#018 Bioenergy Promotion

WP3 Policy
Task 3.1

Sustainable bioenergy production

Defining principles and criteria

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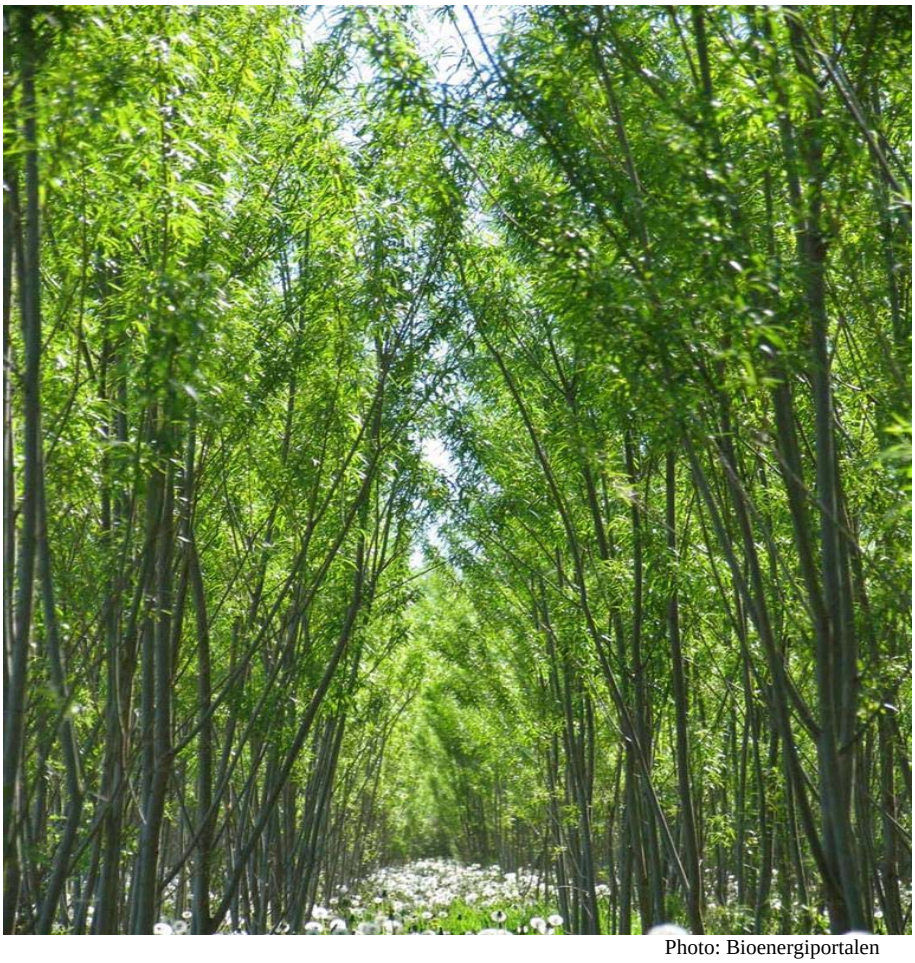

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1 Introduction

1.1 Description of project

In the Baltic Sea Region, only a small fraction of potential biomass resources are used for energy purposes as far as today. However, the interest is increasing as a result of new policies following the increasing awareness of a climate change as well as the opportunities for rural development that are created by a growing bioenergy market. An increased production and use of biomass for energy puts sustainability issues on the agenda and there is a need for applicable strategies for bioenergy production and use that do not have negative effects on environment or social and economic development.

So far, a great part of the policy development to support bioenergy has occurred on the national level. As the production and use of biomass for energy increases, and cross-boarder trade becomes more substantial, international efforts are becoming increasingly common. More emphasis is now put on transnational cooperation as producers and politicians realize that harmonized policies are necessary for continued bioenergy market growth.

The project Bioenergy Promotion is coordinated by the Swedish Energy Agency and is a collaboration between 34 participating partners from ten countries around the Baltic Sea: Belarus; Denmark; Estonia; Finland; Germany; Latvia; Lithuania; Norway; Poland and Sweden. Bioenergy Promotion aims at strengthening the development towards a sustainable, competitive and territorially integrated Baltic Sea Region in the field of production and use of bioenergy. The project will serve as a platform for cross-sectoral and transnational networking to facilitate information and knowledge exchange, coordinated policy development and design and application of bioenergy promoting instruments as well as regional development.

