

A low-angle, upward-looking photograph of a dense forest canopy. The image shows numerous green leaves and dark tree branches against a clear blue sky. The perspective creates a sense of height and growth.

SUSTAINABLE BIOMASS SUPPLY IN EU

According to the analysis of the Member States' National Renewable Energy Action Plans, biomass will make up 19% of total renewable electricity in the year 2020, 78% of total renewable heating and cooling in 2020 and 89% of total renewable energy in transport.

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All together, bioenergy is expected to make up over 50% of total renewable energy use¹. The Biomass Futures project (www.biomassfutures.eu) assesses the role of bioenergy in meeting Europe's renewable energy targets as spelled out in the Renewable Energy Directive (RED)². It does so by conducting sectoral market analyses, estimating the availability of biomass for energy and by modelling the demand and supply of bioenergy within the energy system. In this paper we present results from Biomass Futures modelling work on the supply of different biomass sources in the EU under different sustainability constraints and illustrate how much of these sources could eventually be exploited for reaching the 2020 NREAP targets.

Biomass Futures project investigates Europe's future biomass supply under various scenarios

It is not without a reason that there is large emphasis on sustainability when realizing the EU renewable targets. Firstly, the reduction of GHG emissions for mitigating climate change is one of the main drivers for setting these targets. Second, it is evident that a strong increase in biomass supply is needed which may have significant effects on EU-wide and global agricultural land demand, and overall environmental quality. In the biomass supply estimates presented in this paper, two alternative packages of sustainability criteria are applied: 1) Present RED criteria for biofuel feedstocks only; 2) Stricter sustainability criteria applied to all bioenergy feedstock, including solid and gaseous bioenergy (see Table 1).

Biomass potential will increase and change in composition towards 2020

The present EU biomass supply is estimated at 314 MTOE (see Figure 1)³. In this estimate the biofuel and perennial crop potentials refer to amounts that are actually converted to energy at present. For the other categories the amounts should be seen as real potentials which are largely not converted to bioenergy at present. Especially the forest biomass categories, particularly roundwood production, are mostly going to competing uses. The additionally harvestable forest potential is not harvested at all, not even for competing uses. Towards 2020 the potential categories largely remain in the same size ranges with the exception of the supply of bioenergy crops which will clearly increase as compared to present day use of these sources. In addition the use of waste and forestry residues will clearly increase towards the future as will landscape care wood. The round wood production and the additionally harvestable round wood potential will practically remain the same towards 2020, but their use for bioenergy purposes might increase given increased demand for biomass.

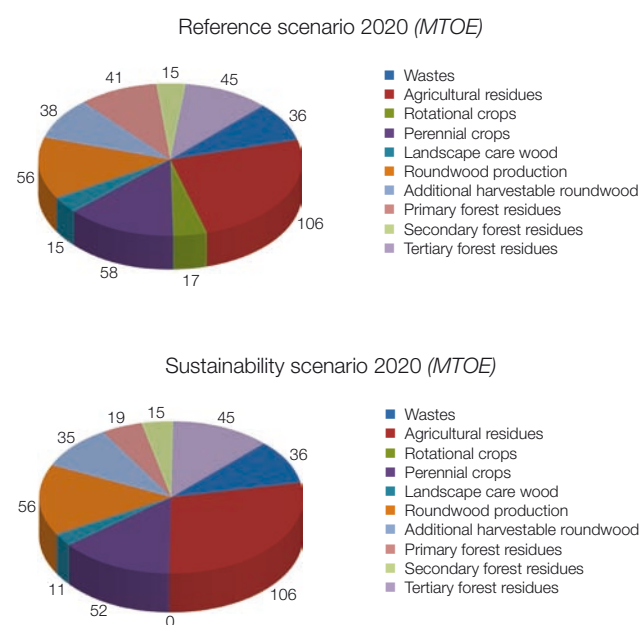
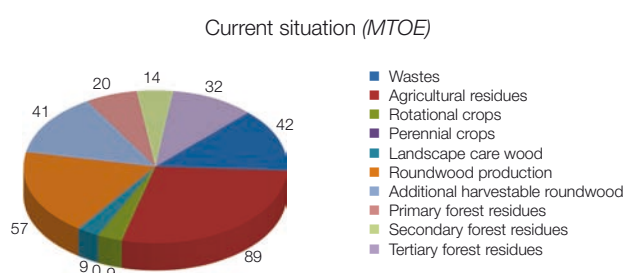


