Value (HNV) farmland and Natura 2000 land in EU) with high carbon stocks 4) Irrigation in dedicated cropping is allowed	2) no crops on biodiversity rich land and on land with high carbon stocks and on fallow land. 3) Marginal lands can be used for dedicated perennial crop, but limited investments and no irrigation allowed. 4) Urban planning policies (more urban sprawl and less land for biomass)
			Irrigation	Yes	Yes	No			
			Yield [% Increase per year]	1	0.5	0.25			
			Competing use [% NOT going to energy /total]	0%	50%	75%			
AGRICULTURAL PRIMARY RESIDUES	Manure	Dry (poultry, sheep, goat)	Livestock	Consistent with Capri animal number and type developments			1) Increase in the removal rate of residues from arable and permanent crops 2)Increase of sustainable yield ratios for straw up to 50% of straw available 3) Minimum use of straw for alternative (non-energy) uses 4) straw use in bedding declines because of alternative uses and new livestock housing systems 5) Re-use of all woody material from pruning and cutting- residues from abandoned grassland are usable for	1) Removal rates of arable and permanent crop residues will stabilise at what is also currently a common practice and sustainable acceptable (not taking account of specific regional circumstances making sustainable removal more of an issue) 2) Use of straw for alternative (non-energy) uses according to current conditions 3) Moderate increase use of woody material from pruning and cutting	1) Today's patterns for residue-producing crops 2) Stricter sustainable yield ratios for straw then in current situation 3) Use of straw for alternative (non-energy) uses according to current conditions 4) Use of woody material from pruning and cutting on today's level 5) No residues from grassland
			Competing use [% NOT going to energy /total]	0%	50%	75%			
		Wet (manure (pig, cattle)	Livestock	Consistent with Capri animal number and type developments					
			Manure available for digestion	All manure produced on farms with >100 Livestock Units	All manure produced on farms with >200 Livestock Units	All manure produced on farms with >500 Livestock Units			
AGRICULTURAL	Pits from olive pitting		Residue ratio	All olive pits going to processing industries in EU					

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW
SECONDARY RESIDUES			EU Collection ratio	50%(2020), 60%(2030), 70%(2040-2050)	30%(2020), 35%(2030), 40%(2040-2050)	20%	bioenergy	from today's level 4) No residues from abandoned grassland	
			Competing use [% NOT going to energy /total]	0%	50%(2020), 60%(2030-2050)	80%(2020), 85%(2030-2050)			
SOLID AGRICULTURAL RESIDUES	Prunings (permanent crops (e.g. orchards, vineyards, olives, citrus, nuts) residues		Area	Consistent with Capri permanent crop area developments					
			Harvest ratio [%/total]	60%(2020), 70%(2030), 80%(2040), 90%(2050)	40%	20%(2020), 10%(2030-2050)			
			Competing use [% NOT going to energy /total]	20%(2020), 15%(2030), 10%(2040-2050)	60%	70%			
	Straw/stubbles		Area	Consistent with Capri cereals, OSR, grain maize, sunflower development					
			Harvest ratio [%/total]	40%	30%	0-30%			
			Competing use [% NOT going to energy /total]	20%(2020-2030), 10%(2040-2050)	50%(2020-2030), 60%(2040-2050)	80%(2020-2030), 85%(2040), 90%(2050)			

Table 4: Summary of scenarios considered for the forestry sector

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW
ROUND-WOOD PRODUCTION	Stemwood (from roundwood and thinnings)		Timber demand [1000 m3]	1239127 (2020), 1419084 (2030), 1661190 (2040), 2072894 (2050)	1063510 (2020), 1167638 (2030), 1267388 (2040), 1471997 (2050)	965949 (2020-2050)	1) stem wood and forestry residues available for energy production 2) Increased woodland productivity by fertilization and harvesting mechanisation efficiency and increased mobilisation of wood from smallholders 3) Reduced competing demand for non-energy purposes 4) Increased mobilization of primary forestry residues because of increased demand for biomass for energy, which leads to increased stump and residue removal1	1) Stem wood is mainly used for non-energy purposes, but improved mobilisation of stemwood, primary and secondary forestry residues compared to today because of increase in contribution of small holders. 2) Stump removal is however limited because of sustainability considerations. 3) reference woodland productivity and mobilization1	1) Forestry harvest patterns according to strict sustainability criteria and low mobilisation of small and medium forest holders use of forestry residues only 2) available residues only from residue extraction, but no stump removal allowed 3) lower ratios of usage of primary and secondary residues and more competition
			Harvesting techniques applied	High efficiency	Medium efficiency	Low efficiency			
			Sustainability considerations	Low	Medium	High			
			Competing use (% NOT going to energy)	45%(2020), 39%(2030), 31%(2040), 23%(2050)	52%(2020), 50%(2030), 47%(2040), 42%(2050)	55%(2020-2050)			
PRIMARY FORESTRY RESIDUES	Logging residues (tops, branches, stumps and early pre-commercial thinnings)		residue removal rate	No limitation for stump and residue extraction	Low stump extraction and medium residue extraction	Stump extraction excluded, low residue extraction			
			Competing use (% NOT going to energy)	0%	50%(2020), 60%(2030-2050)	50%(2020), 60%(2030-2050)			
SECONDARY FORESTRY RESIDUES (FROM WOOD AND PAPER & PULP INDUSTRIES)	Woodchips & pellets		Amount of residue/residue ratio	Linked to wood demand and locations of processing industries					
			Competing use (% NOT going to energy)	0%	50%(2020), 60%(2030-2050)	50%(2020), 60%(2030- 2050)			
	Sawdust		Amount of residue/residue ratio	Linked to wood demand and locations of processing industry					

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	**MED**	**LOW**	**HIGH**	**MED**	**LOW**
			Competing use (% NOT going to energy)	0%	50%(2020), 60%(2030-2050)	70%(2020), 80%(2030-2040), 90%(2050)			
	Black liquor		Amount of residue/residue ratio	Based on Euwood/Biomass Futures (endogenous in JRC-EU-TIMES model)					
			Competing use (% NOT going to energy)	0%	0%	0%			

Table 5: Summary of scenarios considered for the waste sector

BIOMASS CATERGORY	BIOMASS TYPE	BIOMASS SUBTYPE	KEY-PARAMETER	SCENARIO			Limitation of biofeedstocks / land area		
				HIGH	MED	LOW	HIGH	MED	LOW
PRIMARY RESIDUES	Biodegradable waste	Abandoned grasslands cuttings	Area				Landfill gas All landfill gas is used for energy production, because of a ban on landfill on all countries Production of MSW will stabilize at current levels Biowaste (municipal) 1) All biowaste is used for energy production; 100% for all countries from 2030 onwards 2) High efficiencies of (separate) waste collection Biowaste (industrial) 1) All biowaste is used for energy production, recycling quota = 100%, no industrial waste for non-energy purposes 2) High efficiencies of (separate) waste collection 3) Production levels of	Landfill gas Recycling quota for landfill gas harmonized; minimum 80% in 2030 in all EU-countries and 100% in 2050 Production of MSW will go down slightly as compared to current levels Biowaste (municipal) 1) reference efficiencies of (separate) waste collection 2) Recycling quotas for regions harmonize on highest benchmark (today: Austria ~60%) until 2030 an increase up to 80% of waste going to energy until 2050 for all countries Biowaste (industrial) 1) Recycling quotas for regions harmonize on highest benchmark 2) Bioenergy has preference over non-energy use of industrial biowaste	Landfill gas Recycling quota for landfill gas remains on current level in the countries Biowaste (municipal) 1) Today's recycling quotas of the countries persist 2) biowaste in competition with non-energy use Biowaste (industrial) 1) Today's recycling quotas of the countries remain 2) Food chain efficiency improvements (better efficiency and less biowaste)
			Collection ratio	50%(2020), 60%(2030), 70%(2040-2050)	50%(2020), 60%(2030), 70%(2040-2050)	20%			
		Public green = municipal landscape manage-	Area						
			Collection ratio	50%(2020), 60%(2030), 70%(2040-2050)	Base year	20%			
		Road side verges	Area per street category						
			Competing use (% NOT going to energy)	50%(2020), 40%(2030), 30%(2040-2050)	Base-year	80%			
TERTIARY RESIDUES	Biodegradable waste	Shells/ husks	Recycling ratio	Overall recycling quotas for regions increase from status-quo to 100% in 2030 and afterwards, with high residue ratios	Overall recycling quotas for regions harmonize on highest benchmark (today: Austria ~60%), and increase further to 70% in 2040 and 80% in 2050 with reference residue ratios	Today's overall recycling quotas of the countries persist			
		Nut shelling	Recycling ratio						
		Animal and mixed food	Recycling ratio						
		Vegetal waste	Recycling ratio						
		Municipal Solid Waste	Recycling ratio						
	Woody waste (incl.	Discarded	Residue ratio	As in Eurostat for base year extrapolated towards 2050					

furniture, Woody fraction)			according to			waste stabilize at current levels	3) Production levels of waste decline at medium rate towards 2050 as compared to current levels
		Competing use (% NOT going to energy)	20%	Base Year	50%		
Other waste	Paper cardboard	Competing use Residue Ratio	All biomass from other waste sources are used for energy purposes	Interpolation between low and high scenario	Today’s recycling quotas of the countries persist		
	Sewage sludge						
	Dredging spoils						

3.4 Available Land

In the characterization of biomass potentials from agriculture and forest, spatially explicit analysis is a key aspect of the assessment, building on several spatially explicit data sources (see Annex 3). For the potential from waste, the spatial explicit locational characteristics are less influential although for certain types of biomass are also required in the assessment.

For the biomass potential the current and future land use and livestock patterns, derived from Eurostat and CAPRI, are determined. Several constraints are also set on area use depending on the scenario specifications as specified in Table 3.

The exact policy assumptions used in the CAPRI baseline are consistent with those specified in the "Trends to 2050. Reference scenario 2013" (European Commission 2013). In fact the GHG emissions from agriculture for the runs made for this potential assessment were assessed using the CAPRI baseline 2008-2050 as the main input.

Residues from agriculture, i.e. straw, pruning/cutting residues and manure can be harvested in all scenarios, so no area constraints are applied.

For the 2010 situation the structure is different from the future. This is because currently we only know the total division of land over different land uses such as Utilised Agricultural Area (UAA), arable land, fallow land, abandoned land area and land used for rotation biofuel crops and perennial crops. For the latter two categories it is not known which former land uses they were replacing. For the arable crops this is likely to be arable land as these crops only grow on good quality soils. For perennials this could be arable land, former fallow land, land used for permanent crops or even abandoned land.

For the future land used for dedicated crops in 2020 and 2030, expected values based on future land use changes predicted by the CAPRI runs are used. First the total Utilised Agricultural Area (UAA) is computed. This land category includes all land in agricultural use, including fallow land, but excluding land released from agriculture between 2004 and 2020 and excluding abandoned land already out of agricultural use before 2004. The estimation of the size of this abandoned land resource is complicated and is taken from estimates elaborated as part of the ETC-SIA (2013) study.

For biofuel crops the potential follows the CAPRI land potential in the Medium and Low bioenergy scenario. For the High scenario the biofuel crop area predicted by CAPRI is allowed to be 10% above what it is, enabling for more biofuel production assuming that there is also a 10% increase in demand. The same applies for production area for silage maize and grass silage going into digestion pathways. In the High bioenergy scenario this land share can increase up to 10% above the Medium scenario land area used for silage production for biogas. In the Low bioenergy scenario it is assumed that no domestic silage crop production takes place as from 2020 onwards because of very strict resource efficiency requirements.

Dedicated cropping with perennials can take place on released agricultural lands, fallow lands and abandoned lands. In the Medium and High bioenergy scenarios all of the released and fallow lands can be used for this. In the Low bioenergy scenario released lands that are biodiversity rich lands such as HNV farmland and/or Natura 2000 area cannot be used at all and limits are set to the share of fallow land. In the case of the latter it is first ensured that the fallow land area remains stable when it does not exceed an equivalent share of 10% of the arable land area. The reason for this is that the function of fallow land for maintaining biodiversity in agricultural lands is more relevant element than the production of biomass for bioenergy purposes.

As to abandoned land use for perennial cropping, the situation is again different per scenario. In the High scenario it is expected that many stimulation measures are in place to accommodate the large demand for domestic biomass which makes it more likely that long term abandoned lands are taken into production again. Therefore 10% of the abandoned land resource is expected to be used for perennial biomass cropping. In the medium situation this will amount to only 5% and in the Low bioenergy scenario no abandoned lands are converted to perennial plantations as incentives to do this are not in place.

Finally, we consider changes in built-up areas in Europe based on (Baranzelli, Jacobs et al. 2014).

The calculation steps for the different scenarios are summarized in Table 6.

Table 6: Calculation steps for estimating land availability per scenario

	Bioenergy scenarios		
	High	**Medium**	**Low**
Total arable land released (2008-2020, 2030, 2040 and 2050)	YES	YES	YES
Land released from permanent crops	YES	YES	YES
Land released from olives, vines and former set-aside	YES	YES	YES
Total fallow land available	YES	YES	Only part of fallow land that exceeds the size of 10% of arable land
Total abandoned land converted to perennial cropping	10%	5%	0
= Total land released, fallow and abandoned	total	total	total
Total land and use further constrained by:			
Available released grassland for use of grass cuttings (no cropping)	Only cuttings	Only cuttings	NOT USED
Biofuel cropping land as assessed in CAPRI	YES for biofuels	YES for biofuels	NOT USED
Built-up areas (land claim for urbanisation, industry, commerce, and service sectors)	According to LUISA	According to LUISA	According to LUISA+2%
High carbon stock land	Used for cropping	NOT USED	NOT USED
HNV and protected areas	Used for cropping	NOT USED	NOT USED
Irrigation	YES	YES	NO
Assumed yield increase in perennials per year	1%	0,5%	0.25%

4 Biomass energy feedstock potential evaluation

4.1 Biomass from agriculture

As referred before, for the assessment in this study, agricultural land-use and livestock production levels are used based on the most recent CAPRI baseline run 2008-2050, providing intermediate results for 2010, 2020, 2030 and 2050. This baseline run can be seen as the most probable future simulating the European agricultural sector under status-quo policy and including all future changes in policy already foreseen in the current legislation. It also assumes all policy regarding bioenergy targets as agree until now and further specified in the *Trends to 2050* report (European Commission 2013) for as far as affecting agriculture. The CAPRI baseline run is assumed to correspond with the Medium biomass availability scenario situation in this study.

Yields and changes in yield levels per region and country for conventional crops in CAPRI are implemented in the baseline scenario. They are derived from the AgLINK modelling system of the OECD, which takes information from questionnaires to all OECD Member States as a basis. The Member States fill in time series on future developments on several variables including yield developments of their main crops. These values are usually based on country specific modelling baselines, expert consultations, historic projections. The national input is then recovered in AgLINK by adapting the behavioural equations in the model while at the same time adapting these to joint worldwide future development expectations regarding import/and export relations, worldwide price and technological developments. CAPRI then takes AgLINK as an input, but further adapts future developments where needed to keep them within the ranges of analysis based on simple statistical trends for the different EU member States. These developments are then further incorporated into CAPRI but tuned where necessary with internal constraints set on yields for both vegetable and animal products. These internal constraints are needed to maintain stable relationship between the very influential yield increase parameter and other factors such as technology development, seed use and losses, land use ratio factors, etc. Further details on this aspect and also other technical details of the CAPRI model, the CAPRI Coco database and the incorporation of bioenergy crops can be found in (W. Britz and P. Witzke 2014).

Crops used for bioenergy production, particularly the crops going into 1G biofuels and biogas are not registered separately by member States. Dedicated perennial biomass crops are registered now in Farm Structure Surveys (FSS) as a separate land use category, but their area share is still very limited. For the potential assessment in agriculture, FSS data for the current situation are used as input, together with modelled land use changes to assess future biomass potentials from agriculture.

In the data sets information for the member states of the EU, Balkan countries, Norway and Iceland are included. In Switzerland, feedstock from forestry is the most important bioenergy source, and is included in the assessment. For non-forestry feedstock in Switzerland and other non-EU member states a separate approach (compared to the EU member states) has been applied in order to assess the bioenergy potentials since these countries are not covered by CAPRI and results from other projects are not available yet. Here we follow a top-down approach to identify national bioenergy potentials for biomass from agriculture and waste. In this approach we scale national bioenergy potentials, derived from available literature, to NUTS-2 level by using Globecover and population distribution data when available.

4.1.1 Biofuel crops

The biofuel crop potentials are directly derived from the CAPRI baseline simulations assessing the domestic biofuel potential. The emphasis in the CAPRI run is on predicting biofuel cropping response. Demand for biofuels, both first generation and second generation in the CAPRI baseline is taken from the PRIMES baseline for domestic biofuel production quantities and mixes for the future years. The total demand for 1G biofuels (bioethanol and biodiesel) from PRIMES, which comes from rotational arable crops also used for food and feed purposes (e.g. oil seed rape, sunflower, wheat, barley, maize, sugar beet), is added to the total market demand in the CAPRI market module. The CAPRI module then determines the match between the total biomass demand needs and the best mix of biomass crops and distribution over production countries according to several production and market constraints internal to the CAPRI model. These are not necessarily consistent with the PRIMES assumptions in terms of exact conversion efficiencies, but much more in line with farm production realities.

The baseline situation of CAPRI for biofuel potential is applied to the Medium and Low bioenergy scenario of this study. For biofuel supply in the High scenario we assumed that the domestic potential increases by 10%

above the CAPRI baseline and Medium bioenergy scenario situation. In this way the PRIMES and CAPRI logic is overruled for biofuel demand in the High scenario only. In this case it is assumed that in the High scenario this will just lead to higher food and feed imports (and ILUC effects). In the Low bioenergy scenario it is assumed that the amount of biofuel crops is still the same as for the Medium scenario situation. However, these crops are not produced on HNV farmland and not with irrigation. This implies that food and feed crops can still be produced with irrigation and on HNV farmland but that these are not sourced for Biofuels. So the amount of biofuel crops sourced is still the same as in the Medium scenario.

4.1.2 Dedicated perennial crops

The demand for ligno-cellulosic crops is exogenous to CAPRI. It is assumed that this demand can be satisfied without interfering in the food and feed market equilibrium simulated by the CAPRI market module. Since also the biomass demand from dedicated crops is exogenous to CAPRI, in this study we assess this demand in a post-model analysis taking account of land releases simulated in CAPRI in different land categories (related to high and low quality soils). So the land available for dedicated cropping can range according to the scenario specifications in this study, which affect the land availability level and the yield level increases per year for dedicated perennial crops.

In this assessment it is expected that dedicated cropping with perennials for bioenergy production is most likely to take place on land that is neither needed for the production of food and feed nor for biofuel crops. In order to estimate the amount of land that can be included in this potential, a comparison of the size of different types of land uses in future years with the 2008 situation is made. In this way not only the amount of land released is assessed, but also categories of land released. Good quality land is released in the arable cropping category and low quality land in vineyards and olives category and fallow.

The different calculation steps for Land availability across scenarios are given in Table 6. The land release estimate excludes a further potential of land that has been abandoned already before 2008 and therefore not included in the total utilised agricultural area figures of 2008 used in the CAPRI modelling exercise. This abandoned land resource is expected to be considerable especially in Central and Eastern Europe (CEEC) and in the Mediterranean and could also add significantly to future potentials ((Pointereau, Coulon et al. 2008), (Terres, Anguiano et al. 2013), (Elbersen, Beaufoy et al. 2014)). Good estimates of the size of this land are very scarce however. In a joint study by ETC-SIA and the EEA ((Elbersen, Fritsche et al. 2013) the extent of this land resource was estimated at a regional level and this assessment is taken as a basis for further land availability assessment in this study.

Because of the constraints set on the type of land to be used in the Low bioenergy scenario as compared to the High and Medium scenario the land availability is smaller. These constraints are limitations set on the use of land of high biodiversity and carbon stock. In the Low scenario these types of land are fully excluded from the potential. The land being covered by the category HNV farmland and protected areas are excluded for transformation into dedicated perennials cropping land in the Medium and Low scenarios. Their area share per region was already estimated (Paracchini, Petersen et al. 2008). These area shares were also already used to calculate which part of the arable and permanent cropping land is covered on average by these type of lands in every region in the ETC-SIA and EEA study (Elbersen, Fritsche et al. 2013). The shares of these studies were also applied to the land releases per region in this study. It was assumed that the released land categories had the same HNV and protected area shares as the rest of the cropping land remaining in agricultural production.

The share of abandoned land resource expected to be put back to production is also considerably lower in this scenario.

To determine the final use of the land available also different considerations and constraints per scenario are applied. The overall choice of the perennial crop mix per region and type of released land is assessed by building on the regional crop mix selection and yield and irrigation assessments published in (Elbersen, Fritsche et al. 2013). These results were developed as part of the EEA/ETC-SIA study (Elbersen, Fritsche et al. 2013) and the Biomass Policies Project. This mix fits with the soil and climate characteristics per region, but to determine the final mix priority is given to the cheapest crop mix per region, in terms of production cost levels per ton dry biomass. These cost estimates per crop per region were also done as part of this project and of the Biomass Policies but will be further improved in work currently in process in the S2BIOM project.

In addition to the land availability which is scenario specific, additional assumptions were also applied regarding the yield level increases for perennials in future situations. In the High scenario the yield level increase for these crops is assumed to be 1%, for the Medium 0.5% and for the Low 0.25% per year.

4.1.3 Agricultural residues

Residual biomass from agriculture comes from primary residues from arable crops (straw and stubbles), pruning, cutting and harvesting residues from permanent crops and manure. The most suitable data for assessing the availability of agricultural residues are from Eurostat. It concerns the Farm Structural Survey (FSS) data which provide detailed crop area and livestock number (heads and Livestock Units) data at NUTS2 and 3 levels. These data are reported by the national statistical offices to Eurostat and are based on the national agricultural surveys and census held at regular intervals and collected following EU wide guidelines. These data are very suitable for assessing the current biomass potential of agricultural residues[7]. In this study the FSS data are used indirectly as they are one of the main input data sources for the CAPRI model.

The residual biomass from straw, stubbles and permanent crops need to be assessed according to current and future cropping patterns of the crops delivering residues. The manure potential needs to be assessed according to current and future livestock patterns combined with cropping patterns data to assess excess manure levels, i.e. levels of manure above what is needed for maintaining stable soil fertility under current and future land use patterns.

4.1.3.1 Energy maize and grassland cutting for biogas conversion

For the estimation of the energy maize and grassland cutting potential there is little solid information to build on. In CAPRI there is no incorporation of demand for energy maize in the baseline run. However, indirectly it is incorporated as the market demand and production for own consumption of maize builds on the real market and use situation as from 2008. CAPRI simulates with 2008 as the reference year and further calibrates the model on statistical information available. The production of fodder maize and permanent grassland cuttings (used for digestion) is incorporated in the input statistics used. To distinguish between fodder maize and energy maize share national data had to be used in this study on the amount of energy maize produced. For grassland cuttings this figure is not available but it is known that the use of grassland cuttings in digestion is considerably lower than for energy maize in Germany and Austria. Data on energy maize production were only available for Germany and Austria, which are also the countries where the energy maize production was considerably larger than in other countries because of stimulation measures (e.g. feed-in tariffs). The data on energy maize production area were collected as part of the ETC-SIA (Elbersen, Fritsche et al. 2013) and Biomass Futures project assessments (Elbersen, Fritsche et al. 2013). For Germany this area was estimated at around 295.000ha in 2006 and from that year onwards until 2010 it can be expected to increase further. In Germany this would equal about 1% of the fodder maize area which is likely to be an underestimation. In Austria the energy maize area was estimated at 40,000ha which amounts to more than 10% of the total fodder maize area. In this study we therefore decided to use an average percentage of 5% of the total fodder maize production for assessing the potential in the Medium scenario which was only applicable to Germany and Austria. For grassland cuttings we assumed that 2% of the intensive grassland production goes to biogas production in Germany and Austria. In the rest of the countries this percentage is set at 1% and 0.25% respectively. In the Medium scenario this is assumed to remain stable until 2050. In the High scenario it is assumed that the energy maize and grassland cuttings potential for digestion are 10% above the Medium scenario potential. For the Low scenario it is assumed that the potential is declined by the proportion of land in HNV farmland and/or conservation areas. So the potential is lowered depending on the ecologically valuable area share.

4.1.3.2 Solid and liquid manure

For the calculation of the manure potential we use the MITERRA model (Velthof, Oudendag et al. 2009) which uses the CAPRI livestock and land use patterns and the GAINS nitrogen excretion factors as input. The model calculates exactly per region and farm size group how much solid and wet manure is produced. The farm size information is obtained from Eurostat FSS and developments in farm size from the past are extrapolated to the

[7] http://ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics, last accessed on 20 November 2015.

future for the situation at country level. Subsequently the following assumptions are made per scenario about manure potentials:

1) In the High bioenergy scenario it is assumed that all liquid manure (coming from pigs and dairy cows) produced on farms with 100 or more Livestock Units (LU) is included in the potential. The reason to work with LU size thresholds is that a minimal size is required from an economic and logistical point of view to establish manure digestion installations. It is also assumed that the digestate can still be used as manure, so all manure will first be digested before it is (partly) used as a fertiliser for on-farm use locally or on a wider region. Additionally all (solid) poultry manure produced on farms with a farm size of >100 LU will be available for incineration. Manure produced on smaller farms (<100 LU) is not included in this potential. This is because logistically and economically it would not be feasible and generally not be necessary from a regulatory framework to put this small and spatially dispersed manure potential into digestion.

2) In the Medium bioenergy scenario the potential for both liquid and solid manure is only assumed to be produced on farms with a size threshold above 200 LU.

3) In the Low bioenergy scenario the potential only refers to the liquid and solid manure that is produced on farms with a size threshold above 500 LU.

4.1.3.3 Pruning from permanent crops

For an indication of harvest ratios and the type of permanent crops to be involved see Table 7. This table builds on pruning ratios collected in the Biomass Futures project, but further up-dated with new data from national sources and experts. Figures on current removal practices were also collected for some countries, although very difficult to generalise as they refer to very specific local practices for very specific types of permanent crops.

Table 7: Average residue ratios per type of permanent crop (preliminary overview)

Land use category	Residue yields ton DM/HA/Year
Fruit and berry plantations – total	2.7
Temperate climate fruit and berry plantations	
Subtropical climate fruit and berry plantations	
Cherries and other soft fruit	2.2
Nuts fruit and berry plantations	2.2
Citrus plantations	2.8
Olive plantations - table olives	1.8
Olive plantations - oil production	
Vineyards - quality wine	2.7
Vineyards - other wines	
Vineyards - table grapes	
Vineyards – raisins	

Sources: The figures are calculated averages found in the following studies: (Mladen Ilic and Tesic 2004); (Di Blasi, Tanzi et al. 1997); (Bernetti, Fagarazzi et al. 2004), (Vamvuka 2006), (BTG, ESD et al. 2004), (OECD 2004); (Mardikis, Nikolaou et al. 2004), (Diaz and Avedo 2004).

The harvest ratios for pruning are applied to total hectares of the different permanent crops from CAPRI baseline runs 2010, 2020, 2030, 2040 and 2050. For the scenario specific calculation of pruning potential, the pruning removal rates vary as the competing use level:

1) In the High bioenergy scenario the pruning removal rate is set at 50% above current removal rates used as removal rates in the Medium scenario. Competing uses are assumed to be low and set at 20% for non-energy uses.
2) In the Medium bioenergy scenario the removal rate is set at current levels. Competing uses are assumed to be at 40% for non-energy uses.
3) In the Low bioenergy scenario the sustainable yield is set at 20% below the Medium scenario removal rates. Competing uses are assumed to be very high at 60% for non-energy uses.

4.1.3.4 Straw and stubbles from arable crops

Residual biomass from agriculture comes from primary residues from arable crops (straw and stubbles). A methodology for estimating the straw potential available for bioenergy production was developed by the JRC already since 2006 ((JRC-IES and CENER 2006), (Scarlat, Martinov et al. 2010)). In this work the methodology for estimating a sustainable potential applies to a wide range of crops delivering straw including all cereals, rice, and maize, sunflower and oil seed rape. Based on a wide range of EU expertise (derived from expert meetings and literature inventories by the JRC) the straw yield ratios per type of crop are provided together with sustainable harvest levels. The latter relate to harvest practices aimed at maintaining the soil carbon levels in the soil. These were estimated in (Scarlat, Martinov et al. 2010) to be at 40% for wheat, rye, oats and barley and at 50% for the other crops.

The potential for these residues is assessed using the JRC methodology but applying the factors on the land uses as assessed with CAPRI for 2020, 2030, 2040 and 2050. Straw and stubble potential is assessed for all cereals (including rice), maize, rape and sunflower. Subsequently a competing use level is assessed and this is subtracted from the total potential. For cereal straw these competitive uses are well known and were quantifiable using livestock numbers and mushroom production levels. Competitive uses are for bedding in specific livestock systems (including horses) and for mushroom production. The exact quantification is done by using data on livestock type and number data from CAPRI baseline runs. For the non-cereal straw types competition is not known and therefore an assumption on competition level is made assuming 40% competitive uses in the Medium scenario (see Table 3).

For the scenario-specific calculation of straw and stubble potential the following thresholds for sustainable straw harvest and competing uses are applied:

1) In the High bioenergy scenario the sustainable yield is set at 50% for cereals and rice and 60% for maize, sunflower and oil seed rape. Competing uses are assumed to be low in this scenario and therefore estimated at 40% lower than the competing use in the Low bioenergy scenario.
2) In the Medium bioenergy scenario the sustainable yield is set at 40% for cereals and rice and 50% for maize, sunflower and oil seed rape. Competing uses are assumed to be at 20% below the competing use in the Low bioenergy scenario.
3) In the Low bioenergy scenario the sustainable yield is set at 30% for cereals and rice and 40% for maize, sunflower and oil seed rape. Competing uses are assumed to be very high which implies that all straw is needed for all livestock and mushroom production in an area.

4.1.3.5 Olive pits

The secondary residues from agriculture covered in this exercise are olive pits which are currently already used as biomass for co-generation. They are a by-product from the olive oil industry and can be transported and shipped easily over longer distances given their high energy content per m^3 and their concentration in processing industry locations. In order to estimate their potential, olive area shares are multiplied with olive pit residue ratio which is set at 0.3 ton DM/ha/year (based on (Di Blasi, Tanzi et al. 1997))[8].Subsequently to

[8] The exact yield per hectare of olive pits is difficult to establish as there are very few publications specifying the yield factors of olive pits. The per hectare yield is dependent on the total olive yield which vary strongly per country. According to CAPRI olive yields in France are at 1.8 ton/ha,

determine the potential per scenario different harvest/availability ratios will be assumed together with competing use levels as follows:

1) In the High bioenergy scenario the availability rate is set at 100% of the availability level. Competing uses are assumed to be low and set at 40% of total potential going to non-energy uses in all years.
2) In the Medium bioenergy scenario the availability rate is set at 40% of the availability level. Competing uses are assumed to be set at 10% in 2010 increasing towards 30% in 2050 for non-energy uses.
3) In the Low bioenergy scenario the availability rate is set at 30% of the availability level. Competing uses are assumed to be low and set at 20% in 2010 increasing to 50% by 2050 for non-energy uses.

4.2 Biomass from the forest sector

In this sector roundwood for fuelwood, primary residues and secondary residues from forest industries are available. The assessment of these is discussed separately in the following sections.

4.2.1 Stemwood and primary residues

Several sources and models were used as input for the assessment of the primary biomass potential from forest, summarised in Figure 2.

The EFISCEN model (Schelhaas, Eggers et al. 2007) is used to calculate the level of roundwood extraction that can be sustained for a prolonged period, resulting in the data for potentially harvestable stemwood. The input data for running the EFISCEN model is the national forest inventory data providing as detailed information as possible on 'forest available for wood supply' specifying data on area (ha); growing stock volume (m^3/ha overbark); (if available) net annual increment (m^3/ha/yr overbark); if available gross annual increment (m^3/ha/yr overbark) and annual mortality (m^3/ha/yr overbark). The national input data used for the current potential assessment is specified per country in Table 8.

Table 8: National forest inventory used as input into EFISCEN

Country	National forest inventory	Country	National forest inventory
Albania	1990	Luxembourg	1989
Austria	2001-2002	Macedonia	2010
Belgium	1997-1999	Moldova	2000
Bosnia & Herzegovina	2010	Montenegro	2010
Bulgaria	2000	Netherlands	2001-2005
Croatia	1995	Norway	1995
Czech republic	2005	Poland	1993
Denmark	2000	Portugal	1997-1998
Estonia	1999-2001	Romania	1985

in Greece 2.5 ton/ha, Italy 3.2, Portugal 0.8 ton/ha, Spain 3.3 ton/ha and in Slovenia at 2.8 ton/ha. Overall it implies that estimate in Di Blasi, C., V. Tanzi, et al. (1997). "A study on the production of agricultural residues in Italy." Biomass and Bioenergy **12**(5): 321-331., which applies to Greece, should represent an average per hectare yield level as the average olive yields in Greece are also somewhere at the average of the EU.

Country	National forest inventory	Country	National forest inventory
Finland	2004-2008	Serbia	2010
France	1988-2000	Slovakia	1994
Germany	2001-2002	Slovenia	2000
Greece	2010	Spain	1986-1995
Hungary	2005	Sweden	2004-2008
Ireland	2004-2005	Switzerland	1995
Italy	2005-2008	Ukraine	1995
Latvia	2004-2008	United Kingdom	1995-2000
Lithuania	2000		

For the associated extraction of primary forestry residues three mobilisation scenarios from EFSOS are applied through a spatial method (see EFSOS[9] and (Verkerk, Anttila et al. 2011)). The High EFSOS mobilisation scenario is applied to assess the High biomass scenario in this study; EFSOS reference scenario is for the Medium scenario and the low mobilisation for the Low biomass scenario in this study. Implementation of these EFSOS scenarios in the EFISCEN model run then lead to the scenario specific estimates of the total forest residue potential.

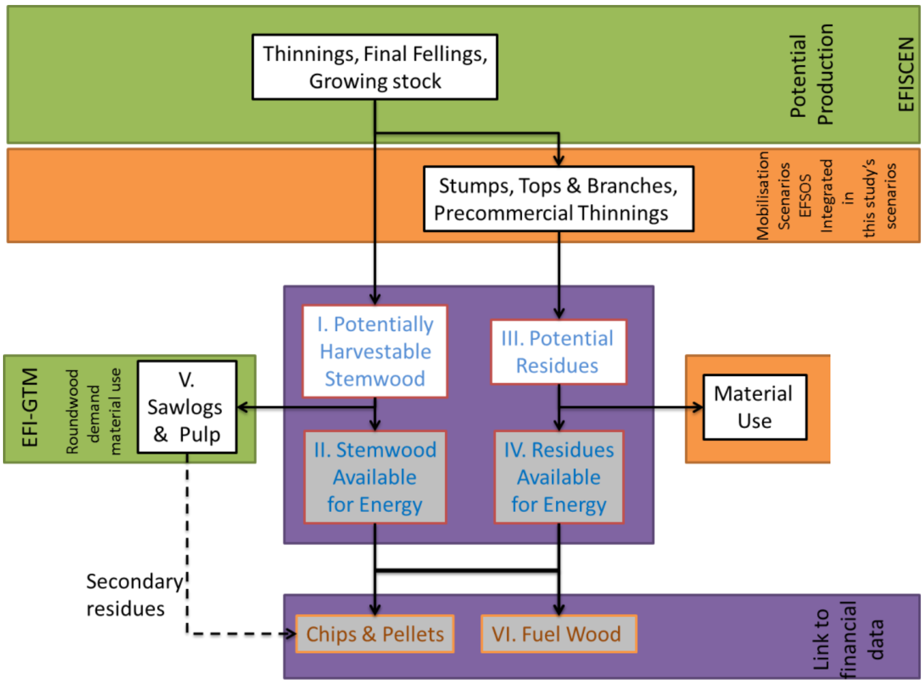

Figure 2 Schematic overview of assessment of biomass from roundwood and primary residues.

9 http://www.unece.org/forests/outlook/welcome.html, last accessed on 20 November 2015.

For both the stemwood and the residues there is a competition between the use for energy and material use (see Figure 2). The material use for roundwood is taken from the EFI-GTM calculations used in EFSOS. These results are at country level, and are downscaled proportional to the potentially harvestable stemwood. The result of this is the potential for saw logs and pulp both for material and energetic use. The material use of residues is defined by a fixed percentage specific for the High, Medium and Low scenarios in a given year, anticipating a demand from a future technology development of biorefinery applications. The stemwood and residues not used for material products are then available for energy production.

It is assumed that the total forest area develops according to the trends described in the EFSOS reference scenario. The environmental constraints for stemwood and residues are assessed in a spatially-explicit approach using the following spatial datasets:

- Site productivity, soil surface texture, soil depth and soil bearing capacity (ESDBv2 2006);
- Natural soil susceptibility to compaction (Houšková 2008);
- Slope (TUSGS 1996);
- Natura 2000 sites (DG Environment 2009).

All spatial datasets were combined with the relevant constraint values for the different scenarios. A raster layer was created for each constraint with a resolution of 1 km × 1 km. Finally, all relevant layers were combined and the lowest, permitted extraction rate according to each scenario was defined for each pixel. The resulting raster layers were then combined with the *European forest map* (Schuck, Van Brusselen et al. 2002), (also on a 1 km x 1 km resolution) and tree species distribution maps (Brus, Hengeveld et al. 2012) to calculate the weighted average restriction per EFISCEN region and country. This was done separately for the constraints for:

- Stem and crown biomass from early pre-commercial thinnings;
- Logging residues from thinnings;
- Logging residues from final fellings;
- Stump extraction from final fellings; and
- Stump extraction from thinnings.

It is then assumed that both stemwood and residues available for energy can be used flexibly either as traditional fuelwood, or in the form of chips and pellets. To assist in the development of biomass supply for energy we first made an estimate of current and future fuelwood use. This fuelwood use is based on the FAOstat reported fuelwood use for 2010 at national level. From this statistical figure the fuelwood use is calculated as a regional and scenario specific percentage of the wood available for energy. This percentage is then applied to the future wood available for energy. These values are not too restrictive however, as fuelwood use is a dedication of wood to a specific pathway that can be altered in further simulations.

For a detailed overview of the sustainability constraints applied in the three scenarios see Annex 4 (following (Verkerk, Anttila et al. 2011)).

