BIOMASS FUTURES

Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders. **IEE 08 653 SI2. 529 241**

Sustainable biomass for electricity, heat and transport fuels in the EU27

Policy summary

Deliverable D5.4

Ayla Uslu
Joost van Stralen

May 2012
ECN-E--12-030

ECN
Energy research Centre of the Netherlands

INTELLIGENT ENERGY EUROPE

BIOMASS FUTURES

May, 2012

INTELLIGENT ENERGY EUROPE

BIOMASS FUTURES

Preface

This publication is part of the BIOMASS FUTURES project ('*Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders*' - IEE 08 653 SI2. 529 241, www.biomassfutures.eu) funded by the European Union's Intelligent Energy Programme.

In this publication the summary of a scenario based modelling analysis of biomass use to produce electricity, heat and transport fuels in 2020 and 2030 is presented. The analysis is focused particularly on reaching the biomass demands included in the National Renewable Energy Action Plans (NREAPs). NREAPS detail how the Member States plan to reach their renewable energy target set by the Renewable Energy Directive in 2009.

BIOMASS FUTURES

Contents

1

Introduction

Biomass plays a key role in any low-carbon roadmap [i.e. EU Energy Road Map 2050,]. There is, however, an on-going debate concerning the environmental and socioeconomic consequences of biomass use for energy purposes. The large variety of feedstocks and applications, combined with the challenges around sustainable use of biomass resources call for a sound analysis of how the potential can be used in a wise manner. Therefore, the Biomass Futures project aims to contribute to the discussion by addressing the role biomass resources can play to meet the renewable energy targets laid down by the Renewable Energy Directive (RED) (Directive 2009/28/EC, 2009) and detailed in the National Renewable Energy Action Plans (NREAP).

This study focuses on three scenarios – reference scenario, sustainability scenario and the high biomass scenario – that aim at illustrating the likely impacts of sustainability criteria on biomass supply to meet bioenergy targets of the EU27 Member States. These scenarios are briefly introduced below. Further details of the scenarios developed can be found in (Uslu and van Stralen, 2012).

Reference scenario: NREAP targets reassessed

This scenario aims at re-analysing the contribution of bioenergy in reaching the national renewable energy targets. In their NREAPs Member States specified the total contributions expected from biomass to electricity, heating and cooling, and transport sectors up to 2020. However, the Member States did not indicate whether they included the sustainability criteria for biofuels into their estimates. Therefore, the objective of this scenario is to provide a refined basis for assessing sustainable bioenergy supply based energy demand per Member States.

As this scenario looks into the current policy process **sustainability criteria are only applied to biofuels for transport sector**. An important dilemma within the sustainability criteria – the indirect land use change issue – is not addressed in this scenario.

Sustainability scenario: binding sustainability criteria and indirect land use change

This scenario considers **binding sustainability criteria for bioenergy that covers all energy sectors (electricity, heating and cooling, and transport sectors), and imports**. Different from the reference scenario, this scenario applies higher GHG mitigation targets-increasing to 80% by 2030. Furthermore, this storyline presents a future in which the indirect land use change implications of the biofuels are

compensated through crop specific indirect Land Use Change (iLUC) factors. Crop specific iLUC factors are derived from Elbersen et al. (2012) and presented in Annex I.

High biomass scenario: ambitious policy targets

While the first two scenarios aim at analysing the biomass role defined by the NREAPs this scenario considers stronger policy ambitions. The objective of this scenario is to analyse the role of biomass given the fact that there is quite a large amount of unutilised biomass potential in the EU. As a starting point 25 % higher targets for solid biomass for bio-electricity and bio- heat (in comparison to NREAP figures) are targeted. As a next step, it is assumed that the EU Member States are willing to pay the required policy costs.

The sustainability criteria in line with the current RED directive are only applied to biofuels for transport.

The assumptions applied to the scenarios are presented in **Annex II.**

Based on the scenario based modelling work (Uslu et al.,2012) this document addresses the questions listed below.

- Where does the EU stand with regard to the bioenergy ambitions?
- Can EU primary biomass supply satisfy the demand in 2020?
- Can EU meet the NREAP bioenergy goals in 2020?
- What will be the implications of indirect land use change and expanding the sustainability criteria to electricity and heat sector?
- What role will import of biofuels and wood pellets play ?
- How much GHG emissions can be avoided if the bioenergy targets are met?

2

Where does the EU stand with regard to bioenergy ambitions?

Article 4 of Directive 2009/28/EC on renewable energy requires each Member State to adopt a national renewable energy action plan (NREAP) to be submitted to the European Commission.

These plans are to set out the Member State's national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, demonstrating how the Member States will meet their overall national target established under the Directive. While the goals set for each renewable energy source may change in time they clearly represent the ambitions of the countries and what role they foresee for different renewable energy resources. In this regards, presenting the 2010 and 2020 goals of the Member States for bioenergy in comparison to the recent progress can shed some light to how far the EU27 is in reaching their policy ambitions. The 2020 progress data presented in this section is mainly derived from the recent progress reports[1] published in [EC, 2012].