The objective of Work Package 3 “Policy” (WP 3) within the project Bioenergy Promotion is to promote a sustainable production and use of biomass for energy purposes. As a part of WP 3, task 3.1 aim to develop principles and sustainability criteria and formulate these into a guidance document.

1.2 Purpose of paper

This report is the resulting document of task 3.1 and should be seen as a tool and guidance for reaching sustainable systems for bioenergy production in the Baltic Sea Region and possibly beyond.

The principles and criteria developed in our project can be used when planning and developing strategies for sustainable production of bioenergy and the EU Member States can use the report as an orientation to optimize their support schemes on voluntary basis. We also aim at reaching other stakeholders with interest in production of bioenergy, NGOs, energy companies and producers.

Furthermore, the sustainability criteria formulated in this report will be used within other tasks of the project Bioenergy Promotion, aiming at e.g. assessing sustainable biomass potentials, promoting sustainable bioenergy use at sub-regional levels, developing certification systems and also translating criteria into policy instruments.

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Besides principles and criteria we also suggest indicators for compliance. Indicators are used to provide information of trends and developments and whether or not the principles are fulfilled. Therefore they must be practical, reliable and measurable. We do not suggest any methods for how to apply the indicators, merely what to be measured.

1.3 Parallel processes

There are several parallel processes on the development of criteria for sustainable production of bioenergy going on at the moment but there are still no complete or fully covering suggestions of international standards at hand.

One of the most important documents for EU Member States on the subject is Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources. It includes a mandatory sustainability scheme for biofuels and bioliquids[1]. Furthermore, the European Commission published in the end of February 2010 a report on sustainability criteria for the use of solid and gaseous biomass sources in electricity, heating and cooling[2]. In their report the Commission states that binding criteria for the use of biomass specifically for energy purposes is not an option at this stage. To prevent the development of different sustainability schemes for solid and gaseous biomass sources for electricity, heating and cooling in the Member States, the Commission recommend to, as far as possible, use the sustainability criteria laid down in the Directive 2009/28/EC. They also suggest extending the calculation method for greenhouse gas emissions to include conversion efficiency.

In annex 1 we compare the sustainability criteria developed by the European Commission and some of the other projects on sustainable bioenergy that has been done so far. In this comparison it is only the project supported by the Nordic Council that cover solid, liquid and gaseous biofuels from forestry as well as from agriculture. However, the Nordic Council project focused on the Nordic countries and the developed criteria may therefore not be applicable on the whole Baltic Sea Region. The comparison shows that criteria developed for forestland cannot be used for agricultural land. Furthermore, the Directive 2009/28/EC does not cover solid biomass and does not include criteria for land use, water and soil environment or local prosperity.

Criteria for sustainable forest management have been developed within certification systems, two of the most important being the Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification schemes (PEFC). The two systems present general criteria that should be followed in all countries. The details may, however, differ considerably between countries. Therefore, the criteria from these certification systems were not included in the comparison.

1.4 Methodology for developing principles, criteria and indicators

The work within Bioenergy Promotion took basis in the sustainability criteria developed in the Nordic Council project and Directive 2009/28/EC. Two workshops have been organized, one in Jönköping, Sweden in May, 2009 and one in Helsinki, Finland in November 2009, the first one involving external experts. The workshop group discussions and open round table discussions

[1] For further information see section 4.1.
[2] Report on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling COM(2010)11

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resulted in suggestions for principles and criteria. Subsequently, drafts have been circulated and commented on by e-mail.

2 Definitions

Here we define some expressions used in this document.

2.1 What is biomass?

Within the context of this document, and in accordance with Directive 2009/28/EC, biomass is defined as the biodegradable fraction of products, waste and residues with biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.

The term biomass production refers to production of biomass in forestry and agriculture.

2.2 What are waste, residues and co-products?

According to Directive 2008/98/EC on waste, waste is any substance or object, which the holder discards or intends or is required to discard. Co-products are products produced in the same process as main products. Co-products are not waste. In this document we use the same definition for waste as in the directive.

