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Final report

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1. Task 1: Review of GREEN-X assumptions on biomass availability and costs

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The key objective of Task 1 is to validate the present and future availability (up to 2020) and costs of biomass energy in the EU 27. In the Renewable Energy Road Map Impact Assessment (Road Map IA)[1] it was estimated that around 195 Mtoe biomass will be consumed in primary energy to meet the 20% renewable energy target in 2020. The estimations were largely based on GREEN-X modelling[2].

The focus is thereby on the following issues:
- *The import of forest biomass.* The goal is to check if the assumption on ex-EU imports of forestry material is realistic.
- *The import of biofuels for transportation.* In the Renewable Energy Road Map Impact Assessment it is assumed that 30% of domestic biofuels production is imported. This again seems to be a conservative estimate, since sugar cane ethanol is expected to remain the least-cost biofuels on the mid-term. Import tariffs are probably a crucial factor here.
- *The costs and potentials of biomass.* The present and future availability (up to 2020) and costs of biomass energy in the EU 27 as presented in the Renewable Energy Road Map Impact Assessment are compared with estimates from the literature.
- *The prospects for biomass availability in the EU 27 beyond 2020 towards 2050.* The trend in the availability of biomass in the EU 27 between 2020 and 2050 is evaluated based on existing studies.
- *The prospects for biomass availability from import towards 2050.* A comparison is made of the global availability of and demand for biomass for energy in the coming decades to indicate the availability of biomass for export to the EU.

1.1 The Renewable Energy Road Map Impact Assessment and GREEN-X

The data about the availability and costs of biomass that are presented in the Renewable Energy Road Map Impact Assessment are derived from the GREEN-X model. The GREEN-X model forecasts the deployment of renewable energy systems under various scenarios in terms of supporting policy instruments, the availability of resources and generation technologies and energy, technology and resource price developments. The Green-X model matches demand and supply of energy sources. The demand is based on the EU energy outlook. The supply is described by means of a cost-resource curve build up in two parts:
- *A static cost-resource curve* that describes the relationship between available technical potentials and the corresponding costs of utilising this potential.
- *A dynamic cost-resource curve*, which is based on the static cost-resource curve but incorporates such dynamic parameters as technological change (using the concept of experience curves or expert judgment) and the dynamic barriers to implementation, determining the yearly available RES potential. The dynamic curve is endogenous to the model and is determined annually.

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1 SEC(2006)1719.

2 The Green-X model was originally developed under Microsoft Windows by EEG in the EC-funded project (5th FWP - DG Research, Contract No: ENG2-CT-2002-00607) http://www.green-x.at.

The Green-X model calculations are complemented by simulations from the GreenNet model (GreenNet, 2009) that determines the additional costs for system operation and grid extension resulting from variable RES-E. Besides the detailed depiction of RES deployment and cost the model also allows to briefly investigate the impact of applying different energy policy instruments (e.g. quota obligations based on tradable green certificates, feed-in tariffs, tax incentives, investment subsidies) at country or at the European level.

In this report, results for the Accelerated Deployment Policies (ADP) scenario[3] are used. This scenario assumes that the European RES policy framework will be improved with respect to its efficiency and effectiveness. These changes will become effective by 2011 in order to meet the agreed target of 20% RES by 2020. Improvements refer to both the financial support conditions (if necessary) as well as to non-financial barriers (i.e. administrative deficiencies etc.) where a rapid removal is also preconditioned. In the default "policy" case ADP scenario, which is used in this report, an improvement of RES support incentives for all EU member states is assumed. The further fine-tuning of national support schemes involves in case of both feed-in tariff and quota systems a technology-specification of RES support. The fulfilment of the target of 20% RES by 2020 is preconditioned at EU level as well as at national level. For the case that a Member State (MS) would not possess sufficient potentials, MS based trade (i.e. where MS posses the possibility to transfer their surplus to other MS) would serve as complementary option to fulfil given 2020 RES objectives.

The results of the GREEN-X model, for the default "policy" case Accelerated Deployment Policies (ADP) scenario are shown in Table 1.1.

[3] As presented in the EMPLOY-RES study available at: http://ec.europa.eu/energy/renewables/studies/doc/renewables/2009_employ_res_report.pdf.

Table 1.1 *The use and costs of biomass for energy production in the EU 27 in 2010, 2020 and 2030*

Solid biomass - Primary potentials & corresponding fuel cost	Potentials (in terms of primary energy)											
	2005	2010	2015	2020	2005	2010	2015	2020	2005	2010	2015	2020
	GWh	GWh	GWh	GWh	Mtoe	Mtoe	Mtoe	Mtoe	PJ	PJ	PJ	PJ
AP1 - rape & sunflower	76.617	77.395	79.315	81.235	6,6	6,7	6,8	7,0	275,8	278,6	285,5	292,4
AP2 - maize, wheat (corn)	144.087	145.543	162.769	179.996	12,4	12,5	14,0	15,5	518,7	524,0	586,0	648,0
AP3 - maize, wheat (whole plant)	0	51.905	138.395	207.593	0,0	4,5	11,9	17,8	0,0	186,9	498,2	747,3
AP4 - SRC willow..	19.860	33.410	56.004	74.076	1,7	2,9	4,8	6,4	71,5	120,3	201,6	266,7
AP5 - miscanthus	18.246	29.419	48.034	62.943	1,6	2,5	4,1	5,4	65,7	105,9	172,9	226,6
AP6 - switch grass	31.365	56.111	97.333	130.318	2,7	4,8	8,4	11,2	112,9	202,0	350,4	469,1
AP7 - sweet sorghum	14.633	23.449	33.871	43.490	1,3	2,0	2,9	3,7	52,7	84,4	121,9	156,6
AR1 - straw	193.610	227.796	268.059	315.416	16,6	19,6	23,0	27,1	697,0	820,1	965,0	1.135,5
AR2 - other agricultural residues	20.452	24.061	28.307	33.302	1,8	2,1	2,4	2,9	73,6	86,6	101,9	119,9
FP1 - forestry products (current use (wood chips, log wood))	569.356	569.356	569.356	569.356	49,0	49,0	49,0	49,0	2.049,7	2.049,7	2.049,7	2.049,7
FP2 - forestry products (complementary fellings (moderate))	40.735	54.313	72.417	96.556	3,5	4,7	6,2	8,3	146,6	195,5	260,7	347,6
FP3 - forestry products (complementary fellings (expensive))	61.102	81.469	108.626	144.834	5,3	7,0	9,3	12,5	220,0	293,3	391,1	521,4
FR1 - black liquor	119.396	125.471	131.856	138.566	10,3	10,8	11,3	11,9	429,8	451,7	474,7	498,8
FR2 - forestry residues (current use)	98.024	98.024	98.024	98.024	8,4	8,4	8,4	8,4	352,9	352,9	352,9	352,9
FR3 - forestry residues (additional)	22.169	23.336	24.564	25.857	1,9	2,0	2,1	2,2	79,8	84,0	88,4	93,1
FR4 - demolition wood, industrial residues	83.516	87.782	92.375	97.195	7,2	7,5	7,9	8,4	300,7	316,0	332,5	349,9
FR5 - additional wood processing residues (sawmill, bark)	48.679	51.160	53.768	56.508	4,2	4,4	4,6	4,9	175,2	184,2	193,6	203,4
FR6 - forestry imports from abroad	29.740	44.410	66.951	101.429	2,6	3,8	5,8	8,7	107,1	159,9	241,0	365,1
BW1 - biodegradable fraction of municipal waste	149.056	165.813	185.303	207.815	12,8	14,3	15,9	17,9	536,6	596,9	667,1	748,1
Agricultural products	304.809	417.233	615.722	779.650	26,2	35,9	52,9	67,0	1.097,3	1.502,0	2.216,6	2.806,7
Agricultural residues	214.061	251.857	296.366	348.718	18,4	21,7	25,5	30,0	770,6	906,7	1.066,9	1.255,4
Forestry products	671.192	705.138	750.399	810.746	57,7	60,6	64,5	69,7	2.416,3	2.538,5	2.701,4	2.918,7
Forestry residues	371.784	385.773	400.587	416.150	32,0	33,2	34,4	35,8	1.338,4	1.388,8	1.442,1	1.498,1
Biodegradable waste	149.056	165.813	185.303	207.815	12,8	14,3	15,9	17,9	536,6	596,9	667,1	748,1
Forestry imports	29.740	44.410	66.951	101.429	2,6	3,8	5,8	8,7	107,1	159,9	241,0	365,1
Solid biomass - TOTAL	1.740.644	1.970.224	2.315.327	2.664.508	149,7	169,4	199,1	229,1	6.266,3	7.092,8	8.335,2	9.592,2

Solid biomass - Primary potentials & corresponding fuel cost	Fuel cost (minimum)				Fuel cost (maximum)				Fuel cost (weigthed average)			
	2005	2010	2015	2020	2005	2010	2015	2020	2005	2010	2015	2020
	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p	€/MWh-p
AP1 - rape & sunflower	32,3	40,3	44,2	48,0	40,4	50,3	55,2	59,9	36,8	45,8	50,1	54,3
AP2 - maize, wheat (corn)	26,6	33,1	36,4	39,5	33,2	41,3	45,4	49,2	27,3	33,9	37,2	40,3
AP3 - maize, wheat (whole plant)	29,8	37,1	40,7	44,2	29,8	37,1	40,7	44,2	0,0	34,6	38,0	41,2
AP4 - SRC willow..	27,4	34,1	37,4	40,6	32,9	41,0	45,0	48,8	21,0	28,2	32,3	35,5
AP5 - miscanthus	27,1	33,7	37,0	40,2	34,1	42,5	46,6	50,6	19,4	27,9	33,2	37,1
AP6 - switch grass	17,9	22,3	24,4	26,5	31,9	39,7	43,5	47,3	16,3	24,7	29,7	33,2
AP7 - sweet sorghum	31,0	38,6	42,4	46,0	40,9	51,0	55,9	60,7	40,9	51,0	55,9	60,7
AR1 - straw	12,2	14,9	16,2	17,5	14,7	18,0	19,6	21,1	12,4	15,2	16,5	17,9
AR2 - other agricultural residues	12,2	14,9	16,2	17,5	14,7	18,0	19,6	21,1	12,7	15,6	17,0	18,3
FP1 - forestry products (current use (wood chips, log wood))	17,8	20,7	22,1	23,4	22,3	25,9	27,7	29,3	18,6	21,6	23,0	24,4
FP2 - forestry products (complementary fellings (moderate))	19,1	22,2	23,7	25,1	23,8	27,7	29,6	31,3	21,0	24,4	26,0	27,6
FP3 - forestry products (complementary fellings (expensive))	25,8	30,1	32,1	34,0	32,3	37,6	40,1	42,4	28,4	33,1	35,3	37,3
FR1 - black liquor	5,6	6,6	7,0	7,4	7,7	9,0	9,6	10,1	6,1	7,1	7,6	8,0
FR2 - forestry residues (current use)	6,3	7,3	7,8	8,2	8,6	10,0	10,6	11,2	7,2	8,3	8,9	9,4
FR3 - forestry residues (additional)	12,5	14,6	15,5	16,4	17,1	19,9	21,2	22,5	12,9	15,0	16,0	16,9
FR4 - demolition wood, industrial residues	5,0	5,7	6,1	6,4	6,8	7,8	8,3	8,7	5,6	6,4	6,7	7,1
FR5 - additional wood processing residues (sawmill, bark)	6,3	7,2	7,6	8,0	8,6	9,8	10,4	10,9	6,7	7,7	8,1	8,6
FR6 - forestry imports from abroad	16,0	20,2	22,4	24,4	16,8	21,3	23,5	25,7	16,6	21,1	23,3	25,5
BW1 - biodegradable fraction of municipal waste	-3,8	-4,4	-4,7	-4,9	-3,8	-4,4	-4,7	-4,9	-3,7	-4,3	-4,5	-4,7
Agricultural products	17,9	22,3	24,4	26,5	40,9	51,0	55,9	60,7	28,3	35,1	38,1	41,3
Agricultural residues	12,2	14,9	16,2	17,5	14,7	18,0	19,6	21,1	12,4	15,2	16,6	17,9
Forestry products	17,8	20,7	22,1	23,4	32,3	37,6	40,1	42,4	19,6	23,1	25,1	27,1
Forestry residues	5,0	5,7	6,1	6,4	17,1	19,9	21,2	22,5	6,7	7,8	8,3	8,8
Biodegradable waste	-3,8	-4,4	-4,7	-4,9	-3,8	-4,4	-4,7	-4,9	-3,7	-4,3	-4,5	-4,7
Forestry imports	16,0	20,2	22,4	24,4	16,8	21,3	23,5	25,7	16,6	21,1	23,3	25,5
Solid biomass - TOTAL	-3,8	-4,4	-4,7	-4,9	40,9	51,0	55,9	60,7	15,5	19,3	22,1	24,6

Source: GREEN-X.

1.2 Selection of studies

First, a list of circa 50 potentially useful biomass energy potential analysis of the EU is compiled. This list is shown in Annex I. Second, a selection is made of studies that are subjected to a detailed analysis and comparison with the results of the GREEN-X study. This selection is based on the following criteria:

- *The level of advancement.* The selected studies include the current state-of-the-art of biomass energy assessments.
- *The geographic scope.* The focus in the Renewable Energy Road Map Impact Assessment is on the EU 27. Therefore only studies that focus on the EU 27 or on a comparable geographic scope (e.g. EU 25) are included.
- *The time horizon.* The assessments that are selected all include projections of the biomass energy potential. Priority is thereby given to studies that include results up to 2030, which is the time horizon in GREEN-X.
- *The type of potential.* The GREEN-X study includes detailed results for the actual production, import and use of biomass energy in the EU 27, i.e. the implementation-economic potential. Studies that focus on the theoretical-technical potential to produce biomass for energy production are excluded from detailed analysis and comparison.
- *The age of the assessments.* Several assessments were left out, because they were considered to be outdated or have been replaced by a new study of the same author or team of authors.
- *The sustainability aspects* that are included. Studies that specifically analyse the potential of biomass energy taking into account environmental criteria are selected. Environmental criteria and related EU policies, such as the projected increase of organic agriculture, can result in a decrease of the productivity and thereby limit the amount of surplus land that can be used for energy crop production. However, it should be noted that such criteria are often not well defined. Most studies limit the potential taking into account certain aspects or limitations that implicitly limit or reduce the environmental impacts. Within the European context social criteria are generally not perceived as a bottleneck for the domestic production, especially considering the favourabel employment effects of biomass energy feedstock production. Social criteria are therefore not further investigated. The economic sustainability (costs) of biomass energy is a crucial aspect of this study.
- *The level of detail of the analysis.* In GREEN-X detailed results for the potential and costs are shown for various feedstocks. Therefore only studies that include results at a similar level of detail are included.

In addition, the GREEN-X results and the results of the selected studies are also compared with the aggregated results of studies that investigate the theoretical-technical potential of biomass energy production. Typically, the theoretical-technical potential is larger than the implementation-economic potential, although this depends on the assumptions on agricultural policies and the growth of the population and income (demand for food and materials).

The five issues identified above are further investigated below, where it is specified which studies in particular were used for assessing biomass availability and costs.

1.3 Imports of forestry material

In this section the import of forestry biomass for the production of energy as projected by the GREEN-X model (see line FR 6 in Table 1.1) is compared with projections from the literature.

According to the GREEN-X model the total import of forestry biomass from abroad was 2.6 Mtoe in 2005. The import is projected to increase to 3.8 and 8.7 Mtoe primary energy in 2010 and 2020, respectively. The price of the imported biomass is projected to increase from 4.6 euro per GJ in 2005, to 5.9 and 7.1 euro per GJ in 2010 and 2020, respectively.

These results are compared with data from the study “Environmentally compatible bio-energy potential from European forests” of the European Environmental Agency (EEA, 2007a). In the EEA study the potential of biomass energy from forests to 2030 is evaluated taking into account environmental criteria as well as the demand of biomass from industrial users. Further, based on the environmentally compatible resource potentials, some economic analysis are carried out with the forest sector model EFI-GTM (Kallio *et al.*, 2004). As a partial-equilibrium market model, EFI-GTM calculates the supply of biomass from, among others, the import of wood, for different price levels. The results are shown in the figure below.

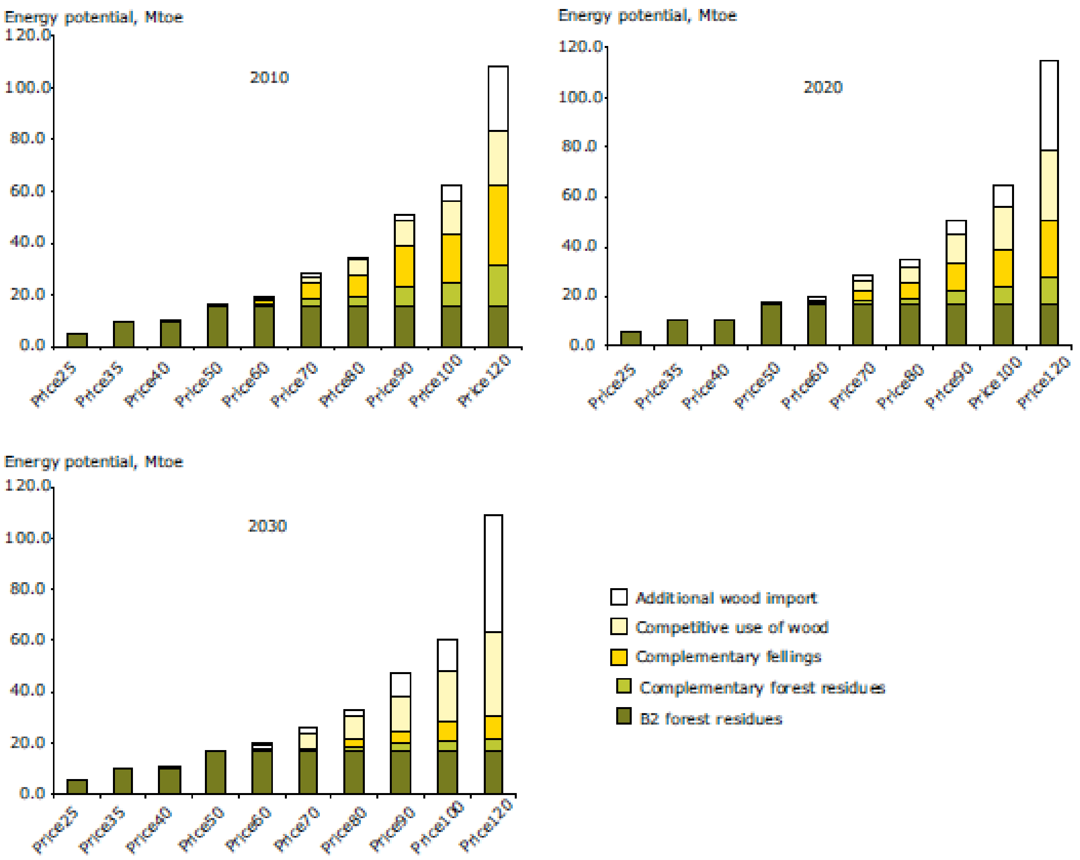

Figure 1.1 *The costs and supply of biomass from different sources in 2010-2030 - total energy potential (Mtoe) in EU-25. The cost for forest residues (euro per m^3 at the mill gate) is calculated from extraction costs. Data for complementary fellings and other sources of wood chips are derived from the forest sector model EFI-GTM. 1 euro per m^3 equals approximately 4.8 euro per 1 toe of energy potential.*
Source: (EEA, 2007a).

The category ‘complementary fellings’ includes stemwood biomass from both thinnings and final harvests. The present harvest levels in Europe use less than the sustainable wood harvest potential, so it would be possible to use complementary fellings to increase the supply of bio-energy from forest biomass. The term ‘competitive use of wood’ refers to the use of wood which would otherwise be used for other purposes than energy. At high(er) prices, especially the use of domestically produced biomas in the pulp and paper industry decreases, which results in an increase of the import of cheap(er) feedstocks.

Figure 1.1 shows that an increasing market price for biomass would lead to a strong increase in both the wood chip supply from complementary fellings as well as wood imports. Complementary felling could be an important source of wood for bio-energy in the short term (around 2010), while utilisation of forest resource potential is still not very high. However, the forest resource utilisation is projected to increase and this limits the biomass potential.The results also show that the import of wood is only attractive when the price of wood chips is 60 euro per m^3 or higher, which is equal to 6.9 euro per GJ. According to the GREEN-X results, this price level will only be realised shortly before the year 2020. In 2020 the price is estimated at 7.1 euro per GJ. At this price level, the import of forest biomass in 2020 is estimated at 3.0 Mtoe according to Figure 1.1 (estimated from graph). So the import is slightly lower than the import of forestry biomass of 2.6, 3.8 and 8.7 Mtoe in 2005, 2010 and 2020, respectively, which is projected by the GREEN-X model. However, the results are consistent as the use of forest biomass from imports is limited in both studies when compared to the domestic production. The differences might partially be explained by differences in the definitions. The EEA data include the costs of chipping and transport. It is not exactly defined what costs are included in the GREEN-X. Wood accounts only for one-third of the total costs (excluding VAT) (Nemestothy, 2009). Yet, researchers from the Joint Research Centre of the European Commission (JRC) indicate that the costs of domestically produced wood could be underestimated (see further Section 1.6). Consequently, the share of imports of forestry material would be higher (E. Kottasz, pers. comm.).

These results are also in line with other projections of the production and use of wood for industrial purposes (UNECE and FAO, 2005). According to this study, the net import of wood to the EU is projected increase during the coming decades, mainly from the Commonwealth of Independent States (CIS). And also the price of wood imports is projected to increase slightly: +0.5% per year between 2000 and 2020. However, the net import of wood to the EU remains limited compared to the domestic supply of wood.

1.4 Imports of biofuels for transportation

The purpose is to validate whether the assumption on imports of biofuels for transportation that are used in GREEN-X is realistic. This assumption is that biofuels imports are equivalent to the size of 30% of domestic biofuels production.

Imports depend on projected global availability of biomass for biofuels, reviewed in Section 1.9. Equally important is the competition between domestic production and imports. Estimates suggest that biofuels produced in the EU are competitive without subsidies at a price of oil of roughly 80 dollars a barrel (Bamiere *et al.*, 2008). This figure seems a reasonable order of magnitude, even if the range of results that brackets this central result is broad. The same studies find that Brazilian ethanol is competitive with the gasoline as soon as the price of a barrel of oil prices exceeds 30 dollars. For diesel produced from palm oil the break even price is 50 dollars. It is expected that biofuels will become competitive with a barrel of oil at 60-70 dollars in the coming years, and second generation biofuels might drive costs of production further down after 2020. However, the cost of production of biofuels is not constant, and the interactions with the food market must be taken into account. The valorization of co-products (rapeseed cake and glycerine in the case of biodiesel) will go down with larger quantities of biodiesel produced, and this will result in a higher break even point for the latter.

Based on these observations it can be concluded that the production of first-generation biofuels is much cheaper in developing regions compared to the EU. However, the price of first-generation biofuels will likely not go below the price of conventional gasoline and diesel. If the price of first-generation biofuels decreases to a level that is similar or lower then the price of conventional gasoline and diesel, than the demand for and production of biofuels will increase rapidly up to a point where the price will be the same as the price of conventional gasoline and diesel. It should be noted that first-generation bioethanol and biodiesel fuels can be used directly as substitutes for conventional gasoline and diesel, so the use of biofuels can be changed relatively quickly.

Crucial for the trade of liquid biofuels are also the import tariffs. It goes beyond the scope of this analysis to investigate scenarios for the combined impact of these aspects. Yet, it can be concluded that these aspects are crucial, but highly uncertain, determinants of the import of first-generation biofuels. Also the implementation of sustainability standards and technical standards can become a bottleneck for the import of biofuels to the EU.

Yet, one study was found that included detailed projections of the consumption of biodiesel and ethanol to the year 2010 (ICTSD, 2009), which are based on the projections of the United States Department of Agriculture (USDA, 2008). These results show that the import of biodiesel and bioethanol will rapidly increase, but that the total imports of biodiesel and bioethanol are equivalent to 20% and 53%, respectively, in the year 2010. The cause of these differences could not be established. These data suggest that the assumption in GREEN-X that biofuels imports are equivalent to the size of 30% of domestic biofuels production is realistic, although there seems to be a considerable uncertainty attached to this estimate, and projections for 2020 could not be found.

Table 1.2 *EU-27 biodiesel production, imports and consumption (1000 tonnes), and percentage share of diesel market.*

Source	2006	2007 e	2008 e	2009 f	2010 f
Rapeseed oil	3150	3550	3700	4900	5650
Soybean oil	800	900	900	1000	1200
Palm oil	150	400	400	420	450
Sunflower	180	220	300	420	450
Other and not attributed	110	110	100	100	160
Subtotal vegetable oils	4390	5180	5400	6840	7910
Recycled vegetable oil	120	135	230	300	490
Animal fats	10	35	130	160	200
Grand total	4520	5350	5760	7300	8600
Imports	136	750	1000	1200	1400
Consumption	4658	6100	6700	8500	10 000
Biodiesel share of diesel market	2.3 percent	3.0 percent	3.2 percent	4.0 percent	4.6 percent

Source: ICTSD, 2009.

Table 1.3 *EU -27 bioethanol production, imports and consumption (1000 tonnes), and percentage share of petrol market*

	2006	2007 e	2008 e	2009 f	2010 f
Production	1584	1711	2155	2535	3346
Imports	317	995	1267	1584	1774
Exports	38	44	63	63	51
Consumption	1863	2662	3359	4056	5070
Bioethanol share of petrol market	0.8 percent	1.2 percent	1.5 percent	1.8 percent	2.2 percent

Source: ICTSD, 2009.

1.5 Potential of biomass energy in the EU

In this section the focus is on the potential of biomass production as reported in the GREEN-X study, see Table 1.1. The focus is thereby on the potential of forestry biomass and energy crops, since earlier studies indicate that these are the biomass categories with the largest uncertainties. Especially the availability of land for energy crops is an uncertain factor.

Two studies are used as starting point, which are REFUEL (2008) and the underlying studies (Fischer *et al.*, 2007b; De Wit *et al.*, 2008) and EEA (EEA, 2006; EEA, 2007b; EEA, 2007a). In REFUEL the potential of bioenergy crops is limited to surplus agricultural land, i.e. land that is not needed for the production of food and materials. Also in the EEA study only surplus agricultural land is considered, whereby environmental criteria are included, such as an increase in the use of organic farming. An assessment of the potential for energy crop production is also given in both studies.

As can be seen in Figure 1.2 the GREEN-X study comes to a relatively low estimate for dedicated bioenergy crop production in the EU27 towards 2020 compared to the EEA and the REFUEL studies.

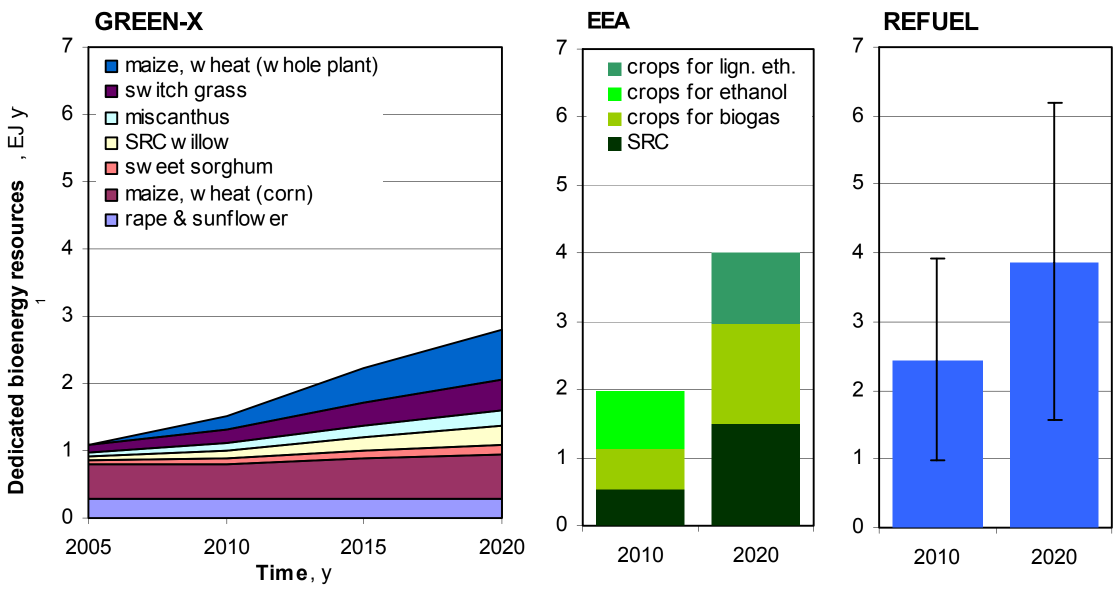

Figure 1.2 *Summary overview of dedicated bioenergy crop potentials for the EU27 towards 2020 in GREEN-X, EEA and REFUEL. Note that the EEA study does not consider Romania and Bulgaria (and Malta, Cyprus and Luxemburg)*

The estimated biomass resource potentials for 2020 differ between the studies. The GREEN-X results show the lowest potential of 2.8 EJ y^{-1} (67 Mtoe y^{-1}) by 2020, followed by the EEA 4.0 EJ y^{-1} (96 Mtoe y^{-1}) Both the GREEN-X and the EEA study provide a breakdown of resources that are produced on the available land by 2020 to arrive at their total resource potential. REFUEL on the other hand considers the land resource base without allocating the land to specific crop production. Instead the range for REFUEL in Figure 1.2 stems from the choice of the crop that is produced on the available land. In the case where poor (from energy perspective) performing oil crops are produced the potential is 1.6 EJ y^{-1} (38 Mtoe y^{-1}) If, on the other hand, high yielding grassy crops are produced the potential could amount 6.2 EJ y^{-1}. (148 Mtoe). By 2020 the EEA study considers only lignocelluloses crops to be produced (for 2nd generation biofuels and biogas). While in the EEA study in 2010 some 40 % of the agricultural bioenergy potential would be dedicated to bioenergy crops for conventional arable biofuels production, this would decrease rapidly after 2010 with the assumed introduction of advanced conversion technologies. The production of oil crops in 2010 is very low (<0.2 EJ y^{-1} or <5 Mtoe y^{-1}) and is negligible in 2020. The difference is crop mix explains why the biomass resources potential seems high relative to the average REFUEL result. When, however, only lignocelluloses crop production is considered in REFUEL the resource potential arrives at approximately 6 EJ y^{-1} or 143 Mtoe y^{-1}. A more detailed comparison of the potentials at the level of crops is not possible, because no detailed data for specific energy crop mixes are available for EEA and in REFUEL. Note, however, that both the EEA and REFUEL studies have been criticised as being optimistic in their basic assumptions: the EEA study in its degree of trade liberalisation in agriculture (Eickhout et al. 2008), REFUEL on relatively high agricultural productivity increases in the new EU member states (Bindraban et al. 2009). See also Section 1.7.

On the other hand, it should be noted that several other studies indicate higher potentials from energy crops, although the estimates typically in the same order of magnitude (Table 1.4). For example, Thrän *et al.* (2006) estimated the total potential from energy crops in the year 2020 at approximately 2.3-8.0 EJ (55-191 Mtoe y^{-1}), most of which comes from dedicated energy crops. See further also the section on land availability elsewhere in this report (Section 1.7).

For the three categories used in Ganko *et al.* the GREEN-X values for 2000 all lie within the range of values given by the different studies compared in the table above. Only the value for agricultural residues is somewhat on the low side, 771 PJ y^{-1} or 18 Mtoe y^{-1} although the lower limit of the range given by (Thran *et al.* 2005) is even lower with 680 PJ y^{-1} (16 Mtoe y^{-1}). For 2010 the differences are slightly higher. Especially for agricultural projects the projections made by the GREEN-X study seems low, the same holds for agricultural residues. Note that recently two meetings were held about, among others, the availability of straw (E. Kottasz, pers. comm.). Experts argued that that only 1/3 of the quantities in the EEA report would be realistically available, due to various technical, environmental and economic constraints. The EEA estimated that without environmental constraints the potential in the EU 21 is 24 and 27 Mtoe in 2000/2005 and 2020, respectively, and with environmental constraints the potential is 14 to 16 Mtoe for the same years. If only 1/3 of these volumes would be realistically available, than the projections of GREEN-X overestimate the availability of this type of biomass. The value for Forestry residues for 2010 is well within the range, though only two studies have figures for the year 2010. The estimate for the year 2020 by GREEN-X is higher than most of the values listed by the other studies. While forestry residues for the same year seem to be estimated quite high by GREEN-X, the value for agricultural products is well within range (though the lower range). However, when the increase of the use of biomass is considered, than the Differences in the base year are potentially the result of difference in geographic scope and definitions. These results indicate that there is a considerable inherent uncertainty related to these estimates. Yet, the results also indicate that the GREEN-X projections are within the realistic range.