The biomass potentials on landscape care wood are based on the Biomass Futures potential data which derived these data from the EUwood project (Mantau and et al. 2010). In the Biomass Future project, the EU wood potentials included cuttings from permanent crops in agriculture. Therefore, a further processing step was applied in this study. The EUwood potential for cuttings from fruit trees and vineyards was separated from the rest of the landscape care potential according to percentages reported in the EUwood study. The remaining potentials of EU wood on landscape care now only refer to landscape care potentials outside agricultural permanent crop land. The results of this assessment were also used in this study. Since the EU-wood/Biomass Future data are only reported at national level in this study a further disaggregation of these figures was done from national to NUTS2 level. This extrapolation was done by using the harvested wood potential per region as a weighting factor as it was assumed that there is a relation between the forested area in every region and the availability of biomass from landscape elements. It is acknowledged that this is a simplification assumption and that a better spatial dispersion factor could be considered in future updates.

The assessment of potential biomass from road side verges was already done as part of the Biomass Futures project (Elbersen and Staritsky 2012) and the results of this assessment for 2010 were also used in this study.

For the assessment of the road side verge grass potential an EU-wide road network map[10] combined with a more precise road network map for The Netherlands (TOP10 Kadaster[11]) was used as input. Since the EU-wide data source only contains the main roads, the more detailed information from The Netherlands could be used and extrapolated EU wide using road density relations between the 2 data sources to the EU-wide data layer. A 10-meter boundary was assumed along the total road length in every region for which an average grassland potential was calculated. The average road verge size estimation was made based on an analysis of aerial photographs (AEROGRID) and Google Maps. For the estimation of the grassland yield we build on (Smith, Metzger et al. 2008) which estimated an average grassland productivity factor for different types of grassland per environmental zone in Europe. The type of grassland used in this map was assumed to be the most extensive grassland type. The environmental zonation ensures that grassland productivity is directly linked to climatic factors such as rainfall, evapotranspiration and length of growing season.

[10] ESRI® Data & Maps 2008 Update, http://www.esri.com/data/data-maps Europe Roads represents the roads (European Highway System, national, and secondary roads) in Europe. Europe Roads provides a base map layer of roads for Europe. Largest scale when displaying the data: 1:10,000.

[11] http://www.kadaster.nl/web/artikel/producten/TOP10NL.htm, last accessed on 20 November 2015.

4.2.2 Secondary residues from wood processing industries

As for the biomass potential from wood processing industry, the secondary forestry residues include sawing mill residues, which are generally converted in chips and pellets before they are sold further; saw dust; and black liquor. For the assessment of the secondary residues that come from wood processing industries we build on former assessments in the EU-wood and Biomass Futures project (Elbersen and Staritsky 2012). Estimates for this potential were made at national level taking account for the size of wood processing industry activities.

The saw mill by-products have many competing uses particularly for the plywood industries and the paper and pulp industry. Their biomass availability is partly driven by level of stemwood and primary forestry residue harvesting, although many wood industries also use imported wood. Their original geographic distribution however, is strongly related to where the forest production areas are. The geographic distribution of the forest industry is also the basis for the biomass potential assessment which uses the EU-wood data (Mantau and et al. 2010) as a basis and further adapts and improves these with national data on forest industry production of main and by-products. In principle the secondary forest residues availability for bioenergy production is determined by the expected future developments in the forest industry production and the competing non-energy uses. Figures on current alternative non-energy uses are derived from EFSOS and also from national statistical sources.

The first factor on future developments in forest industry is a function of forest harvest mobilisation assumptions (from EFSOS). In the Medium bioenergy scenario it is assumed that the use of secondary forestry residues partly is a continuation of current residue production and competing uses levels. In the High bioenergy scenario there is more forest mobilisation which also increases the production in the forest industries with higher levels of residue production. At the same time competing uses for non-energy purposes are low. In the Low bioenergy scenario the opposite occurs, resulting in considerably lower secondary forest biomass availability (see Table 3, competing use levels).

The potentials for secondary forestry residues were derived from the EUwood project (Mantau and et al. 2010) which are available at a national level. In this project these national figures were further disaggregated to NUTS2 regional level by using the stemwood production levels as assessed with the EFISCEN model as distribution data. This is a logical choice as the local wood processing capacity is likely to be largely determined by the wood harvesting activities in a region.

4.3 Biomass from waste

The waste potentials are mainly assessed using the Eurostat waste generation and waste treatment data 2010 as input[12]. Since 2004 data on waste generation and treatment are collected per EU member state[13]. Because this data is collected according to fixed categories (European Waste Classification for statistical purposes) which are based on the waste sources, it is logical that the potentials assessed in this study are also ordered accordingly. At the highest level a distinction is made between waste from households (HH) and waste from business activities (NACE classification).

The total waste generation reported by Eurostat is only the basis for assessing the biomass potential in this study as in this study the data also needed to be extrapolated to the 3 scenario situations and to the future (2020, 2030, 2040 and 2050). For the Medium scenario is was assumed that the collected waste per category develops over the years according to the population growth for household waste and according to Gross Domestic Product (GDP) growth rate for the NACE waste categories.

GDP and population growth figures (annual percentage change figures) for EU-28 were derived from (European Commission 2013). For western Balkan countries, Norway and Turkey extrapolations were made using population and GDP levels and growth levels from the World Bank statistics. Since for these countries

[12] http://ec.europa.eu/eurostat, last accessed on 20 November 2015.

[13] European Commission (2002). Regulation on waste statistics (EC) No. 2150/2002., amended by European Commission (2010). Commission Regulation (EU) No. 849/2010., prescribes that data on the generation and treatment of waste is collected from the Member States.

Eurostat waste generation and treatment data were not available for the current situation nor the future extrapolations were made by calculating average per category waste generation per head (for household waste) or per GDP point (for NACE waste) in the neighbouring countries. This per head or per GDP point level of the neighbouring countries was then multiplied with the total population and GDP level in the related country for which the extrapolation was required. For all western Balkan countries an average per head and per GDP point was calculated as an average of five countries i.e. Croatia, Greece, Bulgaria, Romania and Hungary. For Turkey an average was taken of Greece and Bulgaria. For Norway the average of Sweden and Denmark was taken.

The next step was then to assess which part of the waste is already recovered for other uses and which part can really be seen as potential for bioenergy and other unknown future uses. In order to assess this the waste generation data were combined with the figures on waste treatment which are reported in Eurostat according to the following categories:

1) Waste going to recovery/treatment:	No potential/Competing
2) Incineration with energy recovery:	Potential (already going to energy)
3) Incineration without energy recovery:	Potential (scenario specific)
4) Disposal on or into land (landfill):	Potential (scenario specific)
5) Other disposal	No potential/Competing

The treatment figures have been applied to the total waste generation figures as percentages and not as absolute figures as the latter never add up to the total of the waste generation. The treatment data is specified at regional level (NUTS1), while the waste generation data are only available at national level.

In the Medium scenario it is assumed that the proportion of the waste per category that is already going to energy (Incineration with energy recovery) in 2010 also continues to go to energy in 2020, and after this year this proportion grows towards the level of energy recover rate of the best performing country in the EU.

Overall competing use levels were established per scenario as follows:

- High scenario: the percentage going to energy increases 10% as compared to the Medium level, due to a decrease in competing use and disposal and incineration.
- Medium scenario: the percentage going to energy for 2030 and beyond increases according to Population or GDP level growth as compared to the 2010 situation. Lagging countries grow faster than no lagging countries. The increase rate cannot exceed the highest EU 2010 benchmark.
- Low scenario: the percentage going to energy decreases in time by 10% as compared to the Medium situation, due to an increase in competing use.

For estimating the unused potential for paper and cardboard wastes the Eurostat figure is further corrected for recycling levels. The recycling data were derived from CEPI and not from the Eurostat treatment figures. It is assumed that the potential amount of the total paper and cardboard waste minus the proportion reported by CEPI that is going to recycling of the total paper and pulp production.

Post-consumer wood is based on the Eurostat waste category ‘wood waste’ coming from either households or from other economic sectors. The competing use categories for this type of waste were also derived from the Eurostat reporting in relation to waste treatments as specified in the former paragraph.

The category used fats and oils (UFO) is not reported in Eurostat as a separate waste category. In fact the used fats and oils are part of the Eurostat waste category ‘Animal and mixed food waste’. For this study we reported the used fats and oils potential from the Biomass Futures project (Elbersen and Staritsky 2012). Because this category is not reported separately in Eurostat, the UFO amount is subtracted from the category ‘animal and mixed food wastes’. For used fats and oils it is assumed that 100% of the generated UFO goes to energy.

4.4 Imports of bioenergy

In order to compile scenario-specific biomass import potentials to Europe from rest of the world, different maximum import quantities are assumed based on the assessment of a report elaborated by IINAS (Fritsche and Iriarte 2014) as part of the Biomass Policies project. The methodology to assess the cost-supply of imports was as follows (see Figure 3):

- First, the relevant bioenergy carriers and regions of production were determined;
- Next, the sustainable potential available to be exported to Europe was evaluated;

- Finally, costs were determined for each bioenergy carrier in the given time horizons, and regions.

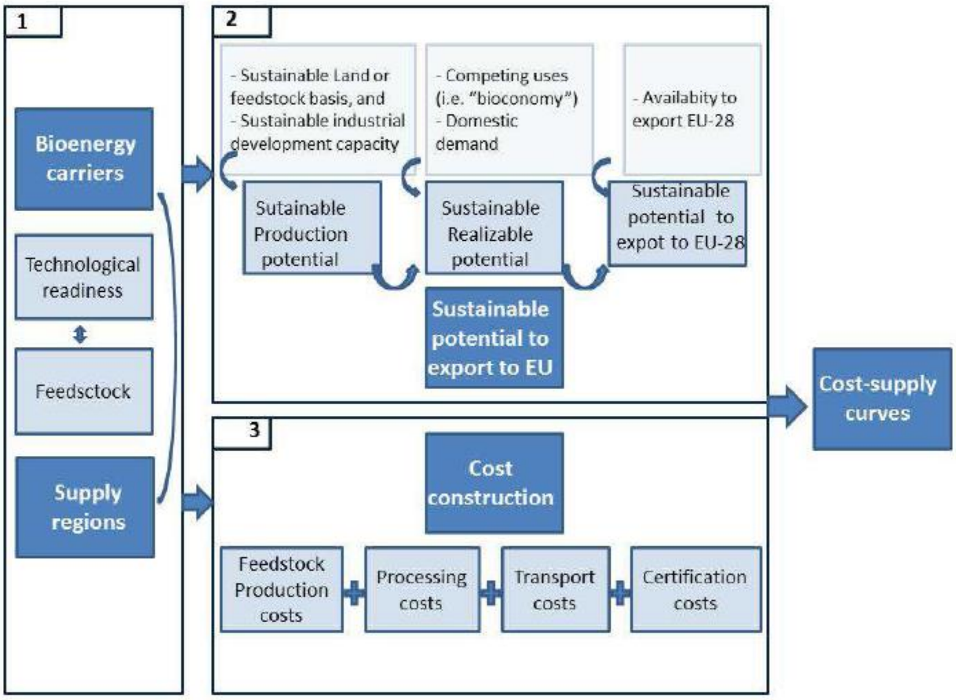

Figure 3 Overview of methodology for assessing the cost-supply information from imports

For the cost assessment, (Fritsche and Iriarte 2014) focussed on the technology readiness levels and the currently imported energy carriers as imports can only refer to tradable products to be realistically made available on international markets which can be transported overseas and stored for longer period of time. So from this the following focus was made:

- 1G biofuels (EtOH and biodiesel): the focus is on countries with most promising contexts (availability of land, forest or agricultural resources, infrastructure readiness, favourable conditions to develop infrastructure, etc.), even though there are currently imports from other countries too;
- Wood pellets (either torrefied or standard pellets) from a comprehensive list of most promising countries to produce and export pellets;
- 2G biofuels: only countries with relevant resources available were taken into account. The US has not been considered given the ambitious domestic targets for 2GEtOH, which limits export options.
- For biomethane: only EU neighbouring countries (Ukraine and the western part of Russia) were considered since these countries have significant biomethane potentials from agricultural residues, energy crops, and forest biomass, and also have access to the existing high-pressure natural gas pipeline system for international transport to the EU ((Thrän and Pfeiffer 2011)).

Figure 4 depicts the methodology used to calculate the potential available for imports. The process starts with a literature review (step 1), for which land availability to grow feedstocks, primary feedstocks and residues (mainly primary residues) and waste were considered. From the technical potentials, the sustainable potentials (step 2) were estimated taking into consideration the sustainability issues stated in the Renewable Energy Directive (European Union 2009). In addition to sustainable biomass availability in a given region and timeframe, the pace of development at which these sustainably produced feedstocks are mobilized is extremely relevant to avoid negative and unintended effects in related sectors (e.g. agricultural sector for the case of 1G biofuels or forest sector in the case of woody pellets). This is considered sustainable industrial development capacity (step 3) and has been considered as a reference proxy to avoid indirect unintended impacts in other sectors (competition and displacement of other traditional sectors as in the pulp and paper sector when wood pellets are boosted). The sustainable production capacity was calculated by extrapolating the production capacity or the exports for a given bioenergy carrier from 2009-2012 by means of a linear regression for 1G biodiesel or wood pellets exporting countries. From this sustainable production capacity the sustainable production capacity to be exported was then deducted by subtracting first the domestic demand for biofuels and other known biomaterials. For further details on the cost-supply calculations see (Fritsche and Iriarte 2014) (2014)[14].

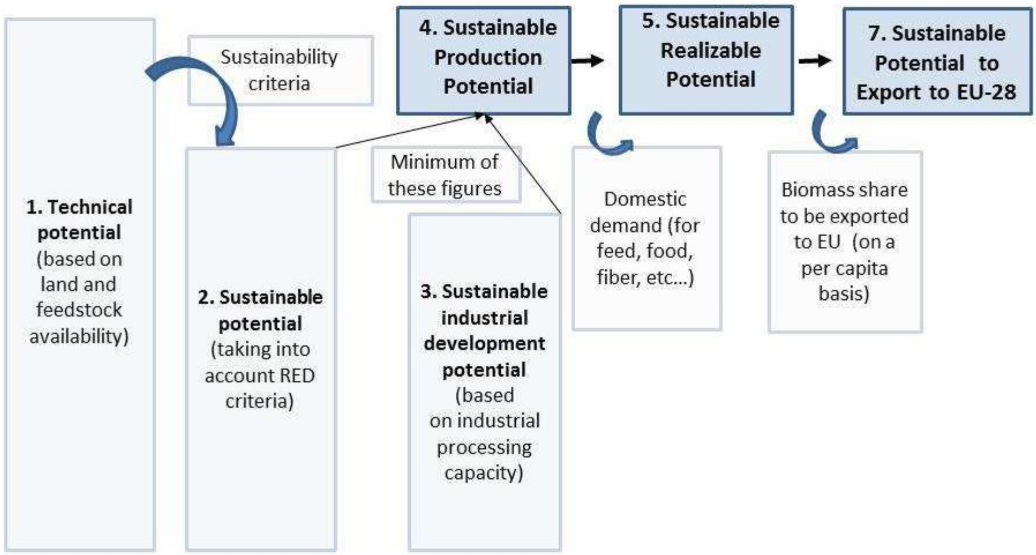

Figure 4 Overview of steps to assess importable potentials

[14] The report can be downloaded from: http://www.biomasspolicies.eu/

5 Biomass Energy potentials

This section shows the estimated values for the present and future available biomass potential for each category.

A summary overview of the potentials per scenario is presented in Figure 5. It shows that the largest contribution to the biomass potential is from forestry, closely followed by agriculture, while waste is by far the smallest contributor. The biomass potential in the High scenario is twice as large as that in the Low scenario and towards 2050 this difference increases to almost three times. More stringent sustainability criteria, competing uses and lower mobilisation assumptions lead to a considerably smaller biomass supply.

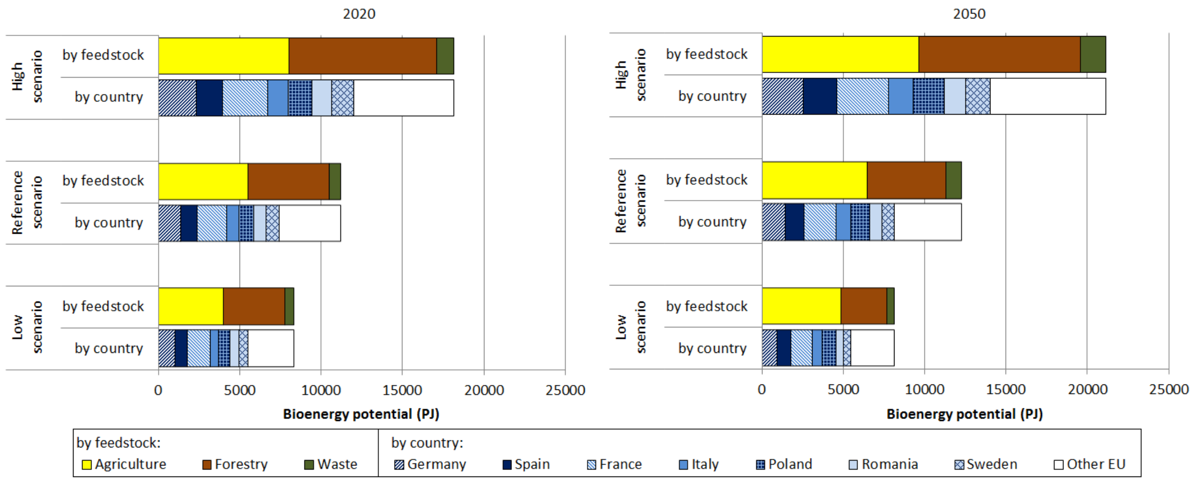

Figure 5 Total biomass potentials per scenario

From Figure 6 to Figure 8 an overview of the main energy categories results is given (corresponding heating values can be found in Annex 5). Each figure shows the potentials map for the reference year together with the gradient code for each category. Table 9 summarises the results, including the maximum technical potentials for imports of pellets and biofuels. The corresponding maps for the availability/sustainability scenarios for 2030 and 2050 are given.

Table 9: Bioenergy potentials for the EU28 under the three reference scenario – summary table (PJ)

		2020			2050		
		Low scenario	**Reference scenario**	**High scenario**	**Low scenario**	**Reference scenario**	**High scenario**
Domestic production	Agriculture	4000	5495	8030	4871	6452	9648
	Forestry	3794	5000	9095	2799	4856	9938
	Waste	545	716	1061	492	975	1545
Imports	Pellets	283	283	283	283	517	944
	Bioethanol	177	177	177	177	615	2133
	EMHV	259	259	259	259	451	783

In Annex 6: Biomass energy potentials per feedstock, Table 27 to Table 43 show the estimated available potential for each energy category for 2010, 2020, 2030, 2040 and 2050. The results are given for the Low, Reference and High biomass availability scenarios (corresponding to the High, Reference and Low sustainability criteria). The corresponding energy category in the JRC-EU-TIMES is also given for each crop. In general, as expected countries with higher surfaces have higher potentials.

For biofuel crops, in the reference year, France has already a total potential over 500 PJ. It is followed by Germany over 150 PJ and the rest of the countries are all bellow 50 PJ. This potential evolves to be more distributed. Other countries such as Spain, Italy, Poland or UK will increase their potentials to over 100 PJ.

For wood based potentials, the main players in the reference year are Germany, France and Sweden, with a potential over 1000 PJ each. They are followed by Finland, Spain, Poland and Romania with over 400 PJ. The total available current potential will be reduced from the current 9000 PJ down to close to 8000 PJ in 2050. The sustainability criteria has a remarkable influence in the future wood available potential, as it can reduce it close to 40% or increase it a 100% by 2050.

Finally, for the different waste potentials, France and Germany have a potential over 200 PJ, while Spain, Italy and UK have more than 100 PJ each. It is expected that the total potential available will increase a 20% by 2050. The sustainability criteria can reduce or increase the estimated available potential for 2050 around a 40% in both directions.

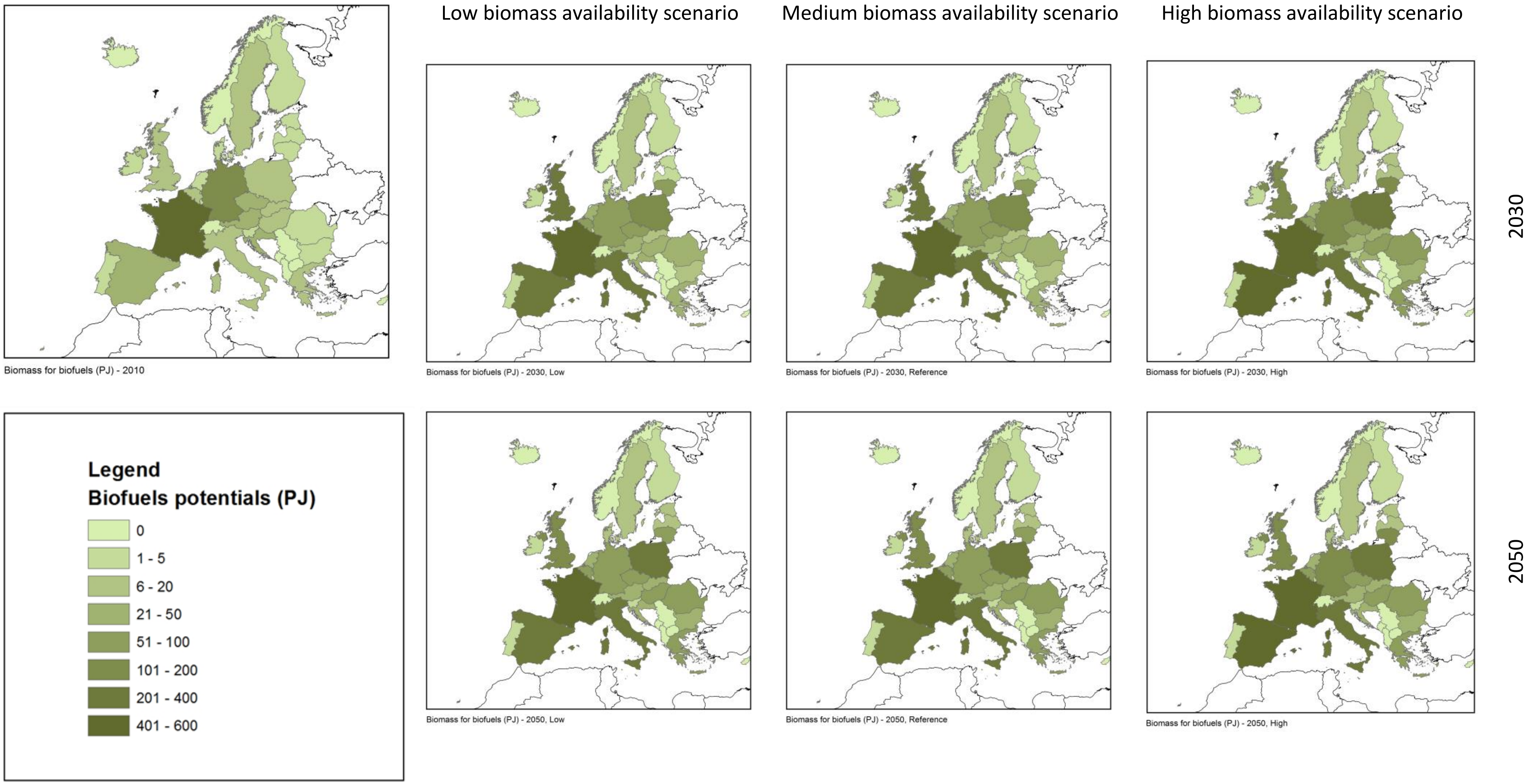

Figure 6 Total biofuel crop potential maps – Time evolution and sustainability scenarios

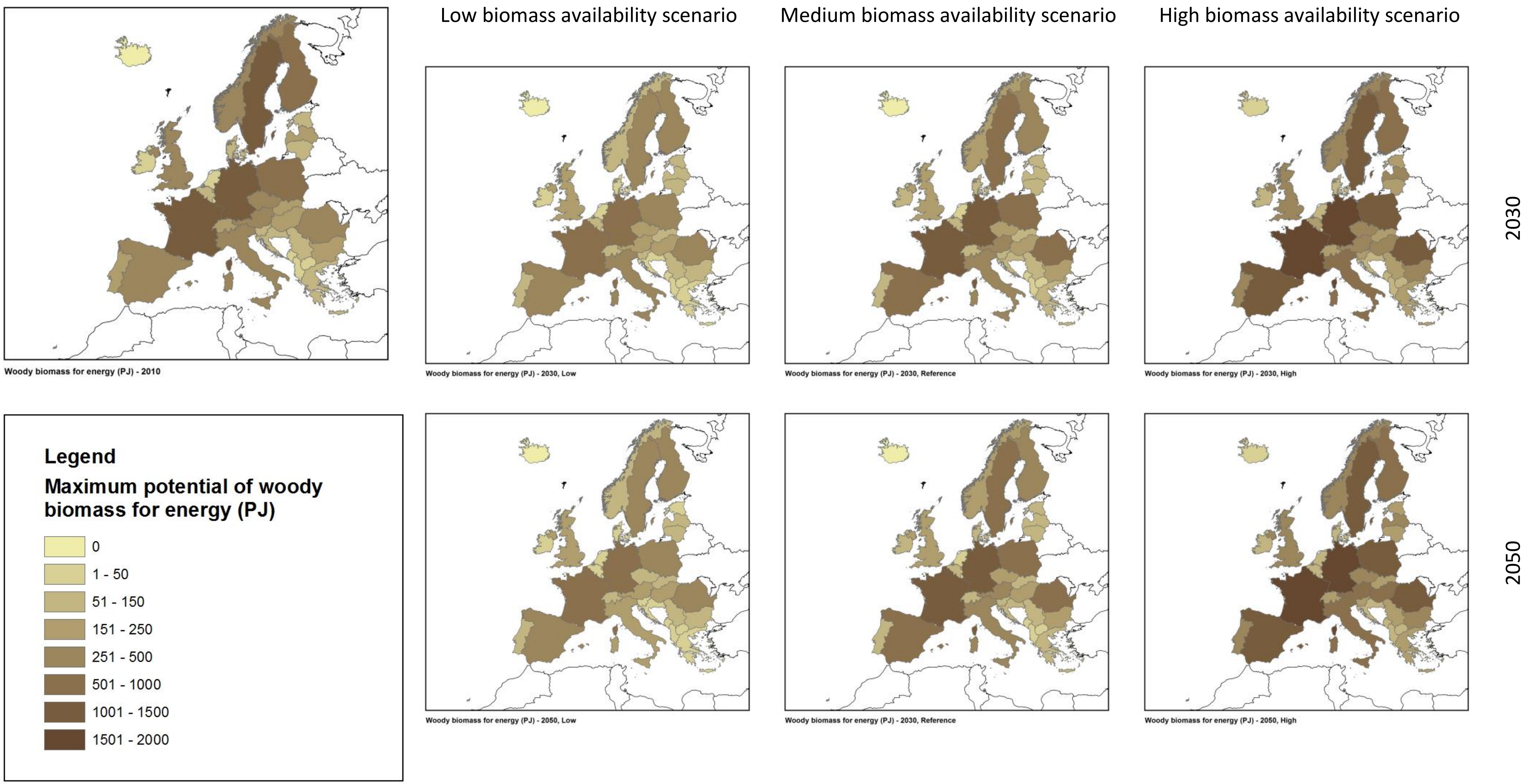

Figure 7 Total woody potential maps – Time evolution and sustainability scenarios

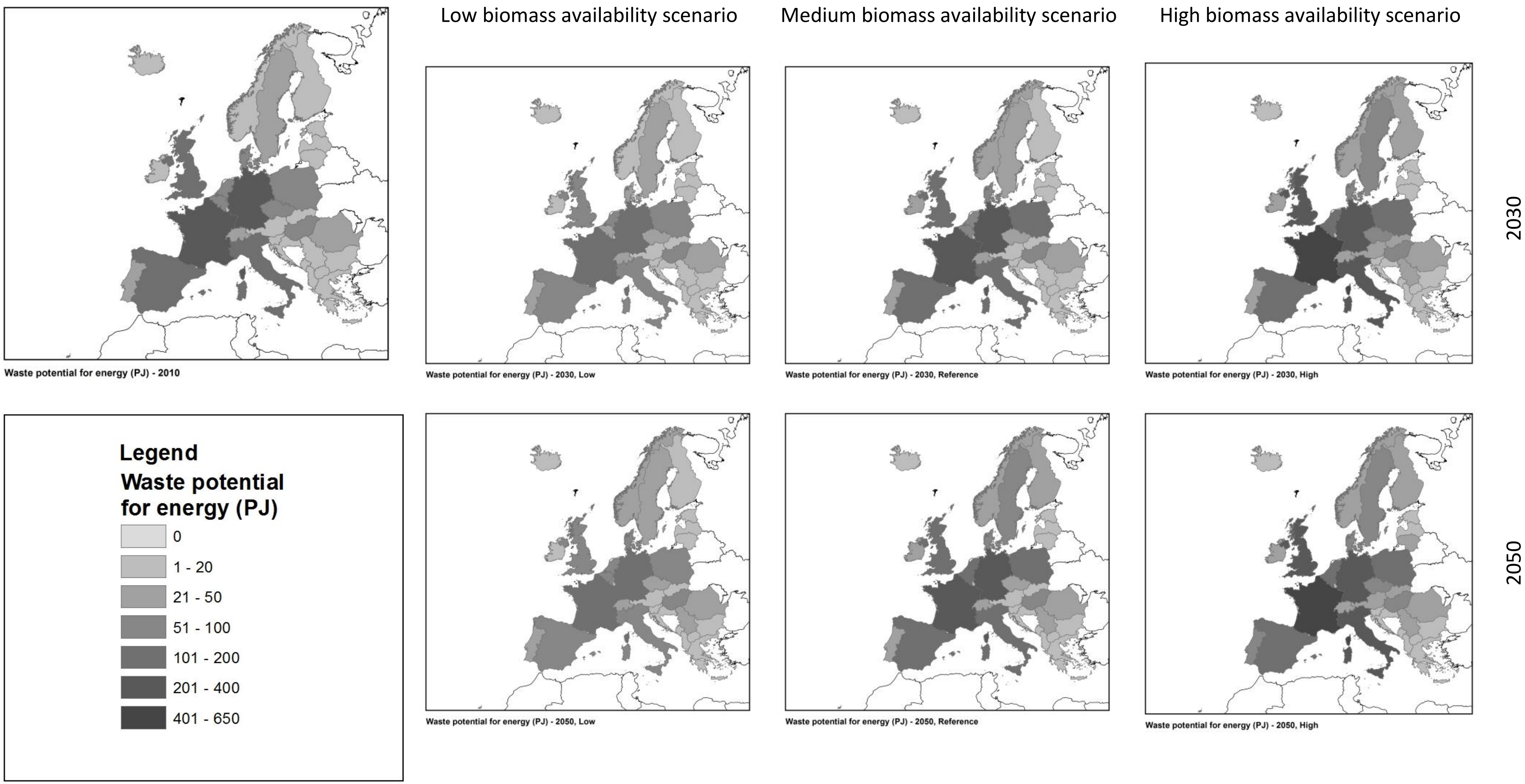

Figure 8 Total waste potential maps – Time evolution and sustainability scenarios

6 Biomass cost supply

6.1 Introduction

The estimation of the costs associated with the biomass energy feedstock potentials is important for energy system models, as it will determine the relative competitiveness of biomass compared to other energy sources.

In order to estimate such costs, we consider where relevant both the cost of biomass production and of harvesting for biomass at the place of origin, and transport, pre-treatment cost up-to the conversion gate (including the cost made after harvesting for pre-processing), and forwarding and transport to the place of collection. A distinction is made between types of cost and price estimates specific per biomass type and, based on data availability, different assumptions and methodologies are applied.

For biomass types that are already traded in the market, the market price is considered as a good proxy for cost levels. This situation applies to cereal straw, and all primary and secondary residues from the forest sector. For the other biomass categories, cost estimates are made taking account of national specific labour and machinery cost for production (in case of crops), harvesting and collecting of the biomass up to the road side. Country-specific cost levels have been assessed taking into account labour costs, diesel and machinery price levels.

In addition, for some types of feedstock we also consider logistics costs, estimated using country-specific transportation costs per km/ton in three different supply chains, including up- and off-loading cost (see Section 6.5). These cost levels are then multiplied with the average number of kilometres the biomass needs to be transported within a 20, 50, 100 and 200 km circle around the centroid of a NUTS2 region, taking account of the average biomass availability per type per km^2.

While the calculations for the supply costs are performed at NUTS2 level, the input required by the JRC-EU-TIMES is at country level. Moreover, the level of detail in terms of crops and residue is lower in the energy system model than the underlying calculations. To derive the supply costs at the level of aggregation required as input into the JRC-EU-TIMES, the weighted average of the supply cost for each NUTS2 region is taken. Finally, the derived costs in Euro/t are converted to Euro/GJ using crop and feedstock specific conversion factors.

The prices of (some of the) feedstock also vary depending on the scenario considered, based on assumptions made regarding mobilisation and market demand and technological learning. Overall, in the High availability scenario it is assumed that prices are 10% lower than those for the Reference scenario because of more efficient mobilisation measures that increase the supply. Lower competition from non-energy sectors also contributes to lowering bioenergy costs. At the same time we assume more technological learning in harvesting, pre-treating and transport of biomass making the prices go down too in the High scenario. For the Low scenario a 10% higher price was assumed than in the Reference for the opposite reasons. In this report the Reference scenario prices are reported.

It is important to point out that the costs of converting biomass feedstock into useful energy are not included in these estimates. Each conversion technology has specific biomass input requirements, while the quality of biomass differs largely between the different biomass types, harvest and drying techniques, and pre-treatment technologies. Conversion technologies are modelled explicitly in the JRC-EU-TIMES, and the techno-economic parameters associated with each technological options included in the model separately. Current technologies include: combustion (small/large heating and small/large CHP), anaerobic digestion (small/large biogas, waste digestion, biomethane), fermentation (bioethanol), (trans)esterification (biodiesel), hydrogenation, and gasification. Future technologies include: new combustion (Micro-CHP), lignocellulosic ethanol, large gasification. The technology characteristics include plant capacity, feedstock demand, conversion factors, energy output and costs (installation, maintenance). See (Simoes, Nijs et al. 2013) for a description of the biomass conversion technologies currently modelled in JRC-EU-TIMES. The techno-economic parameters associated with each conversion technologies have also been updated, but are not part of this report.

6.2 *Biomass from agriculture*

6.2.1 Biofuel crops

The prices for these commodities have been taken from the CAPRI model. The model calculates expected future prices given market changes and supply-demand relations. For all traded products, CAPRI provides a producer price (PPRI) and a market price (MP).

For the biofuel crop products from sugar and starch crops CAPRI's PPRI is used as a proxy of production costs. For sugar beet the PPRI is given for the sugar and not of the sugar beet themselves. It can be assumed that the sugar contents of a sugar beet is around 17% (FAO 2009).

For the oil crop seeds used for the production of 1G biodiesel the producer prices estimated by CAPRI are considerably higher than the domestic market prices currently paid for this feedstock. We therefore decided to use domestic market prices for these crops.

The prices associated with biofuel crops in the medium scenario are summarised in Table 10.

Table 10: Cost associated with biofuel crops and energy maize in the medium scenario (Euro$_{2010}$/GJ)

	Sugar beet			Oil crops (rapeseeds, sunflower and soya)			Starchy crops (barely, wheat, maize, oats, rye)		
	2010	2030	2050	2010	2030	2050	2010	2030	2050
AL	-	-	-	-	-	-	-	-	-
AT	3.7	4.0	4.1	20.5	33.5	33.6	12.5	18.3	19.0
BE	3.7	4.0	4.1	20.6	33.7	33.6	12.1	17.6	18.4
BG	-	3.9	4.0	15.8	26.2	26.1	11.4	17.3	17.9
BH	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-
CZ	3.7	4.0	4.0	18.8	31.4	30.8	11.3	16.9	17.6
DE	3.7	4.0	4.1	20.5	33.6	33.5	13.6	19.7	19.9
DK	5.3	5.7	5.8	21.0	34.2	34.1	13.3	19.9	20.9
EE	-	-	-	-	-	-	11.6	16.3	16.9
ES	-	4.0	4.1	20.9	33.5	33.4	14.2	21.3	22.8
FI	-	-	-	-	-	-	12.5	18.4	19.2
FR	3.7	4.0	4.1	20.5	33.6	33.6	13.5	20.2	20.8
GR	-	4.0	4.0	20.6	33.4	33.2	19.4	28.8	31.0
HR	-	-	-	-	-	-	13.3	13.4	14.0
HU	-	3.9	4.0	19.9	31.5	31.3	11.7	17.4	18.3
IE	-	-	-	-	-	-	11.0	16.7	18.0

	Sugar beet			Oil crops (rapeseeds, sunflower and soya)			Starchy crops (barely, wheat, maize, oats, rye)		
	2010	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
IS	-	-	-	-	-	-	-	-	-
IT	-	4.1	4.1	19.8	33.6	33.6	17.2	25.2	27.6
LT	3.6	3.9	4.0	18.6	31.3	30.6	10.5	16.2	16.7
LU	-	-	-	-	-	-	12.1	17.6	18.4
LV	-	-	-	-	-	-	11.1	16.8	17.2
ME	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-
NL	3.8	4.1	4.1	20.6	33.8	33.7	12.9	18.9	19.4
NO	-	-	-	-	-	-	-	-	-
PL	3.6	3.9	4.0	18.7	31.4	30.7	10.8	16.2	16.3
PT	-	4.0	4.0	20.6	33.8	33.6	-	20.6	21.9
RO	-	3.9	4.0	18.0	27.4	27.9	16.9	25.6	27.1
RS	-	-	-	-	-	-	-	-	-
SE	3.8	4.1	4.1	20.7	33.9	33.8	13.3	18.4	19.7
SI	-	-	-	-	-	-	-	16.0	16.9
SK	3.7	4.0	4.0	18.9	31.3	30.8	11.3	16.9	17.5
UK	3.8	4.1	4.1	20.6	33.8	33.7	13.4	20.3	21.3

(No value means that the feedstock is not available domestically)

6.2.2 Dedicated perennials biomass crops

A well-developed market for dedicated biomass crops is still absent. There is therefore no clear price setting for this type of biomass, so the production costs are assessed and based on an excel-based cost model developed as part of the Biomass Policies project (Alterra B.V., Centre for Renewable Energy Sources et al. 2012). The cost calculation takes into account as input:

- Land rent/ ha specific per country and type of soil (high quality, medium and low quality land). The land rent data were derived from an inventory among experts per country using different sources.
- Material inputs in terms of N, P_2O_5 and K_2O and diesel. It is assumed that low-input systems use 40% less input than the average.
- Labour time input for ploughing, harrowing, herbiciding, fertilising, sowing, planting, fertilising, harvesting and irrigation. A distinction in time investment was made between intensive and extensive systems. The labour costs were then calculated by multiplying the input time with the labour cost per country as specified in Annex 7.

