Biomass Energy Europe

Political Framework and User Requirements of Biomass Resource Assessments for Energy Version 3 (Final)

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Preface

Reliable knowledge of the biomass potentials for energy in Europe is essential basic information needed for both policy and industry to achieve the challenging European policy targets in the renewable energy sector.

This report consists of two areas:
Part 1: Political Framework and
Part 2: User Requirements of Biomass Resource Assessments for Energy.

The objective of part 1 of this study is to understand the differences between the political frameworks and to estimate the impact of these differences on the outcomes of different resource assessments. In almost every country there are some stated targets for increased production of renewable energies. However, the political framework to support the targets differ from country to country, ranging from strong financial incentives to no measures at all - or even political barriers. To define the status of biomass resource assessments it is necessary to understand the circumstances the assessments are dealing with, starting with the different definitions of the term "biomass" not only between countries but also between different legislative and policy papers in one country.

The objective of part 2 of this study is to find out the needs of those who use the results of different biomass resource assessments. The target is to understand the user requirements in such a detailed level that this information can be taken into account when defining the proposal for a harmonised biomass assessment methodology.

To achieve the potential and political targets it is essential to have resource assessments that are clear, reliable and detailed enough, both for policy and industry. In addition to policy makers and authorities at different levels (local, national, EU, etc.) and industrial investors, however, there are also several other potential users of biomass resource assessments, such as research organisations, NGOs, etc. Different user groups – and even different single users – have different requirements of the assessments, depending on the intended use of the results. Different requirements appear in regards to biomass categories to be covered, time frame, geographical coverage, type of potential, as some examples.

The results of this study will be used as a baseline to begin WP4 “Analysis of biomass resource assessments”. Aside from this, it will also be used – but to a lesser extent - in WP5 “Harmonisation of biomass resource assessments”, which aims to harmonise the methods and data sources for current and future biomass resource assessments.

Jyväskylä, June 30, 2010
Authors

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List of Abbreviations

BAP	EU Biomass Action Plan
BEE	Biomass Energy Europe
BPU	Biomass production unit
CAP	EU Common Agricultural Policy
CBD	Convention on Biological Diversity
CEEC	Central and eastern European countries
CHP	Combined heat and power production
CITES	Convention on International Trade in Endangered Species
CNDP	Complementary national direct payment
EAFRD	European Agricultural Fund for Rural Development
EAP	Environmental Action Programme
EBTP	European Biofuels Technology Platform
EBTP	European Biofuels Technology Platform
EIBI	European Industrial Bioenergy Initiative
EJ	exajoule (10^{18} joules)
EU ETS	The European Emissions Trading Scheme
EurepGAP	Integrated Farm Assurance for Combinable Crops
FLEGT	Forest Law Enforcement, Governance and Trade
FOE-US	Friends of the Earth US
FP7	7^{th} Frame Work Programme
FSC	Forest Stewardship Council
GHG	Greenhouse gas(es)
GIS	Geographic information system
GRI	Global Reporting Initiative
HCV	High conservation value
IATP	Institute for Agriculture and Trade Policy
IFOAM	International Federation of Organic Agriculture Movements
IPCC	Intergovernmental Panel on Climate Change
LCP Directive	EU Directive on Large Combustion Plants (2001/80/EC)
MCPFE	Ministerial Conferences on the Protection of Forests in Europe
MGA	Maximum guaranteed area
MSW	Municipal solid waste
Mtoe	Million tonnes of oil equivalence
nBAP	National Biomass Action Plan
NFP	National forest programme
NFSA	Non-food set-aside scheme
NGO	Non-governmental organisation

odt	Oven dry ton
OECD	Organisation for Economic Cooperation and Development
OMC	Open method of coordination
RD&D	Research, development and demonstration
RES-E	Electricity from renewable energy sources
RES-E Directive	EU Renewable Energy Sources Directive (2001/77/EC)
RME	Rape methyl ester
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Round Table on Responsible Soy
SA 8000	Social Accountability International
SAN/RA	Sustainable Agriculture Network / Rainforest Alliance
SAPS	Single Area Payment Scheme
SDS	EU Sustainable Development Strategy
SET-Plan	EU Strategic Energy Technology Plan
SFM	Sustainable forest management
SRC	Short rotation coppice
TGC	Tradable green certificate
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
WP	Work package

1 Introduction

The Biomass Energy Europe (BEE) project aims at a harmonisation of biomass resource assessments, focusing on the availability of biomass for energy in Europe and its neighbouring regions. Within the working sequence of the project, the first work package, "Status of Biomass Resource Assessments" (WP3), covers two major pillars: (i) the assessment and analysis of the policy background and the requirements of the users of the information from resource assessments and (ii) a comparative analysis of existing biomass resource assessments at the global, European, regional, and national scale, with the aim of analysing the heterogeneity of the results, methodologies and data sources used. The goal of this work package is to provide an overview of biomass resource assessments with regard to their scope and results and to develop a baseline, including all definitions and information necessary for work in WP4 and – to a lesser extent – WP5.

The above mentioned pillars comprise five out of seven tasks within WP3: pillar I consists of one task only (Task 3.2), whereas pillar II is made up of four tasks (Tasks 3.3 to 3.6). The main work within WP3 is based on the results of Task 3.1, in which all information, definitions, procedures and principles are compiled and concluded upon. A synthesis will finally conclude WP3. Figure 1 illustrates this internal structure.

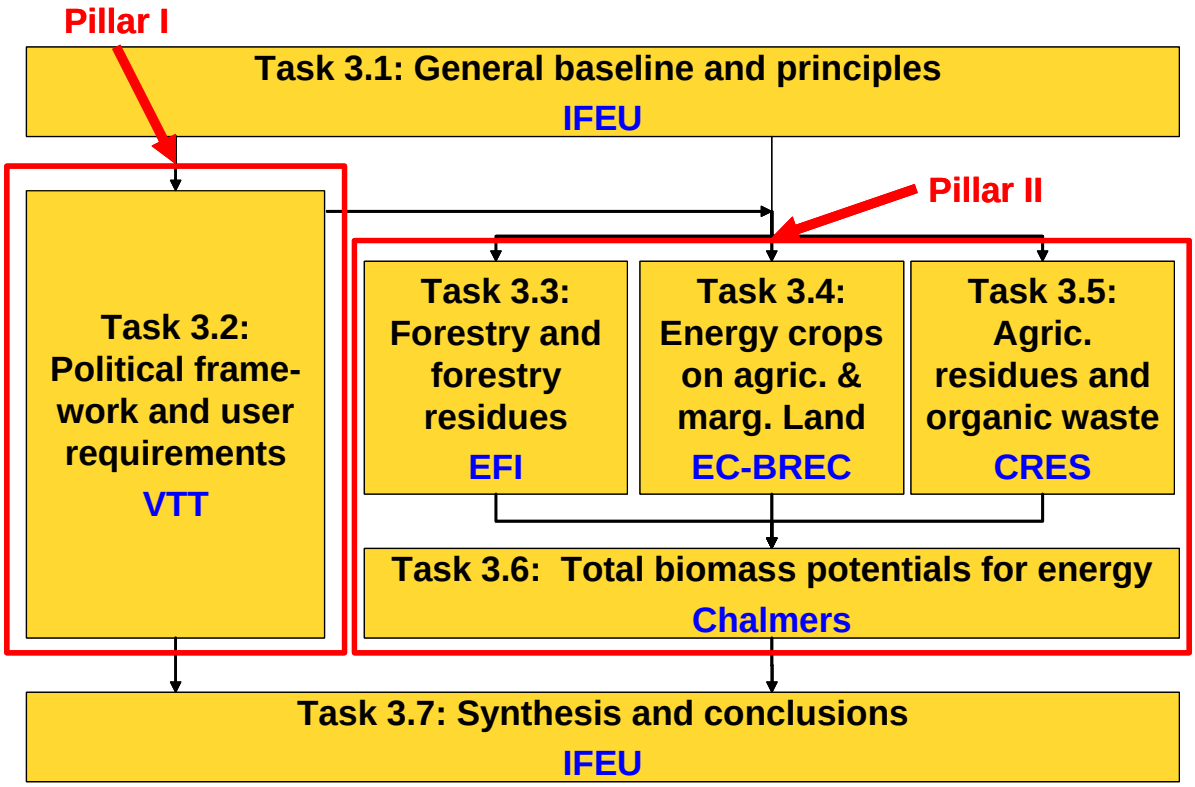

Figure 1 Structure of WP3: the two main pillars are highlighted in the red boxes.

The objective of the first pillar is to understand the differences between the political frameworks and to estimate the impact of these differences on the outcomes of different resource assessments. In almost every country there are some stated targets for increased production of renewable energies. However, the political framework to support the targets differ from country to country, ranging from strong financial incentives to no measures at all – or even political barriers.

To define the status of biomass resource assessments it is necessary to understand the circumstances the assessments are dealing with, starting with the different definitions of the term "biomass" not only between countries but also between different legislative and policy papers in one country. These differences are presented in Chapter 3. Chapter 4 describes the renewable energy and greenhouse gas (GHG) mitigation targets, part of which are binding while the others are indicative. To be able to reach the targets in practice, it is necessary to offer some support mechanisms which promote renewable energies and motivate the investors to invest in biomass technologies. Different financial instruments and other support measures are presented in sub-chapter 4.3.

Availability of biomass resources and development of bioenergy is not only dependent on energy policies. Many other policy sectors have an impact on the competitiveness of bioenergy as well; the most important of these are described in Chapter 5. When defining political targets, resource assessments and other background studies are used. The role of biomass resource assessments in policy making is clarified in Chapter 2. The results of a study of user requirements for biomass resource assessments are presented in Chapter 6. Finally, the different aspects of political framework and user requirements are summarised in Chapter 7.

2 Role of biomass resource assessments in policy making

Reliable knowledge of the biomass potentials for energy in Europe is essential basic information needed for both policy and industry to achieve the challenging European policy targets in the renewable energy sector. However, biomass resource potential assessments for energy for the same geographic entity differ largely from each other. The most significant reasons for the considerable variation in the results are

- the heterogeneity of general methodological approaches used,
- the heterogeneity of datasets used,
- the heterogeneity of the methods used to identify the land potential for energy crop plantations,
- missing empirical data for certain aspects (e.g. conversion factors, waste fractions, yields),
- the heterogeneity of factors and assumptions used to consider the production and utilisation of biomass, e.g. sustainability, demand and competition with other sectors,
- the heterogeneity of approaches used for the integration of technological learning curves, both in the production sector of biomass and in biomass-to-energy conversion.

Furthermore, the scope of existing biomass resource assessments vary with regard to the biomass categories considered, e.g. energy crops, forest residues or total potentials, the scale of the analysis (e.g. local, regional and global), the timeframe of the analysis, and the type of potentials considered.

Biomass potentials can be divided into bio-physical, technical, economic and implementation potentials. Bio-physical potential is the maximum sustainable yield potential for a specific land use, e.g. a forest or a specific energy crop. Technical potential is the theoretical potential limited by the demand for land for other purposes and based on an assumed level of technology. Economic potential is the technical potential limited by economic profitability. Finally, also meeting the criteria of sustainable production, as well as implementation aspects, can further limit usable biomass resources. As a consequence, different nomenclatures and categorisations, and the differing definitions of resource levels from bio-physical to implementation potential, hinder the comparability of the results of various assessments.

Biomass resource assessments are used, for example, when setting targets for different bioenergy sectors. While transport biofuels have the highest employment intensity and the greatest security of supply benefits, biomass in electricity has the greatest greenhouse gas benefits and biomass in heating is cheapest. Therefore the EU Biomass Action Plan (EC 2005b) stresses, that biomass should be promoted in all three sectors. According to the Plan, at least until 2010 there will be no major competition for raw material as biofuels rely mainly on agricultural crops while electricity and heating rely mainly on wood and wastes. This argument has been based on the estimation by the European Environmental Agency, according to which the full biomass potential would be about 185 Mtoe in 2010, while complying with good agricultural practice, safeguarding sustainable production of biomass and without significantly affecting domestic food production.

A study carried out in WP3 of the BEE project (Goltsev & Lindner 2008) compared the results of 10 different wood resource assessments. The study revealed that the estimations vary within a wide range depending on scenario assumptions. For example, the estimations of the global wood biomass resources varied from 38.34 EJ up to 138.997 EJ. The 3.5-fold difference has a major importance when political targets for bioenergy are set. The lowest estimations may provide too tight limits for the biomass availability, leading to unnecessarily conservative targets.

On the other hand, if over-optimistic resource assessments are used, there is a risk of unrealistic targets, which may lead to unwanted indirect impacts. For example, the indirect land use change impacts of biofuels, also known as iLUC, relate to the unintended consequence of releasing more carbon emissions due to land use changes around the world induced by the expansion of croplands for ethanol or biodiesel production in response to the increased global demand for biofuels. As farmers worldwide respond to higher crop prices in order to maintain the global food supply and demand balance, pristine lands are cleared and converted to new cropland to replace the crops for feed and food that were diverted elsewhere for biofuels production.

The importance of reliable resource assessments becomes even more apparent, when competing uses of biomass are taken into account. In both national and EU level separate targets are set independently for different policy areas, such as energy, agriculture and forestry. Moreover, the security of food supply as well as availability of reasonably priced industrial raw materials should be secured. Also land availability may become a restrictive factor for separately defined political targets.

To avoid competing and overlapping targets, it is necessary to create cooperation between policy makers in different sectors. At least as important is to develop biomass resource assessment methods with well-defined assumptions, taking into account the different uses of land area and biomass resources. This way it would be possible to set ambitious but still achievable political targets which support each other instead of competing for the same resources.

3 Political framework: Definitions of "biomass"

In different connections – EU directives, national legislation, EU and national policy and strategy papers, etc. – the term "biomass" has different meanings. This makes it difficult to get comparable results from different information sources. For example, in national statistics the basics for calculating bioenergy figures may be different.

In the RES-E Directive (2001/77/EC), and later the directive on the promotion of the use of energy from renewable sources amending and subsequently repealing the RES-E Directive (2009/28/EC), biomass is defined to mean the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

In the LCP Directive (2001/80/EC), on the other hand, biomass means products consisting of any whole or part of a vegetable matter from agriculture or forestry which can be used as fuel for the purpose of recovering its energy content and the following waste used as fuel:

- vegetable waste from agriculture and forestry;
- vegetable waste from the food processing industry, if the heat generated is recovered;
- fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered;
- cork waste;
- wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste.

To supplement the Emissions Trading Directive (2003/87/EC), the Commission Decision 2007/589/EC establishes guidelines for the monitoring and reporting of greenhouse gas emissions. In this decision, biomass has been defined to mean non-fossilised and biodegradable organic material originating from plants, animals and micro-organisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilised and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilised and biodegradable organic material. In this document, biomass is defined as CO_2 neutral, and an exemplary list of different types of materials accepted as biomass is given, classified into four main categories:

(1) plants and parts of plants
(2) biomass wastes, products and by-products
(3) biomass fractions of mixed materials
(4) fuels whose components and intermediate products have all been produced from biomass

The commission's decision also provides instructions for how to determine a biomass fraction. According to the decision, the term biomass fraction refers to the mass percentage of biomass carbon according to the biomass definition out of the total mass of carbon in a sample. Fuel or material shall qualify as pure biomass with simplified provisions for the

monitoring and reporting, if the non-biomass content accounts to no more than 3% of the total quantity of the fuel or material concerned. The procedures applied to sample the fuel or material and to determine the biomass fraction shall, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards shall be used if available.

The CEN 335 Standardisation of solid biofuels, Working group 1 has prepared a technical specification for solid biofuels related terminology, definitions and descriptions (prEN 14588, January 2008, revised in 2010). In this document, biomass is defined from a scientific and technical point of view as material of biological origin excluding material embedded in geological formations and/or transformed to fossil. Different types of biomass are classified based on their sources to three main categories, which each have several sub-categories:

(1) woody biomass
(2) herbaceous biomass and grassy biomass
(3) other biomass and mixed biomass

In its 2006 Guidelines for National Greenhouse Gas Inventories, IPCC defines biomass as (IPCC 2006):

(1) The total mass of living organisms in a given area or of a given species usually expressed as dry weight.
(2) Organic matter consisting of or recently derived from living organisms (especially regarded as fuel) excluding peat. Includes products, by-products and waste derived from such material.

In addition to different international definitions of biomass, there is also a great variety of national definitions. Some terms have the same meaning in all countries, for example in forest and plantation wood related definitions for firewood, short rotation coppice (willow and poplar), forest residues, thinning residues, bark from forestry operations and stumps (Alakangas 2006). However, there are differences in the borderline between biomass and waste: used wood and waste wood, wood industry by-products and residues, as well as biodegradable fraction of agricultural, industrial and municipal waste. As regards forest industry residues, vegetable fibrous waste from wood processing industry is considered in CEN/TC 335 and all directives as biomass, but in Slovakia industrial waste is not biomass, in Germany paper, cardboard and pasteboard are not biomass.

In most countries biodegradable fraction of municipal and industrial waste is biomass (usually more than 60% of waste is bio-based), but in Germany mixed MSW from private households is not biomass. In Finland, Sweden, Latvia, Lithuania and Russia peat is defined as slowly renewable biomass, while in e.g. Germany it is not considered biomass (Alakangas 2006).

4 Political framework: Energy policy

4.1 Renewable energy and EU's GHG mitigation objectives

Bioenergy plays an essential role in the European ambitions to increase the share of renewable and indigenous energy sources. Various EU countries have a leading position in the world in the bioenergy field. Especially Scandinavia as a whole has been the leading region, both in terms of the contribution bioenergy makes and in terms of technological development (Faaij 2006). Germany, the Netherlands and the UK are countries with considerable ambitions in the bioenergy field, but with the natural 'handicap' that the national biomass resource base is less than in Northern Europe. France and Spain are key examples in Southern Europe.

4.1.1 Biomass Action Plan

In 2005, the commission presented the Biomass Action Plan (BAP) in a wider context of an integrated and coherent energy policy and, in particular, of the promotion of renewable energy sources. It is just one component of the measures needed to achieve the objectives set – but an important one, since biomass presently accounts for about half of the renewable energy used in the EU.

Essential elements of the Action Plan are, within the context of stronger economic growth, the need to reduce energy demand; increase reliance on renewable energy sources; and enhance international cooperation (EC 2005b). These elements can help Europe to reduce dependence on energy imports, increase sustainability and stimulate growth and jobs.

The Action Plan sets out measures to increase the development of biomass energy from wood, wastes and agricultural crops by creating market-based incentives to its use and removing barriers to the development of the market. In this way Europe can cut its dependence on fossil fuels, cut greenhouse gas emissions and stimulate economic activity in rural areas.

The Action Plan is a first, coordinating step. It sets out measures to promote biomass in heating, electricity and transport, followed by cross-cutting measures affecting biomass supply, financing and research. It is accompanied by a general impact assessment. As a second step, individual measures will be brought forward subject to specific impact assessment in line with commission rules.

According to the BAP (EC 2005b), in 2005 the EU met 4% of its energy needs from biomass. If it made full use of its potential, it would more than double biomass use by 2010 (from 69 Mtoe in 2003 to about 185 Mtoe in 2010) – while complying with good agricultural practice, safeguarding sustainable production of biomass and without significantly affecting domestic food production. Bulgaria and Romania's accession improved availability, and imports offer more potential still.

In the commission's judgement, the measures of the Action Plan could lead to an increase in biomass use to about 150 Mtoe in 2010 or soon after. This is less than the full potential; it is in line with the indicative renewable energy targets.

While transport biofuels have the highest employment intensity and the greatest security of supply benefits, biomass in electricity has the greatest greenhouse gas benefits and biomass in heating is cheapest. Biomass should be promoted in all three sectors. At least up to 2010, there will be no major competition for raw material: biofuels rely mainly on agricultural crops while electricity and heating rely mainly on wood and wastes.

In addition to biomass heating and electricity and transport biofuels, the Action Plan also presents measures to promote cross-cutting issues and research.

4.1.2 The EU Strategy for Biofuels

In the EU, transport is responsible for an estimated 21% of all greenhouse gas emissions, and the percentage is rising (EC 2006c). In order to meet sustainability goals, in particular the reduction of greenhouse gas emissions agreed under the Kyoto Protocol, it is therefore essential to find ways of reducing emissions from transport.

This is not the only challenge. Nearly all the energy used in the EU transport sector comes from oil. Known oil reserves are limited in quantity and restricted to a few world regions. New reserves exist but will mostly be more difficult to exploit. Securing energy supplies for the future is therefore not only a question of reducing import dependency, but calls for a wide range of policy initiatives, including diversification of sources and technologies.

In the EU a range of actions is already being taken (EC 2006c). Vehicle manufacturers are developing new models that are cleaner and more fuel efficient, as well as working on new concepts. Efforts are also being made to improve public transport and encourage the use of environmentally-friendly modes of transport where possible. Further endeavours are needed to make reductions in the amount of energy used for transport.

The EU Strategy for Biofuels (COM(2006) 34 final) looks at the role biofuels could play. Processed from biomass, biofuels are a direct substitute for fossil fuels in transport and can readily be integrated into fuel supply systems.

Although most biofuels are still more costly than fossil fuels their use is increasing in countries around the world. Encouraged by policy measures, global production of biofuels is now estimated to be over 35 billion litres (EC 2006c).

The EU is supporting biofuels with the objectives of reducing greenhouse gas emissions, boosting the decarbonisation of transport fuels, diversifying fuel supply sources and developing long-term replacements for fossil oil. The development of biofuel production is expected to offer new opportunities to diversify income and employment in rural areas.

While existing technologies do not at present offer cost-competitive solutions for the EU, the benefits of encouraging development of biofuels should outweigh the cost. In this context, the development of second generation biofuels, in which research and development has an important role, could further contribute to their cost-effectiveness. In view of the complex,

cross-cutting and dynamic character of the issues, the approach taken is a strategic one, the impact of which will be carefully monitored. As the biofuels market evolves, appropriate modifications will be discussed and incorporated into the strategy (EC 2006c).

The Biomass Action Plan (see chapter 4.1.1) already described various actions that will be taken to encourage the use of all kinds of biomass for renewable energy production. To complement that, the EU Strategy for Biofuels has three aims (EC 2006c):

- to further promote biofuels in the EU and developing countries, ensure that their production and use is globally positive for the environment and that they contribute to the objectives of the Lisbon Strategy taking into account competitiveness considerations;
- to prepare for the large-scale use of biofuels by improving their cost-effectiveness through the optimised cultivation of dedicated feedstocks, research into "second generation" biofuels, and support for market penetration by scaling up demonstration projects and removing non-technical barriers;
- to explore the opportunities for developing countries for the production of biofuel feedstock and biofuels, and to set out the role the EU could play in supporting the development of sustainable biofuel production.

Even using the most modern technologies, the cost of EU-produced biofuels will make it difficult for them to compete with fossil fuels. With the technologies currently available, EU-produced biodiesel breaks even at oil prices around €60 per barrel, while bioethanol becomes competitive with oil prices of about €90 per barrel (EC 2006c).

Biofuels can be used as an alternative fuel for transport, as can other alternatives such as liquid natural gas, compressed natural gas, liquefied petroleum gas and hydrogen. Nevertheless, encouraging the use of currently available biofuels may be seen as an intermediate step to reduce greenhouse gas emissions, to diversify transport energy sources, and to prepare the EU economy for other alternatives in the transport sector which are not yet mature. By actively embracing the global trend towards biofuels and by ensuring their sustainable production, the EU can exploit and export its experience and knowledge, while engaging in research to ensure that the EU remains in the vanguard of technical developments. A clear strategy for the EU will also promote lower production costs.

The supply of feedstock is crucial to the success of the biofuel strategy. Some of the provisions of the Common Agricultural Policy (see chapter 5.6) will therefore be reviewed and adapted if necessary. The expected increase in the world trade in biofuels will also contribute to stability of supply in the EU and other parts of the world.

The construction of plants to produce alternative fuels, the introduction of new engine types and the adaptation of the fuel distribution system entail long-term investments, which need stable prospects for market demand. This implies that supply-side measures need to be complemented by an effective market-based incentive system. In the medium-term, additional investment will be necessary to bring new technologies and feedstock into use. Forestry and waste materials will play an increasing role if "second-generation" processes can be made to work effectively in commercial terms (EC 2006c).

The CARS 21 High Level Group, set up by Vice President Verheugen to consider the competitiveness challenges facing the European automotive industry, has identified second-

generation biofuels as particularly promising and has recommended that their development should be given substantial support. The group also concluded that further policy developments should take into account and reflect the differing climate change benefits of different biofuel technologies and production processes (EC 2006c).