Table 1.4 *Comparison of values from different studies, three biomass categories for the reference year (2000), 2010, 2015 and 2020. Data are in Mtoe. Source: (Ganko et al., 2008) and GREEN-X*

	2000	2010	2015	2020	Source
Agricultural	34.2			57.1-113.7	RENEW (2008a; 2008b)
products		47.1		95.8	EEA (2006; 2007b)
(energy crops)	16.2-27.5	25.1-79.8		60.9-182.2	Thran *et al.* (2006)
	43.2			124.2-148.1	Ericsson and Nilsson (2006)
	26.2	35.9	52.9	67.0	GREEN-X
Agricultural residues	43.7			35.3-37.5	RENEW
(crop residues)	18.6	18.6		17.4	Thran *et al.* (2006)
	21.3			19.6	Ericsson and Nilsson (2006)
	18.4	21.7	25.5	30.0	GREEN-X
Forestry residues	17.2			19.6-20.1	RENEW (2008a; 2008b)
		42.3		39.2	EEA (2005)
	10.5	11.9		13.1	Thran *et al.* (2006)
	40.1			3.8-55.4	Ericsson and Nilsson (2006)
	32.0	33.2	34.4	35.8	GREEN-X

For black liquor and biodegradable municipal waste, the results of GREEN-X are compared with Nikolaou et al. (2003), see Table 1.5. The results indicate the technical potential, whereby factors are included to compensate for realistic limits like physical and economic factors. For agriculture the potential was calculated using the cultivated area for each crop multiplied by a conservative availability factor of 30% to compensate for various technical and economic reasons. Results are aggregated to EU 24 level[4].

Table 1.5 *The use of residues in GREEN-X compared to the potentials estimated by Nikolaou et al. (2003).*

	G-X	N	G-X	N	G-X	N
	2005	2000	2010	2010	2020	2020
FR1 - black liquor	10,3	10,9	10,8	12,0	11,9	13,1
BW1 - biodegradable fraction of municipal v	12,8	16 (7,3)	14,3	17,6	17,9	
Agricultural residues	18,4	32,0	21,7	35,2	30,0	38,4

Data are in Mtoe. G-X = GREEN-X, N = Nikolaou et al. (2003)

Further, in Hetsch et al (2008) the European Forest Sector Outlook Study (EFSOS) model is used and combined with national renewable energy policy targets to predict the production and consumption of forest products for 2010 and 2020. The EFSOS presents long term trends for supply and demand of forest products (roundwood, sawnwood, panels, pulp, paper, non-wood products) and services and outlook to 2020.

Table 6 shows a comparison between the results of Hetsch et al (2008) and GREEN-X. The results of Hetsch *et al.* are compared with the sum of 'Forestry products', which is the category that overlaps most with the assumptions made by Hetsch and his colleagues.

4 The following countries are included: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, UK, Slovak Republic, Slovenia and Spain.

Table 1.6 *Comparison of results of Hetsch et al. study with GREEN-X values*

	2005	2010	2020
material use	131	136	147
wood supply forests	150	151	160
wood supply outside forests	69	70	72
GREEN-X energy from forestry	58	61	70
total supply	218	221	232
total demand	189	197	217

Source: Hetsch et al (2008) and GREEN-X.
Note: Data are in Mtoe

The results also show that sufficient biomass from forestry is available to fulfil the wood demand for materials and energy. However, the difference is quite small. These results above indicate that the use of forest biomass as projected in GREEN-X is reasonable, although the ranges found in the literature are quite large (Figure 1.1).

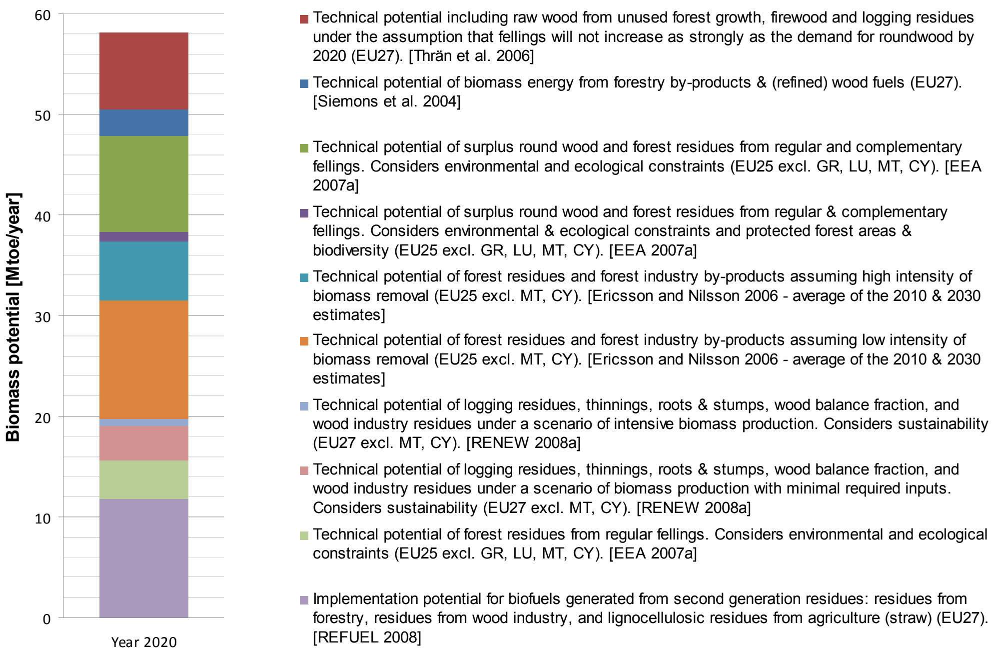

Figure 1.3 *The potential of forest biomass in year 2020 according to various studies. The potentials should be measured from the x-axis to the upper edge of the respective colour*

Sources: Ericsson and Nilsson, 2006; Thrän et al., 2006; EEA, 2007a; REFUEL, 2008; Renew, 2008a; Renew, 2008b.

The maximum potential for forest biomass for the EU27 in the year 2020 is reported by Thrän *et al.* (2006), namely 58 Mtoe. This figure represents a technical potential of biomass derived from forest and logging residues as well as additional feelings. In GREEN-X the total use of biomass for energy production from these sources is estimated at 75 Mtoe in 2020. However, in the year 2005 a total use of 68 Mtoe was estimated. Consequently, the additional demand for biomass for energy is relatively limited compared to the supply in 2020 as indicated in Figure 1.3. Even when environmental criteria are included the biomass potential of forests and forest residues is limited to circa 15 Mtoe (EEA in Figure 1.1). The latter result is broadly in line with the potentials depicted in Figure 1.1 and based on a price of 7 € GJ^{-1} that is assumed in GREEN-X (Table 1.1). However, it should be noted that differences in the definitions are possibly partially a reason for these discrepancies, as further discussed in Section 1.3.

1.6 Costs of biomass energy

Several studies are available in which data on the costs of energy crop production are presented. First, the GREEN-X results for the years 2010 and 2020 are compared with the results of REFUEL (De Wit *et al.*, 2008). REFUEL is selected since this is one of the few studies for which detailed cost data are available per crop type. However, it should be noted that the comparison of costs is problematic, since the yield of crops, which is an important factor for the costs, are not the same in both studies. Further, the costs in REFUEL are expressed in terms of cost-supply curves, whereby the costs depend on the production volume.

For the REFUEL study detailed cost-supply curves are available that are also geographically explicit. The results are thus shown in the form of ranges that represent the variability in the costs in 2010-2030, measured across the total cost supply curves (Figure 1.4). Cost-supply curves in the REFUEL study indicate that a relatively large resource base is available at the lower end of the production costs, mainly because these resources are located in the Central and Eastern European Countries (CEEC), where both labour and land rents are generally lower than in the Western European Countries (WEC) (see further Annex II). Additionally, accumulating experience with crop production (especially for lignocellulose crops) is assumed to reduce costs over time. In GREEN-X the costs are assumed to increase.

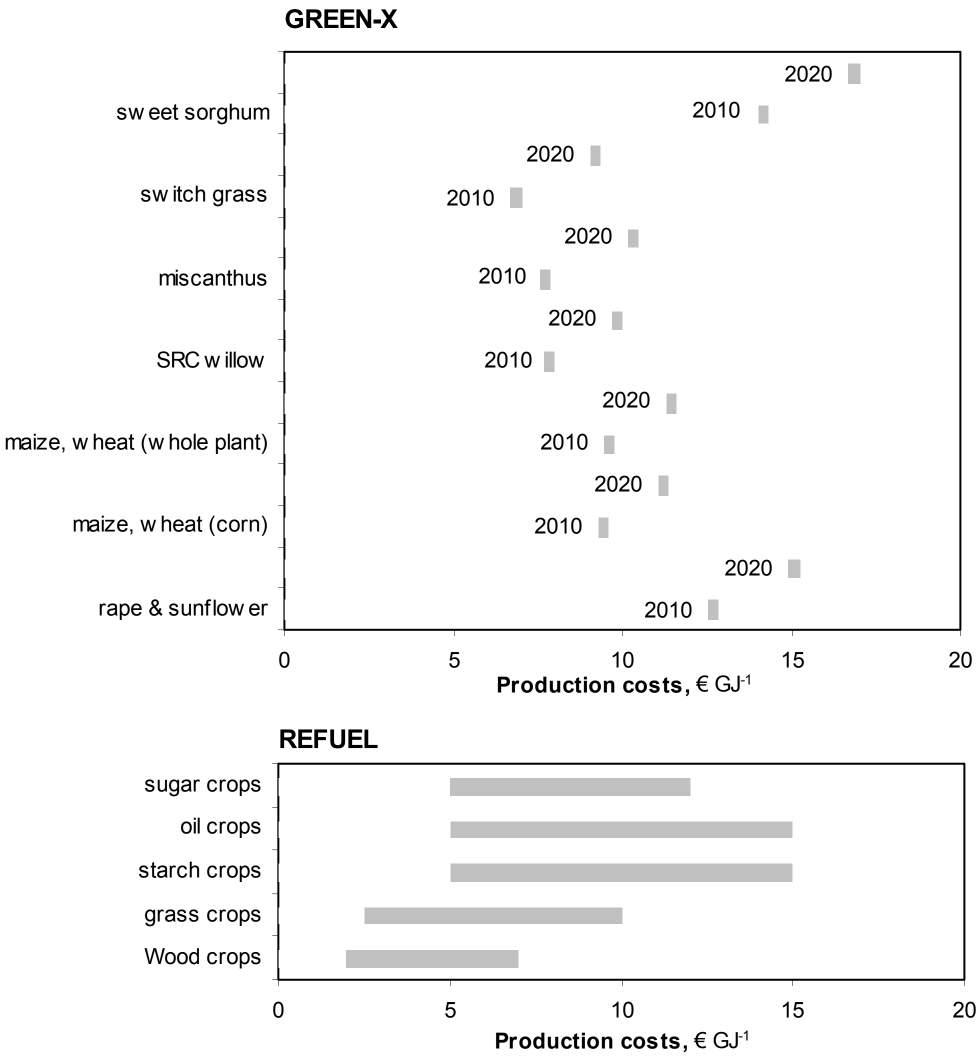

Figure 1.4 *Dedicated bioenergy crop production costs in GREEN-X and REFUEL*

From Figure 1.4 it can be seen that the average production costs from GREEN-X correspond at best with the higher end of the range from REFUEL. The reason for this can - at least partially be - because REFUEL considers a large part of its resource base from the CEEC where as mentioned production costs tend to be lower.

The GREEN-X results for woody biomass are compared with the results from the EEA (2007a), see Figure 1.1. According to GREEN-X a total volume of forest products and forestry residues of 68, 71 and 80 Mtoe will be used in 2005, 2010 and 2020, respectively at an average price of 51, 60 and 68 €/toe or 11, 13 and 14 €/m^3. The cost-supply graphs in the EEA study indicate that at these cost levels only a minor amount of biomass will be available. According to these curves an 80 Mtoe supply in 2020 would require a price of 120 €/m^3 or 576 €/toe Experts from the Joint Research Centre (JRC) of the European Commission suggest that cost levels in GREEN-X are likely underestimated, as these figures are based on studies that ignore the impact of an increasing demand and use of biomass, which results in increasing prices. Consequently, also the share of imports could be probably too low (see also Section 1.3).

In Alakangas et al (2007) prices, excluding VAT, are reported for several solid biofuels in June 2005 (Table 1.7). Data are based on questionnaires and are available for the following solid biofuels: forest residues, industrial by-products and residues, used wood, other biomass (mainly agricultural residues).

Table 1.7 *The production costs of forest biomass in GREEN-X compared to Alakangas et al. (2007)*

	2005	2010	2020
FR2 - forestry residues (current use)	6.3 (6.7)	8.6 (16.1)	7.16 (10.8)
FR3 - forestry residues (additional)	12.5 (6.7)	17.1 (16.1)	12.9 (10.8)
FR4 - demolition wood, industrial residues	5.0 (12.6)	6.8 (0.8)	5.6 (7.1)
FR5 - additional wood processing residues (sawmill, bark)	6.3 (3.8)	8.6 (16.6)	6.7 (8.4)
Agricultural residues	12.2 (3.7)	14.7 (32.0)	12.4 (12.3)
Forestry residues	5.0 (6.7)	17.1 (16.1)	6.7 (10.8)

Note: Alakangas data are between brackets

The results are given per country for 20 countries in the EU, but also average prices for the EU are given. Further, prices are reported for the retail sector, for municipal plants and for industrial plants. Prices of biomass feedstocks for industrial plants were compared with the GREEN-X cost calculations. The results show that the prices reported for forest residues, used wood and wood processing residues are considerably higher than the GREEN-X costs. The reasons for this difference are not exactly known, but a feasible explanation are the high costs of oil in 2005 (circa 50 US $ per barrel), which most likely also results in high prices of biomass, while in GREEN-X an oil price of 27.5 US $ per barrel is assumed.

1.7 Key factors and underlying assumptions

Earlier studies indicate that the largest uncertainty for the availability of biomass for energy production is the availability of land for energy crop production. The availability of land is mainly determined by the demand for land for other purposes (mainly for the production of food) and thus by the productivity of the land. This is further illustrated using results from the EEA, REFUEL and GREEN-X.

Although differences in resource allocation to the land for energy crops between EEA, REFUEL and GREEN-X can hamper an ‘honest’ interpretation and comparison of the outcomes, the ‘real’ differences between the studies are mainly influenced by the assumed availability of land, which, in turn, is heavily influenced by productivity development assumptions. This has further been investigated in a study by Bindraban *et al.* (Bindraban et al., 2009) provides a comprehensive overview on the different productivity developments that are assumed by the FAO, EEA and REFUEL.

> *"According to **FAO prognosis**, world increase of crop productivity per annum varies from 1.1% (rice) to 1.6% (horticulture), see Table 2.1. Differences in rates of yield increase significantly affect land area requirement to meet demand as has been elaborated in section 2.4.*
>
> ***The EEA study (2006)** has used another source for their yield growth estimations in the EU (see Table 2.2). Comparison reveals for instance that yield increase of grain crops is much lower in EU15 (Table 2.2) of the EEA study than in the FAO prognosis (FAO: ca. 1.2% and Table 2.2: ca. 0.4 - 1.0%), while oil crops show opposite expectations (FAO: ca. 0.4% and Table 2.2: ca. 0.5 - 1.4%).*
>
> *In the **REFUEL study** (Fischer et al., 2007), another approach was used. For EU15 they used an extrapolation of historic trends based on FAO statistics, but for EU10 it was assumed that in 2050 the yields of both EU parts would converge, meaning that EU10 would have reached the production level of EU15 by then. For the crops growing in EU15 an increase of 0.8% per annum was applied which is in the range of the data from the FAO (between 0.4 and 1.2%), but for EU10 the assumed increase in growth amounts to 2.2% which is significantly above the values given by the FAO for CEEC (highest value equals 1.2%) and by the EEA (beyond 2011 most values around or below 1%; Table 2.2). Other estimates for cereal yield increases are given in Figure 2.5, which are again different from the studies above."*

Essentially, the EEA considers lower productivity growth estimations than in the REFUEL study and also than the FAO projections. Key rationale for this lower growth is the environmentally sound farming that is considered (for example organic farming). The growth expectations in the REFUEL study on the other hand are set higher than the FAO projections, mainly for the Central and Eastern European Countries (CEEC). Rationale for this is the mentioned convergence hypothesis, which assumes that the CEEC will over time catch up to western European yields.

As a result of the different assumptions for future productivity developments the EEA and REFUEL study arrive at different land resource availabilities. Note, however, that the EEA study does not include the countries Romania and Bulgaria which both have considerable agricultural land resources.

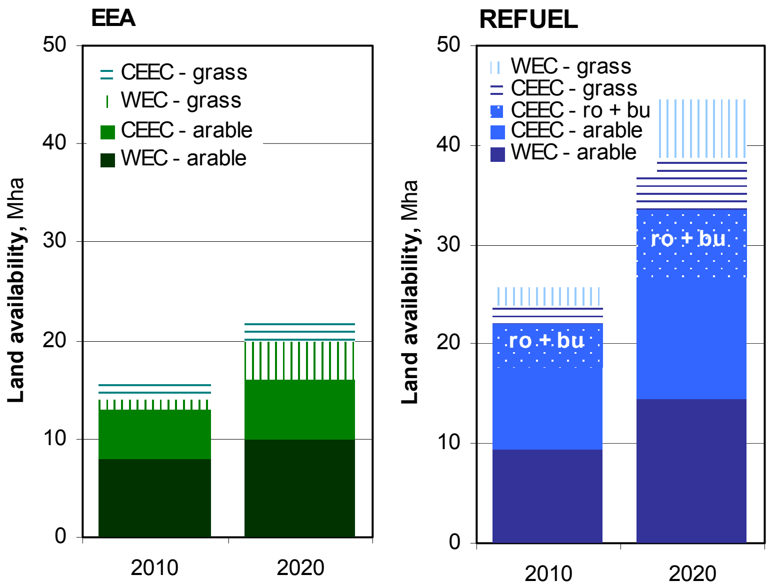

Figure 1.5 *Land resources availability for 2010 and 2020 in the EEA and REFUEL study*

The difference in land resource availability is especially apparent for the arable land in the CEEC. This difference can be explained by the different assumptions for the productivity developments, assumed in both studies (see next page). Furthermore, the exclusion of Romania and Bulgaria in the EEA study adds to the difference. If we compare EEA and REFUEL without including Romania and Bulgaria then the difference remains high in 2020; the EEA comes to 6 Mha in the CEEC and REFUEL only comes to 8.3 Mha (both excluding Romania and Bulgaria). These two countries in the REFUEL study add an additional 4.3 Mha to the CEECs potential by 2020, or more than a third of the total potential in that region. It should also be noted that in the EEA study it is assumed that agricultural markets will be liberalised. Together with the assumed increase in crop yields, this is the most important driver behind the release of agricultural land.

For the GREEN-X study there is no information available about estimations on the agricultural land resources required to meet the 2.8 EJ y^{-1} by 2020. To make an estimation of what the production would mean in terms of land requirements we combine the resource distribution of GREEN-X (Figure 1.2) with the EEA bioenergy crop yields and with the average yields from REFUEL. The REFUEL study specifies the yield per land suitability class and specifies the amount of land of certain suitability in a region. Combining these data it is possible to determine weighted average European yields that are used in REFUEL. Following the REFUEL yield levels the GREEN-X production portfolio corresponds to a land claim of 19 Mha in 2010 and 25 Mha in 2020. In case EEA yields are used an average primary crop yield op 100 GJ ha^{-1} is realised on 28 Mha. The EEA study itself, which considers only lignocelluloses crop production by 2020, the average yield is 182 GJ ha^{-1} and the total potential 4.0 EJ on 22 Mha. As with the total bioenergy production REFUEL makes no assumptions with respect to a resource distribution.

It can be concluded that the relatively considerable share (~ 39%) of 1st generation bioenergy crops by 2020 in the GREEN-X study, compared to the EEA study, causes a high demand for agricultural land. With an estimated land requirement of 28 Mha the demand for land is higher than is estimated to be available by the EEA in 2020. Note (again) that the EEA did not consider Romania and Bulgaria while GREEN-X did. The 28 Mha from the GREEN-X study can, however, be met under the REFUEL assumptions on land resource availability.

Table 1.8 *Bioenergy crop yield from EEA, REFUEL and FAO in Europe for the year 2000. Data are in tonne ha^{-1} y^{-1}*

	EEA		REFUEL	FAO
	Min	Max		
First generation				
Rape	1.4	3.0	1.1	2.5
Sunflower	1.5	2.5	1.4	1.2
Sugar beet	10.1	18.1		40.7
Maize corn	5.3	9.5	7.6	4.6
Wheat corn	3.5	7.6	5.8	3.3
Barley	3.0	6.1		3.0
Sorghum			5.0	
Second generation				
SRC poplar	6.7	7.5		
SRC willow	7.5	7.5	10.9	
Miscanthus	8.8	16.5	17.7	
Reed canary grass	6.2	16.6		
Giant reed	9.0	16.6		
Switchgrass	7.7	9.0	14.7	

Note: For the EEA data "For the calculation of the energy potential from the land potential for each crop yield, yield increase and harvested dry matter was specified per environmental zone (see Tables 5.2 to 5.4). Most yield figures are estimated from long term averages in FAO STAT. Where these were not available yields" (EEA technical report)

These results are also broadly in line with results from other studies (Figure 1.6), although the 25-28 Mha are on the high side of the spectrum. However, there are several other studies that indicate much higher availability of land. For example, Thrän and co-workers carried out an analysis of the availability of land for energy crop production. Only land that is no longer needed for the production of food, materials or for other purposes is considered. The total potential in this study is estimated at approximately 34-66 Mha for the EU28 in the year 2020, depending on the assumptions. Further, it can also be concluded that the assumptions on productivity development are crucial for the availability of land for energy crop production and for the biomass energy potential from these areas.

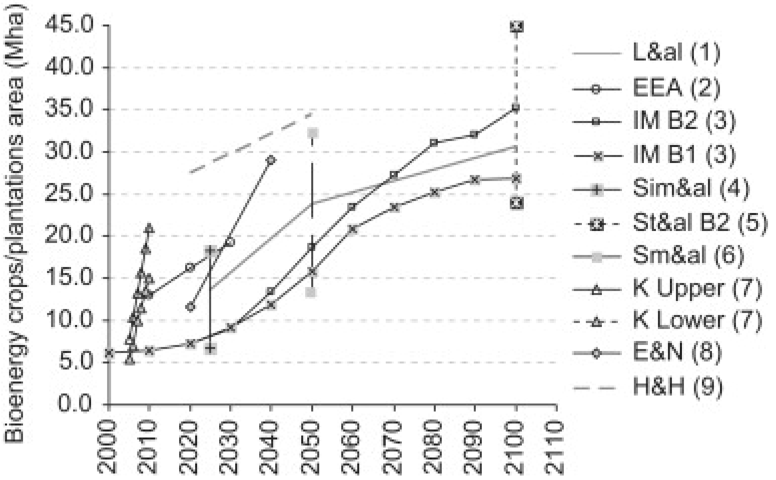

Figure 1.6 *Bioenergy crops/plantation in the EU-25 from 2000 to 2100*
Note: [(1)]L&al: Adapted from (Leemans et al., 1996). Land demand for the biomass intensive scenario (LESS-BI) in OECD and Eastern Europe. [(2)]EEA: (EEA, 2006) for EU-22 (no data for Luxemburg, Cyprus and Malta) land demand for bioenergy crops from 2010 to 2030. [(3)]IM: Adapted from the IMAGE 2.2 (IMAGE-team, 2001) B1 and B2 IPCC/SRES implementation scenarios. Data for the OECD Europe. [(4)]Sim&al.: Adapted from (Sims et al., 2006), energy crop area projected by 2025, based on A1 and B2 IPCC/SRES scenarios in OECD and Eastern Europe. [(5)]St&al.: Adapted from (Strengers et al., 2004). Biofuel crops area projected by 2100 in OECD and Eastern Europe. [(6)]Sm&al.: Adapted from (Smeets et al., 2007). Biofuel crops area projected by 2050 in Western and Eastern Europe under mixed animal production systems. [(7)]K: (Kavalov, 2004). Land-resources demand to meet EU Directive 2003/30/EC target for biofuel for transportation in the period 2005-2010, for the Upper (U) and the Lower (L) Optimal Technical Potential scenario. [(8)]E&N: (Ericsson and Nilsson, 2006). Energy crops area in the next 10-40 years (we assume year 0 is 2000). [(9)]H&H: (Hall and House, 1995) for Western Europe by 2020 and 2050.
Source: Ovando and Caparrós, 2008.

However, several other studies indicate that there are many more factors that influence the availability of biomass. Existing studies typically incorporate these factors by means of scenario and sensitivity analysis. Annex III shows an overview of scenario variables that are included in the different studies. It goes beyond the scope of this study to investigate the scenario parameters and the impact on the results of all these studies in detail. Instead, the key scenario parameters are discussed, whereby specific attention is paid to the two studies that are analysed above (EEA, 2007b; Fischer *et al.*, 2007a).

Based on the scenarios described in Annex III, the most important variables that determine the availability of biomass are:

- The demand for food, feed and materials. The exogenous drivers behind these are population growth and income growth. In Europe the population is projected to increase slightly in Western Europe and decrease in Central and Eastern Europe. The per capita food consumption has reached saturation levels in most countries. Therefore, population growth and income growth are in theory crucial variables for the availability of biomass, but this is not the case for Europe. More important is the Common Agricultural Policy.

- The Common Agricultural Policy (CAP). Agricultural markets in Europe are protected by, among others, import tariffs and export subsidies. Most studies assume that no drastic changes in the CAP are implemented. If the CAP would drastically be revised by reducing protective measures, resulting in full trade liberalisation, then the import of food, feed will be at the expense of domestic production. This would further increase the availability of land compared to many existing studies. The impact of trade liberalisation is further illustrated in e.g. Rousevell et al. (2006), Van Dam et al. (2007) and the in Scenar 2020 study (Scenar2020, 2006).
- The development of technology. The development of technologies for the production of 2nd generation biofuels can have a large impact on the availability of biomass, because of the higher yields of lignocellulose energy crops compared to conventional starch, sugar and oil energy crops. And in addition the volume of biofuels that can be produced is also higher, because of the higher conversion efficiency per unit biomass. Also the use of breeding, genetic modification, and improved management systems can greatly enhance the future yields of lignocellulose energy crops, although the effects are highly uncertain. For example, estimates of future yield increases of miscanthus vary between approximately 24-81% during 30 years (Smeets *et al.*, 2008).
- The use of land for carbon sequestration. An alternative to the use of land for energy crop production is the use of land for carbon sequestration. Which will be the preferred depends on, especially, the development of policies and on the price of agricultural commodities, oil and carbon credits.
- The price of biomass and other agricultural commodities, oil and carbon credits. Several studies express the availability of biomass for energy in terms of cost-supply curves, such as REFUEL (see Annex II) and the EEA (see Figure 1.1). The availability of biomass thus depends on the market price. The price of oil and carbon credits is thereby becoming increasingly important, considering the increasing use of biomass for energy production. For example (taken from (EEA, 2007a), the price for one ton of CO_2 emission under the European Union Emissions Trading Scheme exceeded 29 euro in early July 2005. This would be translated into a cost contribution of 19 euro per m^3 wood (if the wood is used to replace fossil fuels). The storylines developed for the EEA bio-energy study project an increase in the price for carbon credits to 65 euro per ton of CO_2 emission reduction by 2030 (EEA, 2006). This would translate into a cost contribution of approximately 40 euro per m^3, which is the current price level for industrial roundwood in many European countries. As shown in Figure 1.1 this would have a very large impact on the availability of biomass from forestry.
- The demand for land for forest expansion. This is indicated in Figure 1.7. This picture shows the percentage of land that according to a number of studies could be potentially diverted to forest or devoted to bioenergy crops with respect to the current agricultural land in the EU-25 by the 2020-2025. Different studies suggest that from 4% to 18% of EU-25 agricultural land could be used for growing bioenergy crops, whilst this figure drops from 4% to 13% in the case of forest expansion addressing only agricultural lands. The main constraint is that these estimations come from different sources, so adding them up is a risky exercise.

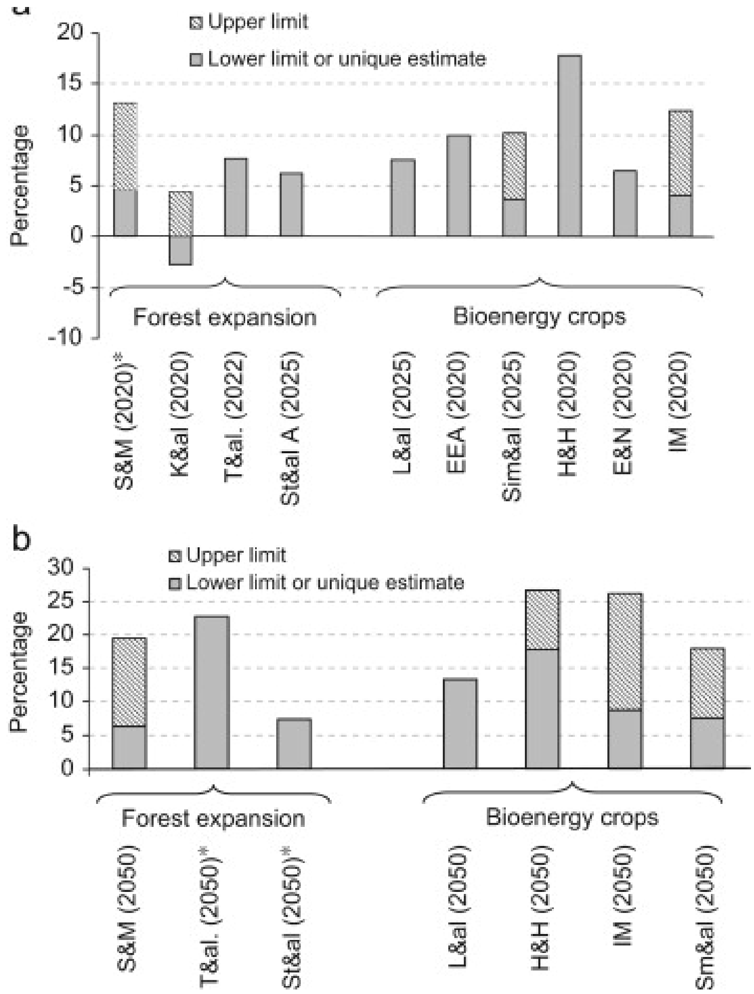

Figure 1.7 *Land resources demand for forest expansion and bioenergy crops as percentage of the available agricultural in the EU-25*
Source and original references: Ovando and Caparrós, 2008.

In the EEA study on the availability of land for energy crops the following key parameters are included in a sensitivity analysis:

- share of environmentally orientated farming
- higher fossil fuel prices and CO_2 allowances
- yield increases.

The results are shown in the figure below. According to the EEA report the following conclusions can be drawn. Higher prices for fossil energy and CO_2 allowances as well as yield assumptions had a stronger effect on the potential than the share of environmentally orientated farming. The price for CO_2 allowances to come to the calculated potential of 159 Mtoe in 2030 was assumed to amount to at least 30% of the commodity price. Consequently, a lower CO_2 allowance price or a higher increase in world global food prices could lower the relative attractiveness of bioenergy crops. Furthermore, it would reduce the available land for bioenergy. The analysis also shows that for reaching an environmentally compatible biomass production, a higher price needs to be paid. Thus, this price difference can be regarded as the price paid for the environmental constraints, which can be seen as a tool for internalising potential external environmental costs. The results also show that high energy prices lead to an increase of 29% of the modelled potential compared to a scenario with low energy prices. The assumptions concerning future yield increases also matter as a low yield increase of 1% for all crops would reduce the bioenergy potential by 9% in 2010 and by 23%.