The yields per hectare for each perennial type at regional level as calculated for this study has been then used to derive the cost per ton of dedicated perennial biomass crop. For grassy perennial crops yields have been assessed using a crop growth simulation model (GWSI) (Elbersen, Fritsche et al. 2013), (Elbersen, Fritsche et al. 2013). For woody biomass crops, yields are derived from the GLOBIOM model from IIASA (Elbersen, Fritsche et al. 2013), (Böttcher, Frank et al. 2012).

The resulting final costs for perennials are provided in Table 11.

Table 11: Cost associated with dedicated perennials in the medium scenario (Euro$_{2010}$/GJ)

	Dedicated perennials (miscanthus, switchgrass, RCG)			Willow			Poplar		
Year	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**
AL	3.0	2.8	3.4	-	-	-	7.9	7.5	8.9
AT	4.9	4.6	5.0	9.8	9.3	10.7	-	-	-
BE	5.7	5.0	5.7	9.7	8.3	10.6	-	-	-
BG	2.9	3.0	2.8	7.6	8.1	7.5	-	-	-
BH	3.6	2.8	3.9	-	-	-	9.1	7.5	10.1
CH	-	-	-	-	-	-	-	-	-
CY	5.5	5.2	5.3	-	-	-	13.0	12.3	12.7
CZ	3.2	2.9	2.9	7.6	6.7	6.4	-	-	-
DE	6.0	5.4	5.1	11.8	10.3	10.0	-	-	-
DK	9.7	10.0	-	17.8	18.8	-	-	-	-
EE	3.0	3.0	3.3	7.9	8.0	8.9	-	-	-
ES	7.4	6.7	6.5	-	-	-	16.7	15.3	14.8
FI	5.4	5.0	4.6	13.5	12.4	11.8	-	-	-
FR	5.6	5.0	4.8	10.6	9.1	8.8	13.2	11.5	11.1
GR	7.4	8.2	7.8	-	-	-	16.9	16.5	15.5
HR	-	-	-	-	-	-	-	-	-
HU	2.9	2.8	2.8	7.5	7.2	7.0	-	-	-
IE	4.9	5.0	5.1	9.9	10.2	10.8	-	-	-
IS	-	-	-	-	-	-	-	-	-
IT	7.5	7.5	7.4	-	-	-	18.3	18.2	17.7
LT	2.4	2.1	2.7	6.9	6.2	8.0	-	-	-
LU	-	-	-	-	-	-	-	-	-
LV	2.5	2.1	3.1	7.1	5.9	8.6	-	-	-

	Dedicated perennials (miscanthus, switchgrass, RCG)			Willow			Poplar		
Year	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**
ME	3.6	3.4	3.9	-	-	-	9.1	8.7	10.1
MK	3.6	3.4	3.9	-	-	-	9.1	8.7	10.1
MT	-	-	-	-	-	-	-	-	-
NL	8.4	7.7	7.2	15.1	13.5	12.9	-	-	-
NO	6.0	6.9	7.4	0.0	11.5	13.0	-	-	-
PL	4.2	3.7	3.7	8.9	7.8	7.9	-	-	-
PT	4.6	4.3	4.3	-	-	-	11.4	10.9	10.2
RO	2.6	2.5	2.6	6.8	6.5	7.0	-	-	-
RS	3.6	2.8	3.9	-	-	-	9.1	7.5	10.1
SE	8.0	7.4	7.3	14.0	13.0	13.2	-	-	-
SI	3.5	3.1	3.0	-	-	-	10.2	8.9	8.7
SK	3.0	2.7	3.5	7.1	6.0	8.1	-	-	-
UK	7.4	6.7	6.8	10.4	8.9	9.9	-	-	-

(No value means that the feedstock is not available domestically)

6.2.3 Liquid and solid manure

Most of the liquid manure is used on the farm either as fertiliser or as both source of energy and fertiliser (digestate can still be used as fertiliser). When manure is used on-site, then it is in principle free and the price is set at ‘0’. However, there is evidence that liquid manure can also be traded as a commodity in many countries, particularly if it involves solid poultry manure. For instance, it is well known that southern regions of The Netherlands transport large amounts of this manure to France where it is used to manure arable fields. Furthermore transport of liquid manure usually takes place because there is an excess of manure at farm level. According to the Nitrate Directive (European Council 1991), it is the farmers responsibility to dispose of the manure.

When liquid manure is traded, a positive cost is assigned, including transport costs. For the allocation of cost a manure transport cost calculation model available online was used[15]. This tool specifies the machine cost, the labour time input and diesel input requirements per ton liquid manure/km transport given different transport distances. This information is then multiplied with the national specific labour and diesel price cost (from Annex 7 and Annex 8: Diesel price per country used in cost calculations)

Solid manure is less costly to transport and therefore more attractive to sell on a market to be used as fertiliser and as feedstock for burning in co-heat and power installations. Solid manure is already a traded commodity with a market price. Therefore data were collected on current price levels in different countries. The best data were found for France[16], UK (Marches Biogas Ltd 2013),and Croatia (Loncaric, Kanisek et al. 2013), ranging

[15] The online tool is available from KTBL, the ‘Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V’ (https://www.ktbl.de/), and was developed by DBFZ.

[16] http://www.fdsea60.fr/sites/d60/actu/economie/2013/baremes_2013.pdf, last accessed on 20 November 2015.

from 42€/ton to 5.5 €/ton. These prices were then averaged between the minimum and maximum price level and extrapolated to the rest of the European countries, based on similarities in the agricultural sector.

For the North-Western countries an average price level of France and UK solid manure was applied which is at 28.2 €/ton. For the central and southern European countries the average between the minimum and maximum price level found in Croatia was applied which is at the level of 12 €/ton.

The resulting final costs for solid and liquid manure are provided in Table 12.

Table 12: Cost associated with manure in the medium scenario (Euro$_{2010}$/GJ)

	Liquid and solid manure						
	2010	**2030**	**2050**		**2010**	**2030**	**2050**
AL	3.9	3.9	3.9	**IS**	-	-	-
AT	6.1	6.1	6.1	**IT**	5.0	5.0	4.9
BE	6.2	6.2	6.2	**LT**	3.6	3.8	3.9
BG	3.4	3.5	3.4	**LU**	6.0	6.0	6.0
BH	3.9	3.9	3.9	**LV**	3.6	3.7	3.9
CH	6.1	6.1	6.1	**ME**	3.9	3.9	3.9
CY	4.3	4.3	4.5	**MK**	3.8	3.8	3.8
CZ	3.7	3.6	3.7	**MT**	3.5	3.4	3.4
DE	5.9	5.9	6.0	**NL**	6.1	6.2	6.2
DK	7.0	7.0	7.0	**NO**	6.5	6.5	6.6
EE	3.8	3.8	3.8	**PL**	3.6	3.8	3.9
ES	4.6	4.6	4.7	**PT**	3.9	4.0	4.1
FI	6.2	6.2	6.4	**RO**	3.5	3.6	2.9
FR	6.3	6.3	6.3	**RS**	4.3	4.3	4.3
GR	4.3	4.3	4.5	**SE**	6.5	6.5	6.6
HR	4.0	4.0	4.0	**SI**	4.2	4.2	4.1
HU	3.6	3.5	3.6	**SK**	3.8	3.8	3.6
IE	6.0	6.0	6.0	**UK**	6.4	6.5	6.6

(No value means that the feedstock is not available domestically)

6.2.4 Primary and secondary agricultural residues

Energy maize and grassland cuttings, pruning and cuttings from permanent crops, straw and stubble, and olives and olive pits are considered under the broad category of primary agricultural residues.

The CAPRI model is used to derive cost elements for energy maize and grassland cuttings, which are not traded in the market. A Unit Value Gross producer price (UVAG-level) is derived for non-tradable products (which largely stay on the farm where they are produced). The UVAG levels from CAPRI are used for energy maize and grassland cuttings.

Pruning and cuttings from permanent crops are currently not traded in the market. Their harvesting cost was therefore estimated based on existing literature and experts' opinion on the cost of pruning (hours/year) required per hectare of apple, pear, soft fruits and citrus orchard, and for vineyards and olive plantations.

Since pruning is part of conventional management of the main crops, the cost of this operation cannot be imputed to the harvesting of the residue. However, harvesting, chipping and transporting the residues to the road side involve costs, which need to be (partly) earned back by the producer to trigger delivery to the market. In this study we assume that 10% of pruning costs for apple and pear orchards and 15% for soft fruit, vineyards, olives and citrus (which have generally lower conventional pruning cost than the first group) can be attributed to harvesting, chipping and transporting residues for energy.

In addition to the pruning time, an average mechanisation input was also assumed of 3 to 5 litre diesel per hectare, depending on the labour input. In the maximum labour input situation the mechanisation is expected to be lower than with minimal labour input.

For the cost calculation of the pruning per hectare, the minimum and maximum time and the diesel investment is multiplied by the country-specific labour and diesel costs (see Annex 7 and Annex 8). This results in country-specific pruning cost per type of permanent crops, which is then used to derive the average cost of pruning per ton of products considering the average pruning harvest levels.

Straw is a commodity which is sold on the market. There are therefore regional-specific price levels published in reports and available from advertising by sellers/traders. These data on straw prices were collected for all EU28 countries, and used as a basis to calculate average prices per country for the medium availability scenario. From the sources review, minimum and maximum prices were derived, and average prices per country were calculated. For the countries where it was not possible to find the prices of straw, the price from another country with similar structure was taken. The countries with proxy price levels from other countries are Cyprus, Romania, Sweden, Slovenia, Italy, Lithuania, Luxembourg, Latvia, Malta, Estonia and Bulgaria.

The prices on other straw than from cereals were challenging to find as this is not a traded commodity. However, the price of corn stover of 43 €/ton DM was found for one country, Hungary[17]; and this was used to extrapolate the price (based on cereal straw prices) to other countries.

For prices for stubbles from rape, sunflower and rice, no references on current market prices could be identified. The price level was therefore estimated by assuming that it would be related to the straw price. More in detail, the price of sunflower and rapeseed stubbles was assumed to be 50% of the price of cereal straw, whereas the relationship of rice straw price was estimated at 80% of the price of straw. This lower price is justified by the lower quality of these types of straw. E.g. rape and sunflower stubbles are more polluted with sand, and rice straw is generally wetter than cereal straw.

There is very limited information on the market price of olive pits in Europe. Estimates from the olive kernels for Greece range from 58.7€/ton to 50 €/ton for olive kernels (Mardikis, Nikolaou et al. 2004), (Vourdoubas 2007). Based on existing literature and experts' assumptions, it was decided to use a price of 55€/ton for whole of EU.

For the final road side cost level for primary agricultural residues see Table 13.

Table 13: Cost associated with primary agricultural residues (Euro$_{2010}$/GJ) (stubbles, OSR and sunflower, cereal straw, rice straw, sugar beet, cherries and other soft fruits, apples and pears, citrus, olives and olives pits, vineyards, grass and maize)

	Primary agricultural residues (stubbles, OSR and sunflower, cereal straw, rice straw, sugar beet, cherries and other soft fruits, apples&pears, citrus, olives and olives pits, vineyards, grass and maize for biogas)

[17] See: http://www.biocore-europe.org/file/D1_2%20Assessment%20of%20procurement%20costs%20for%20the%20preferred%20feedstocks.pdf last accessed on 20 November 2015.

	2010	2030	2050		2010	2030	2050
AL	2.6	3.4	3.5	**IS**	-	-	-
AT	7.5	6.1	5.1	**IT**	3.8	3.8	3.3
BE	4.7	3.9	3.5	**LT**	3.2	2.6	2.1
BG	3.0	2.6	2.1	**LU**	5.5	5.3	4.9
BH	2.9	3.3	3.1	**LV**	3.2	2.6	2.2
CH	7.5	6.1	5.1	**ME**	3.6	4.2	3.9
CY	4.1	4.2	4.0	**MK**	3.2	3.3	3.1
CZ	4.9	4.0	3.3	**MT**	2.3	3.7	3.2
DE	4.7	4.2	4.1	**NL**	4.4	3.7	3.5
DK	5.4	4.4	3.9	**NO**	5.1	4.1	3.5
EE	3.1	2.6	2.4	**PL**	3.1	2.6	2.2
ES	3.8	3.7	3.3	**PT**	3.6	3.3	3.3
FI	5.4	4.4	3.6	**RO**	3.1	2.7	2.3
FR	3.0	2.6	2.3	**RS**	3.6	3.5	3.0
GR	4.8	4.5	4.0	**SE**	5.1	4.1	3.5
HR	3.1	2.9	2.7	**SI**	3.1	3.5	3.3
HU	3.8	3.3	2.7	**SK**	5.2	4.3	3.6
IE	2.1	2.1	2.6	**UK**	5.4	4.3	3.5

(No value means that the feedstock is not available domestically)

6.3 Cost of biomass from forests, wood industries and landscape care

6.3.1 Stemwood and primary forest residues

For forest products like saw logs, fire wood, chips and pellets markets are well developed and prices can be obtained at national level from many different sources. These national price levels were then used as a basis to be extrapolated to other countries by using the EFSOS wood log prices (United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations 2011) as distribution factors.

The EUBIONETIII results are an important source for price levels for pellets and chips delivered at gate (so including all transport and pre-treatment cost). It should be remembered however that the biomass supply data elaborated in this study are not directly referring to pellets, but only to harvested pulp wood or primary residues which still need to be converted to pellets. This implies that the pellets price can only be applied to the potential if a conversion factor is applied from harvested wood residues to pellets.

There are many published prices for fire wood from a wide variety of national sources. However, often these refer to small bag delivery to domestic consumers. The prices taken for Austria, Slovakia and Croatia were average domestic prices for large scale fuel wood delivery based on different tree species and different years including VAT (2010-2013).

The price of top and stem wood directly delivered from the forest to a buyer is more difficult to find information on because usually these type of prices are not easily shared. Based on experts' opinion and inputs for Belgium, which sees a gate-level price of 40 €/ton, average prices for other European countries were derived.

Price observations on dry chipped residues from forest and landscape care wood were derived from three studies in different EU countries (Germany, Croatia and the Netherlands). Further extrapolations were made from these country levels using the EFSOS roundwood price levels as index.

Table 14 provides the Reference scenario cost for the wood commodities commented. It is important to point out that prices fluctuate strongly, and are a result of specific negotiations between buyers and traders/sellers: there is therefore uncertainty surrounding the regional or a national average price for stemwood and forest residues.

Table 14: Cost associated with forest products and primary forest residues in the medium scenario ($Euro_{2010}$/GJ)

	Roundwood fuelwood			Roundwood Chips & Pellets			Forest residues (chips and pellets, energy residues)		
Year	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
AL	1.9	1.6	1.3	3.6	3.0	2.4	2.6	2.2	1.8
AT	5.0	4.2	3.5	10.4	8.7	7.1	6.1	5.1	4.2
BE	5.1	4.3	3.5	10.6	8.9	7.3	6.2	5.2	4.3
BG	4.2	3.5	2.9	4.1	3.5	2.9	3.2	2.7	2.2
BH	1.9	1.6	1.3	3.6	3.0	2.4	2.6	2.1	1.7
CH	5.0	4.2	3.5	10.4	8.7	7.1	6.1	5.1	4.3
CY	-	-	-	-	-	-	-	-	-
CZ	4.7	4.0	3.3	10.0	8.4	6.8	5.8	4.9	4.0
DE	5.0	4.2	3.5	9.9	8.3	6.8	6.2	5.2	4.3
DK	4.3	3.7	3.1	8.3	7.0	5.8	5.1	4.4	3.7
EE	4.3	3.6	3.0	4.3	3.6	3.0	3.3	2.8	2.3
ES	5.3	4.4	3.7	11.1	9.3	7.6	6.4	5.4	4.5
FI	5.7	4.8	4.0	12.1	10.1	8.3	7.1	6.0	4.9
FR	4.7	4.0	3.3	9.9	8.3	6.8	5.6	4.7	3.9
GR	4.6	3.9	3.2	9.7	8.1	6.6	5.5	4.7	3.8
HR	2.2	1.8	1.5	4.0	3.3	2.8	3.0	2.6	2.1
HU	3.6	3.0	2.5	3.6	3.0	2.5	2.8	2.4	2.0
IE	4.6	3.9	3.2	9.9	8.3	6.8	5.7	4.8	4.0
IS	-	-	-	-	-	-	-	-	-

	Roundwood fuelwood			Roundwood Chips & Pellets			Forest residues (chips and pellets, energy residues)		
Year	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
IT	4.7	4.0	3.3	9.8	8.2	6.8	5.7	4.8	4.0
LT	4.6	3.9	3.2	4.5	3.8	3.1	3.5	3.0	2.5
LU	5.0	4.3	3.5	10.6	8.8	7.3	6.3	5.3	4.4
LV	4.3	3.6	3.0	4.3	3.6	3.0	3.3	2.8	2.3
ME	1.9	1.6	1.3	-	-	-	1.9	1.6	1.3
MK	1.9	1.6	1.3	3.6	3.0	2.4	2.3	1.9	1.5
MT	-	-	-	-	-	-	-	-	-
NL	5.7	4.8	4.0	12.0	10.1	8.3	4.2	3.6	3.0
NO	4.6	3.9	3.3	9.6	8.1	6.6	5.7	4.8	4.0
PL	4.7	4.0	3.3	4.7	3.9	3.2	3.5	3.0	2.5
PT	5.3	4.4	3.6	11.2	9.3	7.6	6.5	5.5	4.5
RO	3.8	3.2	2.6	3.7	3.1	2.6	2.8	2.4	2.0
RS	1.9	1.6	1.3	-	-	-	1.9	1.6	1.3
SE	6.0	5.0	4.2	12.5	10.5	8.6	7.4	6.2	5.1
SI	4.2	3.5	2.9	4.2	3.5	2.9	3.2	2.7	2.3
SK	4.0	3.4	2.8	4.0	3.3	2.8	3.0	2.5	2.1
UK	6.4	3.7	3.1	13.4	7.7	6.3	7.4	7.4	6.0

(No value means that the feedstock is not available domestically)

6.3.2 Secondary forestry residues

Cost of secondary forestry residues were identified for the same categories as for which the biomass potentials were assessed, namely saw-dust, chipped wood-residues from saw mills and other industrial wood residues. The price levels for these biomass types are largely based on the price levels identified in the Biomass Futures study (Alterra B.V., Centre for Renewable Energy Sources et al. 2012). The results for 2010 price levels are presented in Table 15. The prices presented in the table all refer to market prices so these should include cost for short distance delivery at gate.

For wood residues from saw mills (no saw dust) a national price from Austria of 82 € (Market reports of the Chamber of Agriculture) was taken. This price was extrapolated to other countries using the EFSOS road side cost as a weighting. For the countries of the Western Balkans, Turkey and Moldova the same price as in Croatia was assumed. For Norway the same price level as in Sweden was used.

For prices of saw-dust, other industrial wood residues and black liquor, the price levels were taken from Biomass Futures prices. These prices were based on the assessment of (Siemons, Vis et al. 2004) but were corrected for inflation up to 2010 (see (Elbersen and Staritsky 2012)). Again for the countries of the Western

Balkans, Turkey and Moldova the same prices as in Croatia were assumed. For Norway the same price level as in Sweden was used.

Table 15: Costs associated with secondary forest residues in the medium scenario (Euro$_{2010}$/GJ)

	Secondary Forestry residues - woodchips			Secondary Forestry residues - sawdust		
Year	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
AL	1.9	1.7	1.4	1.7	1.5	1.3
AT	2.8	2.4	2.0	2.5	2.2	1.8
BE	2.3	2.0	1.7	2.5	2.2	1.9
BG	2.7	2.3	1.9	1.8	1.6	1.3
BH	1.9	1.7	1.4	1.7	1.5	1.3
CH	2.8	2.4	2.0	2.5	2.2	1.8
CY	-	-	-	-	-	-
CZ	3.0	2.5	2.1	2.0	1.7	1.4
DE	3.5	3.0	2.5	2.5	2.2	1.8
DK	3.0	2.6	2.2	2.5	2.2	1.9
EE	2.1	1.8	-	1.9	1.7	1.7
ES	3.0	2.6	2.2	2.7	2.3	1.9
FI	2.6	2.2	1.9	2.0	1.7	1.5
FR	3.1	2.7	2.2	2.4	2.0	1.7
GR	2.8	2.4	2.0	2.2	1.9	1.6
HR	-	1.7	1.3	-	1.8	1.5
HU	3.1	2.6	2.2	2.5	2.1	1.8
IE	4.2	3.5	2.9	2.7	2.3	1.9
IS	-	-	-	-	-	-
IT	3.3	2.8	2.4	2.8	2.4	2.1
LT	2.0	1.7	1.5	1.9	1.6	1.4
LU	2.9	2.4	2.1	2.5	2.2	1.8
LV	1.8	1.6	1.3	1.8	1.6	1.3
ME	1.9	1.7	1.4	1.7	1.5	1.3
MK	1.9	1.7	1.4	1.7	1.5	1.3

Year	Secondary Forestry residues - woodchips 2010	2030	2050	Secondary Forestry residues - sawdust 2010	2030	2050
MT	-	-	-	-	-	-
NL	3.0	2.6	2.2	2.5	2.2	1.8
NO	2.9	2.7	2.3	2.1	1.8	1.6
PL	3.0	2.5	2.1	1.7	1.5	1.3
PT	2.9	2.4	2.0	2.4	2.1	1.7
RO	1.9	1.7	1.4	1.7	1.5	1.3
RS	1.9	1.7	1.4	1.7	1.5	1.3
SE	2.8	2.4	2.1	2.0	1.8	1.5
SI	2.5	2.1	1.8	1.9	1.6	1.4
SK	2.5	2.1	1.8	2.4	2.0	1.7
UK	2.3	1.8	1.6	2.2	1.8	1.5

(No value means that the feedstock is not available domestically)

6.3.3 Landscape care wood and road side verge grass

The prices for landscape care wood and road side verge grass for 2010 are presented in Table 16. They refer to dry mass products delivered as dry chips and for grass in bales at gate. So these include chipping and drying and short distance transport.

For the assessment of the price of landscape care wood the price level identified in the Netherlands and Germany was taken from a Dutch study (Schrijvers and Oosterkamp 2011). This price was extrapolated to other countries according to EFSOS roundwood price levels.

The price estimate for verge grass was taken from the Biomass Futures study. The assumption in the study was that the price for this biomass would still be at 0 after it was cut along the road side, but as soon as delivered to a gate about 10 €/ton wet has to be spend to collect, bale and transport it at short distance to a further conversion plant. No extrapolation to other country price levels was made.

Table 16: Costs associated with landscape care wood and road side verge grass ($Euro_{2010}$/GJ)

	Residues from landscape care 2010	2030	2050		2010	2030	2050
AL	2.8	2.4	2.1	**IS**	-	-	-
AT	3.5	3.0	2.6	**IT**	3.3	2.9	2.5
BE	3.5	3.1	2.7	**LT**	3.2	2.8	2.4
BG	3.0	2.6	2.2	**LU**	-	3.1	2.6
BH	2.9	2.5	2.2	**LV**	3.1	2.7	2.3

	Residues from landscape care						
	2010	2030	2050		2010	2030	2050
CH	3.5	3.0	2.6	**ME**	2.8	2.4	2.1
CY	-	-	-	**MK**	2.8	2.4	2.1
CZ	3.3	2.9	2.5	**MT**	-	2.8	2.4
DE	3.5	3.1	2.6	**NL**	3.9	3.4	2.9
DK	3.1	2.8	2.4	**NO**	4.1	3.5	3.0
EE	3.1	2.7	2.7	**PL**	3.3	2.9	2.5
ES	3.7	3.2	2.7	**PT**	3.6	3.1	2.7
FI	3.9	3.4	2.9	**RO**	2.8	2.4	2.1
FR	3.3	2.9	2.5	**RS**	2.8	2.4	2.1
GR	3.3	2.8	2.4	**SE**	4.1	3.5	3.0
HR	3.1	2.7	2.3	**SI**	3.0	2.6	2.3
HU	2.7	2.3	2.0	**SK**	2.9	2.5	2.2
IE	3.3	2.8	2.5	**UK**	3.2	2.8	2.4

(No value means that the feedstock is not available domestically)

6.4 Cost of waste biomass

Price levels for waste categories (Table 17) were derived from different sources, but mostly build on the price levels already identified in the Biomass Policies study (Elbersen and Staritsky 2012).

The paper cardboard price is used from the Biomass Futures study and is assumed to be applicable to all countries as this is a clear traded commodity. The price for both household and industrial paper and cardboard waste is set at 121 €/ton D.M which is 7.93 €/GJ assuming a lower heating value of 15.21 MJ/kg DM.

Prices from wood waste from households and industry (non-forest industries) were derived from the Biomass Policies study and in this study these figures were derived from (Roland Siemons, Martijn Vis et al. 2004), but inflation rate correction was applied to translate to a 2010 level.

The price level of animal and vegetal mixed food waste was set at 24 €/ton which was a price level for the Netherlands published by (Lensink, Wassenaar et al. 2010).

The price of used fats and oils of 261 €/ton was based on an average price level for published price levels from different national sources. Also in the study Ecofys (Spöttle, Alberici et al. 2014) a price level for UCO (crude oil) between 200 and 300 €/ton is reported for Germany.

Finally prices for MSW and Common sludge are set at 0 as they are seen as waste for which the producers has to find ways to get rid of these at lowest possible cost or alternatively by earning some margin. At the road side these potentials are set to have a price of 0, but as soon as they are used in some conversion to energy cost have to be made for transporting and pre-treating the waste.

Table 17: Costs associated with biomass waste in the medium scenario

Municipal solid waste ($Euro_{2010}$/MJ)	Sludge ($Euro_{2010}$/GJ)

Year	2010	2030	2050	2010	2030	2050
AL	161.4	125.6	89.9	6.5	6.8	5.5
AT	173.0	163.8	117.9	6.5	6.8	5.5
BE	57.0	50.3	33.9	6.5	6.8	5.5
BG	0.0	0.1	0.1	6.5	6.8	5.5
BH	-	-	-	-	-	-
CH	173.0	163.8	117.9	6.5	6.8	5.5
CY	5.5	6.0	4.3	6.5	6.8	5.5
CZ	0.3	0.3	0.2	6.5	6.8	5.5
DE	68.0	66.2	50.2	6.5	6.8	5.5
DK	3.7	4.0	3.3	6.5	6.8	5.5
EE	6.6	4.8	3.2	6.5	6.8	5.5
ES	0.2	0.2	0.2	6.5	6.8	5.5
FI	53.1	45.6	31.1	6.5	6.8	5.5
FR	77.2	75.0	55.4	6.5	6.8	5.5
GR	84.4	84.1	61.3	0.0	0.0	0.0
HR	32.0	31.4	24.6	6.5	6.8	5.5
HU	3.8	3.8	3.0	6.5	6.8	5.5
IE	42.9	36.8	26.8	6.5	6.8	5.5
IS	2.8	3.5	3.4	6.5	6.8	5.5
IT	84.4	84.1	61.3	6.5	6.8	5.5
LT	60.1	44.6	28.9	6.5	6.8	5.5
LU	0.2	0.7	0.5	6.5	6.8	5.5
LV	0.2	0.2	0.1	6.5	6.8	5.5
ME	-	-	-	-	-	-
MK	98.1	66.8	31.5	6.5	6.8	5.5
MT	0.0	0.0	0.0	6.5	6.8	5.5
NL	58.7	54.2	38.0	6.5	6.8	5.5
NO	4.1	4.1	2.9	6.5	6.8	5.5
PL	2.5	2.9	2.4	6.5	6.8	5.5

	Municipal solid waste ($Euro_{2010}$/MJ)			Sludge ($Euro_{2010}$/GJ)		
Year	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
PT	4.5	4.7	4.0	6.5	6.8	5.5
RO	161.4	125.6	89.9	6.5	6.8	5.5
RS	161.4	125.6	89.9	6.5	6.8	5.5
SE	2.8	3.5	3.4	6.5	6.8	5.5
SI	147.9	134.7	100.8	6.5	6.8	5.5
SK	19.8	18.3	15.2	6.5	6.8	5.5
UK	40.3	39.9	28.2	6.5	6.8	5.5

6.5 Other logistics costs

Additional logistics costs per biomass feedstock were calculated covering transport cost over different distances and cost for chipping, baling and storage. Additional logistical cost need to be combined with road-side cost of the feedstock if the estimated costs only cover the production, harvesting and forwarding to road side. If biomass prices are given for a traded biomass, all logistics and pre-treatment costs up to the conversion plant gate are already included in the price.

In

Table 18 an overview is given, per biomass type, of whether prices or cost have been assessed and whether there is a need to add to the road side cost additional logistical costs for transport and other pre-treatment.

The assessment of the transport cost take account of the specific per ton/kilometre cost calculated using the transport model on (Brosowski 2012) and further developed in this project. It contains country-specific calculations for transport costs with trucks in three different transport supply chains. Taking account of nationally specific labour, diesel price, lubrication and machinery cost. Further detail is provided in Annex 9.

In order to estimate the transport cost the biomass density is taken into account. First all biomass potentials per type are spread evenly over the area. Then the centroid is determined per region. For this centroid, biomass type specific, it is then calculated the average transport distance for one ton of biomass to be transported within a 20, 50, 100 and 200 km circle. If the density of a certain biomass type is high, the average travel distance is smaller and therefore the average transport cost.

It is more likely that biomass with higher energy density will be transported farther than biomass types with low energy density and high water content. For the latter, therefore, transport distance calculations have been limited to 20 or 50 km. For certain biomass types which are already a commodity, such as biofuel crops, it is expected they are bought locally from auctions and warehouses where they are processed in the direct vicinity.

If biomass types are to be converted in large scale installations transport distances are likely to increase to get access to enough biomass and to create more security of supply.

Table 18: Cost segments per type of biomass

	A:Road-side-cost (RSC)/ market price (MP)	B: Pre-treatment until road side(e.g. drying, chipping, pelletising, collecting)	B: Cost pre-treatment until road side (€/ton)	C: Transport, up- and off loading cost				D: Storage
				<20 km	21-50 km	51-100 km	100-200 km	€/ton

			A:Road-side-cost (RSC)/ market price (MP)	B: Pre-treatment until road side(e.g. drying, chipping, pelletising, collecting)	B: Cost pre-treatment until road side (€/ton)	C: Transport, up- and off loading cost <20 km	21-50 km	51-100 km	100-200 km	D: Storage €/ton
Energy crops	Bioethanol 1G crops	Cereals	MP			X				
		Sugarbeet	MP			X				
		Maize	MP			X				
	Biodiesel 1G crops	Rape	MP			X				
		Sunflower	MP			X				
		Soya	MP			X				
	Biogas crops	Maize	MP			X				
		Grass cuttings				X				
	Woody/ligno cellulosic crops	Miscanthus	RSC	Baling in piles at road side	2	X	X	X		2
		Switchgrass	RSC		2	X	X	X		2
		Reed Canary Grass	RSC		2	X	X	X		2
		Poplar	RSC	Chipping (54 €/ton), storage in piles at road side (1.99€/ton)	56	X	X	X		2
		Willow	RSC		56	X	X	X		2
Manure	Solid manure	Poultry	RSC			X	X	X	X	
		Cattle	RSC			X	X			
		Pig	RSC			X	X			
	Liquid manure	Poultry	RSC			X				
		Cattle	RSC			X				
		Pig	RSC			X				
Primary residues	Straw/stubbles	Cereals	MP			X	X	X	X	2
		Rape-sunflower	MP			X	X	X	X	2
		Grain maize (stover)	MP			X	X	X	X	2
		Sugarbeet tops	MP	Storage in piles at road side (1.99€/ton)	2.0	X				
		Rice	MP			X	X	X	X	2
	Pruning/cutting	Apple, pear & apricot pruning	RSC	Chipping (30 €/ton), storage in piles at	32	X	X	X	X	2

			A:Road-side-cost (RSC)/ market price (MP)	B: Pre-treatment until road side(e.g. drying, chipping, pelletising, collecting)	B: Cost pre-treatment until road side (€/ton)	C: Transport, up- and off loading cost				D: Storage
						<20 km	21-50 km	51-100 km	100-200 km	€/ton
		Cheries and other soft fruits	RSC	road side (1.99€/ton)	32	X	X	X	X	2
		Vineyards	RSC		32	X	X	X	X	2
		Olives	RSC		32	X	X	X	X	2
		Citrus	RSC		32	X	X	X	X	2
Secondary residues		Olive pits	MP			X	X	X	X	
Roundwood	Roundwood	Roundwood (fire wood logs)	MP			X				
		Roundwood chips	MP			X	X	X	X	
		Roundwood pellets	MP			X	X	X	X	
	Primary residues	primary residues (fire wood)	MP			X				
		primary residues- chips	MP			X	X	X	X	
		primary residues - pellets	MP			X	X	X	X	
	Secondary residues	Sawmill by-products (excl saw dust)-chips	MP			X	X	X	X	
		Saw-dust	MP			X	X	X	X	
		Other industrial residues- woodchips	MP			X	X	X	X	
		Black liquor	0							
Landscape	Landscape care wood	Landscape care wood (chips)	RSC	Chipping (30 €/ton), storage in piles at road side (1.99€/ton)		X	X			2
	Road side verge grass	Road side verge grass	RSC	X		X				
	Household waste	HH paper carboard	MP			X				
		HH wood (chips)	MP	X		X	X	X	X	
		HH_AnMixfood	RSC			X				
		HH_Vegetal	RSC			X				
		HH_MSW	RSC			X				

		A:Road-side-cost (RSC)/ market price (MP)	B: Pre-treatment until road side(e.g. drying, chipping, pelletising, collecting)	B: Cost pre-treatment until road side (€/ton)	C: Transport, up- and off loading cost				D: Storage
					<20 km	21-50 km	51-100 km	100-200 km	€/ton
	HH_Comslud	RSC			X				
Waste from other sectors then households	NACE paper carboard	MP			X				
	NACE wood	MP			X	X			
	NACE_AnMixfood	RSC			X				
	NACE_Vegetal	RSC			X				
	NACE_MSW	RSC			X				
	NACE_Comslud	RSC			X				
	UFO	MP			X	X			

6.6 *Cost of bioenergy imports*

Estimating the import price for bioenergy feedstock is difficult, both because of the scarcity of current information, and because import prices are generally volatile. For this study, the prices of imported biomass are derived through a detailed cost calculation. For the Reference scenario the costs are presented in Table 19.

Table 19: Import potentials cost for EU-28 in the medium scenario

	2020	2030	2050
Bioethanol crops (M€ 2010/kt)	883	670	670
Biodiesel crops (M€ 2010/kt)	532	472	472
Woody biomass (M€ 2010/PJ)	7.1	7	7

To derive the cost-supply curves four main cost categories have been determined, as follows:

- Feedstock production costs: encompassing land, labour, and fertilizer costs, harvesting, transport to the factory, capital cost & miscellaneous costs when relevant. Particular production costs categories depend on the feedstocks i.e. crops vs. residues or forest vs. agricultural biomass.
- Processing costs: include investment and operating costs, maintenance, etc… When co-products are obtained from the bioenergy carrier production process, their value has been deducted from the total cost.
- Transport costs: from the mill to the port and overseas freight to Amsterdam-Rotterdam-Antwerp (ARA), the delivery point.
- Certification costs: here it is assumed that all type of bioenergy i.e. biofuels, bioliquids and solid biomass (wood pellet) have to comply with a set of mandatory criteria by 2020. From the literature revision it is assumed that certification costs might be 4 % of the cost of the bioenergy delivered to ARA.

For further details on the cost-supply calculations see (Fritsche and Iriarte 2014)[18].

[18] The report can be downloaded from: http://www.biomasspolicies.eu/

7 Estimation of emission factors

The Renewable Energy Directive (RED) (European Union 2009) and the Fuel Quality Directive (FQD) (European Commission 2009) fix a threshold of savings of greenhouse gas (GHG) emissions for biofuels and bioliquids, and set the rules for calculating the greenhouse impact of biofuels, bioliquids and their fossil fuels comparators. Typical default values for emissions for different solid and gaseous bioenergy pathways are presented in (Giuntoli, Agostini et al. 2014).

Typically, energy system models only consider direct energy-related emissions. Therefore, biomass cultivation and harvesting are considered carbon-neutral from an energy system perspective, whereas the burning of biomass for electricity or as biofuels leads to process-related emissions. This is in line with the other primary energy sources, for which upstream GHG emissions are not considered.

Nonetheless, in this study we calculated emissions from cultivation of biomass feedstock that could be used in case of a whole-chain GHG emission analysis. Emissions from the cultivation of crops have direct and indirect emissions. Direct land use emissions from the cropping process are determined by input and output levels, which differ strongly per EU-region and cropping system. For the calculation of emissions from crop cultivation and harvesting the MITERRA-Europe model was used (Velthof, Oudendag et al. 2009), (Drenbos and Kassam 1979). The assessment with MITERRA was already done as part of previous work (Elbersen, Fritsche et al. 2013; Elbersen, Fritsche et al. 2013). The model assesses the impact of measures, policies and land use changes on environmental indicators at the regional (NUTS2) level in the Europe. MITERRA-Europe calculates all relevant GHG emissions from agriculture (CH_4 from enteric fermentation and manure management, N_2O from manure management and direct and indirect soil emissions, and CO_2 from changes in soil carbon stocks and cultivation of organic soils), according to the IPCC 2006 guidelines (IPCC 2006). GHG emissions from fertiliser production and mechanisation are also included. The emission and mitigation levels for crops depend very much on the yield at the different locations. For biofuel crops, the yield potentials are taken from the CAPRI baseline run also used for the assessment of the biomass potentials in this study for crops and agricultural residues. For perennial crops, the yield potentials for the perennial grasses are derived using the Global Water Satisfaction Index (GWSI) crop growth model (Allen, Pereira et al. 1998) and the yield levels for willow and poplar were derived from the Globiom simulations for Europe (Böttcher, Frank et al. 2012). The yield levels for the perennial crops were used as input for the MITERRA-Europe model to calculate the direct emissions at the three management levels per NUTS 2 region.

There are large differences between regions in soil-related climatic conditions and management and these determine the large differences among cropped biomass emissions in different locations for similar crops. Table 20 summarises the GHG emission factors per biomass type in the medium scenario.