To prepare for the large-scale use of cost-competitive biofuels, continued research and development is needed to make the new techologies successful. Work should also be encouraged on the development of dedicated feedstock and to increase the range of raw materials that can be used to make biofuels. Partnership among all the relevant stakeholders will be necessary to promote best practices and facilitate long-term private sector investments.

Development will be monitored at EU level with the aim of providing support at the appropriate time for the upgrading of demonstration projects to commercial-scale operations. At the same time, guarantees must be given as to the environmental benefits of all new processes and any non-technical barriers to their acceptance will have to be removed.

Advanced biofuel technologies could also provide a stepping stone to renewably-produced hydrogen, which offers the prospect of virtually emission-free transport. However, hydrogen fuel cells require new engine technology as well as big investment in plants to produce the hydrogen and a new distribution system (EC 2006c). In this context, the sustainability of hydrogen has to be carefully assessed. Any shift to hydrogen-based transport would therefore call for a major decision, embedded in a large-scale, long-term strategy.

Biomass productivity is highest in tropical environments and the production costs of biofuels, notably ethanol, are comparatively low in a number of developing countries. Bioethanol produced from sugar cane is currently competitive with fossil fuels in Brazil which is the world's leading producer of bioethanol. Moreover, the fossil energy input for producing ethanol from sugar cane is lower than for ethanol produced in Europe, so the corresponding emission reductions are greater. For biodiesel, the EU is currently the principal producer and there is no significant trade (EC 2006c). Developing countries such as Malaysia, Indonesia and the Philippines, that currently produce biodiesel for their domestic markets, have the potential for export.

In general, the production of biofuels could provide an opportunity to diversify agricultural activity, reduce dependence on fossil fuels (mainly oil) and contribute to economic growth in a sustainable manner. But the differentiated picture among developing countries has to be recognised, while concerns exist regarding environmental, economic and social issues.

In countries where a large-scale expansion of feedstock production is likely to take place, environmental concerns relate to pressures on eco-sensitive areas, like rainforests. There are also concerns regarding the effect on soil fertility, water availability and quality, and pesticide use. Social effects concern potential dislocation of communities and competition between biofuel and food production. These concerns need specific investigation and quantification and, if necessary, should be addressed through strong regulatory frameworks (EC 2006c). EU development policy will aim to help suitable developing countries capture the benefits offered by biofuels, while addressing these concerns in an appropriate way.

The EU Strategy for Biofuels describes seven policy axes, under which are grouped the measures the Commission will take to promote the production and use of biofuels. These are (EC 2006c):

1. Stimulating demand for biofuels: the commission will
   - bring forward a report in 2006 with a view to a possible revision of the Biofuels Directive. This report will *inter alia* address the issues of setting national targets for the market share of biofuels, obligations for the use of biofuels and ensuring sustainable production;
   - encourage Member States to give favourable treatment to second-generation biofuels in biofuels obligations;
   - encourage the council and European Parliament to give speedy approval to its recently adopted legislative proposal to promote public procurement of clean and efficient vehicles, including those using high blends of biofuels.
2. Capturing environmental benefits: the commission will
   - examine how biofuel use can count towards the CO_2 emission reduction targets for car fleets;
   - explore and, where appropriate, propose measures to ensure optimal greenhouse gas benefits from biofuels;
   - work to ensure the sustainability of biofuel feedstock cultivation in the EU and third countries;
   - examine the issues of limits on the content of ethanol, ether and other oxygenates in petrol; limits on the vapour content of petrol; and limits on the biodiesel content of diesel.
3. Developing the production and distribution of biofuels: the commission will
   - encourage Member States and regions to take into account the benefits of biofuels and other bioenergy products when preparing their national reference frameworks and operational plans under cohesion policy and rural development policy;
   - propose setting up a specific ad hoc group to consider biomass including biofuels opportunities within national rural development programmes;
   - ask the relevant industries to explain the technical justification for practices that act as barriers to the introduction of biofuels and monitor the behaviour of these industries to ensure that there is no discrimination against biofuels.
4. Expanding feedstock supplies: the Commission will
   - make sugar production for bioethanol eligible for both the non-food regime on set-aside land and the energy crop premium;
   - assess the opportunities for additional processing of cereals from existing intervention stocks into biofuels, to contribute to reducing the amount of cereals exported with refunds;
   - assess the implementation of the energy crop scheme by the end of 2006;
   - monitor the impact of biofuel demand on commodity and by-product prices, their availability for competing industries and the impact on food supply and prices, in the EU and in developing countries;
   - finance a campaign to inform farmers and forest holders about the properties of energy crops and the opportunities they offer;
   - bring forward a Forestry Action Plan, in which the energy use of forest material will play an important part;

- review how animal by-products legislation could be amended in order to facilitate the authorisation and approval of alternative processes for the production of biofuels;
- implement the mechanism proposed to clarify standards for the secondary use of waste materials.

5. Enhancing trade opportunities: the commission will
   - assess the advantages, disadvantages and legal implications of putting forward a proposal for separate nomenclature codes for biofuels;
   - maintain market access conditions for imported bioethanol that are no less favourable than those provided by the trade agreements currently in force, maintain in particular, a comparable level of preferential access for ACP (African, Caribbean and Pacific) countries and take into account the problem of preference erosion;
   - pursue a balanced approach in ongoing and future trade negotiations with ethanol-producing countries and regions – the EU will respect the interests of both domestic producers and EU trading partners, in the context of the rising demand for biofuels;
   - propose amendments to the "biodiesel standard" to facilitate the use of a wider range of vegetable oils for biodiesel production and allow ethanol to replace methanol in biodiesel production.
6. Supporting developing countries: the commission will
   - ensure that accompanying measures for sugar protocol countries affected by the EU sugar reform can be used to support the development of bioethanol production;
   - develop a coherent biofuels assistance package that can be used in developing countries that have a potential for biofuels;
   - examine how the EU can best assist the development of national biofuel platforms and regional biofuel action plans that are environmentally and economically sustainable.
7. Supporting research and development: the commission will
   - in the 7th Framework Programme continue its support for the development of biofuels and strengthen the competitiveness of the biofuel industry;
   - give high priority to research in to the "bio-refinery" concept – finding valuable uses for all parts of the plant – and into second-generation biofuels;
   - continue to encourage the development of an industry-led "Biofuel technology platform" and mobilise other relevant technology platforms;
   - support the implementation of the strategic research agendas prepared by these technology platforms.

4.1.3 Renewable Energy Road Map

The EU and the world are at a cross-road concerning the future of energy (EC 2006d). Climate change, increasing dependence on oil and other fossil fuels, growing imports, and rising energy costs are making our societies and economies vulnerable. These challenges call for a comprehensive and ambitious response.

The European Council of March 2006 called for EU leadership on renewable energies and asked the commission to produce an analysis on how further to promote renewable energies over the long term, for example by raising their share of gross inland consumption to 15% by 2015. The European Parliament has by an overwhelming majority called for a 25% target for renewable energies in the EU's overall energy consumption by 2020.

The Renewable Energy Road Map (COM(2006) 848 final) sets out a long-term vision for renewable energy sources in the EU. It proposes that the EU establish a mandatory target of 20% for renewable energy's share of energy consumption in the EU by 2020, explains why it is necessary, and lays down a pathway for mainstreaming renewables into EU energy policies and markets. It further proposes a new legislative framework for the promotion and the use of renewable energy in the European Union. In doing so, it will provide the business community with the long term stability it needs to make rational investment decisions in the renewable energy sector so as to put the European Union on track towards a cleaner, more secure and more competitive energy future.

The objectives set out can only be achieved by significantly increasing the contribution from renewable energy sources in all Member States in electricity, transport and in the heating and cooling sector. The challenge is huge, but the proposed target can be achieved with determined and concerted efforts at all levels of government assuming the energy industry plays its full part in the undertaking (EC 2006d).

Reaching the target will generate major greenhouse gas emissions savings, reduce annual fossil fuel consumption by over 250 Mtoe by 2020, of which approximately 200 Mtoe would have been imported and spur new technologies and European industries. These benefits will come at an additional cost of between €10-18 billion per year, on average between 2005 and 2020, depending on energy prices (EC 2006d). With a conducive regulatory framework, heavy investment has been made in the past in conventional energy sources, notably coal and nuclear energy. The time has now come to do the same for renewable energy sources.

Pursuing an ambitious energy policy for Europe, including a more vigorous and ambitious promotion of renewable energy sources, will require changes in policy. It will entail action at all policy and decision making levels. The Renewable Energy Road Map sets out a framework for such action.

For renewables to become the "stepping stone" to reaching the dual objective of increased security of supply and reduced greenhouse gas emissions, it is clear that a change in the way in which the EU promotes renewables is needed (EC 2006d). Strengthening and expansion of the current EU regulatory framework is necessary. It is, in particular, important to ensure that all Member States take the necessary measures to increase the share of renewables in their energy mix. Industry, Member States, the European Council and the European parliament have all called for an increased role for renewable energy sources.

On the basis of the experience gained, a number of key principles for the future renewable energy policy framework need to be established. With a view to significantly increase the share of renewable energy sources in the EU's energy mix, the commission considers that such a framework should (EC 2006d):

- be based on long term mandatory targets and stability of the policy framework,
- include increased flexibility in target setting across sectors,

- be comprehensive, notably encompassing heating and cooling,
- provide for continued efforts to remove unwarranted barriers to renewable energies deployment,
- take into consideration environmental and social aspects,
- ensure cost-effectiveness of policies, and
- be compatible with the internal energy market.

The share of renewable energy in overall energy consumption has been growing, but too slowly. Having carefully examined the feasibility, the technical and economic potential including variant breakdowns between the renewable energy subsectors, the commission has come to the conclusion that the overall objective of 20% contribution of renewable energy to the EU energy mix is possible and necessary (EC 2006d). Meeting this target will require a massive growth in all three renewable energy sectors, but it is feasible.

Electricity production from renewables could increase from the current 15% to approximately 34% of overall electricity consumption in 2020. Wind could contribute 12% of EU electricity by 2020. The biomass sector can grow significantly using wood, energy crops and bio-waste in power stations. The remaining novel technologies, i.e. photovoltaic (PV), solar thermal power, wave & tidal power, will grow more rapidly as their costs come down.

To meet the overall target in 2020, the contribution from renewables in the heating and cooling sector could more than double, compared with the current share of 9%. Most of the growth could come from biomass and will involve more efficient household systems and highly efficient biomass-fired combined heat and power stations. The rest could come from geothermal and solar installations. A large proportion of the targets can be reached by applying current best practices.

Biofuels could contribute 43 Mtoe, corresponding to 14% of the market for transport fuels. The growth would come both from bioethanol and from biodiesel. Domestically grown cereals and tropical sugar cane would be the main ethanol feedstocks, later complemented by cellulosic ethanol from straw and wastes. Rapeseed oil, both domestically grown and imported, would remain the main biodiesel feedstock, complemented by smaller quantities of soy and palm oil and later by second-generation biofuels, i.e. Fischer-Tropsch diesel mostly from farmed wood.

In addition to the legislative measures and their application by Member States, the commission will take the following action (EC 2006d):

- propose strengthening the legal provisions to remove any unreasonable barrier to the integration of renewable energy sources in the EU energy system;
- propose legislation to address the barriers to growth in the use of renewable energies in the heating and cooling sector;
- take further action to improve the functioning of the internal electricity market considering the development of renewable energies;
- re-examine the situation concerning Member States' support systems for renewable energies with a view to assessing their performance and the need to propose harmonising support schemes for renewables in the context of the EU internal electricity market;

- promote a proposal for an incentive/support system for biofuels that, for instance, discourages the conversion of land with high biodiversity value for the purpose of cultivating biofuel feedstock, discourages the use of bad systems for biofuel production, and encourages the use of second-generation production processes;
- continue to promote the use of renewable energy sources in public procurement for fostering clean energies, in particular with regard to transport;
- continue to pursue a balanced approach in ongoing free trade negotiations with ethanol-produced countries/regions, respecting the interest of domestic producers and EU trading partners, within the context of rising demand for biofuels;
- continue to co-operate closely with grid authorities, European electricity regulators and renewable industry to enable a better integration of renewable energy sources into the power grid;
- fully exploit the possibilities offered by the community's financial instruments;
- continue to promote the exchange of best practices on renewable energy sources, using different information and debate platforms;
- continue to internalise external costs of conventional fossil energy (*inter alia* by means of energy taxation);
- reap all the opportunities offered for renewable energy by the result-oriented actions of the European Strategic Energy Technology Plan (SET-Plan, see chapter 4.1.5);
- promote the use of renewable energy sources in its external energy policies and favour opportunities for sustainable development in developing countries;
- fully implement the Biomass Action Plan (see chapter 4.1.1);
- continue to use the Intelligent Energy for Europe programme to help bridge the gap between successful demonstration of innovative technologies and effective market entrance to achieve mass deployment and to boost large-scale investment across the EU in new and best performing technologies and to ensure that renewable energy is given the highest priority in the sustained efforts to maximise the use of the EU research and technology development programmes in support of zero- or low carbon energy technologies whilst developing synergies with Member States involved in similar development.

In addition to these commission initiatives, it should be underlined that Member States, regional and local authorities have to make a significant contribution towards increasing the use of renewables. To make progress towards the proposed new targets, Member States will have to make further use of the range of policy instruments at their disposal, in compliance with the provisions with the EC Treaty.

Member States and/or local and regional authorities are in particular called upon to:

- ensure that authorisation procedures are simple, rapid and fair with clear guidelines for authorisation;
- improve pre-planning mechanisms whereby regions and municipalities are required to assign suitable locations for renewable energies;
- integrate renewable energies in regional and local plans.

The impact assessment, which accompanies the Renewable Energy Road Map, provides a detailed account of the various impacts of the measures set out and compares the impacts of various alternative policy options (EC 2006d):

1. *Impact on greenhouse gas emissions and other environmental impacts.* Greenhouse gas emissions, including CO_2 emissions, from renewable energy sources are either low or zero. The additional renewable energy deployment needed to achieve the 20% target will reduce annual CO_2 emissions in a range of 600-900 Mt in 2020. Considering a CO_2-price of 25 € per tonne, the additional total CO_2 benefit can be calculated at a range of €150-€200 billion. Actual CO_2 prices will depend on the future international climate regime. Replacing fossil fuels also has generally positive air quality benefits. These are especially positive in the electricity sector.
2. *Security of energy supply.* Benefits in the security of energy supply are seen in all sectors and are particularly marked in transport. Assuming the EU achieved 20% deployment of renewables, the annual reduction in fossil fuel demand can be calculated to be 252 Mtoe from 2020 onwards. About 200 Mtoe of this saving would come from imports, including 55 Mtoe of oil and 90 Mtoe of gas, predominantly from the Middle East and CIS countries.
3. *Cost and competitiveness.* It is important to note, that the main factor influencing the cost of a renewable portfolio is oil price. Under a scenario with oil prices at $78/barrel by 2020, the additional average annual cost would fall to €10.6 billion. Low international oil prices of $48/barrel, the resulting additional average annual cost would be approximately €18 billion. By comparison, the EU's total energy bill is expected to be about €350 billion that year. If the greenhouse gas savings are taken into account, carbon prices of €25 per tonne combined with high oil prices ($78) would almost entirely cover the additional cost associated with the reaching the proposed share of renewable energy. The range cited above assumes energy efficiency policies, without them the average annual additional cost would increase by more than €7 billion annually.
4. *GDP and employment.* Studies vary in their estimates of the GDP impact of increasing the use of renewable energy, some suggesting a small increase (of the order of 0.5%), and others a small decrease. Studies also suggest that support for renewable energy will lead to a small net increase in employment. Much of the economic activity generated is located in agricultural areas, often in peripheral regions. Further business opportunities will arise from the export of renewable energy technology.

4.1.4 Climate-energy legislative package

The commission opened a wide-ranging debate on a future European energy policy with the publication of a Green Paper in March 2006. In March 2007 the European Council endorsed the commission's proposal for an energy and climate package. It made an independent commitment to reduce emissions of greenhouse gases by at least 20% by 2020 and concluded that the reduction target would be increased to 30% in the context of an international agreement that includes other industrialised countries. As a part of the package the council set binding 2020 targets: a 20% target for the overall share of energy from renewable sources and a 10% target for energy from renewable sources in transport. It also stressed the need to increase energy efficiency in the EU and set the objective of reducing the EU's energy consumption by 20% compared to projections for 2020 (EC 2007b).

In April 2009, the council adopted the climate-energy legislative package containing measures to fight climate change and promote renewable energy. This package is designed to achieve the EU's overall environmental target of a 20% reduction in greenhouse gases and a

20% share of renewable energy in the EU's total energy consumption by 2020. It includes the following acts (EC 2009c):

New EU rules promoting the use of energy from renewable sources. The council adopted a directive setting a common EU framework for the promotion of energy from renewable sources (3736/08, 8037/09 ADD1). The aim of this legislative act is to achieve by 2020 a 20% share of energy from renewable sources in the EU's final consumption of energy and a 10% share of energy from renewable sources in each Member State's transport energy consumption.

To achieve these objectives, the directive for the first time sets for each Member State a mandatory national target for the overall share of energy from renewable sources in gross final consumption of energy, taking account of countries' different starting points. The main purpose of mandatory national targets is to provide certainty for investors and to encourage technological development allowing for energy production from all types of renewable sources. To ensure that the mandatory national targets are achieved, Member States have to follow an indicative trajectory towards the achievement of their target. To reach the mandatory targets, Member States will apply support schemes or measures of cooperation between different Member States and with third countries.

The directive also establishes sustainability criteria for biofuels and bioliquids with the aim of ensuring, in particular, that biofuels and bioliquids can be counted as renewable energy for the purposes of this directive only when it can be guaranteed that they meet these criteria which relate *inter alia* to biodiversity, the protection of rare, threatened or endangered species and ecosystems, and greenhouse gas emission savings.

Revised EU Emissions Trading System. The council adopted a revised Emissions Trading System (ETS) for greenhouse gases in order to achieve greater emissions reductions in energy-intensive sectors including electricity generation, coking, mineral-oil refineries, ferrous-metal production, cement, lime, ceramics, bricks, glass, pulp and paper. From 2013 onwards heavy industry will contribute significantly to the EU's overall target of cutting greenhouse gas (GHG) emissions by one-fifth compared to 1990 levels by 2020.

To stimulate the adoption of clean technologies, the new ETS (3737/08, 8033/09 ADD1 REV1) provides that GHG emissions permits will no longer be given to industry for free, but be auctioned by Member States from 2013 onwards. ETS sectors must start by purchasing 20% of their emission permits at auctions in 2013. That rate will rise gradually to 70% in 2020, with a view to reaching 100% in 2027. Power producers, on the other hand, are obliged to acquire all of their emissions allowances at auctions so as to prevent windfall profits. To facilitate the energy transition for countries with high dependence on fossil fuel or insufficient connection to the European electricity network, a derogation is available for ten Member States which can apply for reduced auctioning rates in power production, still reaching 100% in 2020.

Each EU state will determine the use of its revenues from auctioning the pollution permits. At least half of the proceeds should be used to fight climate change in the EU and abroad and also to alleviate the social consequences of moving towards a low-carbon economy.

It was anticipated, that if international negotiations on climate change in Copenhagen, in December 2009, do not lead to a new international agreement on climate change (as it actually happened), a number of sectors could be exposed to a risk of "carbon leakage", i.e. investments and production move to third countries with lower environmental standards. With that in mind, the council introduced the possibility of reducing auctioning for a limited number of sectors. In addition, if an industry can demonstrate that purchasing permits significantly increases its costs (more than 5% of its gross value added) and that it faces international competition (non-EU trade intensity above 10%), it can qualify for the free allocation of its allowances. Full free allocation will not, however, exceed the level of an ambitious benchmark corresponding to the 10% cleanest technologies in the EU. It remains to be seen whether these measures of precaution are adequate.

EU Member States share the effort to make carbon emissions reductions. The council adopted a decision to reduce greenhouse gas emissions across a wide range of activities including transport, agriculture and housing (3738/08). The so-called "effort-sharing" decision sets binding emissions targets for EU Member States in sectors not subject to the EU's Emissions Trading System.

Across the entire EU, greenhouse gas emissions from the relevant sectors are to diminish by 10% from the2005 levels by 2020, thus contributing to the EU's goal of a 20% reduction in CO_2 ejects across the entire economy. EU Member States have agreed to share this effort in line with the principles of solidarity and equity so that individual countries have different targets. EU states with low GDP per capita and strong prospects for economic growth may increase their carbon emissions by up to 20% whereas those with high national income per capita must cut CO_2 pollution by up to a fifth. The national trajectory of carbon emissions until 2020 is binding on Member States.

To make the reductions more cost-effective, the council has introduced several flexibility mechanisms, including the possibility of trading emissions cuts among Member States and carrying forward excess reductions to future years. EU countries can also use a limited amount of carbon credits from developing countries, through the so-called "Clean Development Mechanism".

The decision also includes provision for its adaptation after the conclusion of an international agreement to fight climate change and for a subsequent move beyond the EU's overall 20% reduction target.

New rules for cleaner cars in Europe. The council adopted a regulation setting the first legally-binding standards for CO_2 emissions from new passenger cars, to apply as of 2012 (443/2009). The main objective of this new law is to reduce the contribution of road transport to global warming, thus helping the EU to meet its objective of a 20% reduction in greenhouse gas emissions by 2020.

The regulation will give legal effect to the EU's existing goal of reducing average emissions from new cars to 130 g CO_2/km. A so-called limit value curve implies that heavier cars are allowed higher emissions than lighter cars while preserving the overall fleet average. The new regulation makes the objective binding for the average fleet of a given car manufacturer in successive stages, from 2015 the whole fleet needs to comply with the CO_2 emissions

objective. To send a signal to industry for further production cycles, the council and European Parliament introduced in addition an objective of 95 g CO_2/km for 2020.

If car manufacturers do not comply, they face penalties depending on how far their fleet exceeds the targets and on the number of their new passenger cars.

New environmental quality standards for fuels and biofuels. The council approved the revision of a directive that will improve air quality and reduce greenhouse gas emissions through environmental standards for fuel. It will also facilitate the more widespread blending of biofuels into petrol and diesel and, to avoid negative consequences, set ambitious sustainability criteria for biofuels (3740/1/08, 8040/09 ADD1).

The revised directive introduces for the first time a reduction target for greenhouse gas emissions from fuels. By 2020, fuel suppliers have to decrease by 6% climate-harming emissions over the entire life-cycle of their products. This can be reached in particular by admixing biofuels to petrol and diesel as well as by improving production technology in refineries. Member states may require an additional 4% reduction from fuel companies, achieved through the supply of energy for electric vehicles or other clean technologies, including carbon credits from third countries.

To enable these GHG emissions cuts, petrol may have a higher biofuel content. From 2011, petrol may contain up to 10% ethanol. In order to avoid damage to old cars, however, fuel with 5% ethanol (E5) will continue to be available until 2013, with the possibility for Member States to extend that period.

A regulatory framework for carbon capture and storage. The council adopted a directive which set up a regulatory framework for the geological storage of carbon dioxide. The new act (3739/08, 8036/09 ADD1) is intended to make the deployment of this technology in the EU possible, which could help to mitigate climate change.

Whether to use carbon capture and storage or not is still a matter for independent decision by each EU Member State. For EU countries that wish to do so, the directive sets out the conditions for the assessment of storage sites, for authorisation procedures and for the closure of such sites. In order to ensure harmonized application throughout the European Union, the Commission will review the draft storage permits and draft decisions on closure prepared by national authorities before their final approval.

4.1.5 The European Strategic Energy Technology Plan (SET-Plan)

To meet the targets, it is necessary to lower the cost of clean energy and put EU industry at the forefront of the rapidly growing low carbon technology sector (EC 2007a). In the longer term, new generations of technologies have to be developed through breakthroughs in research if EU is to meet the greater ambition of reducing its greenhouse gas emissions by 80% by 2050.

Existing measures taken over recent years have provided a foundation for further EU action. The creation of European technology platforms has brought together stakeholders to define common research agendas and deployment strategies (EC 2007a). Building on this momentum, the SET-Plan focuses, strengthens and gives coherence to the overall effort in

Europe. The plan is a dedicated policy to accelerate the development and deployment of cost-effective low-carbon technologies. Thus, it will facilitate the achievement of the 2020 targets and the vision of the 2050 energy policy for Europe.