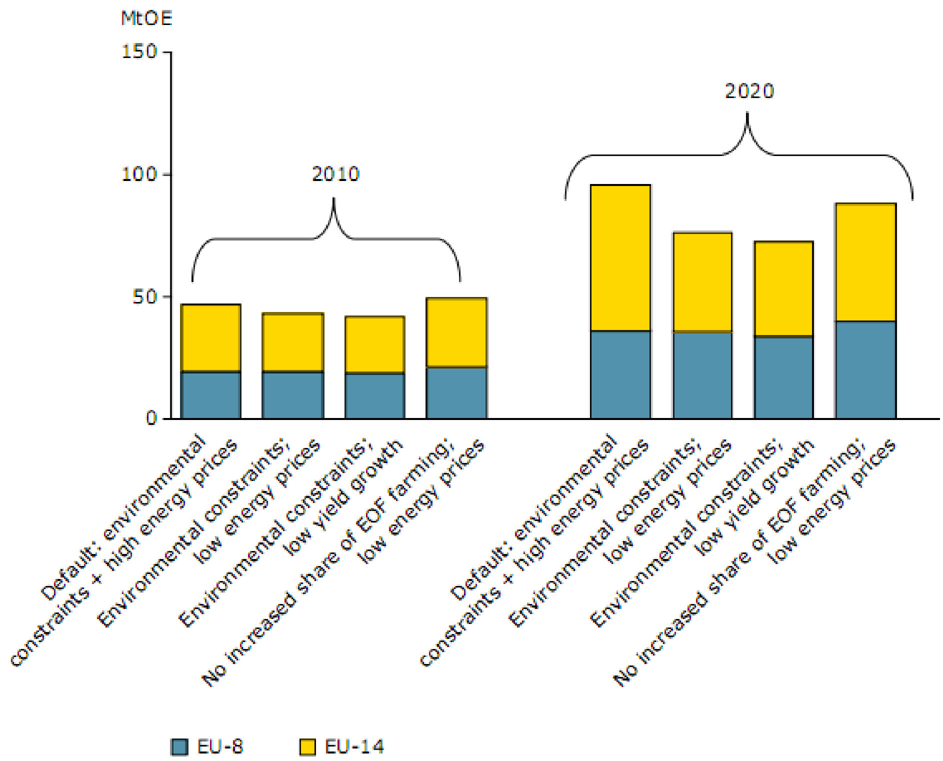

Figure 1.8 *Overall effect of different scenario assumptions*
Source: EEA, 2007b.

In REFUEL three scenarios are included:

- The 'baseline' scenario reflects a continuation of past trends in yields and per capita consumption. Baseline essentially reflects effects of ongoing trends in food consumption patterns on the one hand and technological progress in food production on the other hand, and it assumes a continuation of current self-reliance levels in Europe's aggregate food and feed commodities. Continued increases in crops yields and livestock production intensity will free land for bio-fuel production. For Western Europe a continuation of historic trends from 1985 to 2002 is considered to represent the basis for the reference scenario.
- The 'low' scenario anticipates a higher share of areas with organic agricultural production. As a consequence yields in Western Europe are lower compared to 'baseline'. For Central and Eastern Europe we assume 'baseline' yield increases can also be realized under conditions of organic agricultural production.
- The 'high' scenario reflects an intensified agricultural production system compared to 'baseline'. The 'high' scenario reflects an intensified agricultural production system compared to 'baseline'. Reasons may be manifold including new varieties, intensified rotation systems or farm restructuring towards larger entities.

Table 1.9 *Land availability in Europe for bio-fuel feedstocks in 2030*

ARABLE land	EU 15 +	EU 12
Baseline (trend)	19.3	23.4
Low (more organic cultivation)	16.9	23.4
High (higher yields)	23.4	28.3
PASTURE		
Baseline	4.8	0.3
High (as in baseline + partial use of grassland not required for feed)	10.1	8.4

Source: Fischer et al., 2007a.

The results highlight the large contribution of Central and Eastern European countries. Further, by 2030 more than half of EU's 40 to 50 million hectares cultivated land potentially available for bio-fuel feedstock production will be found in Central and Eastern European countries. The results are also largely influenced by the assumptions on agricultural efficiency. The difference between the baseline and high scenario is more than 20 Mha for the EU.

1.8 Biomass availability beyond 2020 towards 2050

All studies indicate that between 2020 and 2050 the availability of land for biomass energy will (continue to) increase (Figure 1.6). Underlying reasons are that the population in Europe is projected to decrease and the consumption of food is saturated, while the efficiency of agriculture is projected to increase. Studies that predict otherwise were not found. Also the availability of forest biomass is projected to increase (see Figure 1.7). This is also confirmed by other studies (Ericsson and Nilsson, 2006; EEA, 2007a; REFUEL, 2008).

1.9 Global biomass availability

In the past fifteen years, a large number of studies have assessed the longer term (2050-2100) bioenergy supply potential for different regions and globally (this section is largely based on results from (IEA, 2009). Since the studies used different approaches to consider determining factors - such as demand for food, soil and water constraints, biodiversity and nature preservation requirements, and a variety of other sustainability requirements - they come to diverging conclusions regarding the bioenergy supply, ranging from virtually zero to levels above the current world energy consumption (about 500 EJ primary energy). The table below provides a synthesis of global assessments made. Energy crop production is potentially the largest supply source. But it is also difficult to narrow down the potential estimate for this category since it mainly depends on two parameters that are very uncertain: land availability and crop yields.

Table 1.10 *Overview of the global potential of bioenergy supply over the long term for a number of categories. For comparison, current global primary energy consumption is ca. 500 EJ*

Biomass category	Definition	Technical bioenergy potential year 2050 [EJ/yr]
Energy crop production on surplus agricultural land	Biomass that can be produced on future surplus agricultural land not required for food, fodder or other agricultural or forestry commodities production. Two types of energy crops can be distinguished: 1) Conventional energy crops, normally used to produce food and animal feed (e.g. maize, sugar beet, sugarcane, rapeseed, oil palm, soybeans) 2) Lignocellulosic energy crops, composed of cellulose, hemicelluloses and lignin (e.g. poplar, willow, eucalyptus, miscanthus, switchgrass).	0 - 700
Energy crop production on marginal lands	Biomass that can be produced on deforested or otherwise degraded or marginal land that is still suitable for e.g. reforestation	<60 - 110
Residues from agriculture	Residues associated with food production and processing, both primary (e.g. cereals straw from harvesting) and secondary (e.g. rice husks from rice milling)	15 - 70
Forest residues	Residues associated with wood production and processing, both primary (e.g. branches and twigs from logging) and secondary (sawdust and bark from the wood processing industry)	30- 150
Dung	Biomass from animal manure	5 - 55
Organic wastes	Biomass associated with materials use, e.g. waste wood (producers), municipal solid waste	5 - 50+
Total		<50 - >1100

While assessments have not succeeded in providing narrow distinct estimates of the bioenergy potential, they reveal important information for policy: the most critical parameters are identified and therefore strategies for improving the prospects for longer term bioenergy supply can be formulated. Land availability for biomass production is particularly impacted by the level of modernization of agriculture that can be achieved globally, particularly in developing countries. In total, up to circa 1500 EJ could (in theory) be produced from energy crops produced on surplus agricultural land in the year 2050 when the most advanced agricultural systems would be applied across the world.

More moderate scenarios, taking into account a number of uncertainties and sustainability constraints can be summarized in the following three main categories of biomass:

1. Residues from forestry and agriculture and organic waste, including Municipal Solid waste (MSW). In total, this category represents between 50 and 150 EJ/year, with a mean estimate of around 100 EJ/yr. This part of the potential biomass supply is relatively certain, although consumption changes (including diet) and competing applications may push the net availability for energy applications to the lower end of the range.
2. Surplus forestry, i.e. apart from forestry residues an additional 60-100 EJ/yr of surplus forest growth could be available.
3. Biomass produced via cropping systems:
   - A lower estimate for energy crop production on possible surplus good quality agricultural and pasture lands, taking account of water scarcity, land degradation and new land claims for nature reserves represents an estimated 120 EJ y^{-1} (potential indicated as "with exclusion of areas" in Figure 1.9)

- The potential contribution of water-scarce, marginal and degraded lands for energy crop production, could amount to an additional 70 EJ y^{-1}. This would comprise a large area where water scarcity provides limitations and soil degradation is more severe and excludes current nature protection areas from biomass production (additional potential indicated as “no exclusion” in the figure below). Note, however, that this ‘exlusion’ does not relate to the land exclusion criteria in the RES directive.
- Faster development of agricultural technology could add some 140 EJ y^{-1} to the above mentioned potentials of energy cropping.

In summary, under the preconditions listed above, the three categories added together lead to an indicative biomass supply potential of up to about 500 EJ. Note that this is not a ‘maximum’ potential as e.g. increasing improvements in agriculture could still cause this potential to increase, both before and after the year 2050. In comparison, many energy demand models calculating the amount of biomass used if energy demands are supplied cost-efficiently at different carbon tax regimes, estimate that in 2050 about 50-250 EJ y^{-1} of biomass could be used. Scenario analyses predict a global primary energy use of about 600 - 1040 EJ y^{-1} in 2050.

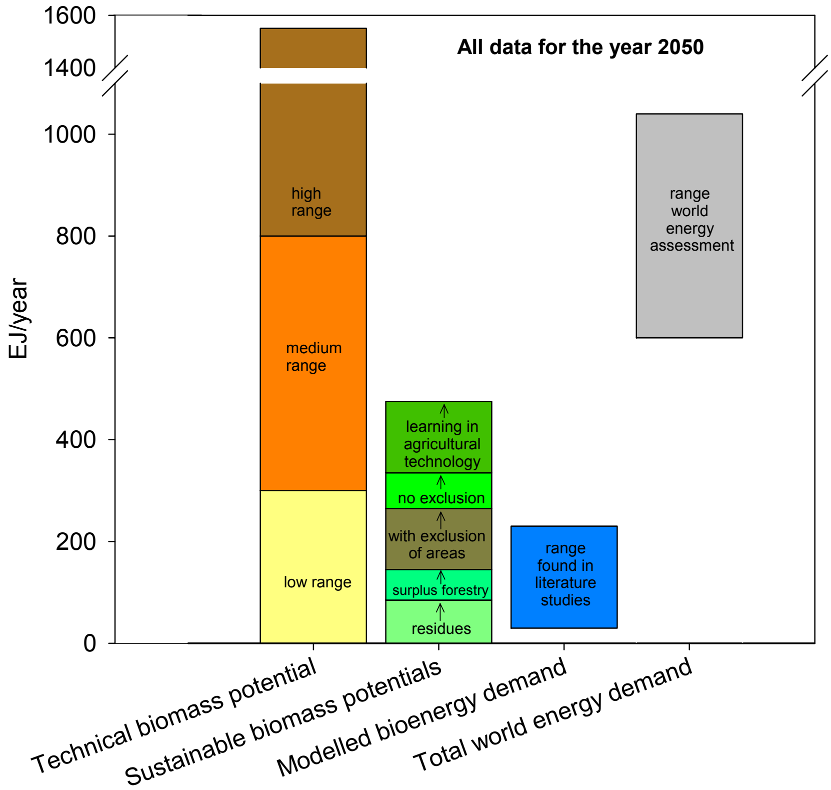

Figure 1.9 *Comparison of ranges of technical biomass supply potentials in several review studies, the sustainable potential as determined by Dornburg et al (2008a; 2008b), the expected demand for biomass based on global energy models and the expected total world energy demand, all for 2050. See text for an explanation of the build-up of the sustainable biomass potential. The word ‘exclusion’ in this bar does not refer to the exclusion criteria in the RES directive*

The conclusions from these studies seem to be that bioenergy could make a significant contribution to worlds energy supply (between 8 and 25%). These results also show that sufficient biomass is available for export to the EU and that the import of biomass not necessarily competes with the demand for biomass energy in other regions. The most important factor determining use is likely to be the user side and price constraints rather than biomass availability, with most of the likely feedstock demand supplied by residues, surplus forestry and energy crop production from less sensitive areas.

2. Task 2: Impacts of sustainability criteria on biomass availability and costs

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2.1 Introduction

Objective of this task is to assess to what extent the sustainability criteria as specified in the RED (EP/EC 2009) affect availability and costs of biofuels. Table 2.1 summarises the sustainability criteria as mentioned in the directive, as they were agreed upon in Task 2.1.

Table 2.1 *Sustainability criteria as found in the RES Directive and an indication of their foreseen impact on bioenergy*

Article	Criterion	Affecting[1]
17.2	Full-chain GHG emission reduction >50-60% [2]	AC
17.3	Exclusion of lands with high biodiversity value (a) Primary forest and other wooded land (b) areas designated by law or by the relevant competent authority for nature protection purposes[3] (c) Highly biodiverse grasslands	A
17.4	Exclusion of lands with high carbon stock that have been converted into e.g. cropland after 1 January 2008, viz: (a) wetlands (b) continuously forested areas (c) semi-forested areas (10-30% canopy cover)	A
17.5	Exclusion of land that was peatland on January 1, 2008, unless proven that drainage of previously undrained soil is not involved	A/C
17.6	Condition of good agricultural practice (EU)	AC
17.7	Obligation to the Commission to report on soil, water and air impacts and social impacts in regions that are a significant source of feedstock	-

[1]: A: Land and Biomass availability; C: Production costs

[2]: The directive sets a minimum reduction of 35% for the initial years of the directive, with the target increasing over time. This threshold will be increased: by January 1, 2017, all then existing installations need to save 50% GHG emissions; all installations coming on-line after this date need to meet a 60% threshold by January 1, 2018.

[3]: The article also refers to areas identified by international NGOs. In the kick-off meeting it has been agreed to neglect this criterion

The assessment was split in two according to the sustainability criteria:
- An assessment of the impact of the GHG emission reduction requirement (17.2)
- An assessment of the impact of the criteria related to the no-go areas and the no-conversion areas (17.3-5).

The criterion in Article 17.6 of the directive claims that supportable biofuels should be produced from EU-cultivated crops only when these are cultivated in concordance with the standard requirements for good agricultural practice as provided in the framework of the EU Common Agricultural Policy. For EU-15 countries, it seems to be self-evident that cultivation practices will meet these requirements, as support payments to farmers also depend on these requirements. For EU-12 Central and Eastern European countries, the situation may be different. It will be checked at DG AGRI whether these requirements should be addressed specifically. In general, however, it seems that all potential assessments take proper agricultural management as a starting point, so no strong impacts are expected in relation to this criterion.

For forestry products and residues and wastes, no reference to ‘good practices’ in forestry management are included in the directive. We assume that any of such reference that may be included in a later stage (e.g. when criteria for biomass to other energy purposes are elaborated), do not have an impact on biomass availability or costs, as all potential assessments take proper forestry management as a starting point as well.

The criterion in 17.7 refers to reporting obligations, which may lead to additional administrative costs. As the criterion does not contain requirements for land or management practice in the biomass-to-energy chain, we propose to assume that this criterion does not have any impact on biomass potentials and costs. By doing so, we neglect the effect that reporting (and possible public ‘naming and shaming’) may have on cultivation practices, mainly because we consider such effects to difficult to be quantified in the context of this project.

2.2 Impact assessment of the GHG emission reduction requirement (17.2)

For this criterion, the following steps were made:

1. Identification of chains that currently do not meet the GHG thresholds for 2017/2020
2. Identification of autonomous developments in these chains affecting their greenhouse gas emissions, and a projection of the 2017/2018 typical values
3. Identification and quantification of a ‘baseline’ scenario in terms of biofuel and bioliquid chains that would be deployed to meet the targets of the RES directive, with a focus on the chains that do not meet the 2017/2018 threshold in their autonomous development
4. Identification of effects caused by the application of the 50%-60% thresholds (e.g. by additional GHG reducing measures or shifts in biofuel shares)
5. Quantification of these effects.

2.2.1 Identification of chains that do not meet the 50-60% threshold

Only chains were analysed that have current greenhouse gas emission reductions (as mentioned in Annex V of the directive) lower than 60%. For bioenergy chains that meet the 60% reduction requirement, it can be simply concluded that the criterion will not affect either potential or costs. For this assessment, we used *typical* values as a reference. Rationale behind this is that:

- This value should be attainable for the ‘average’ installation;
- Most industries will be able to report in detail on energy efficiency of their installation, using the standard values for other chains steps (such as crop cultivation)
- Efforts to improve an installation from ‘default’ to ‘typical’ would most probably be cost-effective as such
- The time frame to realise these improvements (1 January 2017) is sufficient to implement these improvements along with regular maintenance and/or overhaul activities.

Table 2.2 indicates the *biomass-to-transport* chains that were analysed in this context. Two biofuel chains were excluded from the analysis, viz. biodiesel from sunflower and pure vegetable oil from rapeseed. These chains both have current typical values of 58%, which is so close to the 60% threshold that it is certain that they will meet this threshold by 2018 given the autonomous developments as specified in Section 2.2.2.

Table 2.2 *Biomass-to-energy chains analysed for the impact of the GHG criterion*

Chain	Typical GHG red. [%]
wheat ethanol (lignite as process fuel in CHP plant)[1]	32
wheat ethanol (natural gas as process fuel in conventional boiler)	45
wheat ethanol (natural gas as process fuel in CHP plant)	53
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	56
Rape seed biodiesel	45
Soy bean biodiesel	40
Palm oil biodiesel (process not specified)	36
Hydrotreated vegetable oil from rape seed	51
Hydrotreated vegetable oil from palm oil (process not specified)	40
CHP from biogas based on dedicated crops such as maize	?[2]
CHP based on vegetable oils such as palm, rapeseed and soy	?[2]

[1]: This chain was also used for the category 'wheat ethanol (process not specified)'.

For routes that convert *biomass into electricity and/or heat*, using two chains were analysed that were suspected of not meeting the 60% threshold:

- The anaerobic digestion (plus CHP or power-only) route in case cultivated crops are used.
- CHP (or power-only) in diesel engines fed by vegetable oils such as palm oil.

2.2.2 Baseline improvements to the GHG emissions of the different chains

The 2017 and 2020 GHG thresholds need to be evaluated in the context of future 'typical' greenhouse gas emission reductions that can be expected for the different chains. Autonomous improvements in the typical values as specified in Annex V-D of the directive will occur, not induced by the GHG thresholds but by other (EU) policies, such as:

- The 20% greenhouse gas emission reduction ambitions of the Climate directive, what will affect chain emissions in several ways: through the recent inclusion of the fertiliser production sector in the EU-ETS, but also possibly through non-ETS activities, such as CO_2 emission limits for vehicles and specific objectives in different sectors.
- The 20% energy efficiency ambition of the European Commission; although this ambition has not been converted into a directive, there will be incentives for efficiency improvement and corresponding CO_2 emissions.

The autonomous developments in GHG emissions related to the biofuels chains were assessed as follows.

Feedstock production: N_2O emissions related to N fertiliser

Nitrous oxide emissions from the N fertiliser industry make up a considerable share of total greenhouse gas emissions related to biofuel feedstock production. Since 2008, however, N_2O emissions in the fertiliser industry have become part of the EU-ETS. Several sources, such as the IPCC Fourth Assessment Report (Metz et al. 2007) indicate that N_2O abatement cost in this sector lie in the order of several €/tCO_2-eq. Recently, several major parties in the fertiliser manufacturing industry have successfully implemented end-of-pipe technology to existing N fertiliser plants, reducing N_2O emissions by 90% or more (DSM 2008). Also, the popularity of fertiliser production related N_2O emission reduction projects in the CDM and JI programmes (UNFCCC 2009) illustrates that major reductions can be achieved here against very competitive CO_2 abatement costs.

For this study, we assumed a 90% reduction of nitrous oxide emissions in N fertiliser to be realised on a relatively short term.

Feedstock production: CO_2 emissions related to N fertiliser

Apart from its N_2O emissions, the N fertiliser industry is also a very energy intensive sector, with substantial CO_2 emissions. These emissions will also be subject to reduction ambitions, either through the EU-ETS or through (sector-specific) non-ETS policies. In order to assess autonomous improvements or energy and CO_2 efficiency in this sector, we used the detailed data from the PRIMES EE scenario and the corresponding 2006 baseline (Mantzos and Capros 2006), taking the chemistry industry as a reference sector. The baseline projects a 21% CO_2 efficiency gain between 2010 and 2020 in this sector; the EE scenario projects 27% in this period. For this study, we assumed a 25% reduction of CO_2 emissions in N fertiliser production by 2020.

Feedstock production: emissions not related to N fertiliser production

Major other sources of GHG emissions in feedstock production are N_2O emissions from fertiliser application and CO_2 emissions related to energy inputs (transport of inputs, management of the land, etc.). A wide variety of emission reduction options exists, but its mitigation potential is difficult to assess. For example, the IPCC FAR indicates a reduction potential in agriculture between 5% and 30% at mitigation costs of 20 $/t$CO_2$ and below (Metz et al. 2007). Specifically for the EU, a study for DG-ENV (Bates 2001) indicates an abatement potential for N_2O and methane emissions in agriculture of approximately 5%. More specifically, a covenant between the Dutch ministry of agriculture and the agrosector agrees on circa 10% emission reductions in arable farming and animal husbandry between 2008 and 2020. For this study, we assumed a 5% reduction of GHG emissions in feedstock production by 2020, for emissions other than those related to N fertiliser.

Biofuel processing: GHG emission reductions

The biofuel processing industry will also be subject to CO_2 reduction and energy efficiency improvement policies. In order to assess autonomous improvements or energy and CO_2 efficiency in this sector, we used the detailed data from the PRIMES EE scenario and the corresponding 2006 baseline (Mantzos and Capros 2006), taking the food and beverages industry as a reference sector. The baseline projects a 6% CO_2 efficiency gain between 2010 and 2020 in this sector; the EE scenario projects 14% in this period. Furthermore, in palm oil processing, methane emissions will be further reduced by methane capture. For this study, we assumed a 10% reduction of CO_2 emissions in the biofuel processing industry by 2020, with a linear development towards that level from 2008. Additionally, we assumed a 20% average reduction in methane emissions at palm oil mills by 2020.

Additional assumptions related to biogas CHP from cultivated crops

For the calculation of the typical greenhouse gas emission reductions of this option, we made use of a recent study by Wageningen UR on this topic (Conijn and Corré 2009), standard reference values for efficiencies that ECN uses for the Dutch renewable energy policy (Tilburg et al. 2008), and reference CO_2 emissions for power and heat production as supplied by DG-TREN. See Appendix A for a specification of the calculations. For the developments up to 2020, additional assumptions were:

- A 15% efficiency improvement of digester and gas engine up to 2020, also valid for new plants by 2018.
- A 40% reduction of methane emissions in processing, as these are mainly attributed to methane slip in the gas engine which can be well avoided by better engine management. This assumption also applies to new plants after 2018.

Additional assumptions related to CHP based on vegetable oils

For the calculation of the typical greenhouse gas emission reductions of these options, we used the draft values from JRC as provided by DG-TREN. For the developments up to 2020, additional assumptions were:

- A 5% efficiency improvement of the related diesel engines, also valid for new plants by 2018.
- A 10% efficiency improvement in long-distance transport, also valid for new plants by 2018.

Table 2.3 summarises the key assumptions on biofuels. In order to come from the 2020 projections to values for 2017 and (new plants) 2018 we used the following assumptions:

- For emissions related to feedstocks, emission reductions we linearly interpolated between 2020 and 2008, except for N_2O emissions in N fertiliser production, which were assumed to reach 90% reduction by 2018.
- For emissions related to biofuel processing, 2017 emission reductions were obtained by linear interpolation between 2020 and 2008. New plants by 2017, however, we assumed to have reached 2020 emission reduction levels by that time.

Table 2.3 *Overview of key assumptions on autonomous GHG emission reductions affecting the typical GHG emissions of biofuel chains*

Emission reduction in sector/substance	Typical emission reduction 2017 [%]	Emission reduction new plants 2018 [%]	Typical emission reduction 2020 [%]
N_2O in N fertiliser production	81	90	90
CO_2 in N fertiliser production	19	21	25
Overall GHG in agriculture	3.8	4.2	5
CO_2 in biofuels processing industry	7.5	10	10

2.2.3 Typical values for GHG reductions by 2017 and 2018

Biofuels

Using the detailed JRC methodology, we subsequently calculated the 2017 and 2018 typical greenhouse gas emissions that would result from the projected autonomous emission reductions. These are summarised in Table 2.4. Many biofuel and CHP chains that do not meet the 50-60% thresholds by their 2008 values are projected to do so by their 2017 (existing plants) and 2018 (new plants) values.

However, the biofuel chain that falls short of the 2017 (existing plants) 50% threshold is:

- Biodiesel from soy

The biofuel chains that fall short of the 2018 (new plants) threshold of 60% are:

- Wheat ethanol with lignite as process fuel
- Wheat ethanol with natural gas (conventional boiler) as a process fuel
- Biodiesel from rapeseed
- Biodiesel from soy
- Biodiesel from palm (process not specified)

Table 2.4 *Typical biofuel GHG reduction values for 2008, 2017 and 2018. Pink marks signify where a chain does not meet a threshold*

Biofuel, chain	Typical GHG red. [%]	Typical GHG red 2017 [%]	Typical GHG red 2018 new [%]
Bioethanol (1st generation)			
Wheat			
lignite as process fuel in CHP plant	32	41	42
natural gas as process fuel in conv. boiler	45	53	54
natural gas as process fuel in CHP plant	54	61	62
Corn (maize)			
natural gas as process fuel in CHP plant)	56	61	62
Biodiesel			
Rape seed	45	54	55
Soy bean	40	43	44
Palm oil (process not specified)	36	38	40
Hydrotreated vegetable oil			
Rape seed	51	60	61
Palm oil (process not specified)	40	45	47
Pure vegetable oil			
Rape seed	59	67	68

Biomass to power/CHP

In the power and CHP options, Annex V of the RES directive specifies a methodology for comparison on primary energy basis. However, for CHP on the basis of biogas, a comparison on that basis was not considered feasible, as maize does not directly substitute a fuel of fossil origin. In consultation with DGTREN, it was chosen to analyse all CHP/power options according to an adapted methodology, under development at DGTREN, in which greenhouse gas savings are based on avoided fossil emissions of the substituted power and/or heat production.

For the biogas option, detailed calculations are given in Appendix A. Key assumptions are:

- The energy content of the crop is converted to energy in biogas with an efficiency of 60%.
- The gas engine has an electric efficiency of 40%, and a thermal efficiency of 5%. This relatively low value was based on the notion that many biogas-CHPs can only usefully apply their heat due to limited (nearby) heat demand.
- Fossil energy generation emissions of CO_2 were obtained from DGTREN and set at 198 gCO_2/MJ_{final} for electricity production and at 87 gCO_2/MJ_{final} for heat generation.

For the bioliquids option, detailed calculations are given in Appendix B. The same figures were taken for the substitution of fossil-generated power and heat. As a reference system for bioliquids application, their use in diesel engines was taken, although these liquids can also be applied in conventional gas boiler power plants with a slightly higher efficiency. The conversion efficiency of bio-oil to power was set at 40% (for CHP and power-only), the heat efficiency in CHP at 30%.

The results are given in Table 2.5. All options meet the 50% threshold by 2017. Only the power generation options on the basis of soy and palm (process not specified) fall short of the 60% threshold. For comparison, the results for bioliquids based on the methodology in the RES directive are given in Appendix C.

Table 2.5 *Typical power/heat GHG reduction values for 2008, 2017 and 2018*

Chain	Typical GHG red. [%]	Typical GHG red 2017 [%]	Typical GHG red 2018 new [%]
CHP options			
CHP from biogas based on crops (maize)	68	74	76
CHP based on vegetable oils: rapeseed	67	73	76
CHP based on vegetable oils: soy	63	67	68
CHP based on vegetable oils: palm (no CH4 cap)	58	64	66
CHP based on vegetable oils: palm (CH4 cap)	77	80	81
Power generation options			
Power only from biogas based on crops (maize)	66	73	75
Power only on vegetable oils: rapeseed	56	65	68
Power only on vegetable oils: soy	51	56	58
Power only on vegetable oils: palm (no CH4 cap)	44	53	55
Power only on vegetable oils: palm (CH4 cap)	70	73	75

Note: Based on substitution of final energy

2.2.4 Construction of a baseline scenario for the deployment of the identified biofuel/liquid chains

Biofuels

To be able to assess overall impacts, a baseline scenario was constructed that quantifies the developments in production capacity for all the chains that are identified as susceptible to not meeting the 50-60% GHG threshold, both for the period until the end of 2016 (to which the 50% threshold applies) and for the period 2017-2020 (for which 60% applies). This scenario was mainly based on the scenarios formulated for the biofuels progress report (EC 2007); a 10% scenario was constructed by averaging the scenarios and adding some expert judgement where necessary. For the pathway towards 2020, a linear increase was assumed for all biofuel chains. Note that in reality however, advanced second-generation biofuels may show a growth acceleration towards 2020, while conventional biofuels such as biodiesel may show less than linear growth in the years towards 2020. Particularly the biodiesel saturation can be observed in the most recent GREEN-X analyses as deployed in the EmployRES study (Ragwitz et al. 2009), in which biodiesel production peaks in 2015. The impact of such a non-linear development on costs is included in Section 2.2.4. Table 2.6 summarises the linear baseline.

Table 2.6 *Specification of the baseline scenario needed for each biofuel chain*

all Mtoe	Scenarios in biofuels progress report (2020)			Newly constructed for this IA		
				2020	2017	2020-2017
Domestic	7%	14% dom	14% imp	10%	8%	2%
biodiesel from rape	4.7	3.9	4.7	4.0	3.2	0.8
biodiesel from sunflower				1.0	0.8	0.2
BTL from farmed wood	-	10.5	-	1.6	1.3	0.3
BTL from straw	2.5	0.5	7.5	4.0	3.2	0.8
ethanol from sugar beet	0.6	0.8	0.6	0.6	0.5	0.1
ethanol from wheat	5.6	11.2	5.6	7.4	5.9	1.5
ethanol from maize	1.3	1.5	1.3	1.5	1.2	0.3
cellulosic ethanol from straw	2.1	5.0	-	2.1	1.7	0.4
imports						
rape for biodiesel	2.4	2.6	2.6	2.5	2.0	0.5
palm for biodiesel	0.4	2.9	4.2	2.0	1.6	0.4
soy for biodiesel	2.6	3.2	4.6	2.5	2.0	0.5
ethanol from sugar cane	0.8	0.9	11.9	2.6	2.1	0.5
Total biofuels consumption	23.0	43.0	43.0	31.8	25.4	6.4
Relative shares:						
share of imports	27%	22%	54%	30%	30%	
share of diesel replacers	55%	55%	55%	55%	55%	
share of second-generation	20%	37%	17%	24%	24%	
share of HVO in rape				20%	20%	
share of HVO in palm				50%	50%	
share of HVO in soy				20%	20%	

Biomass to power/CHP

For the biogas option and the application of bioliquids in CHP, no baseline scenario was constructed as the option meets the 50% and 60 % thresholds.

For the application of bioliquids for power, no straightforward projections were available. In the detailed technology projections of the EmployRES study (Ragwitz et al. 2009), the option is probably included in two technology groups:

- Small-scale electricity production (bioliquids in diesel engines). This category has a production peak in EmployRES by 2018 at ca 26 TWh and then slightly decreases in capacity. Although production capacity using bioliquids may substitute small-scale power production with other feedstocks in the period 2017-2020, we conclude that the additional production capacity for bioliquids is negligible in this period.
- In EmployRES, large-scale co-firing for electricity production (bioliquids in conventional gas-fired power plants) increases in 2017-2020 by circa 5 TWh. The dominant feedstock in this option is co-firing of solid biomass; here we assume a 10% share of bioliquids, which for 80% consists of soy and palm. This results in ca 4 PJ of palm/soy bioliquids to be used for power production.

2.2.5 Identification and assessment of GHG improvement options

Different options for the chains to improve their GHG performance to meet the 50%-60% criteria will be elaborated, and their impacts on biomass availability and costs will be quantified as well as possible.

Ethanol from wheat

The most straightforward way for the sector to deal with the 2020 GHG threshold is to shift their process fuel towards CHP, on the basis of NG or biomass. This improves the GHG emission reduction to 62% for new plants by 2018 (NG CHP) or higher.

Biodiesel from rapeseed

For the biodiesel sector to meet the 60% threshold for new plants after 2017, additional efforts will be required. First-order option for the sector would be the introduction of biomethanol in stead of fossil methanol. Detailed data are specified in Appendix B; this option leads to a typical GHG reduction of 62%.

Biodiesel from soy

For soy biodiesel, additional options to improve the GHG profile seem to be insufficient to meet the 50% and the 60% threshold. For existing installations by 2017, the 50% threshold can be met by the introduction of biomethanol in stead of fossil methanol; it leads to a GHG emission reduction of just 50%. For new installations 2018, a shift in feedstocks for biodiesel would be expected, in which soy is phased out and substituted for rapeseed and sunflower.

Biodiesel and HVO on the basis of palm (process not specified):

For the options using palm (without methane capture) that do not meet the 50% and/or 60% threshold, it can be foreseen that methane capture will be implemented, which can be done relatively cost-effectively. This leads to a typical GHG reduction of well over 60%.

Power generation from palm (process not specified) and soy

Technically, soy and palm oil are fully exchangeable when applied for power generation. Therefore, it can be assumed that soy oil is substituted by palm oil; this palm oil can then be fully obtained from milss with methane capture. This increases the greenhouse gas emission reduction to 75% (see Table 2.5).