The directive 2009/28/EC[3], uses the expressions co-product and residue, but they are not defined. In this document the term residue is used for leftover biomass from agriculture and forestry, for example straw and branches and tops of trees. Co-products are other products than main products from forest industry and animal production. It can also be products produced during the conversion of biomass to bioenergy. Co-products are for example sawdust, manure, ash from combustion of forest fuels, wheat pulp, oil cakes of rape and digestate from biogas plants, and can be used for energy or other purposes.

2.3 What is renewable energy and bioenergy?

Renewable energy is produced from non-fossil sources. Renewable energy sources are continuously replenished such as for example wind, water, sun and biomass.

Bioenergy is energy from biomass. Bioenergy is thus renewable and unlike fossil energy, bioenergy have the potential to be carbon neutral over their lifecycles, emitting only as much carbon as the plants absorbs from the atmosphere as they grow. However, this is generally not the case in practice due to greenhouse gas emissions produced in the feedstock production, processing and distribution.

The combustion of peat is included in the emission trading system and peat is according to the European Commission as well as IPCC[4] not classified as a renewable energy source. Therefore we have not included peat in the scope of this document.

[3] Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources
[4] Intergovernmental Panel of Climate Change

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2.4 What are biofuels?

Biofuels are liquid and gaseous fuels for transport produced from biomass. Bioliquids are liquid fuels for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass[5].

2.5 What are principles, criteria and indicators?

Principles are the general starting points and describe the objective aimed at. The criteria translate this objective into measurable requirements. Subsequently the indicators are the parameters by which the measuring is done.

3 Sustainable bioenergy systems

Sustainable development means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. Sustainable consumption and production is at the core of sustainable development, encompassing the three dimensions — economic, social and environmental.

A sustainable energy system has, in its production and consumption, minimal negative impacts on human health and the healthy functioning of ecological systems, including the global environment, and can be supplied continuously to future generations.

The big challenge for the energy sector is how to promote the development of modern energy services, and at the same time ensure that the energy services provided do not cause further adverse environmental and socio-economic impacts. For a sustainable development the fraction of renewable energy in the energy mix must increase substantially. In addition, the energy systems would have to produce and use energy much more efficiently. However, regardless of energy source (fossil or renewable) and how efficient the production and use of energy is, it is important to reduce energy consumption.

Sustainability requires a system perspective where costs and benefits are considered and summed up in a common context. The assessment of sustainable bioenergy therefore needs to be based on an integrated view, taking into account both bioenergy production and use. However, the question of using a system perspective and developing sustainability criteria for the whole system is not necessarily the same.

While sustainable production and extraction of biomass for energy significantly deals with consequences on economic, social and environmental issues, sustainable use of bioenergy puts up a different set of questions. Sustainable use of bioenergy, or energy as a whole, is very much a question of using the right kind of energy for the right purpose and using it in an efficient manner. The latter is touching ethical dimensions and technical solutions.

This project basically uses a system perspective, considering the bioenergy chain from production, via conversion of biomass to bioenergy, including end-use. However, when formulating principles and criteria for sustainable bioenergy we have chosen to exclude several important aspects of end-use. We suggest criteria that are valid for the whole bioenergy system only in the case of energy efficiency and climate mitigation efficiency.

[5] The definition of biofuels is in line with directive 2009/28/EC

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There are several reasons for this. First, the focus within the project Bioenergy Promotion is upon supply rather than consumption. Second, the development of sustainability criteria for end-use would comprise all sectors in the society. Third, prerequisites concerning energy use differ largely between countries. Taken together, the development of sustainability criteria for end-use that are meaningful in all its aspects and for all countries is too complex to handle on a joint level.

4 Legal framework

Already existing and future legislation at EU and national level sets the frames for our work and must always be given priority. The formulated criteria therefore take basis in existing regulations, mainly relevant EU- regulations.

4.1 EU regulations

There are several regulations at the EU level to be taken into account and which influence our work in this project, for example Directive 91/676/EEC on nitrates and Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora[6]. The following directives are the most prominent ones used in the developed sustainability criteria:

Directive 2009/28/EC on the promotion of the use of energy from renewable sources
The objective of the directive is to increase the use of renewable energy in order to reduce greenhouse gas emissions, enhance security of energy supply, promote technological development and provide opportunity for regional development. The directive establishes a common framework for the promotion of energy from renewable sources. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport. It lays down rules relating to statistical transfers between Member States, joint projects between Member States and with third countries, guarantees of origin, administrative procedures, information and training, and access to the electricity grid for energy from renewable energy sources.