Markets and energy companies acting on their own are unlikely to be able to deliver the needed technological breakthroughs within a sufficiently short time span to meet the EU's energy and climate policy goals (EC 2009d). Locked-in investments, vested interests, as well as high risks and need for significant investments in less profitable alternatives, mean that the change will be slow without a major push. Public policy and public investment partnering with the private sector is the only credible route to meet the goals, established for the public good.

The SET-Plan is the technology pillar of the EU's energy and climate policy, as the Member States are unlikely on their own to be willing or able to accelerate technology development over a sufficiently broad portfolio of technologies. The European Strategic Energy Technology Plan (SET-Plan) is the EU's response to the challenge of accelerating the development of low carbon technologies, leading to their widespread market take-up. It sets out a vision of a Europe with world leadership in a diverse portfolio of clean, efficient and low-carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs. It proposes joint strategic planning and more effective implementation of programmes. It now needs to be taken forward to implementation.

A European approach is essential to realise the ambition of seeing low carbon technologies effectively developed in view of bringing them to the market: it allows key players to come together on a continental scale; it helps to identify and to tackle the barriers holding back innovative products and services in the single market; and it allows different sources of private and public funding to be brought together.

The SET-Plan Technology Roadmap (EC 2009e) proposes seven roadmaps with estimations of total budgets. The estimates of resources are not a proposal for funding from the EU budget, but represent an effort to identify key areas where Europe needs to invest in the coming years to give concrete expression to its low carbon vision. The figures presented should be understood as indications of orders of magnitude. The bulk of the funds required will have to come from the private sector and from Member States, with a contribution from the EU budget towards some of it.

The roadmaps put forward concrete action plans aimed at raising the maturity of the technologies to a level that will enable them to achieve large market shares during the period up to 2050. The main sectoral targets are:

- Up to 20% of the EU electricity will be produced by *wind energy technologies* by 2020.
- Up to 15% of the EU electricity will be generated by *solar energy* in 2020. However, if the DESERTEC vision (initiative for a massive deployment of solar technology) is achieved, the contribution of solar energy will be higher, especially in the longer term.
- The *electricity grid* in Europe will be able to integrate up to 35% renewable electricity in a seamless way and operate along the "smart" principle, effectively matching supply and demand by 2020.
- At least 14% of the EU energy mix will be from cost-competitive, sustainable *bioenergy* by 2020.

- *Carbon capture and storage* technologies will become cost-competitive within a carbon-pricing environment by 2020 – 2025.
- While existing nuclear technologies will continue to provide around 30% of EU electricity in the next decades, the *first Generation-IV nuclear reactor* prototypes will be in operation by 2020, allowing commercial deployment by 2040.
- 25 to 30 *European cities* will be at the forefront of the transition to a low carbon economy by 2020.

It is noted that there is no directly quantifiable link between research expenditures and the value of the results obtained from research. However, as a pre-requisite for any cost-competitive deployment of technologies, each roadmap presents the technology objectives that are critical for making each low carbon technology fully cost-competitive, more efficient and proven at the right scale for market roll-out. For these technology areas, concrete research, development, demonstration and market replication activities, for which working together can make a difference in terms of maximizing the industrial and society returns, have been identified.

This European research, development and demonstration programme of low carbon energy technologies has been estimated by the commission together with the industry to cost between 58.5 to 71.5 billion euros over the next 10 years, divided between the European Industrial Initiatives and the Smart Cities Initiative. This should be shared between industry, the Member States and the European Commission. The partition of the cost for each initiative may vary as well as for the activities within each initiative. Typically, R&D programmes should have a prominent public and EU investment component, the demonstration programmes should have a strong industrial drive, accompanied by public support, both EU and national; and the market replication measures should have a large participation from industry.

4.1.6 European Industrial Bioenergy Initiative (EIBI)

The European Industrial Bioenergy Initiative (EIBI) intends to accelerate the commercial deployment of advanced technologies to boost the contribution of sustainable bioenergy to the EU 2020 targets (EBTB 2009).

The purpose of the EIBI is to boost the contribution of sustainable bioenergy to EU climate and energy objectives (see chapter 4.1.1), with a focused approach leveraging public private partnership to manage risks and share financing. It implies and acceleration of ongoing research, development & demonstration efforts in order to deploy reliable and efficient technologies on the EU market by 2020. The EIBI requires a supportive, reliable and harmonized regulatory framework across the Member States to ensure sustainable and competitive supply of biofeedstocks and to target end markets that are politically relevant and economically attractive.

The scope of the EIBI is innovative bioenergy value chains which are not yet commercially available (thus excluding current biofuels, heat & power, biogas, etc.) and could be deployed at large scale, either as large single units or larger number of smaller units.

The key objectives are:

- enabling commercial availability of advanced bioenergy at large scale by 2020, aiming at production costs which are competitive with fossil fuels at the prevailing economic and regulatory market conditions, and advanced biofuels covering up to 4% of EU transportation energy needs by 2020.
- Strengthening EU world technology leadership for renewable transport fuels for diesel and jet engines, serving the fastest growing area of transport fuels, in the world.

The core activities of the EIBI are selection and funding of demonstration and/or reference plants projects with the budget and timeline of 6-8 billion over 10 years, to fund 15 to 20 demonstration and/or reference plants.

A set of innovative industrial bioenergy value chains could be successfully deployed in Europe provided supportive framework is available to manage high cost and risk of industrial deployment. The focus of EIBI should be on those value chains, which could bring large volume contributions, which are too costly to be developed and funded at national level.

Seven such innovative bioenergy value chains, that could bring significant contributions to EU ambitious objectives, in addition to the existing bioenergy value chains, have been identified. The list is not exhaustive:

A) Conversion paths based on thermochemical processes:
   - Synthetic fuels / hydrocarbons from biomass via gasification
   - Bio-methane and other gaseous fuels from biomass via gasification
   - High efficiency power generation via gasification of biomass
   - Bioenergy carriers from biomass via other thermochemical processes like pyrolysis, torrefaction etc.

B) Conversion paths based on biological and chemical processes:
   - Ethanol and higher alcohols from sugars containing biomass
   - Renewable hydrocarbons from sugars containing biomass via biological and/or chemical process
   - Production of bioenergy carriers from CO_2 & sunlight through micro-organism based production (algae, bacteria etc.) and further upgrading into transportation fuels and valuable bio-products

Within each of these seven "generic" value chains, different paths based on significantly different fossil feedstock (including fossil co-processing) technological and/or industrial options are possible. Combinations of thermochemical and biological processes are also possible. They all correspond to different types of energy-driven biorefineries.

The critical technologies for these value chains are at different levels of maturity. Within the industry, technology developers and universities/research institutions are able to provide relevant scientific and technological knowhow. Demonstration of the sustainable performance of these technologies over the complete value chain is critical for securing financing for commercial large scale deployment and gaining social acceptance.

The earliest industry actors are ready to move to a demonstration and/or commercial reference plant, provided a relevant framework ensures sharing risks and financing via public/private partnership. Others will be ready in the coming years, allowing to spread EIBI project selection activity between 2010 and 2015. The preliminary estimated budget to build and

operate 1 to 3 demonstration and/or reference plants within each of the seven "generic" value chains is 6-8 billion over 10 years.

The EIBI initiative will include also important R&D challenges for the existing public research capacities in Europe. Applied R&D will play a key role in directly supporting selected demonstration and reference projects; strategic R&D will be needed for the long term development of the whole sector.

4.1.7 Other policies and measures

Under the Kyoto Protocol to combat climate change, EU-15 committed itself to achieve an 8% decrease of greenhouse gas emissions within the period 2008 – 2012 as compared to 1990 levels. Each of the EU-15 countries also has an agreed, legally binding target for limiting or cutting its own emissions to ensure the overall 8% reduction is met (EEA 2004). The EU-15 target does not apply to the 10 Member States that joined the EU on 1 May 2004. Under the Protocol most of these have their own reduction targets of 8% or 6% compared with a given base year (1990 or earlier). Table 1 presents the emissions projections for EU-15 Member States, while Table 2 presents the projections for the 10 new Member States.

In regards to climate change, each Member State has committed itself to legally binding targets under the 'Burden Sharing Agreement' (Decision 2002/358/EC) in order to reach the Kyoto target (EC 2007b). The EU-wide Emissions Trading Scheme (ETS) has been successfully launched and is a mechanism that can be developed into a global scheme for limiting emissions. Progress towards the EU reduction commitment under the Kyoto Protocol is broadly on track but achieving the target will require additional efforts from all sectors and in particular energy, transport, industry and agriculture.

Table 1 Emissions projections for EU-15 Member States, based on existing and additional domestic policies and measures and use of Kyoto mechanisms, compared with their Kyoto targets (EEA 2004).

	EU burden sharing target (in % of base year emissions)	With existing policies and measures		With additional policies and measures		Gap including use of Kyoto Mechanisms (in % of base year)
		Projections for 2010 (in % of base year)	Gap between projections and target (in % of base year)	Projections for 2010 (in % of base year)	Gap between projections and target (in % of base year)	
Austria	-13.0%	+8.7%	+21.7%	-9.2%	+3.8%	-5.2%
Belgium	-7.5%	+6.5%	+14.0%	-3.3%	+4.2%	-1.4%
Denmark	-21.0%	+15.7%	+36.7%	-	-	+31.3%
Finland	0.0%	+16.5%	+16.5%	-0.5%	-0.5%	-
France	0.0%	9.0%	9.0%	-1.7%	-1.7%	-
Germany	-21.0%	-19.7%	+1.3%	-	-	-
Greece	+25.0%	+38.6%	+13.6%	+22.4%	-2.6%	-
Ireland	+13.0%	+29.4%	+16.4%	+3.6%	-9.4%	-16.3%
Italy	-6.5%	+3.7%	+10.2%	-3.4%	+3.1%	-
Luxembourg	-28.0%	-22.4%	+5.6%	-	-	-17.9%
Netherlands	-6.0%	+3.3%	+9.3%	-	-	-0.1%
Portugal	+27.0%	+53.1%	+26.1%	+45.7%	+18.7%	-
Spain	+15.0%	+48.3%	+33.3%	+28.0%	+13.0%	-
Sweden	+4.0%	-0.2%	-4.2%	-	-	-
UK	-12.5%	-13.9%	-1.4%	-22.5%	-10.0%	-
Total EU-15	**-8.0%**	**-1.0%**	**+7.0%**	**-7.7%**	**+0.3%**	**-0.8%**

Note: For projected emissions, plus figures signify that the target is not met; minus figures mean a projected over-delivery compared to target. The column 'Gap including use of Kyoto mechanisms' shows the gap after use of the Kyoto mechanisms combined with existing policies and measures in the case of Denmark, Luxembourg and the Netherlands. For Austria, Belgium and Ireland, the gap is shown after the use of the Kyoto mechanisms in combination with additional domestic policies and measures.

Table 2 Emissions projections for new EU Member States, based on existing and additional domestic policies and measures, compared with their Kyoto targets (EEA 2004).

	Kyoto target (in % of base year)	With existing policies and measures		With additional policies and measures	
		Projections for 2010 (in % of base year)	Gap between projections and target (in % of base year)	Projections for 2010 (in % of base year)	Gap between projections and target (in % of base year)
Cyprus	-	-	-	-	-
Czech Republic	-8.0%	-30.0%	-22.0%	-	-
Estonia	-8.0%	-56.6%	-48.6%	-60.0%	-52.0%
Hungary	-6.0%	-6.0%	+0.0%	-	-
Latvia	-8.0%	-58.2%	-50.2%	-	-
Lithuania	-8.0%	-43.3%	-35.3%	-	-
Malta	-	-	-	-	-
Poland	-6.0%	-12.1%	-6.1%	-	-
Slovakia	-8.0%	-26.6%	-18.6%	-33.5%	-25.5%
Slovenia	-8.0%	+4.0%	+12.0%	-3.9%	+4.1%

Note: For projected emissions, plus figures signify that the target is not met; minus figures mean a projected over-delivery compared to the target. All data are excluding sequestration from land-use change and forestry. Slovenia projects it will achieve its target if carbon sequestration is included.

The European Emissions Trading Scheme (EU ETS) became operational in January 2005 and was revised in 2009 (see chapter 4.1.1). In the first phase from 2005 to 2007, the EU ETS covered the sectors power generation, mineral oil refineries, coke ovens, ferrous metal processing, cement, glass, ceramics, and pulp & paper (referred to as "trading sectors"). The scheme also covers emissions from large combustion installations (larger than 20 MW_{th}) found, for instance, in the chemical industry, food processing, etc. Emission allowances have been allocated by governments to companies in those sectors to a large extent based on past emissions, discounted to meet Kyoto targets.

Europe, including the new Member States (EU25), emits a CO_2 equivalent of 4 800 M tons of greenhouse gases p.a., of which around 3 950 M tons are CO_2. The rest consists of CH_4, NO_2, PFC, HFC, and SF6. According to the national allocation plans for the first trading period, companies in the trading sectors are allocated about 2 200 M tons of CO_2 p.a. The power sector accounts for more than 50% of the allocated emission allowances.

To tackle climate change effectively, much greater reductions of greenhouse gas emissions will be needed at a global level and this is why "climate diplomacy" is needed. The EU is responsible for around 14% of the world's greenhouse gas emissions – a figure that will decrease as countries such as China and India continue to develop. The EU is committed to engaging with third countries in order to build support for a global agreement on greenhouse gas emission limitations when the first Kyoto Protocol period ends in 2012 (EC 2007b). This means convincing the United States, and other countries, that it is in their own interests to be at the forefront of the fight against climate change.

A global response will also mean finding a way to allow developing countries to continue economic growth with the least competitive distortions, but with decreasing growth in emissions. There will need to be an increase in technical assistance and technology transfers. Climate change, in all its dimensions (energy, development, transport, health), is increasingly

part of the EU's core external policy. If we are to define the global response then both the commission and Member States will need to set diplomatic priorities (and allocate resources) accordingly. A specific and urgent challenge will be developing a mechanism to stop and then reverse global deforestation which is responsible for 20% of greenhouse gas emissions (EC 2007b).

4.2 Directives on the promotion of the use of renewable energy

The generation of bioenergy is strongly influenced by a wide range of legal and fiscal provisions, many of which stem from European legislation (Faber et al. 2006). Thus, EU directives set targets for renewable energy production, encourage low-carbon energy production and set limits on emissions from biomass combustion or disposal. EU legislation affects the availability of biomass and its use for heat and power generation in variety of ways.

4.2.1 Biofuels Directive and Directive on Electricity from Renewable Energy Sources

The Biofuels Directive (2003/30/EC) aimed at 'promoting the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes in each Member State, with an aim to contribute to objectives such as meeting climate change commitments, an environmentally friendlyand supply, and promoting renewable energy sources'(Faber et al. 2006). It did so by requiring Member States to set indicative targets for biofuel use. The European Union as a whole had an indicative target of 2% (based on energy content) of total fuel consumption by the end of 2005, and 5.75% by the end of 2010. Most Member States have transposed the directive into their national legislation. Many of them have set indicative targets below the levels of the directive, though some have set higher targets.

The Biofuels Directive has had a direct impact on biomass supply and demand (Faber et al. 2006). In particular, liquid biomass like palm oil as well as other vegetable and animal fats and oils can be used for either bioenergy or biofuels. The directive may also have had significant indirect impacts, due to competition for agricultural raw materials as well as for arable land. When the second generation of biofuels becomes economically viable, competition for raw materials may increase. These biofuels (Fischer-Tropsch fuel from biomass, bioethanol from wood, hydrothermal upgrading (HTU) diesel from wet biomass) are made from biomass currently used to produce heat or power. Strong incentives to use these materials may limit the amount of biomass available for the generation of useful energy. The impacts of this directive are not only potentially large; they are also potentially distorting. The market for biofuels is shaped mainly by public policy measures. As these differ across countries, the market for biofuel is distorted, which will have consequences for the raw materials from which biofuels are made.

The Directive on Electricity from Renewable Energy Sources (RES-E Directive, 2001/77/EC) required Member States to increase the share of renewable sources in electrical power generation.

Table 3 shows the indicative targets for electricity from renewable sources for the 25 Member States as set in the RES-E Directive. The range of values reflects the variety in natural endowments, for example the scope of hydropower or large wind farms (Faber et al. 2006). For the EU as a whole, a target of 21.0% has been set for 2010.

Table 3 Indicative targets (obligation quota) for electricity from renewable sources under the RES-E Directive (EC 2009b).

	RES-E % in 1997	RES-E % in 2002	RES-E % in 2006	RES-E % 2010
Austria	70.0	68 **	61.6	78.0
Belgium	1.1	1.4	3.9	6.0
Bulgaria			6.0	11
Cyprus	0.05	0	0	6.0
Czech Republic	3.8	3.9	4.1	8.0
Denmark	8.7	20	25.9	29.0
Estonia	0.2	0.2 *	1.5	5.1
Finland	24.7	24.7	26.5	31.5
France	15.0	14.4	14.3	21.0
Germany	4.5	8.1	12.6	12.5
Greece	8.6	5.8 **	8.8	20.1
Hungary	0.7	0.6	3.7	3.6
Ireland	3.6	5.1	8.6	13.2
Italy	16.0	16.8	18.3	25.0
Latvia	42.4	48	40.4	49.3
Lithuania	3.3	4.6	3.9	7.0
Luxembourg	2.1	2.2	3.7	5.7
Malta	0.0	0	0	5.0
Netherlands	3.5	3.4	7.9	9.0
Poland	1.6	2.0	3.1	7.5
Portugal	38.5	21.8 **	31.2	39.0
Romania			28.1	33
Slovakia	17.9	20.2	16.0	31.0
Slovenia	29.9	30.4	28.3	33.6
Spain	19.9	12.6 **	19.1	29.4
Sweden	49.1	46	52.3	60.0
UK	1.7	2.8	4.6	10.0

* Figure for 2001
** Affected by drought: much less hydropower

Europe is still likely to fail to meet its 2010 renewable energy targets (Table 4). There has been only limited progress. In the electricity sector new policy measures have resulted in substantial growth in some Member States, six of whom achieved an increase in their share of at least 2 percentage points since 2004. At the same time, seven Member States' renewable electricity shares have actually stagnated or shrunk since 2004. In the transport sector, quite a widespread change in the use of obligation measures rather than just taxation measures has contributed to an increase in the EU share of 1.6 percentage points since 2004, driven by growth in shares of over 2% in 7 Member States.

Whilst some recent progress has been achieved, the rate of growth has remained slow and the barriers to growth, across all sectors, remain high in most Member States. Europe is unlikely to reach either the target for the share of electricity from renewable energy sources or the target for the share of renewable energy in transport. The European Commission will continue to take legal action to ensure compliance with the existing directives and so improve progress towards the 2010 targets (EC 2009b). For this purpose, Directive 2009/28/EC (on the

promotion of the use of energy from renewable sources) amends and subsequently repeals Directives 2001/77/EC and 2003/30/EC (see chapter 4.2.2 below).

Table 4 Summary of Member States' progress in developing renewable energy (EC 2009b).

			Electricity			Biofuels		
	2006 share %	2010 target %	Recent growth	Progress made	2007 share %	2010 target %	Recent growth	Progress made
Austria	61.6	78.1	😐	☹	4.2	5.75	☺	☺
Belgium	3.9	6	☺	😐	1.1	5.75	☺	☹
Bulgaria	6.8	11	😐	☹	4.8[27]	5.75	☺	☺
Cyprus	0.0	6	☹	☹	0(2005)	5.75	☹	☹
Czech Rep.	4.1	8	😐	☹	0.5	2.5	😐	☹
Denmark	25.9	29	☹	☺	0.1	5.75	😐	☹
Estonia	1.5	5.1	😐	☹	0.1	5.75	😐	☹
Finland	26.5	31.5	☹	☹	0.1(2006)	5.75	😐	☹
France	14.3	21	😐	☹	3.6	7.0	☺	😐
Germany	12.6	12.5	☺	☺	7.4	5.75	☺	☺
Greece	8.8	20.1	☺	☹	1.2	5.75	☺	☹
Hungary	3.7	3.6	☺	☺	0.2	5.75	😐	☹
Ireland	8.6	13.2	☺	😐	0.6	5.75	😐	☹
Italy	18.3	22.5	☺	😐	0.5	5.75	☹	☹
Latvia	40.4	49.3	☹	☹	0.1	5.75	☹	☹
Lithuania	3.9	7	😐	☹	4.4	5.75	☺	☺
Luxemburg	3.7	5.7	😐	😐	1.5	5.75	☺	😐
Malta	0.0	5	☹	☹	1.1	1.25	😐	☺
Netherlands	7.9	9	☺	☺	2.0	5.75	☺	😐
Poland	3.1	7.5	☺	☹	0.7	5.75	😐	☹
Portugal	31.2	39	☹	☹	2.5	5.75	☺	😐
Romania	28.1	33	☹	☹	0.8	5.75	😐	☹
Slovakia	16.0	31	☺	☹	2.5	5.75	☺	😐
Slovenia	28.3	33.6	☹	☹	0.8	3.5	😐	☹
Spain	19.1	29.4	😐	☹	1.1	5.75	😐	☹
Sweden	52.3	60	😐	😐	4.0	5.75	☺	😐
UK	4.6	10	😐	☹	0.8	5.0	😐	☹

Progress made in relation to the target: ☹ <33%, 😐 33% to 66%, ☺ >66%.

4.2.2 Renewable Energy Directive

Directive on the promotion of the use of energy from renewable sources (RED, 2009/28/EC) establishes an overall binding target of a 20% share of renewable energy sources in energy consumption and a 10% binding minimum target for renewable sources in transport to be achieved by each Member State, as well as binding national targets by 2020 in line with the overall EU target of 20%. This directive amends and subsequently repeals Directives 2001/77/EC and 2003/30/EC (EC 2009a).

Each Member State will adopt a national renewable energy action plan. The national action plans set out Member States' targets for the shares of energy from renewable sources in transport, electricity and heating and cooling in 2020, and adequate measures to be taken to achieve these targets, including national policies to develop existing biomass resources and

mobilise new biomass resources for different uses, and the measures to be taken to fulfil the requirements from the directive. Member States notify their national action plans to the Commission by 31 March 2010 at the latest. One target of mandatory national targets is to provide certainty for investors and to encourage continuous development of technologies which generate energy from all types of renewable sources.

A Member State whose share of energy from renewable sources falls below the indicative trajectory in the immediately preceding two-year period submits a new national action plan to the commission by 30 June of the following year at the latest, setting out adequate measures to ensure that in future the share of energy from renewable sources equals or exceeds the indicative trajectory.

4.2.2.1 Sustainability requirements

The directive pays special attention to the sustainability of biofuels and bioliquids production but also mentions biomass.

Irrespective of whether the raw materials were cultivated inside or outside the territory of the community, biofuels and bioliquids used for compliance with the targets laid down in the directive, and those that benefit from national support schemes, should be required to fulfil sustainability criteria.

According to Article 15, biofuels and other bioliquids are taken into account for a) measuring compliance with the requirements of the directive concerning national targets; b) measuring compliance with renewable energy obligations; c) eligibility for financial support for the consumption of biofuels and other bioliquids **only if they fulfil certain criteria**. The greenhouse gas emission saving from the use of biofuels and bioliquids taken into account for the purposes referred above must be at least 35%. Target for the period starting 2017 – 2018 is even higher, 50% and 60% respectively. The calculation method for greenhouse gas emission impact from the use of biofuels and bioliquids is given in the directive.

The sustainability criterion sets out that biofuels and other bioliquids should not be made from raw material obtained from land with recognised high biodiversity value, e.g. forests undisturbed by significant human activity, areas designated for nature protection purposes, or highly biodiverse grassland. On the other hand, increased rate of productivity on land already used for crops, the use of degraded land, and the adoption of sustainability requirements should be encouraged.

The directive also accentuates the negative greenhouse gas impacts of land use changes of land with high stocks of carbon. The full carbon effects of such conversion should therefore be accounted for in calculating the greenhouse gas emission saving of particular biofuels and bioliquids (EC 2009a).

Member States are required to verify that the sustainability criteria have been fulfilled.

Table 5 National overall targets for the share of energy from renewable sources in final consumption of energy in 2020. National overall targets.