2.2.6 Quantification of the impacts of the GHG improvement options on biomass/bioenergy availability and costs

Biofuels

The impacts on biofuel costs of the measures described in were assessed as follows (see Appendix E for calculation details). All costs are annual costs for the year 2020, no cumulative costs for 2008-2020 were calculated.

- The introduction of CHP in wheat ethanol on the basis of NG boilers is considered cost-effective as such. Industry federation Ebio has already indicated that it expects new investments in ethanol plants to use biomass as a process fuel (Vierhouten 2009). Also for existing installations, which mostly run on natural gas, the introduction of CHP is a cost-effective investment, particularly in a future with high fuel costs (Edwards et al. 2006). Ebio indicated that there is one plant in the EU that uses lignite as a process fuel (Vierhouten 2009). Its upgrade to a more advanced and carbon efficient process fuel will have negligible impacts on overall ethanol costs in the EU.
- Introduction of biomethanol in rapeseed biodiesel production: we took methanol from wood waste as the green reference, and the average of methanol from NG and coals as fossil reference. On the basis of the cost data for methanol in the WTW study (Edwards et al. 2006), oil price of 50 €/bbl taken): additional costs of this option are ca 0.2 €/GJ biodiesel (see Appendix D); total additional costs for the new biodiesel production in 2017 and beyond (see Table 2.6) are € 12 million per year.
- Introduction of biomethanol in soy for existing installations by 2017: on the basis of the same cost assumptions as for rapeseed biodiesel, this leads to additional costs for the 2 Mtoe of soy biodiesel capacity of € 18 million per year.
- Phase out of soy biodiesel for new 2018 installations: The total additional soy production of 0.5 Mtoe by 2020 (see Table 2.6) is replaced for 80% by rapeseed biodiesel, for 20% by sunflower. Based on a price difference of € 30 /toe between rapeseed/sunflower and soy biodiesel (EC 2007) this leads to an additional cost of € 15 million.

- The additional introduction of methane capture in palm oil production: on the basis of several CDM projects on this technology (UNFCCC 2009), we conclude that methane capture is usually profitable at CO_2 prices below € 10/t$CO_{2\text{-eq}}$, which is equivalent to 0,2 €/GJ biodiesel. Purchasing 100% palm oil with methane capture would lead to 80% higher costs (as 20% methane capture is already part of the baseline), which, given the project use of palm oil of 2 Mtoe (Table 2.6) equals ca € 15 million.

When, assuming a biodiesel peak by 2015, several cost items change. Assuming that biodiesel production already reaches its 2020 levels before 2017, no additional costs are projected for biodiesel from rapeseed and soy to meet the 60% thresholds. All soy production shifts to biomethanol use, while the shift in palm oil towards methane capture remains unchanged. Table 2.7 summarises the findings.

Table 2.7 *Summary of biofuel chains not meeting the 60% threshold by 2018, improvement options and related costs*

Biofuel chain	Autonomous GHG emission reduction	Improvement option	Resulting GHG emission reduction	Additional costs for the year 2020 (linear baseline)	Additional costs for the year 2020 (2015 biodiesel peak)
Ethanol from wheat (NG boiler)	54% (2018)	Shift to NG CHP	62% (2018)	0	0
Biodiesel from rapeseed	55% (2018)	Biomethanol in processing	62% (2018)	13 M€	0
Biodiesel from soy	43% (2017)	Biomethanol in processing	50% (2017)	18 M€	23 M€
Biodiesel from soy	44% (2018)	Shift to rape, sunflower	>62% (2018)	15 M€	0
Biodiesel/HVO from palm (p.n.s.)	45/47% (2017) 43/47% (2018)	Methane capture	> 62/68%[1] (2018)	15 M€	15 M€
Total additional costs				61 M€	38 M€

[1]: 62% and 68% are the current typical values for respectively biodiesel and HVO from palm with methane capture at oil mill. 2017 and 2018 values have not been calculated but will be above these values.

Biomass to power/CHP

A full shift to methane capture in palm oil production comes at an estimated cost of 0,2 €/GJ palm oil. The estimated 4 PJ of palm oil use as a bioliquid in power generation would then lead to additional costs in the order of € 1 million.

2.2.7 Conclusions and discussion remarks

Conclusions

- Many biofuel chains are expected to meet the 50% and 60% greenhouse gas thresholds due to autonomous developments in agriculture and processing, mainly induced by climate policy.
- For the chains that do not meet the thresholds, additional measures or feedstock shifts are available that allow them to comply with them.
- The additional costs of these measures are estimated between € 40 and 60 million for the year 2020, depending on the development pathway of biodiesel production.

- For the use of biomass in power generation, all CHP chains and most power generation chains analysed also meet the (hypothetical) 50% and 60% thresholds for greenhouse gas emission reductions by autonomous development. For this analysis, the new (draft) methodology of DGTREN was used, using fossil fuel comparators based on substitution of final energy.
- For the chains that do not meet the thresholds, additional measures and feedstock shift options are available.
- Given the projected limited penetration of bioliquids application in power generation, additional costs are limited to ca € 1 million.

Discussion remarks:
- In the calculation of the typical greenhouse gas emissions, impacts of direct and indirect land use change were not taken into account. These impacts can be substantial.
- We based our calculations on the typical values of biofuel chains, as specified in the renewables directive. These may be subject to debate. For example, N_2O emissions from land use are extremely variable and hard to be summarised into on 'typical' value.
- The assessment of autonomous improvement contains considerable uncertainties. Sectorial averages might not be fully valid for the specific sectors to which they were applied.
- The baseline scenario for the development of the different biofuels chains is also subject to uncertainties. One critical issue is the projected share of 2nd generation biofuels by 2020 of almost 25%. This could be considered ambitious. In the most conservative case, if 2nd generation biofuels would not be part of the mix by 2020, additional costs for meeting the GHG threshold would be circa one quarter higher (assuming proportional coverage of the gap by all conventional biofuels).
- Many projections depend on the successful deployment of EU and national climate policies. If these policies fail, more chains may not meet the different thresholds.
- On the other hand, all indications were based on a 20% GHG emission objective for the EU. If the Copenhagen negotiations appear to be successful, the EU steps up its ambition to a 30% emission reduction (and succeeds in implementing this), autonomous greenhouse gas savings will be higher than assessed here.

2.3 Task 2.3: The land exclusion criteria (17.3, 4 and 5)

2.3.1 Assessment of impacts on EU potential and costs

The land exclusion criteria (see Table 2.1) could directly affect the land base available for agriculture in general and thereby the potential availability of biomass. The studies used in Task 1 were checked whether:
- They claimed that the specified no-go areas (article 17.3) are not considered part of the available land resource base for agriculture (criteria 17.3)
- They claimed that the land types of articles 17.4 and 17.5 were only used for residues without bringing changes to the status of the land , and if forests were used in a responsible way consistent with Article 17.4.

The detailed results are given in Appendix 2.F.

Impacts on agricultural crop availability

For this part, studies from the EU projects REFUEL (Fischer et al. 2007) and RENEW (Ganko et al. 2008), the EEA Background study on agricultural crops (EEA 2007b) and one other relevant study from task 1 (Ericsson and Nilsson 2008) were studied. All studies assess the availability of crops on the basis of (existing) agricultural land, with REFUEL being the most explicit in its exclusion of specific categories of land cover. Overall, we can conclude that the land exclusion criteria do not reduce the biomass potentials or costs for agricultural crops as reviewed in Task 1.

Impacts on agricultural residues

All studies reviewed (Edwards et al. 2005; EEA 2007b; Fischer et al. 2007; Ericsson and Nilsson 2008; Ganko et al. 2008) relate agricultural residue availability to crop production on existing agricultural areas. As no expansion of EU agricultural area is projected, it can be concluded that the biomass potentials and costs for agricultural residues in Task 1 will not be reduced by the land exclusion criteria.

Impacts on forestry products and residues

All of the studies reviewed for this part (Alakangas et al. 2007; EEA 2007a; Wit et al. 2007; Asikainen et al. 2008; Ericsson and Nilsson 2008; Ganko et al. 2008; Hetsch et al. 2008; Mantau et al. 2008) claim to either exclude primary forests and nature reserves, or indicated only to analyse 'exploitable forest' or 'forest available for wood supply'. Although the strictness of these definitions could not be verified, it seems reasonable to assume that EU forestry as it functions today has sufficient safeguards in place so that it does not exploit no-go areas, and uses forestry residues in a manner consistent with the criteria specified in articles 17.4 and 17.5.

2.3.2 Assessment of impacts on availability and costs of imports

The GREEN-X database makes use of two bioenergy import flows: forestry imports and (feedstocks for) biofuels. In order to assess the possible impact of the land exclusion criteria, we did the following:

- We analysed the material that was used in Task 1 (Section 1.3 and 1.4) to evaluate the feasibility of these import availability and costs on attention to land exclusion.
- We analysed to what extent the assessment of global biomass availability (as reviewed in section 1.9) takes into account land exclusion.
- If available and relevant, we checked how the projected imports of biomass relate to current trade flows.

Forestry imports

Imports of forestry residues is projected at 9 Mtoe in the GREEN-X dbase (Ragwitz et al. 2009). In the EEA study (EEA 2007a) applied in Task 1 (section 1.3) to assess forestry import availability and costs, no specific attention is paid to sustainability issues related to these imports. In the analysis of section 1.0 (global biomass availability), the IEA Bioenergy Review (IEA 2009) mentions a potential of forest residues of 30-150 EJ (700-3600 Mtoe) by 2050, of which a major share would become available in the coming one or two decades. However, these indications do not explicitly take into account any land exclusion criteria. Of the key import regions for the EU, Canada has a good reputation in sustainable forest management (CCFM s.d.). Russia is on one hand reported to have elaborate forestry legislation (Filiptchouk et al. 2001) is also criticized for poor forest management and illegal logging (Alekseeva 2007). It may be clear that not all forest import materials currently available will meet the land exclusion criteria in the directive. However, given the ratio between projected availability and the 9 Mtoe used in GREEN-X, it can be concluded that there will be sufficient forestry material available for import that does meet the land exclusion criteria.

Biofuels imports

In GREEN-X (Ragwitz et al. 2009), it is assumed that 30% of biofuels consumption will be met by ex-EU imports, mainly consisting of vegetable oils (rape seed, soy and palm oil) and bioethanol. At a 10% biofuels share in 2020, total imports would add up to almost 10 Mtoe, of which (see Table 2.6) 3 Mtoe rapeseed, 2 Mtoe soy, 2 Mtoe palm and 2,5 Mtoe bioethanol. In the analysis in Task 1 (section 1.4), in which it is concluded that the assumption is realistic though related to major uncertainties, the literature cited does not paid specific attention to the land exclusion criteria. The analysis of global biomass potentials (section 1.9, mainly based on IEA (IEA 2009)) projects a production potential for energy crops of 0-700 EJ, with a moderate estimation of 120 EJ (or almost 3.000 Mtoe) by 2050. As the underlying studies for this assessment usually limit their analysis to currently available agricultural lands (see e.g. the detailed review by Dornburg et al (Dornburg et al. 2008)), it is expected that the lion's share of this potential will meet the land exclusion criteria. The share that can become available by 2020 is not further specified. Again, it should be stressed that these availability estimations strongly depend on developments in agricultural productivity, animal husbandry and food consumption. Particularly in soy (Latin America) and palm oil (South-East Asia), deforestation is a much-debated issue and it is clear that not all current trade flows of these products meet the land exclusion criteria. However, even current global trade volumes of palm and soy (ca 25 Mtoe and 10 Mtoe, respectively, (Thoenes 2006)), are substantially larger than 2020 demand for these sources. Therefore, it seems reasonable that this demand can be met by oils that meet the land exclusion criteria, provided a verification system is put in place.

2.3.3 Conclusions and discussion remarks

Conclusions

- On the basis of the material reviewed, it is unlikely that the land exclusion criteria will substantially affect availability and costs of EU domestic biomass and biomass imports as assumed in GREEN-X.
- For EU-produced biomass, this conclusion is be better supported by the studies reviewed, as they are more explicit on e.g. the types of land available for crop production. Furthermore, it can be safely assumed that current management practices of e.g. nature reserves, forests and wetlands provide sufficient compliance with the land exclusion criteria.
- For ex-EU imports, a straightforward assessment could not be made, as e.g. global biomass potentials are still very uncertain. However, given the size of projected imports and the considerably larger order of magnitude of global potentials, it seems reasonable to conclude that this demand can also be met by feedstocks that meet the land exclusion criteria. This, however, does *not* mean that current and future trade flows of e.g. palm and soy are free from product batches that are e.g. grown on no-go areas; it means that the biofuels industry will be able to purchase sufficient quantities of feedstock grown outside such areas provided a verification system is in place.

Discussion remarks

- The directive criteria in Articles 17.2 to 17.5 do not go into *indirect* land conversion or expansion into no-go areas: land that is currently used for food cultivation starts being used for energy while e.g. other forest land is converted to arable in order to produce food. This issue will be addressed by additional work by the commission on indirect land us change (Article 19.6). In our analysis, most studies assessing biomass potentials focus on agricultural lands, thereby also preventing indirect intrusion into no-go areas. However, as indirect effects are extremely complicated to assess, our conclusions do not fully cover all possible impacts of indirect land use change.
- All studies used land use information that was dated earlier than January 1, 2008. This leads to a somewhat conservative estimation of the potential, as e.g. wetlands that have been converted before January 1, 2008 were also excluded.

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Appendix 2.A Calculations for biogas CHP using cultivated crops (maize)

Energy yield

				Source
crop yield		17,5	ton d.s./ha/yr	Conijn et al
energy content dry matter		17	GJ/ton d.s.	Conijn et al
overall E efficiency digester + engine		24%		Conijn et al and Tilburg et al
electricity yield	71		GJ/ha/yr	
overall heat efficiency		3%		Tilburg et al.
heat yield	9		GJ/ha/yr	

GHG-emissions

N_2O emisison	1,56	tCO_2-eq/ha/yr	Conijn et al
CH4 emission	1,34	tCO_2-eq/ha/yr	Conijn et al
CO_2 agri	0,66	tCO_2-eq/ha/yr	Conijn et al
CO_2 transport	0	tCO_2-eq/ha/yr	Conijn et al
CO_2 processing	1,26	tCO_2-eq/ha/yr	Conijn et al
total	4,8	tCO_2-eq/ha/yr	
or	60	gCO_2/Mjfinal	

GHG emissions fossil reference

electricity part	198		gCO_2/MJfinal	DGTREN
heat part		87,3	gCO_2/MJfinal	DGTREN
total fossil emissions for a ha's yield	14,9		tCO_2-eq/ha/yr	

	typical	default
GHG emission saving vs fossil	*68%*	*64%*
power only:	*66%*	*62%*

Autonomous improvement up to 2020						
	2020	2017	2018 new		Improvement assumptions for 2020 and motivation:	
crop yield	18,4	18,16	18,23	ton d.s./ha/yr	5%	Average yield increase not outbalanced by higher inputs
energy content dry matter	17	17	17	GJ/ton d.s.		
overall E efficiency digester + engine	27,6%	26,7%	27,6%		15%	Efficiency improvement of digester and gas engine
electricity yield	86	82	86	GJ/ha/yr		
overall heat efficiency	3%	3%	3%		0%	Local heat demand usually the limiting factor, no improvement assumed
heat yield	9	9	9	GJ/ha/yr		
N2O emisison	1,56	1,56	1,56	tCO2-eq/ha/yr	0%	Improvements already taken into account in the average yield increase
CH4 emission	0,80	0,94	0,80	tCO2-eq/ha/yr	40%	Mostly methane slip in gas engine, reduced by better engine management
CO2 agri	0,66	0,66	0,66	tCO2-eq/ha/yr	0%	Moderate efficiency gains in agriculture
CO2 transport	0	0	0	tCO2-eq/ha/yr		
CO2 processing	1,26	1,26	1,26	tCO2-eq/ha/yr	0%	Improvements already taken into account in the system efficiency improvement
total	4,3	4,4	4,3	tCO2-eq/ha/yr		
or	45	48	45	gCO2/MJf		
fossil reference:						
electricity part	198	198	198	gCO2/MJf	0%	Fossil conversion efficiency gains to be outbalanced by larger coal share
heat part	87	87	87	gCO2/MJf	0%	Hardly any gains to be reached here any more
total fossil emissions for a ha's yield	17,9	17,1	17,7	tCO2-eq/ha/yr		
GHG emission saving vs fossil CHP)	*76%*	*74%*	*76%*			
power only	*75%*	*73%*	*75%*			
With default values (+40% in processing)						
GHG emission saving vs fossil CHP)	*73%*	*71%*	*73%*			
power only	*72%*	*70%*	*72%*			

Appendix 2.B Key data for calculations on bioliquids, comparison on final energy

2008					
energy yields					
electric efficiency	40%		198	gCO2/MJfinal	
heat efficiency	30%		87,3	gCO2/MJfinal	
Avoided fossil GHG emissions:					
power production part	79,2	gCO2/Mjoil	reference		
heat production part	26,19	gCO2/Mjoil	reference		
total	105,39	gCO2/Mjoil			
GHG emissions	palm (c.)	palm (n.c.)	rape	soy	
feedstock	15	15	30	20	
cult	13	13	18	18	
N-fert	2	2	12	2	
transport	5	5	1	14	
conversion	4	24	4	5	
total	24	44	35	39	
GHG emission saving	77%	58%	67%	63%	

2017				
energy yields				
electric effici	42%			
heat efficien	30%			
Avoided fossil GHG emissions:				
power produ	82,17	gCO2/Mjoil		
heat product	26,19	gCO2/Mjoil		
total	108,36	gCO2/Mjoil		
	palm (c.)	palm (n.c.)	rape	soy
feedstock	13,8	13,8	24,3	18,6
cult	12,5	12,5	17,3	17,3
N-fert	1,3	1,3	7,0	1,3
transport	4,6	4,6	1,0	13,0
conversion	3,4	20,4	3,4	4,3
total	21,8	38,8	28,7	35,8
GHG emissi	80%	64%	73%	67%

2018 new					
energy yields					
electric effici	42%				
heat efficien	30%				
Avoided fossil GHG emissions:					
power produ	83,16	gCO2/Mjoil			
heat product	26,19	gCO2/Mjoil			
total	109,35	gCO2/Mjoil			
	palm (c.)	palm (n.c.)	rape	soy	
feedstock	13,4	13,4	22,3	18,3	gCO2eq/Mjoil
cult	12,4	12,4	17,3	17,3	gCO2eq/Mjoil
N-fert	1,0	1,0	5,0	1,0	gCO2eq/Mjoil
transport	4,6	4,6	1,0	12,8	gCO2eq/Mjoil
conversion	3,2	19,2	3,2	4,0	gCO2eq/Mjoil
total	21,1	37,1	26,5	35,1	gCO2eq/Mjoil
GHG emissi	81%	66%	76%	68%	

Electricity only

2008				
energy yields				
electric efficiency	40%			
heat efficiency	0%			
Avoided fossil GHG emissions:				
power production part	79,2	gCO2/Mjoil		
heat production part	0	gCO2/Mjoil		
total	79,2	gCO2/Mjoil		
GHG emission saving vs fc	70%	44%	56%	51%

2017				
energy yields				
electric effici	42%			
heat efficien	0%			
Avoided fossil GHG emissions:				
power produ	82,17	gCO2/Mjoil		
heat product	0	gCO2/Mjoil		
total	82,17	gCO2/Mjoil		
GHG emissi	73%	53%	65%	56%

2018 new				
energy yields				
electric effici	42%			
heat efficien	0%			
Avoided fossil GHG emissions:				
power produ	83,16	gCO2/Mjoil		
heat product	0	gCO2/Mjoil		
total	83,16	gCO2/Mjoil		
GHG emissi	75%	55%	68%	58%

Appendix 2.C GHG savings for bioliquids, methodology as in RES directive

CHP options	[%]	[%]	[%]
CHP based on vegetable oils: rapeseed	59%	66%	69%
CHP based on vegetable oils: soy	54%	58%	59%
CHP based on vegetable oils: palm (no CH4 cap)	48%	54%	56%
CHP based on vegetable oils: palm (CH4 cap)	72%	74%	75%
Power generation options			
Power only on vegetable oils: rapeseed	62%	68%	71%
Power only on vegetable oils: soy	57%	61%	61%
Power only on vegetable oils: palm (no CH4 cap)	52%	57%	59%
Power only on vegetable oils: palm (CH4 cap)	74%	76%	77%

Appendix 2.D Calculation impact of 'green methanol'

GHG emissions 'green methanol'			
Source: JRC/CONCAWE/EUCAR appendix 2			
Farmed wood		correction	
Feedstock	4,7	4,7	gCO_2/Mjfuel
Road transport	0,7	0,7	gCO_2/Mjfuel
Gasifier + MeOH synthesis	0,2	0,2	gCO_2/Mjfuel
Methanol distribution & dispensing	1,1	0,5	gCO_2/Mjfuel
Total	6,7	6,1	gCO_2/Mjfuel

GHG emission fossil methanol			
Source: JRC/CONCAWE/EUCAR appendix 2			
Piped NG, EU plant			
NG Extraction & Processing	5,2	5,2	gCO_2/Mjfuel
NG Transport	11	11	gCO_2/Mjfuel
NG Distribution (HP)	0,8	0,8	gCO_2/Mjfuel
Methanol plant	11,7	11,7	gCO_2/Mjfuel
Methanol distribution & dispensing	1,9	1	gCO_2/Mjfuel
Subtotal		29,7	gCO_2/Mjfuel
Fossil emissions		69,1	gCO_2/Mjfuel
Total	30,6	98,8	gCO_2/Mjfuel
Piped NG, EU plant			
NG Extraction & Processing	4,7	4,7	gCO_2/Mjfuel
Methanol plant	11,7	11,7	gCO_2/Mjfuel
Methanol transport	5,9	5,9	gCO_2/Mjfuel
Methanol distribution & dispensing	1,9	1	gCO_2/Mjfuel
subtotal		23,3	gCO_2/Mjfuel
Fossil emissions		69,1	gCO_2/Mjfuel
Total	24,2	92,4	gCO_2/Mjfuel
GHG reduction of green methanol:		94%	

Calculation impact of biomethanol in eserification		
Source: JRC/CONCAWE/EUCAR appendix 3		
Impact on GHG emissions biodiesel:		
Methanol input in biodiesel prod	0,0585	MJ/MJfuel
fossil GHG emissions of meOH in bd	5,59	gCO_2/Mjfuel
GHG emissions when green MeOH	0,36	gCO_2/Mjfuel
total emission of esterif (fossil) 2020	11,49	gCO_2/Mjfuel
corrected for green MeOH	6,26	gCO_2/Mjfuel

Appendix 2.E Additional costs of measures induced by the GHG thresholds

1. Additional costs biomethanol in rapeseed biodiesel 2018 new

Total new rape biodiesel consumption 2017-2020	1,44	Mtoe
or	60,336	PJ
Total additional costs biomethanol	13	Million € /yr

2. Additional costs biomethanol in soy biodiesel 2017

Total soy biodiesel consumption existing 2017	2	Mtoe
	83,8	PJ
Total additional costs methanol	18	Million €/yr

3. Additional costs feestock shift soy-rape/sunflower 2018 new

Costs biodiesel rape/sunflower	700	€/toe	EC (2007)
Costs biodiesel soy	670	€/toe	EC (2007)
Total substituted new soy biodiesel production 2017-2020	0,5	Mtoe	
Total cost shift soy-rape	15	Million € /yr	

4. Additional costs methane capture palm oil mill

palm:	GHG red	emisison				
Pns	36%	54	gCO_2-eq/MJ			RES directive
Mc	62%	32	gCO_2-eq/MJ			
Reduction		22	gCO_2-eq/MJ			
Competitive at:				10	€/tonCO_2	UNFCC (2009)
add. Costs:		0,2	€/GJ			
Autonomous development:						
By 2020,		20%	of palm oil production is fitted with methane capture			
Additional effortsca be		80%	additional costs			
Total palm oil use in biofuel production 2020:				2	Mtoe	
			or	83,8	PJ	
Total additional costs				15	Million €	

5. Additional costs methane capture at bioliquids use 2018 new

Projected additional small-scale electricity 2018-2020	0	GWh	EMPLOYRES policy case (Ragwitz et al)
share of projects with bioliquids	20%		
share of palm/soy in this production	70%		

Total production from palm/soy	0	GWh	
oil input	0		
Projected additional large-scale co-firing 2018-2020	5.298	GWh	EMPLOYRES policy case (Ragwitz et al)
share of projects with bioliquids	10%		
share of palm/soy in this production	80%		
Total production from palm/soy	424	GWh	
oil input	4	PJ	
or	0,08	Mtoe	
add costs	0,8	M€	

Appendix 2.F Evaluation of the land exclusion criteria in the studies used in Task 1

Legend to the tables:

CLEARED: study is explicit in exclusion of areas
Cleared: study is not fully explicit in its exclusion, but on the basis of the methodology areas seem to be (almost) fully excluded
Not cleared: Study is not fully explicit in its inclusion, but on the basis of the methodology areas seem to be partly included, impact on biomass potential is negligible
NOT CLEARED: Study is (not fully) explicit in its inclusion, (but on the basis of the methodology areas seem to be partly included,) impact on biomass potential is not negligible

Availability of crops

	Excluded for all resources			Excluded for land conversion/crops, not excluded for residues without conversion				
Study	3a Primary forest	3b Nature areas	3c Highly biodiverse grasslands	4a Wetlands	4b Continuous forests	4c Semi-forested areas	5 Peatland	Reference (year)
REFUEL	CLEARED	CLEARED	CLEARED [1]	CLEARED	CLEARED	Not cleared[2]	CLEARED [3]	CORINE (2000) IUCN-WMCM for 3b
EEA (agriculture)	Cleared[4]	Cleared [4]	Cleared[5]	Cleared[4]	Cleared[4]	Cleared[4]	Cleared[4]	n.s.
RENEW	Cleared[6]	Cleared[6]	Not cleared[7]	Cleared[6]	Cleared[6]	Not cleared[9]	Cleared[8]	n.s.
Ericsson (2005)	Cleared[10]	Cleared[10]	Cleared[10]	Cleared[10]	Cleared[10]	Cleared[10]	Cleared[10]	

Remarks on REFUEL:

: These grasslands are specified as 'natural grassland' in this publication and excluded from the resource base.

[2]: Semi-forested areas could partly be in the category 'heterogeneous agriculture' that is available for energy crops. This category includes (i) agricultural land with significant areas of natural vegetation and (ii) agro-forestry areas, ca 24 Million ha in total in the EU27. Category (i) contains lands with grassland and lands with woodland as the natural vegetation; both might be excluded given criterion 3c and 4c, respectively. Agroforestry (ii, most clear example the Spanish Dehesas) could also fall under criterion 4c. However, if these areas are to remain in current (agricultural) production for food/feed, sufficient areas would remain available in other categories to accommodate the estimated land potential for energy crops.

[3]: Peatland is not explicitly given. However, 'peat bogs' are considered a type of wetland and excluded from the land resource base.

Remarks on EEA:

[4]: The land availability is based on the Utilised agricultural area. HNV farmland area is increased from its current levels and excluded from the available land. No conversion of permananent grassland, dehesas and olive grives through ploughing.

[5]: If in future extensive land use categories such as permanent grassland, olive groves and dehesas/montados are released from agriculture, and therefore become potentially available for biomass production, these should not be ploughed for targeted biomass crops. Instead they should be maintained under their current land cover and ecological structure, while biomass from grass cutting or tree pruning could be harvested for bioenergy production. Thus, the approach assumes that permanent grassland is not converted into arable land due to nature conservation considerations and the high release of carbon from ploughed grassland.

Remarks on RENEW:

[6]: The RENEW analyses assesses biomass potentials on agricultural lands only.

[7]: Permanent pastures are (partly) eligible for bioenergy crops, in total this category makes up less than 5% of total potential. We assume highly biodiverse grasslands consist of a negligible part of this category.

[8]: Drained peatland may be part of 'agricultural area', but as energy crop production will not alter the level of drainage, this subgroup does not need to be excluded.

[9]: Semi-forested areas could partly be in 'agricultural land' that is available for energy crops. This category includes agricultural land with significant areas of natural vegetation and agro-forestry areas.

Additional remarks:

[10]: Limitation to 'agricultural land'.

Availability of agricultural residues

	Excluded for all resources			Excluded for land conversion/crops, not excluded for residues without conversion				
Study	3a Primary forest	3b Nature areas	3c Highly biodiverse grasslands	4a Wetlands	4b Continuous forests	4c Semi-forested areas	5 Peatland	Reference (year)
REFUEL	Directly related to (food) crop production statistics; no conflict with land exclusion criteria foreseen							
EEA	Consistent with the assumptions on agricultural crops, no conflict with criteria foreseen							
RENEW	Directly related to (food) crop production statistics; no conflict with land exclusion criteria foreseen							
Ericsson (2004)	Directly related to (food) crop production statistics; no conflict with land exclusion criteria foreseen							
Edwards (2005)	Directly related to (food) crop production statistics; no conflict with land exclusion criteria foreseen							

Availability of forestry products and residues

Study	Excluded for all resources: 3a Primary forest	Excluded for all resources: 3b Nature areas	Excluded for all resources: 3c Highly biodiverse grasslands	Excluded for land conversion/crops, not excluded for residues without conversion: 4a Wetlands	4b Continuous forests	4c Semi-forested areas	5 Peatland	Reference (year)
REFUEL	Not cleared[1]	Cleared[2]	Cleared	Cleared	Cleared[3]	Cleared[3]	Cleared[3]	
EEA	Cleared[4]	Cleared[4]	Cleared	Cleared	Cleared[6]	Cleared[6]	Cleared[5]	EFISCEN 2001
RENEW	Cleared[7]	Cleared[7]	Cleared	Cleared	Cleared[8]	Cleared[8]	Cleared[8]	
Mantau (2008)	Using existing forestry product flows; no explicit exclusion but implicitly cleared							
Hetsch (2008)	Using existing forestry product flows; no explicit exclusion but implicitly cleared							
Ericsson (2005)	Cleared[9]			Cleared[11]	Cleared[11]	Cleared[11]		
Asikainen (2008)	Cleared[10]			Cleared[11]	Cleared[11]	Cleared[11]	Cleared[11]	
Alakangas (2007)	No exclusion of areas; definition of 'techno-economic potential' seems sufficient safeguard			Significant discrepancy between techno-economic potential and NAI seems sufficient safeguard				

Remarks on REFUEL

[1]: Underlying material is not explicit in its exclusion. However, harvest from primary woodland seems to be negligible (and is a contradiction in terminis)

[2]: Underlying material explicitly excludes 'protected' forest from resource base

[3]: Only included as long as harvest does not harm basic structure of the vegetation

Remarks on EEA:

[4]: It is difficult to identify the forest area applied in the EEA study based on the above classifications. However they are all implicitly applied as the principal was excluding unproductive forest as well as nature conservation areas. Forest area used in the model **was restricted to forest area available for wood supply.** In EFISCEN, the state of the forest available for wood supply is described as an area distribution over age and volume classes in matrices. Protected forests that are not managed are not included in the analysis. In this study only 21 EU member states are included. There were no data for Greece, Luxemburg, Malta and Cyprus. EFISCEN database was 12% lower than the European Forest map. According to the MCPFE (at the time this assessment was conducted) report, 11.7% of EU forest was protected and of this area only 3.2 (less than 0.4% of the total forest area in EU) were areas without active management intervention. Thus the amount of area excluded approximately represents the share of nature conservation area in EU).

[5]: Peatlands were classified as only marginally suitable (meaning only 15 % of the residues from stem and branches can be extracted). This seems consistent with the criterion.

[6]: Only included as long as harvest does not harm basic structure of the vegetation

Remarks on RENEW:

[7]: Assessment was limited to 'forests available for wood supply'. We assume reserves and primary forests are excluded by this limitation

[8]: Limitation to 'ecological potential' seems to safeguard responsible use of these areas.

Additional remarks:

[9]: Assessment limited to woody biomass from ‘exploitable forests’.

[10]: Assessment limited to ‘forests available for wood supply’

[11]: Potential limited by Net Annual Increment, with a reservation for wood that needs to be left in the forest.

3. Task 3: Applicability of existing certification schemes

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3.1 Objective

The objective of this task is to assess to what extent national and international certification schemes (existing and under development) would be applicable for safeguarding the sustainability criteria as mentioned in the RES directive. This applicability has several dimensions:

- Whether the schemes include the criteria in the RES directive
- If the criteria are translated into practically applicable, and possibly quantifiable indicators. How compliance is monitored
- How compliance information is linked to the biomass through the chain

Furthermore, the schemes are also checked for their attention to several issues on which the Commission will have a reporting obligation according to the RES directive, viz. monitoring soil, water and air protection, and the restoration of degraded land. On request, the way how biodiversity is included in certification schemes is discussed in more detail.