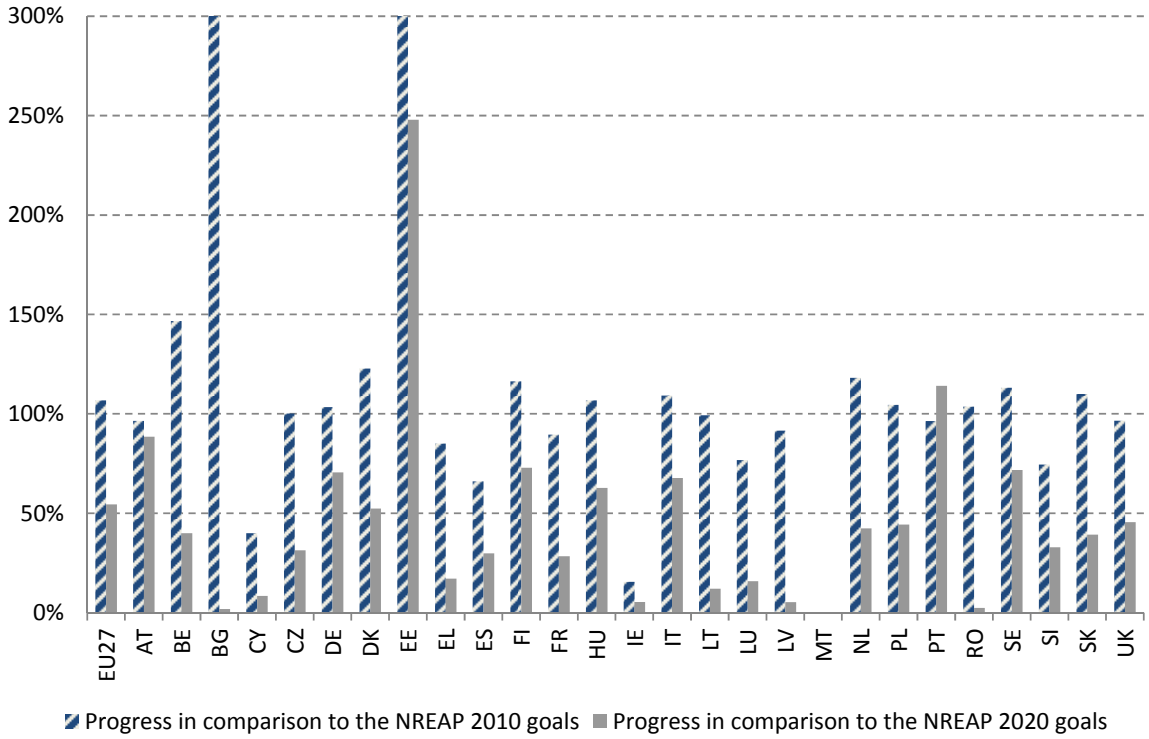
Biomass in the electricity sector:

EU27 as a whole achieves 2010 indicative targets, doubling of the current production is needed to meet the 2020 targets

Figure 1 presents the progress in 2010 in comparison to NREAP data for the same year and for 2020. The figure clearly shows that EU27 as a whole meet 2010 NREAP indicated goals, whereas countries like Cyprus, Greece, Spain, Ireland, Luxemburg, Malta, and Slovenia remain below their indicative targets. Austria, Estonia, Portugal, German and Sweden project relatively low ambitious growth rates up to 2020 when compared to the other countries. On the other hand countries like Bulgaria and Romania assume to achieve more than 40 times the 2010 electricity production figures. Other ambitious countries are Cyprus, Ireland, Latvia, with 10 times the 2010 achievements to happen in the coming 10 years' time.

[1] At the time this analysis is conducted 20 Member States submitted their progress reports. The data for the remaining countries are collected from EurObserv'ER barometers. The 2020 bioenergy goals are derived from (Beurskens et al,2010).

Figure 1: Relative progress in bioelectricity in 2010 in comparison to NREAP 2010 and 2020 figures.

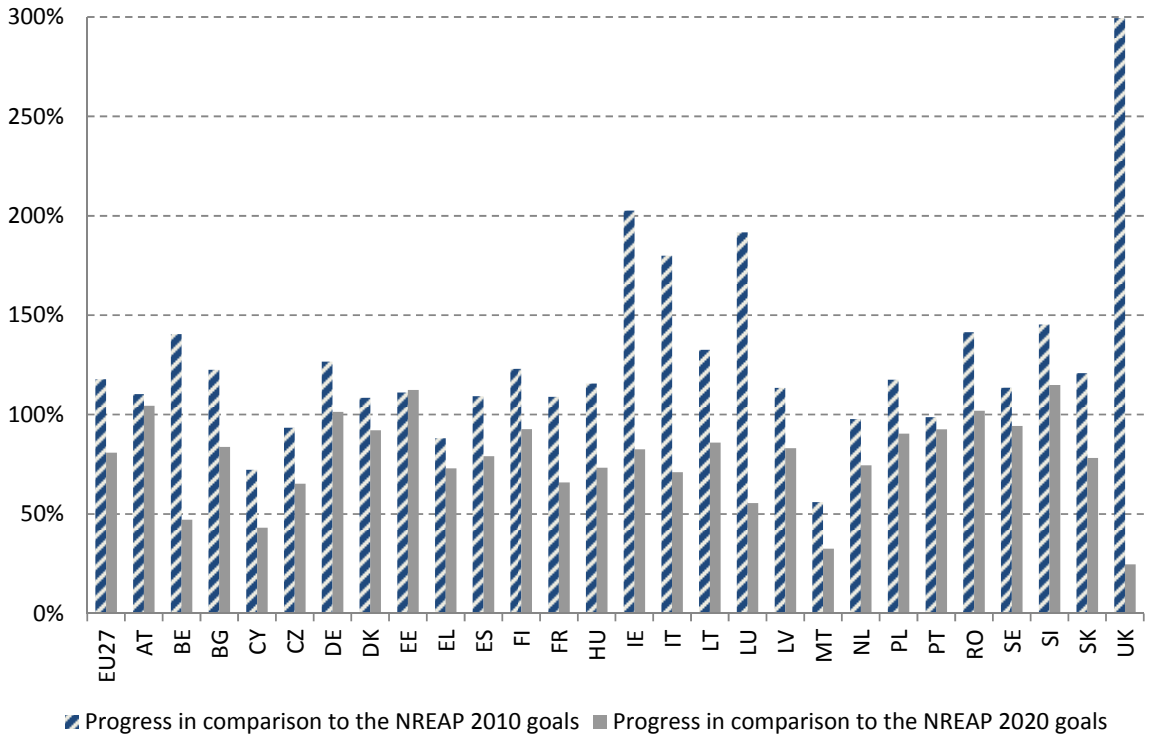


Biomass in the heat sector:

2010 indicative targets were easily achievable for many countries.