It also establishes sustainability criteria for the production of biofuels and bioliquids. The main objectives of the sustainability criteria are to:

- Ensure minimum greenhouse gas savings (From 35% to 50% from 2017 (60% for new plants)).
- Prevent conversion of high carbon-stock land (no conversion of wetland, “continuously forested area” or peatland. Emissions from land use change are included in the biofuel life-cycle assessment).
- Avoid losses of highly biologically diverse land (no use of raw material from primary forest, protected areas or highly biodiverse grassland unless compatible with nature protection or nature management plans).

[6] The EU policy assessment is elaborated in more detail in Task 3.3 of Bioenergy Promotion. See www.bioenergypromotion.net

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- Ensure environmental and social standard (the "cross compliance" rules under the CAP[7] are in force, reporting obligations for operators including information on measures taken on soil, water and air protection, and social requirements. The type of information to be provided will be defined by the Commission).

Member States of the EU have to implement the directive in national legislation by December 2010.

Directive 2008/98/EC on waste
The directive regulates waste and the use of waste. The directive includes a waste-hierachy stating that: Production of waste should be prevented. Waste produced should be recycled or processed for re-use. If this is not possible an alternative use, for example for energy purposes, should be preferred over dumping.

Directive 2000/60/EC on establishing a framework for Community action in the field of water policy
The directive regulates protection and sustainable management of water. The directive aims at maintaining and improving the aquatic environment in the Community. The production of bioenergy shall, as any other production, comply with the directive.

4.2 National regulations

All countries in the Baltic Sea Region have some national legislation and regulations concerning forestry and agriculture and several of these regulations include recommendations for sustainable management[8]. Already existing national regulations must be considered and complied with.

5 Visions related to bioenergy

In our vision, bioenergy can make an important contribution to the global energy demand and at the same time contribute to a reduction in greenhouse gas emissions. An efficient use of biomass and bioenergy is crucial from a sustainable development perspective.

A sustainable bioenergy system is energy efficient, resource efficient and has a high potential for mitigating climate change. Energy efficiency is a key objective relating to the whole process chain, from the energy services obtained, through bioenergy, back to the different sources of bioenergy feedstock. Input energy must be minimized in all phases of the production system and the use of bioenergy should be as efficient as possible.

Processes and technologies for a better use of waste heat and energy from industry and the combined production of heat and electricity deserve more attention. A higher energy quality than needed for the purpose should not be used. Security of supply and accessibility of resources are other key issues affecting energy efficiency and the use of biomass should be optimized from both a climate protection and security of supply point of view. This calls for practices that are sustainable in the long term.

[7] Common Agricultural Policy
[8] More information can be found in related reports elaborated in Task 3.2 and 3.3 of Bioenergy Promotion. See www.bioenergypromotion.net

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Resource efficiency presupposes an efficient use of residues, co-products and waste. Minimization of waste production is achieved by promoting a circular flow of resources through for example recycling of co-products containing important nutrients for plants. In addition, the use of both land and landscape as resources must be optimized. This includes placing and designing production units in a way that maximize the output and makes sufficient use of the added values of bioenergy production.

An increased production and use of biomass for energy restrict the consumption of finite resources such as oil and coal if it is used for fossil fuel substitution. Thereby environmental benefits are provided and the increased use of bioenergy also contributes to the mitigation of climate change. Synergetic effects of greenhouse gas savings, carbon dioxide removals, sustainability of ecosystems and bioenergy use shall be fully utilized. The reduction of consumption of oil, coal and natural gas goes step by step through development of local renewable energy systems. Locally the energy supply is secured, community resilience improved and jobs created.