In this chapter, we will first discuss the approach and list of reviewed schemes. Paragraph 3 shows the results of the review in a series of 4 tables. Paragraph 4 will focus more in detail on the topic of biodiversity and how this is included in the certification schemes. Then, the key conclusions are presented in paragraph 4. A reference list shows the literature used for this review.

3.2 Approach

A list of certification schemes is selected in consultation with the commissioner. The list of reviewed schemes is included in Table 3.1.

The list of schemes include existing schemes and schemes under development to guarantee the sustainability of forestry (natural forests and plantations), agricultural production (ranging from commodities, tropical products and agricultural products in general) and bioenergy (biofuels and bioenergy for heat and power).

The results of the review are included in four tables. The formats of the tables are developed in consultation with the commissioner and include:

- Table 3.2: Chain analysis of schemes
- Table 3.3: Governance and organization of schemes
- Table 3.4: Verification and assessment procedures schemes
- Table 3.5 to 3.10: Compatibility criteria schemes to European Renewable Energy Directive

The tables give a comprehensive overview of the compatibility and applicability of the schemes for safeguarding the sustainability criteria as mentioned in the RES directive. We worked with foot notes in the tables to provide additional information on the schemes where needed.

Table 3.1 *List of reviewed schemes under Task 3*

Abbreviation	Full name of scheme
RTRS	Roundtable on Responsible Soy
RSPO	Roundtable on Sustainable Palm Oil
BSI	Better Sugarcane Initiative
RSB	Roundtable on Sustainable Biofuels
Laborelec	Laborelec
SEKAB	SEKAB
SWAN label	Swan Label
Greenergy	Greenergy Label
ISCC	International Sustainability and Carbon Certification
UK-RTFO	UK-Renewable Transport Fuel Obligation
NTA 8080	NTA 8080
GGL S2	Green Gold Label S2 - Agricultural Source Criteria
CCBS	Climate, Community & Biodiversity Standard
FLO	Fairtrade Labelling Organization
IFOAM	International Federation of Organic Agriculture Movements
Naturland	Naturland
EurepGAP / GlobalGAP*	GlobalG.A.P. (Good Agricultural Practices)
SAN standard (RA)	Sustainable Agriculture Network
GGL S5	Green Gold Label S5 -Forest Source Criteria
FSC	Forest Stewardship Council
PEFC	Programme for Endorsement of Forest Certification Schemes
CERFLOR	Brazilian Program of Forest Certification
Canadian SAFM	Canadian Schemes Association - Sustainable Forest Management
RA Certified**	Rainforest Alliance Certified
Malaysian MTCC	Malaysian Timber Certification Council
PAFC	Pan African Forest Certificate
CERTFOR	Chilean System for Sustainable Forest Management
AFS	Australian Forestry Standard
LEI	Lembaga Ekolabel Indonesia
ATFS	American Tree Farm Systems
SFI	Sustainable Forestry Initiative

* EurepGAP changed its name to GlobalGAP in 2007. ** RA Certified includes certification for agriculture and forestry. Agricultural products are discussed under SAN (see above). Forestry certification will be discussed under the standard RA Certified.

3.3 Results of review schemes

Table 3.2 *Chain analysis of schemes*

Chain analysis	Chain analysis								Scope		
	Biomass re-source					End-use fuel					
	Agriculture	Forestry	Transportation	Processing	Conversion	Biodiesel	Bioethanol	End-use electricity	National level	International level	Meta-standard
RTRS	•		•	•						•	
RSPO	•		•	•						•	
BSI	•		•	•	•1)					•	
RSB	•	•	•	•	•	•	•			•	•
Laborelec	•2)	•	•	•					•3)		•
SEKAB	•		•	•	•		•		•4)		
SWAN label	•	•5)	•	•		•	•			•6)	•7)
Greenergy	•		•8)	•8)	•1) 8)				•9)		
ISCC	•	•	•	•	•	•	•			•	•
UK-RTFO	•	•	•	•	•	•	•			•	•
NTA 8080	•	•	•	•	•	•	•	•		•10)	•
GGL S2	•11)									•	•
CCBS	•12)	•12)								•	
FLO	•										
IFOAM	•		•	•						•	
Naturland	•	•	•	•						•	
GlobalGAP	•		13)							•	•14)
SAN standard (RA)	•	15)								•	
GGL S5		•16)								•	•17)
FSC		•	•	•					•	•18)	
PEFC		•	•	•						•	•19)
CERFLOR		•	•	•					•		
Canadian SAFM		•	•	•					•		
RA Certified		•20)	•20)	•20)						•	
Malaysian MTCC		•	•	•					•		
PAFC		•	•	•						•	•21)
CERTFOR		•	•	•					•		
AFS		•	•	•					•		
LEI		•	•	•					•		
ATFS		•	•	•					•		
SFI		•	•	•					•22)		

Explanation of notes from Table 3.2:

[1)] Ethanol processing is included. End-use at the consumer is not included.
[2)] Focus on residues.
[3)] Destination region is Belgium (national), source areas are worldwide.
[4)] Involves two countries: Sweden (destination) and Brazil (producer country).
[5)] As source for biofuel pellets
[6)] Source area: international, destination: Nordic countries
[7)] Meta standard: Raw materials must be certified in accordance with a standard and certification system specified in appendix, e.g. standard must balance economic, ecological and social interests and comply with Agenda 21 and Forestry principles.
[8)] Only included for source country (Brazil); system is developed for bioethanol supply from Brazil
[9)] Source area: Brazil, destination: UK
[10)] Source area: international, Destination: Netherlands
[11)] Note: GGLS2 is one of the schemes from the Green Gold Label and focuses on Agricultural Source Criteria. Criteria for processing and trade are included in a separate standard.
[12)] CCBS is designed for LULUCF / biosequestration projects
[13)] Product processing remains outside GlobalGAP scope where not explicitly included. In addition, GlobalGAP links up with other systems to cover the supply chain.
[14)] Existing national or regional quality assurance schemes that have successfully completed their benchmarking process are recognized as equivalent to GlobalGAP.
[15)] Rainforest Alliance has a Forestry label in cooperation with FSC. This is not further included in this overview.
[16)] Note: GGLS5 is one of the schemes from the Green Gold Label and focuses on Forest Source Criteria. Criteria for processing and trade are included in a separate standard.
[17)] GGLS5 is derived from existing and internationally recognized forest management schemes (FSC, PEFC, CSA SFM, and SFI). GGLS5 has not been developed to replace the existing schemes, rather to enable participating parties and stakeholders to perform a quick-scan assessment on sound forest management practices.
[18)] The global FSC schemes are translated into national and regional schemes. A requirement is that they meet the global schemes.
[19)] PEFC requires that recognized national forestry schemes are compatible with the current ATO/ITTO (for African countries with tropical forest) or ITTO (for countries with tropical forest) or PEOLG (Pan-European countries, developed on a country level) criteria.
[20)] RA Certified includes: a) Smartwood program to assist companies to get certified for SFM (based on FSC), b) Smartlogging: a generic standard developed to guarantee sustainable harvesting of logging operations.
[21)] African countries can use the PAFC standard on a national level. The PAFC P&C are based on ATO/ITTO principles. PAFC-Gabon was set up at the end of 2004 and endorsed by PEFC in 2009.
[22)] Applicable for North America: US and Canada. Some requirements are set for sourcing material from outside this region.

Table 3.3 *Governance and organization of schemes*

(• Included, – not included, ◦ not yet in place / in process)

Schemes:	Certification body is:				Accreditation body is:		Standard setting procedure:	
	Certification:		CoC certification:					
	ISO certified	National recognized and in place	ISO certified	Recognized and in place	ISO certified	National recognized and in place	Members are equally represented	Standard setting process is
RTRS	◦	◦	◦	◦	◦	◦	•	•
RSPO	•	•	•	•	•	•	•	•
BSI	◦	◦	◦	◦	◦	◦	•	•
RSB	◦	◦	◦	◦	◦	◦	•	•
Laborelec	–[1]	•	–[1]	•	–	–	–	–
SEKAB	•	•	•	•	–	–	–	–
SWAN label	•	•	•	•	•	•	•	•
Greenergy	•	•	–	–	–	–	–	–
ISCC	◦	◦	◦	◦	◦	◦	•	•
UK-RTFO	–[2]	•[2]	–[2]	•[2]	–[3]	–[3]	•	•
NTA 8080	•◦	•◦	•◦	•◦	•◦	•◦	•	•[4]
GGL S2	–	•	–[5]	–[5]	•	•	•	–[6]
CCBS	–	•[7]	–	–	•	•	•	•
FLO								
IFOAM[8]	•	•	•	•	•	•	•	•
Naturland	•	•	•	•	•	•	•[9]	•
GlobalGAP	•	•			•	•	•	•
SAN standard	•	•	–[10]	–[10]	•	•	•	•
GGL S5	–	•	–[5]	–[5]	•	•	•	–[4]
FSC	•	•	•	•	–[11]	•	•	•
PEFC	•	•	•	•	–[12]	–[12]	–[13]	–[13]
CERFLOR	•	•	•	•	•	•[14]	•[15]	•
Canadian SAFM	•	•	•	•	•	•	•	•
RA Certified	• –[16]	• –[16]	• –[16]	• –[16]	–[17]	•–[17]	•	•
Malaysian MTCC	•	•	•	•	•	•	•–[18]	•
PAFC[19]	•[20]	•[20]	•[20]	•[20]	•[20]	•[20]	•–[21]	•–[21]
CERTFOR	•	•	•	•	•	•	•[18]	•
AFS	•	•	•	•	•	•	•[22]	•
LEI	•[23]	•	•[23]	•	◦–[24]	◦–[24]	•[25]	•
ATFS	–[26]	•	•[27]	•[27]	◦[28]	◦[28]	•	•
SFI	•	•	•	•	•	•	•[22]	•

Explanation of notes from Table 3.3:

[1] This requirement is not explicitly mentioned in scheme.

[2] The RFA is the administrative body of the UK government that takes care of the provision of Renewable Transport Fuel Certificates.

[3] The Guidelines for selecting verifiers are detailed within the Technical Guidance and the Guidance for Verifiers. RFA will not accredit verifiers

[4] Standard setting processes defined for first standard. The standard will become part of the policy framework in the Netherlands.

[5] Included in GGL Schemes GGLS1, S4 and S6.

[6] There is a standard setting procedure within the advisory board. Not clearly described.

[7] Required: accredited by CDM EB for Afforestation and Reforestation auditors accredited by the FCS

[8] IFOAM has developed its own Accreditation Criteria. This establishes, together with the basic schemes, the basis for certification.

[9] There is a specific rule. However, not clearly (publicly) defined

[10] Based on a self assessment, a determination is made as to the need for a verification audit for CoC

[11] FSC certification bodies must operate in accordance with procedures set out in the FSC Accreditation Manual. National or regional schemes must meet FSC requirements. FSC has its own accreditation program, which is based (and largely conforms) ISO 61.

[12] Accreditation of the certification body is the responsibility of the national accreditation organization.

[13] PEFC participation models differ from country to country. Participation from relevant stakeholder groups is needed. Balanced representation is not a strict requirement.

[14] The CoC accreditation is in place. In 2005 (last assessment), Cerflor did not fully demonstrate structural independence between the CoC requirements and the certification and accreditation processes at a level specified by PEFC.

[15] There was a broad stakeholder consultation in the standard setting process. The equal representation of stakeholders in this process is under discussion.

[16] RA/FSC: Auditors and certification bodies are ISO certified. Smartlogging: Qualified lead auditors have to be selected based on expertise, knowledge and must be free of conflicts.

[17] RA/FSC: FSC has its own accreditation program. SmartLogging is not an FSC-accredited program.

[18] Full stakeholder participation is addressed and required. A balanced participation is not a requirement. Previous there have been complaints that views of minority groups have not been sufficiently addressed.

[19] Here indicated for PAFC Gabon.

[20] Forest management certification is delivered for a 3-year period by independent certification bodies, accredited by COFRAC or any other accreditation body member of EA or IAF (ISO compliance), according to a specific program. CoC certification is delivered for a 5-year period.

[21] The compliance assessment report for PEFC mentions that: "although the colleges that were responsible for the PAFC Gabon standard setting procedure for the GFCS represented a wide variety of stakeholders it was not clear from the documentation, or from the field mission if consensus building procedures have been appropriate/balanced".

[22] Although balanced stakeholder participation is not required in the standard development, a representative participation of stakeholders seems having been involved.

[23] The forest certification matrix indicates "a minor observation" when indicating whether the certification bodies are conform ISO 62, 66 and 65. Certification bodies must conform to LEI Guideline 99-01 which defines specific requirements for certification against the LEI Standard 5000 in Indonesia.

[24] LEI act as the schemes-setting body and accreditation authority. It approves certification bodies to carry out assessments against the standard. LEI is not a recognized national accreditation body and has no other national affiliations. LEI makes reference to international schemes and schemes (such as ISO, ILO, ITTO, and FSC) and is in the process of revising its accreditation function.

[25] Secondary sources indicate that development of the standard was based on an extensive process of stakeholder consultation. However available documentation includes no details of the schemes setting process or of the organizations which participated.

[26] Certification bodies meet ISO 19011 but do not meet ISO requirements 62.

[27] CoC certification procedures are according to PEFC requirements. ATFS does not have its own label.

[28] The accreditation program is being developed by ANAB and needs formal endorsement (in progress).

Table 3.4 *Verification and assessment procedures schemes*

• Included, – not included, ◦ not yet in place / in process, ¹ remark

Auditing process:	Certification biomass resource						Certification chain of custody						
	Assessment procedure						CoC			Assessment procedure			
	Field visits required	Reporting required: Reporting owner	Reporting required: Reporting accountant	External stakeholder consultation required	Frequency auditing (no/year)	Validation certification contract (years)	Mass balance	Track and Trace	Book and Claim	Production controls required	Documentation required	Labeling required	Remarks/ description
RTRS	•	•	–	•[1]	○	○	•	•	[2]	○	○	○	[1] Defined as "to be important" [2] Book and Claim not ruled out. CoC: rules for control of claims and logos to be developed.
RSPO	•	•	–	•	1	5	•	•	•	•	•	○	
BSI	○	○	○	○	○	○	○	○	○	○	○	○	Status: standard development.
RSB	○	○	○	○	○	○	○	○	○	○	○	○	
Laborelec	–	•	–	–	Per load	Per load	•[3]	–	–	–	•	–	[3] System enables administrative segregation. CoC does not cover whole supply chain (excludes production).
SEKAB[4]	•	•	–	–	0,5	0,5	–	•	–	–○[5]	•	–	[4] This is a business to business label. [5] Still partly under development. Seems to be based on tracing of documentation and certificates.
SWAN label	•[6]	•	–	–	1	3-5	–	•	–	– / •[7]	•	•	[6] Only for: license holder list of raw material suppliers will be checked on site or if needed unexpected site inspections. [7] Only for unexpected site inspections.
Greenergy	•	•	–	–	1	○[8]	–[9]	–[9]	–[9]	–	–	–	[8] Still in process: auditing has been taken place for 1st year [9] Greenergy focuses on source countries. Destination country covered under RTFO.
ISCC	○[10]	•	○[10]	○[10]	1	○[10]	•	○	○	○[10]	•	•	[6] Verification process and guidelines for auditors to verify and gather data is ongoing.
UK-RTFO[11]	•	•	•[12]	○	1	1	•	– •[13]	–•[13]	•	•	–	[11] Guidelines for verification still under consultation. [12] Execution of assurance control includes performance of substantive testing. [13] Where an existing standard operates its own certifiable CoC this should be used. Else mass balance should be used.

Auditing process:	Certification biomass resource						Certification chain of custody						
	Assessment procedure						CoC			Assessment procedure			
	Field visits required	Reporting required: Repor-ting owner	Reporting required: Reporting accountant	External stakeholder consultation required	Frequency auditing (no/year)	Validation certification contract (years)	Mass balance	Track and Trace	Book and Claim	Production controls required	Documentation re-	Labeling required	Remarks/ description
NTA 8080	•	•	–	•	◦	◦	•[14]	•[14]	•[14]	◦	◦	•	[14] The three CoC models are all acceptable but in combination with different sustainability claims. For all counts that certain verification requirements have to be met.
GGL S2	•	•	–	–	1	1,3	–[15]	–[15]	–[15]	–[15]	–	–	[15] CoC in GGL S1, S4 and S6
CCBS	•	•	–	•	0,2	0,2	–[16]	–[16]	–[16]	–	–	–	[16] No CoC included in system.
FLO	•	•	–	–	1[17]	1-3[18]	–	•	–	•	•	•	[17] Audits once per year, additional audits are possible. [18] Validation certificates vary between 1-3 yrs. CoC based on generic trade standard from FLO.
IFOAM	•	•	•[19]	•	1	1-1,2[20]	–	•	–	•	•	•	[19] Inspection procedure includes e.g., recon-ciliation of production / sales and input/output and residue sampling. This is documented in inspection report. [20] The validity of the certificate is in practice 12 to 15 months.
Naturland	•	•	–	–	1[21]	1	–	•	–	•	•	•	[21] At least on an annual basis combined with unexpected visits.
GlobalGAP	•	•	–	–	1[22]	1	–	•	–	•[23]	•[23]	•	[22] At least on an annual basis combined with unexpected visits. [23] Required: CoC chain linked with other approved systems
SAN standard	•	•	–	•	1	3	–	•	–	– / •[24]	– / •[24]	•	[24] Audit of CoC only implemented when there is an assumed risk for mixing of products (based on self-assessment)
GGL S5	•	•	–	–	1	4[25]	–[15]	–[15]	–[15]	–[15]	–	–	[25] Approval is valid for a maximum of 4 years. After this period a GGL approval can only be given if a pre-scope route towards certification is initiated at one of the independent approved forest management systems.
FSC	•	•	–	•	1	<5	•	•	–	•	•	•	
PEFC	•	•	–	•	1	5	•	•	–	•	•	•	
CERFLOR	•	•	–	•[26]	1[27]	<5	•	–	–	•	•	•	[26] Stakeholder consultations mainly focused at dissemination and communication of results. [27] Annual auditing required for CoC. Not spe-cific specified for forest management schemes.

Auditing process:	Certification biomass resource						Certification chain of custody						
	Assessment procedure						CoC			Assessment procedure			
	Field visits required	Reporting required: Repor-ting owner	Reporting required: Reporting accountant	External stakeholder consultation required	Frequency auditing (no/year)	Validation certification contract (years)	Mass balance	Track and Trace	Book and Claim	Production controls required	Documentation re-	Labeling required	Remarks/ description
Canadian SAFM	•	•	–	•	1	<5[28]	•	•	–	•	•	•	[28] There is a review of the standard at least every 5 years
RA Certified - RA/FSC - Smartlogging	• •	• •	– –	• •	1 1	<5[28] ○	• –	• –	– –	• –	• –	• –	
Malaysian MTCC	•	•	–	•	1	<5[28]	•	•	–	•	•	•	
PAFC	•	•	–	•	1	<3[29]	•[30]	•[30]	–	•	•	•	[29] Forestry certifications and chain of production are accorded for a maximum period of 3 years. [30] ATFS does not have its own CoC procedure: based on PEFC.
CERTFOR	•	•	•[31]	•	1	<5[28]	•	•	–	•	•	•	[31] Systems of sampling are responsibility of the certification body and audit team.
AFS	•	•	–	•	1	3[32]	•	•	–	•	•	•	[32] After 3 years, the certified forest owner/manager must be reassessed
LEI	•	•	–	•	1,2 - 2,5	<5	–	•	–	–	•	•	Depending on certification level (gold to bronze): 2 to 4 within period of 5 years
ATFS	•	•	–	•	1	<5	•	•	–	•	•	•[33]	[33] ATFS does not have its own label. CoC procedure based on PEFC.
SFI	•	•	–	•	< 1,5	<5[28]	•	•	–	•	•	•	

Table 3.5 (1) *Compatibility criteria schemes to European Renewable Energy Directive*

Compatibility to criteria	RTRS		RSPO		BSI		RSB		Laborelec [4]		SEKAB	
	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel	•	N	•	Y	•	Y	•		•		•••	Y
GHG methodology is defined in standard	-		◦		•		•		-		•	
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	-		-		-		••[11]	Y	-		••[13]	
Exclusion of lands with high biodiversity value	••	Y	••[5]	Y	••[6]	Y	••[10]	Y	-		•[15]	
Exclusion of wetlands and continuously forested areas	•[1]	N	•[8]	Y	•[8]	Y	••[10]	Y	-		•[15]	
Exclusion of lands designated for nature purposes as of January 2008	••	Y	••[9]	Y	••[9]	Y	••[10]	Y	-		••[14]	
Exclusion of biodiverse forest with no significant human intervention	•[1]	N	••[7]	Y	••[7]	Y	••[10]	Y	-		•[15]	
Exclusion of high biodiverse grasslands	-		•[8]	Y	•[8]	Y	•[10]	Y	-		•[15]	
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	-		•[8]	Y	•[8]	Y	••[11]	Y	-		•[15]	
Condition of good agricultural practice	•[2]		•[2]	Y					-			
• Integrated Pest Management Techniques	••	Y	••	Y								
• Chemicals	••	Y	••	Y	••	Y	••	Y			••[16]	Y
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	••	Y	•••	Y	•••	Y	•••[12]	Y	-		••[17]	Y
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	••	Y	•••	Y	•••	Y	•••[12]	Y	-		••[17]	Y
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	•[3]	Y	•[3]	Y	•••	Y	•••[12]	Y	-		••[16]	Y
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock	•••		•••		•••		•••		-		•••[18]	Y
• Child labour	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
• Wages	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
• Freedom to trade unions / associations	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
• Land use rights	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
Extra principles and/or criteria are included not indicated in list above.	•••		•••		•••		•••				•••	Y
• Compliance of local and national laws	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
• Social and/or environmental Impact Assessment	•••	Y	•••	Y	•••	Y	•••	Y				

P = Principle, C = Criterion, I = Indicator
••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Explanation of notes from Table 3.5 (1):

[1] Not included as separate criterion: incorporated only if areas are recognized as HCV areas. [2] Not specifically mentioned but incorporated in other criteria. [3] General principles on waste handling are included. [4] Laborelec does not have its own sustainability standard (meta-standard or 'no violations of minimum basic sustainability schemes'). [5] For new plantings since 2005: identified by stakeholder assessment. [6]Cut off date still to be determined, HCV on national level determined. [7] Assumption: Undisturbed forest can be considered a HCV. [8] Only if considered as HCV. [9] Assuming as defined by local or national law. [10] HCV areas shall be identified and protected, ecosystem functions are to be preserved. [11] Soil organic matter content shall be maintained at or enhanced to its optimal level. [12] Minimization of soil, water and air impacts are required and to be defined in plans. Data are most probably available in combination with data collection for EISA. Criteria and auditor check include existence of implementation plan to improve soil, water and air. [13] Conversion of land use is not allowed after November 2005. [14] Deforestation of other forests only according to national laws. [15] Only if recognized under national law (note: Brazil has recognized CBD and Ramsar Wetland Convention). [16] Good practices for pesticides handling, disposal and to minimize air pollution is required. [17] Management plan to improve soil and water conservation is required. [18] Right and safety measures for all employees in accordance with UN Guidelines. Type of data reporting to monitor progress is not specified.

Table 3.5 *(2) Compatibility criteria schemes to European Renewable Energy Directive*

Compatibility to criteria	SWAN label[1]		Greenergy		ISCC		UK-RTFO[10]		NTA 8080		GGL S2	
	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel	•[2]	Y	-[6]	-	••[8]	Y	••[11]	Y	••	Y	••[16]	Y
GHG methodology is defined in standard	Y		-		Y		••		••		Y	
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	••[3]	Y	••	Y	••	Y	••[11]	Y	••	Y	-	
Exclusion of lands with high biodiversity value	••[4]	Y	••	Y	••	Y	••[11]	Y	••[12]	Y	•[17]	N
Exclusion of wetlands and continuously forested areas	••[3]	Y	••	Y	••	Y	••[11]	Y	••[13]	Y	•[17]	N
Exclusion of lands designated for nature purposes as of January 2008	••[4]	Y	••	Y	••	Y	••[11]	Y	••	Y	•	N
Exclusion of biodiverse forest with no significant human intervention	••[4]	Y	••	Y	••	Y	••[11]	Y	••[12]	Y	•	N
Exclusion of high biodiverse grasslands	••[3]	Y	••	Y	••	Y	••[11]	Y	••[13]	Y	-	
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	••[3]	Y	••	Y	••	Y	••[11]	Y	••[13]	Y	-	
Condition of good agricultural practice	•[5]	Y	•••	Y			•••[11]	Y		Y	•••	Y
• Integrated Pest Management Techniques			•••	Y	•••	Y			••[14]		••	Y
• Chemicals			•••	Y			•••[11]	Y	•••		-	
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	•[5]	Y	•••	Y	••[9]	N	•••[11]	Y	•••	Y	•••	Y
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	•[5]	Y	•••	Y	••[9]	N	•••[11]	Y	•••	Y	•••	Y
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	•[5]	Y	••[7]	Y	-		•••[11]	Y	•••	Y	•[18]	
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock	•••	Y	•••	Y					•••	Y	•[19] -	Y
• Child labour	•••	Y	•••	Y	•••	Y	•••[11]	Y	•••	Y	-	
• Wages	•••	Y	•••	Y	•••	Y	•••[11]	Y	•••[15]	Y	-	
• Freedom to trade unions / associations	•••	Y	•••	Y	•••	Y	•••[11]	Y	•••	Y	-	
• Land use rights	•••	Y	•••	Y	•••	Y	•••[11]	Y	•••	Y	••	Y
Extra principles and/or criteria are included not indicated in list above.	•••	Y	•••	Y	•••	Y	•••[11]	Y	•••	Y		
• Compliance of local and national laws	•••	Y	•••	Y			•••[11]	Y	•••	Y	-	
• Social and/or environmental Impact Assessment			•••	Y			•••[11]	Y	•••	Y	-	

P = Principle, C = Criterion, I = Indicator
••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Explanation of notes from Table 3.5 (2):

[1] Based on standard for fuels. [2] Dependent on reference case: emissions must not exceed 50 g CO_2 eq/MJ fuel. [3] Biomass must not be cultivated on land that binds up large quantities of carbon. If the cultivation of biomass has resulted in a change in land use since November 2005, any emissions of carbon must be repaid, using the fuel in question, within a period of no more than 20 years. [4] Requires that the raw material does not originate in areas in which biodiversity or values worthy of protection for social reasons are under threat. Not further defined. [5] Raw materials used in the production of the fuel must be certified in accordance with a specified standard and certification system (which might fulfill these requirements). [6] Greenergy is complimentary to RTFO standard; GHG emission reduction requirement according to RTFO (falls outside the scope of Greenergy). [7] Local records of air pollution, where available. [8] GHG emission reduction and methodology according to EU requirements. [10] UK-RTFO is based on meta-standard. Qualifying schemes must meet most RTFO sustainability criteria. Supplementary information is needed for Gap criteria. [11] UK-RTFO requires performance targets over time. Required data capture goes from 50% in 2008-09 to 90% in 2010-11. Fulfillment environmental standard goes from 30% in 2008-09 to 80% in 2010-11. Required GHG emission reduction goes from 40% in 2008-09 to 50% in 2010-11. [11] Soil and water protection is required. Indicators (including reporting) are not mentioned (yet). [12] HCV areas to be identified in dialogue with stakeholders. [13] Wetlands, continuously forested areas and peat land considered as an area with high risk of carbon soil losses. [14] Measures have to be taken to avoid disruption of environment by use of agrochemicals. [15] Measures with respect to employment have to be taken and recorded. [16] Included in GGLS8 standard. [17] The land conversion standard is strict. No explicit biodiversity standard is included. [18] General principle on waste treatment is included. [19] Included: monitoring of living conditions in general (social and cultural aspects).

Table 3.5 *(3) Compatibility criteria schemes to European Renewable Energy Directive*

Compatibility to criteria	CCBS		FLO[1]		IFOAM		Naturland[13)]		GlobalGAP		SAN[18)]	
	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel	•[2)]	Y	-	-	-	-	-	-	-	-	•[19)]	-
GHG methodology is defined in standard	Y											
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	•••[3)]	Y	-	-	-	-	-	-	-	-	•[19)]	-
Exclusion of lands with high biodiversity value	•[4)]	Y	••	Y	•[10)]	N	••	N	•[16)]	Y	•[20)]	Y
Exclusion of wetlands and continuously forested areas	•[7)]	Y	•[7)]	Y	•[10)]	N	•[7)]	N	•[16)]	Y	••[20)]	Y
Exclusion of lands designated for nature purposes as of January 2008	••[5)]	Y	••[6)]	Y	•[10)]	N	••	N	•[15)]	Y	•••[20)]	Y
Exclusion of biodiverse forest with no significant human intervention	•[7)]	Y	••	Y	••[9)]	N[12)]	••	N[12)]	•[16)]	Y	••[20)]	Y
Exclusion of high biodiverse grasslands	•[7)]	Y	•[7)]	Y	•[10)]	N	•[7)]	N	•[16)]	Y	••[20)]	Y
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	•[7)]	Y	•[7)]	Y	•[10)]	N	••	N	-		•[20)]	Y
Condition of good agricultural practice	-											
• Integrated Pest Management Techniques			•••	Y	•••	Y	•••	Y	•••	Y	•••	Y
• Chemicals			•••	Y	•••	Y	•••	Y	•••	Y	•••	Y
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	••	Y	•••	Y	•••[11)]	Y	•••[11)]	Y	•••	Y	•••	Y
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	••	Y	•••	Y	•••[11)]	Y	•••[11)]	Y	•••	Y	•••	Y
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	-		•[8)]	Y	•••[11)]	Y	•[14)]	Y	•••[17)]	Y	•[8)]	Y
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock	••	Y	•••	Y	•••	Y	•••		-		•••	
• Child labour			•••	Y	•••	Y	•••	Y			•••	Y
• Wages			•••	Y	•••	Y	•••	Y			•••	Y
• Freedom to trade unions / associations			•••	Y	•••	Y	•••	Y			•••	Y
• Land use rights	••	Y	•••	Y								
Extra principles and/or criteria are included not indicated in list above.	•••	Y	•••	Y	•••	Y	•••	Y	•••	Y	•••	Y
• Compliance of local and national laws	•••	Y							•••	Y	•••	Y
• Social and/or environmental Impact Assessment	•••	Y	•••	Y					•••	Y	•••	Y

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••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Explanation of notes from Table 3.5 (3):

[1)] Based on Generic Flo Product Standard for small producer's organizations [2)] Calculation GHG emissions is included for land-use conversion in project development stage. [3)] Carbon benefit is required (focus on biosequestration projects) [4)] HCV areas and areas with socio-environmental benefits are identified and should not be negatively affected. [5)] As defined by local or national law. [6)] Identified conservation areas will not be cultivated. [7)] Only if identified as conservation / HCV area. [8)] Principle on waste treatment is included. [9)] Clearing of primary ecosystems is prohibited and measures to enhance biodiversity are required. [10)] Only if identified as primary ecosystem. [11)] Minimization of impacts, combined with analysis of results, is required. No information on which elements are monitored. [12)] No clear description on which areas are excluded and how this is defined. [13)] This is based on general schemes and specific schemes on organic forest management. [14)] Minimization of waste is required. No specific and clear principle defined on this topic (intermingled with other principles). [15)] Recommended (not required!): There should be a plan to convert unproductive sites and identified areas which give priority to ecology into conservation areas where viable. [16)] Only if defined as conservation area under note 15. [17)] Identification of waste pollutants including air contamination. [18)] Based on SAN General Principles + Additional criteria for sugarcane, soy, palm oil, peanuts and sunflower farms. [19)] Practices to reduce GHG emissions and promote carbon dioxide sequestration are required. [20)] From the date of application for certification, the farm must not destroy any natural ecosystem. From 2005 onwards, no high value ecosystems must have been destroyed due or by purposeful farm management activities.