Table 20: Biomass emission factors GHG (kg $CO_{2eq.}$)/GJ

	Sugarbeet (for bioethanol)			Oil crops other than rapeseeds (sunflower and soya)			Rape seeds (for biodiesel)			Starchy crops (barely, wheat, maize, oats, rey)			Dedicated perennials (miscanthus, switchgrass, RCG)			Willow		
	2010	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**
AL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	14.4	14.1	0.0	0.0	0.0
AT	16.9	16.9	16.9	14.0	13.9	16.9	21.0	21.0	21.0	10.6	9.3	9.3	21.3	21.2	21.1	15.0	15.0	14.9
BE	31.2	31.2	31.2	0.0	0.0	0.0	37.8	37.8	37.8	26.0	26.8	26.3	20.5	20.5	20.5	16.4	16.4	16.4
BG	0.0	22.9	22.9	15.9	15.2	15.4	1.5	1.5	1.5	9.9	9.1	9.2	15.0	15.0	15.0	15.5	15.6	15.6
BH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	14.4	14.1	0.0	0.0	0.0
CH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	13.8	13.5	0.0	0.0	0.0
CZ	20.3	20.3	20.3	13.2	5.5	8.4	27.8	27.8	27.8	13.5	11.9	11.7	18.5	18.5	18.1	14.4	14.3	14.2
DE	22.3	22.3	22.3	0.0	0.0	0.0	19.4	19.4	19.4	16.0	7.7	6.7	25.4	25.4	25.4	23.7	23.6	23.7
DK	29.8	29.8	29.8	0.0	0.0	0.0	32.6	32.6	32.6	16.1	20.7	22.2	37.5	37.5	37.5	15.5	15.7	15.9
EE	0.0	0.0	0.0	0.0	0.0	0.0	41.8	41.8	41.8	39.0	27.4	27.0	43.8	43.9	44.0	19.8	19.9	19.9
ES	0.0	23.6	23.6	33.7	33.7	33.7	0.0	19.9	19.9	14.3	11.3	13.1	14.9	15.0	15.0	16.8	16.8	16.8
FI	0.0	0.0	0.0	0.0	0.0	0.0	98.1	98.1	98.1	44.3	40.3	43.2	42.0	42.3	43.1	24.6	24.6	24.4
FR	25.9	25.9	25.9	22.2	20.0	24.2	26.3	26.3	26.3	17.9	19.1	18.1	18.5	18.6	18.6	15.0	15.2	15.2
GR	0.0	27.5	27.5	51.9	39.1	26.2	39.0	39.0	39.0	16.1	17.2	16.3	14.3	14.2	14.0	0.0	0.0	0.0

	Sugarbeet (for bioethanol)			Oil crops other than rapeseeds (sunflower and soya)			Rape seeds (for biodiesel)			Starchy crops (barely, wheat, maize, oats, rey)			Dedicated perennials (miscanthus, switchgrass, RCG)			Willow		
	2010	2030	2050	2010	2030	2050	2010	2030	2050	2010	2030	2050	2020	2030	2050	2020	2030	2050
HR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6	11.5	11.5	0.0	0.0	0.0	0.0	0.0	0.0
HU	0.0	26.1	26.1	32.6	28.2	29.4	47.4	47.4	47.4	21.9	22.1	22.1	41.3	41.6	43.0	46.8	48.0	52.3
IE	0.0	0.0	0.0	0.0	0.0	0.0	33.2	33.2	33.2	13.7	10.2	9.8	61.2	61.2	61.2	24.6	24.6	24.4
IS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT	0.0	23.4	23.4	15.4	18.6	17.7	39.0	39.0	39.0	16.1	15.2	16.3	20.8	20.8	20.7	0.0	0.0	0.0
LT	18.3	18.3	18.3	0.0	0.0	0.0	26.9	26.9	26.9	6.3	6.2	6.5	43.8	43.9	44.0	19.8	19.9	19.9
LU	31.2	31.2	31.2	0.0	0.0	0.0	37.8	37.8	37.8	26.0	26.8	26.3	0.0	0.0	0.0	0.0	0.0	0.0
LV	0.0	0.0	0.0	0.0	0.0	0.0	28.2	28.2	28.2	12.3	12.7	12.8	43.8	43.9	44.0	19.8	19.9	19.9
ME	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	14.4	14.1	0.0	0.0	0.0
MK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	14.4	14.1	0.0	0.0	0.0
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	53.4	53.4	53.4	25.7	25.7	25.7	61.8	61.8	61.8	55.1	42.1	41.1	23.9	23.7	23.8	49.1	49.6	48.3
NO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PL	29.5	29.5	29.5	30.2	19.1	16.0	46.0	46.0	46.0	14.2	12.6	12.3	43.8	43.9	44.0	19.8	19.9	19.9
PT	0.0	26.7	26.7	36.3	36.3	36.3	0.0	19.9	19.9	0.0	22.9	26.1	8.1	8.4	10.0	0.0	0.0	0.0
RO	0.0	34.0	34.0	6.7	7.2	6.0	24.7	24.7	24.7	8.5	8.7	8.7	16.6	16.6	16.6	16.6	16.6	16.5

	Sugarbeet (for bioethanol)			Oil crops other than rapeseeds (sunflower and soya)			Rape seeds (for biodiesel)			Starchy crops (barely, wheat, maize, oats, rey)			Dedicated perennials (miscanthus, switchgrass, RCG)			Willow		
	2010	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**	**2020**	**2030**	**2050**	**2020**	**2030**	**2050**
RS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	14.4	14.1	0.0	0.0	0.0
SE	0.1	0.1	0.1	0.0	0.0	0.0	22.8	22.8	22.8	16.8	14.2	14.2	29.8	29.6	29.3	15.5	15.7	15.9
SI	0.0	0.0	0.0	0.0	0.0	0.0	37.6	37.6	37.6	0.0	20.2	21.3	17.3	17.3	17.3	0.0	0.0	0.0
SK	15.9	15.9	15.9	11.8	10.0	1.0	18.8	18.8	18.8	9.7	9.2	9.0	23.8	23.7	22.8	15.0	15.0	14.9
UK	28.8	28.8	28.8	0.0	0.0	0.0	20.6	20.6	20.6	11.3	11.6	11.6	15.9	15.9	15.6	24.6	24.6	24.4

8 Bioenergy use pathways in the JRC-EU-TIMES

In this chapter, the biomass potentials described in the report are tested as input to the JRC-EU-TIMES model under two policy scenarios for the EU28 countries: the Current Policy Initiatives scenario (CPI) that includes the 20-20-20 policy targets ((European Commission 2009), (European Union 2009), (European Union 2009) and (European Union 2012)) until 2020. In addition, the CPI is consistent with the medium-term goals of the European Commission Communication on *A policy framework for climate and energy in the period from 2020 to 2030* (European Commission 2014); (ii) a long-term decarbonisation scenario (CAP) that, in addition to the assumptions for 2020 and 2030 as in the CPI scenario, is consistent with the medium and long-term CO2 emissions reduction underlying (Russ, Ciscar et al. 2009), reaching a CO2 reduction of 80% below 1990 values in 2050 (European Commission 2014). In addition, both scenarios achieve a reduction in primary energy consumption (excluding non-energy) of 27% in 2030, aligned with the target adopted by the European Council.

The results obtained with the JRC-EU-TIMES model for the two policy scenarios are summarised and represented in Figure 9 to Figure 12 for the medium biomass availability scenario.

These results are presented for four main energy end-uses for biomass. They group the energy end-uses of the biomass types, as described in Table 2. All the crops that are currently grown to provide raw material for 1st generation biofuel production processes (bioethanol and biodiesel) are grouped together, whereas lignocellulosic second generation biofuels feedstock are included under the woody biomass category. The detailed biofuel products and blending options implemented in the JRC-EU-TIMES can be found in (Simoes, Nijs et al. 2013). Liquid biomass, which is used mainly through gasification, is grouped under biogas end-use. All the solid wood-like biomass use which can be input in any combustion or in transformation process for lignocellulosic raw materials, are included in the woody biomass category. Finally, the use of biomass waste from municipal or other activities is grouped under biomass from waste.

Figure 9 to Figure 12 show the share of the total potential available for each EU-28 country that is exploited for 2010, 2030 and 2050 under the two policy scenarios.

Biofuels crops follow a similar pathway in bot CPI and CAP scenario. There is a remarkable share of the available potential used in all countries devoted to meet the 2020 biofuel production targets. Once this happens, by 2030 biofuel production will shift to lignocellulosic based second generation technologies, resulting in a low use of the available starch, oil and sugar crops potential. Without specific target for them, all the biofuel production after 2020 is concentrated in second generation technologies producing mainly wood based biodiesel to be used in air transport.

Biogas results show a steady and constant development in all EU28 countries. Biogas in the JRC-EU-TIMES is modelled as an energy carrier that can be used in most end-use sectors, in electricity and cogeneration appliances. It can be a cost-competitive fuel option that increases its relevance as the emission reduction targets get more restrictive. For the CPI scenario the usage pattern stays similar between 2030 and 2050, with an average usage of the available potential over 60% for the EU28. The CAP scenario, with increased need for further emission reductions, takes this figure over 90%.

A similar pattern is shown by the woody biomass, the most relevant resource in energy terms. There is a remarkable development from 2010 to 2030, increasing the medium usage share from over 30% to close to 70% under a CPI scenario. Under a CAP scenario, the wood resource available is almost fully used in 2050, highlighting that an 80% emission reduction target may not be met without a very ambitious mobilization of the full potential from here to 2050. It is important to point out that, in the JRC-EU-TIMES model, this result is partly driven by the assumption that biomass use coupled with carbon capture and storage allow the net removal of CO_2 from the atmosphere. This is an important driver in the technology uptake, and it reflects the concept of negative emissions from bioenergy with CCS (Bio-CCS) which has been gaining increasing importance in the last decade (IEA 2011; Zero Emissions Platform 2012).

The assumptions made for the cost of waste potential evaluation (see Chapter 4.3) make it a very competitive option for 2010, so it is almost fully used. This is because the cost of waste collection is not fully included in the waste-for-energy pathway. Therefore, in our model, we implement a restriction on the growth of the waste combustion technologies with a maximum yearly growth rate of 0.5% to reflect the inertia in the system. Even with this restriction, the potential calculation hypothesis made result in almost a 50% increase from 2010 to

2050. The resulting pathway shows a reduced mean usage of the available resource.

The runs analysed highlight the key role that biomass for energy may have in the future, and above all in contributing to meeting an 80% emissions reduction target by 2050. First generation biofuels crops will not play a significant role in the long term, as the production will shift to second generation technologies. Biogas could play a significant role whose relevance will increase significantly under a CAP scenario. Wood is the most relevant resource. Its full deployment will turn out a pre-requisite to achieve an ambitious 80% CO_2 emissions reduction target. The role of waste could become very relevant under current cost assumptions, providing that open issues with processing technologies are addressed.

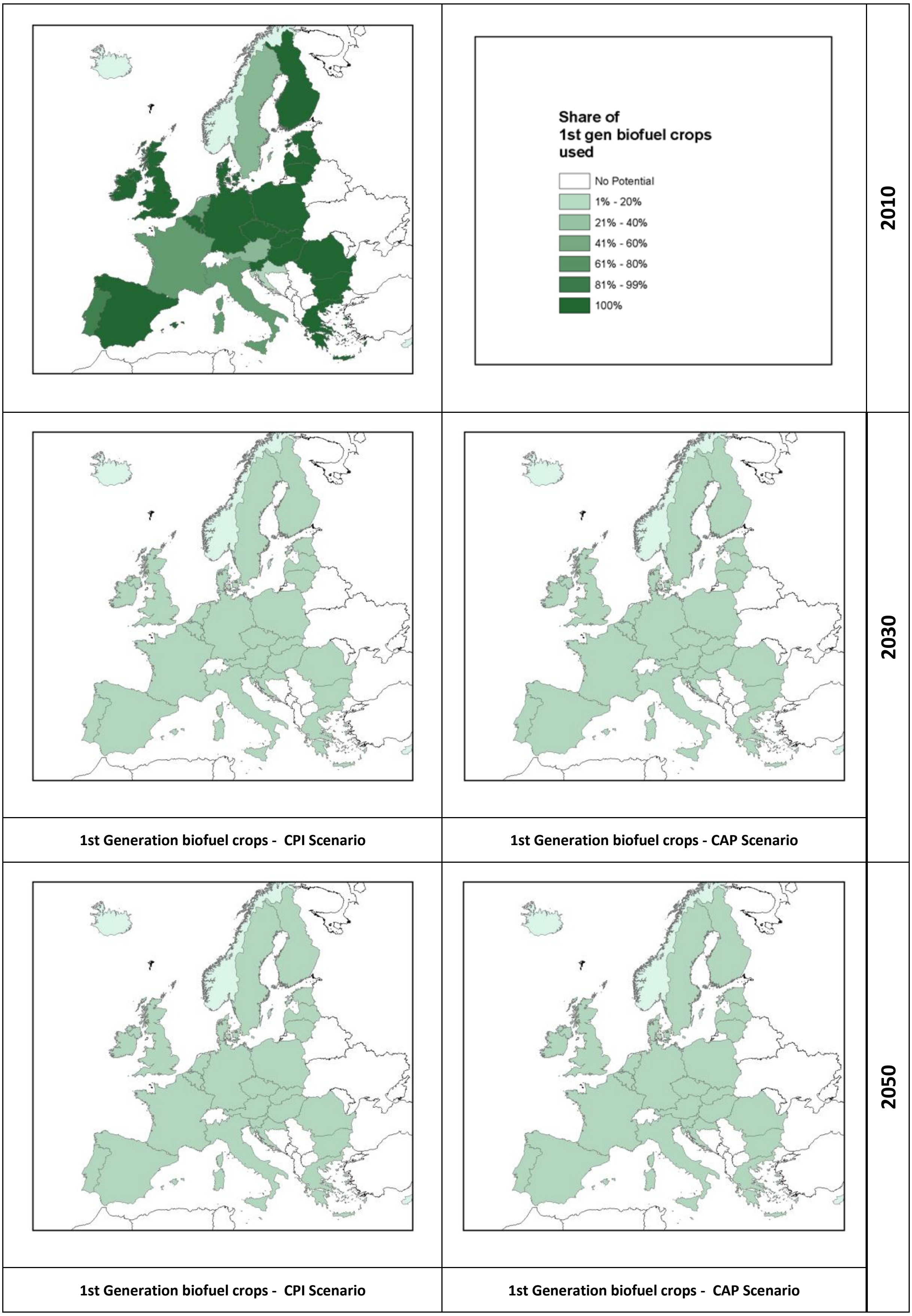

Figure 9 1st generation biofuel crops use in JRC-EU-TIMES scenarios

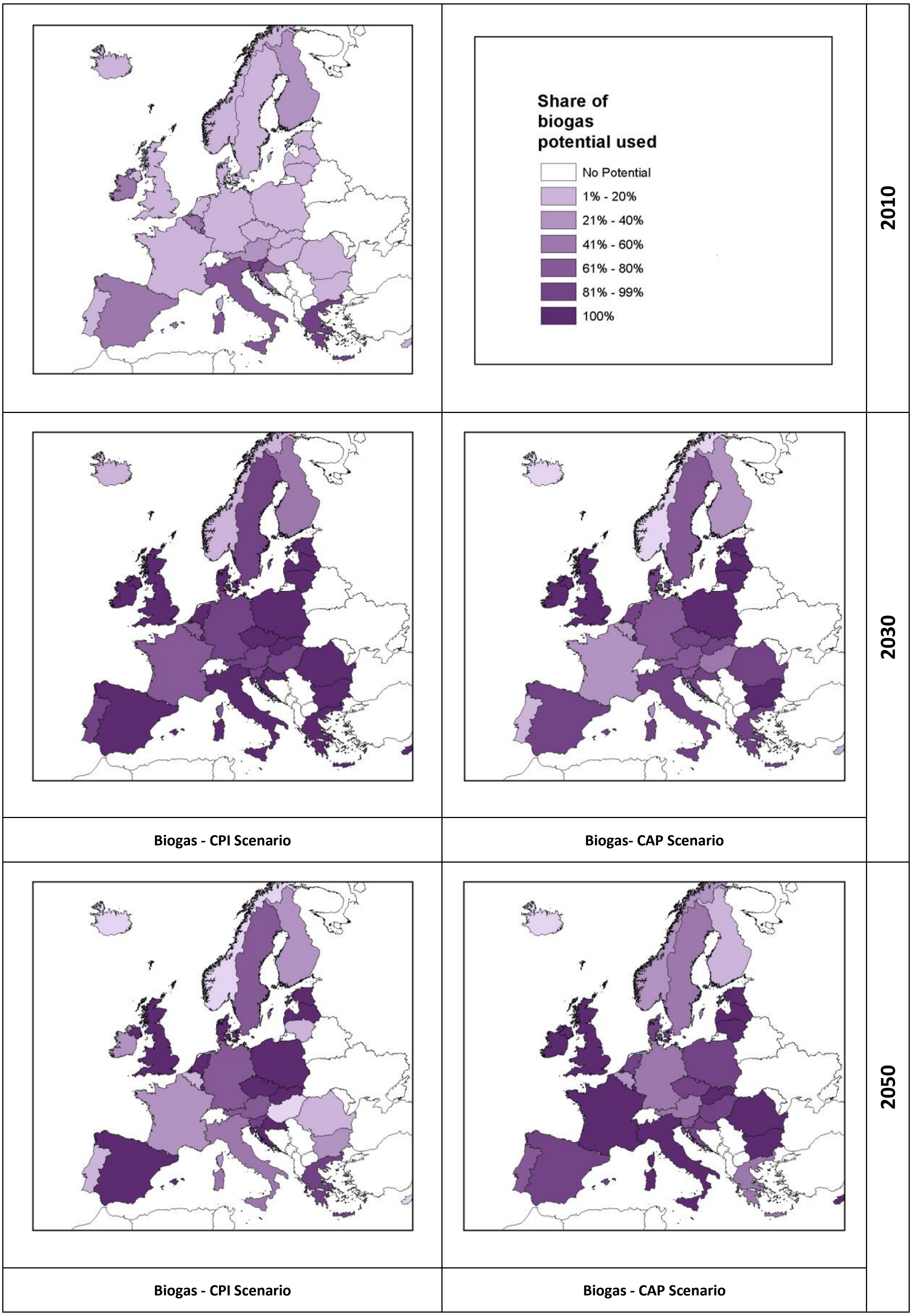

Figure 10 Biogas use in JRC-EU-TIMES scenarios

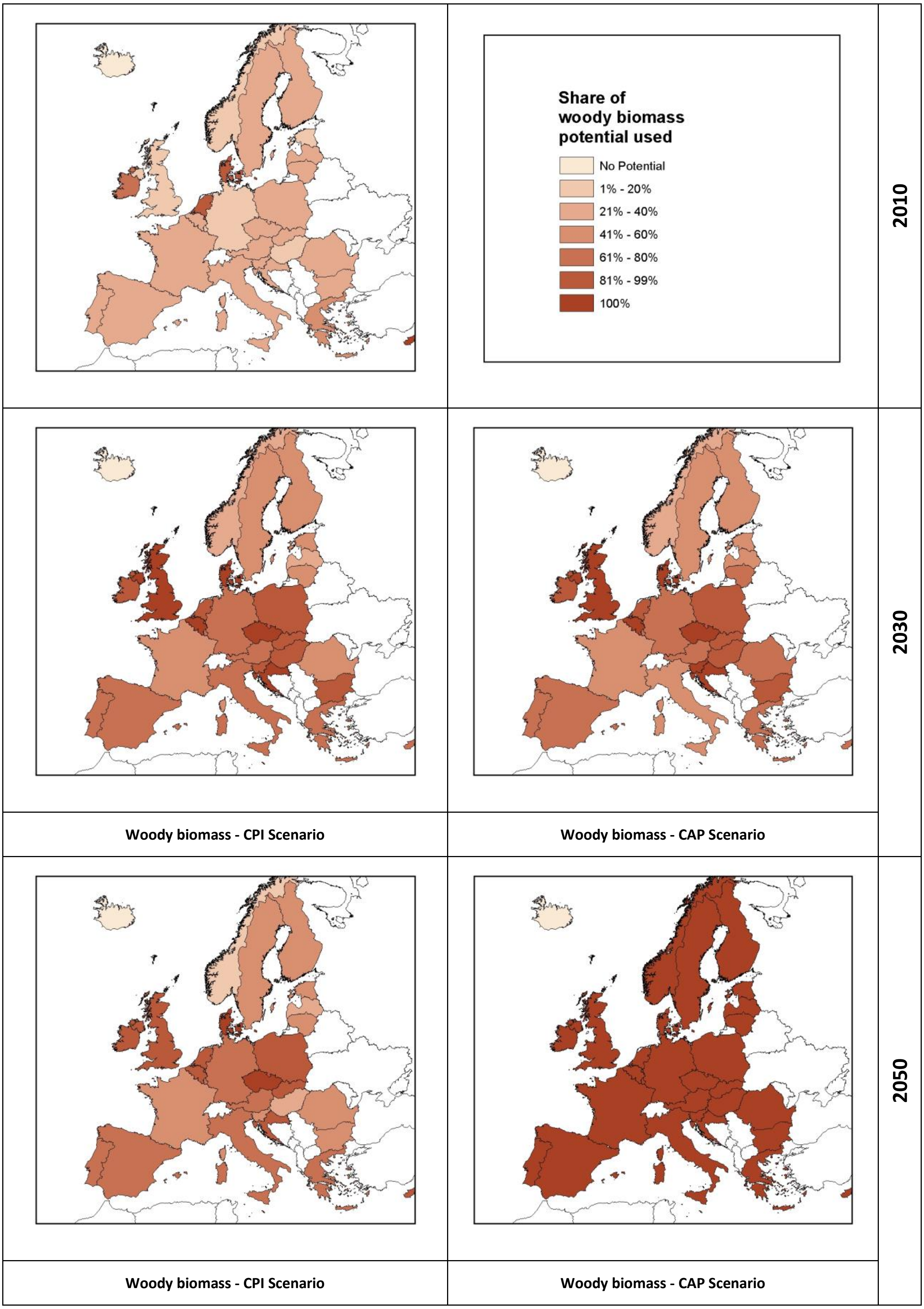

Figure 11 Woody biomass use in JRC-EU-TIMES scenarios

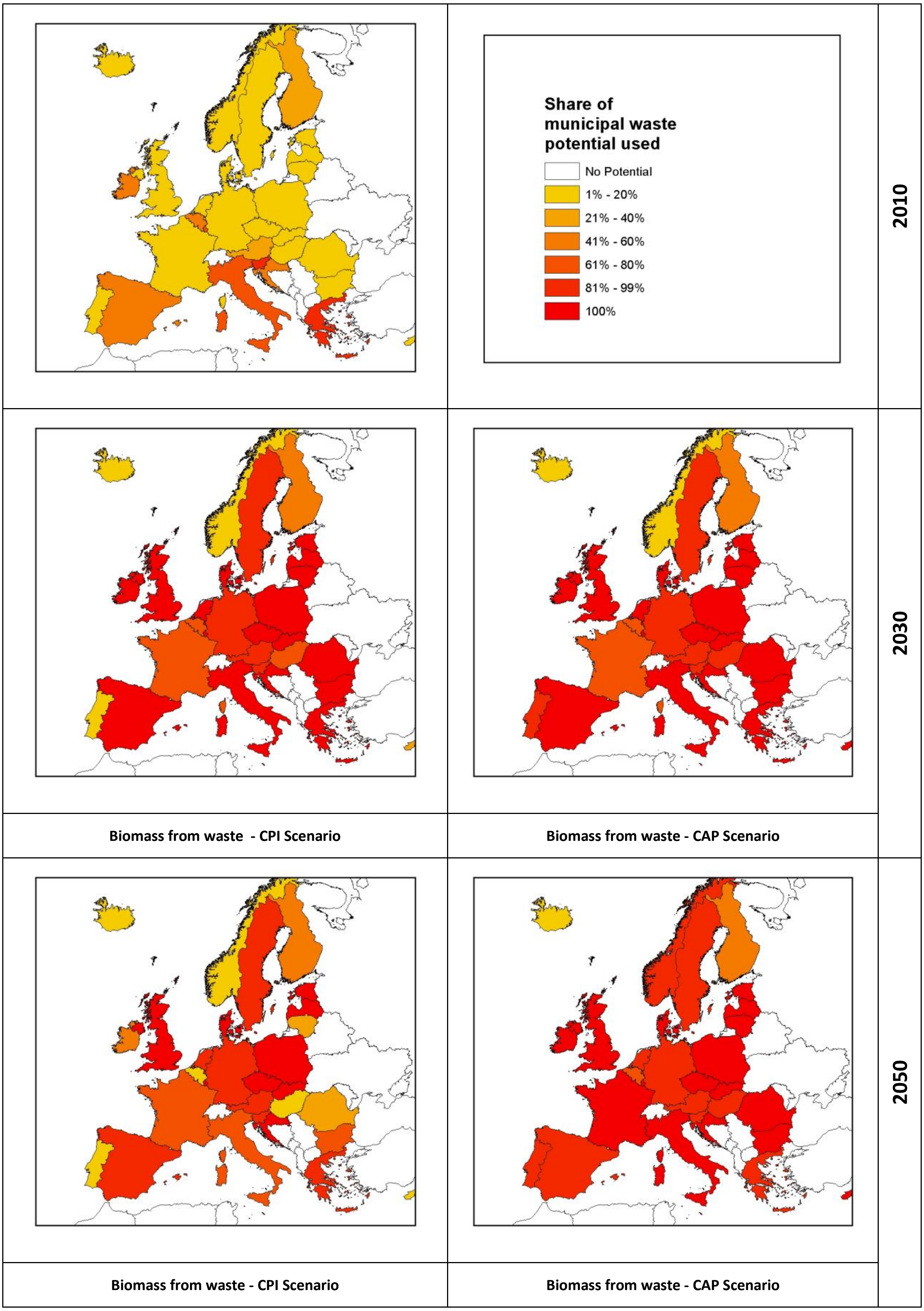

Figure 12 Biomass from waste use in JRC-EU-TIMES scenarios

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Annex 1: List of countries and country codes

Table 21 Eurostat Country Codes

Country	ISO code	Country	ISO code
Austria	AT	**Malta**	MT
Belgium	BE	**Netherlands**	NL
Bulgaria	BG	**Norway**	NO
Croatia	HR	**Poland**	PL
Cyprus	CY	**Portugal**	PT
Czech Rep.	CZ	**Romania**	RO
Denmark	DK	**Slovakia**	SK
Estonia	EE	**Slovenia**	SI
Finland	FI	**Spain**	ES
France	FR	**Sweden**	SE
Germany	DE	**United Kingdom**	UK
Greece	GR	**Albania**	AL
Hungary	HU	**Bosnia**	BA
Ireland	IE	**FYROM**	MK
Italy	IT	**Iceland**	IS
Latvia	LV	**Montenegro**	ME
Lithuania	LT	**Serbia**	RS
Luxembourg	LU	**Switzerland**	CH

Annex 2: Discussion and data issue

Based on former and comparable project results, literature and expert knowledge the qualitatively evaluation gives an overview about data's validity. For the most relevant feedstock (energy crops, biomass from forestry) a high validity can be noticed.

The highest sensitivities are related to area potential, yields and competing uses. The reason for medium and uncertain results is in most of the cases a missing or uncertain database. Due to these gaps assumptions (or scenarios) are the only feasible option to determine results. The regional circumstances can be very heterogeneous and a higher level of detail is often interrelated to a comparatively high (and expensive) effort.

However, a generalized approach is qualified to identify regionally differences with a harmonized methodology. That is why the overall approach for more than 30 countries results is a very suitable database for further analysis.

Table 22 Overall results for evaluation

Sector	Biomass category	Biomass type	Evaluation ■/■/■ Good/Medium/Uncertain	
Biomass from agriculture	Energy crops	Sugar, starch & oil crops	■	good
		Energy maize/silage	■/■	good/medium
		Woody/lignocellulosic biomass	■	good
	Agricultural primary residues	Dry manure	■/■	medium/uncertain
		Wet manure	■/■/■	good/medium/un-certain depending on scenario
	Agricultural secondary residues	Pits from olive pitting	■	good
	Solid agricultural residues	Prunings residues	■	good
		Straw/stubbles	■	medium
Biomass from forestry	Roundwood production	Stemwood	■	good
	Primary forestry residues	Logging residues	■/■	good/medium
	Secondary forestry residues		■	medium
Biomass from waste sector	Landscape management	Landscape management wood	■	uncertain
		Road side verges	■	uncertain
	Household waste	HH paper cardboard	■	good
		HH wood		
		HH animal and mixed food		
		HH vegetal waste		

Sector	Biomass category	Biomass type	Evaluation ■/■/■ Good/Medium/Uncertain	
		HH municipal solid waste		
		HH com sludge		
	Waste from other sectors	NACE paper cardboard	■/■	medium/uncertain
		NACE wood		
		NACE animal and mixed food		
		NACE vegetal waste		
		NACE municipal solid waste		
		NACE com sludge		
		UFO		

Annex 3: Available Land Data sources

Table 23 Data Sources for Available Land

	Forest Area harvest-able	Arable land/ crops	Perma-nent grassland	Permanent crops	Released land	Fallow land available	Abandoned land	Livestock-patterns	Urbanisa-tion+ road network [%]	Main data source used
Sugar		X								Eurostat-FSS data, CAPRI-baseline data, HNV farmland area (EEA, 2013), Natura 2000 areas, CLC (2010)
Starch		X								
Oil		X								
Wet/silage		X	x							
Woody/ligno-cellulosic biomass dedicated crops					x	x	x		x	
Manure		X	x					x		Eurostat-FSS data, CAPRI-baseline data
Pits from olive pitting				x						Eurostat-FSS data, CAPRI-baseline data
Prunings (permanent crops (e.g. orchards, vineyards, olives, citrus, nuts) residues				x						Eurostat-FSS data, CAPRI-baseline data
Straw/stubbles		X								Eurostat-FSS data, CAPRI-baseline data
Stemwood	x								x	• Site productivity, soil surface texture,

	Forest Area harvest-able	Arable land/ crops	Perma-nent grassland	Permanent crops	Released land	Fallow land available	Abandoned land	Livestock-patterns	Urbanisa-tion+ road network [%]	Main data source used
Additionally harvestable stemwood	x									soil depth and soil bearing capacity (EC, 2006) 19 . • Natural soil susceptibility to compaction (Houšková, 2008) 20 . • Slope (USGS, 1996) 21 . • Natura 2000 sites (EC, 2009)22.
Logging residues	x									
additionally harvestable logging residues	x									
Woodchips	x									EU-wood
Sawdust	x									EU-wood
Biodegradable waste from Primary residues									x	National/regional waste statistics, Population density
Biodegradable waste from Tertiary residues									x	National/regional waste statistics, Population density
Woody waste (incl. Discarded furniture, Woody fraction)									x	National/regional waste statistics, Population density
Other waste									x	National/regional waste statistics, Population density

[19] EC, 2006, European Soil Database (v. 2.0), raster version 1 km×1 km. European Commission – DG Joint Research Centre, Ispra

[20] Houšková, B., 2008. Natural Susceptibility of Soils to Compaction. European Commission, Institute of Environment and Sustainability, Land Management and Natural Hazards Unit, Ispra

[21] USGS, 1996. GTOPO30. United States Geological Survey's Center for Earth Resources Observation and Science.

[22] EC, 2009, Natura 2000 sites, version January 2009. EC – DG Environment, Brussels

Annex 4: Sustainability constraints per scenario for primary residues from forest

Table A3-1 to Table A3-5 provide an overview of the assumptions made to quantify the constraints included in this study for the three scenarios for different types of biomass and different felling activities.

Table A3-1: Maximum extraction rates for extracting stem biomass during early thinnings due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Site productivity	Not a constraining factor	Not a constraining factor	Not a constraining factor
Soil and water protection: Slope	0% on slopes over 35%; not a constraining factor on slopes up to 35%	0% on slopes over 35%; not a constraining factor on slopes up to 35%	0% on slopes over 35%; not a constraining factor on slopes up to 35%
Soil and water protection: Soil depth	Not a constraining factor	Not a constraining factor	Not a constraining factor
Soil and water protection: Soil surface texture	Not a constraining factor	Not a constraining factor	Not a constraining factor
Soil and water protection: Soil compaction risk	Not a constraining factor	Not a constraining factor	Not a constraining factor
Biodiversity: protected forest areas	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk
Recovery rate	95%	95%	95%
Soil bearing capacity	Not a constraining factor	Not a constraining factor	Not a constraining factor

Table A3-2: Maximum extraction rates for extracting <u>crown biomass during early thinnings</u> due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Site productivity	0% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); 70% on other soils	Not a constraining factor	0% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); 20% on other soils
Soil and water protection: Slope	0% on slopes over 35%;	0% on slopes over 35%;	0% on slopes over 35%;
Soil and water protection: Soil depth	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0% on Rendzina, Lithosol and Ranker (very low soil depth)
Soil and water protection: Soil surface texture	35% on peatlands (Histosols)	40% on peatlands (Histosols)	0% on peatlands (Histosols)
Soil and water protection: Soil compaction risk	0% on soils with very high compaction risk; 25% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with very high compaction risk; 50% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with very high and high compaction risk; not a constraining factor on other soils
Biodiversity: protected forest areas	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk
Recovery rate	80%	80%	80%
Soil bearing capacity	0% on Histosols, Fluvisols, Gleysols and Andosols	0% on Histosols, Fluvisols, Gleysols and Andosols; not a constraining factor in Finland and Sweden	0% on Histosols, Fluvisols, Gleysols and Andosols

Table A3-3: Maximum extraction rates for extracting <u>logging residues from final fellings</u> due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Site productivity	Not a constraining factor	Not a constraining factor	35% extraction rate on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); not a constraining factor on other soils
Soil and water protection: Slope	67%on slopes up to 35%; 0% on slopes over 35%, unless cable-crane systems are used	67% factor on slopes up to 35%; 0% on slopes over 35%, unless cable-crane systems are used	67% factor on slopes up to 35%; 0% on slopes over 35%, unless cable-crane systems are used
Soil and water protection: Soil depth	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0% on Rendzina, Lithosol and Ranker (very low soil depth)
Soil and water protection: Soil surface texture	0% on peatlands (Histosols)	33% on peatlands (Histosols)	0% on peatlands (Histosols)
Soil and water protection: Soil compaction risk	0% on soils with very high compaction risk; 25% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with very high compaction risk; 50% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with high or very high compaction risk; 50% on soils with medium compaction risk; not a constraining factor on other soils
Biodiversity: protected forest areas	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk
Recovery rate	67% on slopes up to 35%; 0% on slopes over 35%, but 67% if cable-crane systems are used	70% on slopes up to 35%; 0% on slopes over 35%, but 67% if cable-crane systems are used	65% on slopes up to 35%; 0% on slopes over 35%, but 67% if cable-crane systems are used
	Cable cranes are applied in Austria, Italy, France, Germany, Czech Republic, Slovakia, Slovenia, Romania[23]	Cable cranes are applied in Austria, Italy, France, Germany, Czech Republic, Slovakia, Slovenia, Romania, Bulgaria	Cable cranes are applied in Austria, Italy, France, Germany, Czech Republic, Slovakia, Slovenia, Romania
Soil bearing capacity	0% on Histosols, Fluvisols, Gleysols and Andosols	0% on Histosols, Fluvisols, Gleysols and Andosols; not a constraining factor in Finland and Sweden	0% on Histosols, Fluvisols, Gleysols and Andosols

23 Based on personal communication with Karl Stampfer

Table A3-4: Maximum extraction rates for extracting logging residues from thinnings due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Site productivity	0% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); 33% on other soils	67%	0%
Soil and water protection: Slope	33% on slopes up to 35%; 0% on slopes over 35%, unless cable-crane systems are used	67% factor on slopes up to 35%; 0% on slopes over 35%, unless cable-crane systems are used	0%
Soil and water protection: Soil depth	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0% on Rendzina, Lithosol and Ranker (very low soil depth)	0%
Soil and water protection: Soil surface texture	0% on peatlands (Histosols)	33% on peatlands (Histosols)	0%
Soil and water protection: Soil compaction risk	0% on soils with very high compaction risk; 25% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with very high compaction risk; 50% on soils with high compaction risk; not a constraining factor on other soils	0%
Biodiversity: protected forest areas	0%; not a constraining factor in areas with high or very high fire risk	0%; not a constraining factor in areas with high or very high fire risk	0%
Recovery rate	67% on slopes up to 35%; 0% on slopes over 35%, but 47% if cable-crane systems are used	70% on slopes up to 35%; 0% on slopes over 35%, but 47% if cable-crane systems are used	0%
	Cable cranes are applied in Austria, Italy, France, Germany, Czech Republic, Slovakia, Slovenia, Romania[24]	Cable cranes are applied in Austria, Italy, France, Germany, Czech Republic, Slovakia, Slovenia, Romania, Bulgaria	
Soil bearing capacity	0% on Histosols, Fluvisols, Gleysols and Andosols	0% on Histosols, Fluvisols, Gleysols and Andosols ,not a constraint in Finland and Sweden	0%

24 Based on personal communication with Karl Stampfer

Table A3-24: Maximum extraction rates for extracting stumps from final fellings due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Countries	Finland, Sweden, UK	All	0%
Species	Conifers	All	0%
Site productivity	33% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); not a constraining factor on other soils	67% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); not a constraining factor on other soils	0%
Soil and water protection: Slope	0% on slopes over 20%; 33% - slope[%] * 0.33 on slopes up to 20%	0% on slopes over 35%; 67% - slope[%] * 0.67 on slopes up to 35%	0%
Soil and water protection: Soil surface texture	0% on peatlands (Histosols)	33% on peatlands (Histosols)	0%
Soil and water protection: Soil depth	0% on soils < 40 cm (including Rendzina, Lithosol and Ranker); 33% on soils >40 cm	0% on soils < 40 cm (including Rendzina, Lithosol and Ranker); 67% on soils >40 cm	0%
Soil and water protection: Soil compaction risk	0% on soils with very high compaction risk; 15% on soils with high compaction risk; not a constraining factor on other soils	0% on soils with very high compaction risk; 33% on soils with high compaction risk; not a constraining factor on other soils	0%
Biodiversity: protected forest areas	0%	0%	0%
Recovery rate	Not a constraining factor	Not a constraining factor	0%
Soil bearing capacity	0% on Histosols, Fluvisols, Gleysols and Andosols	0% on Histosols, Fluvisols, Gleysols and Andosols; not a constraint in Finland and Sweden	0%

Table A3-25: Maximum extraction rates for extracting stumps from thinnings due to environmental and technical constraints for three scenarios.