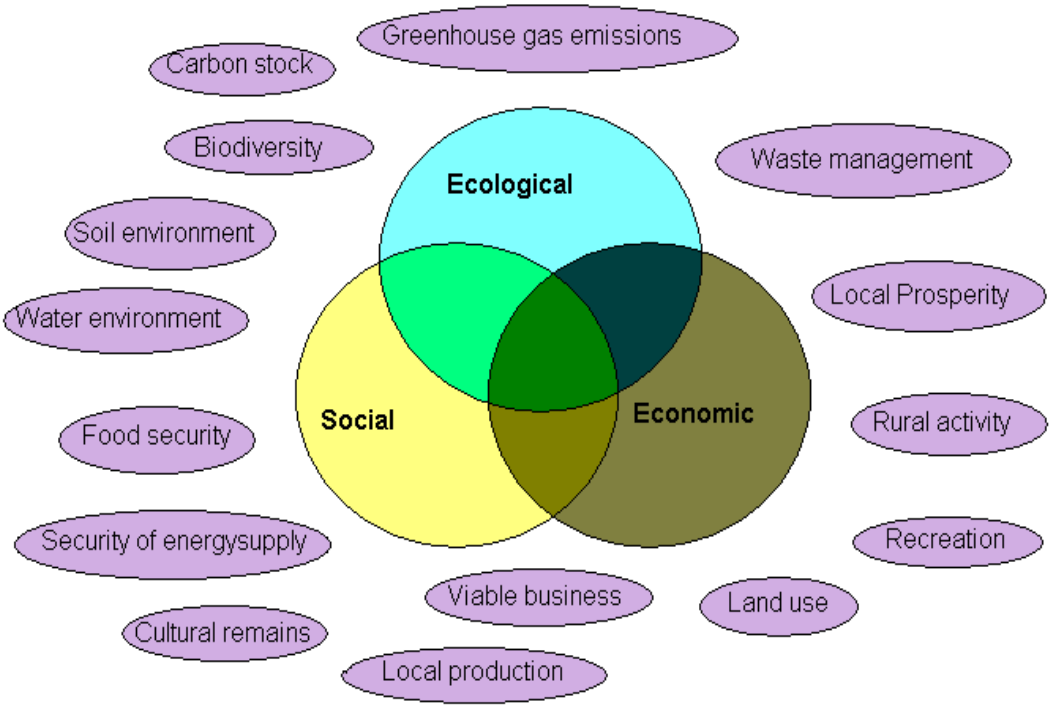

Figure 1. Schematic picture of parameters that may be relevant for a sustainable production of bioenergy.

Biomass production, extraction and use must comply with EU regulations and be performed in accordance with respective national regulations and recommendations that provide guidance on how to obtain a sustainable forestry or agriculture. The criteria used for sustainable bioenergy production in EU Member States should also be applied for biomass and bioenergy imported from third countries.

National authorities should provide information to producers on recommendations and recent development concerning production, extraction and use of biomass for energy. Monitoring programs should be promoted to assess that negative impact of practices are avoided.

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5.1 Sustainable bioenergy production

The basic principles in this section are formulated as general objectives for sustainable bioenergy production. The identified criteria are the key to fulfil the principles.

It is the producer that should take the responsibility for effects of the production and therefore also for the assessment of the values of the production area and how the production may affect the local community and the environment.

In order to facilitate monitoring and evaluation of the effects of bioenergy production, the supply chains of raw materials should be easily followed from production to end-use.

1. Biodiversity

Principle:
Biomass production and extraction shall not endanger biodiversity at the landscape[9] level. However, special considerations to threatened species shall be taken at the local level. Biomass production shall whenever possible strengthen biodiversity by contributing to landscape variability.

Criteria:

i. Biomass production or extraction shall have neutral or positive effects on biodiversity at the landscape level
ii. Biomass production or extraction can only be performed in protected areas or areas with high conservation values if it is part of a management plan to protect biological values
iii. The integrity of relevant ecosystems and habitats for rare and endangered species shall be maintained
iv. Alien species shall be cultivated under conditions of careful control and monitoring to avoid unintended dispersal
v. Biomass plantations shall, preferably, be located and designed to contribute to a varied landscape
vi. Biomass extraction shall, if possible, be conducted in relation to other management practices in the landscape so as to sustain or enhance biodiversity, for example by avoiding unnecessary disturbance and the creation of refugees
vii. Buffer zones or vegetation filters between biomass production areas and waters and wetlands shall, if needed, be used to reduce the risk for damage on water and near water zone qualities

Indicators:
Number and abundance of species at the landscape level
Spreading of alien species
Land use within the landscape
Occurrence and design of buffer zones

[9] Biodiversity should be addressed from a landscape perspective instead of stand or field level.