Table 3.5 *(4) Compatibility criteria schemes to European Renewable Energy Directive*

Compatibility to criteria	GGL S5		FSC[7]		PEFC[17]		CERFLOR[24]		Canada SAFM		RA Certified[35]	
	P	C/I	P	C/I[8]	P	C/I[23]	P	C/I	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel	••[1]	Y	-	-	-	-	-	-	-	-	-	-
GHG methodology is defined in standard	Y		-		-		-		-		-	
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	•	N[4]	•[9]	Y	•[18]	Y	-	-	•[31]	Y[34]	•[9]	Y
Exclusion of lands with high biodiversity value	••[2]	N[4]	••[10] [11]	Y	••[19]		••[25]		•[32]	Y[34]	••[10] [11]	Y
Exclusion of wetlands and continuously forested areas	••[2]	N[4]	••[10]	Y	••[19]		••[25] [26]		••[32] [26]	Y[34]	••[10]	Y
Exclusion of lands designated for nature purposes as of January 2008	•[3]	N[4]	••[11]	Y	••[19]		••[25]	Y	••	Y[34]	••[11]	Y
Exclusion of biodiverse forest with no significant human intervention	••[2]	N[4]	••[10]	Y	••[19]		••[25]		••[32] [26]	Y[34]	••[10]	Y
Exclusion of high biodiverse grasslands	•	N[4]	•[11]	Y	•[19]		•[25]		•[32]	Y[34]	•[11]	Y
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	•[3]	N[4]	•[11]	Y	•[19]		•[25]		•[32]	Y[34]	•[11]	Y
Condition of good agricultural practice									-			
• Integrated Pest Management Techniques	••	Y	•••[12]	Y	-		•••[27]	Y			•••[12]	Y
• Chemicals	••	Y	•••	Y	•••	Y	•••	Y			•••	Y
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	••[5]	Y	•••[13] [15]	Y	•••[20]	Y	•••[28]	Y	•••[33]	Y[34]	•••[13] [15]	Y
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	••[5]	Y	•••[13] [15]	Y	•••[20]	Y	•••[28]	Y	•••[33]	Y[34]	•••[13] [15]	Y
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	-		•[14]	Y	•[21]	Y	•[29]	Y	-		•[14]	Y
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock	••[6]	Y	•••[15]	Y					••	Y[34]	•••[15]	Y
• Child labour	-		•••[16]	Y	••[22]	Y	••[30]	Y			•••[16]	Y
• Wages	-		•••[16]	Y	••[22]	Y	••[30]	Y	••	Y[34]	•••[16]	Y
• Freedom to trade unions / associations	-		•••[16]	Y	••[22]	Y	••[30]	Y			•••[16]	Y
• Land use rights	•••	Y	•••[16]	Y	•••[22]	Y	•••	Y			•••[16]	Y
Extra principles and/or criteria are included not indicated in list above.			•••	Y	•••	Y	•••	Y	•••	Y[34]	•••	Y
• Compliance of local and national laws			•••	Y	•••	Y	•••	Y	•••	Y[34]	•••	Y
• Social and/or environmental Impact Assessment	•	Y	•••	Y			•••	Y	•••	Y[34]	•••	Y

P = Principle, C = Criterion, I = Indicator
••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Explanation of notes from Table 3.5 (4):

[1] Included in GGLS8 standard. [2] Plantations are not established by converting a forest and should promote the restoration and conservation of natural forests. Other sources than natural forests and plantations must not contain HCV areas. [3] Only if principle as defined under 2) is met. [4] Although some guidance is given, clear criteria and indicators are considered to be missing. [5] Management plan includes information on soil types, rainfall catchment areas, and erosion risk. [6] Socio-economic descriptions are described. [7] Based on global criteria on forest management. [8] Indicators are defined on a national and regional level. [9] A forest carbon working group is established in 2009. [10] Plantations established in areas converted from natural forests after November 1994 normally shall not qualify for certification. Forest conversion to plantations or non-forest land uses shall not occur, except in specified circumstances and conservation of High Conservation Value Forests. [11] If falling under national legislation or international agreements as CITES and CBD. [12] Integrated pest management shall form an essential part of the management plan for plantations. [13] Conversion of soil and water resources. [14] General criterion on waste management is included. [15] Monitoring of plantations shall include regular assessment of potential on-site and off-site ecological and social impacts including effects on water resources and soil fertility, and impacts on local welfare and social well-being. [16] International conventions as ILO are binding. [17] Based on criteria from ATO/ITTO and ITTO. [18] ITTO: Total amount of carbon stored has to be documented. [19] ITTO: Retaining undisturbed areas, conservation of protected areas. ATO/ITTO: Precautionary principle for protected areas (to be defined in mapping exercise). PEFC: Other international conventions relevant to forest management (CITES, CBD, Ramsar) *and* ratified by the country will be respected through the legislative framework. [20] ATO/ITTO and ITTO: There are soil and hydrological maps available. Impacts on soil and water characteristics are minimized. [21] ATO/ITTO: Wastage is minimized. [22] ITTO and ATO/ITTO: Legal rights in terms of ownership and tenure are respected. The national PEFC certification criteria shall be in compliance with ILO conventions. [23] The national PEFC certification criteria shall include management and performance requirements that are applicable at the level of a forest management unit. [24] Based on criteria for planted forests [25] unique ecosystems shall be preserved and areas of relevant ecological interest, as declared by legislation, or recognized for their exceptional natural, socio-cultural or environmental attributes, shall be maintained and protected. [26] Standard is PEFC approved. PEFC requires the recognition of RAMSAR and CBD. [27] Integrated management of pests and diseases techniques shall be adopted. [28] Existence of monitoring of parameters of the relevant water and soil resources including data on classes and types of soils and on available water resources. [29] The producer shall adopt and implement a policy aimed at reducing or properly treating solid, liquid and gaseous residues. Data reporting not explicitly mentioned. [30] Evidence that social security issues and labor legislation are in accordance with current legislation. [31] The need to maintain the processes that take carbon from the atmosphere and store it in forest ecosystems is recognized. [32] The conservation of ecosystem and species diversity is required and forest Ecosystem resilience and productivity should be maintained. [33] Conservation of soil and water resources is required. [34] Criteria are included and its values and indicators are defined in a public participation process (which can thus differ per region within the country). [35] RA Certified (forestry) is based on the FSC principles and criteria. A separate generic standard on sustainable harvesting is developed. As this standard is only specified for the logging operation itself, this is not included for this overview.

Table 3.5 *(5) Compatibility criteria schemes to European Renewable Energy Directive*

Compatibility to criteria	MTCC		PAFC		CERTFOR		AFS		LEI		ATFS	
	P	C/I	P	C/I	P	C/I	P	C/I[23)]	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel			-	-	-	-	•[16)]	-			-	-
GHG methodology is defined in standard			-		-		-				-	
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	•[3)]		•[6)]	Y	•[12)]		•[16)]	Y			•[25)]	Y
Exclusion of lands with high biodiversity value	••[1)]		•[6) 7)]	Y	••[12)]		••[17)]	Y			•[24) 25)]	Y
Exclusion of wetlands and continuously forested areas	••[1) 2)]		••[8)]	Y	••[12)]		••[17)]	Y			••[25)]	Y
Exclusion of lands designated for nature purposes as of January 2008	••[1)]		••[8)]	Y	••[12)]		••[17)]	Y			••	Y
Exclusion of biodiverse forest with no significant human intervention	••[1) 2)]		••[8)]	Y	••[12)]		••[17)]	Y			••[24)]	Y
Exclusion of high biodiverse grasslands	•[3)]		•[6)]	Y	•[12)]		••[17)]	Y			•[25)]	Y
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	•[3)]		•[6)]	Y	•[12)]		••[17) 16)]	Y			•[25)]	Y
Condition of good agricultural practice												
• Integrated Pest Management Techniques	•••	Y	•••[9)]	Y	•••	Y	-	Y			•••[26)]	Y
• Chemicals	•••	Y	•••[9)]	Y	•••	Y	•••[18)]	Y			•••	Y
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	•••[4)]	Y	•••[10)]	Y	•••[13)]	Y	•••[19)]	Y			•[27) 28)]	-
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	•••[4)]	Y	•••[10)]	Y	•••[13)]	Y	•••[19)]	Y			•••[28) 29)]	Y
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	•[5)]	Y	•[5)]	Y	•[14)]	Y	•[20)]	Y			•[27)]	-
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock			•••	Y	•••	Y	•••[21)]	Y			•[30)]	-
• Child labour	•••	Y	•••[11)]	Y	•••	Y	•••[22)]	Y			••	Y
• Wages	•••	Y	•••[11)]	Y	•••	Y	•••[22)]	Y			••	Y
• Freedom to trade unions / associations	•••	Y	•••[11)]	Y	•••	Y	•••[22)]	Y			••	Y
• Land use rights	•••	Y	•••[11)]	Y	•••	Y	•••[22)]	Y			••	Y
Extra principles and/or criteria are included not indicated in list above.			•••	Y	•••	Y	•••	Y				
• Compliance of local and national laws	•••	Y	•••	Y	•••	Y	•••	Y			•••	Y
• Social and/or environmental Impact Assessment	-		•••	Y	•••[15)]	Y	-				-	

P = Principle, C = Criterion, I = Indicator
••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Explanation of notes from Table 3.5 (5):

[1)] National legislation and International conventions as CITES, CBD and Convention on Wetlands of International Importance are recognized and HCV areas are conserved. [2)] Forest conversion to plantations or non-forest land uses shall not occur, except in specified circumstances. [3)] Only if recognized as HCV area. [4)] Water and soil resources should be conserved and data collection is part of EIA. [5)] A general principle on waste management is included. [6)] Only if area is nationally recognized or recognized in international agreement / convention. [7)] Only of this is a forest area: The conversion of forest to plantations or to non-forestry utilization forms of land-use shall not be encouraged, except in circumstances where the conversion: a) is related to a seriously degraded area/zone or a tiny part of the forest management unit; b) does not take place in areas of the forest with a high conservation interest; c) will ensure a clearly defined, substantial and additional conservation benefits to the forest management unit over a long-term period. [8)] PEFC recognized. PEFC requires the recognition of international conventions as CBD and Ramsar wetlands. [9)] Management systems shall promote the development and adoption of environmentally friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides. [10)] The impact of activities on water and soil is minimized biological, based on e.g. physical and chemical characteristics of soils and water flow rates. [11)] The legal and customary rights of local populations for ownership, use and tenure is acknowledged and respected. All relevant labour code regulations are applied. [12)] No plantations on native forest areas or areas with HCV (according to classification procedure). For new plantations: Only if identified as area with HCV. [13)] Standard covers criteria to protect soil and water resources including data collection. [14)] General criterion on reduction waste is included. [15)] The management plan and EIA contain a description of environmental and social factors to be taken into account. [16)] Criterion 7.1 says that the forest manager shall acknowledge the forests' capacity to act as a net carbon sink and demonstrate a commitment to minimizing GHG emissions. [17)] The forest manager shall not convert native vegetation to plantation forest cover or non-forest cover (as of 2006). For native forest: significant biodiversity values have to be protected. [18)] Reliance on chemicals is reduced and damaging agents are identified. [19)] Soil and water values are identified (type of records undefined) and protected. [20)] General requirements on waste management are included. [21)] Criterion 9 mentions that forest management shall maintain and enhance long-term social and economic benefits specified to various topics. [22)] Defined in criteria and embedded in Australian legislation. [23)] Type of indicators and records are not specified. [24)] The standard mentions that "Where practicable, management plans consider and address opportunities to protect rare species and special habitat features and sites of special interest must be recognized". [25)] Only if protected under local, federal or national law. [26)] Management plans consider Integrated Pest Management. [27)] Standard 5 mentions that forestry practices maintain or enhance the environment, including air, water, soil, and site quality. [28)] Management according to State Best Management Practices (BMP). [29)] Land owner must minimize disturbances with riparian zones. Details on data requirement are limited. [30)] As fulfillment of national laws is required, indicated social impacts are fulfilled. However, no to very limited records requested on social impacts in region.

Table 3.5 (6) *Compatibility criteria schemes to European Renewable Energy Directive*

P = Principle, C = Criterion, I = Indicator
••• = Principle is included and goes beyond EU Directive, •• = Principle is included and meets EU directive, • = Principle is included and does not meet EU directive,
- = Principle is not included, ◦ not yet in place / in process, Y = specific criteria / indicators are defined, N = principles are not further defined (yet).
Note: The level of detail of criteria and indicators can differ strongly per system.

Compatibility to criteria	**SFI**[1]											
	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I	P	C/I
At least 50% GHG emission reduction compared to fossil fuel	-	-										
GHG methodology is defined in standard	-											
Exclusion of lands with high carbon stock that have recently been converted into e.g. cropland	•[3]	Y										
Exclusion of lands with high biodiversity value	••[2]	Y										
Exclusion of wetlands and continuously forested areas	••[2]	Y										
Exclusion of lands designated for nature purposes as of January 2008	••[2]	Y										
Exclusion of biodiverse forest with no significant human intervention	••[2]	Y										
Exclusion of high biodiverse grasslands	•[3]	Y										
Exclusion of peat land unless proven that draining of previously undrained soil is not involved	•[3]	Y										
Condition of good agricultural practice												
• Integrated Pest Management Techniques	•••[4]	Y										
• Chemicals	•••[5]	Y										
Reporting obligation to the EC on soil impacts in regions that are significant source of feedstock	•••[6]	Y										
Reporting obligation to the EC on water impacts in regions that are significant source of feedstock	••[7]	Y										
Reporting obligation to the EC on air impacts in regions that are significant source of feedstock	•[8]	Y										
Reporting obligation to the EC on social impacts in regions that are significant source of feedstock	••[9] [10]	Y										
• Child labour	••	Y										
• Wages	••	Y										
• Freedom to trade unions / associations	••	Y										
• Land use rights	••	Y										
Extra principles and/or criteria are included not indicated in list above.	•••	Y										
• Compliance of local and national laws	•••	Y										
• Social and/or environmental Impact Assessment	-[10]											

Explanation of notes from Table 3.5 (6):

[1)] The auditing manual mentions "Program Participants, with consent of the CB, may substitute or modify indicators to address local conditions based on a thorough analysis and adequate justification to the CB". This means that the standard of these schemes may vary on a case-by-case basis. [2)] Promotion of conservation of native biological diversity. Recognition of local, federal and (inter-) national laws is required including (for US and Canada) Ramsar convention. Special sites (ecologically, culturally) are protected and conserved but not explicitly excluded. [3)] Only if recognized under local, federal or (inter-)national laws and regulations. [4)] Use of integrated pest management where feasible. [5)] Minimized chemical use is recommended. [6)] Management practices to maintain and restore the soil. Data are collected. [7)] Fulfillment of local, federal and national laws and development of riparian protection measures (mapping of streams and water bodies, data on water quality not specified). [8)] Minimization of waste is required and conservation of air resources mentioned in principles. [9)] National labor laws cover the identified topics on social impacts. Written policy required to comply with social laws. [10)] No specific requirement on collection socio-economic data or EIA.

3.4 Including biodiversity in a certification scheme

3.4.1 Including and structuring of biodiversity in set of schemes

The RED excludes specific areas with a high biodiversity (and / or carbon content) as areas for biomass production. All schemes recognize the importance of conserving areas or high biodiversity. However, the translation of this general recognition to principles and, even more specific, criteria and indicators, vary strongly from scheme to scheme.

Some examples are:
- Some schemes (e.g. GlobalG.A.P. Flo) have defined criteria aiming to enhance habitats and increase biodiversity on the production unit. The basic principle here is that forestry or agricultural production (e.g. organic production) contributes to an improvement of the biodiversity in the area or region. This is a different line of approach then the approach followed by the RED of excluding lands;
- High biodiversity or conservation areas are recognized as important in various schemes. The interpretation of a "high conservation area" varies (or lacks), however, from scheme to scheme. For example, BSI requires for example that HCV areas are recognized on a national level. RSB gives as guidance for the protection of HCV areas that the identification and mapping of HCV areas should be undertaken by governmental, inter-governmental, and conservation organizations, as part of larger process involving non-biofuel sectors.
- Peat land areas, wetlands or highly biodiverse grasslands are in most schemes not specifically mentioned (unlike as in the RED) as conservation areas. However, these areas may be protected indirectly under the scheme under the condition that:
  - The scheme requires the recognition of international conventions (CBD or Ramsar Wetland Convention);
  - The areas are protected on a national level;
  - The areas are recognized as a HCV area.

  It must be noted that the conditions mentioned above are subject to a country's policy and to a certain level of subjectivity.

The way how biodiversity is structured and included in a set of selected certification schemes is included in table 3.6.

3.4.2 Level of detail of assessment

Most schemes have not defined explicitly a criterion to protect primary forest or biodiverse grasslands. However, it should be noted that the protection of these areas is indirectly covered by:
- Recognition of international regulations (CBD, Ramsar)
- National laws and policies on protected areas
- The formulation of High Conservation Value (HCV) areas.

Various schemes follow the approach that HCV areas are defined in a participatory process (on a national or regional level). The so-called HCV network defines HCV areas as natural habitats where inherent conservation values are considered to be of outstanding significance or critical importance. A generic Global Toolkit is available to provide guidance on how to take the generic HCV definitions and develop specific, detailed and clear National Interpretations for a particular country or region.

Table 3.6 *Structuring and including biodiversity in a set of selected certification schemes*

Primary forests				
Schemes	**Criteria**	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	7. New plantings since November 2005, have not replaced primary forest or any area required to maintain or enhance one or more High Conservation Values.	• An HCV assessment, including stakeholder consultation, is conducted prior to any conversion. • Dates of land preparation and commencement are recorded	Results of HCV assessment (maps). Records of land preparation.	Check of management plans, records and documentation. Check of HCV assessment and land records.
2. GGL (GGLS2)	The areas to be converted must not contain high conservation value forest or HCV. Conversion can only take place where the manager can clearly indicate that none of the areas to be converted contains HCV. The relative conservation value of the area before and after conversion must be clearly demonstrated.	Identification of land and conservation areas and formulation of management measures. According to definition of WWF: areas of outstanding and critical importance due to their environmental, socio-economic, biodiversity + landscape values	Identification of land and conservation areas and formulation of management measures.	Control of identification of land and conservation areas and formulation of management measures.
3. NTA 8080	Not explicitly mentioned in criteria			
4. SAN	2. Production areas must not be located in places that could provoke negative effects on national parks, wildlife refuges, biological corridors, forestry reserves, buffer zones or other public or private biological conservation areas. 2. Farms with agroforestry crops located in areas where the original natural vegetative cover is forest must establish and maintain a permanent agroforestry system distributed homogenously throughout the plantations. 2. The harvesting or other taking of threatened or endangered plant species is not permitted. Cutting, extracting or harvesting trees, plants and other non-timber forest products is only allowed in instances when the farm implements a sustainable management plan that has been approved by the relevant authorities, and has all the permits required by law. If no applicable laws exist, the plan must have been developed by a competent professional (SUB).	- 2. The agroforestry system's structure must meet the following requirements: a. The tree community on the cultivated land consists of minimum 12 native species per hectare on average. b. The tree canopy comprises at least two strata or stories. c. The overall canopy density on the cultivated land is at least 40%. -	Identification of natural ecosystems (see definitions). Protection and restoration of natural ecosystems.	Control of management practices and documentation.
5. Greenergy	Preservation of above and below ground carbon stocks relative to stocks on 30 November 2005.	Evidence that the biomass production unit has not been established on soils with large risk of significant soil stored carbon losses as peat lands, man-	* Documentation of environmental assessments of expansions	Check of verifier

		groves, wetlands and certain grasslands. All protected under the Forest Law no 4.771 - 15 September 1965	since 2005, showing no conversion of natural ecosystems (forests or Cerrado) since 2005; * Verification that the scope of the environmental licenses (issued since 2005) does not include conversion. Where there has been any conversion of natural ecosystems, evidence that the carbon payback does not exceed 10 years.	
6. CERFLOR	Not explicitly mentioned in criteria			
7. SFI	4. Program Participants shall have programs to promote biological diversity at stand and landscape levels.	Support of and participation in plans or programs for the conservation of old-growth forests in the region of ownership. Included are additional set of criteria	Support for plans or programs for conservation of old-growth forest (if available)	Control of management practices and documentation.
8. BSI	Not explicitly mentioned in criteria			

Nature protected areas by relevant authority (national level)

	Criteria	indicator	Allowed proof/evidence	Auditing practice
1. RSPO	5. The status of rare, threatened or endangered species and HCV habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account into management plans and operations.	Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations. Information should cover the Legal protection and the conservation status. Red Data Lists on national government level are mentioned as example. If any rare, threatened or endangered species or HCV habitats are present, appropriate measures for management will include: Ensuring that any legal requirements relating to the protection of the species or habitat are met.	Information gathering should include checking available biological records, consultation with relevant stakeholders and (if needed) a field study.	Check of management plans, records and documentation.
2. GGL (GGLS2)	The management plan is dealing with the policy on improvement of production, harvesting, storage, processing, distribution and marketing of products on local, national and regional level.	Availability of management plan	Management plan	Check availability management plan.

	Maintenance of and conversion to high (er) conservation value areas must be supported by relevant and recognized national and local stakeholders.			
3. NTA 8080	5. No violation of national laws and regulations that is applicable to biomass production and the production area. 5. In new or recent developments, no deterioration of biodiversity by biomass production in protected areas.	The organization shall: • Prove, as far as applicable, that the national laws and regulations are known in general and the laws and regulations with respect to land ownership and land use rights, forest and plantation management, forest and plantation, exploitation, protected areas, wildlife management, hunting, spatial planning and the rules arising from signing of international conventions in particular; • Take measures which are needed to ensure that the requirements of the mentioned laws and regulations are complied with; • Take measures which are needed to ensure that the changes in applicable laws and regulations and the enforcement of these are established and applied properly. The Biomass production shall not be practiced in a 'gazetted protected area' or in a zone which at any point is moved off a distance less than 5 km from a 'gazetted protected area'. Biomass production at the PU is started before 1 January 2007, or a reference dates from other certification systems (currently under development) and has taken place since in a continuous series of production cycles.	Knowledge of national laws and regulations and measures taken accordingly. Position of protected areas is verified and management practices are arranged accordingly.	Control of measures taken to ensure compliance of national laws and regulations. Check of protected areas
4. SAN	1. The farm's upper management must demonstrate a commitment to certification and to complying with the requirements stipulated in the standard and by law. The management must also be familiar with and endorse the system and its programs and support its execution by providing the necessary resources. 2. Cutting, extracting or harvesting trees, plants and other non-timber forest products is only allowed in instances when the farm implements a sustainable management plan that has been approved by the relevant authorities, and has all the permits required by law	- -	Availability of management plan and compliance of national laws.	Control of measures taken to ensure compliance of national laws and control of management plan.

5. Greenergy	Compliance with national laws and regulations relevant to biomass production and in the area where biomass production takes place.	No evidence of noncompliance with applicable national and local laws, decrees and regulations including: • Forest and plantation management • Protected and gazetted areas • Nature and wild life conservation • National laws resulting from the adoption of CBD and CITES Evidence that the organization is: • familiar with relevant national and local legislation • is seeking to comply with the legislation • remains informed of changes in legislation	Means of verification: * Documentation showing that the location and extent of permanent preservation areas and legal reserves has been legalized (or a plan is in place). * Maps showing the legal reserves. * Figures indicating the legal reserve area (or planned area) will meet the State's percentage requirements. * Confirmation of the existence of permanent preservation areas and legal reserves in the field. * Other licenses, legal documents, certificates provided by relevant legal bodies stating that there are no outstanding debts or infractions or interviews with workers and other stakeholders with regards to legal compliance. * Documented information on applicable legal requirements (expected of large-scale producers). * Knowledge of the main legal requirements * Procedures and practices relating to legal compliance implemented in the field. * System in place to incorporate changes to the legislation (this may include membership to an organization that provides such updates).	Control of verifiers
	No conversion of high biodiversity areas after November 30, 2005.	Evidence that production does not take place in gazetted areas or Conservation Units. Guidance: IBGE, the Brazilian Institute for Geography and Statistics, maintains a database of parks and reserves	Means of verification: * Maps showing conservation units, in context with production areas. * Documented permission for use in conservation units, where applicable.	Control of verifiers
6. CERFLOR	1. The organization must undertake the pertinent activities for establishing and managing forests in accordance with current legislation and other forest and environmental regulations applicable. 3. - Forest operations shall be undertaken with protection of remaining ecosystems taken into consideration. Unique ecosystems of environmental,	- Existence of procedures for identifying laws and other regulations that are applicable to the establishment and management of the forest management unit; - Existence of records providing evidence of compliance with laws and other regulations that is applicable to the establishment and management of the forest management unit. • Forest plantations, as well as infrastructure works, must be established in already anthopized areas or in areas that are susceptible to suppression as set forth by legislation;	Availability of procedures and records for identifying and compliance with laws and regulations. Existence of maps, identification of conservation units in areas.	Control of availability of procedures and records for identifying and compliance with laws and regulations. Control of veri-

	archaeological, historical, cultural or social importance shall be preserved.	• Existence of mapping, demarcation and protection of historic, archaeological sites, and those of cultural and social value; • Identification of the existing conservation units in areas influenced by the production activity; • Others		fier
	3. Areas of relevant ecological interest, as declared by legislation or recognized for their exceptional natural, socio-cultural or environmental attributes, shall be maintained and protected.	• existence of maps or sketches indicating permanent preservation areas and legal reserves, with their respective identification; • existence of silvicultural practices or procedures aimed at protecting, restoring and maintaining areas of relevant ecological interest; • existence of measures or plans for conserving or managing refuge areas or wildlife reproduction; • Existence of monitoring of invasive wild plant and animal species that may alter the equilibrium among naturally occurring species.	Existence of maps, appliance of management practices, measures. Availability of management plan.	Control of verifier
	3. Hunting and fishing activities shall be controlled within the forest management units, in accordance with current legislation.	• Existence of a hunting and fishing surveillance and control system; • Existence of signage and notification instruments regarding the control of hunting and fishing; • Existence of measures favouring the reproduction and movement of local wild animals; • Existence of information for employees regarding the control of hunting and fishing.	Existence of surveillance and control system. Appliance of measures and distribution of information among employees.	Control of verifier
7. SFI	Program Participants that utilize improved planting stock, including trees derived through biotechnology, shall use sound scientific methods and follow all applicable laws and international protocols.	Program for appropriate research, testing, evaluation, and deployment of improved planting stock, including trees derived through biotechnology.	Availability of program	Control of verifier
8. BSI	1. To comply with relevant applicable laws	Relevant national laws and international conventions are complied with.	Compliance of laws and conventions (yes/no)	Check of compliance of laws and conventions (yes/no)

Protected areas recognised by international agreements (CBD, Ramsar Wetlands, Kyoto)				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	2. There is compliance with all applicable local, national and ratified international laws and regulations. This also includes laws made pursuant to a country's obligations under international laws or conventions (e.g. CBD, Kyoto, etc.)	Indicators: Evidence of compliance with relevant legal requirements, documented system, which includes written information on legal requirements, a mechanism for ensuring that they are implemented, a system for tracking any changes in the law. The systems used should be appropriate to the scale of the organisation.	Documented system including written information, tracking changes and records.	Control of availability system including checking of documentation, actuality, etc.
2. GGL (GGLS2)	GGL recognizes other agricultural standards as Greenergy that may include information on this topic.	-	-	-
3. NTA 8080	The organization shall enforce all applicable laws and regulations of the country of establishment, as well as <u>international agreements and treaties</u> which the country of establishment has signed and shall comply with P&C of NTA8080. This includes CBD, Kyoto Protocol, etc.	This implies that: • The organizations shall enforce all applicable national laws and regulations; • The organization shall comply with all applicable legal prescribed reimbursements, royalties, taxes, etc. • The organization shall enforce the provisions of all bound international treaties as far as the country of establishment has signed the treaty; • Conflicts between laws and regulations and the provisions of this NTA for the purpose of certification shall be evaluated case by case by the CB and the parties concerned to which the conflict applies; • Regions, to which this NTA applies or is implemented, shall be safeguarded against illegal chopping or harvesting, illegal establishment and other unauthorized activities; Administrators of regions, to which the NTA applies or is implemented, shall show long time involvement to comply with requirements of this NTA.	Enforcement and compliance of relevant laws and regulations.	Check of enforcement and compliance of relevant laws and regulations.
	5. In new or recent developments, no deterioration of biodiversity by biomass production in protected areas. The position of protected areas shall be verified by one of the following sources: IUCN List	The Biomass production shall not be practiced in a 'gazetted protected area' or in a zone which at any point is moved off a distance less than 5 km from a '<u>gazetted protected area</u>'. Biomass production in gazetted protected areas or in a zone of 5 km around these areas is only permitted when: • Biomass production is permitted according to applicable laws and regulations (under provision) in the area;	Enforcement and compliance of relevant laws and regulations.	Check of enforcement and compliance of relevant laws and regulations.

	of protected areas, Ramsar area Wetlands, World Heritage Sites UNESCO or the Integrated Biodiversity Assessment Tool.	• Biomass production is part of acknowledged management to protect the biodiversity values in areas that own their great 'historical' biodiversity value to human intervention; Biomass production at the PU is started before 1 January 2007, or a reference dates from other certification systems (currently under development) and has taken place since in a continuous series of production cycles.		
4. SAN	Not specifically mentioned in criteria. Reference made to international conventions in definition list and sources.	-	-	-
5. Greenergy	No conversion of high biodiversity areas after November 30, 2005. Compliance with national laws and regulations relevant to biomass production and in the area where biomass production takes place.	Evidence that production does not take place in any areas of high biodiversity. The RTFO guidance refers to UNESCO World heritage sites; IUCN List of Protected Areas categories I, II, III and IV, according to the list from 2003 or more up to date national data; RAMSAR sites Reference to adoption of international regulations and conventions as CBD.	Mapping, evidence that no conversion takes place on high biodiversity areas. Compliance of laws and regulations.	Control of verifier
6. CERFLOR	CERFLOR was recognized by the PEFC council in 2005. PEFC requires that: 1. The production country recognizes a set of international conventions and 2. If not: the Production Unit follows the regulations stipulated in the conventions.	Among the international conventions and protocols, four are considered fundamental by the PEFC Council: - Convention on Biological Diversity - Cartagena Protocol on Preventing Biotechnological Risks Related to the Convention on Biological Diversity (non ratified) ; - The United Nations Framework Convention on Climatic Changes Convention and The Kyoto Protocol; - The Washington Convention or the Convention on the International Commerce of Wild Fauna and Flora Species Endangered of Extinction CITES.	Enforcement and compliance of relevant laws and regulations.	Control of compliance regulations international conventions
7. SFI	SFI was recognized by the PEFC council in 2005. PEFC requires that: 3. The production country recognizes a set of international conventions and 4. If not: the Production Unit follows the regulations stipulated in the conventions.	Among the international conventions and protocols, four are considered fundamental by the PEFC Council: - Convention on Biological Diversity - Cartagena Protocol on Preventing Biotechnological Risks Related to the Convention on Biological Diversity (non ratified) ; - The United Nations Framework Convention on Climatic Changes Convention and The Kyoto Protocol; - The Washington Convention or the Convention on the International Commerce of Wild	Enforcement and compliance of relevant laws and regulations.	Control of compliance regulations international conventions

		Fauna and Flora Species Endangered of Extinction CITES.		
8. BSI	1. To comply with relevant applicable laws	Relevant national laws and international conventions are complied with. List of international conventions included in annex, mentioning: CBD, Ramsar Wetlands, World Heritage Conventions.	Compliance of laws and conventions (yes/no)	Check of compliance of laws and conventions (yes/no)
Protected areas in lists drawn up by intergovernmental organisations (EU, Mercosur, African Union, ASEAN)				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	2. There is compliance with all applicable local, national and ratified international laws and regulations. This also includes laws made pursuant to a country's obligations under international laws or conventions.	Indicators: Evidence of compliance with relevant legal requirements, documented system, which includes written information on legal requirements, a mechanism for ensuring that they are implemented, a system for tracking any changes in the law. The systems used should be appropriate to the scale of the organisation.	Documented system including written information, tracking changes and records.	Control of availability system including checking of documentation, actuality, etc.
2. GGL (GGLS2)	GGL recognizes other agricultural standards as Greenergy that may include information on this topic.			
3. NTA 8080	The organization shall enforce all applicable laws and regulations of the country of establishment, as well as international agreements and treaties which the country of establishment has signed and shall comply with P&C of NTA8080. This includes CBD, Kyoto Protocol, etc.	This implies that: • The organizations shall enforce all applicable national laws and regulations; • The organization shall comply with all applicable legal prescribed reimbursements, royalties, taxes, etc. • The organization shall enforce the provisions of all bound international treaties as far as the country of establishment has signed the treaty; • Conflicts between laws and regulations and the provisions of this NTA for the purpose of certification shall be evaluated case by case by the CB and the parties concerned to which the conflict applies; • Regions, to which this NTA applies or is implemented, shall be safeguarded against illegal chopping or harvesting, illegal establishment and other unauthorized activities; Administrators of regions, to which the NTA applies or is implemented, shall show long time involvement to comply with requirements of this NTA.	Enforcement and compliance of relevant laws and regulations.	Check of enforcement and compliance of relevant laws and regulations.
4. SAN	Not specifically mentioned in criteria. Compliance possibly via national laws and regulations.	-	-	-
5. Greenergy	Not specifically mentioned in criteria. Compliance possibly via national laws and regulations.	-		