	Share of energy from renewable sources in final consumption of energy, 2005 (S_{2005})	Target for share of energy from renewable sources in final consumption of energy, 2020 (S_{2020})
Belgium	2.2%	13%
Bulgaria	9.4%	16%
The Czech Republic	6.1%	13%
Denmark	17.0%	30%
Germany	5.8%	18%
Estonia	18.0%	25%
Ireland	3.1%	16%
Greece	6.9%	18%
Spain	8.7%	20%
France	10.3%	23%
Italy	5.2%	17%
Cyprus	2.9%	13%
Latvia	32.6%	40%
Lithuania	15.0%	23%
Luxembourg	0.9%	11%
Hungary	4.3%	13%
Malta	0.0%	10%
The Netherlands	2.4%	14%
Austria	23.3.%	34%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovenia	16.0%	25%
The Slovak Republic	6.7%	14%
Finland	28.5%	38%
Sweden	39.8%	49%
United Kingdom	1.3%	15%

4.2.2.2 Sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling

The Renewable Energy Directive includes a sustainability scheme for (a) biofuels for transport and (b) bioliquids used in other sectors (electricity, heating and cooling). The Directive provides that the Commission should report by December 2009 on requirements for a sustainability scheme for energy uses of biomass other than biofuels and bioliquids (i.e. solid and gaseous fuels in electricity, heating and cooling). The Commission is now preparing a report (EC 2010) intended to fulfil that obligation.

The growing production and use of biomass for energy purposes already gives rise to international trade, and this market is bound to expand in future. Most of the increased trade is expected to be in the form of pellets. Several non-EU countries are producing wood pellets specifically for the European market (EC 2010).

For biomass produced within the EU, the current legal framework (notably related to agriculture and forest management) gives certain assurances for the sustainable management

of forest and agriculture. The same is true for some third countries – but others lack such a framework. For this reason, concerns have been expressed that an expansion of international trade of biomass and increasing imports from third countries may lead to the unsustainable production of biomass. As a result, the main importing countries of biomass have started to develop national sustainability requirements for bioenergy (EC 2010). This has led to certification schemes (voluntary and mandatory) in the agriculture, forestry and energy sectors which are not necessarily complementary or compatible. This in turn has led to calls from utilities, environmental organisations and biomass importing countries for a common sustainability scheme for biomass in order to limit intra-EU cross-border barriers in setting up bioenergy projects.

In its analysis of requirements for extending the EU sustainability scheme, the Commission has considered three principles which a European-wide policy on biomass sustainability has to meet (EC 2010):

- effectiveness in dealing with problems of sustainable biomass use,
- cost-efficiency in meeting the objectives and
- consistency with existing policies.

During the public consultation carried out in July-September 2008 and in the accompanying impact assessment, the main sustainability issues were identified, bearing in mind the need for consistency with the sustainability scheme adopted for biofuels and bioliquids. These include:

- sustainability in production (land management, cultivation and harvesting),
- land use, land use change and forestry accounting,
- life cycle greenhouse gas performance and
- energy conversion efficiency.

The sustainability concerns identified raised the issue of (1) at what level is it appropriate for action to be taken and (2) what should the content of the action be?

The wide variety of biomass feedstocks make it difficult to put forward a harmonised scheme at this stage. Different feedstocks present different challenges to sustainable production, greenhouse gas performance or efficient energy conversion. It is also considered that the sustainability risks relating to domestic biomass production originating from wastes and agricultural and forestry residues, where no land use change occurs, are currently low (EC 2010). For these reasons, the Commission does not at this stage propose binding criteria at the EU level. However, to minimise the risk of the development of varied and possibly incompatible criteria at national level, the Commission has made recommendations to Member States on the development of their sustainability schemes.

The Commission recommends that Member States that either have, or who introduce, national sustainability schemes for solid and gaseous biomass used in electricity, heating and cooling, ensure that these in almost all respects are the same as those laid down in the Renewable Energy Directive. This would ensure greater consistency and avoid unwarranted discrimination in the use of raw materials.

Due to the characteristics of the production and use of solid and gaseous biomass used in electricity, heating and cooling, the following differences can be distinguished (EC 2010):

1. According to the Renewable Energy Directive, wastes and certain residues should only be required to fulfil the greenhouse gas performance criteria. It is challenging to set greenhouse gas default values for the wide range of possible feedstock such as wastes, or common default values to cover a range of similar feedstock or a mixture of feedstock. It is also difficult to justify imposing obligations and additional costs for proving compliance with greenhouse gas performance criteria for sectors which routinely achieve high greenhouse gas savings, such as by using wastes. It is recommended that the greenhouse gas performance criterion not be applied to wastes, but to the products for which default greenhouse gas emission values have been calculated and listed in an annex of the report.
2. The methodology for the calculation of greenhouse gas emissions should be extended, resulting in the methodological rules described in an annex of the report. The recommended methodology in the annex would require that the default value is divided by the actual energy conversion efficiency value of the electricity or heating/cooling installation to obtain a value for total greenhouse gas emissions.
3. To stimulate higher energy conversion efficiency, Member States should in their support schemes for electricity, heating and cooling installations differentiate in favour of installations that achieve high energy conversion efficiencies, such as high-efficiency cogeneration plants. For small-scale solid-fuel boilers, the Commission is expected to propose minimum efficiency and environmental requirements related to air quality in 2010.

The biomass sector is fragmented and there are numerous small-scale users of biomass. It is recommended that sustainability schemes apply only to larger energy producers of 1 MW thermal or 1 MW electrical capacity above. Placing requirements on small-scale producers to prove sustainability would create undue administrative burden, although higher performance and efficiency should be encouraged.

Biomass trade in the EU plays an important role in the development of the bioenergy sector. National and European statistics have large knowledge gaps concerning the amount of biomass used for energy purposes. In order to improve data on biomass use, it is recommended that Member States keep records of the origin of primary biomass used in electricity, heating and cooling installations of 1 MW or above, helping to improve statistics on biomass use and to monitor the effects of biomass use on the areas of origin. Member States are also encouraged to monitor small-scale (mainly household) biomass use through surveys and strive to improve the availability and quality of data.

Member States are invited to take into account the recommendations for sustainability criteria and for reporting and monitoring. These recommendations aim to promote the sustainable production and use of biomass, a well functioning internal market in biomass trade and to lift barriers to bioenergy development (EC 2010). It is therefore recommended in particular to those Member States that have already developed sustainability criteria which differ from the recommendations, to duly integrate these recommendations. In any event, Member States must ensure that national sustainability schemes do not constitute a means of arbitrary discrimination or a disguised restriction on trade.

4.3 Instruments and measures to reach the targets

4.3.1 Financial and policy instruments

For renewable energy implementation at the present time, there is a need for policy instruments designed to regulate or economically incentivise change. These instruments can either hinder investment in a certain activity, or conversely, stimulate development and investment of another activity. The main instruments that have been put in place by governments EU-wide include (Cooper & Thornley 2007):

- *Deregulation:* Deregulation entails the opening up of markets that were previously closed and regulated, these are normally markets that were formerly a monopoly e.g. a state-owned company that dominated the market. In deregulating the market, governments allow other developers and suppliers of electricity to enter the market and offer a wider choice of sources of electricity (for example, renewable electricity). The aim of deregulation is to induce competition into the market, which, in turn, will provide scope for investment in renewable electricity and may also reduce the price of electricity for consumers.
- *Regulation:* Environmental regulation is the implementation of law or directives which aim to remove externalities. In order to address externalities and promote a cleaner environment, governments can introduce laws to prevent or reduce the maltreatment of the environment and encourage more sustainable behaviour. In the case of renewable energy, governments may use regulation to ensure that electricity producers are ensuring that a share of electricity is derived from a renewable source of energy, which will in turn reduce externalities to society.
- *Fixed prices for renewable energy:* Governments also have the choice of introducing fixed prices for renewable energy. This ensures that suppliers or developers of electricity are rewarded for their renewable energy and are guaranteed a fixed price for a given number of years. Normally, this fixed price (also known as a feed-in tariff, or a fixed price premium) is higher than the prices paid for conventional fossil fuel electricity. In order to supplement producers and suppliers of renewable electricity, government often use the funds amassed from taxation on the generation of fossil fuel electricity.
- *Taxation of environmental damages:* Environmental tax generally signifies a regulated sum charged against a polluting activity, such as electricity produced from a fossil fuel source. In an environmental context, taxes are used to remove externalities from the market. Taxation is often employed as a punishment; to discourage a polluting activity, in the hope of encouraging its replacement with a sustainable one. In practice a carbon tax is used to tax the carbon content of fossil fuels. Taxes can be used to punish polluters, however, with renewable electricity they are often used as rewards, so that producers of renewable electricity benefit from tax exemption, which makes them a more attractive option than fossil fuels which face a tax.
- *Green certificates:* Governments can also use the market in conjunction with an obligation or regulation. This would typically require that energy suppliers supply a given percentage of their electricity from a renewable source and for every unit of renewable electricity they produce they are awarded a green certificate. By law, they must ensure they have a sufficient number of certificates corresponding to the required percentage of renewables. This mechanism takes into account that some suppliers will not be able to finance investment in alternative forms of energy, thus they are able to

buy certificates from other companies who have succeeded in doing so. A market of certificates is created and suppliers may trade their certificates to gain a higher price from those who have not succeeded. The detail of these schemes varies across countries, e.g. there may be price controls for the certificates or a penalty may be payable for deficits, which may be recovered by central government or recycled back to certificate holders.

- *Investment subsidies:* Governments can opt to use grants as a means of stimulating uptake of a certain activity. Grants are subsidies that are made available to firms, to compensate them for their costs in developing a renewables project. This financial help towards the initial capital outlay serves as a great cost advantage, as it instantly renders the project more economical for the developer. Bioenergy is unique in the way that it often requires financial aid to support the growth of biomass material, such as energy crops. Thus in the case of bioenergy, grants can be awarded for capital costs and also for fuel supply costs.

Governments have a large choice regarding policy instruments that they can implement in order to eliminate externalities (Cooper & Thornley 2007). Some instruments are very straightforward and simply provide help with capital costs and the growth of biomass fuel. Thus by reducing the costs of bioenergy projects they are rendered more accessible. Other instruments are more complex and depend on the creation of a market to bring about the trading of green certificates earned from employing bioenergy, which in turn stimulates growth in the uptake of bioenergy projects as the market for certificates evolve.

It is important to remember, however, that each country must choose a system of policy instruments that best fits its objectives. Each country will differ in their goals and targets and thus the type of instruments used,Also the rate at which they are implemented will vary according to the urgency of their targets. Furthermore, the status of bioenergy differs in every country. Some countries have a long forestry tradition, so the emphasis will be on supporting new conversion plants rather than fuel production or supply. For other countries, bioenergy is relatively undeveloped and attention may need to be paid to develop particular resource bases, supply chains or infrastructure, depending on policy objectives. It is essential therefore that policy instruments are chosen and adapted to suit the natural resources, level of experience, and specific targets and goals (Cooper & Thornley 2007).

EU-15 countries have implemented policies for supporting bioenergy. These include the deployment of compensation schemes, tax deduction (in some cases specifically aimed at biofuels), feed-in tariffs, tax incentives, energy tax exemption, bidding schemes, CO_2-tax and quota (Harmelinck et al. 2003). Precise targets on the national level differ strongly, however, and are hard to compare because of differences in definitions and fuels in or excluded (such as MSW and peat). The same is true for the level of (financial) support provided through the various programs and instruments (Faaij 2006).

4.3.2 Support measures for bioenergy in place

Table 6 reviews national policies on renewable energy in EU-27, based on the RES Legal website (RES Legal 2010). Different price regulation systems, especially fixed feed-in tariffs, are the most popular support mechanisms, adopted by 22 Member States.

Table 6 Policies to promote renewable energy production (RES Legal 2010).

Member State	Policies
Austria	• Price regulation (Green Electricity Act) • Subsidies (investment subsidy)
Belgium	• Fiscal regulation mechanisms (income tax reduction) • Quota system (*Certifacts verts)*
Bulgaria	• Price regulation (Feed-in tariff)
Cyprus	• Price regulation (LPRES) • Subsidy I (SSEEA I) • Subsidy II (SSEEA II)
Czech Republic	• Fiscal regulation mechanisms (exemption from income tax) • Loans (operational programme enterprise and innovations – ECO-ENERGY programme) • Price regulation (act on the promotion of the use of renewable energy sources) • Subsidy I (EFEKT programme) • Subsidy II (state environmental fund) • Subsidy III (Operational Programme Enterprise and Innovations – ECO-ENERGY programme) • Subsidy IV (Operational programme environment)
Denmark	• Loan (Loan guarantees for local initiatives involving the erection of wind-energy systems) • Price regulation (law on the promotion of renewable energy) • Subsidy (subsidies for small renewable energy technologies – ForskVE)
Estonia	• Price regulation I (guaranteed payment) • Price regulation II (bonus)
Finland	• Fiscal regulation mechanisms (tax aid) • Price regulation (feed-in tariff for electricity from peat) • Subsidy (energy aid)
France	• Fiscal regulation mechanisms I (*Crédit d'impôts*) • Fiscal regulation mechanisms II (value-added tax reduction) • Price regulation (*tarif d'achat*)
Germany	• Price regulation (EEG)
Greece	• Price regulation I (feed-in tariff) • Price regulation II (PV support scheme) • Subsidy (investment grant)
Hungary	• Price regulation
Ireland	• Price regulation I (renewable energy feed in tariff 2006) • Price regulation II (renewable energy feed in tariff 2009)
Italy	• Fiscal regulation mechanisms I (reduction in value-added tax) • Fiscal regulation mechanisms II (reduction in property tax) • Price regulation I (feed-in tariff for solar electricity – *conto energia II*) • Price regulation II (Feed-in tariff for RES electricity except solar power – *tariffa omnicomprensiva*) • Price regulation III (purchase and sale by the grid operator – *ritiro dedicato*) • Price regulation IV (Net metering – *scambio sul posto*) • Quota system (*Certificati verdi*)
Latvia	• Price regulation
Lithuania	• Price regulation (law on electricity) • Subsidy (LEIF)
Luxembourg	• Fiscal regulation mechanisms (income tax reduction) • Price regulation (RGD 08/02/08) • Subsidy I (*regime d'aides pour la mise en valeur des énergies renouvelables*) • Subsidy II (*regime d'aide à la production d'énergie de sources renouvelables*)
Malta	• Price regulation (net-metering system)

	• Subsidy (once-only grant) • Subsidy (solar grant)
Netherlands	• Fiscal regulation mechanisms I (environmental protection tax reduction) • Fiscal regulation mechanisms II (EIA) • Price regulation (SDE) • Subvention (programme EOS)
Poland	• Fiscal regulation mechanisms (Exemption from consumption tax) • Loans (national fund for environmental protection and water management) • Quota system
Portugal	• Fiscal regulation mechanisms (Value-added tax reduction) • Price regulation
Romania	• Quota system
Slovakia	• Fiscal regulation mechanisms (exemption from consumption tax) • Price regulation • Subsidy I (Operational programme competitiveness and economic growth) • Subsidy II (Operational Programme Bratislava Region)
Slovenia	• Loan (*Eko sklad*) • Price regulation I (guaranteed payment) • Price regulation II (premium) • Subsidy (for investment projects)
Spain	• Fiscal regulation mechanisms (business tax reduction) • Price regulation (*Régimen Especial*)
Sweden	• Fiscal regulation mechanism I (reduction of real estate tax) • Fiscal regulation mechanisms II (energy tax reduction) • Quota system • Subsidy I (grants for research and development in the field of wind energy) • Subsidy II (grants on the planning of wind energy projects) • Subsidy III (grants for the installation of photovoltaic systems on buildings)
United Kingdom	• Fiscal regulation mechanisms (Climate Change Levy) • Quota system (Renewables Obligation Order) • Subsidy (Environmental Transformation Fund)

To encourage development and investments in the production of renewable electricity, there are a range of different support systems in use in Member States (see Table 7). The (economic) support systems that are in place can generally be categorized into (investment) subsidies, fiscal mechanisms, price regulation (especially feed-in tariffs), quota systems and different loans (RES Legal 2010).

Table 7 Support mechanisms for RES and bioelectricity in the EU-27 in 2010 (RES Legal 2010).

	Subsidies	Fiscal regulation mechanisms	Price regulation	Quota systems	Loans
Austria	X		X		
Belgium		X		X	
Bulgaria			X		
Cyprus	X		X		
Czech Republic	X	X	X		X
Denmark	X		X		X
Estonia			X		
Finland	X	X	X		
France		X	X		
Germany			X		
Greece	X		X		
Hungary			X		
Ireland			X		
Italy		X	X	X	
Latvia			X		
Lithuania	X		X		
Luxembourg	X	X	X		
Malta	X		X		
Netherlands	X	X	X		
Poland		X		X	X
Portugal		X	X		
Romania				X	
Slovakia	X	X	X		
Slovenia	X		X		X
Spain		X	X		
Sweden	X	X		X	
UK	X	X		X	

Since the RES-E Directive does not require harmonisation, Member States continue to develop their own mix of policy instruments to stimulate renewable electricity (Kautto 2007). While a common mechanism for RES-E support has been under discussion it has not been introduced so far. The Commission considers that the harmonized support schemes for renewables should be the long term objective in the context of the EU internal electricity market. The EU BAP (Biomass Action Plan) has stated that the establishment of national biomass action plans (nBAPs) is one of the key actions to boost energy market. The development of these plans is encouraged by the Commission and should indicate the measures that will be taken at national level to promote bioenergy use.

Most Member States are currently using a mix of policy measures to promote the use of biofuels in transport. The most popular measure is a tax exemption or reduction, already adopted by 16 Member States, with several others currently studying its impact (Faber et al. 2006). Many countries support R&D in this area and some have introduced an obligation for the sale of biofuels. Table 8 reviews the support measures in place.

Table 8 Support measures for biofuels in place in 2005 (Faber et al. 2006).

	Tax exemption or reduction	Obligation	R&D support	Other policy measures
Austria	Yes	Yes		
Belgium	Possible		Yes	Funds for public relations
Cyprus			Yes	Lower taxes for flexible-fuel cars
Czech Republic		Yes		
Denmark				
Estonia	Yes			
Finland	Yes		Yes	
France	Yes			
Germany	Yes		Yes	Funds for public relations
Greece	Possible			
Hungary				
Ireland	Yes		Yes	Support for energy crops in agriculture
Italy	Yes			
Latvia	Yes		Yes	Investment subsidy for plants
Lithuania	Yes	Yes		
Luxembourg				
Malta	Yes			
Netherlands	Yes	Yes		
Poland	Yes		Yes	
Portugal	Yes	Possible		Funds for public relations
Slovakia				
Slovenia				
Spain	Yes			
Sweden	Yes		Yes	Investment subsidy for plant; differentiated congestion charges
UK	Yes		Yes	Investment subsidy for plant

The different countries clearly have chosen very different approaches in developing and deploying various bioenergy options. Partly this is caused by the natural conditions (type of resources and crops, climate) and the structure of the energy system and also by the specific political priorities linked to the agricultural and forestry sectors in those countries (Faaij 2006). The frontrunner position of Sweden and Finland is to a large extent directly explained by the strong position of the forestry sector and the available (and leading) capabilities for innovations in this area. A key explanatory factor as to why France focuses on biofuels and production of heat is the excess of (nuclear) electricity production capacity, making electricity production an uninteresting alternative. Also for Sweden this argument is important because support for bioenergy has especially been granted to production of heat (by means of a CO_2-tax on fossil fuels for heat generation). For Sweden, this situation may change once nuclear power generation capacity will, as targeted, be decreased. Both Germany and France have key political as well as cultural interests in their agricultural sectors, explaining the high support levels for rapeseed production as well as ethanol production from surplus cereal production. The activities and recent policy and R&D initiatives in Spain, the UK and the Netherlands seem to reflect the interest in the longer term (i.e. after 2012 for which the Kyoto targets were formulated) when desired GHG emission reductions will require far more dramatic contributions from all renewables than projected so far (Faaij 2006).

What is striking considering the development of bioenergy is that policy measures, targets and choices have proved to be of vital importance for the success of its development (Faaij 2006).

Roughly said, the nineties were a decade where much was achieved for bioenergy, but the focus was on national programs and contexts. The stronger the national policy in terms of support and legal embedding, the more substantial the results were. The Swedish carbon tax and subsequent development of the biomass (including SRC-willow production) and CHP markets, German financial support for biodiesel and CHP, the Danish straw utilization program, Austrian CHP program and the Finnish industrial approach on advanced boiler concepts to name a few, paid off and led to strong positions for those respective countries and industries present.

The more recent trend of liberalization of the energy markets decreased direct support from national governments for technology development. The same is true for investments of the energy sector in longer-term options. For bioenergy, this has proven to be a barrier for further developments because many options are not profitable yet. The need for financial support and certainty over prolonged periods of time suggests that revisiting this trend is desirable (Faaij 2006).

Cooper and Thornley analysed the effectiveness of different policy instruments in their ability to promote bioenergy. For this, four European countries (Germany, Italy, Sweden and UK) were selected and their policy instruments were examined, with the aim of eventually concluding which instruments seem to be the most effective. Country specific factors, policy context and other related issues were evaluated in conjunction with representatives from each country in order to better understand the reasons for policy successes and failures. General findings and recommendations were extracted from this as follows (Cooper & Thornley 2007):

- Continuity of policy instruments is critical in supporting any bioenergy industry.
- Policy instruments should be used to specifically guide investment in the country's preferred form(s) of bioenergy, i.e. electricity, CHP and/or co-firing.
- Fixed prices are a prime way to kick-start a bioenergy industry. To sustain activity, premiums for bioenergy need to be sufficiently generous to take account of capital and fuel supply costs.
- Investment subsidies can help a bioenergy industry in its initial stages and temporarily reduce costs, but will not generally attract long term investment.
- However, for countries lacking in biomass fuel supply investment subsidies are an important means to encourage and support the growth of biomass.
- Trading certificates generate investment in bioenergy, however, the degree of investment will depend on the obligation and if it is weighted to specifically favour bioenergy.
- Taxation has a degree of effectiveness but generally is best used alongside another stronger mechanism.
- For taxation alone to be effective it needs to be at a high level, increased incrementally and long term.

4.4 Discussion and conclusions

Financial and policy instruments have been designed to support the above-mentioned directives and policy targets. Different instruments - compensation schemes, tax deduction (in some cases specifically aimed at biofuels), feed-in tariffs, tax incentives, energy tax exemption, bidding schemes, CO_2 tax and quota – are there to support bioenergy development.

EU directives set targets for renewable energy consumption, encourage low-carbon energy production and set limits on emissions from biomass combustion or disposal. EU legislation affects the availability of biomass and its use for heat and power generation in a variety of ways. The ambitions of the European Union to increase the share of renewable and domestic energy sources and to combat climate change are high and constitute the driving force behind many policies, actions and support schemes as well as the EU international policy.

The European Strategic Energy Technology Plan (SET-Plan) focuses, strengthens and gives coherence to the overall effort in Europe. The Plan is a dedicated policy to accelerate the development and deployment of cost-effective low-carbon technologies. Thus, it will facilitate the achievement of the 2020 targets and the 2050 vision of the Energy Policy for Europe. To put the Plan into action, European Industrial Initiatives on several energy technologies including bioenergy have been proposed, with the aim to strengthen energy research and innovation by bringing together appropriate resources and actors in a particular industrial sector. The European Industrial Bioenergy Initiative (EIBI) intends to accelerate the commercial deployment of advanced technologies to boost the contribution of sustainable bioenergy to the EU 2020 targets.

As regards the climate change, the EU is leading the world in its fight against it, committing itself to stringent targets and willing to go further and sign up to a 30% reduction target in the context of a sufficiently ambitious and comprehensive international agreement. Within this framework, each Member State has committed itself to legally binding targets under the 'Burden Sharing Agreement'. This puts pressure on increased use of renewable energy and finding new resources, but also on finding new methods and technologies to produce fuels.

Theoretical potential is described as the overall maximum amount of terrestrial biomass which can be considered theoretically available for bioenergy production within fundamental bio-physical limits. **Technical potential** is the fraction of the theoretical potential which is available under the regarded technostructural framework conditions and with the current technological possibilities, also taking into account spatial confinements due to competition with other land uses (food, feed and fibre production) as well as ecological (e.g. nature reserves) and other non-technical constraints. The directives discussed in this chapter do not affect so much on the results of biomass assessments when it comes to the theoretical potential. Only incentives which have impact on land use change and afforestation may change the amount of growing biomass. Also financial support for silvicultural actions may improve the physical growth of forest biomass. For the technical potential the directives may have a positive impact, since the support for science and technology development and investment subsidies for new technology will in long term make new resources available.