Biomass comprises the highest share of the renewable heat market -around 55% of all renewable energy sources in EU27. Figure 2 illustrates the 2010 progress in comparison to the NREAP goals. Many countries meet the 2010 ambitions. However, countries like, Cyprus and Greece are behind their targets. On the other hand, Ireland, Italy, Luxemburg, UK, Finland, France, Sweden and Germany already overshoot their 2010 targets. More interestingly, Austria, Germany, Estonia, Romania and Slovenia appear to already reach their 2020 targets. Belgium, Cyprus, Czech Republic, Luxemburg and France require doubling of their current use, while the UK require increasing bio-heat consumption 4 times the current use in 10 years' time. Overall EU27 requires around 22% growth in bio-heat sector.

Figure 2: Relative progress in bio-heat in 2010 in comparison to 2010 and 2020 NREAP figures.



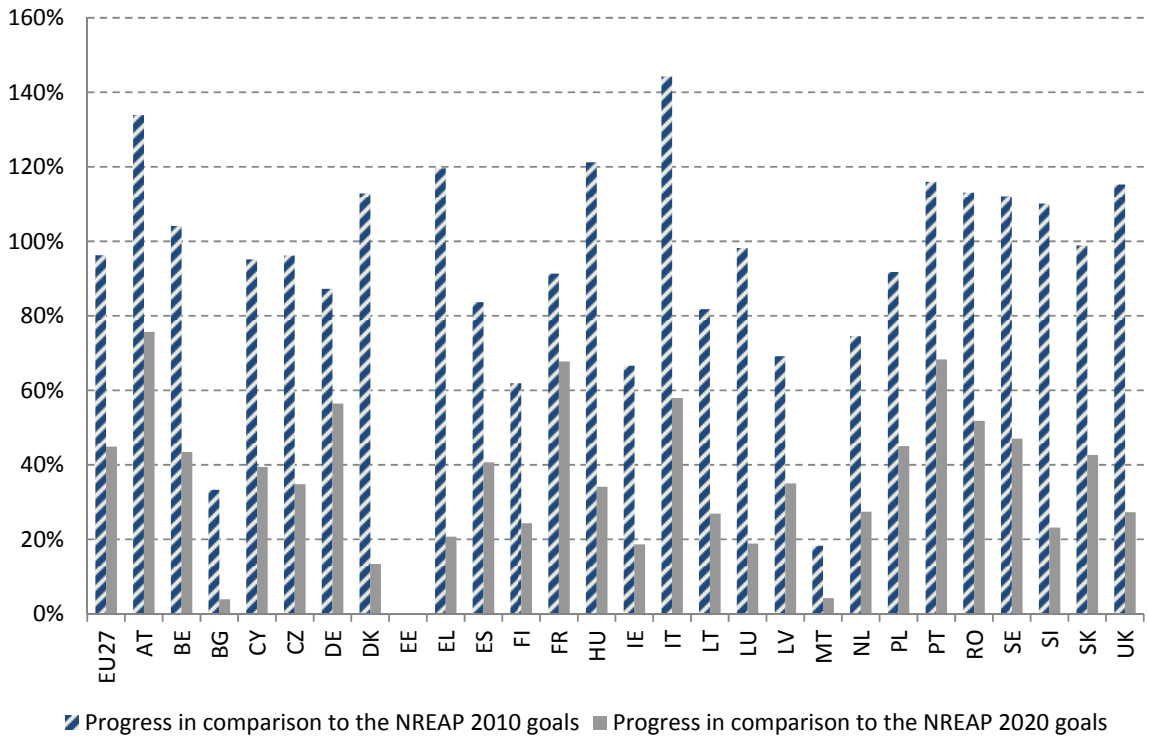
Biofuels in transport:

EU27 could not achieve the 2010 target and the 2020 target is far more challenging.

In 2010 total consumption of biofuels reached around 14 Mtoe in 2010, around 4.7% of the EU27 total transport consumption. The 5.75% targets set for 2010 by the Biofuel Directive (Directive 2003/30/EC**)** are achieved only by Sweden, Austria, France, Germany, Poland, Portugal and Slovakia.

When it concerns the 2020 10% transport fuel targets much heftier efforts will be required from a number of countries (see Figure 3). A complicating factor is that the NREAP targets can change in time as they are dependent on the total fuel consumption, the developments in 2nd generation technologies, the evolution of electric vehicles.

Figure 3: Relative progress in biofuels in 2010 in comparison to 2010 and 2020 NREAP figures

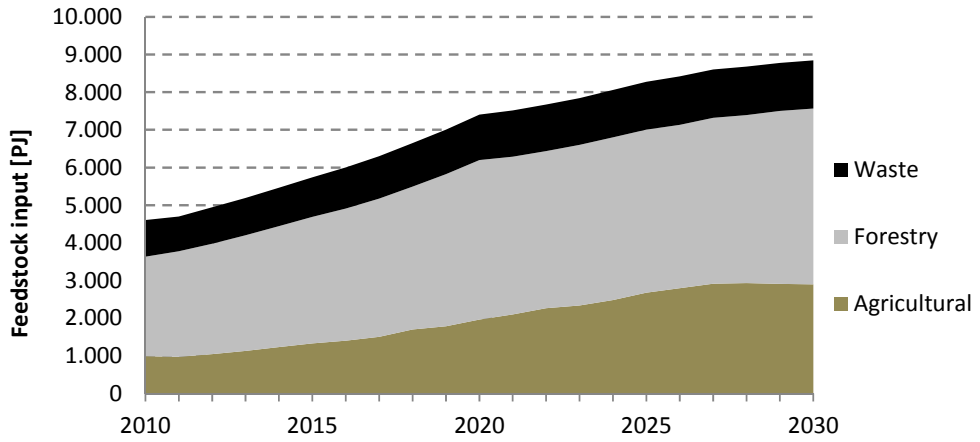


3

Can EU primary biomass supply satisfy the demand in 2020?