Table 1: Sustainability criteria in reference and sustainability scenarios applied to estimate the EU wide 2020 biomass potential

	GHG mitigation	Other constraints
Reference scenario	Mitigation target for biofuels of 50% as compared to fossil alternative, excluding compensation of ILUC ⁴ related emissions. Mitigation target for other biofuels must be positive.	No use of biomass for biofuels cropped on biodiverse land or land with high carbon stock.
Sustainability scenario	Mitigation target for bioenergy (fuels, heat and electricity) of 70% as compared to fossil alternative, including compensation for ILUC ⁵ related emissions.	No use of biomass cropped on biodiverse land or land with high carbon stock. For forests, strict biomass harvesting guidelines apply (application of fertilizer after logging residue and stump extraction not permitted, part of forests are set aside to protect biodiversity, limited intensification in forest exploitation).

When the 2020 situation is compared between the reference and the sustainability scenario (see Figure 1) it is clear that stricter sustainability criteria lead to a reduction in domestic supply by 13%. In total there is a potential of 429 MTOE in the reference and 375 MTOE in the sustainability scenario. This reduction is especially caused by smaller potentials for energy crops (reduced perennials and no rotational biofuel crops), no biofuel cropping being possible under the sustainability criteria of 70% mitigation requirement with ILUC compensation. The analysis shows that a 70% mitigation as compared to the fossil alternative is still feasible in most EU biofuel crops (e.g. cereals, rape, sunflower, sugarbeet, maize) if only direct emissions need to be compensated. However, since these crops need good agricultural lands they compete with food and feed crops. Exchange of the latter with biofuel crops will lead to a displacement effect, e.g. the food and feed crops will be grown elsewhere causing land use changes elsewhere. The emissions caused by the displacement effect also need to be compensated in the sustainability scenario. Because of this the amount of GHG emissions to be compensated often increase with an extra 50% to 100% of the direct emissions and this compensation is no longer possible.

Figure 1: Supply of biomass categories (MTOE) in present situation and 2020 reference and sustainability scenarios



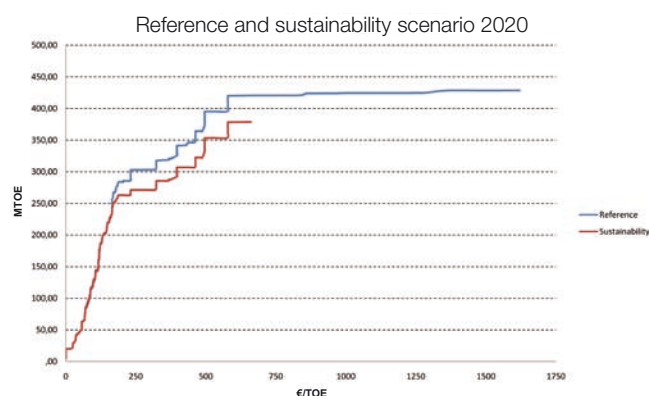
Also for dedicated cropping with perennials it becomes more difficult in the sustainability scenario to reach the mitigation target. The same principle applies to these crops where displacement effects are caused, ILUC emissions also need to be compensated too. This however does not happen as often as with rotational biofuel crops as these need better soils and are therefore competing with food and feed crops more often. Perennial crops can be grown on lower quality soils which could be fallow lands or lands released from agriculture. ILUC effects on these lands are therefore not applicable, reaching the mitigation targets then becomes more feasible. In addition there will also be a significantly smaller supply from the additional harvestable round wood and primary forestry residues categories in the sustainability scenario, because of stricter exploitation criteria.