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2. Resource efficiency

Principle:
Natural resources, such as soil, water and land, shall be used efficiently and biomass production or extraction shall not endanger soil status or cause further deterioration of water quality and quantity.

Criteria:

i. Methods shall be chosen to minimize the risk for permanent physical damage to the soil
ii. Methods that cause a net depletion (after compensatory measures) of humus, nutrients and minerals in the soil below levels necessary for the maintenance of the long-term soil production capacity shall be avoided
iii. Nutrient rich waste products and co-products should preferably be recycled
iv. Residues from forestry and agriculture should be used for energy production or other purposes
v. Biomass production and extraction shall be conducted in a way that prevents further deterioration, for example by erosion or nutrient leakage, and protects (or enhances) the status of aquatic ecosystems[10]
vi. Water shall be used efficiently without endangering water supply
vii. Land shall be used efficiently, and practices that optimize productivity shall be used
viii. The use of the land should be optimized through locating, managing and designing the production in the best suitable way and where synergistic effects are at the best

Indicators:
Water quality and quantity
Methods and compensatory measures
Soil damages
Soil nutrient status
Local management plans to optimize land use

3. Energy efficiency

Principle:
For a sustainable production and use of bioenergy the energy balance shall be considered, and the use of fossil energy sources during production of bioenergy should preferably be avoided.

Input energy shall be minimized throughout the whole production chain and be distributed and accounted for on all products (main and co-products) based on an average product value proportion basis.

[10] Modified from the Directive 2000/60/EC on establishing a framework for Community action in the field of water policy

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Criteria:

i. Residues and co-products should be used for energy or other applications in order to increase efficiency
ii. If reuse or recycling of waste is not possible, use for energy shall be preferred over dumping[11]
iii. The energy input in production, extraction and conversion of biomass to bioenergy should be minimized
iv. Efficient conversion technologies shall be used
v. Long-distance transports of non-processed raw materials shall be avoided
vi. Use of waste heat shall be encouraged
vii. Combined production of heat, electricity and other products (cooling, steam) should be promoted whenever possible

Indicators
Part of waste products recycled
Use of residues, co-products and waste
Energy yield ratio: quantity of useful bioenergy produced per unit of fossil fuel consumed
Conversion efficiency: the amount of energy produced as a percentage of the amount of energy consumed (according to Directive 2009/28/EC the Member States should promote biomass conversion technologies that achieve a conversion efficiency of at least 85 % for residential and commercial applications and at least 70 % for industrial applications)
Suggestions for energy efficient systems: For the production of heat and electricity, the energy used in biomass production, extraction and conversion to bioenergy should preferably be less than 20 % of the energy gained. For the production of biofuels the energy input in biomass production, extraction and conversion should preferably be less than 50 % of the energy output

4. Climate mitigation efficiency

Principle I:
Greenhouse gas emissions (i.e. emissions of CO_2, CH_4 and N_2O in CO_2 equivalents) from bioenergy production and use shall be minimized.

Criteria:

i. The greenhouse gas emission savings of the production chain - including production, extraction, conversion and transport - shall be maximized and compared to a reference scenario with fossil fuels. Both long and short term gain and losses shall be evaluated
ii. The use of waste, residues and co-products shall be encouraged and accounted for when calculating greenhouse gas emission savings
iii. Special consideration shall be taken to biomass production on organogenic soils
iv. Bioenergy production that leads to a reduction of greenhouse gas emissions, for example usage of manure for biogas production, shall be promoted
v. Bioenergy production from waste should be encouraged[12]

[11] Modified from the Directive 2008/98/EC on waste

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Indicators:
A methodology for calculating greenhouse gas emission reductions is described in Directive 2009/28/EC
The greenhouse gas emission savings from the production and use of biomass for heat, cooling and electricity production should preferably be at least 80 % compared to if fossil fuels had been used
The greenhouse gas emission savings from the production and use of biofuels should, compared to if fossil fuels had been used, preferably be at least 35 %. From 1 January 2017 it shall be 50 % and from 2018 60 % for new plants

Principle II:
Biomass production shall not endanger important carbon stocks. Greenhouse gas emissions caused by **land-use change** shall be low in relation to the amount of greenhouse gas emissions that can be saved in a long-term perspective.