Type of constraint	Current (2010) and Medium scenario	High scenario	Low scenario
Countries	0%	All	0%
Species	0%	All	0%
Site productivity	0%	67% on poor soils (Acrisol, Podzoluvisol, Histosol, Podzol, Arenosol, Planosol, Xerosol); not a constraining factor on other soils	0%
Soil and water protection: Slope	0%	0% on slopes over 35%; 67% - slope[%] * 0.67 on slopes up to 35%	0%
Soil and water protection: Soil surface texture	0%	33% on peatlands (Histosols)	0%
Soil and water protection: Soil depth	0%	0% on soils < 40 cm (including Rendzina, Lithosol and Ranker); 67% on soils >40 cm	0%
Soil and water protection: Soil compaction risk	0%	0% on soils with very high compaction risk; 33% on soils with high compaction risk; not a constraining factor on other soils	0%
Biodiversity: protected forest areas	0%	0%	0%
Recovery rate	0%	Not a constraining factor	0%
Soil bearing capacity	0%	0% on Histosols, Fluvisols, Gleysols and Andosols; not a constraint in Finland and Sweden	0%

Annex 5: Heating values

Table 26 Heating values of main biomass feedstocks

Mean LHV	(TJ/ton)		(GJ/ton)
Animal waste	23.67	Saw Dust	14.71
Municipal solid waste	5.20	Grassland Cuttings	14.83
Sewage Sludge	8.71	Straw from Cereals	14.64
Verge Grass	5.42	Olive Pits	18.78
Landfill gas	21.00	Husks from Fruit	7.05
Used fats/oils	36.00	Landscape care wood	15.89
paper cardboard	15.21	Landfill gas	21.00
Post consumer wood	15.66	Used fats/oils	36.00
Other industrial wood residues	16.04	Roundwood/stemwood	14.15
Perennials: woody crops	14.15	Paper cardboard	15.21
Perennials: grassy crops	12.54	Post-consumer wood	15.66
Dry Manure	9.44	Primary Forestry Residues	15.89
Wet manure (corrected assuming wet manure and conversion to biogass)	0.94	Sawmill by-products (excl saw dust)	13.55
Maize	17.02	Other industrial wood residues	16.04
Cereals	15.45	Primary forestry residues dry	19.19
Sugar Beet	16.60	Black Liquor	11.67
Sweet Sorghum	16.24	Grass (fresh	14.83
Rape	18.62	Soya	18.62
Sunflower	18.43		

Annex 6: Biomass energy potentials per feedstock

Table 27 Bioethanol sugar beet biomass potential [PJ]

MINBIOCRP 21	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AT	13.9	13.8	15.3	14.8	14.3	13.9	13.8	15.3	14.8	14.3	13.9	15.1	16.9	16.3	15.8
BE	4.6	17.4	30.8	33.6	36.4	4.6	17.4	30.8	33.6	36.4	4.6	19.1	33.9	37.0	40.0
BG	-	8.6	1.5	8.8	11.7	-	8.6	1.5	8.8	11.7	-	9.4	1.7	9.7	12.8
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	9.7	14.6	25.0	29.7	34.4	9.7	14.6	25.0	29.7	34.4	9.7	16.1	27.5	32.6	37.8
DE	72.4	48.9	45.8	44.6	43.5	72.4	48.9	45.8	44.6	43.5	72.4	53.8	50.3	49.0	47.9
DK	1.4	0.7	1.3	2.1	2.7	1.4	0.7	1.3	2.1	2.7	1.4	0.7	1.5	2.3	3.0
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	-	106.1	136.7	154.3	170.0	-	106.1	136.7	154.3	170.0	-	116.7	150.3	169.8	187.0
FI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FR	230.3	228.3	251.4	241.6	231.9	230.3	228.3	251.4	241.6	231.9	230.3	251.1	276.5	265.8	255.1
GR	-	14.7	16.5	19.2	21.8	-	14.7	16.5	19.2	21.8	-	16.2	18.2	21.2	24.0
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	-	4.3	9.1	12.8	17.0	-	4.3	9.1	12.8	17.0	-	4.7	10.0	14.1	18.7
IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	-	44.3	111.0	120.0	130.3	-	44.3	111.0	120.0	130.3	-	48.8	122.1	132.0	143.3
LT	1.6	24.3	33.9	37.8	41.6	1.6	24.3	33.9	37.8	41.6	1.6	26.7	37.2	41.6	45.8
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

MINBIOCRP 21	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
NL	1.6	14.2	20.9	17.6	14.4	1.6	14.2	20.9	17.6	14.4	1.6	15.6	23.0	19.3	15.8
NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PL	1.8	28.7	47.7	89.4	133.0	1.8	28.7	47.7	89.4	133.0	1.8	31.6	52.4	98.3	146.3
PT	-	0.2	0.1	0.2	0.5	-	0.2	0.1	0.2	0.5	-	0.2	0.1	0.2	0.5
RO	-	9.9	0.0	9.6	9.4	-	9.9	0.0	9.6	9.4	-	10.9	0.0	10.5	10.3
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	4.9	4.5	5.1	5.3	5.4	4.9	4.5	5.1	5.3	5.4	4.9	5.0	5.6	5.8	6.0
SI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SK	1.5	1.6	4.2	6.3	8.8	1.5	1.6	4.2	6.3	8.8	1.5	1.8	4.6	6.9	9.7
UK	3.0	18.2	126.2	96.8	68.0	3.0	18.2	126.2	96.8	68.0	3.0	20.0	138.8	106.4	74.8

Table 28 Rapeseeds for biodiesel potentials [PJ]

	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AT	13.9	13.8	15.3	14.8	14.3	13.9	13.8	15.3	14.8	14.3	13.9	15.1	16.9	16.3	15.8
BE	4.6	17.4	30.8	33.6	36.4	4.6	17.4	30.8	33.6	36.4	4.6	19.1	33.9	37.0	40.0
BG	-	8.6	1.5	8.8	11.7	-	8.6	1.5	8.8	11.7	-	9.4	1.7	9.7	12.8
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	9.7	14.6	25.0	29.7	34.4	9.7	14.6	25.0	29.7	34.4	9.7	16.1	27.5	32.6	37.8
DE	72.4	48.9	45.8	44.6	43.5	72.4	48.9	45.8	44.6	43.5	72.4	53.8	50.3	49.0	47.9
DK	1.4	0.7	1.3	2.1	2.7	1.4	0.7	1.3	2.1	2.7	1.4	0.7	1.5	2.3	3.0
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	-	106.1	136.7	154.3	170.0	-	106.1	136.7	154.3	170.0	-	116.7	150.3	169.8	187.0
FI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FR	230.3	228.3	251.4	241.6	231.9	230.3	228.3	251.4	241.6	231.9	230.3	251.1	276.5	265.8	255.1
GR	-	14.7	16.5	19.2	21.8	-	14.7	16.5	19.2	21.8	-	16.2	18.2	21.2	24.0
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	-	4.3	9.1	12.8	17.0	-	4.3	9.1	12.8	17.0	-	4.7	10.0	14.1	18.7
IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	-	44.3	111.0	120.0	130.3	-	44.3	111.0	120.0	130.3	-	48.8	122.1	132.0	143.3
LT	1.6	24.3	33.9	37.8	41.6	1.6	24.3	33.9	37.8	41.6	1.6	26.7	37.2	41.6	45.8
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	1.6	14.2	20.9	17.6	14.4	1.6	14.2	20.9	17.6	14.4	1.6	15.6	23.0	19.3	15.8
NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	1.8	28.7	47.7	89.4	133.0	1.8	28.7	47.7	89.4	133.0	1.8	31.6	52.4	98.3	146.3
PT	-	0.2	0.1	0.2	0.5	-	0.2	0.1	0.2	0.5	-	0.2	0.1	0.2	0.5
RO	-	9.9	0.0	9.6	9.4	-	9.9	0.0	9.6	9.4	-	10.9	0.0	10.5	10.3
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	4.9	4.5	5.1	5.3	5.4	4.9	4.5	5.1	5.3	5.4	4.9	5.0	5.6	5.8	6.0
SI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SK	1.5	1.6	4.2	6.3	8.8	1.5	1.6	4.2	6.3	8.8	1.5	1.8	4.6	6.9	9.7
UK	3.0	18.2	126.2	96.8	68.0	3.0	18.2	126.2	96.8	68.0	3.0	20.0	138.8	106.4	74.8

Table 29 Oil crops other than rapeseeds (sunflower and soya) for biodiesel potentials [PJ]

	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AT	0.9	0.8	1.5	1.5	1.6	0.9	0.8	1.5	1.5	1.6	0.9	0.9	1.7	1.7	1.7
BE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BG	0.9	5.8	5.9	5.6	5.4	0.9	5.8	5.9	5.6	5.4	0.9	6.3	6.5	6.2	5.9
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	0.2	0.6	0.8	0.6	0.3	0.2	0.6	0.8	0.6	0.3	0.2	0.7	0.9	0.6	0.3
DE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	7.0	9.3	6.7	4.4	2.6	7.0	9.3	6.7	4.4	2.6	7.0	10.2	7.3	4.9	2.9
FI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FR	8.0	32.1	27.0	16.1	7.7	8.0	32.1	27.0	16.1	7.7	8.0	35.3	29.6	17.7	8.5
GR	0.2	0.6	0.8	2.1	3.3	0.2	0.6	0.8	2.1	3.3	0.2	0.6	0.8	2.3	3.6
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	5.2	7.5	9.0	8.1	7.2	5.2	7.5	9.0	8.1	7.2	5.2	8.2	9.9	8.9	7.9
IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	3.1	3.2	6.0	4.2	2.6	3.1	3.2	6.0	4.2	2.6	3.1	3.5	6.6	4.6	2.8
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	0.0	0.3	0.5	0.3	0.2	0.0	0.3	0.5	0.3	0.2	0.0	0.3	0.6	0.4	0.2
PT	0.1	1.1	0.7	0.6	0.4	0.1	1.1	0.7	0.6	0.4	0.1	1.2	0.8	0.6	0.4
RO	0.9	5.0	7.1	7.3	7.1	0.9	5.0	7.1	7.3	7.1	0.9	5.5	7.8	8.1	7.8
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SI	0.0	-	-	0.0	-	0.0	-	-	0.0	-	0.0	-	-	0.0	-
SK	0.4	1.0	0.7	0.4	0.1	0.4	1.0	0.7	0.4	0.1	0.4	1.1	0.8	0.4	0.1
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 30 Starchy crops biomass potential [PJ]

MINBIOCRP 11	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AT	3.3	1.1	1.8	1.8	2.0	3.3	1.1	1.8	1.8	2.0	3.3	1.2	2.0	2.0	2.2
BE	4.9	4.7	5.0	5.3	5.6	4.9	4.7	5.0	5.3	5.6	4.9	5.2	5.5	5.8	6.2
BG	3.0	8.6	10.8	10.2	9.7	3.0	8.6	10.8	10.2	9.7	3.0	9.4	11.9	11.3	10.7
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	3.7	3.3	6.4	4.7	3.0	3.7	3.3	6.4	4.7	3.0	3.7	3.6	7.1	5.2	3.3
DE	12.5	2.5	3.7	5.9	8.3	12.5	2.5	3.7	5.9	8.3	12.5	2.8	4.1	6.4	9.1
DK	0.4	1.6	2.1	1.9	1.7	0.4	1.6	2.1	1.9	1.7	0.4	1.8	2.3	2.1	1.9
EE	0.0	0.4	4.5	9.5	14.1	0.0	0.4	4.5	9.5	14.1	0.0	0.4	5.0	10.4	15.5
ES	13.4	25.9	30.6	32.5	33.2	13.4	25.9	30.6	32.5	33.2	13.4	28.5	33.6	35.7	36.5
FI	0.4	0.7	0.9	1.1	1.3	0.4	0.7	0.9	1.1	1.3	0.4	0.8	1.0	1.2	1.5
FR	34.2	27.1	37.2	32.2	26.6	34.2	27.1	37.2	32.2	26.6	34.2	29.8	41.0	35.4	29.3
GR	9.0	5.7	8.8	8.1	6.9	9.0	5.7	8.8	8.1	6.9	9.0	6.3	9.7	8.9	7.6
HR	30.2	26.5	40.3	41.0	41.3	30.2	26.5	40.3	41.0	41.3	30.2	29.2	44.4	45.0	45.4
HU	10.0	15.1	21.8	22.4	22.4	10.0	15.1	21.8	22.4	22.4	10.0	16.6	23.9	24.6	24.6
IE	0.0	0.2	0.3	0.2	0.2	0.0	0.2	0.3	0.2	0.2	0.0	0.3	0.3	0.3	0.2
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	4.5	19.5	18.5	17.0	16.2	4.5	19.5	18.5	17.0	16.2	4.5	21.5	20.3	18.7	17.9
LT	1.5	2.4	7.1	9.8	12.4	1.5	2.4	7.1	9.8	12.4	1.5	2.6	7.8	10.8	13.7
LU	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
LV	0.8	0.7	3.2	5.4	7.7	0.8	0.7	3.2	5.4	7.7	0.8	0.8	3.5	6.0	8.4
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	0.6	0.7	0.8	0.9	1.0	0.6	0.7	0.8	0.9	1.0	0.6	0.8	0.9	1.0	1.1
NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

MINBIOCRP 11	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	7.9	11.2	15.8	17.5	18.5	7.9	11.2	15.8	17.5	18.5	7.9	12.3	17.4	19.2	20.3
PT	-	0.2	0.1	0.1	0.1	-	0.2	0.1	0.1	0.1	-	0.2	0.2	0.1	0.1
RO	3.5	17.8	24.2	26.0	26.7	3.5	17.8	24.2	26.0	26.7	3.5	19.6	26.6	28.5	29.3
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	8.8	0.8	0.6	0.5	0.5	8.8	0.8	0.6	0.5	0.5	8.8	0.9	0.7	0.6	0.5
SI	-	0.0	0.2	0.2	0.1	-	0.0	0.2	0.2	0.1	-	0.0	0.2	0.2	0.2
SK	5.8	3.4	5.2	4.0	2.7	5.8	3.4	5.2	4.0	2.7	5.8	3.8	5.7	4.4	3.0
UK	13.9	18.1	37.7	29.9	22.3	13.9	18.1	37.7	29.9	22.3	13.9	19.9	41.4	32.9	24.5

Table 31 Grassy crops biomass potential [PJ]

MINBIOCRP 31	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	9.9	10.2	10.7	28.6	-	24.7	25.9	27.3	28.6	-	30.5	33.3	36.3	39.4
AT	-	10.7	10.9	9.3	7.4	-	14.5	15.2	12.9	10.4	-	30.0	32.7	28.7	23.7
BE	-	11.0	15.9	9.5	2.4	-	14.2	20.7	12.3	3.0	-	17.7	26.9	16.5	4.3
BG	-	26.3	22.9	24.4	28.2	-	51.5	46.8	47.5	52.1	-	92.8	88.4	92.9	103.7
BH	-	24.4	24.6	24.9	63.6	-	60.6	62.6	63.2	63.6	-	74.9	80.5	84.2	87.4
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	0.4	0.4	0.4	0.3	-	0.6	0.7	0.6	0.6	-	2.2	1.6	1.5	1.4
CZ	-	10.1	12.8	10.3	10.1	-	22.5	25.5	26.8	28.2	-	34.7	41.0	45.2	49.6
DE	-	59.6	107.4	111.3	115.1	-	80.4	148.2	153.2	158.1	-	98.2	188.3	201.7	214.7
DK	-	-	-	-	-	-	0.0	0.0	0.0	-	-	8.9	9.3	8.6	7.7
EE	-	3.1	3.0	2.0	0.9	-	5.8	5.6	3.9	1.9	-	7.5	7.7	5.4	2.7
ES	-	129.0	143.5	155.9	172.9	-	208.9	240.6	253.7	267.5	-	400.7	486.6	520.2	553.7
FI	-	5.0	6.3	9.8	13.6	-	11.0	12.5	16.3	20.5	-	17.3	20.0	26.7	34.2
FR	-	111.7	160.2	156.4	151.7	-	167.3	240.4	234.0	226.0	-	208.5	312.9	316.2	316.0
GR	-	8.9	9.6	10.4	11.1	-	16.3	13.6	14.4	15.2	-	38.8	27.9	29.8	31.6
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	-	51.2	51.5	53.4	55.9	-	87.3	89.9	93.2	96.5	-	120.0	128.1	137.6	146.9
IE	-	7.3	6.6	4.8	2.8	-	12.3	11.4	8.3	4.8	-	16.0	15.5	11.6	6.9
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	-	78.7	71.3	66.5	61.0	-	157.2	145.3	134.9	122.9	-	252.6	242.9	233.0	218.4
LT	-	16.8	18.8	13.1	6.8	-	29.5	33.4	23.6	12.9	-	35.9	42.5	31.0	17.1
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	2.0	2.8	1.5	0.0	-	5.8	7.5	4.9	2.1	-	10.3	13.5	9.6	4.9
ME	-	0.9	0.9	1.0	2.5	-	2.3	2.4	2.4	2.5	-	2.9	3.0	3.3	3.5
MK	-	6.0	6.1	6.6	17.9	-	14.9	15.6	16.8	17.9	-	18.5	20.1	22.4	24.7
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	-	8.6	15.7	14.1	12.3	-	11.7	21.9	19.6	17.1	-	14.2	27.7	25.7	23.0
NO	-	1.5	1.6	1.6	4.3	-	3.8	4.0	4.1	4.3	-	4.8	5.2	5.5	5.9

MINBIOCRP 31	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	-	82.4	100.9	98.4	95.2	-	154.2	189.9	185.2	179.3	-	226.2	289.5	292.3	292.0
PT	-	9.4	9.0	11.6	14.3	-	17.9	19.5	19.3	19.1	-	36.0	41.9	39.7	36.5
RO	-	174.3	181.3	167.5	151.7	-	267.0	279.1	260.8	239.7	-	372.7	405.2	390.6	368.6
RS	-	13.9	13.7	12.8	30.2	-	34.7	34.8	32.7	30.2	-	43.0	45.0	43.8	41.7
SE	-	6.1	7.2	6.6	5.9	-	10.4	12.7	11.6	10.4	-	14.2	18.2	17.3	16.2
SI	-	0.7	1.8	1.6	1.3	-	1.0	2.7	2.3	1.9	-	2.7	7.5	6.6	5.5
SK	-	6.6	8.0	4.8	1.1	-	10.8	13.2	8.3	2.9	-	13.6	17.4	11.3	4.0
UK	-	26.7	34.2	30.6	26.6	-	28.0	36.0	32.1	27.6	-	35.0	46.8	43.3	38.7

Table 32 Willow biomass potential [PJ]

MINBIOCR P41	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AT	-	4.6	4.7	4.0	3.2	-	2.3	2.5	2.1	1.8	-	5.9	6.5	5.8	4.8
BE	-	5.2	7.6	4.5	1.1	-	3.7	5.2	3.1	0.7	-	4.5	6.7	4.1	1.0
BG	-	9.1	7.9	8.4	9.7	-	6.7	4.8	5.6	6.5	-	14.5	11.8	13.7	15.8
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	-	4.7	5.0	4.0	4.0	-	4.0	5.1	7.6	10.3	-	7.2	9.1	13.3	18.1
DE	-	23.7	42.7	44.2	45.7	-	10.2	18.8	19.5	20.2	-	12.7	24.4	26.2	28.0
DK	-	-	-	-	-	-	0.0	0.0	0.0	-	-	3.7	3.9	3.6	3.2
EE	-	2.3	2.2	1.5	0.7	-	3.0	2.9	2.1	1.2	-	3.9	3.9	2.9	1.6
ES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FI	-	2.0	2.6	4.1	5.7	-	3.5	4.2	5.8	7.4	-	5.3	6.5	9.0	11.9
FR	-	45.6	65.5	63.8	61.7	-	25.5	33.5	31.9	29.9	-	29.0	39.8	39.3	38.2
GR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	-	17.3	17.4	18.0	18.8	-	15.4	17.0	18.3	19.6	-	20.7	23.7	26.5	29.4
IE	-	6.4	5.8	4.2	2.4	-	6.6	6.1	4.4	2.6	-	8.6	8.3	6.2	3.7
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LT	-	13.2	14.7	10.3	5.3	-	15.5	17.2	12.6	7.6	-	18.7	21.7	16.4	10.1
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	1.6	2.2	1.2	0.0	-	3.0	3.7	2.7	1.7	-	6.1	7.7	6.0	3.9
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	-	3.4	6.2	5.6	4.8	-	1.3	2.3	2.1	1.8	-	1.5	2.9	2.7	2.4
NO	-	1.4	1.5	1.5	4.0	-	3.6	3.7	3.9	4.0	-	4.4	4.8	5.2	5.6

MINBIOCRP41	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	-	58.5	71.6	69.6	67.2	-	67.2	81.0	79.1	76.6	-	103.4	129.7	131.1	131.0
PT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RO	-	63.1	65.6	60.7	55.1	-	62.1	66.5	63.9	60.8	-	82.1	91.7	91.0	89.1
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	-	3.8	4.4	4.1	3.6	-	4.0	4.7	4.4	4.0	-	5.7	7.2	6.9	6.5
SI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SK	-	3.0	3.6	2.2	0.5	-	2.3	2.6	2.0	1.4	-	2.9	3.4	2.7	1.9
UK	-	19.5	24.9	22.4	19.5	-	27.6	35.9	32.1	27.8	-	34.3	46.6	43.2	38.7

Table 33 Poplar biomass potential [PJ]

MINBIOCR P41a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	-	2.2	2.2	2.3	6.2	-	5.4	5.6	5.9	6.2	-	6.6	7.2	7.9	8.6
AT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH	-	5.3	5.4	5.4	13.8	-	13.2	13.6	13.7	13.8	-	16.3	17.5	18.3	19.0
CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CY	-	0.2	0.2	0.2	0.1	-	0.3	0.3	0.3	0.3	-	0.8	0.7	0.6	0.6
CZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ES	-	34.3	38.4	41.5	45.9	-	40.5	44.9	49.5	54.3	-	75.1	87.8	97.6	107.8
FI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FR	-	4.2	6.0	5.9	5.9	-	2.7	3.1	3.1	3.1	-	4.6	5.9	6.1	6.3
GR	-	2.8	2.8	3.1	3.3	-	3.2	3.7	4.0	4.4	-	7.2	7.4	8.3	9.2
HR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	-	21.0	19.1	17.8	16.4	-	11.7	11.1	11.0	10.8	-	22.1	21.7	21.8	21.6
LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ME	-	0.2	0.2	0.2	0.5	-	0.5	0.5	0.5	0.5	-	0.6	0.7	0.7	0.8
MK	-	1.3	1.3	1.4	3.9	-	3.2	3.4	3.6	3.9	-	4.0	4.4	4.9	5.4
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

MINBIOCR P41a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PT	-	2.4	2.3	3.0	3.7	-	2.9	2.6	3.7	4.9	-	5.7	5.5	7.4	9.4
RO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RS	-	3.0	3.0	2.8	6.6	-	7.5	7.6	7.1	6.6	-	9.4	9.8	9.5	9.1
SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SI	-	0.1	0.4	0.3	0.3	-	0.1	0.2	0.1	0.1	-	0.2	0.4	0.4	0.3
SK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 34 Manure biomass potential [PJ]

MINBIOGAS 1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
AL	1.8	0.8	0.8	0.8	0.8	1.8	1.8	1.8	1.8	1.8	1.8	2.8	2.8	2.8	2.8
AT	4.7	0.3	0.3	0.3	0.3	4.7	4.7	4.7	4.7	4.8	4.7	9.2	9.2	9.2	9.2
BE	38.8	10.8	10.8	10.9	10.9	38.8	38.5	38.6	38.6	38.7	38.8	66.3	66.3	66.4	66.4
BG	6.7	2.9	3.4	3.2	3.1	6.7	5.5	6.0	5.8	5.7	6.7	8.1	8.6	8.4	8.3
BH	1.6	0.8	0.8	0.8	0.8	1.6	1.6	1.6	1.6	1.6	1.6	2.4	2.4	2.5	2.5
CH	4.5	1.5	1.4	1.6	1.7	4.5	4.3	4.2	4.3	4.5	4.5	7.1	6.9	7.1	7.2
CY	3.9	2.9	3.0	3.2	3.4	3.9	4.0	4.1	4.3	4.5	3.9	5.1	5.3	5.4	5.6
CZ	56.3	41.9	37.7	36.2	34.7	56.3	49.3	45.1	43.6	42.1	56.3	56.7	52.5	51.0	49.6
DE	104.0	42.8	43.6	44.8	46.0	104.0	102.4	103.2	104.4	105.6	104.0	162.0	162.8	164.0	165.2
DK	43.7	31.4	31.7	31.5	31.3	43.7	43.3	43.6	43.4	43.3	43.7	55.2	55.5	55.4	55.2
EE	8.9	6.3	6.4	6.4	6.5	8.9	8.1	8.2	8.2	8.3	8.9	9.9	10.0	10.1	10.1
ES	89.6	65.1	67.9	71.5	75.0	89.6	99.8	102.6	106.2	109.7	89.6	134.5	137.3	140.8	144.4
FI	3.7	0.8	0.8	1.0	1.2	3.7	3.7	3.6	3.8	4.0	3.7	6.5	6.5	6.7	6.9
FR	259.8	56.2	56.2	56.1	55.9	259.8	258.7	258.6	258.5	258.4	259.8	461.1	461.1	461.0	460.8
GR	7.1	2.4	2.5	2.8	3.1	7.1	7.0	7.1	7.4	7.7	7.1	11.5	11.6	11.9	12.2
HR	3.3	2.1	2.3	2.3	2.4	3.3	3.3	3.3	3.3	3.3	3.3	4.4	4.3	4.2	4.1
HU	72.2	53.9	52.8	53.9	54.9	72.2	62.6	61.5	62.6	63.7	72.2	71.3	70.2	71.3	72.4
IE	18.1	3.9	4.0	4.0	4.0	18.1	18.2	18.4	18.4	18.4	18.1	32.5	32.7	32.7	32.7
IS	0.3	0.1	0.0	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5
IT	118.2	59.5	58.6	56.8	55.1	118.2	120.0	119.1	117.3	115.6	118.2	180.5	179.5	177.8	176.1
LT	10.9	11.0	12.6	13.9	15.2	10.9	12.7	14.3	15.6	16.9	10.9	14.3	15.9	17.2	18.5
LU	1.5	-	-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	3.0	3.0	3.0	3.0
LV	7.3	5.4	5.9	6.2	6.4	7.3	7.4	7.9	8.2	8.5	7.3	9.4	10.0	10.2	10.5
ME	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
MK	0.8	0.5	0.5	0.5	0.5	0.8	0.8	0.8	0.8	0.8	0.8	1.1	1.1	1.1	1.1
MT	7.3	-	-	-	-	7.3	0.4	0.4	0.4	0.4	7.3	0.8	0.8	0.8	0.8
NL	49.3	25.7	25.8	25.8	25.7	49.3	48.7	48.9	48.8	48.8	49.3	71.8	72.0	71.9	71.9
NO	3.3	1.1	1.0	0.1	0.1	3.3	3.2	3.1	3.2	3.3	3.3	5.3	5.3	5.4	5.5

MINBIOGAS 1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	66.2	48.5	56.2	64.4	72.6	66.2	70.3	78.0	86.2	94.4	66.2	92.0	99.8	107.9	116.1
PT	21.7	10.6	11.2	11.9	12.6	21.7	21.6	22.1	22.9	23.6	21.7	32.6	33.1	33.8	34.6
RO	21.9	17.0	17.9	16.6	15.4	21.9	22.8	23.6	22.4	21.1	21.9	28.5	29.4	28.1	26.9
RS	10.5	8.8	9.1	9.0	9.0	10.5	10.5	10.5	10.5	10.5	10.5	12.1	11.8	11.9	11.9
SE	17.6	5.2	4.9	5.2	5.5	17.6	17.2	17.0	17.2	17.5	17.6	29.2	29.0	29.3	29.5
SI	1.5	0.8	0.9	0.8	0.8	1.5	1.5	1.5	1.5	1.5	1.5	2.2	2.2	2.2	2.2
SK	16.5	10.5	10.3	9.8	9.3	16.5	13.6	13.4	12.9	12.4	16.5	16.7	16.5	16.0	15.5
UK	160.0	66.8	68.5	70.0	71.5	160.0	157.1	158.8	160.3	161.8	160.0	247.4	249.1	250.6	252.1

Table 35 Primary agricultural residues biomass potential [PJ]

MINBIOAGR W1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
AL	1.2	1.2	1.2	1.2	1.3	1.2	1.4	1.5	1.6	1.7	1.2	2.1	2.5	2.8	3.3
AT	21.8	15.0	15.0	14.9	14.8	21.8	21.4	22.2	22.8	23.3	21.8	27.5	29.6	31.2	32.8
BE	7.4	4.1	3.8	3.7	3.6	7.4	6.9	6.9	7.0	7.1	7.4	9.9	10.0	10.5	11.0
BG	27.3	21.2	18.9	16.0	13.3	27.3	31.2	30.1	27.8	25.6	27.3	42.6	44.3	43.3	42.4
BH	2.3	2.0	1.9	1.9	1.9	2.3	2.8	2.8	2.9	3.1	2.3	4.1	4.5	5.2	6.1
CH	2.9	1.7	1.6	1.7	1.7	4.4	3.8	3.6	3.7	3.8	2.9	3.5	3.3	3.5	3.7
CY	0.3	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.6	1.1	1.2	1.3	1.5
CZ	36.8	26.0	25.6	24.2	23.0	36.8	37.5	37.6	36.6	35.5	43.2	60.8	62.5	62.3	61.8
DE	202.3	145.4	138.7	132.3	125.6	202.3	212.8	206.4	201.5	195.1	299.1	401.8	399.3	401.0	399.3
DK	29.0	15.5	13.8	11.8	9.9	29.0	27.2	25.9	23.9	22.0	31.4	42.5	42.3	39.7	36.9
EE	3.4	2.3	3.0	3.6	4.2	3.4	3.6	4.5	5.3	6.1	4.0	5.9	7.0	7.9	8.6
ES	79.6	66.2	64.5	61.1	57.9	79.6	91.3	93.0	91.1	89.4	114.9	210.3	232.0	243.2	264.6
FI	14.5	11.7	12.2	12.1	12.0	14.5	17.0	17.9	17.9	17.9	15.2	23.1	24.4	24.5	24.6
FR	211.8	147.2	133.7	120.1	108.3	211.8	225.2	215.7	203.2	190.8	268.5	415.0	428.4	418.0	406.0
GR	14.0	13.9	13.7	12.6	11.8	14.0	19.0	20.5	20.6	20.8	24.0	49.6	58.7	64.0	72.7
HR	9.9	5.8	4.5	3.8	3.4	9.9	9.7	9.0	8.0	7.5	16.5	24.2	25.8	26.8	28.2
HU	48.2	33.2	29.1	26.3	23.5	48.2	50.1	47.8	47.2	46.7	69.5	108.5	114.5	120.5	126.5
IE	0.2	0.2	0.2	0.2	0.1	0.2	0.4	0.3	0.2	0.2	0.5	0.9	0.9	0.7	0.5
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	61.7	46.1	42.1	38.5	35.4	61.7	64.3	63.3	62.1	60.8	100.9	160.0	173.7	179.9	190.0
LT	14.8	9.6	8.7	10.1	11.7	14.8	14.3	13.5	15.6	17.8	16.2	22.2	22.3	24.5	26.5
LU	0.4	0.2	0.1	0.1	0.1	0.4	0.3	0.3	0.4	0.4	0.5	1.0	0.9	0.9	1.0
LV	7.0	5.8	5.4	4.9	4.5	7.0	8.4	7.9	7.4	6.9	7.5	12.2	11.9	11.0	10.1
ME	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.4	0.5	0.6
MK	1.5	0.7	0.7	0.7	0.7	1.5	1.4	1.5	1.6	1.7	2.1	3.6	4.1	4.7	5.5
MT	6.9	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0
NL	5.7	3.5	3.4	3.5	3.6	5.7	5.3	5.3	5.7	6.2	9.3	11.1	11.9	14.2	16.7
NO	5.9	3.4	3.1	3.1	3.1	5.9	5.1	4.7	4.8	4.9	5.9	6.9	6.5	6.6	6.7

MINBIOAGRW1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	103.2	68.4	57.0	50.1	43.8	103.2	102.7	88.5	79.8	71.3	103.2	139.0	124.4	114.2	103.9
PT	5.8	6.1	6.7	6.1	5.5	5.8	7.2	8.2	7.9	7.5	5.8	10.1	12.7	13.0	13.9
RO	57.0	34.2	33.1	31.9	31.5	57.0	54.6	57.4	59.6	61.8	57.0	80.3	88.9	95.6	102.3
RS	19.9	12.8	12.4	14.1	15.7	19.9	22.1	23.4	27.7	32.0	19.9	34.0	38.3	46.3	54.6
SE	20.1	11.6	10.8	10.8	10.7	20.1	17.4	16.4	16.7	17.1	20.1	23.3	22.4	23.1	23.9
SI	0.8	0.7	0.6	0.5	0.5	0.8	1.0	0.9	0.9	0.9	0.8	1.5	1.5	1.6	1.6
SK	13.4	10.0	8.7	8.0	7.3	13.4	14.7	13.6	13.2	12.8	13.4	19.8	19.4	19.5	19.7
UK	71.3	40.4	42.0	39.0	35.8	71.3	64.1	69.5	67.2	64.7	71.3	89.9	100.6	99.8	98.8

Table 36 Roundwood fuelwood biomass potential [PJ]

MINBIOWOO	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
AL	1.3	1.2	1.1	1.1	1.1	1.3	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.5
AT	11.1	11.1	10.9	11.0	11.4	11.1	11.3	11.6	12.1	13.1	11.1	12.4	13.1	14.2	15.7
BE	1.5	1.5	1.5	1.5	1.7	1.5	1.5	1.6	1.7	1.9	1.5	1.7	1.8	2.0	2.3
BG	3.1	3.2	3.2	3.6	3.6	3.1	3.3	3.4	4.0	4.1	3.1	3.6	3.8	4.6	5.0
BH	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.3	5.5	5.7	5.0	5.6	6.0	6.5	6.9
CH	2.8	2.5	2.5	2.6	2.8	2.8	2.6	2.6	2.8	3.2	2.8	2.8	3.0	3.3	3.9
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	4.5	4.3	4.3	4.3	4.2	4.5	4.4	4.6	4.7	4.8	4.5	4.9	5.2	5.5	5.8
DE	17.4	17.5	16.9	16.6	18.4	17.4	17.9	18.0	18.4	21.2	17.4	19.6	20.4	21.5	25.5
DK	2.3	2.0	2.2	3.0	3.3	2.3	2.0	2.3	3.3	3.8	2.3	2.2	2.6	3.9	4.6
EE	4.3	4.1	4.0	3.8	3.9	4.3	4.2	4.3	4.2	4.4	4.3	4.6	4.8	4.9	5.3
ES	8.0	7.9	7.9	8.1	8.9	8.0	8.0	8.4	9.0	10.3	8.0	8.8	9.5	10.5	12.3
FI	10.6	10.7	10.3	9.7	11.2	10.6	10.9	11.0	10.8	12.9	10.6	12.0	12.5	12.6	15.5
FR	83.7	76.8	81.5	82.4	89.0	83.7	78.5	86.7	91.2	102.2	83.7	86.1	98.5	106.8	123.0
GR	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.6	2.7	2.8	2.4	2.7	3.0	3.2	3.4
HR	3.5	3.6	3.5	3.4	3.3	3.5	3.7	3.7	3.8	3.8	3.5	4.0	4.2	4.4	4.6
HU	7.2	7.3	6.8	7.4	8.0	7.2	7.4	7.2	8.2	9.2	7.2	8.2	8.2	9.6	11.1
IE	0.4	0.5	0.5	0.8	0.8	0.4	0.5	0.6	0.9	0.9	0.4	0.5	0.6	1.0	1.1
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	15.0	14.3	14.4	14.6	14.5	15.0	14.6	15.3	16.1	16.7	15.0	16.0	17.3	18.9	20.1
LT	3.8	3.6	3.8	3.8	4.0	3.8	3.7	4.0	4.2	4.6	3.8	4.0	4.6	4.9	5.6
LU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
LV	5.1	4.8	5.6	5.9	6.0	5.1	4.9	5.9	6.6	6.9	5.1	5.4	6.7	7.7	8.3
ME	0.8	0.8	2.3	2.4	2.3	0.8	0.8	2.5	2.6	2.7	0.8	0.9	2.8	3.1	3.2
MK	4.0	4.0	3.9	3.9	3.9	4.0	4.0	4.2	4.4	4.5	4.0	4.4	4.8	5.1	5.5
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	0.7	0.7	0.7	0.9	1.0	0.7	0.7	0.8	1.0	1.1	0.7	0.8	0.9	1.2	1.3
NO	5.2	5.1	5.1	5.0	5.0	5.2	5.2	5.4	5.6	5.7	5.2	5.7	6.2	6.5	6.9

MINBIOWOO	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	8.1	7.8	7.5	8.1	8.3	8.1	7.9	7.9	9.0	9.5	8.1	8.7	9.0	10.5	11.5
PT	0.8	0.8	0.9	0.9	1.1	0.8	0.8	1.0	0.9	1.2	0.8	0.9	1.1	1.1	1.5
RO	6.2	6.3	6.0	6.2	6.4	6.2	6.4	6.4	6.8	7.3	6.2	7.0	7.2	8.0	8.8
RS	27.3	22.2	20.7	20.1	19.5	27.3	22.7	22.1	22.2	22.4	27.3	24.9	25.0	26.0	27.0
SE	14.0	13.8	14.5	15.1	14.9	14.0	14.1	15.4	16.7	17.1	14.0	15.5	17.5	19.6	20.5
SI	2.6	2.6	2.5	2.3	2.3	2.6	2.6	2.6	2.6	2.7	2.6	2.9	3.0	3.0	3.2
SK	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	1.0	1.1	1.1	1.2
UK	3.1	3.1	3.4	3.7	3.9	3.1	3.2	3.6	4.1	4.5	3.1	3.5	4.1	4.8	5.4

Table 37 Roundwood Chips & Pellets biomass potential [PJ]