Economic potential is the share of the technical potential which meets criteria of economic profitability within the given framework conditions. As in the case of technical potential, the support for research and science is increasingly also influencing the economic potential. Financial instruments, for example, can significantly increase economic profitability of certain biomass types or conversion technologies and thereby increase the (variable) economic biomass potential. The policy instruments reducing the costs of bioenergy projects work in the same way. Different financial instruments, support schemes, the fixed price system for renewable energy or feed-in tariffs, taxation of renewable fuels and fossil fuels, quota obligations, green certificates and tendering systems have an impact on the economic

potential of renewable fuels. Resources that earlier were not economically available may suddenly become available if drastic changes are made to support schemes and taxation. Without the current feed-in tariffs etc. many raw materials might not be economically viable to be used as fuels. Also taxation of environmental damages e.g. electricity produced from a fossil fuel sources, favours use of renewables. Financial instruments are not meant to be used "forever". The target is that eventually the production and use becomes economically viable without the subsidies. However, it is important to keep in mind that in order to earn the investors' trust, some continuity of financial and policy instruments is needed in supporting renewable energies production and use.

Financial support for technology development, such as national and European research programmes contribute to the increased technical and economic potential of bioenergy raw materials. Major development has been seen in last decades in both demand and supply side. Fuel production technologies, for example harvesting of agricultural residues and wood biomass have improved, likewise new combustion technologies make it possible to use "difficult" biomasses for energy production. Also improved transport and logistics systems have enabled the use of raw materials from longer distances from the production site.

Implementation potential is the fraction of the economic potential which can be implemented within a certain time frame and under concrete socio-political framework conditions, including institutional and social constraints and policy incentives. In theory, also a fifth type of potential can be distinguished, which is the **sustainable implementation potential**. It is not a potential on its own but rather the result of integrating environmental, economic and social sustainability criteria in biomass resource assessments. This means that sustainability criteria act like a filter on the theoretical, technical, economic and implementation potentials leading in the end to a sustainable implementation potential.

Strong incentives to use some materials for biofuel production may limit the amount of biomass available for the generation of useful energy. The impacts of this directive are not only potentially large; they are also potentially distortive. The market for biofuels is shaped mainly by public policy measures.

The economic support systems in place to encourage the development and investments in the production of renewable electricity include investment subsidies, tax measures, feed-in tariffs, quota obligations, (tradable) green certificates (TGC systems) and tendering systems. These all should eventually lead to increased demand of bioenergy. These on the other hand may make new resources available as the demand increases – in extreme cases they may stimulate competition on raw material and distort markets.

On the other hand, the sustainability requirements limit the use of resources. Especially the sustainability criteria for biofuels and bioliquids as defined in the Renewable Energy Directive have a strong impact on the bio-physical potential of the raw material of these fuels. The Commission recently recommended to extend these sustainability criteria also to solid and gaseous biomass used in electricity generation, heating and cooling.

The sustainability criteria as defined in the Renewable Energy Directive also limit the resources available when considering sustainable potential. Certain land types are totally ruled out for the production of these fuels, if the fuels are to be taken into account for measuring compliance concerning the national targets and with renewable energy obligations, or

eligibility for financial support. When calculating the greenhouse gas emission saving, the negative greenhouse gas impact of land use changes of land with high carbon stocks has to be accounted for. It can be seen that the Biofuels Directive which set an indicative target of 5.75% of biofuels in 2010 has had a direct impact on biomass supply and demand. The directive may also have had significant indirect impacts, due to competition for agricultural raw materials and arable land. In particular, liquid biomass (e.g. palm oil, other vegetable oils and animal fats) can be used for either stationary bioenergy production or transport biofuels. It is expected that the 10% sectoral target for the transport sector (to be reached in 2020) set in the Renewable Energy Directive will aggravate these indirect impacts. When the second generation of biofuels become economically viable, competition for both agricultural raw materials and arable land may increase. Additionally, environmental regulations set limits to the available land area for fuel production.

5 Political framework: policies in other related sectors

In policy terms, the intermixed character of bioenergy with many other policy fields, such as agriculture, forestry and waste treatment, make integrated strategies necessary (Faaij 2006). For example, the increasing demand for biomass will compete with the conventional forestry sector as well as food production at the moment energy crops really take off. Intelligent use of biomaterials and cascading materials in order to optimize GHG mitigation impacts may affect waste treatment strategies in various countries. The question as to what infrastructure should be built and what biomass applications are most desirable, profitable and efficient over time is dauntingly complex, given the wide range of technological options for production of heat, power, fuels and biomaterials (e.g. in construction, chemistry). The availability of biomass resources and uncertain development of biomass markets, due to the dependency on agricultural policies and many other factors, make it difficult to formulate concrete strategies for specific options and regions.

It should be ensured, that bioenergy is considered an integral part of energy, agriculture and forestry, waste and industrial policies. Such a holistic approach to biomass is much needed, to avoid future conflicting developments and maximize the benefits of bioenergy deployment (Faaij 2006). So far, material substitution through biomass (e.g. feedstock for chemical industries and construction) has received limited attention in national and EC policies. It is recommended biomaterials are considered as an integral part of bioenergy strategies, because the combined material and energy applications (e.g. by means of cascading) may prove to have economic and efficiency benefits.

5.1 Sustainability policies

5.1.1 General principles towards identifying the key sustainability concerns

Expectations are that the worldwide use of biomass in the energy supply will increase considerably in the coming decades (Sustainable Production of Biomass 2007). This will be accompanied by the large-scale planting of energy crops. New areas will be opened up for agriculture. Countries and producers will see opportunities for new activities. But at the same time there is a growing concern that this must not be at the expense of other important values for nature, environment and society. To accommodate these feelings, criteria will be needed that indicate whether biomass has been produced in a responsible manner. An example of national criteria (Dutch), indicators and reporting of sustainably produced biomass is shown in Annex 1.

If done right and at the appropriate scale, using biomass for energy, fuel and industrial production has the potential to make an important contribution toward the sustainability of agriculture, forestry, energy and manufacturing sectors; reduce global warming emissions; protect biodiversity, soil and water quality, and overall environmental health; provide good jobs and markets for communities, workers and farmers; and reduce environmental and industrial health impacts (Sustainable Biomass 2008). Unfortunately, with the rush to develop this sector, these results are by no means guaranteed and biomass production done wrong could go in entirely different directions. Without consideration of environmental impacts

increased biomass production could actually decrease biodiversity, soil health, quality of water and wildlife habitat, with minimal or even negative greenhouse gas reduction impacts. If social and community economic considerations are not met, the expanding biomass sector could increase pressure on alternate land use, extract resources needed by local communities, jeopardize food security, and do nothing to improve the economic situation of rural regions. Also if increased biomass production and use is not matched with greater strides in conservation, efficiency and reduced overall consumption, then the sector is unlikely to have more than very limited impact on the overall sustainability of energy materials and transportation sector.

Therefore, it is vital that biomass production and use is pursued in a way that is environmentally, economically and socially sustainable and responsible. The Institute for Agriculture and Trade Policy (IATP) and Friends of the Earth US (FOE-US) have developed draft general principles as a first step towards identifying through a broad stakeholder process the key sustainability concerns around biomass production and use. The principles are (Sustainable Biomass 2008):

- **Biomass production must be linked to increased energy and resource conservation.** Wasteful use of fossil fuels must not be replaced with wasteful use of bioenergy, biofuels and biomaterials. Instead, significant reductions in total consumption, together with increased conservation, must be the first priority – and must take place at the same time as any increase in biobased production.

- **Biomass production must be sustainable for local communities.** Local strategies for agriculture and biomass production with full citizen input should be created.
    - Biomass production should not impose unjust burdens on economically or socially marginal communities, including communities in the Global South.
    - Large-scale production of biomass must not jeopardize food security. Biomass production must not be undertaken on land needed for food production and cannot undermine local food sovereignty.
    - Safeguards must be put in place to ensure that local consumption is prioritized over transporting or exporting biomass or biomass energy and products away from the communities and regions that produce them.
    - Local farmers and communities should have ownership and control over the biomass production and processing facilities. Income generated from biomass and bioenergy production should be kept to the greatest extent possible within local producing communities. Public support and incentives must be focused on small-scale and local development, production and ownership – from feedstock to processing facilities – and the creation of appropriate sectoral jobs in local communities should be promoted.
    - Agricultural communities and workers must be protected. Family and smallholder farmers and peasants must not be displaced to grow or harvest biomass feedstocks, and should receive fair compensation for biomass feedstocks and the products they produce. In addition, fair wages for agricultural workers should be ensured and abusive employment relationships prohibited. The health and safety of workers and communities must be protected.

- **Biomass production must be sustainable for the climate, environment and public health.**
  - The full life cycle of biomass production (including processing for energy) must significantly reduce greenhouse gas emissions. As part of achieving this objective, the use of fossil fuels in the production and processing of biomass crops should be minimized, prevented whenever possible, and eventually phased out. Selection, production and use of biomass crops should also result in reduced greenhouse gas emissions.
  - Biomass production must maintain and build soil structure and fertility and conserve water quantity and quality. Agricultural practices that promote better soil and water quality should be utilized in biomass production. Perennial biomass crops that enhance and protect soil quality, promote water retention, and reduce nutrient and chemical run-off should be prioritized.
  - Biomass crop production must not encroach on forests and other intact ecosystems. Forests and other habitats or ecosystems need to be protected from encroachment by biomass crops. Protected areas must not be declassified or appropriated for biomass crop production and conversion of native ecosystems must be prevented.
  - Biomass production should improve, not erode, biological diversity. This will require the protection of previously undeveloped habitats, the use of native species and crop diversification, as well as cultivation that does not deplete soil nutrients or reduce soil biodiversity. In addition, biomass production must not involve the use of genetically engineered crops and materials, or the release of genetically engineered organisms into the environment during processing.
  - Biomass crop production must minimize, and eliminate whenever possible, the use of dangerous agrochemicals. Agrochemicals that are hazardous to the environment, workers, and local communities should be used only as a last resort. Chemicals used will be non-persistent, while chemicals that are endocrine disrupting, carcinogenic or mutagenic in humans should be phased out.

- **Sustainable biomass standards, certification and labelling systems need to be developed, administered and supported by a democratic process.**
  - Local and affected populations should be ensured an opportunity for meaningful public review of and participation in development of sustainability criteria for biomass crops.
  - Local stakeholders need to support and be engaged in implementation and enforcement of resulting sustainability standards, certification and labelling.
  - Introduction and implementation of standards need to be preceded by public input and consideration of the impact of proposed bioenergy projects on local and community development and goals.

5.1.2 Sustainable Development Strategy

The overall aim of the renewed EU Sustainable Development Strategy (SDS) is to identify and develop actions to enable the EU to achieve continuous improvement of quality of life both for current and for future generations through the creation of sustainable communities able to manage and use resources efficiently and to tap the ecological and social innovation

potential of the economy, ensuring prosperity, environmental protection and social cohesion (EU 2006).

Environmental protection is the first of the key objectives of the SDS. The aim is to safeguard the earth's capacity to support life in all its diversity, respect the limits of the planet's natural resources and ensure high level of protection and improvement of the quality of the environment. This objective also includes preventing and reducing environmental pollution and promoting sustainable consumption and production to break the link between economic growth and environmental degradation.

The policy guiding principles of the SDS include, among other aspects, also the following (EU 2006):

- *Policy coherence and governance:* Promote coherence between all European Union policies and coherence between local, regional, national and global actions in order to enhance their contribution to sustainable development.
- *Policy integration:* Promote integration of economic, social and environmental considerations so that they are coherent and mutually reinforce each other by making full use of instruments for better regulation, such as balanced impact assessment and stakeholder consultations.
- *Use best available knowledge:* Ensure that policies are developed, assessed and implemented on the basis of the best available knowledge and that they are economically sound and cost-effective.
- *Precautionary principle:* Where there is scientific uncertainty, implement evaluation procedures and take appropriate preventive action in order to avoid damage to human health or to the environment.
- *Make polluters pay:* Ensure that prices reflect the real costs to society of consumption and production activities. Polluters should pay for the damage they cause to human health and the environment.

The EU SDS sets out an approach to better policy-making based on better regulation and on the principle that sustainable development is to be integrated into policy-making at all levels. This requires all levels of government to support and to cooperate with each other, taking into account the different institutional settings, cultures and specific circumstances in Member States.

Bearing in mind worsening environmental trends, the EU's economic and social challenges coupled with new competitive pressures and new international commitments, the EU SDS identifies seven key challenges and corresponding targets, operational objectives and actions. One of these key challenges is Climate change and clean energy, with the overall objective to limit climate change and its costs and negative effects to society and the environment. Another identified challenge is conservation and management of natural resources, the overall objective of which is to improve the management and avoid overexploitation of natural resources, recognising the value of ecosystem services.

The sustainability criteria of the Renewable Energy Directive (2009/28/EC) are presented in chapter 4.2.2 above.

5.2 Environmental policies

The European Union's environmental policy has been one of the Union's success stories in terms of providing tangible benefits for its citizens (EC 2007b). EU legislation lies behind some 80% of national environmental legislation. It is responsible for major improvements in air and water quality and the elimination of pollutants such as lead in petrol. It allows the EU to assume global leadership on questions such as climate change. To ensure its long-term sustainability, the EU economy needs to be based, inter alia, on sound environmental principles and EU environment legislation aims to provide such a basis.

Over the last 30 years the EU has built a comprehensive legislative framework for environmental protection and this process has been guided by strategic Environmental Action Programmes. The Sixth Community Environmental Action Programme (6th EAP) establishes the community framework for environmental policy for the period of July 2002 to July 2012 (EC 2007b). It represents the environmental dimension of the EU's Sustainable Development Strategy (see chapter 5.1 above) and sets out environmental priorities with a particular focus on four issues:

- climate change;
- nature and biodiversity;
- health and quality of life;
- natural resources and waste.

For each of these priority areas, the 6th EAP sets out specific objectives and priority actions. The 6th EAP also addresses a number of cross cutting issues – that include the overall formulation and implementation of environmental policies. It also sets out a number of strategic principles.

The key challenge for the EU will be delivering on these political commitments and important next steps will be widening the ETS to cover more sectors (such as aviation) and to cover more gases. The commission will also look to improve the effectiveness of the ETS through, among other things, a wider use of auctioning. The EU also needs to encourage the take up of renewable energies and increase research into new technologies such as carbon sequestration and storage, the use of hydrogen as a fuel and second generation biofuels. As the necessary technologies are developed a supportive regulatory framework will also need to be elaborated (EC 2007b).

The 6th EAP confirmed the EU's objective of halting the loss of Europe's biodiversity by 2010. At the global level the EU shares the objective of significantly reducing the loss of global biodiversity by the same date (EC 2007b). In May 2006 the commission published a strategy on how to meet these objectives. The main conclusion of the strategy is that inside the EU the policy framework is already largely in place – most importantly with the NATURA 2000 network of protected areas. The priority for the EU must be the full and effective implementation of existing legislation.

It will be necessary for the EU to step up efforts to stop deforestation which, in addition to its impact on climate change, is one of the most important reasons for global biodiversity loss (EC 2007b). Illegal logging is a major problem and the commission recently began negotiations with Malaysia, Ghana and Indonesia under the Forest Law Enforcement, Governance and Trade (FLEGT) agreement. The objective is to ensure that timber imported

from partner countries is legally harvested. To complement this process, the Commission will present a further proposal on the marketing of tropical timber. The Commission will also explore innovative approaches such as attaching an economic value to stop global deforestation.

The 6th EAP aims to decouple economic growth from environmental degradation (EC 2007b). The Thematic Strategy on the sustainable use of natural resources (COM(2005) 670) provides a long-term framework for achieving this objective and takes the first steps towards making the EU the most resource-efficient economy in the world.

Well designed regulation is the foundation of the EU's environmental policies but market mechanisms can be used as part of the policy mix in order to deliver environmental objectives in a cost-effective manner and to contribute to effective implementation (EC 2007b). The Emissions Trading System is one example and the commission has recently adopted a Green Paper on market-based instruments for environment and related policy purposes (COM(2007) 140).

Using the market also means finding a mechanism to put a correct valuation on environmental goods and services. An important instrument which can influence consumer behaviour is the optimal use of environment related taxation (EC 2007b). However, these taxes need to be applied such a way as to avoid distorting the functioning of the internal market and to maximise the environmental benefit. There is also a strong argument for shifting the tax burden away from areas the EU is trying to promote, such as employment, and onto resource and energy consumption and/or pollution. The EU is also committed to removing environmentally damaging subsidies.

There is also a need to improve the functioning of the voluntary instruments that have been designed for industry: EMAS and Ecolabel. These tools have a great potential but have not been fully developed (EC 2007b). The commission will revise these schemes in order to promote their uptake and reduce administrative burdens in their management.

The commission will produce a strategic framework in order to address the issue of policy integration. It will pay particular attention to the sectors where there is the greatest potential for policy synergies in order to improve the quality of the environment (agriculture, fisheries, transport, energy, regional and industrial policy and EU external relations). At the Member State level, different council formations should produce annual reports on how they have dealt with the obligation to integrate environmental issues into their work.

5.3 Waste policies

As European society has grown wealthier it has created more and more rubbish. Each year in the European Union 1.3 billion tonnes of waste are thrown away – of which some 40 million tonnes is hazardous (EU Waste 2008). This amounts to about 3.5 tonnes of solid waste for every man, woman and child. Add to this total a further 700 million tonnes of agricultural waste and it is clear that treating and disposing of all this material – without harming the environment – becomes a major headache. (EC 2008)

Between 1990 and 1995, the amount of waste generated in Europe increased by 10%, according to the Organisation for Economic Cooperation and Development (OECD). Most of

what is thrown away is either burnt in incinerators, or dumped into landfill sites (67%). However,both these methods create environmental damage. Landfillings not only take up more and more valuable land space, it also causes air, water and soil pollution, discharging carbon dioxide (CO_2) and methane (CH_4) into the atmosphere and chemicals and pesticides into the earth and groundwater. This, in turn, is harmful to human health, as well as to plants and animals.

By 2020, the OECD estimates, we could be generating 45% more waste than we did in 1995 (EU Waste 2008). Obviously this trend must be reversed if we are to avoid being submerged in rubbish. The EU's Sixth Environment Action Programme (see chapter 5.2 above) identifies waste prevention and management as one of four top priorities. Its primary objective is to decouple waste generation from economic activity, so that EU growth will no longer lead to more and more rubbish and there are signs that this is beginning to happen. In Germany and the Netherlands, for example, municipal waste generation fell during the 1990s.

The EU is aiming for a significant cut in the amount of rubbish generated, through new waste prevention initiatives, better use of resources, and encouraging a shift to more sustainable consumption patterns.

The European Union's approach to waste management is based on three principles (EU Waste 2008):

1. **Waste prevention:** This is a key factor in any waste management strategy. If we can reduce the amount of waste generated in the first place and reduce its hazardousness by reducing the presence of dangerous substances in products, then disposing of it will automatically become more simple. Waste prevention is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging.
2. **Recycling and reuse:** If waste cannot be prevented, as many of the materials as possible should be recovered, preferably by recycling. The European Commission has defined several specific 'waste streams' for priority attention, the aim being to reduce their overall environmental impact. This includes packaging waste, end-of-life vehicles, batteries, electrical and electronic waste. EU directives now require Member States to introduce legislation on waste collection, reuse, recycling and disposal of these waste streams. Several EU countries are already managing to recycle over 50% of packaging waste.
3. **Improving final disposal and monitoring:** Where possible, waste that cannot be recycled or reused should be safely incinerated and a landfill should only be used as a last resort. Both these methods need close monitoring because of their potential to cause severe environmental damage. The EU has recently approved a directive setting strict guidelines for landfill management. It bans certain types of waste, such as used tires, and sets targets for reducing quantities of biodegradable rubbish. Another recent directive (2000/76/EC) lays down tough limits on emission levels from incinerators. The Union also wants to reduce emissions of dioxins and acid gases such as nitrogen oxides (NO_x), sulphur dioxides (SO_2), and hydrogen chlorides (HCl), which can be harmful to human health.

The first objective of any waste policy should be to minimise the negative effects of the generation and management of waste on human health and the environment. Waste policy

should also aim at reducing the use of resources and favour the practical application of the waste hierarchy.

In its resolution on 24 February 1997 on a community strategy for waste management, the council confirmed that waste prevention should be the first priority of waste management, and that re-use and material recycling should be preferred to energy recovery from waste, since sofar they are the best ecological options.

It was therefore necessary to revise the Directive 2006/12/EC in order to clarify key concepts such as the definitions of waste, recovery and disposal, to strengthen the measures that must be taken in regard to waste prevention, to introduce an approach that takes into account the whole life-cycle of products and materials and not only the waste phase, and to focus on reducing the environmental impacts of waste generation and waste management, thereby strengthening the economic value of waste. Furthermore, the recovery of waste and the use of recovered materials should be encouraged in order to conserve natural resources.

Waste hierarchy

The following waste hierarchy applies as a priority order in waste prevention and management legislation and policy:

a) prevention;
b) preparing for re-use;
c) recycling;
d) other recovery, e.g. energy recovery; and
e) disposal.

When applying the waste hierarchy, Member States should take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where this is justified by life-cycle thinking on the overall impacts of the generation and management of such waste. Member States need to ensure that the development of waste legislation and policy is a fully transparent process, observing existing national rules about the consultation and involvement of citizens and stakeholders. Member States also need to take into account the general environmental protection principles of precaution and sustainability, technical feasibility, economic viability, protection of resources, environmental health, human health, economic and social impacts (EC 2008).

In accordance with the *polluter-pays principle*, the costs of waste management are borne by the original waste producer or by the current or previous waste holders.

Member States may decide that the costs of waste management are to be borne partly or wholly by the producer of the product from which the waste came and that the distributors of such product may share these costs.

5.3.1 Sewage sludge directive

The Sewage Sludge Directive (86/278/EEC), as amended, has a double purpose: to ensure that human beings, animals, plants and the environment are fully safeguarded against the

possibility of harmful effects from the uncontrolled spreading of sewage sludge on agricultural land; and to promote the correct use of sewage sludge on such land (EC 1986, IEEP 2009).

The main provisions of the directive for Member States are (IEEP 2009):

- conditions for using sewage sludge in agriculture for the protection of human health and nature;
- concentration limit values for heavy metals in soils, sludge and maximum annual loads;
- maximum quantities of sludge applicable to soil;
- conditions under which less stringent concentrations of heavy metals are permitted;
- use of sludge treatment technologies;
- frequency of analysis of sludge;
- authorisations for the use of untreated sludge on soil;
- periods of prohibition forspreading sludge before grazing or harvesting;
- limit values or other measures for soils with a pH below 6;
- soil analyses for other parameters than pH and heavy metals;
- minimum frequency of soil analyses;
- up-to-date records on quantities of sludge produce, sludge used in agriculture and average concentration of heavy metals in sludge;
- exemptions granted to small sewage sludge treatment plants.

The Directive provides great flexibility in national implementation resulting in a great variety in approaches and limit values. All Member States have provided the Commission with details on the transposition of the Directive. Most Member States have notified the commission on stricter measures (IEEP 2009).

For heavy metals in soil there is a wide variation in national limit values as well as surprisingly large differences in limit values between similar geographic areas, such as the Baltic States or Nordic countries. For heavy metals in sludge most Member States have set their limit values below the maximums allowed by the Directive. Again there is a wide variation in national limit values, even between similar geographical areas.

The measures used are based on equal requirements for all sludge, an outright prohibition of using sludge from a septic tank or specific measures required for sludge from a septic tank (IEEP 2009).

According to the Directive, Member States shall regulate the use of sludge in such a way that the accumulation of heavy metals in the soil does not lead to the limit values being exceeded. To achieve this, they shall apply one or other of the alternative procedures provided in the Directive (EC 1986):

(a) Member States shall lay down the maximum quantities of sludge expressed in tonnes of dry matter which may be applied to the soil per unit of area per year while observing the limit values for heavy metal concentration in sludge which they lay down; or
(b) Member States shall ensure observance of the limit values for the quantities of metals introduced into the soil per unit of area and unit of time.

Ten Member States have opted for option (a) and five have stated that they have opted for option (b) (IEEP 2009). Apart from Estonia, France and Sweden, all Member States have prohibited the use of untreated sludge if it is injected or worked into the soil. However, also these three countries have set special prerequisites on the spreading of untreated sludge on soil.

5.3.2 Landfill directive

The Landfill Directive (99/31/EC) is currently effectively reducing the amount of biodegradable waste being landfilled (Faber et al. 2006). Waste incineration is one of the most popular options for processing biodegradable waste, together with mechanical-biological treatment and composting. However, due to the required capital investments in incinerators, the volume of waste incinerated will only grow when landfill taxes are raised or use of landfills are otherwise restricted. New incinerators are being built in countries like France, Italy and Portugal. Generation of electrical power and often heat has become a standard technology for waste incinerators. Other countries, like Germany and Austria, while also encouraging the incineration of waste, do not support mixed municipal waste as biomass. Generally in EU language waste as a renewable energy source is limited to biodegradable fraction. The definitions of biomass in legal documents often have little in common with any scientific or technical definition of biomass. First of all, the definition of biomass depends on the goal and scope of the respective legal document. Secondly, the definition is influenced by the document's background, i.e. which political issue it addresses and which Directorate-General (DG) or national ministry it originates from.