The bioenergy targets set in the Members States' NREAPs can in principle be met through utilization of around 7000 PJ (167 Mtoe) primary biomass in 2020 and around 9000 PJ (215 Mtoe) in 2030. The EU primary biomass potential is estimated to be around 15700 PJ (375 Mtoe)[2]- 18000 PJ (429 Mtoe)[3], depending on the scenarios. However, reaching the targets in a cost efficient manner requires around 40% and 50% of the total EU biomass potential for 2020 and 2030, respectively. The modelling exercise calculates the contribution of imported feedstock to be around 14%-18% of the total primary biomass figures representing the reference scenario and the high biomass scenario. Figure 4 illustrates the feedstock input required to reach the 2020 bioenergy targets for the reference scenario.

Figure 4: **Primary biomass utilized in EU27**



[2] Figure is calculated in the reference scenario

[3] Figure is calculated in the high biomass scenario

Figure 5 and Figure 6 present the primary biomass use in comparison to the potentials for the different feedstock categories. There is a relatively low amount of domestic resource use because an important fraction of the total potential is from roundwood and additional harvestable roundwood, which are very expensive(>400 €/toe) in comparison to the alternatives such as imported wood pellets. While the agricultural biomass feedstock potential is significant, model results show that only a limited amount of this potential can actually be utilised (around 30%). One of the underlying reasons is that the agricultural potential (i.e. straw, prunings) faces technical obstacles in transportation and combustion processes and related costs need to be overcome through sufficient incentives. Another important agricultural feedstock, manure, needs policy actions to be used for biogas production. For co-digestion with other crops and residues research is required to define the best combinations that yield larger methane production.

Figure 5: Domestic EU27 primary feedstock: potentials versus utilization in 2020

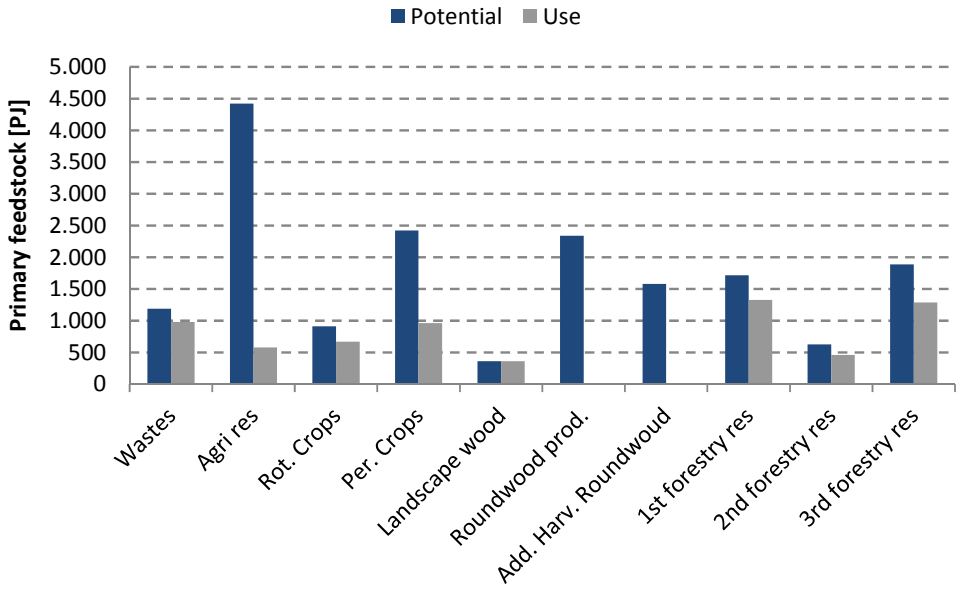
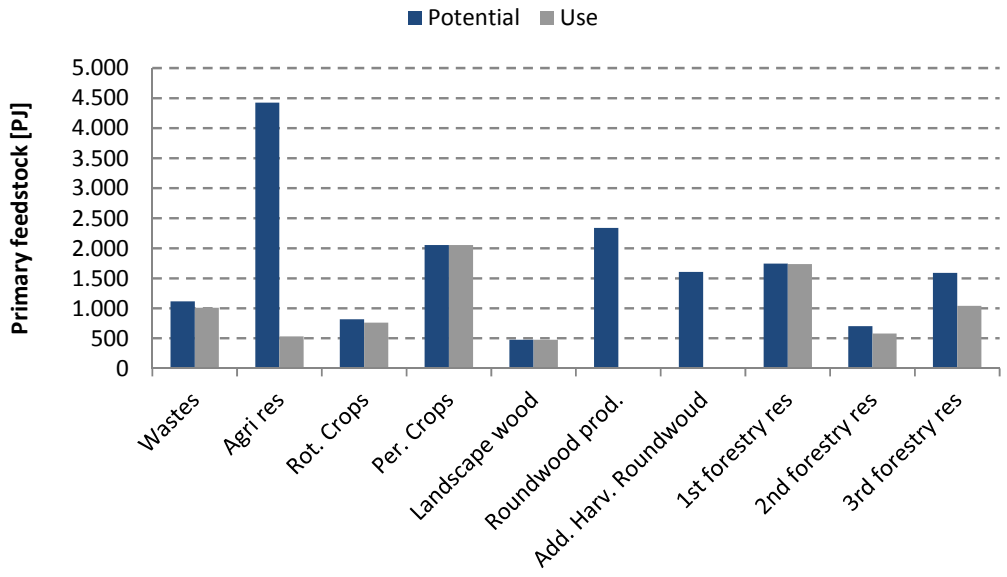


Figure 6: Domestic EU27 primary feedstock: potentials versus utilization in 2030.



4

Can EU meet the NREAP bioenergy goals in 2020?

NREAP targets for biomass based heat, electricity and transport will not be reached under the present regional and national policy/support schemes and market developments in most of the EU countries. While the level of support schemes play an important role they will not immediately lead to enough growth to meet the targets. Many other factors (such as administrative and regulatory conditions, permitting procedures, the maturity of the industry etc.) prevent such developments. In this respect, the time frame up to 2020 might be too tight to achieve the ambitious NREAP bioenergy goals in Member States level.

The current Member States support schemes to produce electricity and heat are very different with respects to their type (such as feed-in tariff, feed-in premium, quota obligation, investment grants, etc.), level of support, and the type of technology (for instance only for CHP) or feedstock they target. This could pose a risk that biomass is not used in areas where it is most cost-efficient.

