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How much biomass can Europe use without harming the environment?

Extending biomass use to produce energy (bioenergy) will both help reduce greenhouse gas emissions and meet the European renewable energy targets. However, biomass production may create additional environmental pressures, such as on biodiversity, soil and water resources. The European Environment Agency is currently assessing how much biomass can be used for energy generation without causing such additional pressures. Preliminary results suggest that there is sufficient biomass potential in the EU-25 to support ambitious renewable energy targets in an environmentally responsible way. Achieving maximum gains and minimising the potential threat of bioenergy production requires careful planning from EU to local level. Socio-economic aspects or an assessment of the policies and measures needed to mobilise this potential are not specifically addressed here and would need further consideration, alongside logistical and cost issues.

A. Bioenergy and renewable energy targets

The European Union has set ambitious 2010-targets for the share of renewable energies in total energy and electricity consumption and for biofuels. Biomass can be used to produce electricity, heat and transport fuels, and currently accounts for about two thirds of renewable energy production in the EU. It will have to contribute even more in order to achieve the 2010 targets. The European Commission estimates that reaching the target of a 12 % share of renewables in total energy consumption requires around 130 Mtoe [1] of biomass (in the pre-2004 EU-15; EC, 2004).

Policy discussions for European renewable energy targets beyond 2010 have commenced. A renewables share of about 20 % of total energy in 2020 would necessitate about 210–250 Mtoe of primary biomass, according to energy projections (e.g. Ragwitz *et al.*, 2005; EREC, 2004; EEA, 2005a).

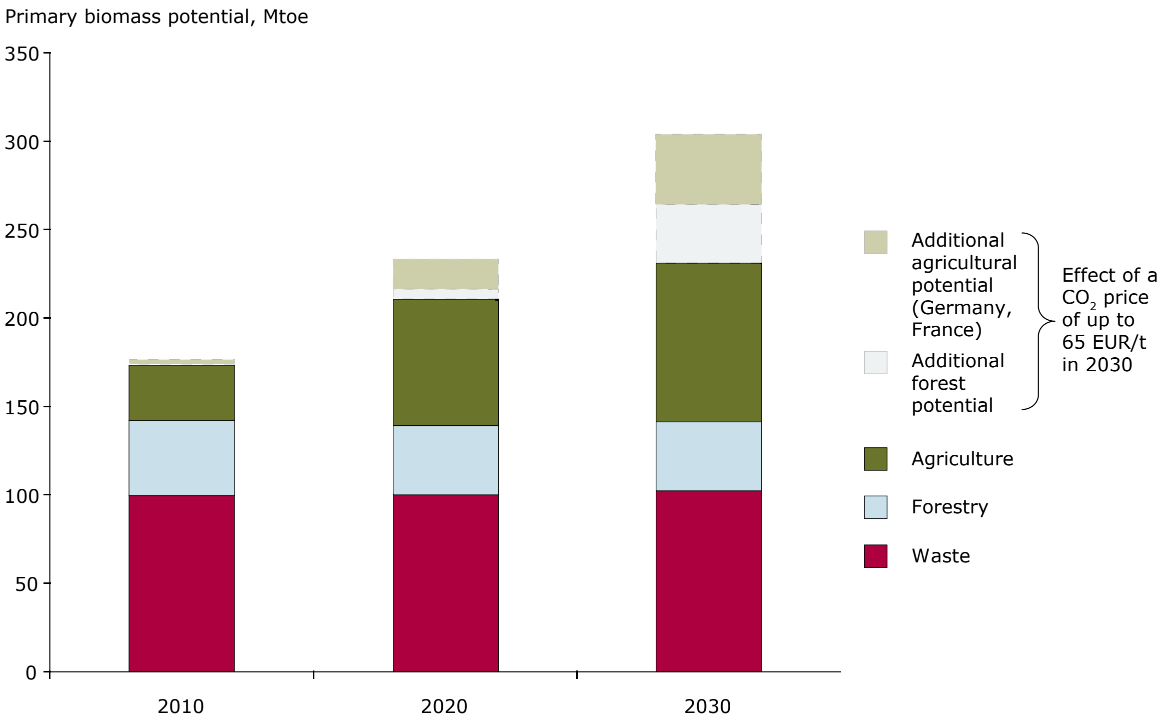
B. The potential of bioenergy in the EU-25