There is ample scope for increasing the volume of waste incinerated within the EU, especially among southern and eastern Member States. Shifting biogenic waste from landfills to energy production could reduce the CO_2-eq. emissions of the EU-15 by 300 Mt CO_2 annually. This is more than the Netherlands' total annual emissions (Faber et al. 2006). As a climate measure, this biomass option is very important because of the avoidance of methane emissions from landfills (as a greenhouse gas, methane is 23 times stronger than CO_2). If the non-biogenic fraction is included, the extra energy from this waste could deliver 4 to 5% of European electricity demand.

5.4 Water policies

Protection of water resources is one of the cornerstones of environmental protection in Europe. Water related issues transcend national boundaries and concerted actions at the level of the EU are necessary to ensure an effective protection.

The purpose of the Water Directive (2000/60/EC) is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

a) prevents further deterioration, protects and enhances the status of aquatic ecosystems and with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
b) promotes sustainable water use based on a long-term protection of available water resources;

c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and
e) contributes to mitigating the effects of floods and droughts.

The success of this Directive relies on close cooperation and coherent action at community, Member State and local level as well as on information, consultation and involvement of the public, including users.

Member States must ensure the establishment of a register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water. For each river basin district, the register or registers of protected areas shall be kept under review and up to date.

Member States take account of the principle of recovery of the costs of water services, including environmental and resource costs, with regard to the economic analysis conducted, and in accordance in particular with the *polluter pays* principle.

Member States must ensure by 2010

- that water-pricing policies provide adequate incentives for users to use water resources efficiently and thereby contribute to the environmental objectives of this Directive,

that there is sufficient contribution from different water users (e.g. industry, household and agriculture) to the cost of providing water services, based on the *polluter pays* principle.

5.5 Biodiversity policies

The EU has the directive on the conservation of natural habitats and wild fauna and flora (92/43/EEC). The aim of this directive is to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the treaty applies.

Measures should be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of community interest and to take account of economic, social and cultural requirements, and regional and local characteristics.

A coherent European ecological network of special areas of conservation has been set up under the title Natura 2000. This network, composed of sites hosting the natural habitat types and habitats of the species, enables the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

The Natura 2000 network includes the special protection areas classified by the Member States pursuant to the Directive 79/409/EEC.

Each Member State has an obligation to contribute to the creation of Natura 2000 in proportion to the representation within its territory of the natural habitat types and the habitats of species. To that effect each Member State designates sites as special areas of conservation.

Where they consider it necessary, Member States should try to improve the ecological coherence of Natura 2000 by maintaining, and where appropriate developing, features of the landscape which are of major importance for wild fauna and flora.

5.6 Common Agricultural Policy

In the preparation of the CAP reform 2003 the commission proposed to replace the existing arrangements for the non-food set-aside scheme (NFSA) with a "carbon credit", a non-crop specific financial aid for energy crops with the objective of achieving carbon dioxide substitution while the set-aside scheme would have been turned into a compulsory long-term non-rotational set aside (EC 2006a).

The result of the CAP reform 2003, i.e. the Council Regulation (EC) 1782/2003, maintains the existing set-aside scheme (and the NFSA) and introduces a new aid supporting the production of energy crops. The amount of this aid is €45 per hectare for a maximum guaranteed area (MGA) of 1 500 000 hectares, not divided among the Member States.

The two regimes (non-food on set-aside land and energy crops) are run in parallel and they both contribute to support the development of energy crops (EC 2006a). Farmers may opt for one or the other regime depending on their specific situation. The aid for energy crops, however, cannot be granted on areas subject to set aside but farmers producing raw materials for energy purposes on set-aside land in the framework of the NFSA scheme are entitled to receive the set-aside payment or the value of the set-aside entitlement.

Under the CAP reform, the new Member States may opt to use the Single Area Payment Scheme (SAPS), which involves the payment of uniform amounts per hectare of agricultural land, up to a national ceiling, set up on the basis of the sum of direct payments to which the given Member State would be entitled in the year in question (EC 2006a). The current rules for SAPS exclude the application of the energy crops scheme in the Member States applying the SAPS. In the lack of a set-aside obligation, these Member States also do not have the possibility to grow energy crops on set-aside land.

However, the new Member States using SAPS may decide to grant farmers a complementary national direct payment (CNDP or "top-up") for energy crops after authorisation by the Commission. The maximum amount of such national top-ups should take into account the actual "phasing in" level. The new Member States choosing not to apply the SAPS (Slovenia, Malta) are subject to the same general conditions as the EU-15 Member States, except that the "phasing-in" applies. The maximum guaranteed area and mandatory set aside of the energy crop scheme (including the possibility of cultivating energy crops on those areas) therefore applies in these countries.

The commission has proposed to extend the energy from the year 2007 to all Member States, including the new Member States applying the SAPS (EC 2006a). The commission considers that the same kind of incentive for the production of energy crops should be provided in the

new Member States as in the EU-15 Member States. Therefore, the regime should be introduced under the same conditions as applies currently for the EU-15, including the full payment of the aid for energy crops. The commission also considers that the extension of the energy crops scheme to the new Member States from 2007 would require an increase in the MGA for energy crops, at least pro-rata to their arable land.

The CAP reform provides for the possibility for Member States to grant national aid covering up to 50% of the costs associated with establishing perennial crops intended for biomass production on set-aside land. The extension of this possibility for the areas under energy crops would make it possible to increase the level of support without additional CAP spending (EC 2006a). Given the present low proportion of perennial crops in the area under energy crops, such a measure could also improve the present imbalance which is in favour of oilseeds. This support could also be an encouragement for an alternative and less intensive use of lower quality arable land or areas with high risk of erosion, giving further environmental benefits to the application of the scheme.

The extension of the EU with a large number of new members in Central and Eastern Europe provides new opportunities for biomass in the whole Europe (Faaij 2006). Current land use and productivity of agriculture and the expected major transitions for the agricultural sector in Central and Eastern European countries (CEECs) once the CAP applies, are likely to lead to reform and rationalization in agriculture, thus providing opportunities for alternative crops. On average lower costs for land and labour in CEECs make energy crop production an attractive option (Dornburg et al. 2003).

"*Cross-compliance*" creates a link between the receipt of direct payments by farmers and their compliance with certain rules which are in the interests of society as a whole. The rules concern the protection of the environment, food safety, animal health, animal welfare, public health, plant health and environmental condition. This link is expressed in concrete terms in the possibility, if the rules are not respected, there will be areduction or cancellation of direct payments. In other words, if farmers do not respect these rules then they may not receive some or all of their direct payments.

The specification of good agricultural and environmental condition is set at the level of the Member State. Cross-compliance applies to farmers who receive direct payments.

5.7 Forest policies

The EU forest sector is characterised by a great diversity of forest types, extent of forest cover, ownership and socio-economic conditions (EC 2005a). In total, forests and other wooded land occupy some 160 million ha or 35% of the EU's land area. EU forests are situated in very different ecological environments, ranging from boreal to Mediterranean and from alpine to lowlands. About 60% of the forests in the EU are under private ownership, with about 15 million private forest owners. The EU is one of the largest producers, traders and consumers of forest products in the world. Forestry and forest-based and related industries employ about 3.4 million people, with an annual production value of about EUR 356 billion (2001).

In the European Union the formulation of forest policies is the competence of the Member States within a clearly defined framework of established ownership rights and with a long history of national and regional laws and regulations based on long term planning (EU Forest Policies 2008). Although the treaties for the European Union make no provision for a common forest policy, there is a long history of EU measures supporting certain forest-related activities, coordinated with Member States mainly through the Standing Forestry Committee.

However, forests are affected by a broad array of community policies and initiatives arising from diverse EU sectoral policies. For several decades now, environmental forest functions have attracted increasing attention mainly in relation to the protection of biodiversity and, more recently, in the context of climate change impacts and policies (EU Forest Policies 2008). In public perception, apart from the traditional production of wood and other forest products, forests are increasingly valued for their role as public amenities, biodiversity reservoirs, regulators of climate and local weather, sources of clean water, protection against natural disasters and renewable energy sources.

The Council Resolution of 15 December 1998 on a Forestry Strategy for the European Union (EC 1998) established a framework for forest-related actions in support of sustainable forest management (SFM), based on the co-ordination of the forest policies of the Member States, community policies and initiatives relevant to forests and forestry. It takes into account the commitments made by the EU and its Member States in the relevant international processes, in particular the UN Conference on Environment and Development in 1992 (UNCED) and its follow-up conferences, and the Ministerial Conferences on the Protection of Forests in Europe (MCPFE).

The strategy emphasises the importance of the multifunctional role of forests and SFM for the development of society and identifies a series of key elements, which form the basis for its implementation. It states that forest policy lies in the competence of the Member States, but that the EU can contribute to the implementation of SFM through common policies, based on the principle of subsidiary and the concept of shared responsibility. It also emphasises the implementation of international commitments, principles and recommendations through national or sub-national forest programmes or equivalent instruments and active participation in all forest-related international processes.It also stresses the need to improve co-ordination, communication and co-operation in all policy areas of relevance to the forest sector.

The context for forest policy in the EU has evolved significantly since 1998, both through decisions directly affecting the forest sector and through changes in the broader policy setting (EC 2005a). During the period of implementation of the Forestry Strategy, the EU has made progress in putting in place the new and improved instruments to promote the protection and sustainable management of forests.

Substantial progress has been achieved in the preparation and implementation of national forest programmes (NFPs) in the EU (EC 2005a). A common approach to NFPs has been developed in the context of the MCPFE, with the aim of establishing a social and political framework for SFM, based on participatory and transparent governance and international forest-related commitments.

The NFPs address issues, such as the productive function of forests and the economic viability of sustainable forest management, the contribution of forestry to rural development,

the protection and enhancement of biodiversity in forests, climate change mitigation, the protective functions of forests, and social, recreational and cultural aspects. Although the programmes have similar aims, they vary in terms of their focus, reflecting the socio-economic and ecological diversity of the European forests.

Community actions carried out in support of SFM cover several major fields of activity: rural development, forest protection and monitoring, biodiversity, climate change, forest-based products, forest certification, research, forest information and communication, and forest reproductive material and plant health (EC 2005a). The Forest Focus Regulation (EC 2152/2003) adopted in 2003 provides an opportunity for the EU to develop a comprehensive and integrated forest monitoring system, including new parameters on soils, biodiversity and climate change. Such a system could eventually also address socio-economic aspects of forests and forestry and lead to a better integration of national forest databases into an EU-wide monitoring and reporting system.

Although the role of forest sector in climate mitigation was confirmed by the rules of the Kyoto Protocol, the development of dedicated measures for carbon sequestration, including afforestation and reforestation, has been slower than expected (EC 2005a). Wood can play an important role as a provider of biomass energy to offset fossil fuel emissions, in line with the EU directives on renewable energy sources and as an environmentally friendly material. The use of biomass for energy purposes has not yet been developed to its full potential in the EU and it should be ensured that in doing so no undue distortions of competition are created. In the future, wood may also play an important role as carbon reservoir.

Certification has been one of the tools used to encourage the sustainable forest management and allow consumers to discriminate positively in favour of wood products originating from sustainably managed forests (EC 2005a). So far, certification has developed as a private-sector, market-based tool, with limited regulatory intervention by public authorities.

In its reporting on the implementation of the EU Forestry Strategy (EC 2005a), the commission proposed the development of an EU Forest Action Plan. This Action Plan (EC 2006b) was adopted on 15 June 2006. It builds on the report on implementation of the EU Forestry Strategy and consequent conclusions by the council.

The overall objective of the EU Forest Action Plan is to support and enhance sustainable forest management and the multifunctional role of forests. It is based on the following principles (EC 2006b):

- national forest programmes as a suitable framework for implementing international forest-related commitments;
- the increasing importance of global and cross-sectoral issues in forest policy, calling for improved coherence and coordination;
- the need to enhance the competitiveness of the EU forest sector and good governance of EU forests;
- respect for the principle of subsidiary.

Recognising the wide range of natural, social, economic and cultural conditions and differences in ownership regimes of EU forests, the Action Plan acknowledges the need for specific approaches and actions for different types of forests. It emphasises the important role played by forest owners in the sustainable management of forests in the EU.

The five-year Action Plan (2007 – 2011) consists of a set of key actions which the commission proposes to implement jointly with the Member States. It also points out additional actions which can be carried out by the Member States according to their specific conditions and priorities, with support from existing community instruments, although implementation may also require national instruments.

The Action Plan defines 18 key actions to be taken, grouped under four main objectives (EC 2006b):

1. To improve the long-term competitiveness of the forest sector and to enhance the sustainable use of forest products and services.
   Key action 1: Examine the effects of globalisation on the economic viability and competitiveness of EU forestry.
   Key action 2: Encourage research and technological development to enhance the competitiveness of the forest sector.
   Key action 3: Exchange and assess experiences on the valuation and marketing of non-wood forest goods and services.
   Key action 4: Promote the use of forest biomass for energy generation
   Key action 5: Foster the cooperation between forest owners and enhance education and training in forestry.
2. To maintain and appropriately enhance biodiversity, carbon sequestration, integrity, health and resilience of forest ecosystems at multiple geographical scales.
   Key action 6: Facilitate EU compliance with the obligations on climate change mitigation of the UNFCCC and its Kyoto Protocol and encourage adaptation to the effects of climate change.
   Key action 7: Contribute towards achieving the revised community biodiversity objectives for 2010 and beyond.
   Key action 8: Work towards a European Forest Monitoring System.
   Key action 9: Enhance the protection of EU forests.
3. To contribute to the quality of life by preserving and improving the social and cultural dimensions of forests.
   Key action 10: Encourage environmental education and information.
   Key action 11: Maintain and enhance the protective functions of forests.
   Key action 12: Explore the potential of urban and peri-urban forests.
4. To improve coherence and cross-sectoral cooperation in order to balance economic, environmental and socio-cultural objectives at multiple organisational and institutional levels.
   Key action 13: Strengthen the role of the Standing Forestry Committee.
   Key action 14: Strengthen coordination between policy areas in forest-related matters.
   Key action 15: Apply the open method of coordination (OMC) to national forest programmes.
   Key action 16: Strengthen the EU profile in international forest-related processes.
   Key action 17: Encourage the use of wood and other forest products from sustainably managed forests.
   Key action 18: Improve information exchange and communication.

5.8 Discussion and conclusions

The first factor affecting the biomass potential in general would be the definition of biomass. Specially, when it comes to the Waste Directive, the definition of biomass clearly describes the part of waste (biodegradable) that is considered as renewable. Different definitions used in different documents, directives, laws, and particularly differences between countries, bear certain risks regarding biomass resource assessments, especially if these are based on bioenergy statistics. Generally in EU language waste as renewable energy source is limited to a biodegradable fraction. The Landfill Directive is currently effectively reducing the amount of biodegradable waste being landfilled.

The target of the three principles of waste management is naturally to reduce the raw material use and to minimize the amount of waste ending up in landfills. Waste prevention, recycling, recovery and reuse targets have impact in the amount of waste produced. When considering waste as a source of renewable energy, again, the definition sets limitation on which kind of waste is considered as renewable. The Landfill Directive bans certain types of waste, such as used tires, and sets targets for reducing quantities of biodegradable rubbish. It is currently effectively reducing the amount of biodegradable waste being landfilled. At least partly this fraction, which even 20 years ago mostly ended up in landfills, is now available for energy production. Techno-economic potential of waste is very much affected by the landfill taxes and restrictions.

When it comes to sustainable potential, sustainability, biodiversity and environmental policies include some limitations which affect the biomass production potential. Land use and land use changes have impact on the available land area for biomass production. Forestry Strategy for the European Union stresses the importance of sustainable forest management. Also the EU Forest Action Plan supports and enhances the sustainable forest management and the multifunctional role of forests. Sustainable forest management may short-sightedly limit the use of forest resources. One of the key actions is to promote the use of forest biomass for energy generation, this would have an increasing effect on the implementation potential. Another key action of the same action plan emphasizes the protection of EU forests, the biodiversity and carbon sequestration perspectives of forest management. They, for their part have a negative impact on implementation potential (see chapter 4.4.).

The financial incentives of the Common Agricultural Policy (CAP) include aid for energy crops and for producing raw materials for energy purposes. However, it also puts some limitations on lands where the energy crops can be grown. These have an impact on the economic and implementation potential. The CAP reform allows Member States to provide national financial support for establishing perennial crops intended for biomass production on set-aside land. The policy encourages the use of set-aside land for energy crop production. Also new grants are available for energy crop cultivation in new Member States. It is expected that the application of CAP in the new Member States will provide new opportunities for alternative energy crops.

Without consideration for environmental impacts, increased biomass production could actually decrease biodiversity, soil health, quality of water and wildlife habitat, with minimal or even negative greenhouse gas reduction impacts. If social and macroeconomic considerations are not met, the expanding biomass sector could increase pressure on

alternative land use, extract resources needed by local communities, jeopardize food security, and fail to improve the economic situation of rural regions.

The sustainable implementation potential is the fraction of the theoretical potential which meets ecologic criteria related to biodiversity as well as to soil erosion – also referred to as "ecologic potential". Biomass resource assessments are based on policies, socio-economic parameters and the state of the environment. Global biodiversity loss, illegal logging and unsustainable land use changes are of great concern. Environmental policies to fight this development impact the sustainable implementation potential, not only in Europe but globally.

Natura 2000 sets some limitations to land use in special areas of conservation. The water directive sets up a framework for protection of inland surface waters, transitional waters, coastal waters and groundwater. The Habitats Directive aims to ensure biodiversity. The sustainability criterion of the Renewable Energy Directive sets out that biofuels and other bioliquids should not be made from raw material obtained from land with recognised high biodiversity value. These directives in principle have a restrictive impact on the sustainable implementation potential of forest and agricultural biomass by limiting the land availability to environmentally sustainable and acceptable areas.

6 User requirements

Policy and decision makers in the EU have put energy policy objectives high on the agenda, including the promotion of the use of biomass as an energy source. To achieve the potential and political targets it is essential to have resource assessments that are clear, reliable and detailed enough, both for policy and industry. For example, investors need the information in their decision making. Average transport distance is one of the main factors when calculating the biomass fuel costs for a certain plant. When deciding upon the location and size of a biomass plant, it is critical to know the real long-term availability of biomass fuels. To be able to compare different investment options – possibly even in different countries – it is necessary to have resource assessments that are comparable with each other.

In addition to policy makers and authorities at different levels (local, national, EU, etc.) and industrial investors, there are also several other potential users of biomass resource assessments, such as research organisations, NGOs, etc. Different user groups – and even different single users – have different requirements on the assessments, depending on the intended use of the results. Different requirements appear in terms of, for example biomass categories to be covered, time frame, geographical coverage, type of potential, etc.

To find out the range of different user requirements, a set of questions was defined to be used in interviews. The questionnaire was sent out to 180 persons. The total number of responds received was 84. Interviews were done by sending out the questionnaire and cover letter by e-mail, by telephone interviews or by face to face interviews. The questionnaire is attached to this report (Annex 2).

6.1 Respondents and use of assessments

The list of organisations participating in the questionnaire is given in Annex 3. Respondents come from several different types of organisations (figure 2). Some organisations fit into several categories, e.g. research and education. For this reason the total number in figure 2 is more than the number of responses. Results marked with an asterisk (*), also include the Croatian responses.

To find information on biomass assessments people use mostly their existing contacts, internet and literature, databases and professional publications. Most are mainly interested in national data and to lesser extent EU/European or global data. Only few mention regional, local or other smaller geographical coverage as the preferred one.

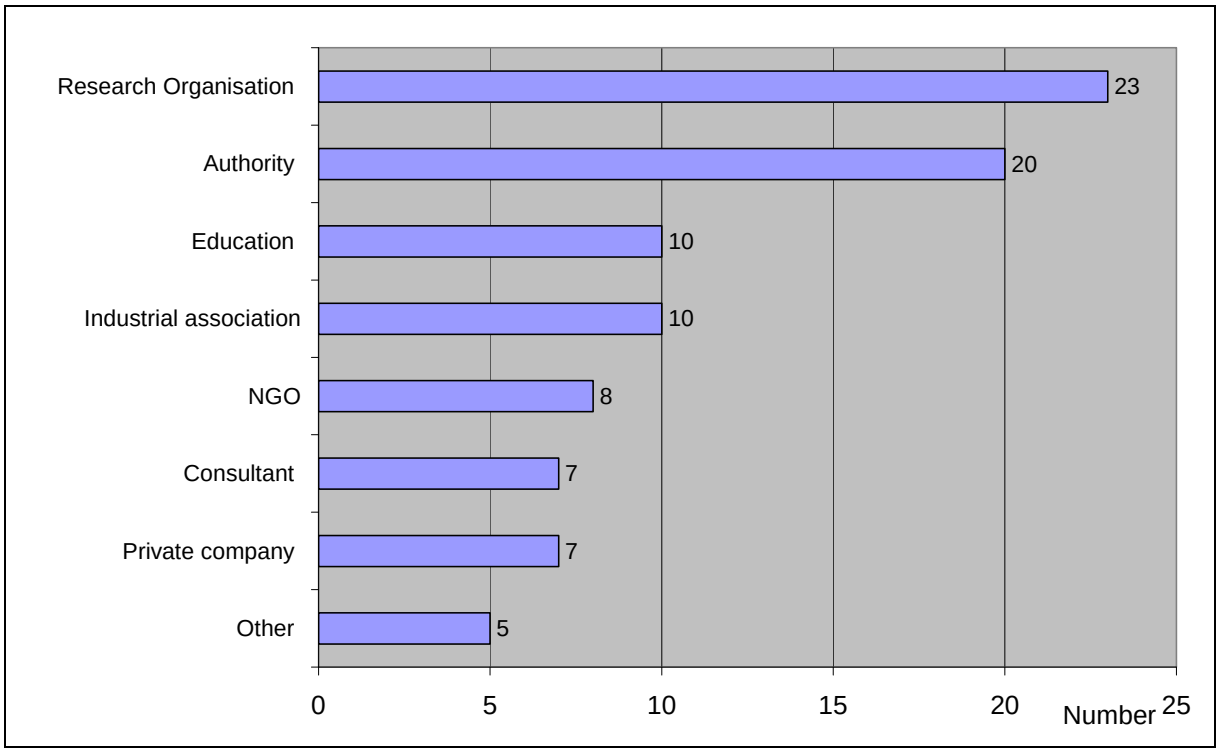

*Figure 2 Type of the organisation of the respondents. **

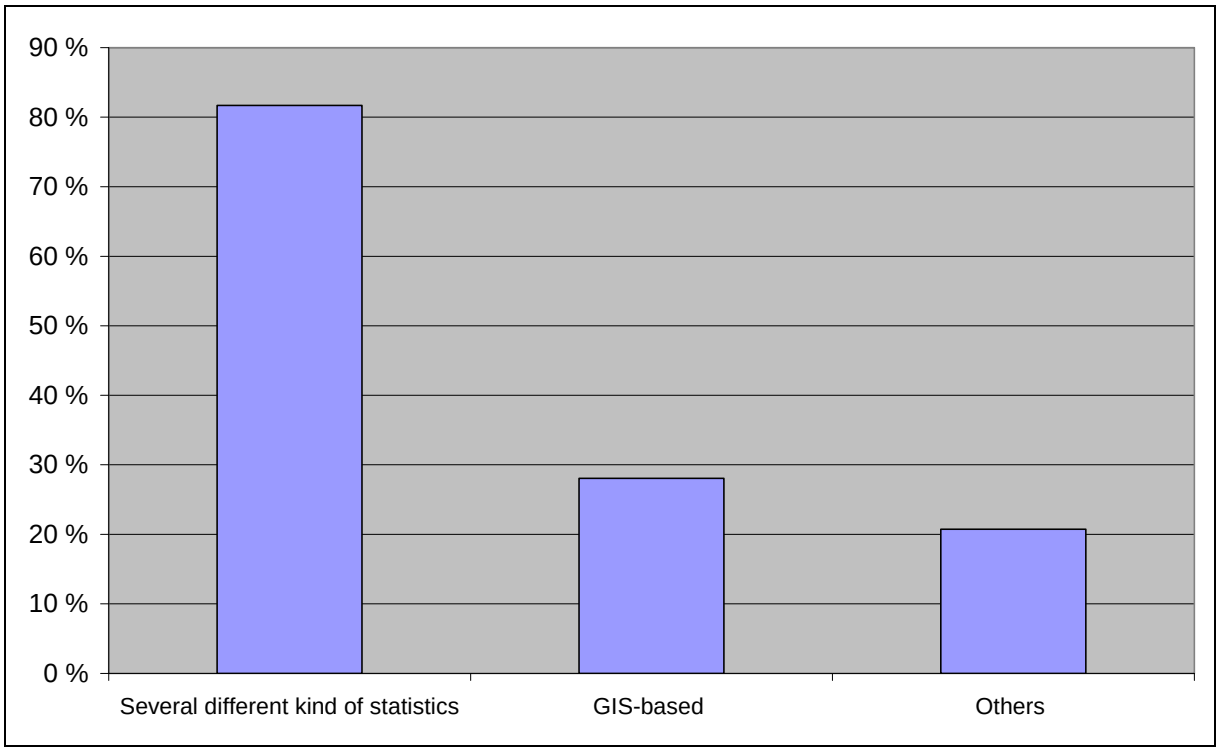

Figure 3 Type of biomass assessments used by the respondents.