Bio-electricity: Such ambitions can only be realised when and if the appropriate policy instruments are in place

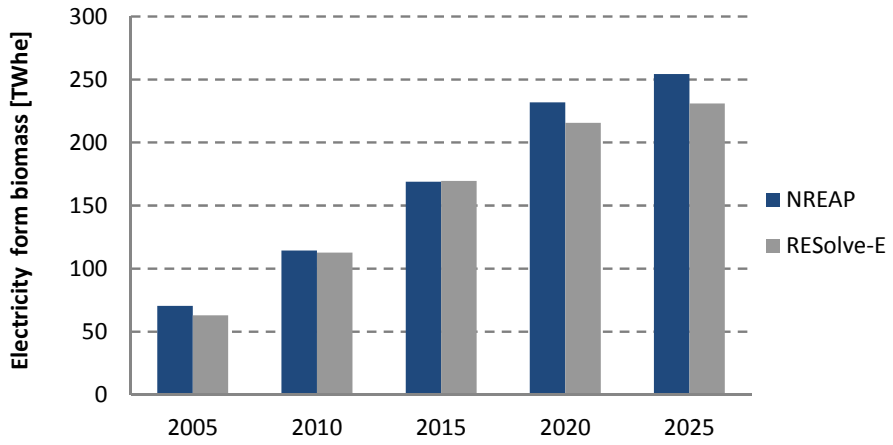
It is modelled that in 2020 around 216 TWhe can be produced from biomass, decreasing to 210 TWhe in 2030, based on the policy measures promoted by the Member States. However, in the NREAPS the bio-electricity demand is estimated to be around 232 TWhe in 2020. **Such ambitions can only be realised when and if the appropriate policy instruments are in place to overcome both techno-economic and non-technical barriers.** Figure 7 illustrates the total electricity production for the EU27 . While these figures indicate that the NREAP set targets in 2020 is achievable with some further efforts the deviations are significant in Member States level. A more detailed country by country analysis can be found in [Uslu et al., 2012]. In 2020 the difference between NREAP targets and the model results is around 4.7% for EU27. After 2025, utilisation of biomass declines. This decline is due to the reduction of certain feedstock potentials (i.e. black liquor, digestible biomass such as forage maize and cereals), the decline in coal fired power plant capacity, or competition with other RES-E options for certain countries.

CHP plays a dominant role in 2020, contributing around 3 % of the total electricity production in 2020. An important aspect- the economic use of heat - drives investment in CHP plants. In fact, a cogeneration unit will not be able to operate in high efficiency mode without sufficient heat demand. In this respect it is important to consider both the heat demand in respective countries and the required investment to supply the produced heat to the end users (through district heating systems).

Biomass co-firing with coal in existing boilers is the most cost effective option of electricity (and heat) production from biomass[4]. According to the model outcomes in 2020 around 48 TWhe can be produced through co-firing. This is however, expected to decrease in 2030 to 34 TWhe . An important reason for this trend is the decrease of the EU27 coal capacity from 161 GWe in 2020 to 142 GWe in 2030[5].

It is important to note that biomass co-firing has been promoted differently in the EU Member States. For instance, Austria, and the Czech Republic support biomass co-firing through a feed-in tariff or a premium. Belgium supports it through green certificates. In the Netherlands co-firing is supported through a fixed premium and there are plans to change this to an obligation for co-firing from 2015 onwards.

Figure 7: **EU27 total electricity production from biomass in comparison to the NREAPs**



Bio-heat: Current policy process is not sufficient enough to achieve the ambitions. Biomass becomes one of the most promising renewable energy source for industry.

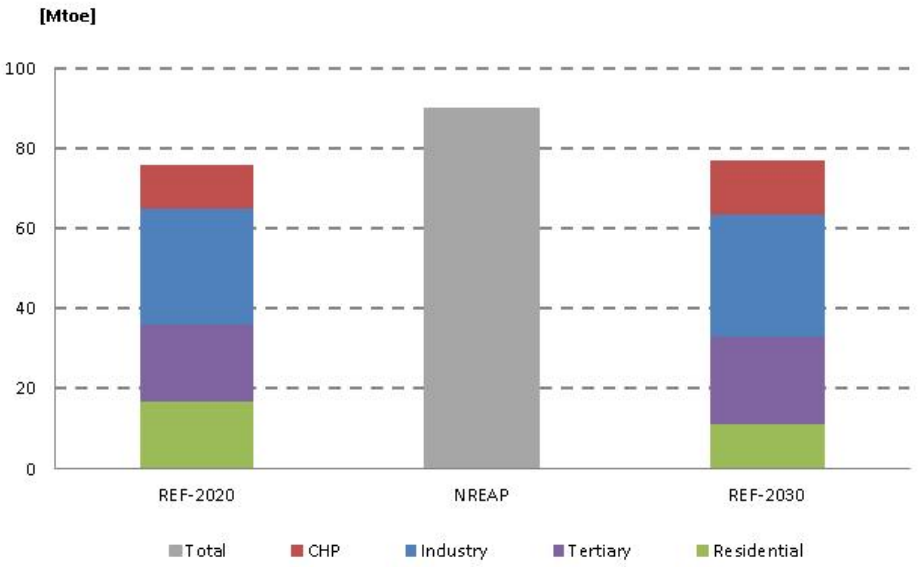
Model results indicate 18% lower final heat demand in 2020 than the NREAPs, in which the industry sector becomes the main biomass user. Biomass is one of the most promising renewable energy sources for industries that require high temperature level - if not the only - options, followed by deep geothermal. The RESolve-H model projects around 11% and 12% of the industrial heat demand to be derived from biomass resources for 2020 and 2030, respectively. On the other hand, the biomass derived heat consumption decreases for residential sector (from a share of 47% in 2010 to 15% by 2030). There are a number of reasons behind this change. First of all, overall heat demand for the residential sector is expected to decrease thanks to the energy efficiency and energy saving policies and other renewable energy sources (particularly solar thermal energy)[6]. The current high penetration of wood stoves decreases due to phasing out of old equipment: when the lifetime has been reached, old stoves are decommissioned and for a considerable part is not replaced, or it is replaced by more efficient installations.