MINBIOWOOa	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	4.7	4.4	3.9	3.9	3.9	4.7	4.5	4.2	4.3	4.4	4.7	4.9	4.8	5.0	5.3
AT	93.5	92.8	91.2	91.9	95.5	93.5	94.8	97.0	101.7	109.7	93.5	104.0	110.2	119.0	132.0
BE	14.5	14.3	14.0	14.6	15.9	14.5	14.6	14.9	16.1	18.2	14.5	16.0	16.9	18.9	21.9
BG	22.5	22.9	22.5	25.6	25.6	22.5	23.4	24.0	28.3	29.4	22.5	25.7	27.2	33.1	35.4
BH	12.2	12.2	12.2	12.2	12.2	12.2	12.5	13.0	13.5	14.0	12.2	13.7	14.8	15.8	16.9
CH	34.0	30.8	30.4	31.6	34.3	34.0	31.4	32.3	34.9	39.4	34.0	34.5	36.7	40.9	47.4
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	65.0	63.4	62.9	62.1	61.4	65.0	64.8	67.0	68.7	70.6	65.0	71.1	76.0	80.4	84.9
DE	273.0	275.4	265.8	261.6	289.7	273.0	281.3	282.9	289.4	332.8	273.0	308.7	321.2	338.8	400.4
DK	8.9	7.8	8.4	11.7	13.0	8.9	8.0	9.0	12.9	14.9	8.9	8.8	10.2	15.1	17.9
EE	35.5	34.6	33.4	31.8	32.2	35.5	35.3	35.5	35.2	37.0	35.5	38.7	40.3	41.3	44.5
ES	66.4	65.5	65.5	67.7	74.5	66.4	66.9	69.7	74.9	85.6	66.4	73.4	79.2	87.7	103.0
FI	159.2	160.4	155.5	146.2	168.5	159.2	163.8	165.4	161.8	193.6	159.2	179.8	187.8	189.4	232.9
FR	227.8	209.1	221.9	224.3	242.1	227.8	213.6	236.1	248.2	278.1	227.8	234.4	268.1	290.5	334.6
GR	10.4	10.4	10.4	10.4	10.4	10.4	10.7	11.1	11.5	12.0	10.4	11.7	12.6	13.5	14.4
HR	19.6	19.8	19.4	18.9	18.4	19.6	20.0	20.6	20.9	21.1	19.6	22.2	23.4	24.5	25.4
HU	30.5	30.7	28.6	31.4	33.9	30.5	31.4	30.4	34.7	39.0	30.5	34.4	34.6	40.6	46.9
IE	10.0	11.6	13.3	19.3	20.0	10.0	11.8	14.2	21.4	23.0	10.0	13.0	16.1	25.0	27.7
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	87.9	84.1	84.4	85.7	85.4	87.9	85.9	89.8	94.8	98.1	87.9	94.3	102.0	110.9	118.1
LT	25.2	23.5	24.8	24.9	26.4	25.2	24.0	26.3	27.6	30.4	25.2	26.3	29.9	32.3	36.5
LU	3.4	3.1	2.9	2.7	2.6	3.4	3.2	3.0	2.9	3.0	3.4	3.5	3.5	3.4	3.6
LV	46.7	43.6	50.7	54.0	54.7	46.7	44.5	54.0	59.7	62.9	46.7	48.8	61.3	69.9	75.7
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.7	2.8	2.9	2.5	2.8	3.1	3.3	3.5
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	4.3	4.0	4.3	5.3	5.7	4.3	4.1	4.6	5.9	6.5	4.3	4.5	5.2	6.9	7.9
NO	60.1	58.9	59.0	58.2	57.2	60.1	60.2	62.8	64.4	65.7	60.1	66.0	71.3	75.4	79.1

MINBIOWOOa	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	164.8	158.9	152.7	166.2	169.8	164.8	162.3	162.4	183.9	195.1	164.8	178.2	184.5	215.2	234.8
PT	31.6	30.2	34.3	32.4	40.0	31.6	30.8	36.5	35.8	45.9	31.6	33.8	41.5	41.9	55.3
RO	101.9	102.5	98.1	101.0	104.4	101.9	104.7	104.4	111.7	120.0	101.9	114.9	118.5	130.8	144.3
RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE	271.1	267.2	280.2	292.8	287.6	271.1	273.0	298.1	324.0	330.5	271.1	299.6	338.5	379.3	397.6
SI	31.1	30.6	29.6	27.9	28.0	31.1	31.2	31.5	30.9	32.2	31.1	34.3	35.7	36.1	38.7
SK	32.4	31.5	31.5	30.6	31.0	32.4	32.2	33.5	33.9	35.6	32.4	35.3	38.0	39.6	42.8
UK	43.4	42.9	47.2	50.9	53.6	43.4	43.9	50.2	56.3	61.6	43.4	48.1	57.1	65.9	74.1

Table 38 Forestry energy residue biomass potential [PJ]

MINBIOFRS R1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	7.6	3.6	2.4	2.4	1.2	7.6	6.0	4.8	4.8	4.8	7.6	14.9	14.4	14.5	14.7
AT	180.2	57.0	37.1	37.4	19.5	180.2	95.0	74.1	74.8	77.9	180.2	227.0	223.3	223.8	232.1
BE	37.1	11.1	7.4	7.8	4.1	37.1	18.5	14.8	15.5	16.3	37.1	42.4	42.1	44.6	47.5
BG	142.2	50.9	22.7	20.2	9.3	142.2	84.9	45.3	40.5	37.2	142.2	190.3	133.2	125.4	118.1
BH	14.9	4.5	3.0	3.0	1.5	14.9	7.5	6.0	6.0	6.0	14.9	36.9	36.9	36.9	36.9
CH	103.6	33.5	21.1	20.3	10.1	103.6	55.8	42.2	40.5	40.3	103.6	122.1	115.8	112.8	114.0
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	135.7	42.6	25.8	25.7	12.5	135.7	71.0	51.6	51.4	49.9	135.7	166.4	153.3	152.9	149.3
DE	785.2	237.4	150.1	140.3	75.8	785.2	395.6	300.2	280.7	303.3	785.2	905.5	862.7	814.5	877.4
DK	26.3	11.5	7.6	8.9	4.7	26.3	19.2	15.2	17.8	18.8	26.3	41.8	41.8	49.7	53.2
EE	82.7	24.9	15.8	14.9	7.5	82.7	41.5	31.5	29.8	29.9	82.7	103.2	98.2	93.0	93.3
ES	265.9	86.7	50.5	48.3	24.0	265.9	144.4	100.9	96.7	96.0	265.9	344.7	308.0	305.9	306.7
FI	358.6	115.6	74.5	63.1	34.7	358.6	192.6	149.0	126.2	138.6	358.6	463.6	447.6	394.5	432.9
FR	430.8	116.2	79.6	78.8	42.0	430.8	193.7	159.2	157.6	168.1	430.8	530.0	559.0	563.6	594.9
GR	18.1	5.4	3.9	4.0	2.0	18.1	9.1	7.8	8.0	8.1	18.1	37.3	38.6	39.2	39.4
HR	37.0	13.1	8.4	8.0	3.9	37.0	21.8	16.7	15.9	15.7	37.0	55.7	53.7	51.8	51.3
HU	91.2	33.5	22.4	24.6	12.8	91.2	55.9	44.9	49.2	51.3	91.2	138.6	136.3	149.3	156.9
IE	19.7	6.2	4.7	7.1	3.7	19.7	10.4	9.3	14.1	14.6	19.7	26.5	29.2	42.1	43.5
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	187.6	80.9	54.0	54.8	31.1	187.6	134.9	108.0	109.7	124.2	187.6	327.8	327.5	331.7	367.5
LT	69.5	20.8	14.6	14.2	7.1	69.5	34.7	29.2	28.3	28.4	69.5	84.9	88.5	86.7	88.0
LU	5.6	1.8	1.1	1.0	0.5	5.6	2.9	2.1	2.0	1.9	5.6	7.0	6.4	5.9	5.7
LV	105.3	35.3	24.8	26.4	13.0	105.3	58.8	49.7	52.7	51.9	105.3	140.4	149.1	158.3	156.2
ME	1.0	0.3	0.5	0.5	0.2	1.0	0.5	1.0	1.0	1.0	1.0	2.2	5.7	5.9	5.7
MK	0.1	1.6	1.1	1.1	0.5	0.1	2.7	2.2	2.2	2.2	0.1	14.3	14.3	14.3	14.3
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	9.3	3.6	2.5	3.1	1.7	9.3	6.0	5.0	6.3	6.9	9.3	14.3	15.0	18.7	20.4
NO	105.2	34.2	22.7	22.0	10.7	105.2	57.1	45.4	44.0	42.8	105.2	145.2	144.4	140.6	136.6

MINBIOFRS R1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	430.0	137.0	85.9	91.0	44.8	430.0	228.4	171.7	182.1	179.4	430.0	534.5	499.7	532.5	531.6
PT	126.8	32.0	23.8	24.3	13.9	126.8	53.4	47.7	48.6	55.6	126.8	135.6	151.9	151.4	174.8
RO	230.9	91.7	61.8	62.9	32.7	230.9	152.8	123.6	125.8	130.9	230.9	355.7	355.4	363.3	379.1
RS	19.3	4.9	3.1	3.0	1.5	19.3	8.2	6.1	6.0	5.8	19.3	31.5	29.6	28.7	27.9
SE	484.1	149.0	99.8	98.4	45.3	484.1	248.4	199.5	196.9	181.1	484.1	624.8	642.1	647.0	614.3
SI	71.7	27.6	18.0	17.0	8.2	71.7	46.0	36.0	34.0	32.7	71.7	104.8	103.1	97.9	95.6
SK	105.4	28.2	18.2	16.8	8.0	105.4	47.0	36.3	33.5	31.9	105.4	109.3	106.7	100.0	96.4
UK	93.3	14.3	9.0	9.4	4.9	93.3	23.8	18.0	18.7	19.4	93.3	56.5	54.6	58.2	61.6

Table 39 Secondary forestry residues – woodchips biomass potential [PJ]

MINBIOWOOW1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	4.1	1.6	1.3	1.3	0.7	4.1	2.6	2.7	2.7	2.7	4.1	5.2	6.6	6.6	6.6
AT	42.1	14.0	10.3	8.4	4.2	42.1	23.3	20.6	16.9	16.9	42.1	46.6	51.4	42.2	42.2
BE	8.4	8.0	5.3	5.3	2.7	8.4	13.4	10.7	10.7	10.7	8.4	26.7	26.7	26.7	26.7
BG	4.0	1.5	1.4	0.8	0.4	4.0	2.5	2.7	1.6	1.6	4.0	5.0	6.8	4.0	4.0
BH	10.9	4.2	3.5	3.5	1.8	10.9	7.0	7.1	7.1	7.1	10.9	14.0	17.7	17.7	17.7
CH	32.7	9.7	6.5	6.5	3.6	32.7	16.1	13.0	12.9	14.3	32.7	32.3	32.5	32.3	35.8
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	36.5	12.1	9.6	7.3	3.6	36.5	20.1	19.3	14.6	14.6	36.5	40.2	48.2	36.5	36.5
DE	98.9	35.1	27.6	20.5	10.3	98.9	58.5	55.2	41.0	41.0	98.9	116.9	138.0	102.6	102.6
DK	1.4	0.4	0.4	0.4	0.2	1.4	0.7	0.7	0.7	0.7	1.4	1.4	1.8	1.8	1.8
EE	8.8	1.8	1.0	-	-	8.8	3.0	2.0	-	-	8.8	6.0	5.0	-	-
ES	23.8	8.3	6.3	6.3	3.1	23.8	13.8	12.6	12.6	12.6	23.8	27.6	31.5	31.5	31.5
FI	65.9	21.9	15.9	15.9	8.0	65.9	36.6	31.9	31.9	31.9	65.9	73.1	79.7	79.7	79.7
FR	46.9	15.0	10.9	10.9	5.5	46.9	25.1	21.8	21.8	21.8	46.9	50.2	54.5	54.5	54.5
GR	2.1	0.8	0.7	0.7	0.4	2.1	1.4	1.4	1.4	1.4	2.1	2.8	3.5	3.5	3.5
HR	-	0.3	0.3	0.3	0.1	-	0.5	0.5	0.5	0.5	-	1.0	1.3	1.3	1.3
HU	2.2	1.0	0.9	0.9	0.4	2.2	1.6	1.7	1.7	1.7	2.2	3.2	4.3	4.3	4.3
IE	5.9	2.1	1.7	1.7	0.8	5.9	3.5	3.3	3.3	3.3	5.9	6.9	8.4	8.4	8.4
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	18.1	6.4	4.9	4.9	2.4	18.1	10.6	9.8	9.8	9.8	18.1	21.2	24.4	24.4	24.4
LT	6.6	2.4	1.8	1.8	0.9	6.6	4.0	3.5	3.6	3.8	6.6	8.1	8.8	8.9	9.4
LU	1.8	0.5	0.4	0.3	0.2	1.8	0.9	0.7	0.7	0.6	1.8	1.8	1.8	1.6	1.6
LV	17.0	6.4	5.2	5.6	2.8	17.0	10.7	10.5	11.1	11.3	17.0	21.4	26.2	27.9	28.3
ME	27.2	10.5	8.8	8.8	4.4	27.2	17.5	17.7	17.7	17.7	27.2	34.9	44.2	44.2	44.3
MK	4.8	1.8	1.5	1.5	0.8	4.8	3.1	3.1	3.1	3.1	4.8	6.1	7.7	7.7	7.7
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	0.8	0.2	0.3	0.3	0.1	0.8	0.4	0.6	0.6	0.6	0.8	0.8	1.5	1.5	1.5
NO	61.5	19.7	13.4	12.7	6.4	61.5	32.9	26.9	25.4	25.4	61.5	65.7	67.2	63.4	63.5

MINBIOWOOW1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	27.8	9.7	8.0	8.0	4.0	27.8	16.2	16.1	16.1	16.1	27.8	32.4	40.1	40.1	40.1
PT	6.6	2.6	2.2	2.2	1.1	6.6	4.4	4.4	4.4	4.4	6.6	8.8	11.0	11.0	11.0
RO	34.0	13.1	11.1	11.1	5.5	34.0	21.8	22.1	22.1	22.1	34.0	43.7	55.3	55.3	55.3
RS	25.9	10.0	8.4	8.4	4.2	25.9	16.6	16.8	16.8	16.8	25.9	33.2	42.0	42.0	42.0
SE	165.0	53.3	38.1	38.0	19.0	165.0	88.8	76.1	76.0	76.1	165.0	177.6	190.3	190.1	190.2
SI	3.7	1.4	1.2	1.2	0.6	3.7	2.4	2.5	2.5	2.5	3.7	4.8	6.2	6.2	6.2
SK	9.4	3.3	2.9	2.9	1.4	9.4	5.5	5.7	5.7	5.7	9.4	10.9	14.3	14.3	14.3
UK	18.8	6.1	4.3	4.3	2.1	18.8	10.1	8.5	8.5	8.5	18.8	20.3	21.4	21.4	21.3

Table 40 Secondary Forestry residues – sawdust biomass potential [PJ]

MINBIOW OOW1a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	1.4	0.5	0.4	0.4	0.2	1.4	0.9	0.9	0.9	0.9	1.4	1.8	2.2	2.2	2.2
AT	15.4	5.1	3.7	3.1	1.5	15.4	8.5	7.4	6.2	6.2	15.4	17.1	18.5	15.4	15.4
BE	1.8	4.0	2.7	2.7	1.3	1.8	6.6	5.3	5.3	5.3	1.8	13.3	13.3	13.3	13.3
BG	1.1	0.4	0.3	0.2	0.1	1.1	0.7	0.6	0.4	0.4	1.1	1.3	1.6	1.1	1.1
BH	3.7	1.4	1.1	1.1	0.6	3.7	2.3	2.3	2.3	2.3	3.7	4.7	5.7	5.7	5.7
CH	15.1	4.4	3.0	3.0	1.6	15.1	7.4	6.0	5.9	6.5	15.1	14.8	14.9	14.8	16.4
CY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CZ	13.0	4.3	3.3	2.6	1.3	13.0	7.2	6.6	5.2	5.2	13.0	14.3	16.4	13.0	13.0
DE	26.7	9.7	7.8	5.5	2.8	26.7	16.2	15.5	11.1	11.1	26.7	32.4	38.8	27.6	27.6
DK	0.4	0.1	0.1	0.1	0.1	0.4	0.2	0.3	0.3	0.3	0.4	0.4	0.7	0.7	0.7
EE	3.5	0.8	0.5	-	-	3.5	1.3	1.0	-	-	3.5	2.5	2.5	-	-
ES	5.5	1.7	1.2	1.2	0.5	5.5	2.8	2.4	2.4	2.4	5.5	5.7	5.9	5.9	5.9
FI	28.8	9.3	6.6	6.6	3.3	28.8	15.5	13.3	13.3	13.3	28.8	31.0	33.2	33.2	33.2
FR	14.2	4.4	3.1	3.1	1.6	14.2	7.4	6.2	6.2	6.2	14.2	14.8	15.6	15.6	15.6
GR	0.4	0.1	0.1	0.1	0.0	0.4	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4
HR	-	0.1	0.1	0.1	0.0	-	0.2	0.2	0.2	0.2	-	0.3	0.4	0.4	0.4
HU	0.4	0.2	0.2	0.2	0.1	0.4	0.3	0.3	0.3	0.3	0.4	0.6	0.8	0.8	0.8
IE	2.2	0.7	0.6	0.6	0.3	2.2	1.2	1.2	1.2	1.2	2.2	2.4	2.9	2.9	2.9
IS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IT	2.3	0.8	0.5	0.5	0.3	2.3	1.3	1.1	1.1	1.1	2.3	2.5	2.7	2.7	2.7
LT	2.7	0.9	0.7	0.7	0.4	2.7	1.6	1.4	1.4	1.5	2.7	3.1	3.5	3.6	3.8
LU	0.2	0.1	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
LV	7.5	2.8	2.3	2.4	1.2	7.5	4.7	4.5	4.8	4.9	7.5	9.3	11.3	12.0	12.2
ME	9.3	3.5	2.9	2.9	1.4	9.3	5.8	5.7	5.7	5.7	9.3	11.7	14.4	14.4	14.4
MK	1.6	0.6	0.5	0.5	0.3	1.6	1.0	1.0	1.0	1.0	1.6	2.0	2.5	2.5	2.5
MT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL	0.4	0.1	0.1	0.1	0.0	0.4	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4
NO	28.4	9.1	6.1	5.8	2.9	28.4	15.1	12.3	11.6	11.6	28.4	30.2	30.7	29.0	29.0

MINBIOW OOW1a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	5.1	1.6	1.2	1.2	0.6	5.1	2.6	2.4	2.4	2.4	5.1	5.3	6.1	6.1	6.1
PT	1.6	0.6	0.5	0.5	0.2	1.6	1.0	1.0	1.0	1.0	1.6	2.0	2.4	2.4	2.4
RO	11.6	4.4	3.6	3.6	1.8	11.6	7.3	7.2	7.2	7.2	11.6	14.6	18.0	18.0	18.0
RS	8.8	3.3	2.7	2.7	1.4	8.8	5.5	5.5	5.5	5.5	8.8	11.1	13.6	13.6	13.7
SE	76.2	24.5	17.4	17.4	8.7	76.2	40.8	34.8	34.8	34.8	76.2	81.6	87.0	86.9	86.9
SI	0.8	0.3	0.3	0.3	0.1	0.8	0.5	0.6	0.6	0.6	0.8	1.0	1.4	1.4	1.4
SK	3.0	1.0	0.9	0.9	0.4	3.0	1.7	1.8	1.8	1.8	3.0	3.4	4.4	4.4	4.4
UK	6.1	2.0	1.3	1.3	0.7	6.1	3.3	2.7	2.7	2.7	6.1	6.5	6.7	6.7	6.7

Table 41 Forestry residues from landscape care biomass potential [PJ]

MINBIOFRS R1a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
AL	4.2	1.5	1.3	1.3	0.6	4.2	2.4	2.5	2.5	2.5	4.2	4.8	6.3	6.3	6.3
AT	7.5	2.7	2.3	1.5	0.8	7.5	4.4	4.6	3.0	3.0	7.5	8.9	11.6	7.5	7.5
BE	4.1	4.3	2.9	2.9	1.4	4.1	7.2	5.7	5.7	5.7	4.1	14.3	14.3	14.3	14.3
BG	8.9	2.9	2.5	1.8	0.9	8.9	4.8	5.1	3.6	3.6	8.9	9.6	12.7	8.9	8.9
BH	7.8	2.7	2.3	2.3	1.2	7.8	4.4	4.6	4.6	4.6	7.8	8.9	11.5	11.5	11.5
CH	3.7	1.3	1.1	0.7	0.4	3.7	2.2	2.3	1.5	1.5	3.7	4.4	5.7	3.7	3.7
CY	0.7	0.2	0.2	0.2	0.1	-	-	-	-	-	-	-	-	-	-
CZ	17.7	6.1	5.3	3.5	1.8	17.7	10.2	10.5	7.1	7.1	17.7	20.5	26.3	17.7	17.7
DE	33.5	11.3	9.9	6.7	3.3	33.5	18.8	19.9	13.4	13.4	33.5	37.6	49.7	33.5	33.5
DK	4.8	1.6	1.5	1.5	0.7	4.8	2.7	3.0	3.0	3.0	4.8	5.5	7.4	7.4	7.4
EE	2.7	2.9	1.1	-	-	2.7	4.9	2.2	-	-	2.7	9.7	5.5	-	-
ES	43.0	14.6	12.7	12.7	6.3	43.0	24.3	25.4	25.4	25.4	43.0	48.5	63.5	63.5	63.5
FI	14.3	4.9	4.3	4.3	2.2	14.3	8.2	8.6	8.6	8.6	14.3	16.4	21.6	21.6	21.6
FR	86.1	29.1	25.5	25.5	12.8	86.1	48.5	51.0	51.0	51.0	86.1	97.0	127.6	127.6	127.6
GR	10.2	3.5	3.1	3.1	1.6	10.2	5.8	6.2	6.2	6.2	10.2	11.6	15.6	15.6	15.6
HR	3.2	1.1	1.0	1.0	0.5	3.2	1.8	2.0	2.0	2.0	3.2	3.6	4.9	4.9	4.9
HU	9.6	3.3	2.9	2.9	1.4	9.6	5.5	5.8	5.8	5.8	9.6	10.9	14.4	14.4	14.4
IE	7.5	2.5	2.2	2.2	1.1	7.5	4.1	4.4	4.4	4.4	7.5	8.2	11.0	11.0	11.0
IS	-	-	-	-	-	-	-	-	-	-	4.8	5.5	7.1	7.1	7.1
IT	22.5	7.6	6.8	6.8	3.4	22.5	12.6	13.7	13.7	13.7	22.5	25.3	34.1	34.1	34.1
LT	6.1	2.0	1.8	1.8	1.0	6.1	3.4	3.6	3.7	3.9	6.1	6.8	9.1	9.2	9.7
LU	-	-	0.1	0.1	0.0	-	-	0.1	0.1	0.1	-	-	0.3	0.3	0.3
LV	5.5	1.8	1.7	1.8	0.9	5.5	3.1	3.3	3.5	3.6	5.5	6.1	8.3	8.8	8.9
ME	2.1	0.7	0.6	0.6	0.3	2.1	1.2	1.3	1.3	1.3	2.1	2.4	3.1	3.1	3.1
MK	9.5	3.3	2.8	2.8	1.4	9.5	5.4	5.6	5.6	5.6	9.5	10.9	14.1	14.1	14.1
MT	-	-	0.0	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.1	0.1	0.1
NL	4.8	1.4	1.3	1.3	0.7	4.8	2.4	2.6	2.6	2.6	4.8	4.8	6.6	6.6	6.6
NO	43.0	14.7	12.7	12.7	6.4	43.0	24.5	25.4	25.4	25.4	43.0	49.0	63.6	63.5	63.6

MINBIOFRS R1a	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
PL	33.5	11.5	10.0	10.0	5.0	33.5	19.1	19.9	19.9	19.9	33.5	38.3	49.8	49.8	49.8
PT	9.6	3.3	2.8	2.8	1.4	9.6	5.5	5.6	5.6	5.6	9.6	10.9	13.9	13.9	13.9
RO	35.2	12.1	10.5	10.5	5.2	35.2	20.1	20.9	20.9	20.9	35.2	40.3	52.3	52.3	52.3
RS	13.4	4.6	4.0	4.0	2.0	13.4	7.7	7.9	7.9	7.9	13.4	15.3	19.9	19.9	19.9
SE	48.4	16.5	14.3	14.3	7.1	48.4	27.5	28.6	28.6	28.6	48.4	55.1	71.5	71.4	71.4
SI	1.4	0.4	0.3	0.3	0.2	1.4	0.7	0.7	0.7	0.7	1.4	1.4	1.7	1.7	1.7
SK	4.8	1.6	1.5	1.5	0.7	4.8	2.7	3.0	3.0	3.0	4.8	5.5	7.5	7.5	7.5
UK	24.6	8.4	7.3	7.3	3.6	24.6	14.0	14.5	14.5	14.5	24.6	28.0	36.3	36.3	36.3

Table 42 Municipal waste biomass potential [PJ]

MINBIOMUN1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	0.7	0.7	0.8	0.8	0.8	1.1	1.2	1.4	1.5	0.0	1.2	1.4	1.6	1.8	0.0
AT	5.5	5.3	5.5	5.7	5.9	5.5	6.2	7.7	9.0	10.5	5.5	7.3	9.1	11.0	13.2
BE	23.6	22.8	24.6	26.8	29.2	23.6	26.7	34.7	43.3	53.8	23.6	32.1	41.7	54.4	68.2
BG	2.0	2.2	2.3	2.5	2.6	2.0	2.5	2.9	3.3	3.8	2.0	2.8	3.2	3.7	4.2
BH	1.3	1.3	1.4	1.4	1.5	-	-	-	-	-	-	-	-	-	-
CH	17.2	17.3	18.7	20.0	21.2	17.2	20.2	24.0	28.1	31.9	17.2	23.5	28.0	33.5	38.8
CY	1.3	1.3	1.5	1.7	1.9	1.3	1.5	1.8	2.2	2.7	1.3	1.6	2.0	2.4	3.0
CZ	2.1	2.2	2.5	2.7	2.9	2.1	2.6	3.1	3.5	4.0	2.1	2.9	3.4	3.9	4.6
DE	101.9	89.7	85.7	80.9	76.4	101.9	104.9	114.7	123.1	131.7	101.9	125.1	136.8	152.5	168.9
DK	17.6	16.6	17.5	18.5	19.6	17.6	19.4	22.3	25.2	28.6	17.6	22.7	25.7	29.1	33.2
EE	1.6	1.8	2.2	2.4	2.6	1.6	2.2	2.7	3.1	3.6	1.6	2.6	3.2	3.8	4.6
ES	20.8	19.6	21.5	22.0	22.6	20.8	22.9	29.6	33.6	38.1	20.8	26.7	34.5	40.4	47.1
FI	8.1	8.0	8.6	9.3	10.0	8.1	9.4	11.8	14.5	17.0	8.1	11.2	14.1	18.1	22.0
FR	61.8	58.4	61.6	63.8	66.2	61.8	68.3	82.6	96.9	113.5	61.8	81.2	98.2	119.6	145.2
GR	2.3	2.0	2.1	2.2	2.3	2.3	2.3	2.7	3.0	3.4	2.3	2.6	3.0	3.4	3.9
HR	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.2
HU	6.7	6.1	6.6	6.8	7.0	6.7	7.2	9.0	10.5	12.1	6.7	8.4	10.7	12.8	15.3
IE	1.0	1.0	1.3	1.5	1.7	1.0	1.2	1.7	2.1	2.6	1.0	1.4	1.9	2.4	3.1
IS	0.7	0.7	0.8	0.8	0.8	0.7	0.8	1.0	1.1	1.2	0.7	1.0	1.1	1.3	1.5
IT	24.1	22.2	23.6	24.5	25.5	24.1	26.0	32.3	37.2	42.8	24.1	30.2	37.6	44.6	52.7
LT	0.8	0.9	1.0	1.0	1.1	0.8	1.0	1.2	1.4	1.7	0.8	1.1	1.4	1.6	1.9
LU	0.8	0.1	0.1	0.1	0.1	0.8	0.1	0.1	0.1	0.2	0.8	0.1	0.1	0.2	0.2
LV	0.4	0.5	0.6	0.6	0.6	0.4	0.6	0.7	0.8	0.9	0.4	0.6	0.8	0.9	1.0
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	0.4	0.4	0.5	0.7	0.9	0.4	0.5	0.7	1.0	1.3	0.4	0.6	0.8	1.1	1.6
MT	2.9	2.9	3.3	3.6	3.9	2.9	3.4	4.1	4.7	5.4	2.9	3.7	4.5	5.1	5.9
NL	38.2	36.0	36.5	36.9	37.3	38.2	42.1	50.3	58.5	67.9	38.2	50.9	60.7	73.8	89.4
NO	12.0	12.7	14.4	16.8	20.0	12.0	14.9	19.0	24.9	33.4	12.0	17.7	22.4	30.3	42.1

MINBIOMUN1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	14.4	16.5	18.4	19.4	20.3	14.4	19.3	24.2	28.3	33.0	14.4	22.3	28.1	33.8	40.5
PT	9.4	8.3	9.0	9.3	9.7	9.4	9.8	12.8	15.0	17.6	9.4	11.6	15.3	18.6	22.6
RO	5.8	6.1	6.4	6.6	6.7	5.8	7.1	8.2	9.1	10.2	5.8	8.1	9.3	10.5	11.8
RS	4.7	5.3	7.0	9.3	12.5	4.7	6.2	9.3	14.0	21.3	4.7	7.3	11.0	17.2	27.2
SE	20.6	20.0	21.1	22.1	23.1	20.6	23.4	27.1	30.9	34.7	20.6	27.3	31.6	36.8	42.2
SI	0.7	0.7	0.7	0.8	0.8	0.7	0.8	1.0	1.1	1.2	0.7	0.9	1.1	1.3	1.4
SK	2.3	2.4	2.9	2.9	3.0	2.3	2.9	3.9	4.5	5.1	2.3	3.3	4.6	5.4	6.3
UK	11.5	11.6	13.1	14.9	16.8	11.5	13.5	16.4	19.8	23.8	11.5	15.0	18.2	22.0	26.5

Table 43 Sludge biomass potential [PJ]

MINBIOSLU 1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
AL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0
AT	2.4	2.4	2.6	2.8	3.1	2.4	2.8	3.2	3.7	4.2	2.4	3.4	3.9	4.7	5.6
BE	8.0	7.9	8.7	9.7	10.8	8.0	9.2	11.8	15.2	19.5	8.0	11.1	14.2	19.2	25.7
BG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CH	0.8	0.9	1.0	1.1	1.2	0.8	1.0	1.3	1.7	2.2	0.8	1.2	1.6	2.2	2.9
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.7	0.3	0.4	0.5	0.7	0.9
DE	6.2	6.0	6.1	6.2	6.2	6.2	7.0	8.3	9.7	11.2	6.2	8.5	10.0	12.2	14.8
DK	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.2	0.2	0.3	0.4	0.5
EE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES	0.8	0.8	0.9	1.0	1.1	0.8	0.9	1.4	1.7	2.1	0.8	1.1	1.7	2.1	2.7
FI	2.2	2.1	2.2	2.4	2.5	2.2	2.5	3.0	3.6	4.1	2.2	3.0	3.7	4.6	5.4
FR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GR	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7	0.9
HR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1
HU	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0.2	0.3	0.4	0.5
IE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1
IT	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.2	0.2	0.3	0.4	0.5
LT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ME	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.4	0.4	0.5	0.2	0.3	0.4	0.6	0.7
NO	0.3	0.3	0.4	0.5	0.6	0.3	0.3	0.5	0.7	1.1	0.3	0.4	0.6	0.9	1.4

MINBIOSLU 1	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050	2010	2020	2030	2040	2050
PL	0.6	0.6	0.7	0.7	0.7	0.6	0.8	1.0	1.2	1.4	0.6	0.9	1.2	1.5	1.8
PT	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.6	0.7	0.9	0.4	0.5	0.7	0.9	1.1
RO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	1.0	1.0	1.1	1.2	1.3	1.0	1.2	1.5	1.9	2.4	1.0	1.4	1.8	2.4	3.2
SI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
SK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.3

Table 44 Import potentials for EU-28

	Low availability scenario					Medium availability scenario					High availability scenario				
	2010	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**	**2010**	**2020**	**2030**	**2040**	**2050**
Bioethanol (kt)	6574	6574	6574	6574	6574	6574	22789	22789	22789	22789	6574	6574	22789	50895	79001
Biodiesel (kt)	7013	7013	7013	7013	7013	7013	12182	12182	12182	12182	7013	7013	12182	16671	21160
Woody biomass (PJ)	283	283	283	283	283	283	283	517	517	517	283.0	283	517	731	944

Annex 7: Labour costs

The labour cost used for calculating the cost for cuttings and pruning from permanent crops, dedicated perennial crops and for calculating transport up- and off-load cost are presented in the underneath table, including sources.

Table 45 Labour cost for cuttings and pruning

	Final labour cost (FADN extrapolated to 2012 or minimum wage extrapolated)			Source
	Skilled	Unskilled	Average	
	€/h	€/h	€/h	
Belgium	16.8	9	12.9	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Bulgaria	7.2	2.6	4.9	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Czech Republic	7.9	3.4	5.7	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Denmark	32.7	19.6	26.1	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Germany	16.8	9.7	13.3	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Estonia	6.4	3.2	4.8	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Ireland	13.2	9.2	11.2	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Greece	10.9	6.1	8.5	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Spain	15.7	6	10.8	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
France	17.4	7.6	12.5	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Italy	16.3	9	12.7	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Cyprus	10.9	6.1	8.5	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Latvia	5.5	3.3	4.4	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Lithuania	5	3	4	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Luxembourg	15.6	10	12.8	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Hungary	5.4	3	4.2	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost

	Final labour cost (FADN extrapolated to 2012 or minimum wage extrapolated)			Source
	Skilled	Unskilled	Average	
	€/h	€/h	€/h	
				statistics data.
Malta	7.9	3.7	5.8	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Netherlands	20.2	12.8	16.5	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Austria	15.2	8.1	11.6	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Poland	8.8	3	5.9	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Portugal	4.8	3.7	4.2	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Romania	5.2	1.9	3.6	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Slovenia	7.5	3.3	5.4	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Slovakia	6.2	3.9	5.1	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Finland	15.4	8.2	11.8	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Sweden	16.2	8.7	12.4	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
United Kingdom	15.6	13	14.3	FADN, 2008. Extrapolated to 2012 labour levels with Eurostat labour cost statistics data.
Croatia*	5.9	3.3	4.6	Minimum wage: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00182
Albania*	2.5	1.4	1.9	Minimum wage: http://www.tradingeconomics.com/albania/minimum-wages
Bosnia and Herzegovina*	2.9	1.6	2.3	Minimum wage: http://www.state.gov/j/drl/rls/hrrpt/humanrightsreport/index.htm?year=2012&dlid=204268
Former Yugoslav Republic of Macedonia*	2.9	1.6	2.2	Minimum wage: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00166
Montenegro*	3.1	1.7	2.4	Minimum wage: http://www.poreskauprava.gov.me/vijesti/122181/OBAVJEsTENJE.html?alphabet=cyr
Serbia*	2.9	1.6	2.2	Minimum wage: http://www.state.gov/j/drl/rls/hrrpt/humanrightsreport/index.htm#wrapper

	Final labour cost (FADN extrapolated to 2012 or minimum wage extrapolated)			Source
	Skilled	**Unskilled**	**Average**	
	€/h	**€/h**	**€/h**	
Kosovo*	2.7	1.5	2.1	Minimum wage: http://mpms.rks-gov.net/News/PublicationNews/tabid/134/articleType/ArticleView/articleId/753/language/en-US/The-minimum-wage-for-2011-in-Kosovo-will-be-170-euros-at-the-national-level.aspx
Ukraine*	1.7	0.9	1.3	Minimum wage: http://mojazarplata.com.ua/ru/main/minimum-wage/faq-o-minimalqno-zarabotno-plate
Turkey*	6.6	3.7	5.2	Minimum wage: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00155
Moldova*	1.1	0.6	0.9	Minimum wage: http://www.state.gov/j/drl/rls/hrrpt/humanrightsreport/index.htm#wrapper

***Minimum wage is taken for unskilled labour cost level. For skilled cost level the factor expressing the average difference between skilled and unskilled labour in from FADN for EU-27 is used.**

Annex 8: Diesel price per country used in cost calculations

Table 46 Diesel price per country

Country	€/l diesel	Country	€/l diesel	Country	€/l diesel	Country	€/l diesel
Albania	1.34	Greece	1.38	Luxembourg	1.20	Serbia	1.31
Austria	1.33	Spain	1.34	Latvia	1.30	Sweden	1.56
Bosnia and Herzegovina	1.22	Finland	1.50	Moldova	0.98	Slovenia	1.39
Belgium	1.40	France	1.32	Montenegro	1.27	Slovakia	1.38
Bulgaria	1.36	Croatia	1.30	Macedonia	1.14	Turkey	1.61
Switzerland	1.20	Hungary	1.44	Malta	1.37	Ukraine	0.81
Cyprus	1.39	Ireland	1.48	Netherlands	1.43	United Kingdom	1.65
Czech Republic	1.31	Italy	1.67	Poland	1.30	Kosovo	1.19
Germany	1.38	Lithuania	1.29	Portugal	1.40		

Annex 9: Transport cost assessment model

Transport with trucks

The biomass supply costs were examined by a calculation model, which was developed at DBFZ based on (Brosowski 2012). It contains country-specific calculations for transport costs with trucks in three different supply chains. The following country-specific parameters were considered:

- Basic parameter: Labour costs; Diesel price; Lubrication; Price level for machinery
- Machinery costs: Fixed costs (Investment, Life span, Depreciation, Operating hours) and variable costs (Repairs, Fuel, Lubrication).

The labour costs, diesel-price, and the price level for machinery (Germany = 100%) are based on European statistics on labour (Eurostat[25]. See also Annex 7). The labour cost levels are mostly derived from FADN as these relate to cost for agricultural labour but where not available minimum wage levels derived from Eurostat and also other sources are used. The FADN labour cost are for 2008, but an extrapolation to 2012 labour levels was made using labour cost index levels calculated from the labour cost levels published by Eurostat on different years and for different sectors.

The costs for lubrication were set to 5€/litre in Germany. Based on a calculated index for diesel-prices, the lubrication costs for other countries were derived. For loading, unloading and transport the following machinery was selected. The figure also contains an overview of relevant performance characteristics.