Most respondents use different kinds of statistical assessments (figure 3). Biomass assessments are used for a very wide range of purposes (figure 4). For example, research organisations use the assessments as input to prepare more refined assessments in a specific area. It often means compiling data from several sources and collecting more information on areas which are not available in official statistics. Energy companies may need detailed information on biomass availability in a certain area. Consultants as well as research organisations and universities analyse data to prepare prognoses for future availability and use of raw material. Assessments are also used in decision making and for policy and strategic planning. In order to plan targets for the future, it is essential to have reliable information of the current situation. National statistical centres collect raw data from several sources to compile official statistics. These are only some examples of the data use.

The respondents named the organisations which prepare the biomass assessments they use. These organisations are listed in Annex 4. Most respondents name organisations that prepare assessments at the national level. FAO, UNECE, European Environmental Agency, AEBIOM, European Commission, Eurostat, IEA are mentioned as examples of international data sources.

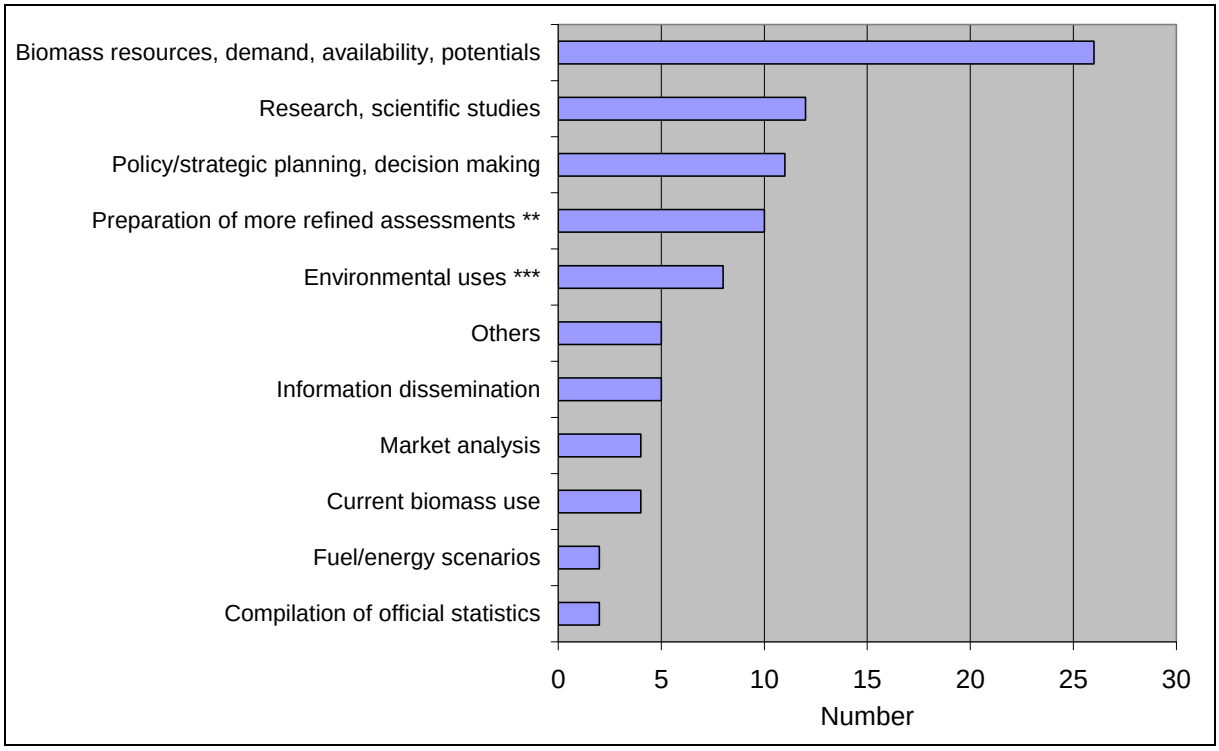

Figure 4 Use of the assessments.

** for own use, or for someone else
*** assessments for environmental protection, to assess sustainability and life cycle environmental impacts of biomass-based products, biodiversity assessments

6.2 Relevant biomass categories

Respondents were asked which biomass categories are relevant to them (figure 5). Most popular was the woody biomass category, about half of the respondents also need information on agrobiomasses and waste. Only 20 respondents are interested in all biomass categories in

general. It seems that there is more interest in acquiring detailed information on a particular category than general information on all biomass categories. Again, this is directly in connection to the purpose of use of the assessments.

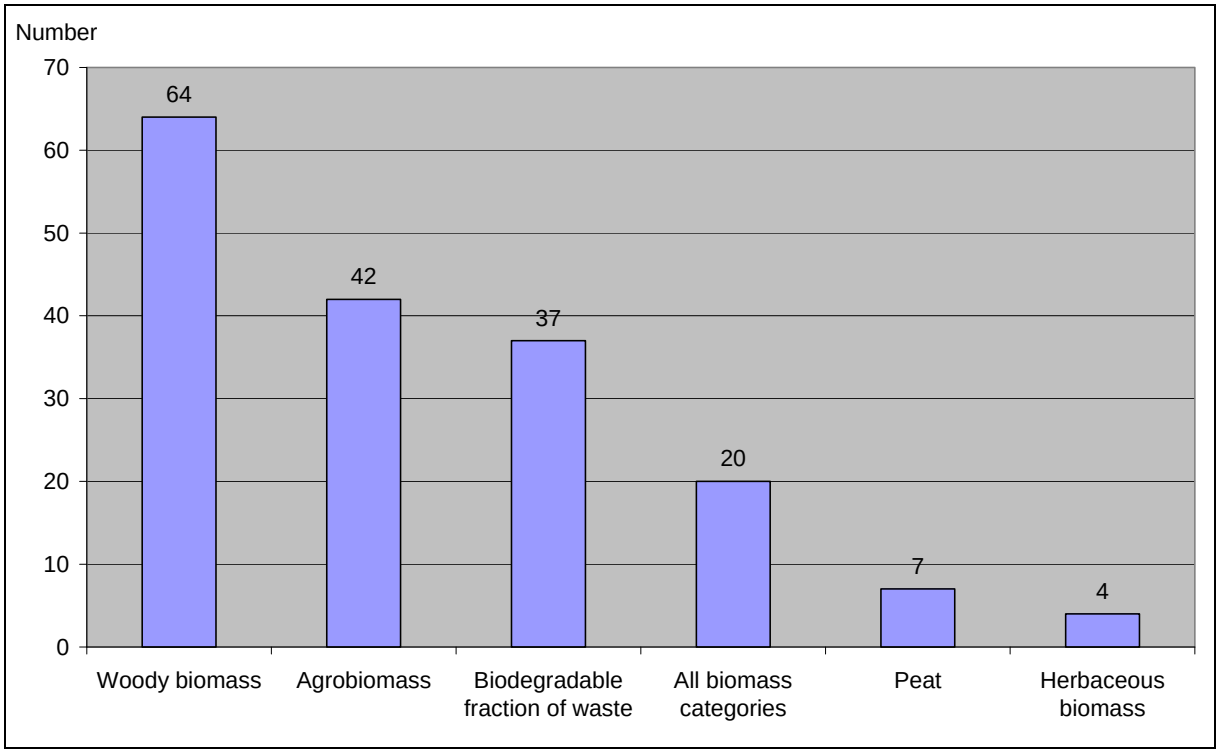

Figure 5 Relevant biomass categories.

In peat-rich countries peat is often referred as a "renewable energy carrier". According to the FAO definition 'biomass' means material of biological origin excluding material embedded in geological formations and transformed to fossil. Peat is not included in this definition. If in some countries peat is included in the biomass resources, in others not, this creates large discrepancy between the biomass assessments. Therefore, a question on the "renewable" status of peat was included in the questionnaire. The interviewees were asked if they consider peat as renewable fuel. As expected, respondents from those countries that actually use peat as fuel in energy production have a more clear opinion on this. It was mostly Finland and Sweden based organisations who answered either "yes", or "yes, slowly renewable".

Respondents were also asked to describe what level of detailed information they needed. This is, however, very subjective (i.e. what people consider to be detailed or very detailed). Most respondents say that they would need detailed information or as detailed as possible. Several respondents emphasize that since the biomass characteristics (e.g. saw dust and forest residue) are very different from one to another, it is important to have detailed data on the amounts of different sub-categories. For example, for a pellet producer the total amount of woody biomass is not very useful information.

6.3 Type of potential and data

Biomass assessments are calculated by using a certain potential (figure 6). Most typically used are theoretical, technical, economic, and sustainable potentials. It should be always clearly spelled out, which type of potential(s) the assessment covers. Many respondents explain that they find most potential types interesting and useful, but due to the focus of their work, they would prefer one to another. Several stress the importance of the "sustainable" potential and feel that the importance of it is growing. However, many also express their concern that this definition may be they most confusing and harmonization would be needed, the term "sustainable potential" should be used in a consistent way so that different assessment would be comparable. Several answered "techno-economic potential", which is counted under both "technical" and "economic". To improve comparability and to avoid misunderstandings it is recommendable to define which potential has been used and explain the limitations of the material.

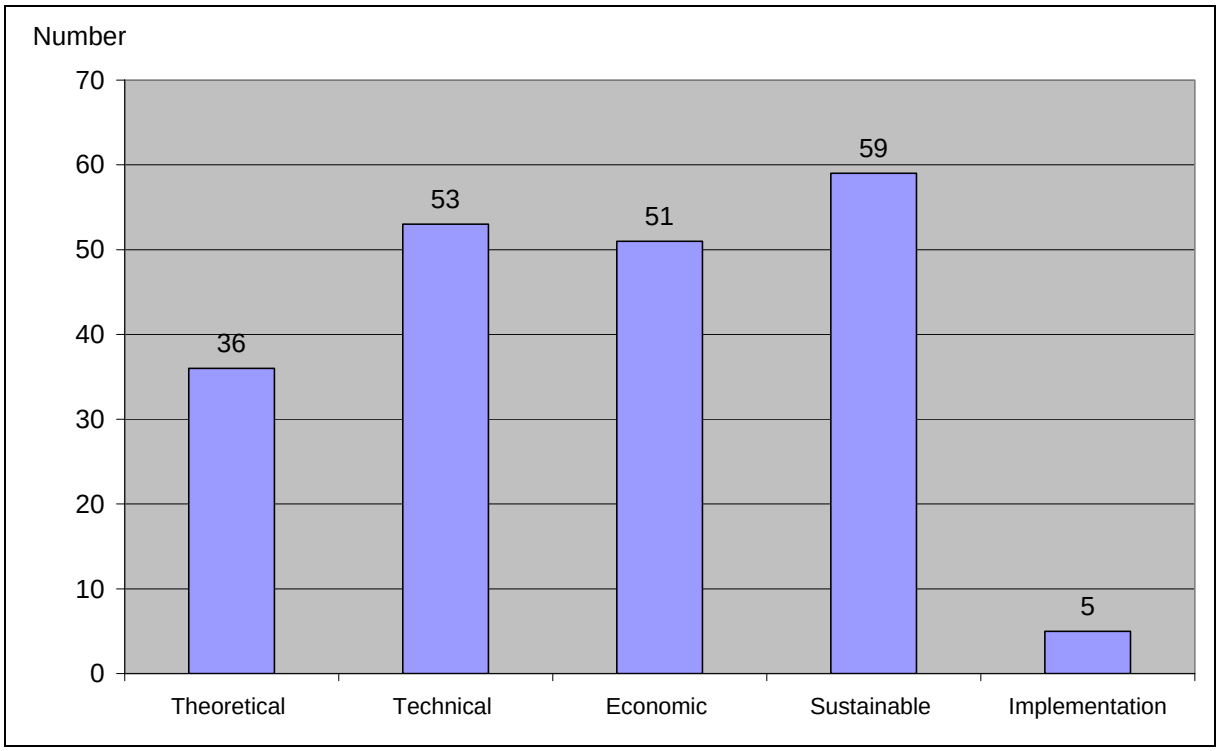

Figure 6 Type of potential needed.

6.4 Units for reporting of biomass potentials

As expected, energy specialists prefer to use energy units, whereas foresters rather use volumes. Some respondents claim that standardised, preferable SI-units should be used. Some comment that the unit is not very essential because when biomass characteristics are known well enough, it is easy to convert to any unit needed. However, this is not always the case. Characteristics of biomasses used at the national level are commonly known but it is not easy to find reliable information on biomass characteristics from other countries. It is not only the heating value of biomass that is of interest. In many cases the energy density of the fuel is a fairly important characteristic, for example to calculate the transport costs from the fuel production site to the power plant. As seen in figure 7, there is large variation in preferred

units for biomass potential reporting. From the user's point of view it would be beneficial to provide more than one unit per value. Or, if it is not possible, to provide conversion factors or an equation for conversion.

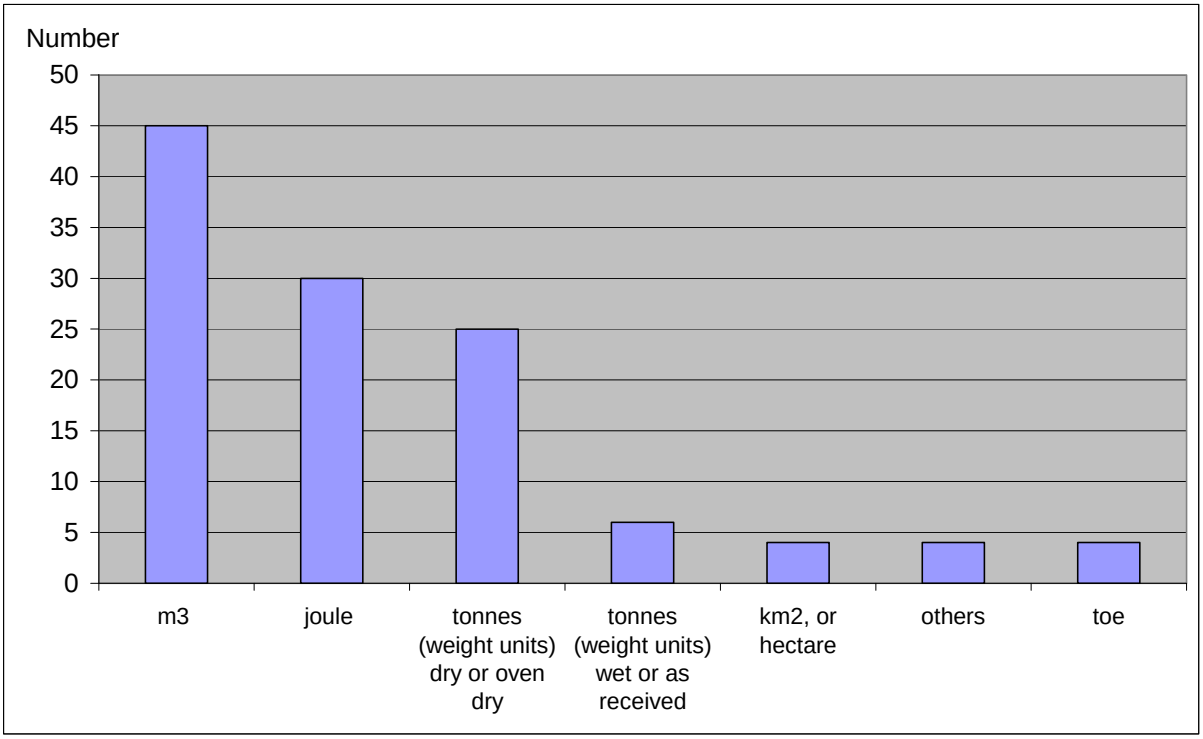

Figure 7 Preferred units for biomass potential estimations. Area units refer for example to area of forest or arable land.

6.5 Main deficiencies of the assessments and how to improve the biomass assessments

Only 28% of the respondents feel that they are happy with the assessments they currently use. 33% are partly satisfied but 39% not. 48% of the respondents say that the data is sufficiently up-to-date. Data should be updated once a year, or more often according to 44% of respondents. For 49% every 2-5 years is enough. Most of the respondents need assessments dealing with the current situation. However, most are interested in future estimates too. Thanks to the EU targets, the majority mention the estimates up to year 2020 as most relevant for them. Few would like to see the prognosis reaching up to 100-200 years from now. Respondents listed many deficiencies of the currently available assessments and had plenty of ideas on how to improve the assessments.

Main deficiencies identified were:

- Data quality and reliability.
- Assessments are too general.
- Lack of transparency and lack of harmonization. Not enough information on default values or definitions used. Assumptions, calculation methods and initial data are not

comparable/accurate. That means that it is not possible to compare data originating from different assessments.
- Lack of harmonization when it comes to biomass categories used.
- Used units are not consistent, or not commensurable, conversion factors not clear.
- There is not enough GIS based information available.

The proposed improvements are generally very much linked to the main deficiencies:
- Standardised terms and definitions of biomass categories would be very helpful.
- Communication and coordination between the main institutes preparing the assessments should be improved.
- Permanent network of biomass assessment specialists for data exchange and methodological improvement should be created.
- Base data and assumptions used for different assessments should be comparable.
- Sensitivity analysis should be done: how a change in the assumptions influences the results.
- More attention should be paid on using commensurable units in different assessments.
- SI units should be used.
- Clear guidelines for methodology should be provided.
- Systematic approach to quantify the constraints and impact of competition from other uses (forest residue) should be developed.
- Calculation methods should be harmonized.
- More information on biomass characteristics should be available.
- Better future projections on biomass trends are needed.
- All agricultural biomass sources should be covered in the assessments.
- Environmental and sustainability aspects should be better taken into account.
- More information on sustainability issues, related limitations and recommendations should be available.
- Scientific methodologies which take into account economic, social, environmental and sustainability aspects should be used.
- An “advisory board” of experts working on different aspects related to sustainability issues should be set up.
- Reporting systems should be improved, biomass users should be obligated to report.
- GIS-based information gathering should be improved.
- Terrestrial sample plot data could be supplemented by GIS-based real data.
- GIS methods should be more widely used.
- Comparability of the data in time series should be improved.
- Data should de updated on annual basis.
- As far as possible, reporting should develop towards internet based online statistics.
- More open exchange of information between different stakeholders should be encouraged.
- Support should be given to countries that need to develop their national reporting and statistics systems.

7 Summary and recommendations

In almost every country there already are some stated targets for increased production of renewable energies. After the transition period of the Renewable Energy Directive (2009/28/EC), i.e. by 5 December 2010, each Member State will have implemented the mandatory targets in their national legislation. However, the political framework to support the targets differs from country to country, ranging from strong financial incentives to no measures at all – or even political barriers. Policy measures, targets and choices have proven to be of vital importance for the success of bioenergy sector development. It should be ensured, that bioenergy is considered an integral part of energy, agriculture, forestry, waste and industrial policies. Such a holistic approach to biomass is much needed, to avoid future conflicting developments and to maximize the benefits of bioenergy deployment.

In different connections – EU directives, national legislation, EU and national policy and strategy papers, etc. – the term "biomass" has different meanings. This makes it difficult to get comparable results from different information sources. Possibly the most used definition can be found in the Renewable Energy Directive, which defines biomass as 'the biodegradable fraction of products, waste and residues from 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'. Several Member States employ definitions of their own. Definition for forestry biomass is similar in all countries, while most of the differences can be found in defining which fractions of wood waste, used wood, industrial and municipal waste are biomass. To enable comparable statistics and biomass resource assessments, more harmonisation is required.

Regarding the impact of the strategies, policies and support measures on biomass resource assessments, it can be concluded that their impact is not considerable – as long as the theoretical biomass potential is regarded. The technical biomass potential, on the other hand, is defined as the theoretical biomass potential limited by the demand for land for other purposes (e.g. food, feed and fibre production but also conservation areas) and based on an assumed level of technology. Political targets and measures may have some impact on the technical potential, but not decisive. However, as soon as economic profitability, social criteria or environmental constraints come into play, the resulting (sustainable) implementation potential is considerably affected by the political framework. Financial instruments, for example, can significantly increase economic profitability of certain biomass types or conversion technologies and thereby increase the (variable) economic biomass potential. As a consequence, biomass resource assessments displaying results for any other potential than the (constant) technical potential are hardly comparable. This is because they are often based on a huge range of scenarios concerning (future) policies, socio-economic parameters and the state of the environment.

During the latest few years, the tendency has been to introduce strategies and policies with larger scope than previously, when most targets were set sector-wise giving a chance to overlapping resource assessments and competition between alternative uses of the same resources. The Biomass Action Plan (see chapter 4.1.1), Renewable Energy Road Map (chapter 4.1.3) and SET-Plan (chapter 4.1.5) can be mentioned as examples of recent papers in which different uses of biomass resources (electricity, heating/cooling, transport) and their

interaction have been taken into account. In the future, the introduction of biorefineries may bring an additional aspect to be considered.

Another recent trend has been to widen the system boundaries of a bioenergy system under consideration in such a way that the sustainability issues can better be taken into account, including indirect impacts like indirect land use changes (iLUC). For example, the ambitious targets for transport biofuels have been questioned due to the fear of impacts on food security, as well as the loss of land with high biodiversity value as consequences of increased demand for biomass and the potentially higher willingness to pay of the biofuel industry as compared to food consumers in poor countries.

Reliable knowledge of the biomass potentials for energy in Europe is essential basic information needed for both policy and industry to achieve the challenging European policy targets in the renewable energy sector. In addition to policy makers and authorities at different levels (local, national, EU, etc.) and industrial investors, there are other potential users of biomass resource assessments, such as research organisations, NGOs, etc. Different user groups – and even different single users – have different requirements on the assessments, depending on the intended use of the results. Different requirements appear in terms of, for example biomass categories to be covered, time frame, geographical coverage, type of potential, etc.

Biomass resource potential assessments for energy for the same geographic entity differ largely from each other. The most significant reasons for the considerable variation in the results are:

- the heterogeneity of general methodological approaches used,
- the heterogeneity of datasets used,
- the heterogeneity of the methods used to identify the land potential for energy crop plantations,
- missing empirical data for certain aspects (e.g. conversion factors, waste fractions, yields),
- the heterogeneity of factors and assumptions used to consider the production and utilisation of biomass, e.g. sustainability, demand and competition with other sectors,
- the heterogeneity of approaches used for the integration of technological learning curves, both in the production sector of biomass and in biomass-to-energy conversion.

Biomass resource assessments are used for example when setting targets for different bioenergy sectors. There is a risk of unrealistic targets if they are based on over-optimistic resource assessments. On the other hand, the lowest estimations may provide too tight limits for the biomass availability, leading to unnecessarily conservative targets.

The importance of reliable resource assessments becomes even more apparent, when competing uses of biomass are taken into account. To avoid competing and overlapping targets, it is necessary to create cooperation between policy makers in different sectors. This is at least as important as it is to develop biomass resource assessment methods with well-defined assumptions, taking into account the different uses of land area and biomass resources. This way it would be possible to set ambitious but still achievable political targets which support each other instead of competing for the same resources.

The results of the study on user requirements show that the current Biomass Energy Europe project is definitely on the right track. The respondents have identified several aspects of biomass assessments, which need more attention so that the assessments would be more useful and reliable in the future. Respondents suggest, that the organisations preparing the assessment should increasingly work together to find better ways to harmonize the methodology and data sources used. This is the main focus of the BEE project.