[4] E.C. Biomass action plan. COM(2005)628final,.Commission, E., 2005

[5] The PRIMES reference scenario has been used as the baseline scenario in the modelling work

[6] A conventional reference scenario for heat sector has been build based on the ODYSSE database. For further details see Uslu et al., (2012)

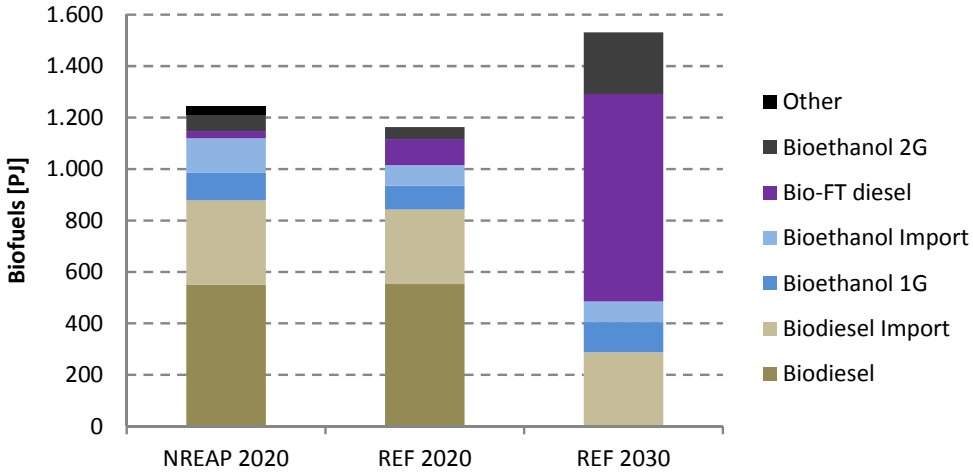
Figure 8: Penetration of biomass in the reference scenario according to RESolve-H in various cross-sections, for the year 2020 in comparison to the NREAP projections.



Biofuels: Imports will play an important role

Based on the minimal cost allocation along the supply the modelling results show that around 30% of the biofuel demand can be met through imports, of which 25% is biodiesel chain. Contribution of 2nd generation biofuels is around 13%, amounting to 148 PJ. On the other hand, NREAPs indicate higher import figures (around 37% of the total) and contribution of 2nd generation technologies to be lower (around 7% of the total). The Renewable Energy Directive considers biofuels produced from waste, residuals, non-food cellulose material and lignocellulosic material to be counted double to the renewable transport target. Model results show a significant growth for the 2nd generation technologies between 2020 and 2030 (see Figure 9).

Figure 9:Biofuel distribution (PJ) in 2020 and 2030 for the reference scenario compared to NREAP figures. 1G refers to 1st generation biofuels.


1.600
1.400
1.200
1.000
800
600
400
200
0
Biofuels [PJ]
NREAP 2020
REF 2020
REF 2030
Other
Bioethanol 2G
Bio-FT diesel
Bioethanol Import
Bioethanol 1G
Biodiesel Import
Biodiesel

5

What will be the implications of expanding the sustainability criteria to electricity and heat sector?

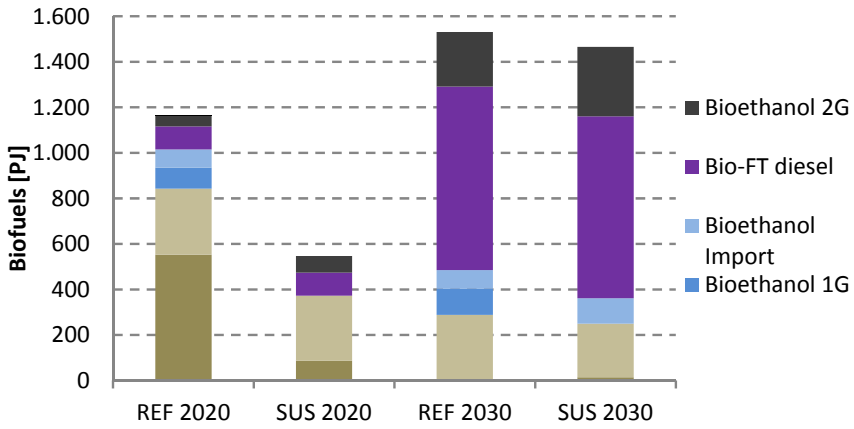
The previous sections considered the sustainability criteria- for only biofuels -excluding iLUC.

While the sustainability criteria, particularly criterion on iLUC, do not affect very much the solid biomass potential they influence the digestible biomass and the rotational crops. In return, electricity and heat production from these digestible biomass and more importantly biofuel production is influenced. Such a pressure on conventional biofuels make it hard to reach the 10% renewable energy in transport fuels.

When the iLUC effect has been – to some degree – compensated through crop specific iLUC factors domestic production of rotational crops for biofuels disappear. Moreover, the import of rotational crops and ethanol disappears as they do not comply with the sustainability criteria any more. This complicates reaching the 10% renewable transport fuel targets.

From a modelling point of view this will be compensated through larger quantities of 2nd generation biofuels and/or importing biofuels that are derived from feedstocks grown on degraded land. Already in the reference scenario 12.7 % of the total is assumed to be met through 2nd generation technologies (in absolute terms-without double counting). Thus, given the fact that it is not likely to have larger quantities of 2nd generation biofuels the demand is assumed to decrease 45% in 2020. In the following 10 years' time 2nd generation technologies show a significant growth in both scenarios, being dominant over 1st generation technologies, including import. Bio-FT diesel reaches in both scenarios the same quantity in 2030.

Figure 10: Biofuel distribution (PJ) in 2020 and 2030 in EU27:reference versus sustainability.



6

What role will imports of biofuels and wood pellets play?