The European Environment Agency is currently assessing an *environmentally-compatible* primary bioenergy potential in Europe for 2010, 2020 and 2030. The outcome of this work will provide input to the policy debates on both the upcoming Biomass Action Plan and proposed post-2010 renewable energy targets. The *environmentally-compatible* potential is the quantity of biomass that is technically available for energy generation based on the assumption that this places no additional pressures on biodiversity, soil and water resources compared to a development without increased bioenergy production. Moreover, it should be in line with other current and future environmental policies and objectives. This concept was realised by taking into account a number of environmental constraints when calculating the available technical potential. It was also assumed that greenhouse gas emissions are further reduced by 20 % in 2020 and 40 % in 2030 by the EU-25. This would lead to a permit price per tonne CO_2 of 30 EUR and 65 EUR, respectively (EEA, 2005a).

Preliminary results indicate that the potential of *environmentally-compatible* primary biomass for

([1]) Million tonnes of oil equivalent (Mtoe).

Figure 1 ***Environmentally-compatible* primary bioenergy potential in the EU-25 — preliminary results**



Note: The effect of a CO_2 permit price of up to 65 EUR/tonne by 2030 was estimated for agriculture in Germany and France only.

from around 180 Mtoe in 2010 to about 300 Mtoe in 2030 (see Figure 1). This figure comprises the bioenergy potential from agriculture, forests and waste. It is determined by projections on the development of key drivers such as crop yields, the common agricultural policy, stem wood demand, waste growth and greenhouse gas emission reductions (outlined in Section B1). In addition, environmental constraints are applied to the potential to ensure that biodiversity, soil and water resources are safeguarded (Section B2).

B1. Key drivers

Agriculture

The agricultural biomass resource for bioenergy mainly depends on the available land area and the yield of bioenergy crops grown. In this project, priority was given to domestic food production needed to satisfy the EU-25 food demand. It was therefore assumed that only the land released from food and feed production could become available for bioenergy production. The released land area is expected to increase significantly after 2010 as a result of increases in agricultural crop yields and the liberalisation of the agricultural markets. This is due to the assumption that further reforms of the common agricultural policy take place. (EEA, 2005b).

Additional land would be dedicated to bioenergy production at the expense of food or fodder production if a CO_2 permit price is assumed. Competition was assumed to be restricted to food produced for exports outside the EU, so as to be consistent with the assumption that priority is given to satisfy the EU food demand. To estimate this additional potential, calculations were done for only two EU countries with an important land area — Germany and France. Preliminary results indicate that only these two countries could already add substantially to the available potential if a CO_2 permit price of up to 65 EUR/tonne in 2030 was assumed (see Figure 1 — additional agricultural potential).

Another reason for the large increase of agricultural bioenergy potential is the assumed introduction of advanced biomass conversion technologies. This would allow the use of a wider range of agricultural feed stocks, especially productive lignocellulosic materials.

Forests

Residues from harvest operations, which are normally left in the forest after stem wood removal, could be extracted and used as bioenergy. Complementary fellings, i.e. the difference between the actual harvest and the maximum sustainable harvest level, could provide an additional resource. The potential of residues and complementary fellings strongly depends on assumptions made about the market demand for stem wood. Without a CO_2 permit price, projections for Europe show a slight increase in stem wood demand. Thus, the amount of forest residues increases. At the same time, complementary fellings would fall due to the increase in the harvest needed to satisfy stem wood demand. The total forest bioenergy potential would almost remain constant over time (see Figure 1). However, if we assume a CO_2 permit price that rises up to 65 EUR/tonne in 2030, the market value of energy wood would increase further. As a result, substantial amounts of wood biomass resources would be used for bioenergy and not in competing industries (see Figure 1 — additional forest potential).