Stricter sustainability criteria also lead to a modest shift in the cost-supply relation as in the reference scenario there is 300 MTOE biomass available at a price of maximum 250 €/TOE while in the sustainability scenario this does not even reach 270 MTOE. At 500 €/TOE the reference reaches 395 MTOE and in the sustainability scenario only 353 MTOE.

Biomass demand much smaller than EU potential but biomass imports remain

The level of possible exploitation of the above mentioned

Figure 2: Cost-supply relation of biomass categories (MTOE) in reference and sustainability scenario



biomass supply has been assessed by the RESolve model⁶. With this model the demand for biomass for electricity, heating and transport as indicated in the NREAPs was analyzed. These demand figures are specified for solid biomass, liquid biomass and biogas for electricity and heat respectively, furthermore a 9% share of biofuels is assumed⁷. The analysis is based on a least costs optimization with respect to a fossil reference. Current and anticipated RES policies have been included and imports of biomass from outside the EU are allowed. These imports mainly consist of wood pellets, feedstocks for biofuel production and biofuels.

Initial results indicate that about 155 MTOE of domestic biomass will be utilized, which is only 37% of the domestic supply, see Table 2. Although this is significantly larger than the amount imported from outside the EU, which is estimated at 46 MTOE, it is clear that in theory there is room to utilize more biomass than indicated in the NREAPs.

As illustrated in Table 2 agricultural and forestry residues fulfill more than half of the demand followed by wastes and perennial crops. The total supply of rotational crops will not be sufficient to fulfill the policy driven demand in the transport sector. Therefore 3 MTOE of biofuels and 23 MTOE of feedstocks for biofuel production will be imported. The preliminary modeling results clearly indicate that most of the cheap domestic feedstock will be utilized (i.e. wastes, landscape care wood, secondary and tertiary forestry residues) to meet the demand and the gap is likely to be filled by imported biomass feedstocks and biofuels. While forestry residues and certainly dedicated cropping with perennials will clearly remain underutilized domestic sources⁸ because at the domestic prices they can hardly compete with imported resources.

Although the demand analysis with RESolve for the supply from the sustainability scenario had not been finalized at the submission date of this article, some significant differences in demand could already be mentioned. In absence of domestic cropped biofuel feedstock supply, used fats and oils meet 6-7% of the biodiesel demand, the largest part of the biofuel feedstock and biofuels will need to come from both domestic and imported resources that comply with the stricter sustainability criteria. One can expect that under stricter sustainability criteria the demand for domestic residues, waste categories and dedicated perennial crops particularly for conversion into (2nd generation) biofuels may increase. This however will only happen if in this scenario

the sustainability criteria are accompanied by stimulation measures that stimulate the technological development and implementation of technologies to produce the ligno-cellulosic based fuels. This will create a larger demand for ligno-cellulosic materials which is likely to lead to larger utilisation of domestic wastes and cropped biomass. As in the reference also in the sustainability scenario it is not likely that the use of roundwood and additionally harvestable round wood for bioenergy production will increase strongly. Prices for these domestic

Table 2: Demand of domestic biomass in the reference scenario in 2020

Category	Demand [MTOE]	Fraction of supply [%]
Wastes	23.7	84%
Agricultural residues	17.1	16%
Rotational crops	8.6	71%
Perennial crops	23.0	40%
Landscape care wood	8.6	100%
Roundwood production	0.0	0%
Additional harvestable roundwood	0.0	0%
Primary forestry residues	31.6	77%
Secondary forestry residues	11.0	73%
Tertiary forestry residues	30.7	56%
TOTAL	154.5	37%

resources ranging from 375-590 €/TOE (=9-14 Euro/GJ) are expected to remain too high as compared to imported feedstocks such as wood pellets.