Not only liquid biofuel imports but also the import of wood pellets will play an important role in the European bioenergy future. The modelling results indicate that around 900-1700 PJ will be imported from outside EU to help reach the 2020 targets. Importing such large quantities outside the EU, however, brings in the concerns on the sustainability of biomass feedstock supply and the completion of the same resources on the international market.

While sustainability criteria for biofuels are also applicable to imported biofuels these criteria need to be expanded to biomass and also harmonized at international level to facilitate and maintain international biomass trade

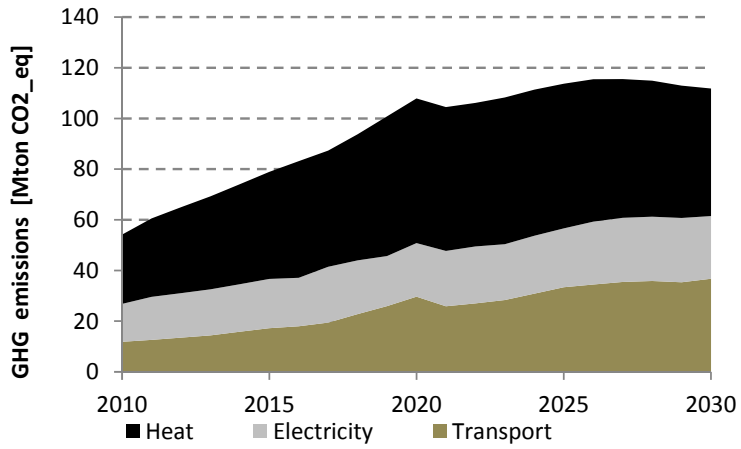
For biofuels many countries already indicated their ambitions. Such ambitions can also be expected for biomass to be used in electricity and heat markets. If heat and power generation from biomass is also promoted outside the EU, this would limit the availability of wood pellets for export to the EU, and increase the prices. On the other hand , even when stricter sustainability criteria is considered, Europe holds a significant amount of domestic resources. There is a need for policies and measures within the EU to maximise indigenous biomass production and use. Policies and measures are required across all biomass categories, supply chains, and efficient conversion technologies, but most particularly in the agricultural sector, which has the greatest potential for increased domestic supply.

7

How much greenhouse gas emissions can be avoided if the bioenergy targets are met?

In 2020, up to 500 Mton CO_2 eq. emissions can be avoided if the NREAP bioenergy targets are met, corresponding to 11 % of the total volume of GHG emissions in EU-27 in 2010[7]. This underpins the importance of bioenergy for meeting EU's future GHG reduction targets. Figure 11 illustrates the LCA[8] GHG emissions of the bioenergy systems, whereas Figure 12 presents the avoided GHG emissions in comparison to the conventional energy system[9]. In line with the significantly higher deployment rate of biomass heat production the total avoided GHG emission from the heat sector is significant On the other hand, specific avoided GHG emissions of biomass electricity is around 7 ton CO_2 eq./toe, whereas it is around 4 ton CO_2 eq./toe for biomass heat and 3 ton CO_2 eq./toe for biofuels. These figures indicate that the utilisation of biomass for electricity production has larger potentials in terms of GHG emission mitigation.

Figure 11: Total GHG emissions of the bioenergy systems (Mton CO_2eq.) in EU27 for the reference scenario.

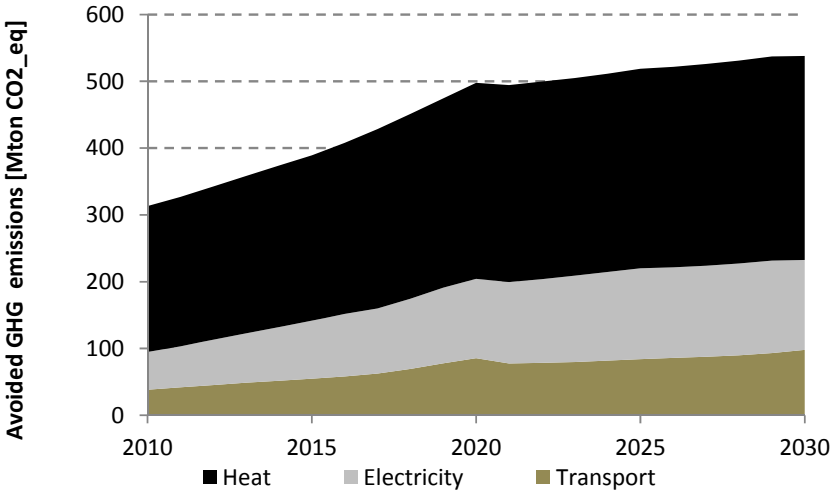


[7] EU27 total GHG emissions in 2010 is indicated as 4 724.1 Mton CO_2 eq. by the EEA (2011)

[88] Life Cycle GHG emissions are considered

[9] Conventional energy system is based on the PRIMES baseline 2010 scenario

Figure 12: Net avoided GHG emissions of the bioenergy systems (Mton CO_2eq.) in EU27 for the reference scenario.



8

Policy conclusions and recommendations

In this study three scenarios have been developed to model the implications and impacts of sustainability criteria and policy measures on future bioenergy demand. Each scenario included a comprehensive set of policy measures. These measures were derived from the NREAPs. Sustainability criteria, in line with the Renewable Energy Directive, have been applied to biofuels for the transport sector for the Reference scenario, whereas it has been expanded to heat and electricity sector in the Sustainability scenario. Moreover, the Sustainability scenario attempted to include the indirect land use change effects through crop-specific iLUC factors. The High biomass scenario included stronger policy instruments to harness further utilisation of domestic biomass resources.

Results show that **EU biomass resources are quite significant in size even when more stringent sustainability criteria are considered. However, only around 40-50% of the total can economically and technically be utilised for energy**. The main reasons are first that an important fraction of the total potential is from roundwood and additional harvestable roundwood, which is very expensive to use directly for energy purposes. Secondly, some of the agricultural potential (i.e. straw, manure) faces technical difficulties and it is more expensive to produce energy from. The agricultural biomass feedstock potential is significant. However, model results show that only a limited amount of this potential can actually be utilised (around 30%). For feedstocks such as straw and prunings sufficient incentives are required to overcome the techno-economic challenges for supply and final conversion. Another important agricultural feedstock, manure, requires policy actions to be used for biogas production. For co-digestion with other crops and residues, further research is required to define the best combinations that yield larger methane production.