Criteria:

i. Biomass (used for heating, cooling or electricity) shall only be produced on land where the loss of carbon stock caused by the land-use change can be compensated for by the accumulated greenhouse gas emission savings from substituting fossil fuels with produced biomass within a period of 20 years. Within a period of 50 years, the greenhouse gas emission savings should be at least 80 %. Emission savings from usage of co-products can also be accounted for
ii. Land with high carbon stock such as wetlands[13] and continuously forested areas[14] should not be used for the production of biofuels or bioliquids if it implies a permanent change in land status[15]

Indicators:
Before a new land area is exploited, the producer shall determine the extent of carbon loss the activities will result in and establish whether the losses will be compensated for by means of the biomass production within the stipulated time period or relevant management cycle
All land-use change shall be reported
Monitoring of biomass origin
Methods for calculating of greenhouse gas emissions associated with land-use change is described in IPCC (2000) Good Practice Guidance for Land Use, Land-Use Change and Forestry

[12] In directive 2009/28/EC the use of waste for energy production is promoted by that the greenhouse gas emission savings criterion (see p.8) should not be applied
[13] Land that is covered with or saturated by water permanently or for a significant part of the year.
[14] Land spanning more than one hectare with trees higher than five meters and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ.
[15] Modified from Directive 2009/28/EC on the promotion of the use of energy from renewable sources

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5. Social aspects

Principle I:
The production and use of biomass for energy shall not endanger food security or local production of biomass for other applications.

Criteria:

i. The production of biomass for energy shall only occur at sites where it does not threaten local/regional food supply
ii. Negative effects of competition between energy, food, fodder and material use should be minimized
iii. The possibilities of a secured long-term supply of biomass shall be considered and demonstrated when establishing a heat or power plant

Indicators:
Use of waste, residues and co-products for energy
No land can be used without the informed consent of the rightful owner
Viability of business that could be threatened by an increased use of biomass for energy

Principle II:
Bioenergy production should not endanger the conservation of cultural remains and heritages or prosperity of local communities and cultures.

Criteria:

i. Production of biomass for energy should not influence the possibility for recreational activity in a negative way
ii. Local acceptance and avoidance of conflicts should be reached through regional and local planning instruments, and preferably comprise multi-stakeholder dialogues
iii. Bioenergy production should be carried out with consideration to local communities and cultures
iv. Biomass production should not violate the basis of existence for the indigenous population

Indicators:
Documented information opportunities (all neighbors affected by a bioenergy installation should be given the opportunity to be a part of or comment on the project already at the planning stage)
Regional planning for land use, including set aside land for recreation

6. Economic issues

Principle:
Bioenergy production, extraction and use should contribute to an increase in rural activity and to the development of viable business and security in energy supply.

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Criteria:

i. Activities shall have generally positive effects on social welfare and accessibility to rural areas
ii. Development of local energy systems that enable combinations of different renewable energy sources shall be encouraged
iii. Bioenergy systems should preferably give positive effects on local economy

Indicators:
Rural income
Migration to and from rural areas
Building of new roads in areas were roads are lacking
Creation of employment

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Annex 1

Table 1.
Comparison of some of the existing works on sustainability criteria

	Nordic Council Project		RES Directive		Forest Europe (MCPFE)		Bioenergy Promotion		Cramer Criteria	
Biomass covered	Solid, liquid and gaseous biofuels from forestry and agriculture		Biofuels for transport, Bioliquids for heat and electricity		Forest biomass		Solid, liquid and gaseous biofuels from forestry and agriculture		Biomass for non-food applications	
Principle	Criterion	Indicator	Criterion	Indicator	Criterion	Indicator	Criterion	Indicator	Criterion	Indicator
GHG balance	Net GHG emission reduction for heat and electricity and for transport fuels.	Heat and electricity: GHG emission savings 80% compared to oil Transport fuels: GHG emission savings 50%	GHG emission savings when using biofuels	GHG emission saving at least 35%, 50% from 2017 (60% for new plants), calculated on LCA methodology contained in the RES Directive			Net GHG emission reduction for heat and electricity and for transport fuels.	Heat and electricity: GHG emission savings 80% compared to oil Transport fuels: GHG emission savings 50%	Net GHG emission reduction	50-70% reduction for electricity, 30% for biofuels