6. CERFLOR	Not explicitly mentioned in criteria. Intergovernmental processes form basis for foundation of Cerflor criteria.	The elements of sustainable forest management used in the development of Cerflor have been drawn from experience gained through intergovernmental processes such as the Montreal Process or the International Tropical Timber Organization (ITTO)		
7. SFI	Not explicitly mentioned in criteria. Intergovernmental processes form basis for foundation of SFI criteria.	The elements of sustainable forest management used in the development of SFI have been drawn from experience gained through intergovernmental processes such as the Montreal Process or the International Tropical Timber Organization (ITTO)		
8. BSI	Not explicitly mentioned in criteria. Criteria 1: To comply with relevant applicable laws	-	-	-
Protected areas in lists drawn up by IUCN				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	5. The status of rare, threatened or endangered species and HCV habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account into management plans and operations.	Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations. Information should cover the conservation status (e.g. IUCN status conservation)	Information gathering should include checking available biological records, consultation with relevant stakeholders and (if needed) a field study.	Check of management plans, records and documentation.
2. GGL (GGLS2)	GGL recognizes other agricultural standards as Greenergy that may include information on this topic.			
3. NTA 8080	5. In new or recent developments, no deterioration of biodiversity by biomass production in protected areas. The position of protected areas shall be verified by one of the following sources: IUCN List of protected areas, Ramsar area Wetlands, World Heritage Sites UNESCO or the Integrated Biodiversity Assessment Tool.	The Biomass production shall not be practiced in a 'gazetted protected area' or in a zone which at any point is moved off a distance less than 5 km from a 'gazetted protected area'. Biomass production in gazetted protected areas or in a zone of 5 km around these areas is only permitted when: • Biomass production is permitted according to applicable laws and regulations (under provision) in the area; • Biomass production is part of acknowledged management to protect the biodiversity values in areas that own their great 'historical' biodiversity value to human intervention; • Biomass production at the PU is started before 1 January 2007, or a reference dates from other certification systems (currently under development) and has taken place since in a continuous series of production cycles.	Position of protected areas is verified and management practices are arranged accordingly.	Check of protected areas
4. SAN	Not specifically mentioned in criteria. Reference made to international conventions in definition list	-	-	-

	and sources.			
5. Greenergy	No conversion of high biodiversity areas after November 30, 2005.	Evidence that production does not take place in any areas of high biodiversity. The RTFO guidance refers to UNESCO World heritage sites; IUCN List of Protected Areas categories I, II, III and IV, according to the list from 2003 or more up to date national data; RAMSAR sites	Mapping, evidence that no conversion takes place on high biodiversity areas.	Control of verifier
6. CERFLOR	Not mentioned in criteria.	-	-	-
7. SFI	Not mentioned in criteria.			
8. BSI	Not mentioned in criteria.			
Biodiverse grassland				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	Not explicitly mentioned in criteria			
2. GGL (GGLS2)	Not explicitly mentioned in criteria			
3. NTA 8080	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 (wetlands). 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 organization shall: • Establish preceding the installation of new PU which carbon storage will be lost in the vegetation and in the soil by the installation of the PU; • Establish whether these losses will be compensated by means of cultivation of the intended biomass during the next 10 years; • Take measures to reduce the emission of GHGs from the soil during cultivation; • Monitor, measure and analyze the measures; • -Document the results	Calculation of carbon stocks before establishment PU and monitoring of changes. Documentation of results	Control of verifier
4. SAN	2. Farms in areas where the original natural vegetation is not forest -as grasslands, savannas, scrublands or shrublands - must dedicate at least 30% of the farm area for conservation or recovery of the area's typical ecosystems. These farms must implement a plan to establish or recover natural vegetation within 10 years.	-	Dedication of land to nature conservation. Identification of nature conservation areas.	Control of identified nature conservation areas (maps, records) and check of conservation measures in field.
5. Greenergy	Preservation of above and below ground carbon stocks relative to stocks on 30 November 2005.	Evidence that the biomass production unit has not been established on soils with large risk of significant soil stored carbon losses as peat lands, mangroves, wetlands and certain grasslands	* Documentation of environmental assessments of expansions since 2005, showing no conversion of natural ecosystems (forests or Cerrado) since 2005;	-

			* Verification that the scope of the environmental licenses (issued since 2005) does not include conversion. Where there has been any conversion of natural ecosystems, evidence that the carbon payback does not exceed 10 years.	
6. CERFLOR	Not explicitly mentioned in criteria	-	-	-
7. SFI	Not explicitly mentioned in criteria	-	-	-
8. BSI	Not explicitly mentioned in criteria	-	-	-
Protected areas defined by stakeholder processes				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	5. The status of rare, threatened or endangered species and HCV habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account into management plans and operations.	Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations. Information should cover the presence of protected areas that could be significantly affected by the grower or miller. • An HCV assessment, including stakeholder consultation, is conducted prior to any conversion. • Dates of land preparation and commencement are recorded	Information gathering should include checking available biological records, consultation with relevant stakeholders and (if needed) a field study. Results of HCV assessment (maps). Records of land preparation.	Check of management plans, records and documentation. Check of HCV assessment and land records.
2. GGL (GGLS2)	Land and conservation areas at risk are identified and the policy and management measures are formulated.	Identification of land and conservation areas and formulation of management measures. According to definition of WWF: areas of outstanding and critical importance due to their environmental, socio-economic, biodiversity + landscape values	Identification of land and conservation areas and formulation of management measures.	Control of identification of land and conservation areas and formulation of management measures.
3. NTA 8080	-	-	-	-
4. SAN	2. All existing natural ecosystems (aquatic and terrestrial) must be identified, protected and restored through a conservation program (C). 2. From the date of application for certification onwards, the farm must not destroy any natural ecosystem. Additionally, from November 1, 2005 onwards no high value ecosystems must have been	2. The program must include the restoration of natural ecosystems or the reforestation of areas within the farm that are unsuitable for agriculture. 2. If any natural ecosystems have been destroyed by or due to purposeful farm management activities between November 1, 1999 and November 1, 2005, the farm must implement the following analysis and mitigations: a. Conduct an analysis of the ecosystem destruction to document the scope and ecologi-	Identification of natural ecosystems (see definitions). Protection and restoration of natural ecosystems.	Control of management practices and documentation.

	destroyed by or due to purposeful farm management activities (SUB).	cal impact of the destruction. b. Develop a mitigation plan with advice from a competent professional that is consistent with applicable legislation and that compensates for the negative impact. c. Implement the activities of this mitigation plan, including for example the set aside of a significant percentage of the farm area for conservation purposes.		
5. Greenergy	No conversion of high biodiversity areas after November 30, 2005.	Evidence that production does not take place in areas with one or more HCV areas: HCV 1, 2, 3 relating to important ecosystems and species; HCV 4, relating to important ecosystem services, especially in vulnerable areas; HCV 5, 6, relating to community livelihoods and cultural values. HCV as a tool is not a well known concept in Brazil, and use of existing systems of identification for values. Guidance: hcvnetwork.org	Means of verification: * Valid environmental license issued by Environment Agency. * Documented evidence of an impact assessment for any expansion that has taken place since 30 November 2005. * Documentation identifying where HCV occur and the area required to maintain them, including areas owned but not under production. * Consultation with stakeholders	
6. CERFLOR	-	-	-	-
7. SFI	4. Program Participants shall have programs to promote biological diversity at stand and landscape levels.	• Program to promote the conservation of native biological diversity, including species, wildlife habitats, and ecological or natural community types, at stand and landscape levels. • Program to protect threatened and endangered species. • Plans to locate and protect known sites associated with viable occurrences of critically imperilled and imperilled species and communities. Plans for protection may be developed independently or collaboratively and may include e.g. Program Participant management, cooperation with other stakeholders, etc • Development and implementation of criteria, as guided by regionally appropriate science, for retention of stand-level wildlife habitat elements • Assessment, conducted individually or collaboratively, of forest cover types and habitats at the individual ownership level and, where credible data are available, across the landscape, and incorporation of findings into planning and management activities, where practical and when consistent with management objectives. • Participation in programs and demonstration of activities as appropriate to limit the introduction, impact, and spread of invasive exotic plants and animals that directly threaten or are likely to threaten native plant and animal communities. • Program to incorporate the role of prescribed or natural fire where appropriate.	Participation in various programs to protect biodiversity and endangered species	Control of verifier
8. BSI	To assess direct and indirect impacts of sugarcane enterprises on biodiversity and ecosystem services For expansion of new sugarcane projects to ensure	Identification of: High Conservation Value areas at risk on national level (see definition) High conservation Value areas (interpreted nationally) used as % of total land affected	Maps of identified HCV areas Verifier: in %. Standard: 0	Control of maps (based on national identified HCV areas)

	transparent, consultative and participatory processes that addresses cumulative and induced effects via environmental and social impact assessment.	by a new project or an expansion.		
Additional biodiversity criteria				
	Criteria	**indicator**	**Allowed proof/evidence**	**Auditing practice**
1. RSPO	5. The status of rare, threatened or endangered species and HCV habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account into management plans and operations.	Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations. Information should cover population status and habitat requirements of rare, threatened or endangered species that could be affected by the grower or miller. If any rare, threatened or endangered species or HCV habitats are present, appropriate measures for management will include: Avoiding damage to and deterioration of applicable habitats and Controlling any illegal or inappropriate hunting, fishing or collecting activities.	Information gathering should include checking available biological records, consultation with relevant stakeholders and (if needed) a field study.	Check of management plans, records and documentation.
2. GGL (GGLS2)	Conversion and maintenance must achieve clear, additional and long term conservation benefits. There is a long term commitment to adhere to the principles and criteria for sustainable conservation, expressed in a written and up to date management plan or in other management documents. The relative conservation value of the area before and after conversion must be clearly demonstrated. The positive effect of maintenance on the conservation value of the area must be clearly demonstrated. The extent to which the converted area provides enhanced conservation benefits in terms of the landscape must be taken into account.			
3. NTA 8080	5. Maintenance and recovery of biodiversity	The organization shall: - At least 10% of the functional soil area of the PU left covered with the original vegetation, representative for the area, for recovery of biodiversity; - Record in which land zone the PU is located; - Record whether the biomass production contributes to the recovery of degraded	Availability of records, management plan, analysis of measures, maps	Control of documentation and records.

	5. <u>Strengthening of biodiversity</u>	areas within the PU; - Establish and record measures in management plans and monitor, measure and analyze these measures; - Document the results The principle of precaution applies to HCV within the PU. The HCV areas in the PU are described in the management plan and as far as possible indicated in a map. The organization shall: - Take measures, which are needed, where possible to improve the biodiversity within the PU and to limit fragmentation and disintegration of natural land on and through the PU; - Take measures, which are need to ensure that disruption of the environment by entering, use of agrochemicals, noise and invasion of exotic species from the PU; - Establish and record measures in management plans and monitor, measure and analyze these measures - Document the results.		
4. SAN	2. The farm must implement a plan to maintain or restore the connectivity of natural ecosystems, within its boundaries, considering connectivity of habitats at the landscape level (ADD). 2. There must be a minimum separation of production areas from natural terrestrial ecosystems where chemical products are not used. A vegetated protection zone must be established by planting or by natural regeneration between different permanent or semi-permanent crop production areas or systems. 2. Aquatic ecosystems must be protected from erosion and agrochemical drift and runoff by establishing protected zones on the banks of rivers, permanent or temporary streams, creeks, springs, lakes, wetlands and around the edges of other natural water bodies.	e.g. through elements such as native vegetation on roadsides and along water courses or river banks, shade trees, live fences and live barriers 2. The separation between production areas and ecosystems as defined in Annex must be respected. 2. Distances between crop plants and aquatic ecosystems as indicated in Annex must be respected. Farms must not alter natural water channels to create new drainage or irrigation canals. Previously converted water channels must maintain their natural vegetative cover or, in its absence, this cover must be restored. The farm must use and expand vegetative ground covers on the banks and bottoms of drainage canals.	Availability of restoration and management measures to improve the biodiversity in and around the area of the production unit.	

	2. The farm must establish and maintain vegetation barriers between the crop and areas of human activity, as well as between production areas and on the edges of public or frequently traveled roads passing through or around the farm. 3. Principle on wildlife conservation and additional criteria.	2. These barriers must consist of permanent native vegetation with trees, bushes or other types of plants, in order to promote biodiversity, minimize any negative visual impacts and reduce the drift of agrochemicals, dust and other substances coming from agricultural or processing activities. The distance between the crop plants and areas of human activity as defined in Annex must be respected.		
5. Greenergy				
6. CERFLOR	3. The introduction and the utilization of genetic material shall be carried out in a controlled way following biosecurity standards. Previous experience with such material shall be available in order to, besides attesting the forest production potential in the region, allows for the assessment of any possible environmental impacts. Forest protection techniques and integrated management of pests and diseases techniques shall be adopted. Natural ecosystems shall be monitored so as to provide information on their biological resources to be used in confirming or revising the management plan. The level of monitoring shall be compatible with scale of operations.	Existence of a program implemented to extend the genetic base. Existence of previous experience or some reference in the region or at the site, attesting the forest production potential of the genetic material for the desired objective; Existence of a program implemented for continuous assessment of alternative genetic materials; Evidence of compliance with biosecurity standards and techniques when using genetically modified organisms • Existence of an integrated pests and diseases management plan; • Existence of a system for prevention, surveillance and control forest fires; • Existence of monitoring and recording of meteorological, pest and disease conditions; • Evidence of procedures aimed at minimizing the use of chemical products in the control of infestation and disease; • Existence of pest and disease prevention or control measures using natural biological control agents, aside from silvicultural, genetic, physical or mechanical techniques. • Existence of phytosociological surveys and studies on the structure of remaining native vegetation; • Existence of periodic surveys or inventories that are sufficient to detect imbalances in the composition of local wildlife; • Evidence that the results of the periodical surveys and inventories are being incorporated into the management plan;	Existence of program on used genetic material and biosecurity standards. Existence of an integrated pests and diseases management plan, system for prevention and monitoring, procedures Existence of surveys and studies, records, list of threatened species in areas.	Control on existence of program on used genetic material and biosecurity standards. Check of verifiers Check of verifi-

		• Existence of lists of threatened species occurring in the forest management unit or its vicinity, and about the plans to protect them.		ers
7. SFI	4. Program Participants shall apply knowledge gained through research, science, technology, and field experience to manage wildlife habitat and contribute to the conservation of biological diversity.	• Collection of information on critically imperilled and imperilled species and communities and other biodiversity-related data through forest inventory processes, mapping, or participation in external programs, such as Nature Serve, state or provincial heritage programs, etc. Such participation may include providing non-proprietary scientific information, time, etc • A methodology to incorporate research results and field applications of biodiversity and ecosystem research into forest management decisions.	Collection of information on threatened species, forest inventories, mapping. Availability of methodology to integrate results into management.	Check of verifiers
8. BSI	To assess direct and indirect impacts of sugarcane enterprises on biodiversity and ecosystem services To consult stakeholders and implement appropriate mitigation where adverse impacts are identified	Identification of: - Aquatic Oxygen Demand per unit mass product - Soil Nutrient Status - Eutrophication per unit mass product - Ecotoxicity to aquatic life per unit mass product Documented consultation plan	Verifier: ton oxygen/ton mass product Verifier: yes/no Verifier: % of fields with fertilizer applied Verifier: ton phosphate equivalent / ton cane Verifier: ton herbicides or pesticides / ton cane Availability of consultation plan	Check of verifiers Availability of consultation plan

The HC values are interpreted in a stakeholder context leading to a certain subjectivity of the defined high conservation value areas (this can differ from country to country). It must be noted, however, that the level of protection and monitoring of compliance will also differ from country to country.

International agreements, regulations and conventions (as IUCN, Ramsar or CBD) provide relevant databases to define the location of recognized protected areas. Assessments made ten years or more ago are annotated as being out of date and users are requested to use them with caution. Updates on statistics of the Red List take much time and not all country data are of high quality. Beside, it must be recognized that satellite images cannot provide all required detailed information on (for example) the quality of ecosystems. This type of information has to be combined with or can only be obtained at a national level or at a project level.

Most mature schemes have developed a list of definitions as a guidance to meet the defined criteria and principles. The definitions related to biodiversity are listed below for the various schemes.

Roundtable on Sustainable Palm Oil

High Conservation Values (HCVs) may be identified in restricted areas of a landholding, and in such cases new plantings can be planned to allow the HCVs to be maintained or enhanced. The HCV assessment process requires appropriate training and expertise, and must include consultation with local communities, particularly for identifying social HCVs. HCV assessments should be conducted according to the National Interpretation of the HCV criteria or according to the Global HCV Toolkit if a National Interpretation is not available.

Development should actively seek to utilise previously cleared and/or degraded land. Plantation development should not put indirect pressure on forests through the use of all available agricultural land in an area. Where landscape level HCV maps have been developed, these should be taken into account in project planning, whether or not such maps form part of government land use plans.

National interpretation should refer to existing national definitions of HCVs (or where these do not exist refer to definitions in the annex) or equivalent land use / conservation plans or consider how growers and the audit team can identify High Conservation Values. This may involve collaboration with other bodies.

Definition High Conservation Value Forest (HCVF): The forest necessary to maintain or enhance one or more High Conservation Values (HCVs):

- HCV1. Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species).
- HCV2. Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.
- HCV3. Forest areas that are in or contain rare, threatened or endangered ecosystems.
- HCV4. Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control).
- HCV5. Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health).
- HCV6. Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

Definition Primary Forest: A primary forest is a forest that has never been logged and has developed following natural disturbances and under natural processes, regardless of its age. Also included as primary, are forests that are used inconsequentially by indigenous and local communities living traditional lifestyles relevant for the conservation and sustainable use of biological diversity. The present cover is normally relatively close to the natural composition and has arisen (predominantly) through natural regeneration. National interpretations should consider whether a more specific definition is required (FAO Second Expert Meeting On Harmonizing Forest-Related Definitions for Use by Various Stakeholders, 2001).

The NTA 8080 - Netherlands

Definition of High Conservation Value Areas are areas with one or more of the following values:

- HCV1: Areas containing globally, regionally or nationally significant concentrations of biodiversity values;
- HCV2: Globally, regionally or nationally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance;
- HCV3: Areas that are in or contain rare, threatened or endangered ecosystems;
- HCV4: Areas that provide basic ecosystem services in critical situations (e.g. watershed protection, erosion control);
- HCV5: Areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)
- HCV6: Areas critical to local communities' traditional cultural identity;

Definition of protected area: Area on land and / or water, designated by national law or otherwise, for the preservation and protection of the ecosystem function and biodiversity or cultural values of the area.

Definition of protected species: Species of plants or animals protected by national law or, in case national law is lacking, species classified as 'vulnerable', 'endangered', or 'critically endangered' in the IUCN red list.

Definition of threatened species: any species of living organisms that is threatened with extinction (because the population is small of range or because the population is threatened due to changes of ecological nature or human interference) and that is classified as 'vulnerable', 'endangered' or 'critically endangered' in the IUCN red list.

Sustainable Agriculture Network SAN

Definition of Native Species: Those species that occur naturally in the place where they are found. For the purpose of this standard, naturalized species - exotic species that have adapted and grow and multiply as if they are native - are also considered as native if it is proven that they do not cause negative economic or environmental impacts.

Definition of Natural ecosystems: A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Source: Convention on Biological Diversity). Examples are aquatic ecosystems, such as streams, rivers, pools, ponds, lakes, lagoons, and other bodies of liquid water that exist naturally; wetlands such as swamps, marshes, mangroves or bogs; terrestrial ecosystems, such as primary and secondary forests, bush lands, grass lands or other advanced natural succession stages without significant human disturbance for minimum 10 years. Each SAN representative provides further local interpretation considering local biophysical conditions.

Definition of Natural resources: A feature or component of the natural environment that is of value in serving human needs, e.g. soil, water, plant life, wildlife, etc. Some natural resources have an economic value (e.g. timber) while others have a "noneconomic" value (e.g. scenic beauty). (Source: UNUN http://www.eionet.europa.eu).

Definition of Protected Area: Land or property under legal protection in order to conserve or protect biodiversity or environmental services. Examples include: national parks, wildlife refuges, forestry reserves and private reserves. Some protected areas may contain private land where certain economic activities are allowed to be carried out according to established regulations.

Definition of Protection Zone: Areas of less intensive or controlled land use with the purpose of reducing the impact of human activities on ecosystems. With respect to this standard, protection zones are also areas of vegetation next to streams, lakes or ponds, or bordering natural water bodies that impede the flow of run-off or drift of agrochemicals coming from production areas.

Definition of Threatened or Endangered Species: Species of flora and fauna indicated as threatened or endangered in applicable laws as well as by the International Union for Conservation of Nature and Natural Resources' IUCN Red List of Threatened Species.

Better Sugarcane Initiative
Definition of High Conservation Value (HCV) areas: natural habitats where conservation / biodiversity values are considered to be of outstanding significance or critical importance based on factors such as the presence of rare or endemic species, sacred sites, or resources harvested by local residents (see www.hcvnetwork.org). For implementation of the BSI standard each country is required to provide a country specific interpretation of High Conservation Value which will be used for audits in that country. Application of HCV will involve the setting of a cut off date the terms and timing of which are still to be determined.

3.5 Discussion key topics

Most bioenergy schemes listed in Table 3.2 focus on biofuels. Only NTA 8080 (in this list!) is developed to guarantee the sustainability of bioenergy for heat and power. Table 19 shows that the schemes that are developed to guarantee the sustainability of bioenergy mainly follow the meta-standard approach. This means that existing schemes for sustainable forest and agricultural production can be used (partly) to cover the required sustainability criteria, providing that they are compatible.

A similar approach already exists for forestry certification schemes. PEFC, based on ITTO/ATO and PEOLG, is an umbrella organization to evaluate and endorse national forestry schemes around the world. National forestry schemes under PEFC are for example MTCC, CERTFOR and SFI. FLO is an umbrella organization for agricultural products to endorse national FLO schemes around the world.

Table 3.3 gives information on the governance and organization of schemes. A certifying body is a body which is responsible for verifying that a product sold or labeled as "sustainable" is produced, prepared, handled and processed according to the standard. There are 3 main ISO standards that are developed to ensure the competency of the certifying body (and its auditors):

- ISO 62: General requirements for bodies operating assessment and certification / registration of quality systems.
- ISO 65: General requirements for bodies operating product certification systems.
- ISO 66: General requirements for bodies operating assessment and certification / registration of environmental management systems.
- ISO 19011: General criteria for Quality Management System Auditors or Environmental Management System Auditors

Organizations that issue credentials or certify third parties against official standards are themselves formally accredited by accreditation bodies. This accreditation process ensures that their certification practices are acceptable, typically meaning that they are competent to test and certify third parties, behave ethically, and employ suitable quality assurance. An accreditation body is an organization delegated to make decisions, on behalf of the higher education sector, about the status, legitimacy or appropriateness of an institution, or programme. ISO 61 is developed to ensure the competence of accreditation bodies and sets general requirements for assessment and accreditation of certification / registration bodies.

Table 3.2 shows that most schemes have certification schemes that are ISO certified and recognized on a national level. This is in most cases accredited by accreditation bodies. Various "new" schemes (e.g. Roundtable Initiatives) are still developing their organizational structure including the establishment of accreditation procedures. Sustainability standards as included in UK-RTFO and NTA8080 are (partly) embedded in the national policy and will most probably require a (partly) different type of organizational structure.

ISO 59 is the Code of Good Practice for Standardization. This includes the minimum requirements expected of a standards-setting body including requirements for standard-setting procedures, transparency, and approval of standards, participation and complaints during standard setting. Some schemes (as shown in Table 20) do not show a clear picture if there was a balanced participation of stakeholders in the standard setting process. It must be noted that the presence of a "balanced stakeholder process" is partly subjective and the opinion is depending on the information source. Especially some forestry certification schemes, recognized by PEFC (MTCC, Canadian SAFM, CERFLOR), show opposite opinions on this topic in literature.

Table 3.4 gives information on the verification and assessment procedures. External audits are implemented on a regular basis to check if the sustainability criteria are met at the production unit. In case a scheme has included a Chain of Custody (CoC) certificate, verification procedures also have to be developed to check if the required procedures are followed in the further chain as well.

FSC and forestry schemes recognized by PEFC apply in general the mass balance system and track-and-trace system to trace the products from the production unit to the end-user of the chain.

RSPO and NTA 8080 (only for biomass for electricity and heating) recognize three systems to trace products from the production unit to the end-user of the chain: Mass balance, track and trace or book and claim). NTA 8080 mentions that the three models are all acceptable but in combination with different sustainability claims. For all counts that certain verification requirements have to be met.

Table 3.5 to 3.10 show in how far the criteria in the schemes are compatible to the European Renewable Energy Directive. The "new" schemes (e.g. Roundtables, Greenergy, and ISCC) have included a requirement on GHG reduction in their principles. Some existing schemes as SAN or AFS also recognize the importance of reducing GHG emissions in their production chain. SAN has for example included as principle "Practices to reduce GHG emissions and promote carbon dioxide sequestration are required".

Most certification schemes recognize the need to conserve biodiversity. Table 3.11 provides information on how biodiversity is included in a certification scheme. Most schemes have not defined explicitly a criterion to protect primary forest or biodiverse grasslands. However, it should be noted that the protection of these areas is indirectly covered by:

- Recognition of international regulations (CBD, Ramsar)
- National laws and policies on protected areas
- The formulation of High Conservation Value (HCV) areas.

Various schemes follow the approach that HCV areas are defined in a participatory process (on a national or regional level). The HC values are interpreted in a stakeholder context leading to a certain subjectivity of the defined high conservation value areas (this can differ from country to country). It must be noted, however, that the level of protection and monitoring of compliance will also differ from country to country.

International agreements, regulations and conventions (as IUCN, Ramsar or CBD) provide relevant databases to define the location of recognized protected areas. Due to required data quality and updates, this type of information has to be combined with or can only be obtained at a national level or at a project level. Beside, most mature schemes have developed a list of definitions as a guidance to meet the defined criteria and principles. The definitions related to biodiversity are listed below for the various schemes.

Only a few schemes have included a specific principle or criterion on air pollution. More schemes have included a general principle or criteria on waste management in general. It must be recognized that minimizing air pollution, although indicated in Table 22 as not compatible to the RED, can still be covered in the scheme through:

- Minimization of burning in the field (which will reduce the air emissions on the field);
- National legislation or international conventions: most schemes require that the national legislation is met which will include legislation on air emissions.

However, the two points mentioned above do not provide the required data to meet the reporting obligation to the European Commission.

A similar remark about the reporting obligation for the water and soil impacts: Although most schemes require improvements in soil and water conservation, the type of records to monitor the progress may differ strongly from scheme to scheme. For example, NTA 8080 request for water conservation measurements in relation with use of irrigation water in liter/ha/year, origin of the irrigation water and surface water level according to BOD on and near the production unit. The Better Sugarcane Initiative request information on the net water consumed per unit mass of product. Both schemes request, in addition, information on soil properties and characteristics. Also, various schemes require the availability of water and soil management plans.

Social impacts (counteracting negative impacts and promoting positive impacts) are included in most schemes by a translation of the ILO standards into a principle or a set of criteria. The level of detail of these criteria and indicators can, however, differ per scheme.

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4. Task 4: Identification of feasible verification options

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4.1 Objective and overview of task 4

The objective of Task 4 is to identify and analyse feasible options to verify compliance with biomass sustainability criteria, in the case of forest biomass. Supply chain control systems as 'book and claim', 'mass balance', and 'track and trace' (full segregation) should be assessed for scenarios where the obligation to show compliance with sustainability criteria is on for example the energy producers in the EU or the biomass producers in the EU. The overall approach for this assessment is explained in section 4.2, including a set of policy options (scenarios). Section 4.3 holds an introduction to woodfuels while section 4.4-4.7 analyses and discusses feasibility of a verification system for sustainable woodfuels, and section 4.8 concludes on these analyses and discussions.

4.2 Approaches

Feasibility of a verification system has at least four overall dimensions. These are that:
1. Sustainable production can be efficiently documented as well as sustainability of supply chains,
2. The supply chain can be efficiently controlled,
3. The system is accessibility to relevant users; and
4. Authorities and businesses are able and willing to endure the administrative and economic burdens that this documentation and control implies.

Approaches and data sources used to analyse these issues are shortly introduced below. A list of some abbreviations for existing systems and used concepts is given in Table 4.1., see however also Table 3.1.

Table 4.1 *List of abbreviations used in Task 4 cf. also Table 3.1.*

Abbreviation	Full name / description
Certification schemes and standards	
GlobalGAP	GlobalG.A.P. (Good Agricultural Practices)
GGL S1	Green Gold Label S1 - Chain of Custody and processing
GGL S2	Green Gold Label S2 - Agricultural Source Criteria
GGL S5	Green Gold Label S5 -Forest Source Criteria
GGL S8	Green Gold Label S8 -Greenhouse gases and energy balances
Laborelec	Laborelec
FSC	Forest Stewardship Council
NTA 8080	NTA 8080
PEFC	Programme for Endorsement of Forest Certification Schemes
RSPO	Roundtable on Sustainable Palm Oil
SAN standard (RA)	Sustainable Agriculture Network
SFI	Sustainable Forestry Initiative
Concepts	
SFM	Sustainable Forest Management certification
GHG	Certification of greenhouse gas balance savings
CoC	Certification of the Chain of Custody
SRC	Short Rotation Coppice
SRF	Short Rotation Forestry

4.2.1 Sustainable production and supply chains

Efficient documentation of sustainable production is indicated by (see e.g. Nussbaum & Simola 2005):

- The standards, including all relevant PC&I for sustainable biomass production and supply chain sustainability.
- Adequate formal auditing quality
- Practical and economical applicability
- That the precise verifiers used are adequately and consistently

These issues are briefly discussed in section 4.4 based on technical documentation, statistics and experiences from existing certification schemes, including results presented in chapter 3.

4.2.2 Supply chain control

Some of the issues that pose a challenge to control of woodfuel supply chains are:

- The number of ownership changes
- The number of processes needed to produce the woodfuel
- The number and size of transports and storages
- Length of transport and storage periods
- The amounts of biomass per purchase and frequency of purchase
- Purchase on long-term contracts or free market purchase
- The degree of separation in relation to storages, processing and manufacturing - for example expressed as mixture percentage

The supply chain control system should balance the efforts and costs needed to apply the system with the credibility that the system offers. Making sustainability claims about wood products made with raw material from certified forest may be more complex compared to claims on sustainable forest or land use management (Nussbaum & Simola 2005). Manufacturing processes in the forest product sector can be complicated: the wood may be cut, peeled, chipped, broken down into fibres, divided into separate loads or mixed, and may also be reprocessed. In many cases it will also change ownership more than once.

The effort and costs it takes to create efficient infrastructures and logistics that separate certified and uncertified material or a system that calculates the percentage of mixture depends on the specific supply chain characteristics for a particular product. There is usually a trade-off between degree to which the biomass can be identified through the supply chain and the effort and costs needed to apply the system (increasing degree of identification from left to right in Table 4.2). Greater separation and preservation of identity usually requires greater investment in segregated storage facilities, more meticulous production, isolation, added cleaning/sorting, and greater documentation and testing, but also greater risks of liability (Gustafson 2003), even if studies of agricultural products suggest that in some cases savings might be obtained by handling materials in separate containers compared to bulk storage and transports (Reichert & Vachal 2000).

Table 4.2 *Supply chain control systems and some of their characteristics. Full segregation, segregation with minimum limits and mass balance systems can be viewed as one type of system, allowing for various degrees of mixing (100% certified material, minimum % of certified material (e.g. 95%) calculated % of certified material)*

Characteristic	Book and claim	Mass balance / percentage system	Segregation with minimum limits (xx %)	Full segregation	Identity preserved
Credits	A certain amount of credits is assigned to the biomass producer, but not necessarily equal to the exact amount volume supplied	"Credits"=supplied volumes	"Credits"=suppl ied volumes	"Credits"=suppl ied volumes	"Credits"=suppl ied volumes
Mixing / segregation	Mixing	Controlled mixing	Controlled mixing	No mixing	No mixing
Market Claim	Supports the production of certified forest biomass (equivalent to xx % of the biomass utilised)	Supports the production of certified forest biomass (equivalent to xx % of the biomass utilised)	Contains xx % of certified forest biomass	Only certified forest biomass	Only certified forest biomass
Requires SFM verification	Yes	Yes	Yes	Yes	Yes
Requires CoC verification	No	Yes	Yes	Yes	Yes
Examples of existing CoC verification systems	RSPO as administered by GreenPalm, NTA 8080	FSC, PEFC, GGL S1, Laborelec, NTA 8080	RSPO (temporarily?)	FSC, PEFC, GlobalGAP, NTA 8080	RSPO

In Section 4.5, woodfuel supply chains are described and possibilities to control them are discussed based on results and experiences described in the literature, especially case studies from the EUBIONET2 project. Technical documentation, product databases and experiences from existing certification schemes, and personal communication with experts is also used as sources of information.