NREAP targets for biomass based heat, electricity and transport will not be reached under the present regional and national policy/support schemes and market developments in most of the EU countries. While the level of support schemes play an important role they will not immediately lead to enough growth to meet the targets. Many other factors (such as administrative and regulatory conditions, permitting procedures, the maturity of the industry etc.) slow down such developments. In this respect, the time frame up to 2020 might be too tight to achieve the ambitious NREAP bioenergy targets in Member States level.

The current Member States support schemes to produce renewable electricity and heat are very different with respect to their type (such as feed-in tariff, feed-in premium, quota obligation, investment grants, etc.), level of support, and the type of technology (for instance only for CHP) or feedstock they target. This could pose a risk that biomass is not used in areas where it is most cost-efficient.

On the other hand, a less fragmented policy approach **- implementing co-operation mechanisms** that are included in the Renewable Energy Directive – **could help Member States reach their targets and increase the cost-efficiency for bioenergy.**

While the sustainability criteria, particularly the criterion on iLUC, do not substantially affect the solid biomass potential they do influence the potential for digestible biomass and the rotational crops. In return, electricity and heat production from these digestible biomass sources and, more importantly, biofuel production is influenced. Such a pressure on conventional biofuels makes it hard to reach the 10% renewable energy in transport fuels.

Not only liquid biofuel imports but also the import of wood pellets will play an important role in the European bioenergy future. The modelling results indicate that around 260-760 PJ [10] wood pellets will be imported from outside the EU to reach the 2020 targets. Importing such large quantities, particularly from developing countries, however, brings in the concerns on the sustainability of biomass feedstock supply. While expanding the sustainability criteria from biofuels to biomass for energy will help decreasing their likely negative impacts, the social and economic impacts on local communities, such as food security, local energy security and land access are open and difficult issues to tackle with.

If and when the NREAP bioenergy targets are achieved **around 500 Mton CO_2 eq. can be avoided in comparison to the conventional energy systems. This figure underpins the importance of bioenergy for meeting EU's future GHG reduction targets**

[10] 881 PJ for the sustainability scenario and 1647 PJ for the high biomass scenario

9

References

Beurskens L.W.M., Hekkenberg M., Vethman P., Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States Covering all 27 EU Member States with updates for 20 Member States. ECN-E--10-069.2011.

DIRECTIVE 2003/30/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport

EC,2012 http://ec.europa.eu/energy/renewables/biofuels/emissions_en.htm. Vised in April 2012

EEA, 2011 Greenhouse gas emission trends and projections in Europe 2011 - Tracking progress towards Kyoto and 2020 targets. EEA Report No 4/2011

Elbersen, B., I. Startisky, G. Hengeveld, M.J. Schelhaas, H. Naeff and H. Böttcher (2012): *Atlas of biomass potentials – Spatially detailed and quantified overview of EU biomass*
potential taking into account the main criteria determining biomass availability from different sources, *Deliverable 3.3 of Biomass Futures WP3, Altera,* 2012.

EU Member States 2011 Progress Reports can be found in
http://ec.europa.eu/energy/renewables/reports/2011_en.htm. Last visited on 15 May 2012.

Uslu, A., van Stralen, J. Biomass Futures scenario set-up and the methodology for analysis -Deliverable D5.2. Biomass Futures project. 2012

Uslu, A., van Stralen, J., Beurskens L., Dalla Longa, F., Use of sustainable biomass to produce electricity, heat and transport fuels in EU27- A model-based analysis of biomass use for 2020 and 2030. Deliverable D5.3. biomass Futures project. 2012.

.

Annex 1

Table 1: Crop specific iLUC factors

Type of biofuel	Median from average values (g CO_2 eq./MJ)
Biodiesel based on rapeseed from Europe	**77**
Ethanol based on wheat from Europe	**73**
Ethanol based on sugar beet from Europe	**85**
Biodiesel based on palm oil from South-East Asia	**77**
Biodiesel based on soy from Latin America	**140**
Biodiesel based on soy from US	**65**
Ethanol based on sugar cane from Latin America	**60**
Bio-electricity based on perennial on arable land	**56**

Annex 2

Table 2: Assumptions applied to the scenarios

	Reference		**Sustainability**		**High Biomass**	
	2020	2030	2020	2030	2020	2030
Bioenergy demands	NREAPs	NREAPs increased applying the PRIMES reference scenario 2020-2030 increase	NREAPs	NREAPs increased applying the PRIMES reference scenario 2020-2030 increase	Bio-electricity and bio-heat using solid biomass >25% than NREAPs	Bio-electricity and bio-heat using solid biomass >25% than reference scenario 2030 figures
Total energy demands	NREAPs	NREAPs increased applying the PRIMES reference 2020-2030 increase	NREAPs	NREAPs increased applying the PRIMES reference 2020-2030 increase	NREAPs	NREAPs increased applying the PRIMES reference 2020-2030 increase
GHG emissions	Only to biofuels as in the RE Directive No iLUC	Only to biofuels as in the RE Directive No iLUC	All sectors (70 % mitigation compared to fossil energy (biofuel comparator EU average diesel and petrol emission, bio-electricity and heat comparator country specific depending on 2020 fossil mix). Includes crop specific iLUC factor	All sectors (80% mitigation as compared to fossil energy (biofuel comparator EU aver diesel and petrol emission, bio-electricity and heat comparator country specific depending on 2030 fossil mix). Includes crop specific iLUC factor	Only to biofuels as in the RE Directive No iLUC	Only to biofuels as in the RE Directive No iLUC

Policy measures	Same as NREAPs	Same as NREAPS	Same as NREAPs	Same as NREAPS	Stronger policy measures	Stronger policy measures