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Carbon stock changes	Land conversion should not result in GHG emissions >30% of potential emissions of replaced oil in a 50-year perspective		No biomass from land with high carbon stock (wetlands, peatland, continuously forested areas, carbon rich land with trees >5m and canopy cover between 10-30%). Carbon losses due to land use change are accounted for in the LCA and should be divided over a 20-year period	GHG emissions from land carbon stock change are divided over 20 years and included in GHG calculations	Maintenance of forest resources and their contribution to global carbon cycles	Area wooded land, growing stock, age structure, carbon stock	Bioenergy production do not endanger important above- or underground carbon sinks	Carbon storage replaced in 20 years	Conservation of carbon sinks	Carbon storage recovered within 10 yrs

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Land use				Bonus for GHG savings in LCA calculation for biofuels produced on degraded and contaminated land Biofuels from wastes, residues, non-food cellulosic material, and ligno-cellulosic material receive economic incentive as they count twice against the target	Maintenance of productive functions of forests	Balance between annual increment and fellings, value of wood and non-wood	Efficient land use, bioenergy production do not endanger food security or production of biomass for other purposes	Promotion of the use of residues, optimize productivity,	Insight in land use change	Reporting

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Biodiversity	Maintenance of forest-dwelling species in viable populations, biomass production should not endanger biodiversity at the landscape level, promotion of increased variation of the landscape, special considerations to preserve meadows and pastures	Harvest in relation to other manage-ment actions, retaining dead wood elements, No degradation of biodiverse habitats, crop rotation of annual crops,	No raw material from highly bio-diverse land to be used for fuel production (undisturbed forest, protected areas, biodiverse grasslands)	Exact geographical origin: will be verified	Maintenance, conservation and appropriate enhancement	Keeping track of: Forest area, regene-ration areas, undisturbed forest area, areas domi-nated by introduced species, dead wood, spatial patterns of forest cover, protected area, # of threatened species	Biomass production should not endanger biodiversity at the landscape level, If possible, biomass production shall strengthen biodiversity and increase landscape variation.	Number and abundance of species, land use in the landscape.	No violation of laws, no deterioration of biodiversity, strengthening if possible	No produc-tion in pro-tected or valuable areas

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Environment (soil, water and air)	Retain humus, nutrients and acid/base contents at levels that maintain soil production capacity Avoid increased N leaching and eutrophication, restrictive use of chemicals	Recycling of nutrients, ashrecycling Buffer zones along waters and wetlands	For biofuels from EU agriculture: Cross-compliance requirements	Obligation for farmers Reporting by MS and Commission on impacts on biodiversity, water resources, water quality and soil quality	Maintenance of forest health and vitality Maintenance and enhance-ment of protective functions in forest management	Deposition of air pollutants, soil properties (acidity, eu-trophication), damaged forests Areas designated to prevent soil erosion	Efficient use of natural resources, no damage on natural ecosystems	Promotion of recycling of nutrients, efficient use of residues and co-products, Compensatory measures, water quality.	Practices to retain soil quality, use of residues not at expense of soil functions Restricted use of water and only from renewable sources. Responsible use of chemicals Best practices to reduce air pollution, no burning unless permitted	Reporting
Energy efficiency	Positive energy balance. Input energy distributed on both main and co-products.	Heat and electricity: Energy input less than 20%of output. Transport fuels: Energy input less than 50% of output.					Positive energy balance. Input energy distributed on both main and co-products.	Heat and electricity: Energy input less than 20%of output. Transport fuels: Energy input less than 50% of output.		

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Local prosperity	Activities should have positive effect on social welfare.						Bioenergy production should contribute to an increase in rural activity and to the development of viable business. Cultural remains and prosperity of local communities and cultures should not be endangered	Information, rural income, migration.	Positive contribution of private company activities	Reporting

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Social well being	No practices that threaten workers health, considerations to local communities and cultures	Monitoring of workers health		The Commission shall report all effects on social sustainability in EU and third countries, caused by the increasing demand for biofuels. Including property rights, whether or not ILO-conventions are ratified and implemented and commodity price changes and effect on food security	Maintenance of other socio-economic functions	Number of forest holdings, contribution to GDP, number of employees, frequency of accidents and diseases, imports/exports, share of wood energy of total energy, public access for recreation, # of sites with cultural values			Working conditions, human rights, consent of original users before land use	Comply with human rights regulations, reporting

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