In order to really harmonize the biomass resource assessments, clear guidelines are needed. Different assessments are comparable only if source data and methods are consistent. More transparency is needed. It is essential to clearly describe the basic assumptions, limitations, and methods used. Different users have different requirements and expectations for the assessments. When it comes to the units used, updating frequency, geographical coverage and level of detail, there are almost as many opinions as there are users. By providing sufficient information on how the assessment has been compiled, it is easier for users to decide if the assessments are appropriate for their needs. Users rely a lot on their existing contacts for finding the information they need. In order to provide more reliable, transparent biomass resource assessments, new kinds of co-operation between organisations preparing the assessments would help.

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Annex 1: The (Dutch) criteria, indicators and reportings of sustainably produced biomass at the company level

At the request of the Dutch government the project group 'Sustainable production of biomass' has been bringing together the different views on sustainable production (Sustainable Production of Biomass 2007). On this basis the project group has drawn up a framework for the testing of the sustainability of biomass production. The project group distinguished six relevant themes. For each theme, a set of principles, indicators and reportings for sustainably produced biomass was defined at the company level.

To find out to what extent the framework shows overlap with existing certification systems, a benchmark analysis was performed (Sustainable Production of Biomass 2007). The standards used most that have an overlap with the testing framework have been compared with this framework. This concerns the following standards:

- SAN/RA: Sustainable Agriculture Network / Rainforest Alliance
- RSPO: Roundtable on Sustainable Palm Oil (currently being developed, criteria have been defined)
- RTRS: Round Table on Responsible Soy (currently being developed, criteria have been defined)
- EurepGAP: Integrated Farm Assurance for Combinable Crops
- FSC: Forest Stewardship Council
- IFOAM: International Federation of Organic Agriculture Movements
- SA 8000: Social Accountability International

The most important results have been included in the following table. In the first instance the benchmark analysis has been performed at the indicator level and after this aggregated to criterion level.

Table 9 Results of the benchmark (Sustainable Production of Biomass 2007).

CRITERIA	SAN/ RA	RSPO	RTRS Basel	Eurep GAP	FSC	SA 8000	IFOAM
1. Greenhouse gas balance							
1a Net emission reduction compared with fossil reference, inclusive of application, is at least 30%.	N	N	N	N	N	N	N
2. Competition with food, local power supply, medicines and building material							
2a Insight into the availability of biomass for food, local energy supply, building materials or medicines.	N	N	N	N	N	N	N
3.1. Biodiversity: The installation of biomass production units will not be at the expense of protected or vulnerable biodiversity							
3.1a No deterioration due to biomass production of biodiversity in protected areas.	Y	Y	Y	N	Y	N	Y
3.1b No deterioration of biodiversity by biomass production in other areas with high biodiversity value or vulnerability.	Y	Y	Y	N	Y	N	N
3.1c No installation of biomass production units in regions where biodiversity has recently been decreased due to conversion.	N	Y	Y	N	Y	N	P
3.2. Biodiversity: The management of biomass production units will contribute towards the conservation or strengthening of biodiversity							
3.2a Concrete contribution towards the maintenance or recovery of biodiversity at or around biomass production units in natural.	P	N	P	P	Y	N	P
4. Prosperity							
4a Insight into possible negative effects on the regional and national economy.	P	P	P	N	P	N	N
5. Social well-being. No negative effects on the well-being of the employees and local population, taking into account:							
5a Working conditions of employees	Y	P	Y	P	P	Y	P
5b Human rights	Y	P	P	N	P	Y	P
5c Property rights and rights of use	P	Y	Y	N	Y	N	P
5d Insight into the social circumstances of local population	Y	Y	Y	N	Y	P	N
5e Integrity	N	N	N	N	N	N	N
6.1. Environment: In the production and processing of biomass, the soil, and the soil quality must be retained or even improved							
6.1a Best practices must be applied to retain or improve the soil and soil quality.	Y	Y	Y	P	P	N	Y
6.1b Crop residues are used for multiple purposes.	P	P	N	N	N	N	P
6.2. Environment: In the production and processing of biomass ground and surface water must not be depleted and the water quality must be maintained or improved							
6.2a Best practices must be applied to restrict the use of water and to retain or improve ground and surface water quality.	Y	Y	Y	P	P	N	P
6.2b No use must be made of water from non-renewable sources.	Y	Y	Y	P	N	N	Y
7. Legislation: Biomass production will take place in accordance with relevant national laws and regulations and international treaties							
7a No violation of national laws and regulations that are applicable to biomass production and the production area.	Y	Y	Y	Y	Y	Y	N
7b No infringement of relevant international treaties.	Y	Y	P	N	Y	Y	P

Y (coloured green): the criterion involved for sustainable biomass production is fully covered in the standard involved.
P (coloured yellow): the criterion involved is partially covered in the standard involved.
N (coloured red): the criterion involved as a whole is not addressed at all or that the formulation in the standard involved is insufficient to speak of a partial (P) score.

Table 10 Relevant themes, and defined set of principles, indicators and reportings for sustainably produced biomass.

THEME 1: GREENHOUSE GAS EMISSIONS	
Principle 1: The greenhouse gas balance of the production chain and application of the biomass must be positive	
Criterion 1.1: In the application of biomass a net emission reduction of greenhouse gases must take place along the whole chain. The reduction is calculated in relation to a reference situation with fossil fuels.	**Indicator 1.1.1 (minimum requirement)** The emission reduction of greenhouse gases amounts to at least 50 – 70% for electricity production and at least 30% for biofuels, calculated with the method described in the project report. These are minimum requirements. Here the basic principle must be that policy instruments should promote a higher percentage above the minimum requirement by differentiating strongly on the basis of the emission reduction of greenhouse gases.
Principle 2: Biomass production must not be at the expense of important carbon sinks in the vegetation and in the soil.	
Criterion 2.1: Conservation of above-ground (vegetation) carbon sinks when biomass units are installed.	**Indicator 2.1.1 (minimum requirement)** The installation of new biomass production units (BPUs) must not take place in areas in which the loss of above-ground carbon storage cannot be recovered within a period of ten years of biomass production. The reference date is 1 January 2007, with the exception of those biomass flows, for which a reference date already applies from other certification systems (currently under development).
Criterion 2.2: The conservation of underground (soil) carbon sinks when biomass units are installed.	**Indicator 2.2.1 (minimum requirement)** The installation of new biomass production units must not take place in areas with a great risk of significant carbon losses from the soil, such as certain grasslands, peat areas, mangroves and wet areas. The reference date is 1 January 2007, with the exception of those biomass flows for which a reference date already applies from other certification systems (currently under development).
THEME 2: COMPETITION WITH FOOD AND LOCAL APPLICATIONS OF BIOMASS	
Principle 3: The production of biomass for energy must not endanger the food supply and local biomass applications (energy supply, medicines, building materials).	
Criterion 3.1: Insight into the change of land use in the region of the biomass production unit.	**Reporting 3.1.1 (only at the request of the Dutch government)** Information on changed land use in the region, inclusive of future developments (if information is available).
Criterion 3.2: Insight into the change of prices of food and land in the area of the biomass production unit.	**Reporting 3.2.1 (only at the request of the Dutch government)** Information about changes in prices of land and food in the region, inclusive of future developments (if information is available).

THEME 3: BIODIVERSITY	
Principle 4: Biomass production must not affect protected or vulnerable biodiversity and will, where possible, have to strengthen biodiversity	
Criterion 4.1: No violation of national laws and regulations that are applicable to biomass production and the production area.	**Indicator 4.1.1 (minimum requirement)** Relevant national and local regulations must be complied with and in regard to: • Land ownership and land use rights; • Forest and plantation management and exploitation; • Protected areas; • Wildlife management; • Hunting; • Spatial planning; • National rules arising from the signing of international conventions CBD (Convention on Biological Diversity) and CITES (Convention on International Trade in Endangered Species).
Criterion 4.2: In new or recent developments, no deterioration of biodiversity by biomass production in protected areas.	**Indicator 4.2.1 (minimum requirement)** Biomass production must not take place in recently cultivated areas that have been recognized as 'gazetted protected areas' by the government, or in a 5 km zone around these areas. The reference date is 1 January 2007, with the exception of those biomass flows for which a reference date already applies from other certification systems (currently under development). If biomass production does take place in the above areas, then only if this is a part of the management to protect the biodiversity values.
Criterion 4.3: In new or recent developments, no deterioration of biodiversity in other areas with high biodiversity value, vulnerability or high agrarian, nature and/or cultural values.	**Indicator 4.3.1 (minimum requirement)** Biomass production must not take place in recently cultivated areas that have been recognized as 'High Conservation Value' (HCV) areas by the parties involved, or in a 5 km zone around these areas. The reference date is 1 January 2007, with the exception of those biomass flows for which a reference date already applies from other certification systems (currently under development). The following areas are considered HCV areas: • Areas with endangered or protected species or ecosystems; • Areas with high vulnerability (e.g. slopes and wetlands); • Areas with high nature and cultural values. By means of a dialogue with the local parties involved it must be determined where the HCV areas are to be found. If biomass production does take place in the above areas, then only if this is a part of the management to protect the biodiversity values.
Criterion 4.4: In new or recent developments, maintenance or recovery of biodiversity within biomass production units	**Indicator 4.4.1 (minimum requirement)** If biomass production is taking place in recently cultivated areas (after 1 January 2007), room will be given to set-aside areas (at least 10%).
	Reporting 4.4.2 If biomass production is taking place in recently cultivated areas (after 1 January 2007), it has to be indicated: • In which land use zones the biomass production unit can be found; • How fragmentation is discouraged; • If ecological corridors are applied; • If the restoration of degraded areas is involved here.
Criterion 4.5: Strengthening of biodiversity where this is possible, during development and by the management of existing production units.	**Reporting 4.5.1** Good practices will be applied on and around the biomass production unit for the strengthening of biodiversity, to take into account ecological corridors and to prevent disintegration as much as possible.

THEME 4: ENVIRONMENT	
Principle 5: In the production and processing of biomass, the soil, and soil quality must be retained or even improved.	
Criterion 5.1: No violation of national laws and regulations that are applicable to soil management.	**Indicator 5.1.1 (minimum requirement)** Relevant national and local regulations must be complied with, in respect to: • Waste management; • The use of agrochemicals (fertilizers and pesticides); • The mineral system; • The prevention of soil erosion; • Environmental impact reporting; • Company audits. At least the Stockholm convention (12 most harmful pesticides) must be complied with, also where national legislation is lacking.
Criterion 5.2: In the production and processing of biomass best practices must be applied to retain or improve the soil and soil quality.	**Reporting 5.2.1** The formulation and application of a strategy aimed at sustainable soil management for: • The prevention and control of erosion; • The conservation of nutrient balance; • The conservation of organic matter in the soil; • The prevention of soil salination.
Criterion 5.3: The use of residual products must not be at variance with other local functions for the conservation of the soil.	**Reporting 5.3.1** The use of agrarian residual products must not be at the expense of other essential functions for the maintenance of the soil and the soil quality (such as organic matter, mulch, straw for housing). The residual products of the biomass production and processing must be used optimally (so, for example, no unnecessary burning or removal).
Principle 6: In the production and processing of biomass ground and surface water must not be depleted and the water quality must be maintained or improved.	
Criterion 6.1: No violation of national laws and regulations that are applicable to water management.	**Indicator 6.1.1 (minimum requirement)** Relevant national and local laws and regulations must be observed, with respect to: • the use of water for irrigation; • the use of ground water; • the use of water for agrarian purposes in catchment areas; • water purification; • environmental impact assessments; • company audits.
Criterion 6.2: In the production and processing of biomass best practices must be applied to restrict the use of water and to retain or improve ground and surface water quality.	**Reporting 6.2.1** The formulation and application of a strategy aimed at sustainable water management with regard to: • Efficient use of water; • Responsible use of agrochemicals.
Criterion 6.3: In the production and processing of biomass no use must be made of water from non-renewable sources.	**Indicator 6.3.1 (minimum requirement)** Irrigation or water for the processing industry must not originate from non-renewable sources.
Principle 7: In the production and processing of biomass the air quality must be maintained or improved.	
Criterion 7.1: No violation of national laws and regulations that are applicable to emissions and air quality.	**Indicator 7.1.1 (minimum requirement)** Relevant national and local regulations must be observed with respect to: • air emissions; • waste management; • environmental impact assessments; • company audits.

Criterion 7.2: In the production and processing of biomass best practices must be applied to reduce emissions and air pollution.	**Reporting 7.2.1** The formulation and application of a strategy aimed at minimum air emissions, with regard to: • production and processing; • waste management.
Criterion 7.3: No burning as part of the installation or management of biomass production units (BPUs).	**Indicator 7.3.1 (minimum requirement)** Burning must not be applied in the installation or the management of biomass production units, unless in specific situations as described in ASEAN guidelines or other regional good practices.
THEME 5: PROSPERITY	
Principle 8: The production of biomass must contribute towards local prosperity.	
Criterion 8.1: Positive contribution of private company activities towards the local economy and activities.	**Reporting 8.1.1** Description of: • the direct economic value that is created; • policy, practice and the proportion of the budget spent on local supply companies; • the procedures for appointment of local staff and the share of local senior management. On the basis of Economic Performance Indicators EC 1, 6 & 7 of GRI (Global Reporting Initiative).
THEME 6: SOCIAL WELL-BEING	
Principle 9: The production of biomass must contribute towards the social well-being of the employees and the local population.	
Criterion 9.1: No negative effects on the working conditions of employees.	**Indicator 9.1.1 (minimum requirement)** Comply with the Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy (compiled by the International Labour Organisation).
Criterion 9.2: No negative effects on human rights.	**Indicator 9.2.1 (minimum requirement)** Comply with the Universal Declaration of Human Rights of the United Nations. It concerns: non-discrimination; freedom of trade union organisation; child labour; forced and compulsory labour; disciplinary practices; safety practices and the rights of indigenous peoples.
Criterion 9.3: The use of land must not lead to the violation of official property and use, and customary law without the free and prior consent of the sufficiently informed local population.	**Indicator 9.3.1 (minimum requirement)** Comply with the following requirements: • no land use without the informed consent of original users; • land use must be carefully described and officially laid down; • official property and use, and customary law of the indigenous population must be recognized and respected.
Criterion 9.4: Positive contribution to the well-being of local population.	**Reporting 9.4.1** • Description of programmes and practices to determine and manage the effects of company activities on the local population. On the basis of the Social Performance Indicator SO1 of the GRI (Global Reporting Initiative).
Criterion 9.5: Insight into possible violations of the integrity of the company.	**Reporting 9.5.1** Description of: • degree of training and risk analysis to prevent corruption; • actions taken in response to cases of corruption. On the basis of the Social Performance Indicators SO2, SO3 and SO 4 of the GRI (Global Reporting Initiative).

Annex 2: Questionnaire for user requirements

1. General questions
   - What kind of biomass assessments you use (statistical, GIS-based, etc.)?
   - By whom have they been prepared?
   - To what purposes are you using them?
   - How did you become aware of them and/or how did you find the data?

2. Biomass categories
   - What biomass categories are relevant for you?
   - How detailed do the categories need to be for you? (e.g. wood – agrobiomass – waste, or forest residues – forest industry by-products – construction and demolition wood)
   - Do you consider peat as a renewable energy source?

3. Time frame
   - Which time horizon are you interested in?

4. Geographical coverage
   - To best meet your needs, what should be the geographical coverage of the studies?
   - How detailed should geographical aggregates be to meet your needs? E.g. global – Europe – EU – regional (Baltic States, Nordic countries, Mediterranean countries, etc.) – national – sub-national (Central Finland, Bavaria, Catalonia, etc.) – municipality level…

5. Type of potential and data
   - Which type of potential (theoretical, technical, economic, 'sustainable') are you interested in?
   - Which units for reporting of biomass potentials do you prefer – solid cubic meters (m^3), oven dry ton (odt), joule (J), watt-hour (Wh), other (which)?

6. Quality of the current biomass assessments
   - Do the assessments you currently use, in general, meet your requirements?
   - What are the main deficiencies?
   - Is the data sufficiently up-to-date? How often should the assessments be updated?
   - How should they be improved?

Annex 3. List of organisations that participated in the "User requirements" questionnaire

- Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austria
- BOKU University of Natural Resources and Applied Life Sciences, Institute of Silviculture, Austria
- Doctoral School Sustainable Development, University of Applied Life Sciences BOKU, Vienna, Austria
- Kompetenzzentrum Holz GmbH, Austria
- Umweltbundesamt, Austria
- University of Natural Resources and Applied Life Sciences, Vienna, Austria
- University of Natural Resources and Applied Life Sciences, Vienna, Department of Economics and Social Sciences, Institute of Marketing & Innovation, Austria
- WWF Hungary, Austria
- Österreichische Bundesforste AG, Austria
- Croatian Forests Ltd, Croatia
- Environment Protection and Energy Efficiency Fund, Croatia
- Forest Extension Service, Croatia
- Forestry Institute, Croatia
- Ministry of Agriculture, Fisheries and Rural Development, Croatia
- Ministry of Economy, Labour and Enterpreneurship, Croatia
- Ministry of reginal development, Forestry and Water Management, Croatia
- North-West Croatia Regional Energy Agency, Croatia
- Woody biomass, Croatia
- Agrifood Research Finland, Finland
- Energy Market Authority, Finland
- Finland's environmental administration, Finland
- Finnish energy industries, Finland
- Finnish Environment Institute, Finland
- Finnish Forest Research Institute, Finland
- Metsäteho, Finland
- MTK, Union of agricultural producers and forest owners, Finland
- Pöyry Consulting, Finland
- Statistics Finland, Finland
- Tapio, Finland
- Technical Research Centre of Finland, Finland
- TEM, Ministry of Employment and the Economy/Energy Department, Finland
- Wenet/Josek Oy, Finland
- Dalkia / CCIAG (District Heating of Grenoble), France
- BLE- Bundesanstalt für Landwirtschaft und Ernährung (Federal Institute for Agriculture and Nutrition), Germany
- Bundesverband der deutschen Bioethanolwirtschaft BDBe, Germany
- Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany
- Federal Agency for Nature Conservation (Bundesamt für Naturschutz), Germany
- German Association for Landcare, Germany
- German Energy Agency (dena), Germany
- IUS Weibel & Ness GmbH, Germany
- Ministry for Food and Regional Development (Ministerium für

Ernährung und Ländlichen Raum), Germany
- Research Centre Karlsruhe, Institute for Technology Assessment and System Analysis, Germany
- Biomass Industrial Network, Japan
- JSC Latvijas valsts mezi, Latvia
- Meža un koksnes produktu pētniecības un attīstības institūts SIA (Forest and Wood Products Research and Development Institute), Latvia
- Balkan Foundation for Sustainable Development, Macedonia
- Macedonian Geothermal Association – MAGA, Skopje, Macedonia
- MZSV - Ruralen Razvoj (Ministry of Agriculture, Forestry and Water Supply – Dpt. Rural Development, Skopje), Macedonia
- MZSV - Sumarstvo (Ministry of Agriculture, Forestry and Water Supply –Dpt. Forestry, Skopje), Macedonia
- St. Kliment Ohridski University – Faculty of Technical Sciences, Bitola, Macedonia
- Sts Cyril & Methodius University – Faculty of Forestry, Skopje, Macedonia
- Sts Cyril & Methodius University – Faculty of Mechanical Engineering, Skopje, Macedonia
- TIMELPROEKT d.o.o., www.timel.com.mk, Macedonia
- Bioshape, The Netherlands
- ECN Energy research Centre of the Netherlands, The Netherlands
- Eneco New Energy, The Netherlands
- Stichting Natuur en Milieu, The Netherlands
- Forest Resources, Kookmin University, Seoul, Korea, South Korea
- E.ON Sverige AB, Sweden
- Jurdbruksverket, Swedish Board of Agriculture, Sweden
- Naturvårdsverket, Swedish Environmental Protection Agency, Sweden
- Skogsindustrierna, Swedish Forest Industries Federation, Sweden
- Sveaskog, Sweden
- Svebio, Sweden
- Swedish Energy Agency, Sweden
- Swedish Forest Agency, Sweden
- Svensk Fjärrvärme AB, Swedish District Heating Association, Sweden
- AEBIOM, International
- CEPF - Confederation of European Forest Owners, International
- EC Joint Research Center, Land Management and Natural Hazards Uni, International
- EC Joint Research Centre, International
- ETA Energieberatung GbR, International
- European Commission DG Agriculture, International
- European Panel Federation, International
- Oeko-Institut (Institute for applied ecology), International
- Russian Swedish Bio-Energy Information and Training Center, International
- UNECE/FAO Timber Section, International

Annex 4. Organisations preparing the biomass assessments (named by the respondents)

Number after the organisation means that if has been mentioned by more than one respondent.

- AEBIOM, 2
- Agricultural associations
- Agriculture administration Baden-Württemberg (Germany)
- Authorities
- BFW Austria
- Biomass associations
- Bioshape company (Netherlands)
- BOKU (Austria)
- C.A.R.M.E.N (Germany)
- Central Bureau of Statistics (Croatia)
- Central Research Institute of Electric Power Industry Japan - CRIEPI
- Consultants
- Consulting companies, 2
- Contracted out
- Croatian Forests ltd
- EC RTD
- Ecofys
- EEA
- EEA Project
- Energy agencies
- ETA
- Eubionet-project
- EuroHeat
- European Commission
- European Environment Agency, 4
- European institutions
- Eurostat, 4
- Faculty of Forestry (Croatia)
- FAO, 7
- Federal agencies or state agencies (Germany)
- Federal Agency of Forestry (Russia)
- Federal Ministry of Agriculture, Forestry, Water and Environment Austria, 2
- Finnish and foreign research institutes
- Finnish Forest Research Institute, 11
- Forest extension service (Croatia)
- Forest Public Enterprise (Macedonia), 3
- Forest Public Enterprise (Macedonia)
- Forest Public Enterprise Macedonia
- Forest Research Institute of Baden-Württemberg (Germany)
- Forestry associations
- Forestry Centres (The Finnish Regional Forestry network)
- Geological Survey of Finland
- Hungarian Academy of Sciences
- Hungarian Central Statistical Office
- Hungarian Environmental Ministry
- Hungarian Forestry Office
- IEA
- IFEU – Institute for Energy and Environment Research Heidelberg (Germany)
- IIASA
- Institute of Geodesy, Cartography and Remote Sensing (Hungary)
- ITAS – Institute for Technology Assessment and Systems Analysis (Germany)
- IUNC (International Union for the Protection of Nature)
- JRC, 2
- Kuopio University (Finland)
- Lesnichestvo (a forest management unit former Leskhoz)
- Metsäteho Oy (Finland)
- Ministries (e.g. environment or agriculture) (Germany)
- Ministries (Germany)

- Ministry of Agriculture (Sweden)
- Ministry of Agriculture and Forestry (Finland)
- Ministry of Natural Resources and Tourism (Tanzania)
- Municipal authorities
- National forest agency Austria
- National forest inventory of Finland
- National Forest Services in Europe and Asia
- National institutions (Russia)
- National statistics agency Austria
- Netherlands Environmental Assessment Agency
- Private companies
- Profu (consulting company Sweden)
- Provincial Sustainability Advisory Board (Germany)
- Public Utilities (Macedonia)
- Pöyry Energy consultant (Finland)
- Regional institutions (Germany)
- RENEW project
- Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)
- Research Centre KA Uni Hohenheim (Germany)
- Research institutes, 4
- SCB Statistics Sweden, 2
- Scientific advisory council of governments SRU (Germany)
- Scientific advisory council of Ministries BMELV (Germany)
- Self, 5
- State agencies (Germany)
- State Statistic Office Macedonia, 5
- State Statistics Office (Macedonia)
- Statistic authorities Latvia
- Statistical Agencies
- Statistical center of Ministry of Agriculture and forestry (Finland)
- Statistics Finland, 4
- Statistics services (Russia)
- Statistics Sweden
- Svebio
- Swedish Board of Agriculture, 2
- Swedish District Heating Association
- Swedish Energy Agency, 3
- Swedish Environmental Protection Agency
- Swedish Forest Agency (SFA), 5
- Swedish University of Agricultural Sciences (SLU)
- Tapio (Finland)
- The Board of Customs (Finland)
- The Finnish Forest Industries
- The Swedish University of Agricultural Sciences
- Umweltbundesamt - Dept. of Biodiversity and Nature Conservation (Austria)
- UNECE, 3
- Universities, 2
- Universities and statistic offices
- University of Hohenheim
- UNO
- Utrecht University
- Wood processing industry and logging companies
- Working Group on renewable statistics (AGEE Stat)
- VTT (Finland)

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