While cropped first generation fuels need to be imported because of sustainability and land constraints, forest and waste biomass remain under-utilized

Stricter sustainability criteria will have strong implications for the demand supply dynamics. The sustainability scenario on biomass supply indicates that the domestic production of rotational crops will totally disappear in 2020 as ILUC⁹ compensation is not feasible. This is expected to lead to increased use of biofuels from waste from domestic and imported sources for 2nd generation based biofuels and of 1st generation biofuels from crops grown on degraded lands and on arable lands in very efficient systems (most probably sugarcane from Brasil). The biofuel targets can however only be realized in the sustainability scenario if this is accompanied by strong technology developments making ligno-cellulosic material from domestic sources more likely to be exploited for biofuel production. How this will influence the final level of imports cannot be presented yet. As to the heat and electricity sector there is sufficient biomass supply to meet the biomass demand (based on NREAPs). In the sustainability scenario there will be however slightly higher import needs for pellets as the primary forestry residues and perennial crops are smaller than in the reference scenario. Wood pellets are an important input for co-firing which is a conversion pathway that is expected to increase significantly towards 2020.

Preliminary conclusions point out that both in the reference and sustainability scenario there is plenty of domestic biomass available for meeting the heat and electricity targets. However, these are only partly available at competitive price ranges (165€/TOE - 350€/TOE). This situation is therefore likely to further drive the increase of imports. Domestic feedstocks can therefore be utilized to the extent they can compete with the imported biomass unless some policy intervention prioritizes the domestic use of resources.

Measures to mobilise the domestic potential may be considered which could include the creation of more efficient logistics and integration of residue use into energy supply for onsite (forest & agro-industry) process activities. The latter may be stimulated through policy interventions like increased support towards targeted research and technology innovation in improving logistics (scale, feedstock typology & regional infrastructure issues), support for change of boilers in the domestic, services & industry sectors to biomass ones, tax exemptions.

Notes:

1) These figures are taken from http://www.ecn.nl/docs/library/report/2010/e10069_summary.pdf. Another valuable Biomass Futures report based on the 23 NREAPs available at the time of drafting is Atanasiu (2010). *The role of bioenergy in the National Renewable Energy Action Plans: a first identification of issues and uncertainties*, (http://www.biomassfutures.eu/work_packages/WP8%20Dissemination/D8.4%20bioenergy_in_NREAPs-final_08_12_2010.pdf), which focuses on analysing the bioenergy information contained in the NREAPs.

2) Directive 2009/28/EC of the European Parliament and of the Council of 5 June 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. The RED requires the EU to generate 20 per cent of energy from renewable sources by 2020, and each Member State to achieve a 10 per cent share of renewable energy sources in the transport sector.

3) For detailed explanation of how potential categories were estimated and which data sources were used we refer to: Elbersen, B., Staritsky, I., Böttcher, H., Frank, S. & Naef, H. (2011). *Deliverable 3.3: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources*. Available at: <http://www.biomassfutures.eu/>

4) Emissions related to indirect land use changes (ILUC).

5) See note 4

6) The RESolve model is an optimization model developed by ECN. The model fulfils given demands for biofuels for transport, electricity and heating using biomass in a least cost manner with respect to fossil references. In this optimization stimulating measures can be included. The model has previously been applied to analyse the EU biofuel sector in several large projects funded by the European Commission (REFUEL). The RESolve model has been extended with electricity and heat as compared to the model described in Lensink, S. and Londo, M. (2010): *Assessment of biofuels supporting policies using the BioTrans model*, Biomass and Bioenergy 34 (2010), 218-226, 2010.

7) According to the NREAPs of the 10% transport target, roughly 9% is biofuel and 1% electrical vehicle.

8) It is important to note that the modeling work did not include the likely price increases even in this cheapest feedstocks due to increased demand from three different sectors (electricity, heat and biofuels).

9) The ILUC factors used here are based on an inventory of published studies in which indirect land use effects of biofuel demand have been modelled (see the report referred to in note 3). The median of the ILUC factors from this compilation of the studies was used in our analysis. The more optimistic ILUC estimates of the ATLASS study (see Commission staff working document, SEC (2011)) were not included in this inventory. So basically the ILUC factors used by us represent the worst case scenario - while if the lower ones from ATLASS would be used there would still be more 1st generation biofuels both from domestic, but particularly from imported sources. But also in this situation the domestic biofuel production would be so limited that it would by far not cover the NREAP 2020 demand for biofuels.

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