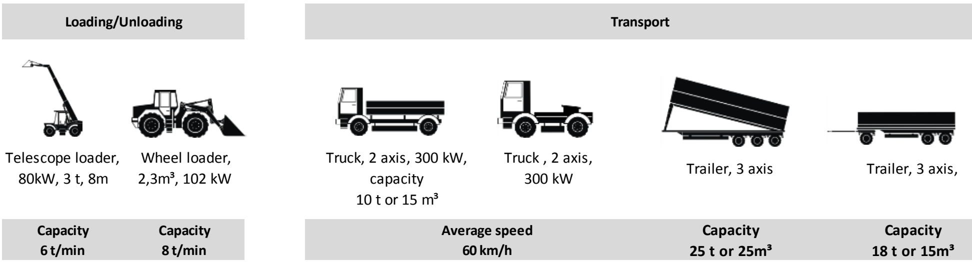


Figure 13 Loading and transport machinery asumptions

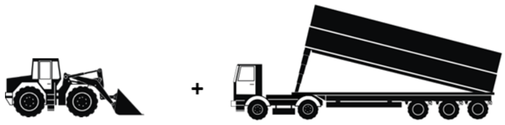
In a next step the machinery costs were determined. The calculations are based on KTBL[26]. This publication lists detailed costs for a high variety of different machines but only for Germany. The costs include fixed costs (investment, life span, depreciation, operating hours) and variable costs (taxes, insurance, repairs, fuel consumption and lubrication). A comparable source for other countries does not exist. That is why the German information was the starting point for further processing. In combination with determined country-specific price-level for machinery (see above) detailed machinery costs for all other countries were calculated. To elevate the level of detail the literature-based cost-information was also combined with country-specific diesel- and lubrication-prices. The determination results in highly detailed cost-information that is available in next section “Machinery costs” and summarized in €/hour including labour costs as specified in Annex 7.

Under application of the detailed cost information the following two different machinery combinations (supply chains) were chosen and calculated:

[25] http://ec.europa.eu/eurostat/en/web/products-statistical-books/-/RY_CH03_2011_Labour_cost, last accessed on 20 November 2015.

[26] KTBL, the ‘Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V’

Table 47 Transport supply chains modelled

Supply Chain	Elements
1	
2	

With regard to specific performance characteristics (see above) and in combination with country specific labour- and machinery-costs the total costs for the supply chain were assessed. In detail the following steps of procedure were taken into account:

Loading

- Time to load the trailer based on machinery's capacity
- Costs for involved machinery
- Waiting time truck driver

Transport

- Costs for trucks at an average speed about 60 km/h
- Costs for trailer based on a full load as costs per trip

Unloading

- Waiting time truck driver
- (Remark: machinery costs for unloading are already included in technology costs)

The results are finally presented from Table 48 to Table 54.

Table 48: Basic parameters – Transport costs

Country	ID	Labour costs (skilled)	Diesel price	Index diesel price	Lubrication (weighted with index diesel price)	Price-level machinery (EUROSTAT)
		€/h	€/l	%	€/l	%
Belgium	BE	16,85	1,44	107%	5,35	107%
Bulgaria	BG	7,20	1,36	101%	5,04	44%
Czech Republic	CZ	7,93	1,30	96%	4,81	68%
Denmark	DK	32,67	1,55	115%	5,74	132%
Germany	DE	16,79	1,35	100%	5,00	100%
Estonia	EE	6,39	1,34	99%	4,96	69%
Ireland	IE	13,24	1,48	110%	5,48	105%
Greece	EL	10,91	1,38	102%	5,10	86%
Spain	ES	15,69	1,34	99%	4,97	88%
France	FR	17,39	1,31	97%	4,87	108%
Italy	IT	16,26	1,69	125%	6,25	97%
Cyprus	CY	10,91	1,39	103%	5,13	85%
Latvia	LV	5,51	1,30	97%	4,83	65%
Lithuania	LT	4,97	1,29	95%	4,77	58%
Luxembourg	LU	15,60	1,20	89%	4,44	116%
Hungary	HU	5,35	1,46	108%	5,40	56%
Malta	MT	7,92	1,38	102%	5,11	72%
Netherlands	NL	20,19	1,46	108%	5,40	106%
Austria	AT	15,19	1,32	98%	4,89	106%
Poland	PL	8,79	1,30	96%	4,81	56%
Portugal	PT	4,78	1,43	106%	5,29	78%
Romania	RO	5,19	1,29	96%	4,79	47%
Slovenia	SI	7,52	1,39	103%	5,14	78%
Slovakia	SK	6,20	1,39	103%	5,16	66%
Finland	FI	15,37	1,49	110%	5,51	117%
Sweden	SE	16,23	1,56	115%	5,77	129%
United Kingdom	UK	15,57	1,66	123%	6,14	110%
Croatia	HR	5,94	1,29	96%	4,79	63%
Albania	AL	2,50	1,34	99%	4,97	43%
Bosnia and Herzegovina	BA	2,91	1,22	91%	4,53	47%
Macedonia	MK	2,88	1,14	85%	4,23	39%
Montenegro	ME	3,08	1,27	94%	4,70	47%
Serbia	RS	2,88	1,31	97%	4,86	44%
Kosovo	XK	2,71	1,19	88%	4,41	47%
Ukraine	UA	1,68	0,81	60%	3,01	47%
Turkey	TR	6,63	1,61	119%	5,97	57%
Moldova	MD	1,14	0,98	72%	3,62	47%
Switzerland	CH	15,19	1,32	98%	4,89	149%

Table 49: Machinery costs in transport 1

Telescope loader, 80kW, 3 t, 8m

ID	Invest-ment	Life span	Depri-ciation	Operating hours	Fixed costs		Variable costs					
							Repairs	Fuel		Lubrication		Sum
	€	h	a	h/a	€/a	€/h	€/h	l/h	€/h	l/h	€/h	€/h
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*KTBL*	*KTBL*	*calc.*	*calc.*	*calc.*	*calc.*
BE	86875	10000	12	833	8977	10,77	4,29	9,3	13,43	0,093	0,50	18,22
BG	35330	10000	12	833	3651	4,38	1,74	9,3	12,65	0,093	0,47	14,86
CZ	55149	10000	12	833	5699	6,84	2,72	9,3	12,09	0,093	0,45	15,26
DK	106929	10000	12	833	11049	13,26	5,28	9,3	14,41	0,093	0,53	20,22
DE	81000	10000	12	833	8370	10,04	4,00	9,3	12,56	0,093	0,47	17,02
EE	55932	10000	12	833	5780	6,94	2,76	9,3	12,45	0,093	0,46	15,68
IE	85074	10000	12	833	8791	10,55	4,20	9,3	13,75	0,093	0,51	18,47
EL	69955	10000	12	833	7229	8,67	3,45	9,3	12,82	0,093	0,47	16,74
ES	71443	10000	12	833	7382	8,86	3,53	9,3	12,48	0,093	0,46	16,47
FR	87737	10000	12	833	9066	10,88	4,33	9,3	12,22	0,093	0,45	17,01
IT	78650	10000	12	833	8127	9,75	3,88	9,3	15,69	0,093	0,58	20,15
CY	68779	10000	12	833	7107	8,53	3,40	9,3	12,89	0,093	0,48	16,76
LV	52329	10000	12	833	5407	6,49	2,58	9,3	12,12	0,093	0,45	15,15
LT	47237	10000	12	833	4881	5,86	2,33	9,3	11,97	0,093	0,44	14,75
LU	94239	10000	12	833	9738	11,69	4,65	9,3	11,14	0,093	0,41	16,21
HU	45044	10000	12	833	4654	5,59	2,22	9,3	13,56	0,093	0,50	16,29
MT	58439	10000	12	833	6039	7,25	2,89	9,3	12,83	0,093	0,48	16,20
NL	86092	10000	12	833	8896	10,68	4,25	9,3	13,57	0,093	0,50	18,32
AT	86092	10000	12	833	8896	10,68	4,25	9,3	12,28	0,093	0,45	16,98
PL	45279	10000	12	833	4679	5,61	2,24	9,3	12,09	0,093	0,45	14,77
PT	63139	10000	12	833	6524	7,83	3,12	9,3	13,29	0,093	0,49	16,90
RO	37915	10000	12	833	3918	4,70	1,87	9,3	12,02	0,093	0,45	14,33
SI	62904	10000	12	833	6500	7,80	3,11	9,3	12,90	0,093	0,48	16,48
SK	53112	10000	12	833	5488	6,59	2,62	9,3	12,95	0,093	0,48	16,05
FI	94631	10000	12	833	9778	11,73	4,67	9,3	13,85	0,093	0,51	19,03
SE	104266	10000	12	833	10774	12,93	5,15	9,3	14,49	0,093	0,54	20,17
UK	88755	10000	12	833	9171	11,01	4,38	9,3	15,42	0,093	0,57	20,37
HR	51232	10000	12	833	5294	6,35	2,53	9,3	12,03	0,093	0,45	15,01
AL	34546	10000	12	833	3570	4,28	1,71	9,3	12,48	0,093	0,46	14,65
BA	37993	10000	12	833	3926	4,71	1,88	9,3	11,38	0,093	0,42	13,68
MK	31335	10000	12	833	3238	3,89	1,55	9,3	10,61	0,093	0,39	12,55
ME	38307	10000	12	833	3958	4,75	1,89	9,3	11,81	0,093	0,44	14,14
RS	35643	10000	12	833	3683	4,42	1,76	9,3	12,21	0,093	0,45	14,42
XK	37993	10000	12	833	3926	4,71	1,88	9,3	11,07	0,093	0,41	13,35
UA	37915	10000	12	833	3918	4,70	1,87	9,3	7,55	0,093	0,28	9,70
TR	46532	10000	12	833	4808	5,77	2,30	9,3	14,98	0,093	0,55	17,84
MD	37915	10000	12	833	3918	4,70	1,87	9,3	9,09	0,093	0,34	11,29
CH	120403	10000	12	833	12442	14,93	5,95	9,3	12,28	0,093	0,45	18,68

Table 50: Machinery costs in transport 2

ID	Wheel loader, 2,3 m³, 96-115 (102) kW, 40 km/h											
	Invest-ment	Life span	Depri-ciation	Operating hours	Fixed costs		Variable costs					
							Repairs	Fuel		Lubrication		Sum
	€	h	a	h/a	€/a	€/h	€/h	l/h	€/h	l/h	€/h	€/h
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*KTBL*	*KTBL*	*calc.*	*calc.*	*calc.*	*calc.*
BE	140502	10000	12	833	14573	17,49	6,17	12,2	17,62	0,12	0,65	24,44
BG	57138	10000	12	833	5926	7,11	2,51	12,2	16,59	0,12	0,61	19,71
CZ	89191	10000	12	833	9251	11,10	3,91	12,2	15,86	0,12	0,59	20,36
DK	172935	10000	12	833	17936	21,52	7,59	12,2	18,90	0,12	0,70	27,19
DE	131000	10000	12	833	13587	16,30	5,75	12,2	16,47	0,12	0,61	22,83
EE	90458	10000	12	833	9382	11,26	3,97	12,2	16,34	0,12	0,61	20,91
IE	137588	10000	12	833	14270	17,12	6,04	12,2	18,04	0,12	0,67	24,75
EL	113136	10000	12	833	11734	14,08	4,97	12,2	16,81	0,12	0,62	22,40
ES	115544	10000	12	833	11984	14,38	5,07	12,2	16,37	0,12	0,61	22,05
FR	141896	10000	12	833	14717	17,66	6,23	12,2	16,03	0,12	0,59	22,85
IT	127199	10000	12	833	13193	15,83	5,58	12,2	20,58	0,12	0,76	26,93
CY	111236	10000	12	833	11537	13,84	4,88	12,2	16,91	0,12	0,63	22,42
LV	84631	10000	12	833	8778	10,53	3,71	12,2	15,90	0,12	0,59	20,20
LT	76396	10000	12	833	7924	9,51	3,35	12,2	15,70	0,12	0,58	19,64
LU	152411	10000	12	833	15808	18,97	6,69	12,2	14,62	0,12	0,54	21,85
HU	72848	10000	12	833	7556	9,07	3,20	12,2	17,79	0,12	0,66	21,64
MT	94513	10000	12	833	9803	11,76	4,15	12,2	16,84	0,12	0,62	21,61
NL	139235	10000	12	833	14441	17,33	6,11	12,2	17,80	0,12	0,66	24,57
AT	139235	10000	12	833	14441	17,33	6,11	12,2	16,10	0,12	0,60	22,81
PL	73228	10000	12	833	7595	9,11	3,21	12,2	15,86	0,12	0,59	19,66
PT	102114	10000	12	833	10591	12,71	4,48	12,2	17,43	0,12	0,65	22,56
RO	61319	10000	12	833	6360	7,63	2,69	12,2	15,76	0,12	0,58	19,04
SI	101734	10000	12	833	10552	12,66	4,47	12,2	16,92	0,12	0,63	22,01
SK	85897	10000	12	833	8909	10,69	3,77	12,2	16,98	0,12	0,63	21,38
FI	153044	10000	12	833	15873	19,05	6,72	12,2	18,17	0,12	0,67	25,56
SE	168628	10000	12	833	17490	20,99	7,40	12,2	19,01	0,12	0,70	27,11
UK	143543	10000	12	833	14888	17,87	6,30	12,2	20,23	0,12	0,75	27,28
HR	82857	10000	12	833	8594	10,31	3,64	12,2	15,79	0,12	0,58	20,01
AL	55871	10000	12	833	5795	6,95	2,45	12,2	16,37	0,12	0,61	19,43
BA	61446	10000	12	833	6373	7,65	2,70	12,2	14,93	0,12	0,55	18,18
MK	50677	10000	12	833	5256	6,31	2,22	12,2	13,92	0,12	0,52	16,66
ME	61953	10000	12	833	6426	7,71	2,72	12,2	15,49	0,12	0,57	18,79
RS	57645	10000	12	833	5979	7,17	2,53	12,2	16,02	0,12	0,59	19,14
XK	61446	10000	12	833	6373	7,65	2,70	12,2	14,52	0,12	0,54	17,75
UA	61319	10000	12	833	6360	7,63	2,69	12,2	9,91	0,12	0,37	12,96
TR	75255	10000	12	833	7805	9,37	3,30	12,2	19,65	0,12	0,73	23,69
MD	61319	10000	12	833	6360	7,63	2,69	12,2	11,92	0,12	0,44	15,05
CH	194726	10000	12	833	20197	24,24	8,55	12,2	16,10	0,12	0,60	25,25

Table 51: Machinery costs in transport 3

Truck, 2 axis, 275-325 (300) kW, Loading area 7,8x2,5 m, 10 t, 80 km/h

ID	Invest-ment	Life span	Depri-ciation	Operating hours	Fixed costs		Variable costs					
							Repairs	Fuel		Lubrication		Sum
	€	h	a	h/a	€/a	€/h	€/h	l/h	€/h	l/h	€/h	€/h
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*KTBL*	*KTBL*	*calc.*	*calc.*	*calc.*	*calc.*
BE	106181	12000	6	2000	25183	12,59	5,90	34,5	49,818	0,345	1,85	57,56
BG	43181	12000	6	2000	10241	5,12	2,40	34,5	46,92	0,345	1,74	51,06
CZ	67404	12000	6	2000	15986	7,99	3,74	34,5	44,85	0,345	1,66	50,26
DK	130691	12000	6	2000	30996	15,50	7,26	34,5	53,4405	0,345	1,98	62,68
DE	99000	12000	6	2000	23480	11,74	5,50	34,5	46,575	0,345	1,73	53,80
EE	68362	12000	6	2000	16213	8,11	3,80	34,5	46,1955	0,345	1,71	51,70
IE	103979	12000	6	2000	24661	12,33	5,78	34,5	51,0255	0,345	1,89	58,69
EL	85500	12000	6	2000	20278	10,14	4,75	34,5	47,541	0,345	1,76	54,05
ES	87319	12000	6	2000	20710	10,35	4,85	34,5	46,299	0,345	1,71	52,86
FR	107234	12000	6	2000	25433	12,72	5,96	34,5	45,333	0,345	1,68	52,97
IT	96128	12000	6	2000	22799	11,40	5,34	34,5	58,2015	0,345	2,16	65,70
CY	84064	12000	6	2000	19938	9,97	4,67	34,5	47,817	0,345	1,77	54,26
LV	63957	12000	6	2000	15169	7,58	3,55	34,5	44,9535	0,345	1,66	50,17
LT	57734	12000	6	2000	13693	6,85	3,21	34,5	44,4015	0,345	1,64	49,25
LU	115181	12000	6	2000	27318	13,66	6,40	34,5	41,331	0,345	1,53	49,26
HU	55053	12000	6	2000	13057	6,53	3,06	34,5	50,301	0,345	1,86	55,22
MT	71426	12000	6	2000	16940	8,47	3,97	34,5	47,61	0,345	1,76	53,34
NL	105223	12000	6	2000	24956	12,48	5,85	34,5	50,3355	0,345	1,86	58,05
AT	105223	12000	6	2000	24956	12,48	5,85	34,5	45,54	0,345	1,69	53,07
PL	55340	12000	6	2000	13125	6,56	3,07	34,5	44,85	0,345	1,66	49,59
PT	77170	12000	6	2000	18303	9,15	4,29	34,5	49,3005	0,345	1,83	55,41
RO	46340	12000	6	2000	10991	5,50	2,57	34,5	44,574	0,345	1,65	48,80
SI	76883	12000	6	2000	18234	9,12	4,27	34,5	47,8515	0,345	1,77	53,90
SK	64915	12000	6	2000	15396	7,70	3,61	34,5	48,024	0,345	1,78	53,41
FI	115660	12000	6	2000	27431	13,72	6,43	34,5	51,3705	0,345	1,90	59,70
SE	127436	12000	6	2000	30224	15,11	7,08	34,5	53,751	0,345	1,99	62,82
UK	108479	12000	6	2000	25728	12,86	6,03	34,5	57,201	0,345	2,12	65,35
HR	62617	12000	6	2000	14851	7,43	3,48	34,5	44,643	0,345	1,65	49,78
AL	42223	12000	6	2000	10014	5,01	2,35	34,5	46,299	0,345	1,71	50,36
BA	46436	12000	6	2000	11013	5,51	2,58	34,5	42,228	0,345	1,56	46,37
MK	38298	12000	6	2000	9083	4,54	2,13	34,5	39,3645	0,345	1,46	42,95
ME	46819	12000	6	2000	11104	5,55	2,60	34,5	43,815	0,345	1,62	48,04
RS	43564	12000	6	2000	10332	5,17	2,42	34,5	45,2985	0,345	1,68	49,40
XK	46436	12000	6	2000	11013	5,51	2,58	34,5	41,055	0,345	1,52	45,16
UA	46340	12000	6	2000	10991	5,50	2,57	34,5	28,014	0,345	1,04	31,63
TR	56872	12000	6	2000	13489	6,74	3,16	34,5	55,5795	0,345	2,06	60,80
MD	46340	12000	6	2000	10991	5,50	2,57	34,5	33,7065	0,345	1,25	37,53
CH	147160	12000	6	2000	34902	17,45	8,18	34,5	45,54	0,345	1,69	55,40

Table 52: Machinery costs in transport 4

ID	Truck , 2 axis, 275-325 (300) kW, 80 km/h											
	Invest-ment	Life span	Depri-ciation	Operating hours	Fixed costs		Variable costs					
							Repairs	Fuel		Lubrication		Sum
	€	h	a	h/a	€/a	€/h	€/h	l/h	€/h	l/h	€/h	€/h
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*KTBL*	*KTBL*	*calc.*	*calc.*	*calc.*	*calc.*
BE	108326	12000	6	2000	26119,42	13,06	7,72	34,5	49,818	0,35	1,85	59,39
BG	44053	12000	6	2000	10622,05	5,31	3,14	34,5	46,92	0,35	1,74	51,80
CZ	68766	12000	6	2000	16580,77	8,29	4,90	34,5	44,85	0,35	1,66	51,41
DK	133332	12000	6	2000	32148,79	16,07	9,50	34,5	53,4405	0,35	1,98	64,92
DE	101000	12000	6	2000	24353	12,18	7,20	34,5	46,575	0,35	1,73	55,50
EE	69743	12000	6	2000	16816,29	8,41	4,97	34,5	46,1955	0,35	1,71	52,88
IE	106079	12000	6	2000	25577,72	12,79	7,56	34,5	51,0255	0,35	1,89	60,48
EL	87227	12000	6	2000	21032,14	10,52	6,22	34,5	47,541	0,35	1,76	55,52
ES	89083	12000	6	2000	21479,63	10,74	6,35	34,5	46,299	0,35	1,71	54,36
FR	109400	12000	6	2000	26378,49	13,19	7,80	34,5	45,333	0,35	1,68	54,81
IT	98070	12000	6	2000	23646,43	11,82	6,99	34,5	58,2015	0,35	2,16	67,35
CY	85762	12000	6	2000	20678,85	10,34	6,11	34,5	47,817	0,35	1,77	55,70
LV	65250	12000	6	2000	15732,89	7,87	4,65	34,5	44,9535	0,35	1,66	51,27
LT	58900	12000	6	2000	14201,99	7,10	4,20	34,5	44,4015	0,35	1,64	50,24
LU	117508	12000	6	2000	28333,33	14,17	8,38	34,5	41,331	0,35	1,53	51,24
HU	56165	12000	6	2000	13542,53	6,77	4,00	34,5	50,301	0,35	1,86	56,17
MT	72868	12000	6	2000	17569,96	8,78	5,19	34,5	47,61	0,35	1,76	54,57
NL	107349	12000	6	2000	25883,89	12,94	7,65	34,5	50,3355	0,35	1,86	59,85
AT	107349	12000	6	2000	25883,89	12,94	7,65	34,5	45,54	0,35	1,69	54,88
PL	56458	12000	6	2000	13613,19	6,81	4,02	34,5	44,85	0,35	1,66	50,54
PT	78729	12000	6	2000	18983,09	9,49	5,61	34,5	49,3005	0,35	1,83	56,74
RO	47277	12000	6	2000	11399,28	5,70	3,37	34,5	44,574	0,35	1,65	49,60
SI	78436	12000	6	2000	18912,44	9,46	5,59	34,5	47,8515	0,35	1,77	55,22
SK	66226	12000	6	2000	15968,41	7,98	4,72	34,5	48,024	0,35	1,78	54,52
FI	117996	12000	6	2000	28451,09	14,23	8,41	34,5	51,3705	0,35	1,90	61,68
SE	130011	12000	6	2000	31348,01	15,67	9,27	34,5	53,751	0,35	1,99	65,01
UK	110670	12000	6	2000	26684,67	13,34	7,89	34,5	57,201	0,35	2,12	67,21
HR	63882	12000	6	2000	15403,15	7,70	4,55	34,5	44,643	0,35	1,65	50,85
AL	43076	12000	6	2000	10386,53	5,19	3,07	34,5	46,299	0,35	1,71	51,08
BA	47374	12000	6	2000	11422,83	5,71	3,38	34,5	42,228	0,35	1,56	47,17
MK	39072	12000	6	2000	9420,89	4,71	2,79	34,5	39,3645	0,35	1,46	43,61
ME	47765	12000	6	2000	11517,04	5,76	3,41	34,5	43,815	0,35	1,62	48,84
RS	44444	12000	6	2000	10716,26	5,36	3,17	34,5	45,2985	0,35	1,68	50,14
XK	47374	12000	6	2000	11422,83	5,71	3,38	34,5	41,055	0,35	1,52	45,95
UA	47277	12000	6	2000	11399,28	5,70	3,37	34,5	28,014	0,35	1,04	32,42
TR	58021	12000	6	2000	13990,02	7,00	4,14	34,5	55,5795	0,35	2,06	61,77
MD	47277	12000	6	2000	11399,28	5,70	3,37	34,5	33,7065	0,35	1,25	38,33
CH	150132	12000	6	2000	36199,77	18,10	10,70	34,5	45,54	0,35	1,69	57,93

Table 53: Machinery costs in transport 5

Trailer, 3 axis, 34t (25t), 80 km/h

ID	Invest-ment	Life span	Depri-ciation	Operating tons	Fixed costs			Variable costs		
							Sum 25 t	Repairs	Sum	Sum 25 t
	€	t	a	t/a	€/a	€/t	€	€/t	€/t	€
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*calc.*	*KTBL*	*calc.*	*calc.*
BE	56844	200000	10	20000	7893,849	0,39	9,87	0,27	0,27	6,70
BG	23117	200000	10	20000	3210,213	0,16	4,01	0,11	0,11	2,73
CZ	36085	200000	10	20000	5011,064	0,25	6,26	0,17	0,17	4,26
DK	69966	200000	10	20000	9716,054	0,49	12,15	0,33	0,33	8,25
DE	53000	200000	10	20000	7360	0,37	9,20	0,25	0,25	6,25
EE	36598	200000	10	20000	5082,244	0,25	6,35	0,17	0,17	4,32
IE	55665	200000	10	20000	7730,135	0,39	9,66	0,26	0,26	6,56
EL	45773	200000	10	20000	6356,364	0,32	7,95	0,22	0,22	5,40
ES	46747	200000	10	20000	6491,605	0,32	8,11	0,22	0,22	5,51
FR	57408	200000	10	20000	7972,147	0,40	9,97	0,27	0,27	6,77
IT	51462	200000	10	20000	7146,46	0,36	8,93	0,24	0,24	6,07
CY	45004	200000	10	20000	6249,594	0,31	7,81	0,21	0,21	5,31
LV	34240	200000	10	20000	4754,816	0,24	5,94	0,16	0,16	4,04
LT	30908	200000	10	20000	4292,147	0,21	5,37	0,15	0,15	3,64
LU	61662	200000	10	20000	8562,94	0,43	10,70	0,29	0,29	7,27
HU	29473	200000	10	20000	4092,843	0,20	5,12	0,14	0,14	3,48
MT	38238	200000	10	20000	5310,019	0,27	6,64	0,18	0,18	4,51
NL	56332	200000	10	20000	7822,669	0,39	9,78	0,27	0,27	6,64
AT	56332	200000	10	20000	7822,669	0,39	9,78	0,27	0,27	6,64
PL	29627	200000	10	20000	4114,197	0,21	5,14	0,14	0,14	3,49
PT	41313	200000	10	20000	5737,099	0,29	7,17	0,19	0,19	4,87
RO	24809	200000	10	20000	3445,106	0,17	4,31	0,12	0,12	2,93
SI	41160	200000	10	20000	5715,745	0,29	7,14	0,19	0,19	4,85
SK	34752	200000	10	20000	4825,996	0,24	6,03	0,16	0,16	4,10
FI	61919	200000	10	20000	8598,53	0,43	10,75	0,29	0,29	7,30
SE	68223	200000	10	20000	9474,043	0,47	11,84	0,32	0,32	8,05
UK	58074	200000	10	20000	8064,681	0,40	10,08	0,27	0,27	6,85
HR	33522	200000	10	20000	4655,164	0,23	5,82	0,16	0,16	3,95
AL	22604	200000	10	20000	3139,033	0,16	3,92	0,11	0,11	2,67
BA	24860	200000	10	20000	3452,224	0,17	4,32	0,12	0,12	2,93
MK	20503	200000	10	20000	2847,195	0,14	3,56	0,10	0,10	2,42
ME	25065	200000	10	20000	3480,696	0,17	4,35	0,12	0,12	2,96
RS	23322	200000	10	20000	3238,685	0,16	4,05	0,11	0,11	2,75
XK	24860	200000	10	20000	3452,224	0,17	4,32	0,12	0,12	2,93
UA	24809	200000	10	20000	3445,106	0,17	4,31	0,12	0,12	2,93
TR	30447	200000	10	20000	4228,085	0,21	5,29	0,14	0,14	3,59
MD	24809	200000	10	20000	3445,106	0,17	4,31	0,12	0,12	2,93
CH	78782	200000	10	20000	10940,35	0,55	13,68	0,37	0,37	9,29

Table 54: Machinery costs in transport 6

Trailer, 3 axis, 24t (18t), 80 km/h

ID	Invest-ment	Life span	Depri-ciation	Operating tons	Fixed costs			Variable costs		
							Sum 18 t	Repairs	Sum	Sum 18 t
	€	t	a	t/a	€/a	€/t	€	€/t	€/t	€
	KTBL	*KTBL*	*KTBL*	*calc.*	*KTBL*	*calc.*	*calc.*	*KTBL*	*calc.*	*calc.*
BE	37002	400000	11	36364	5176,048	0,14	2,56	0,215	0,215	3,86
BG	15048	400000	11	36364	2104,957	0,06	1,04	0,087	0,087	1,57
CZ	23489	400000	11	36364	3285,787	0,09	1,63	0,136	0,136	2,45
DK	45544	400000	11	36364	6370,88	0,18	3,15	0,264	0,264	4,75
DE	34500	400000	11	36364	4826	0,13	2,39	0,200	0,200	3,60
EE	23823	400000	11	36364	3332,46	0,09	1,65	0,138	0,138	2,49
IE	36235	400000	11	36364	5068,7	0,14	2,51	0,210	0,210	3,78
EL	29795	400000	11	36364	4167,909	0,11	2,06	0,173	0,173	3,11
ES	30429	400000	11	36364	4256,588	0,12	2,11	0,176	0,176	3,18
FR	37369	400000	11	36364	5227,389	0,14	2,59	0,217	0,217	3,90
IT	33499	400000	11	36364	4685,981	0,13	2,32	0,194	0,194	3,50
CY	29295	400000	11	36364	4097,899	0,11	2,03	0,170	0,170	3,06
LV	22288	400000	11	36364	3117,764	0,09	1,54	0,129	0,129	2,33
LT	20119	400000	11	36364	2814,389	0,08	1,39	0,117	0,117	2,10
LU	40139	400000	11	36364	5614,776	0,15	2,78	0,233	0,233	4,19
HU	19185	400000	11	36364	2683,704	0,07	1,33	0,111	0,111	2,00
MT	24891	400000	11	36364	3481,814	0,10	1,72	0,144	0,144	2,60
NL	36669	400000	11	36364	5129,375	0,14	2,54	0,213	0,213	3,83
AT	36669	400000	11	36364	5129,375	0,14	2,54	0,213	0,213	3,83
PL	19285	400000	11	36364	2697,706	0,07	1,34	0,112	0,112	2,01
PT	26893	400000	11	36364	3761,853	0,10	1,86	0,156	0,156	2,81
RO	16149	400000	11	36364	2258,979	0,06	1,12	0,094	0,094	1,69
SI	26793	400000	11	36364	3747,851	0,10	1,86	0,155	0,155	2,80
SK	22622	400000	11	36364	3164,437	0,09	1,57	0,131	0,131	2,36
FI	40306	400000	11	36364	5638,112	0,16	2,79	0,234	0,234	4,21
SE	44410	400000	11	36364	6212,191	0,17	3,08	0,257	0,257	4,63
UK	37803	400000	11	36364	5288,064	0,15	2,62	0,219	0,219	3,94
HR	21821	400000	11	36364	3052,422	0,08	1,51	0,126	0,126	2,28
AL	14714	400000	11	36364	2058,284	0,06	1,02	0,085	0,085	1,54
BA	16182	400000	11	36364	2263,646	0,06	1,12	0,094	0,094	1,69
MK	13346	400000	11	36364	1866,925	0,05	0,92	0,077	0,077	1,39
ME	16316	400000	11	36364	2282,315	0,06	1,13	0,095	0,095	1,70
RS	15181	400000	11	36364	2123,627	0,06	1,05	0,088	0,088	1,58
XK	16182	400000	11	36364	2263,646	0,06	1,12	0,094	0,094	1,69
UA	16149	400000	11	36364	2258,979	0,06	1,12	0,094	0,094	1,69
TR	19819	400000	11	36364	2772,383	0,08	1,37	0,115	0,115	2,07
MD	16149	400000	11	36364	2258,979	0,06	1,12	0,094	0,094	1,69
CH	51283	400000	11	36364	7173,658	0,20	3,55	0,297	0,297	5,35

Table 55: Summary for machinery costs in transport in Machinery costs in transport €/hour

Country	SUMMARY: Loading		SUMMARY: Transport costs (incl. labour costs)				
							
	Option 1	**Option 2**	**Option 1**	**Option 1**		**Option 2**	
	6	8	10	28 t		25 t	
	t/min	t/min	t	Truck	Trailer (per trip	Truck	Trailer (per trip)
	€/h	€/h	€/h	€/h	€	€/h	€
BE	45.83	58.77	87.00	87.00	6.42	89.29	16.57
BG	26.44	34.03	63.38	63.38	2.61	64.31	6.74
CZ	30.03	39.40	66.18	66.18	4.08	67.64	10.52
DK	66.15	81.38	110.85	110.85	7.91	113.67	20.40
DE	43.85	55.92	82.33	82.33	5.99	84.46	15.45
EE	29.00	38.56	66.20	66.20	4.14	67.67	10.67
IE	42.25	55.12	84.26	84.26	6.29	86.51	16.23
EL	36.33	47.39	75.10	75.10	5.17	76.95	13.34
ES	41.02	52.12	78.91	78.91	5.28	80.79	13.63
FR	45.28	57.91	83.08	83.08	6.49	85.39	16.74
IT	46.17	59.02	93.36	93.36	5.82	95.44	15.00
CY	36.21	47.18	75.14	75.14	5.09	76.95	13.12
LV	27.15	36.25	63.27	63.27	3.87	64.65	9.98
LT	25.57	34.11	61.07	61.07	3.49	62.31	9.01
LU	43.49	56.41	78.52	78.52	6.97	81.00	17.98
HU	27.22	36.06	67.10	67.10	3.33	68.29	8.59
MT	31.36	41.29	69.73	69.73	4.32	71.27	11.15
NL	49.19	62.09	90.71	90.71	6.37	92.98	16.42
AT	42.84	55.33	80.74	80.74	6.37	83.01	16.42
PL	29.18	37.57	64.94	64.94	3.35	66.13	8.64
PT	29.51	40.05	69.34	69.34	4.67	71.01	12.04
RO	24.22	31.86	59.48	59.48	2.80	60.48	7.23
SI	31.80	42.20	70.53	70.53	4.65	72.19	12.00
SK	28.83	38.27	67.31	67.31	3.93	68.71	10.13
FI	46.14	59.98	88.79	88.79	7.00	91.28	18.05
SE	49.33	64.33	94.16	94.16	7.71	96.91	19.89
UK	46.95	60.72	93.78	93.78	6.56	96.12	16.93
HR	27.31	36.26	63.14	63.14	3.79	64.49	9.77
AL	21.43	28.89	57.87	57.87	2.55	58.78	6.59
BA	21.30	28.74	54.79	54.79	2.81	55.79	7.25
MK	19.32	25.85	50.37	50.37	2.32	51.20	5.98
ME	21.97	29.58	56.67	56.67	2.83	57.68	7.31
RS	21.73	29.20	57.44	57.44	2.64	58.39	6.80
XK	20.78	28.11	53.38	53.38	2.81	54.38	7.25
UA	16.09	22.28	38.80	38.80	2.80	39.80	7.23
TR	30.24	39.68	74.17	74.17	3.44	75.40	8.88
MD	17.14	23.83	44.17	44.17	2.80	45.17	7.23
CH	48.79	64.67	88.04	88.04	8.90	91.21	22.97

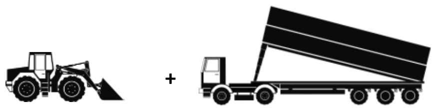
Table 56: Transport up and off-loading costs for total supply chains

SUPPLY CHAIN: 1

Loading			Transport to plant		Unloading	TOTAL		
Time	Machinery costs	Waiting time truck driver	60 average speed km/h	Trailer	Waiting time truck driver	Fix	per km	per km/ton
h	€	€	€/km	€	€	€	€/km	€/km/ton
0.08	3.56	1.31	1.45	6.42	1.31	12.61	0.02	0.47
0.08	2.06	0.56	1.06	2.61	0.56	5.79	0.02	0.22
0.08	2.34	0.62	1.10	4.08	0.62	7.65	0.02	0.29
0.08	5.14	2.54	1.85	7.91	2.54	18.13	0.03	0.68
0.08	3.41	1.31	1.37	5.99	1.31	12.01	0.02	0.45
0.08	2.26	0.50	1.10	4.14	0.50	7.38	0.02	0.28
0.08	3.29	1.03	1.40	6.29	1.03	11.64	0.02	0.44
0.08	2.83	0.85	1.25	5.17	0.85	9.70	0.02	0.37
0.08	3.19	1.22	1.32	5.28	1.22	10.91	0.02	0.41
0.08	3.52	1.35	1.38	6.49	1.35	12.71	0.02	0.48
0.08	3.59	1.26	1.56	5.82	1.26	11.94	0.03	0.45
0.08	2.82	0.85	1.25	5.09	0.85	9.60	0.02	0.36
0.08	2.11	0.43	1.05	3.87	0.43	6.84	0.02	0.26
0.08	1.99	0.39	1.02	3.49	0.39	6.25	0.02	0.24
0.08	3.38	1.21	1.31	6.97	1.21	12.78	0.02	0.48
0.08	2.12	0.42	1.12	3.33	0.42	6.28	0.02	0.24
0.08	2.44	0.62	1.16	4.32	0.62	7.99	0.02	0.30
0.08	3.83	1.57	1.51	6.37	1.57	13.33	0.03	0.50
0.08	3.33	1.18	1.35	6.37	1.18	12.06	0.02	0.45
0.08	2.27	0.68	1.08	3.35	0.68	6.98	0.02	0.27
0.08	2.30	0.37	1.16	4.67	0.37	7.71	0.02	0.29
0.08	1.88	0.40	0.99	2.80	0.40	5.49	0.02	0.21
0.08	2.47	0.58	1.18	4.65	0.58	8.29	0.02	0.32
0.08	2.24	0.48	1.12	3.93	0.48	7.13	0.02	0.27
0.08	3.59	1.20	1.48	7.00	1.20	12.98	0.02	0.49
0.08	3.84	1.26	1.57	7.71	1.26	14.07	0.03	0.53
0.08	3.65	1.21	1.56	6.56	1.21	12.64	0.03	0.48
0.08	2.12	0.46	1.05	3.79	0.46	6.84	0.02	0.26
0.08	1.67	0.19	0.96	2.55	0.19	4.61	0.02	0.18
0.08	1.66	0.23	0.91	2.81	0.23	4.92	0.02	0.19
0.08	1.50	0.22	0.84	2.32	0.22	4.27	0.01	0.17
0.08	1.71	0.24	0.94	2.83	0.24	5.02	0.02	0.20
0.08	1.69	0.22	0.96	2.64	0.22	4.77	0.02	0.19
0.08	1.62	0.21	0.89	2.81	0.21	4.85	0.01	0.19
0.08	1.25	0.13	0.65	2.80	0.13	4.32	0.01	0.16
0.08	2.35	0.52	1.24	3.44	0.52	6.82	0.02	0.26
0.08	1.33	0.09	0.74	2.80	0.09	4.31	0.01	0.17
0.08	3.79	1.18	1.47	8.90	1.18	15.06	0.02	0.56