Waste

Biowaste comprises: agricultural residues (straw, green tops, manure); the biodegradable fraction of municipal solid waste; sewage sludge; food processing waste; wood waste from wood-processing industries; black liquor from the pulp/ paper industry; construction and demolition, and packaging waste. The biowaste potential is influenced by the development of the agricultural sector and assumptions on gross domestic product and the number of households. The results of the analysis suggest that the amount of biowaste would remain more or less constant over the years as resource consumption and waste generation would grow at a slower rate than in a baseline scenario.

B2. Environmental constraints

The following environmental criteria were applied when estimating the potential of *environmentally-compatible* bioenergy:

- *Maintain extensively cultivated agricultural areas*. Grassland is not to be transformed into arable land in line with the cross-compliance objectives agreed in the last reform of the Common Agricultural Policy. This also avoids a release of CO_2 from grassland soils that would occur when such land is ploughed.
- *At least 30 % of the agricultural land dedicated to 'environmentally-oriented farming' in 2030 in the Member States*. This would comprise organic farming and high nature value farmland (i.e. farmland with special importance for biodiversity).
- *Approximately 3 % of the intensively cultivated agricultural land to be set aside for establishing ecological 'stepping stones' in intensive farming areas*. This would be done in order to improve the living conditions of some farmland species, such as the skylark or partridge.
- *Bioenergy crops used that minimize soil erosion and compaction, nutrient inputs into ground and surface water, pesticide pollution and water abstraction*. Regional climatic, soil and landscape considerations and available energy conversion technologies were also taken into account.
- *No residue removal or complementary fellings in protected forest areas.*
- *Maintain current protected forest area.*
- *No removal of foliage and roots at all.* This is due to their high nutrient contents and to avoid soil disturbance and an increased risk of erosion, respectively.
- *Adaptation of the forest residue removal rate to local site suitability*. Forest residues supply the ecosystem with nutrients, reduce the risk of soil erosion and regulate water flows. The site suitability was thus determined by soil fertility, soil acidity, the risk of soil erosion and soil compaction, using the European Soil Database and elevation data.
- *Complementary fellings restricted by an increased share of protected forest areas (5 %) to account for more nature conservation*. Additionally, forest management was assumed to be less intensive: 5 % of the harvestable volume from complementary fellings was left behind as retention trees, thus increasing the amount of large old trees and deadwood. This would enhance the biodiversity value of the managed forest area.
- *Ambitious waste minimisation strategies*. For example, households apply waste prevention measures, and thus generate 25 % less waste

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than in a baseline scenario. Furthermore, for agricultural residues and wood processing waste, the same assumptions were applied as those for agricultural and forestry biomass, respectively.

C. Co-benefits

A substantial amount of greenhouse gas emissions can be avoided by increasing the *environmentally-compatible* production and use of bioenergy. However, this will depend on how the biomass is used in the competing end-use sectors electricity, heat and transport. In addition, it could also offer a number of other benefits to the environment.

Forest management and the removal of residues can contribute to reducing fire risk in forests which are currently unmanaged. The use of biomass to generate energy could cover some of the cost for these fire-prevention measures. This is particularly important for southern Europe.

The harvesting of grass from extensive grassland areas can produce a limited amount of bioenergy. At the same time, it would support the management of species-rich grasslands that maintain their biodiversity value only when mown regularly.

The introduction of new biomass cropping systems can combine high yields with little fertiliser and pesticide input. For example, double cropping systems consist of several crops on the same field (e.g. cereals and legumes). They add to the structural diversity in the field, reduce nutrient leaching and can be harvested more than once a year as green plants. However, they are not well suited for southern European areas as they require plenty of water.

D. Conclusions

Preliminary results indicate that significant biomass is available to support ambitious renewable energy targets in 2010, 2020 and 2030, even after taking environmental constraints into account. The *environmentally-compatible* biomass potential would be in line with other environmental policies and objectives. However, safeguarding biodiversity, and soil and water resources requires that detailed environmental guidelines become an integral part of planning processes at all levels of decision making. The potential for achieving co-benefits between biomass production and nature conservation will have to be further explored and adapted to local environmental conditions.

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