Table 57: Transport up and off-loading costs for total supply chains 2

SUPPLY CHAIN: 2



	Loading		Transport		Unloading	TOTAL		
Time	Machinery costs	Waiting time truck driver	60 average speed km/h	Trailer	Waiting time truck driver	Fix	per km	per km/ton
h	€	€	€/km	€	€	€	€/km	€/km/ton
0.05	3.06	0.88	1.49	16.57	0.88	21.39	0.02	0.88
0.05	1.77	0.37	1.07	6.74	0.37	9.26	0.02	0.39
0.05	2.05	0.41	1.13	10.52	0.41	13.40	0.02	0.55
0.05	4.24	1.70	1.89	20.40	1.70	28.04	0.03	1.15
0.05	2.91	0.87	1.41	15.45	0.87	20.11	0.02	0.83
0.05	2.01	0.33	1.13	10.67	0.33	13.34	0.02	0.55
0.05	2.87	0.69	1.44	16.23	0.69	20.48	0.02	0.84
0.05	2.47	0.57	1.28	13.34	0.57	16.95	0.02	0.70
0.05	2.71	0.82	1.35	13.63	0.82	17.98	0.02	0.74
0.05	3.02	0.91	1.42	16.74	0.91	21.56	0.02	0.89
0.05	3.07	0.85	1.59	15.00	0.85	19.77	0.03	0.82
0.05	2.46	0.57	1.28	13.12	0.57	16.71	0.02	0.69
0.05	1.89	0.29	1.08	9.98	0.29	12.44	0.02	0.52
0.05	1.78	0.26	1.04	9.01	0.26	11.30	0.02	0.47
0.05	2.94	0.81	1.35	17.98	0.81	22.54	0.02	0.92
0.05	1.88	0.28	1.14	8.59	0.28	11.03	0.02	0.46
0.05	2.15	0.41	1.19	11.15	0.41	14.12	0.02	0.58
0.05	3.23	1.05	1.55	16.42	1.05	21.76	0.03	0.90
0.05	2.88	0.79	1.38	16.42	0.79	20.88	0.02	0.86
0.05	1.96	0.46	1.10	8.64	0.46	11.51	0.02	0.48
0.05	2.09	0.25	1.18	12.04	0.25	14.63	0.02	0.60
0.05	1.66	0.27	1.01	7.23	0.27	9.43	0.02	0.39
0.05	2.20	0.39	1.20	12.00	0.39	14.98	0.02	0.62
0.05	1.99	0.32	1.15	10.13	0.32	12.77	0.02	0.53
0.05	3.12	0.80	1.52	18.05	0.80	22.78	0.03	0.94
0.05	3.35	0.85	1.62	19.89	0.85	24.93	0.03	1.02
0.05	3.16	0.81	1.60	16.93	0.81	21.71	0.03	0.90
0.05	1.89	0.31	1.07	9.77	0.31	12.28	0.02	0.51
0.05	1.50	0.13	0.98	6.59	0.13	8.35	0.02	0.35
0.05	1.50	0.15	0.93	7.25	0.15	9.05	0.02	0.38
0.05	1.35	0.15	0.85	5.98	0.15	7.62	0.01	0.32
0.05	1.54	0.16	0.96	7.31	0.16	9.17	0.02	0.38
0.05	1.52	0.15	0.97	6.80	0.15	8.62	0.02	0.36
0.05	1.46	0.14	0.91	7.25	0.14	8.99	0.02	0.37
0.05	1.16	0.09	0.66	7.23	0.09	8.57	0.01	0.35
0.05	2.07	0.35	1.26	8.88	0.35	11.63	0.02	0.49
0.05	1.24	0.06	0.75	7.23	0.06	8.59	0.01	0.36
0.05	3.37	0.79	1.52	22.97	0.79	27.92	0.03	1.14

Annex 10: Additional Information for the assessment of labour time for pruning of permanent crops

Table 58: Information used to assess labour time (hour/year/ha) for pruning in permanent crops

Tree (crop)	Pruning time h/ha MIN time hours/ha	 MAX time hours/ha	Reference
Apple/pears	100	140	Experts from SK, HR and NL provided Min and Max time. Silvestri Silvia (2011) "Recovery of pruning waste for energy use" ppt. Central European Biomass Conference 2011, 26th – 29th January, Graz – Austria
Cherries & other soft fruits	50	70	Expert from SK provided details (for cherries)
Vineyards	19	223	Archer and Van Schalkwyk: "The Effect of Alternative Pruning Methods on the Viticultural and Oenological Performance of Some Wine Grape Varieties". Oplanic M., Stanic A., and Bubola; Ekonomska ocjena tradicionalnog i suvremenog uzgoja vinove loze u Istri. Proceedings 46th Croatian and 6th International Symposium on Agriculture. Opatija, Croatia (221-224).p.223. J. Dias and J.L.T. Azevedo, Evaluation of biomass residuals in Portugal mainland
Olives	92	139	Riccardo Gucci, Claudio Cantini "Time for hand prunning olives", Table 4.3 Philips (2004) Pruning adds value to plantations; Silviculture / Management No. 11
Citrus	7	15	O'Connell et al. (2011), Sample costs to establish a citrus orchard and produce mandarins

Annex 11: Additional input for labour time evaluation

Table 59 Labour time evaluation input parameters

	Saw logs (RSC)		Pulp wood (for fuel or other)						Primary residues			
	Coniferous	Broadleaved	Fire wood (RSC)		Chips (at gate)		Pellets (at gate)		Top&stem wood (with bark) (at gate)		Dry chips (RSC) (from forest residues and landscape care wood)	
	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$	$€/t_{DM}$
SOURCE ->	EFSOS	EFSOS	extrapolated	National sources	extrapolated	EUBIONETIII	extrapolated	EUBIONETIII	extrapolated	National sources	extrapolated	National sources
Austria	124	151	84.2	84.2	143	143	296		39		82	
Belgium	120	154	86.0		146		303		40	40	84	
Bulgaria	83	130	41.1		55		199		34		40	
Cyprus	102	141	78.6		134		277		37		77	
Czech Republic	101	148	46.7		140		290		38		81	
Germany	120	154	85.9		137	137	302		40		84	84
Denmark	109	125	69.5		111		245		32		68	
Estonia	97	133	66.2		57		205		35		41	
Greece	102	141	78.6		134		277	277	37		77	
Spain	132	163	90.9		154		320		42		89	
Finland	93	177	63.4		168		347		46		96	
France	100	143	80.1		136		282		37		78	

	Saw logs (RSC)		Pulp wood (for fuel or other)						Primary residues			
	Coniferous	Broadleaved	Fire wood (RSC)		Chips (at gate)		Pellets (at gate)		Top&stem wood (with bark) (at gate)		Dry chips (RSC) (from forest residues and landscape care wood)	
	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}
SOURCE ->	EFSOS	EFSOS	extrapolated	National sources	extrapolated	EUBIONETIII	extrapolated	EUBIONETIII	extrapolated	National sources	extrapolated	National sources
Croatia	103	134	42.5	42.5	53	53	118	118	35		41	41
Hungary	107	110	34.7		46		168		28		34	
Ireland	141	139	77.6		136	136	273		36		76	
Italy	117	142	79.2		134		279		37		77	
Lithuania	98	143	45.4		61		220		37		44	
Luxembourg	120	154	86.0		146		303		40		84	
Latvia	93	134	42.4		57		205		35		41	
Malta	117	142	44.9		134		279		37		77	
Netherlands	114	176	98.2		167		346		46		50	50
Poland	84	148	46.8		63		291		38		45	
Portugal	126	164	91.8		156		323		43		90	
Romania	79	117	37.1		50	50	230	180	30		36	
Sweden	95	183	64.3		173		359		48		100	
Slovenia	86	128	33.5		54		197		33		39	

	Saw logs (RSC)		Pulp wood (for fuel or other)						Primary residues			
	Coniferous	Broadleaved	Fire wood (RSC)		Chips (at gate)		Pellets (at gate)		Top&stem wood (with bark) (at gate)		Dry chips (RSC) (from forest residues and landscape care wood)	
	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}	€/t_{DM}
SOURCE ->	**EFSOS**	**EFSOS**	**extrapolated**	**National sources**	**extrapolated**	**EUBIONETIII**	**extrapolated**	**EUBIONETIII**	**extrapolated**	**National sources**	**extrapolated**	**National sources**
Slovakia	112	123	36.3	36.3	52		189		32		38	
United Kingdom	138	131	73.2		124		258		34		72	
Albania	168	207	65.7		81		183		54		63	
Bosnia	62	101	31.8		39		89		26		31	
Serbia	94	134	42.5		53		118		35		41	
Kosovo	94	134	42.5		53		118		35		41	
Macedonia	94	134	42.5		53		118		35		41	
Moldova	168	207	65.7		81		183		54		63	
Turkey	168	207	65.7		81		183		54		63	
Norway	112	138	40.7		131		271		36		75	

RSC=road side cost (cost made up to the forwarding of the biomass to the forest road side)

At gate= Cost at gate of further processing facility (so including transport and pre-treatment cost for e.g. chipping, pelletizing, drying)

Sources: (United Nations Economic Commission for Europe and Food and Agriculture Organization of the United Nations 2011), (Vinterbëck and Porsö 2011), and Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe (TFZ), http://www.tfz.bayern.de/

Annex 12: Detailed price information used

In this annex an overview is provided of original price data used for assessing price levels in this study.

Table 60 Straw prices and their sources

Country	Price (€/t)			Methodology	Report reference
	Min	Max	Mid (average)		
AT	110.0	200.0	155.0	Min: as min of 3 found local prices. Max: as max of 3 found local prices. January 2014	http://stmk.lko.at/?id=2500%2C%2C1348378%2C3206&npf_cache=no&fulltext_search=Stroh+Kleinballen+
FR	20.0	50.0	35.0	Chambre agriculture, 2013	http://www.agriculture-npdc.fr/prix-et-indices/prix-de-la-
HR	32.2	45.5	38.9	Min:as min price from 2 sources found; local prices, 2014.	http://www.njuskalo.hr
HU	20.0	79.0	49.5	Min: as min of several prices, Max: as maximum price of several prices found.	Biocore (2012) Deliverable D1.2: http://www.biocore-europe.org/file/D1_2%20Assessment%20of%20procurement%20costs%20for%20the%20preferred%20feedstocks.pdf
IE	20.0	25.0	22.5	STRAW FIRED BIOMASS CHP PLANT; p.49	Prepared on behalf of Organic Power Ltd. by: Erm21c, FBD House, Mardyke Street, Skibbereen, Co. Cork. March 2010
NL	65.0	120.0	92.5	Local prices, 2014	http://www.productschapakkerbouw.nl/teelt/marktprijzen/5
PL	35.0	40.0	37.5	Min: as min of several prices, Max: as maximum price of several prices found.	Rozakis et al. (2012) Straw potential for energy purposes in Poland and optimal allocation to major co-firing power plants. AUA Working Paper Series No. 1. October 2012. p8.
SK	44.0	90.0	67.0	Min: as min of 2 local prices, Max: as maximum price of 2 local prices found. 2 different regions	http://zvierata.bazos.sk
UK	43.0	92.0	67.5	Min: as min of all regions. Max: as maximum price of all UK regions.	http://www.farming.co.uk/prices/baled_hay_straw/
DK	53.0	74.0	63.5	Minimum: STRAW FIRED BIOMASS CHP PLANT; p.49. Maximum price from: Low ILUC potential of wastes and residues for biofuels Straw, forestry residues, UCO, corn cobs. Ecofys (2013) p.16.	Prepared on behalf of Organic Power Ltd. by: Erm21c, FBD House, Mardyke Street, Skibbereen, Co. Cork. March 2010: http://www.organicpower.ie/pdf/midleton/OP7%20Preplanning%2015%20Mar%2010.pdf
DE	61.0	100.0	80.5	Min: as min for 3 types of straw (round bales, small, and cubes). Max: as max of 4 types of straw (round bales, small bales, cubes).	local prices 2014: http://www.proplanta.de/Markt-und-Preis/Agrarmarkt-Berichte/Strohpreise-Heupreise-2013-KW48_notierungen1385496303.html
BE	20.0	120.0	70.0	Min as 1 FRA; Max as NL	
CZ	33.6	90.0	61.8	Min as 1 local price found for 2014. Max: as max of SK.	Prodáváme seno a slámu ze sklizně 2013. Průměr balíků 130 cm. Sláma 200,-Kč/ks: http://zvirata.bazos.cz/inzerat/31330596/Prodej-sena-a-slamy.php
EL	32.2	70.0	51.1	Min as min of HR. Max as found a price for EL.	Karampinis et al. (2012) Investigation of Wheat Straw Supply Chains for Co-Firing Power Plants in Northern Greece. P. 139: http://www.etaflorence.it/proceedings/index.asp?detail=8061
ES	29.6	35.2	32.4	Min as 1 price found for ES; Max as one price found for PT.	http://www.agriaffaires.es/usado/find/475/paja-y-forraje/1/paja.html
FI	53.0	74.0	63.5	as DK	
PT	29.6	35.2	32.4	Min as 1 price found for ES; Max as one price found for PT.	http://www.altercexa.eu/images/archivos/Areas%20Tematicas/Biomasa/artigo_biomassa.pdf
CY	29.6	35.2	32.4	Min as 1 price found for ES; Max as one price found for PT.	
RO	32.2	45.5	38.9	as HR	
SE	53.0	74.0	63.5	as DK	
SI	32.2	45.5	38.9	as HR	
IT	32.2	45.5	38.9	as HR	
LT	35.0	40.0	37.5	as PL	
LU	65.0	120.0	92.5	as NL	
LV	35.0	40.0	37.5	as PL	
MT	29.6	35.2	32.4	Min as 1 price found for ES; Max as one price found for PT.	
EE	35.0	40.0	37.5	as PL	
BG	32.2	45.5	38.9	as HR	

Table 61 Straw prices used for prices levels assessed in the study

Sources for straw prices	
1	http://stmk.lko.at/?id=2500%2C%2C1348378%2C3206&npf_cache=no&fulltext_search=Stroh+Kleinballen+
2	http://www.agriculture-npdc.fr/prix-et-indices/prix-de-la-paille-et-des-fourrages.html
3	http://www.njuskalo.hr
4	http://www.biocore-europe.org/file/D1_2%20Assessment%20of%20procurement%20costs%20for%20the%20preferred%20feedstocks.pdf
5	http://www.organicpower.ie/pdf/midleton/OP7%20Preplanning%2015%20Mar%2010.pdf
6	http://www.productschapakkerbouw.nl/teelt/marktprijzen/5
7	http://zvierata.bazos.sk
8	http://www.farming.co.uk/prices/baled_hay_straw/
9	http://www.organicpower.ie/pdf/midleton/OP7%20Preplanning%2015%20Mar%2010.pdf
10	http://www.proplanta.de/Markt-und-Preis/Agrarmarkt-Berichte/Strohpreise-Heupreise-2013-KW48_notierungen1385496303.html
11	http://zvirata.bazos.cz/inzerat/31330596/Prodej-sena-a-slamy.php
12	http://www.etaflorence.it/proceedings/index.asp?detail=8061
13	http://www.agriaffaires.es/usado/find/475/paja-y-forraje/1/paja.html
14	http://www.altercexa.eu/images/archivos/Areas%20Tematicas/Biomasa/artigo_biomassa.pdf
15	http://www.biocore-europe.org/file/D1_2%20Assessment%20of%20procurement%20costs%20for%20the%20preferred%20feedstocks.pdf

Table 62 Pruning cost and RSC for pruning material

		Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus	Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus
Albania	AL	110	48	16	105	31	11	7	2	16	5
Austria	AT	429	274	83			43	41	12		
Bosnia and Herzegovina	BA	85	56	18			9	8	3		
Belgium	BE	476	304	91			48	46	14		
Bulgaria	BG	182	117	36			18	18	5		
Switzerland	CH	429	274	82			43	41	12		
Cyprus	CY	314	201	61	446	126	31	30	9	67	19
Czech Republic	CZ	210	135	41			21	20	6		
Germany	DE	488	312	94			49	47	14		
Denmark	DK	960	611				96	92			
Estonia	EE	178	115				18	17			
Greece	EL	314	201	61	446	126	31	30	9	67	19
Spain	ES	400	255	77	567	160	40	38	12	85	24
Finland	FI	435	278				43	42			
France	FR	460	294	88	653		46	44	13	98	
Croatia	HR	172	111	34	244	70	17	17	5	37	10
Hungary	HU	155	100	31			16	15	5		

		Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus	Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus
Ireland	IE	413	264				41	40			
Italy	IT	467	298	90	663	187	47	45	14	99	28
Lithuania	LT	148	95				15	14			
Luxembourg	LU	471	301	90			47	45	14		
Latvia	LV	164	106				16	16			
Moldova	MO	34	23	8	49	15	3	3	1	7	2
Montenegro	ME	90	59	19	128		9	9	3	19	
Macedonia	MK	84	55	18	120	35	8	8	3	18	5
Malta	MT	215	138	42	306	87	22	21	6	46	13
Netherlands	NL	606	386	116			61	58	17		
Poland	PL	218	140	43			22	21	6		
Portugal	PT	158	102	32	225	64	16	15	5	34	10
Romania	RO	133	86	27			13	13	4		
Serbia	CS	85	55	18			8	8	3		
Sweden	SE	459	293				46	44			
Slovenia	SI	201	129	40	286	81	20	19	6	43	12
Slovakia	SK	188	121	37			19	18	6		
Turkey	TR	192	124	38	273	78	19	19	6	41	12

		Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus	Apples & pear & appricots	Cherries & other soft fruit	Vineyards	Olives	Citrus
Ukraine	UA	50	32	11			5	5	2		
United Kingdom	UK	526	336	101			53	50	15		
Kosovo	KO	80	52	17			8	8	3		
Norway	NO	459	293				46	44			

Table 63 UVAG price 2010 for forage maize (energy maize) and grassland cuttings from CAPRI

Euro/ton	Forage maize	Grass cuttings	Euro/ton	Forage maize	Grass cuttings
BE	18.36	15.23	SK	6.17	2.97
DK	29.14	8.62	EE	35.20	4.18
DE	29.87	17.96	LT	28.32	3.72
EL	45.42	17.82	LV	6.22	2.68
ES	18.70	7.96	CY	55.36	18.03
FR	16.83	10.68	MT		36.87
IE	44.29	4.95	BG	48.33	6.56
IT	21.63	10.87	RO	67.43	26.23
NL	19.98	4.95	NO		14.13
AT	21.15	10.57	TUR	49.87	5.45
PT	24.91	5.48	AL	42.05	16.68
SE	53.63	8.43	MK	39.27	6.00
FI		4.04	CS	62.17	9.20
UK	11.81	0.70	MO	54.16	7.40
CZ	21.00	7.19	HR	62.73	13.61
HU	26.10	3.92	BA	44.16	0.95
PL	11.81	6.89	KO	56.20	4.37
SI	43.60	40.66			

Table 64 Prices for 1G feedstock 2010 (Source: CAPRI baseline)

	Bioethanol 1G crops							Biodiesel 1G crops		
	€/ton*						€/ton of sugar *	€/ton **		
	barley	wheat	maize	oats	other cereal	rey	sugar-beet	rape seed	sunflower seed	soya seed
BE	130	143	75	116	181	108	305	463	403	337
DK	145	140	212	140	153	124	447	343	403	337
DE	142	153	144	139	143	132	305	340	343	337
EL	175	243	206	158	139	157	305	394	368	38
ES	152	181	179	139	171	155	305	476	384	404
FR	132	152	146	90	117	146	305	323	339	359
IE	119	110	212	109	154	176	703	489	403	337
IT	164	225	174	192	176	143	305	201	257	276
NL	139	138	132	94	169	148	305	227	374	337
AT	123	142	125	107	132	117	305	378	307	370
PT	171	170	153	143	130	133	305	394	670	337
SE	131	141	157	117	120	120	305	298	403	337
FI	132	131	212	113	173	163	305	354	344	337
UK	148	147	212	130	124	73	305	365	319	337
CZ	129	115	132	106	100	118	306	305	273	381
HU	132	144	130	128	130	120	306	346	342	323
PL	119	130	126	99	114	103	306	301	352	240
SI	116	144	120	151	108	132	703	535	840	317
SK	141	129	120	109	132	131	306	342	294	233
EE	107	129	207	82	133	119	703	336	381	330
LT	122	132	162	105	95	97	306	313	381	330
LV	104	126	207	89	114	104	306	299	381	330
CY	143	228	207	464	108	171	703	385	381	330
MT	144	161	207	152	149	171	703	385	381	330
BG	124	127	137	110	92	134	703	294	247	233
RO	170	149	220	203	132	139	306	258	294	362

	Bioethanol 1G crops							Biodiesel 1G crops		
	€/ton*						€/ton of sugar *	€/ton **		
	barley	wheat	maize	oats	other cereal	rey	sugar-beet	rape seed	sunflower seed	soya seed
NO	280	261	167	206	148	228	316	388	369	369
TUR	177	278	191	190	193	167	438	424	367	308
CH	241	645	293	178	293	167	337	767	806	483
UA	163	145	177	136	144	130	363	139	153	255
AL	166	145	158	190	164	146	370	443	233	426
MK	183	145	174	108	140	162	442	333	231	384
CS	142	122	111	158	146	166	370	352	210	320
MO	160	163	148	210	226	216	442	443	458	402
HR	177	156	116	166	184	191	370	527	318	443
BA	164	152	169	186	152	167	442	398	265	298
KO	249	184	195	246	246	167	442	443	421	464

(* Producer price. Source: CAPRI , ** Domestic market price. Source: CAPRI)

Table 65: Transport cost liquid manure per distance and country

		Total cost (€/ton)				
		Distance	Distance	Distance	Distance	Distance
Country	**Country code**	**3 km**	**5 km**	**10 km**	**15 km**	**20 km**
Albania	AL	1.31	1.67	2.56	3.45	4.34
Austria	AT	1.53	1.92	2.91	3.89	4.88
Bosnia and Herzegovina	BA	1.30	1.64	2.51	3.39	4.26
Belgium	BE	1.57	1.97	2.98	4.00	5.01
Bulgaria	BG	1.38	1.75	2.67	3.60	4.52
Switzerland	CH	1.50	1.88	2.84	3.80	4.76
Cyprus	CY	1.47	1.85	2.82	3.78	4.75
Czech Republic	CZ	1.39	1.76	2.68	3.60	4.52
Germany	DE	1.57	1.97	2.99	4.00	5.01
Denmark	DK	1.88	2.35	3.52	4.68	5.85
Estonia	EE	1.37	1.74	2.66	3.58	4.50
Greece	EL	1.46	1.85	2.81	3.78	4.74
Spain	ES	1.51	1.90	2.88	3.86	4.84
Finland	FI	1.56	1.97	2.98	4.00	5.02
France	FR	1.54	1.94	2.93	3.92	4.92
Croatia	HR	1.36	1.73	2.64	3.55	4.45
Hungary	HU	1.38	1.75	2.68	3.62	4.55
Ireland	IE	1.54	1.95	2.96	3.97	4.98
Italy	IT	1.61	2.04	3.09	4.16	5.22
Lithuania	LT	1.35	1.71	2.61	3.51	4.41
Luxembourg	LU	1.53	1.92	2.89	3.86	4.83
Latvia	LV	1.36	1.72	2.63	3.54	4.44
Moldova	MD	1.22	1.54	2.35	3.16	3.97
Montenegro	ME	1.31	1.66	2.54	3.42	4.30
Macedonia	MK	1.28	1.62	2.48	3.33	4.19
Malta	MT	1.40	1.78	2.71	3.64	4.58

		Total cost (€/ton)				
		Distance	Distance	Distance	Distance	Distance
Country	**Country code**	**3 km**	**5 km**	**10 km**	**15 km**	**20 km**
Netherlands	NL	1.65	2.07	3.13	4.18	5.23
Poland	PL	1.39	1.76	2.68	3.60	4.52
Portugal	PT	1.37	1.74	2.67	3.59	4.52
Romania	RO	1.34	1.70	2.59	3.49	4.39
Serbia	RS	1.31	1.67	2.55	3.44	4.33
Sweden	SE	1.59	2.00	3.04	4.08	5.12
Slovenia	SI	1.40	1.77	2.70	3.64	4.57
Slovakia	SK	1.39	1.76	2.69	3.62	4.55
Turkey	TR	1.43	1.82	2.80	3.77	4.74
Ukraine	UA	1.20	1.51	2.29	3.08	3.86
United Kingdom	UK	1.64	2.07	3.14	4.22	5.29
Kosovo	KO	1.29	1.63	2.49	3.36	4.22

(Source: Data from KTBL, the ‘Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V’)

Table 66 Cost for solid and liquid manure (excluding transport cost)

	€/ton manure (as received)				
	Liquid manure	**Solid manure**		**Liquid manure**	**Solid manure**
UK	0	28.2	LT	0	12.0
FR	0	29.5	LV	0	12.0
IE	0	28.2	MT	0	12.0
LU	0	28.2	PL	0	12.0
NL	0	28.2	RO	0	12.0
SE	0	28.2	SI	0	12.0
AT	0	28.2	SK	0	12.0
BE	0	28.2	BG	0	12.0
DE	0	28.2	CY	0	12.0
DK	0	28.2	CZ	0	12.0
FI	0	28.2	EE	0	12.0
HR	0	12.0	EL	0	12.0
HU	0	12.0	ES	0	12.0
IT	0	12.0	PT	0	12.0

Table 67 Cost for perennials per ton DM (2010)

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	Switchgrass	RCG	Willow	Poplar
NUTS2	High	High	High	High	High
AT11	29.2	25.8		48.6	
AT12	33.2	28.1		51.5	
AT13	60.3	30.1		46.0	
AT21	59.5	27.8		40.4	
AT22	37.6	29.4		49.4	
AT31	42.1	34.0		55.8	
AT32	67.9	29.1		38.2	
AT33	94.4	30.4		46.2	
AT34		29.1		43.5	
BE10	49.8	37.4		52.2	
BE21	46.2	45.2		66.6	
BE22	46.2	40.2		55.0	
BE23	46.7	36.9		60.0	
BE24	54.1	33.7		42.4	
BE25	47.2	36.9		58.1	
BE31	54.0	35.2		43.3	
BE32	53.4	34.8		42.7	
BE33	47.5	37.7		54.5	
BE34	47.8	37.4		55.4	
BE35	54.7	36.1		43.4	
BG31	16.3	13.4		24.3	
BG32	14.8	14.6		26.1	
BG33	15.8	17.3		29.5	
BG34	17.9	14.9		31.2	
BG41	15.6	14.4		31.5	
BG42	17.1	16.7		35.3	
CH01	53.0	29.3		47.0	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
CH02	53.0	29.3		47.0	
CH03	53.0	29.3		47.0	
CH04	53.0	29.3		47.0	
CH05	53.0	29.3		47.0	
CH06	53.0	29.3		47.0	
CH07	53.0	29.3		47.0	
CY00	34.4				79.4
CZ01	20.8	12.4		27.7	
CZ02	21.0	15.3		28.2	
CZ03	21.6	16.7		28.2	
CZ04	21.8	14.6		27.9	
CZ05	20.5	16.1		26.9	
CZ06	18.3	14.2		27.3	
CZ07	18.4	13.8		23.4	
CZ08	19.6	14.6		24.6	
DE11	46.9	36.1		69.8	
DE12	45.2	34.8		62.5	
DE13	49.4	38.3		69.1	
DE14	56.3	38.8		73.9	
DE21	72.1	36.1		54.1	
DE22	51.8	38.5		72.2	
DE23	50.2	43.0		83.0	
DE24	50.9	41.2		92.8	
DE25	48.7	39.9		82.4	
DE26	48.6	40.3		72.5	
DE27	73.0	36.8		55.5	
DE30	50.7	42.3		80.4	
DE40	44.9	45.2		98.5	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
DE50	50.7	42.3		80.4	
DE60	50.7	42.3		80.4	
DE71	45.9	37.7		64.6	
DE72	51.1	37.3		64.6	
DE73	52.5	43.9		78.0	
DE80	52.2	44.8		99.5	
DE91	51.0	40.7		80.3	
DE92	51.7	41.2		82.7	
DE93	51.4	47.1		103.2	
DE94	52.4	45.1		99.1	
DEA1	49.5	37.9		61.7	
DEA2	50.1	38.3		67.0	
DEA3	49.2	49.6		93.7	
DEA4	51.9	46.2		87.9	
DEA5	52.4	42.4		76.2	
DEB1	48.7	39.7		66.5	
DEB2	49.6	43.5		71.8	
DEB3	44.4	36.2		65.6	
DEC0	46.2	38.4		62.7	
DED2	48.0	39.5		79.8	
DED4	48.0	39.5		79.8	
DED5	48.8	39.8		87.4	
DEE0	50.7	42.3		80.4	
DEF0	58.0	46.3		104.2	
DEG0	51.6	40.8		83.8	
DK01			61.4	114.0	
DK02			61.4	114.0	
DK03			61.4	114.0	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
DK04			61.4	114.0	
DK05			61.4	114.0	
EE00			14.5	30.4	
EL11	33.4	47.2			112.4
EL12	35.9	46.5			134.6
EL13	40.5	35.9			117.8
EL14	40.5	56.6			146.4
EL21	52.7	70.3			117.8
EL22	47.6	82.9			94.6
EL23	54.5	105.0			158.1
EL24	54.0	112.6			189.5
EL25	55.2	126.3			142.3
EL30	56.9	112.4			148.0
EL41	44.6	107.7			199.8
EL42	53.3	118.4			138.0
EL43	52.1	123.6			111.1
ES11	45.5	58.1			82.5
ES12	55.6	48.5			134.5
ES13	46.1	52.7			96.0
ES21	42.5	53.2			71.3
ES22	45.7	64.9			80.9
ES23	50.8	77.1			111.2
ES24	49.2	89.2			138.7
ES30	55.5	129.9			219.7
ES41	50.5	83.6			159.3
ES42	52.1	120.1			201.9
ES43	44.1	146.2			111.9
ES51	41.6	62.9			128.1

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
ES52	46.1	96.6			154.2
ES53	39.4	80.6			113.4
ES61	42.0	142.2			105.6
ES62	52.2	156.9			189.3
ES63	47.4	91.4			131.2
ES64	47.4	91.4			131.2
ES70	47.4	91.4			131.2
FI19			36.0	89.5	
FI1B			31.5	84.1	
FI1C			33.9	107.2	
FI1D			43.4		
FI20			29.8	389.9	
FR10	44.4	36.4		58.3	
FR21	43.7	38.4		66.0	
FR22	44.5	37.7		63.6	
FR23	45.5	35.3		56.2	
FR24	40.7	41.6		66.5	
FR25	56.4	37.0		40.9	
FR26	42.6	36.9		62.1	
FR30	48.7	34.9		58.7	
FR41	43.5	37.1		61.8	
FR42	46.3	39.0		63.3	
FR43	43.9	34.5		56.0	
FR51	39.4	42.6		58.7	
FR52	44.8	35.2		55.5	
FR53	39.6	42.1		66.2	
FR61	37.8	42.0		61.9	
FR62	40.5	40.7			79.5

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
FR63	40.7	33.8		57.5	
FR71	49.3	37.4			91.5
FR72	40.2	43.6		67.0	
FR81	43.7	58.3			138.2
FR82	45.2	49.4			141.5
FR83	32.5	50.0			63.2
FR91	43.4	40.2		60.0	102.8
FR92	43.4	40.2		60.0	102.8
FR93	43.4	40.2		60.0	102.8
FR94	43.4	40.2		60.0	102.8
HR03	19.6	16.0	13.9	28.5	33.0
HU10	17.0	13.4		26.9	
HU21	15.6	12.1		30.0	
HU22	15.6	11.3		24.5	
HU23	15.5	12.1		27.8	
HU31	16.3	11.4		21.7	
HU32	15.2	14.3		27.1	
HU33	15.1	15.7		29.4	
IE01			33.5	50.4	
IE02			31.2	50.3	
IS00					
ITC1	64.4	55.4			115.4
ITC2	98.6	59.7			462.8
ITC3	49.6	74.6			149.4
ITC4	57.5	55.0			156.5
ITF1	54.0	70.5			151.0
ITF2	49.1	87.0			156.2
ITF3	49.2	92.9			174.2

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
ITF4	43.9	108.1			170.6
ITF5	51.6	113.6			182.2
ITF6	44.4	97.6			173.6
ITG1	46.3	145.7			214.1
ITG2	48.8	102.5			190.5
ITH1	95.9	62.5			267.7
ITH2	96.2	62.6			267.7
ITH3	56.3	69.7			156.9
ITH4	57.8	61.4			222.5
ITH5	45.3	69.4			153.2
ITI1	49.7	81.5			136.2
ITI2	49.9	74.4			145.1
ITI3	45.6	65.6			158.7
ITI4	46.0	70.8			139.5
LI00					
LT00			8.9	19.4	
LU00	49.8	37.4		52.2	
LV00			10.3	21.9	
ME00	17.2	17.0		18.0	42.1
MK00	17.2	17.0		18.0	42.1
MT00	31.6	37.3			73.0
NL11	80.8	72.3		145.1	
NL12	82.4	75.4		128.7	
NL13	83.9	78.1		142.4	
NL21	77.9	76.7		125.5	
NL22	73.0	66.4		99.8	
NL23	78.9	68.6		128.9	
NL31	74.5	62.5		93.7	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
NL32	81.8	67.6		116.3	
NL33	76.5	65.4		108.3	
NL34	74.9	63.2		125.9	
NL41	74.0	70.5		115.3	
NL42	72.7	61.2		93.0	
NO01			61.2	83.1	
NO02			61.2	83.1	
NO03			61.2	83.1	
NO04			61.2	83.1	
NO05			61.2	83.1	
NO06			61.2	83.1	
NO07			61.2	83.1	
PL11			28.1	46.3	
PL12			28.4	49.8	
PL21			29.1	44.2	
PL22			28.9	41.7	
PL31			27.6	41.7	
PL32			27.9	42.0	
PL33			28.1	38.9	
PL34			29.7	48.6	
PL41			28.7	50.8	
PL42			30.1	46.8	
PL43			29.1	50.3	
PL51			28.4	45.9	
PL52			27.8	43.7	
PL61			29.2	49.0	
PL62			31.0	47.9	
PL63			32.1	51.3	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
PT11	34.0	39.3			66.3
PT15	33.7	38.6			86.1
PT16	30.9	35.5			76.3
PT17	25.6	29.5			76.3
PT18	30.1	34.5			84.1
PT20	30.9	35.5			77.8
PT30	30.9	35.5			77.8
RO11	14.8	10.5		19.5	
RO12	13.5	15.7		23.6	
RO21	13.6	11.3		20.7	
RO22	13.6	11.5		19.2	
RO31	13.7	10.7		19.7	
RO32	15.8	10.3		17.6	
RO41	16.2	11.1		18.2	
RO42	13.7	8.8		18.8	
SE11			58.7	67.6	
SE12			57.6	73.1	
SE21			53.7	65.2	
SE22			66.6	120.4	
SE23			85.1	956.8	
SE31			96.0		
SE32			56.0	70.2	
SE33			56.4	71.6	
SI01	18.8	20.5			60.2
SI02	18.8	20.5			60.2
SK01	14.7	14.7		23.2	
SK02	14.3	14.2		21.7	
SK03	16.4	16.4		19.7	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
SK04	15.8	15.8		18.7	
TR10	10.3	10.2		10.8	25.3
TR21	10.3	10.2		10.8	25.3
TR22	10.3	10.2		10.8	25.3
TR31	10.3	10.2		10.8	25.3
TR32	10.3	10.2		10.8	25.3
TR33	10.3	10.2		10.8	25.3
TR41	10.3	10.2		10.8	25.3
TR42	10.3	10.2		10.8	25.3
TR51	10.3	10.2		10.8	25.3
TR52	10.3	10.2		10.8	25.3
TR61	10.3	10.2		10.8	25.3
TR62	10.3	10.2		10.8	25.3
TR63	10.3	10.2		10.8	25.3
TR71	10.3	10.2		10.8	25.3
TR72	10.3	10.2		10.8	25.3
TR81	10.3	10.2		10.8	25.3
TR82	10.3	10.2		10.8	25.3
TR83	10.3	10.2		10.8	25.3
TR90	10.3	10.2		10.8	25.3
TRA1	10.3	10.2		10.8	25.3
TRA2	10.3	10.2		10.8	25.3
TRB1	10.3	10.2		10.8	25.3
TRB2	10.3	10.2		10.8	25.3
TRC1	10.3	10.2		10.8	25.3
TRC2	10.3	10.2		10.8	25.3
TRC3	10.3	10.2		10.8	25.3
UKC1		103.6		72.9	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	Switchgrass	RCG	Willow	Poplar
NUTS2	High	High	High	High	High
UKC2		103.5		72.8	
UKD1	86.1	135.4		72.9	
UKD3	86.5	135.4		73.2	
UKD4	86.4	135.4		73.1	
UKD6	86.5	135.4		73.2	
UKD7	89.2	135.4		75.2	
UKE1	72.0	119.8		73.9	
UKE2	71.8	119.8		73.5	
UKE3	71.9	119.8		73.8	
UKE4	71.6	119.8		73.3	
UKF1	55.7	92.6		65.5	
UKF2	55.8	92.6		65.7	
UKF3	55.9	92.6		65.8	
UKG1	63.8	99.4		48.8	
UKG2	63.6	99.4		48.7	
UKG3	63.6	99.4		48.6	
UKH1	51.1	83.9		55.4	
UKH2	51.2	83.9		55.5	
UKH3	51.0	83.9		55.3	
UKI1	68.5	110.2		65.1	
UKI2	68.5	110.2		65.1	
UKJ1	53.7	82.4		44.4	
UKJ2	53.3	82.4		44.1	
UKJ3	53.5	82.4		44.3	
UKJ4	53.5	82.4		44.3	
UKK1	60.1	94.1		44.1	
UKK2	59.8	94.1		43.9	
UKK3	59.8	94.1		43.9	

	€/ton: cost (€/ha)/yield (ton/ha)				
	Miscanthus	**Switchgrass**	**RCG**	**Willow**	**Poplar**
NUTS2	**High**	**High**	**High**	**High**	**High**
UKK4	59.8	94.1		43.9	
UKL1	73.5	116.5		53.3	
UKL2	73.5	116.5		53.3	
UKM2		43.6		58.8	
UKM3		43.5		58.6	
UKM5		43.7		59.0	
UKM6		43.5		58.6	
UKN0		61.1		54.7	
HR04	19.6	16.0	13.9	28.5	33.0
AL00	10.3	10.2		10.8	25.3
BA00	17.2	17.0		18.0	42.1
CS00	17.2	17.0		18.0	42.1
KO00	17.2	17.0		18.0	42.1

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