4.2.3 Accessibility

Systems to document sustainable production and systems to control the supply chain should be accessible to the relevant user. Accessibility may be affected by:

- The size of the economic operator
- The geographic location of the economic operator
- If relevant certification schemes or standards exist for the country or the region.
- The quality of institutional frameworks supporting certification

Accessibility was briefly discussed in Section 4.6 based on standards, approaches and services offered among existing certification systems and certifiers.

4.2.4 Administrative and economic burdens

The administrative and economic burdens should be minimised while still obtaining adequate documentation of sustainable biomass production and supply chains and efficient supply chain control. The EU Standard Cost Model (EC 2009) was used to assess the administrative and economic burdens of a possible EU directive giving sustainability criteria for solid biomass for heat and electricity, including woodfuels. The assessment presented in section 4.7 was based on inputs by the Control Union, EC standard wage tariffs, various statistics and personal communication with experts. Overview of assumptions and selected background knowledge is presented in the Annexes to this chapter.

4.2.5 Policy options

Based on the results presented in chapter 3, communication with the DG TREN, the iterative execution of this task and the availability of data it was decided to assess the costs of verifying sustainability criteria for four main policy options or scenarios. The four options operate with three different types of verification:

- Verification of criteria for sustainable forest management (SFM). This is supposed to cover all sustainability criteria except greenhouse gas emission savings.
- Verification of criteria on greenhouse gas emission savings along the whole supply chain (GHG).
- Verification of the supply chain control, i.e. Chain of Custody (CoC).

Economic operators were separated into three target groups (T1: biomass producers, T2: intermediate links as woodfuel processors, manufacturers, traders, and T3: energy producers) on which obligations related to these three types of certification were imposed. The four main scenarios were:

1. SFM+CoC (SFM for biomass producers and CoC for all)
2. SFM+CoC+GHG (SFM for biomass producers, GHG for energy producers and CoC for all)
3. CoC only (for all)
4. CoC+GHG (GHG for energy producers, CoC for all)

Two levels were applied for SFM corresponding to requirements by the GGL S5 and FSC respectively. For CoC the costs of the mass balance approach was assessed as available data for physical segregation were inadequate by not including costs of economic operators related to establishment of separate supply chains for certified and uncertified material. For GHG, it was assumed that all economic operators use default values to estimate greenhouse gas emissions, including documentation and verification that they are able to meet these defaults.

Additionally, obligations by economic operators and Member States were included, similar to those mentioned in the RES directive §18(3) ("Member States shall take measures to ensure that economic operators submit reliable information and make available to the Member State, on request, the data that were used to develop the information" and "Member States shall submit to the Commission, in aggregated form, the information referred to in the first subparagraph of this paragraph"). Combinations of six sets of basic requirements (A-F) and their imposition on four target groups thus define the four main scenarios (Table 4.3 and Table 4.4).

Table 4.3 *Defined set of requirements as imposed on 4 target groups (T1: biomass producers, T2: intermediate links as woodfuel processors, manufacturers, traders, T3: energy producers, and T4: Member States) thus forming 4 scenarios or policy options.*

Set of requirements		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Comments
A/B	SFM/CoC	T1	T1			Sub-scenario: A1: GGL Sub-scenario: A2: FSC
C	CoC	T2+T3	T2+T3	T1+T2+T3	T1+T2+T3	Mass balance
D	GHG		T1+T2+T3		T1+T2+T3	Default values with verification that these are met.
E	Rep. oblig. to MS	T3	T3	T3	T3	
F	Rep. oblig. to the Comm.	T4	T4	T4	T4	

Table 4.4 *Imposed sets of requirements for different target groups, thus forming four scenarios*

Target group	Scenario 1	Scenario 2	Scenario 3	Scenario 4
T1 Biomass producers	A+B	A+B+D	C	C
T2 Processing, manufacture, trade	C	C+D	C	C+D
T3 Energy producers	C+E	C+D+E	C+E	C+D+E
T4 Member States	F	F	F	F

4.3 Introduction

4.3.1 Woodfuel classification

Woodfuels can be separated into primary, secondary and tertiary woodfuels (Figure 4.1). Primary woodfuels are the main product from energy forest, whereas it is usually a side product or sometimes one of more main products from conventional forests. Typical tree species used for energy forest in Europe are willow (*Salix spp*), poplar (*Populus spp*) and eucalypt (*Eucalytus spp*). Theses species are grown as short rotation coppice (SRC) on agricultural land or in short rotation forestry (SRF) plantations (Nordh & Dimitriou 2003).

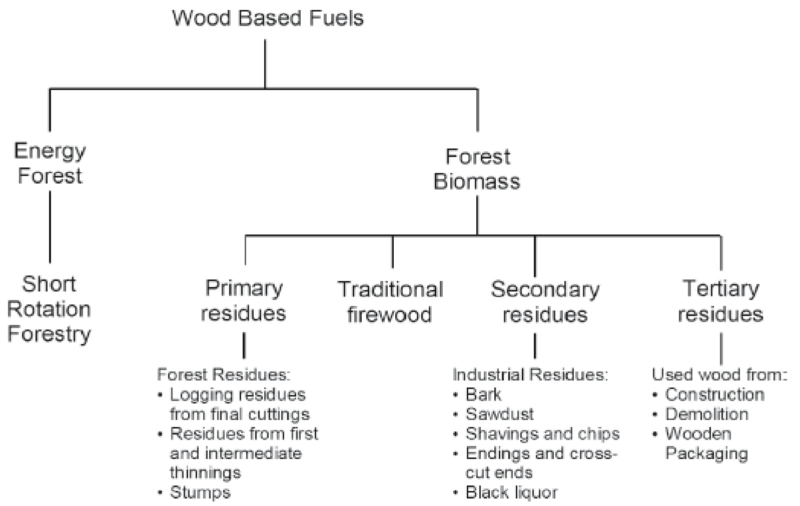

Figure 4.1 *Classification of woodfuels (Röser et al. 2008). In the text, woodfuels from energy forest, primary residues and traditional firewood are collectively referred to as primary woodfuels*

4.3.2 Woodfuel sources

Woodfuels come from conventional forest or dedicated energy tree crops, (Short Rotation Coppice (SRC) and Short Rotation Forestry (SRF).They may also come from trees outside forest, including for example nature reserves, hedges and windbreakers, arboriculture and urban parks. Trees outside forest may contribute significantly to industrial woodfuel supplies in developed countries (Prinz et al. 2008) and household subsistence in developing countries (Bellefontaine et al. 2002). Only wood from forests and dedicated energy tree crops will be considered here. Some countries in EU27 have large forest areas, while the area with SRC and SRF is limited and not necessarily grown for energy purposes (Table 4.5). Poplar, eucalypt and robinia are also harvested as timber or pulp wood and willow is also used for wickerwork.

Table 4.5 *Forest area and areas with short rotation coppice or short rotation forestry species in EU27*

	Total land[1]	Total Forest[1]	Willow[2]	Poplar[2]	Robinia[2]	Eucalypt[2]	Total SRC/SRF[2]	Total Forest	Total SRC/SRF

				1000ha					%
Austria	8,273	3,838						46	
Belgium	3,028	667						22	
Bulgaria	11,063	3,375						31	
Cyprus	924	173						19	
Czech Republic	7,728	2,637						34	
Denmark	4,243	486	1.50[3]				15	11	0.04
Estonia	4,239	2,243		5.00[4]			5	53	0.12
Finland	30,459	22,475	0.05				0	74	0.00
France	55,010	15,351	0.15	0.35		0.50	1	28	0.00
Germany	34,895	11,076	0.10				0	32	0.00
Greece	12,890	3,601						28	
Hungary	9,210	1,907						21	
Ireland	6,889	609						9	
Italy	29,411	9,447		4.50	0.50		5	32	0.02
Latvia	6,205	2,885						46	
Lithuania	6,268	2,020						32	
Luxembourg	259	87						34	
Malta	32	n,s,						-	
Netherlands	3,388	360	0.10	32.00			32	11	0.95
Poland	30,629	9,059	1.50				2	30	0.00
Portugal	9,150	3,583						39	
Romania	22,987	6,366	24.00				24	28	0.10
Slovakia	4,808	1,921						40	
Slovenia	2,012	1,239						62	
Spain	49,944	16,436				1,200.00[5]	1,200	33	2.40
Sweden	41,162	27,474	15.00				15	67	0.04
United Kingdom	24,088	2,793	2.00	0.01			2	12	0.01
EU27	419,194	152,108	57.90	41.86	0.50	1,200.50	1,301	36	0.31

[1]FAO (2005), [2]Compiled from Gustav Melin, Agrobränsle, Örebro, Sweden, in Nordh & Dimitriou (2003), and Eppler & Petersen (2007). The statistics are uncertain. Not all SRC and SCF are planted for energy purposes. [3]Lisbeth Sevel, HedeDanmark, Denmark, pers. comm. [4]Also aspen. [5]Including Portugal.

4.3.3 Woodfuel use and trade

Woodfuel use

The use of wood and other biomass for energy is increasing in EU27 (Figure 4.2). The increase in electricity generation and final consumption (excluding electricity) from biomass from 2002 to 2007 has been about 33%, while the corresponding increase for wood and wood waste energy has been about 20%. The most important sources are firewood, industrial waste liquors, other industrial by-products and wood residues (Figure 4.3). Primary forest residues are still of minor overall importance in most countries.

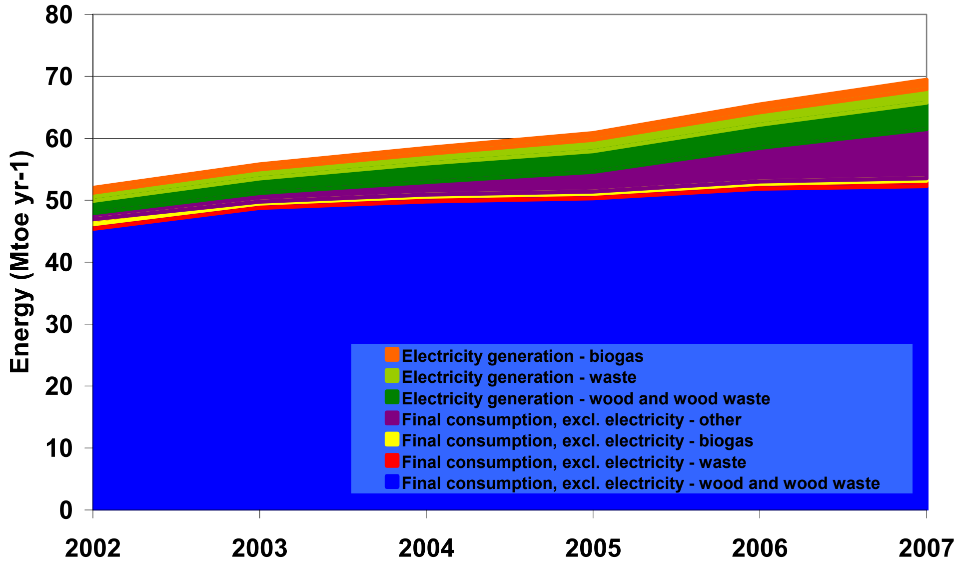

Figure 4.2 *Electricity generation and final energy consumption (excluding electricity) from biomass in EU27*

Source: Data from Eurostat 2009.

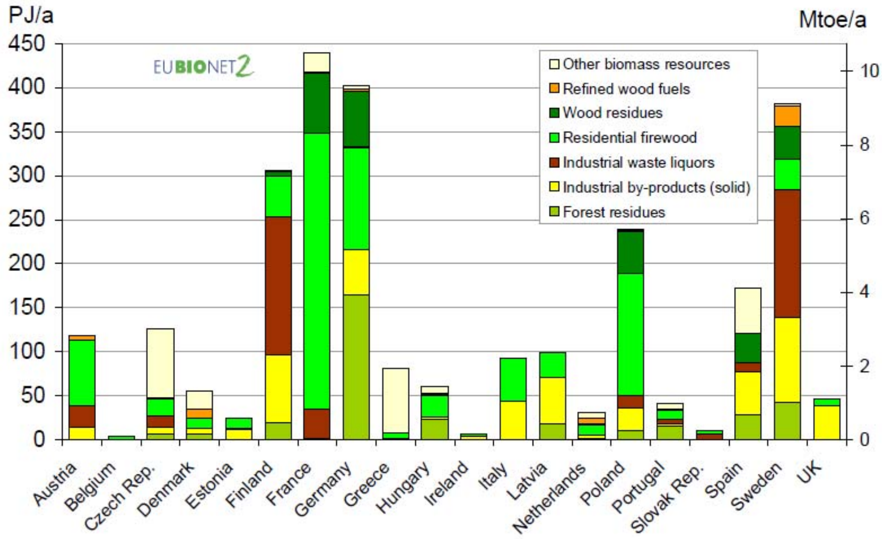

Figure 4.3 *Biomass consumption for energy production in 2004 in 20 EU countries participating in EUBIONET 2*

Source: Figure from Alakangas et al. 2007.

Woodfuel trade

Traditionally, woodfuels have been perceived as a domestic wood fuel. In the last decade, however, wood for fuel purposes has increasingly been traded internationally, especially pellets (Asikainen et al. 2009, Table 4.6). A large part of the trade takes place among the countries in Europe and EU. Within EU, the main flow is from new member states (Estonia, Latvia, Lithuania, Poland) to old member states (especially Sweden, Denmark, Germany and the Netherlands), but also Finland is a major exporting country of pellets. In Central Europe, Austria is a major exporter and importer (Alakangas et al. 2007, Heinimö et al. 2007, Junginger et al. 2008). Biomass fuels are also increasingly traded between Europe and other continents, especially from Canada (Table 4.7). Manufacture and export of wood pellets in Canada has grown exponentially from 1997 to 2006, as have the overseas sales. The export to Europe from Western Canada alone exceeded 400 ktons (Junginger et al. 2008). The export from Europe to non-EU countries seems limited (Alakangas et al. 2007).

Table 4.6 *An overview of world production and trade volumes of biomass fuels in 2004-2006 (from Asikainen et al. 2009)*

Product	Unit	World production			International trade volumes			International trade volume relative to world production		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
Ethanol	Mm^3	40.8	46.0	51.1	2.7	3.0	4.3	7%	7%	8%
Biodiesel	Mt	2.3	3.6 (2.7-3.8)	5.3	n.a.	0.2	0.4	n.a.	6%	8%
Fuelwood	Mm^3	1,771	1,824	1,827	4	4	4	0.2%	0.2%	0.2%
Charcoal	Mt	46	43	43	1.1	1.3	1.4	2%	3%	3%
Wood pellets	Mt	4.0 (3.7-4.8)	5.5 (4.6-6.5)	7.8 (7.1-8.4)	1.5 (1.2-1.7)	2.4	3.6	38%	44%	46%

Table 4.7 *Biomass fuels imported to EU countries from non-EU countries*

Exporting countries	Biomass fuels imported to EU countries	Examples of EU importing countries
Russia	Construction and demolition wood, peat, ethanol, pellets, firewood, sawdust, bark, waste liquors	Austria, Belgium, Finland, Sweden
Canada	Sawdust, wood waste, fuelwood, pellets, tall oil	Belgium, Denmark, Ireland, Sweden
South Africa	Pellets	Belgium
Ukraine	Briquettes	Hungary
USA	Ethanol, tall oil	Belgium, Sweden

Source: Alakangas et al. 2007.

4.4 Sustainable production and supply chains

Efficient documentation of sustainable production is indicated by (see e.g. Nussbaum & Simola 2005):

- The standards, including all relevant PC&I for sustainable biomass production and supply chain sustainability.
- Adequate formal auditing quality
- Practical and economical applicability
- Adequately and consistent use of precise verifiers

In EU, the RES directive sets standards for sustainability of biomass used for liquid biofuels and gives frameworks for controlling the quality of auditing. Similar standards and frameworks have not yet been decided for solid biofuels, including woodfuels. Existing structures already exist for verification of wood products, and verification of sustainability criteria set by a future EC directive may be eased if these are suitable as proof of woodfuel sustainability.

Principles, criteria and indicators (PC&I) were addressed in chapter 3 and results showed that existing systems relevant to verification of sustainable woodfuels include forest (FSC, PEFC endorsed schemes and LEI) and agricultural certification schemes (for example GlobelGap), schemes and standards for sustainable biomass (Green Gold Label - GGL and Laborelec). Systems for sustainable bioenergy, ISCC, UK-RTFO and NTA 8080 were, however, the only systems that covered all the examined sustainability criteria adequately, and addressed forest biomass as well.

Forest management certification in principle applies to all goods from forest and forest plantations goods and management practices in relation to their production and harvesting. Timber logging has historically been the product in focus, but non-timber forest products or non-wood forest products are also addressed (Stupak et al. 2009) and standards include a large range of sustainability criteria that are relevant to woodfuels, even if not all issues are covered equally well (see chapter 3).

Apart from sustainable forest management, standards for certification of 'controlled wood' may also be relevant as proof of sustainable woodfuels. FSC certifies controlled wood and the certification should demonstrate that the forest holding does not supply wood from areas where traditional or civil rights are violated; wood from forests where high conservation values are threatened; wood harvested from genetically modified trees; wood that has been harvested illegally or wood harvested from areas which have been converted from natural forest to plantations or non-forest. PEFC does not offer a similar certification service, but does not allow wood from controversial sources in PEFC products. Controversial wood is defined as wood from "forest management activities which are not complying with local, national or international legislation, in particular relating to the following areas: (a) forestry operations and harvesting, including conversion of forest to other use, (b) management of areas with high environmental and cultural values designed and covered by the legislation, (c) protected and endangered species, including requirements of CITES, (d) health and labour issues relating to forest workers, (e) property, tenure and use right of indigenous peoples, (f) payment of taxes and royalties; and areas utilising genetically modified organisms." Certification of controlled wood is less comprehensive compared to certification of sustainable forest management.

Forest certification schemes do not include criteria for GHG emissions savings along the supply chain, but FSC is currently examining possibilities of using the Chain of Custody to calculate carbon footprints of forest products.

Forest management certification is entirely dominated by two global systems. FSC accounts for about one third of global certified forest area, while PEFC endorsed schemes covers about two thirds (ICPFE, 2007). About 8% of the world's forests are certified, the major part of these being located in the northern hemisphere, in North America and Europe. In EU27 about 70 mill ha or about 45% of the total forest area has been certified (Table 4.8), even if there is some uncertainty due to double certification.

Agricultural schemes may also be relevant for verification of sustainable SRC production, e.g. SAN, GlobalGAP. Apart from a general standard for sustainable agriculture, SAN have specific standards for individual crops as cocoa and coffee etc., but no particular standards for energy crops. It has certified 40 different crops (especially coffee and banana, but also cocoa, tea, many other fruits and berries, nuts, flowers, Aloe Vera, and rubber) in 25 countries in South and Central America, Asia and Africa (SFC 2009).

The GlobalGAP standard for Integrated Farm Assurance (IFA) consists of a larger amount of modules, some of them addressing various agricultural and horticultural products, but none of them addressing energy tree crops. However, the module combination: All Farm + Crop Base + Flowers & Ornamentals has been tested for certification of sustainable Christmas tree production in Denmark, and is now recommended for this purpose (Dansk Juletræsdyrkerforening 2009).

Unlike forestry and agricultural schemes, both GGL and Laborelec for sustainable biomass include standards for calculation of GHG emission savings at the supply chain level. GGL accepts wood biomass produced in forests certified by both FSC and some or all PEFC endorsed schemes. Biomass that fulfil criteria similar to those of forest management certification are also accepted. GGL uses a preliminary standard for this purpose (GGL5). The criteria of GGL5 are based on existing criteria of FSC and selected PEFC endorsed schemes. Forest management and forest biomass can be approved as eligible under this standard for the first 4 years, but after this approval can only be given if the forest is certified by an independent forest management certification scheme approved by GGL. GGL also has own standards for agricultural sources (GGL2). At the moment GGL certification largely concerns wood pellets.

The Belgian Laborelec scheme also accepts wood biomass certified under FSC, PEFC endorsed schemes and the GGL standard. For other woody biomass Laborelec requires that sustainability principles comparable to those of existing forest certification schemes are fulfilled and reported. Laborelec also seems to work with certification of pellets in particular; lately they added specific standards and forms for pellets to their biomass verification procedures (Laborelec 2009). The Laborelec pellet standards specifically include requirements that raw materials must be certified by FSC, PEFC endorsed schemes or hold an approved pre-scope certificate of one of the endorsed forest management certification systems, with the intention of full certification.

International processes as the Ministerial Conferences on Protection of Forests in Europe (MCPFE) is another structure that aims at supporting sustainable forest management. Included criteria are similar to those of forest management certification. MCPFE is currently exploring possibilities to become a legal instrument for ensuring sustainable forest management of European forests, and a working group has assessed the applicability of and potential need to update MCPFE tools to address sustainable forest biomass production (MCPFE 2009). These initiatives may increase it is suitability as a proof of sustainable woodfuel production in the future.

The auditing quality of existing schemes relevant to woodfuels were examined in chapter 3, and results showed that auditing typically takes place annually with validation of certificates taking place with 3-5 year intervals (except Laborelec which audits per load). Field visits and owner reporting are common as are stakeholder consultations. Accountant reporting is only used by a few schemes. Governance and organization of schemes are to a large extent based on ISO standards. The quality of ISCC, UK-RTFO and NTA 8080 varied with regard to the different auditing processes examined and the extent to which the governance and organisation is based on ISO standards.

Practical and economical applicability of these schemes may depend on the certification approaches to they offer; certification of more forest owners under one certificate decreases the administrative and economical burdens on the individual forest owner. FSC offers individual and group certification, while PEFC in addition to this offers regional certification. PEFC describes these three approaches as follows: "*Individual certification* - Certification of an area which belongs to a single owner, with sufficient area for the application of the standards. *Group certification* - Certification of forest management of a group of small and medium sized forest owners under one certificate. *Regional certification* - Certification of the forests within delimited geographic boundaries, being applied for by the authorised organisation for the specified region and providing voluntary access for the participation of individual forest owners and other actors." As two of the most extreme examples, 13 regional PEFC certificates cover about 20 mill ha and 320,000 participants in Finland, while individual FSC certificates in a few cases cover only about 50 ha (Table 4.8).

GlobalGAP also offers group certification, while SAN standards only apply to single farms. However, a standard for groups of farms is currently in review and will be based on the ISEAL Alliance's Common Requirements for the Certification of Producer Groups.

Concerning the adequate and consistent use of precise verifiers, it should also be clear what exactly has to be observed in the field inspections and other checks. The issue continuous to be a challenge to existing forest certification schemes (UPM 2005) and internal meetings to correct such problems are common.

Table 4.8 *Certified forest area in EU27, by FSC and PEFC endorsed schemes, types of certificates and country ()*

	Area					Relative area				FSC FM certificate type			PEFC FM certificate types					PEFC+ FSC cert.		PEFC+ FSC	
	Forest area[1]	FSC[2]	PEFC[3]	FSC +PEFC[4]	Non cer- tified	FSC	PEFC	FSC +PEFC[4]	Non cer- tified	Mul- tisite/group		Indivi- dual	Regional		Group		Indivi -dual	Total cert.	Total part.	1000 ha cert.-1	part. cert.-1
	1000 ha					%				Cert	Part	Cert/ Part	Cert	Part	Cert.	Part.	Cert/ Part.				
Austria	3.838	5	1.956	1.961	1.877	0	51	51	49			4	9					13	4	151	
Belgium	667	13	281	294	373	2	42	44	56	1	42	1	1					3	43	98	
Bulgaria	3.375	114	-	114	3.261	3	-	3	97			7						7	7	16	1
Cyprus	173	-	-	-	173	-	-	-	100				1	708				1	708	-	708
Czech Republic	2.637	53	1.883	1.936	701	2	71	73	27			5						5	5	387	1
Denmark	486	192	220	412	74	40	45	85	15			5			7	73	7	19	85	22	4
Estonia	2.243	1.083	-	1.083	1.160	48	-	48	52			3						3	3	361	1
Finland	22.475	10	20.806	20.816	1.659	0	93	93	7	1	1	2	13	319615				16	319618	1.301	19.976
France	15.351	17	5.114	5.131	10.220	0	33	33	67	1	11	3	14	23244	1	1899		19	25157	270	1.324
Germany	11.076	525	7.341	7.866	3.210	5	66	71	29	4	45	50	13	7055				67	7150	117	107
Greece	3.601	37	-	37	3.564	1	-	1	99			1						1	1	37	1
Hungary	1.907	252	-	252	1.655	13	-	13	87			4						4	4	63	1
Ireland	609	446	-	446	163	73	-	73	27			2						2	2	223	1
Italy	9.447	52	716	768	8.679	1	8	8	92	2	22	11	2	355	8	22791	19	42	23198	18	552
Latvia	2.885	1.621	-	1.621	1.264	56	-	56	44			2						2	2	810	1
Lithuania	2.020	386	-	386	1.634	19	-	19	81	1	7	42						43	49	9	1
Luxem- bourg	87	19	27	46	41	22	31	53	47	1	31	2	1	86				4	119	11	30
Malta	n.s.	-	-	-	-	-	-	-	-									0	0		
Nether- lands	360	152	-	152	208	42	-	42	58	3	183	5						8	188	19	24
Poland	9.059	6.996	-	6.996	2.063	77	-	77	23			19						19	19	368	1
Portugal	3.583	204	168	372	3.211	6	5	10	90	6	24	6					2	14	32	27	2
Romania	6.366	917	-	917	5.449	14	-	14	86	2	16	1						3	17	306	6
Slovakia	1.921	174	1.221	1.395	526	9	64	73	27	2	15	5	4	278				11	298	127	27
Slovenia	1.239	212	-	212	1.027	17	-	17	83			1						1	1	212	1
Spain	16.436	127	1.120	1.247	15.189	1	7	8	92			11	6	948	3	25	10	30	994	42	33
Sweden	27.474	9.739	7.507	17.246	10.228	35	27	63	37	8	12	15			15	15293	4	42	15324	411	365
United Kingdom	2.793	1.144	-	1.144	1.649	41	-	41	59	18		84						102	84	11	1
EU27	152.108	24.490	48.360	72.850	79.258	16	32	48	52	50	409	291	64	352289	34	40081	42	481	393112	151	817

Source: FSC 2009, PEFC 2009.

4.5 Woodfuel supply chains and supply chain control

Some of the issues that pose a challenge to control of woodfuel supply chains are:

- The number of ownership changes
- The number of processes needed to produce the woodfuel
- The number and size of transports and storages
- Length of transport and storage periods
- The amounts of biomass per purchase and frequency of purchase
- Purchase on long-term contracts or free market purchase
- The number of biomass suppliers and mixing of the material.

Woodfuel supply chains are diverse and differ with regard to these factors depending on for example the type and source woodfuel, the scale of production, and local geographical and economic conditions (Alakangas & Virkkunen 2007). The specific characteristics of a certain woodfuel supply chain influence the practical and economical applicability of the different supply chain control methods as outlined in Table 4.2.

Occasionally the whole supply chain for primary woodfuels is contained within one company. For example, large forest industry groups like Stora Enso and UPM Kymmene own forests, saw mills and industrial energy plant for heating (UPM 2008, Stora Enso 2008). At a small scale, a forest owner or farmer may be harvesting firewood on his property for his own purposes. More often, however, the supply chain holds at least two independent economic operators taking ownership of the biomass: the forest or land owner and the energy plant. Entrepreneurs for harvesting, forwarding, transport, and chipping are often involved as contractors to either forest owners or energy companies, but may also take possession of the woodfuel. In some cases the logistics for a large number of smaller forest owners or farmers are managed by a large scale or SME businesses or forest cooperatives providing services as forest management planning, forest management, certification, harvesting and sales. Examples are F&BE in France, HedeDanmark in Denmark, UPM Tillhill in UK, and COMBUbois in Belgium. Such companies are also often forest owners.

When moving from primary woodfuels to secondary and tertiary woodfuels, supply chains generally become more complex, involving also saw mills, pulp and paper mills, additional manufacturers as pellet and briquette producers, traders, whole-sales, retailers etc. (Alakangas & Virkkunen 2007)

In the following sections, woodfuel supply chains are described according to type and source of the woodfuel (based on EUBIONET2 2007a-w, see also Annex I for details), and discussed with regard to three main supply chain control methods: book and claim, mass balance and physical segregation.

4.5.1 Primary woodfuels

Forest residues

There are four main types of supply chains of forest residues (EUBIA 2009, AEBIOM 2007), which are defined by the location of the chipping:

- Terrain chipping
- Chipping at a landing (generally roadside chipping)
- Terminal chipping
- Chipping at plant

The operations and elements connected to these chains typically include wood production, harvesting and forwarding, chipping, storage, and long distance hauling. All or several operations are sometimes performed by one single economic operator, or they may be performed by several independent actors, which either takes ownership of the biomass or only act as contractors. The types of involved actors are for example forest owners, forest enterprises, forest services, forest entrepreneurs, biomass suppliers, hauling services, energy entrepreneurs, and energy producers.

In Sweden, the first three types of supply chains have been practiced, while the latter is still being tested. In Finland it is already an established method. The most predominant supply chain in Sweden is roadside chipping, accounting for 75-80% of the production (EUBIA 2009). In Denmark, the most common method is terrain chipping of whole-trees from thinnings.

Short Rotation Coppice (SCR) and Short Rotation Forestry (SRF)
The main types of supply chains for SRC/SRF correspond to those of forest residues. Harvesting lines and associated supply chains can largely be divided into three types: log, bundle or chip lines/chains (Scholz et al. 2008). In the three types of lines: cut-to-length logs, tied bundles and chips, respectively, are produced in connection with the harvesting. Cut-to-length logs and tied bundles may be chipped at a landing, a terminal or at the plant, similar to forest residues. Storages facilities may be located at the forest or farming property, at a terminal or at the energy plant, also similar to forest residues. The types of economic operators involved are typically farmers, agricultural enterprises and services (see e.g. Ny Vrå Bioenergi 2009, EUBIONET 2007t), and energy producers.

Firewood
Firewood is usually made from wood which is unsuitable for other purposes. This may include early thinnings, thick branches, tops, low quality wood. It may also be other types of wood which it is non-profitable to pick up from small scale users. Three firewood production chains may be distinguished according to the scale of production and degree of mechanisation (Sanchez et al. 2009, see also EUBIONET 2007c).

- Small scale manual production
- Large scale semiautomatic production
- Large scale professional production

Operations involved are wood production, transport to the firewood producer, cutting and splitting, drying, and transport to consumers, and private storage. In the first type of production chain the firewood is produced manually by use of chain saws, belt saws and log splitters, while in the second type of supply chain installations involving for example power saw or circular saw, hydraulic mechanisms for chopping, and conveyor belts for transport are used. Large scale professional production is mainly based on pulpwood assortments and in additional to production the focus is on trade. Subcontractors may be used for splitting and transport.

Firewood producers are usually companies that also have other activities. They may be forest owners, forest entrepreneurs, biomass suppliers and traders, or forest owner associations. Typically, they are small companies; 80 % of them having less than 5 employees (Sanchez et al. 209). Small-scale firewood production has long been carried out by farmers, but the use of modern cutting and splitting technology is increasing together with commercial firewood markets and e-trading (Quality Wood 2009). Apart from the above mentioned producers, other economic actors in the supply chain may be wholesales and retailers, and energy producers, which are most often households.

A large part of the firewood production and sales takes place at informal markets (Sanchez et al. 2009).

4.5.2 Secondary and tertiary woodfuels

Producers of secondary woodfuels include sawmills, carpentry industry, plywood mills and other panel industry, and chemical and mechanical pulp mills (Peksa-Blanchard et al. 2007). More detailed models of the flow of roundwood based raw materials and intermediate products in the forest processing sector are given by UN (2005) and Peksa-Blanchard et al. (2007). Secondary woodfuels are typically used by the industry producing them. Store Enso for example uses 70% biomass fuels in the internal energy production (including also primary sources as logging residues). Saw dust and other industrial wood residues may also are used as feedstock for further processing into pellets or briquettes (Alakangas et al. 2007, UPM 2008, Stora Enso

2008). Occasionally other types of biomass are mixed with the wood, e.g. reed canary grass (EUBIONET 2007a).

Tertiary woodfuel sources are typically recovered wood from construction and demolition, packaging, other industries, and household wastes, or it is a component in industrial and household wastes. In the Netherlands, household wastes, including wood components, are collected by municipalities, while commercial wastes are probably collected by producers or other commercial actors. These wastes are processed or stored in landfills, waste incinerators, or compost installations (EUBIONET 2007i).

4.5.3 Supply chain characteristics and challenges to supply chain control

Some typical woodfuel supply chain characteristics are summarised in Table 4.9 and further described below, while discussion points on challenges of various supply chain control systems (full segregation, mass balance and book and claim) for some typical woodfuel supply chains are presented in Table 4.10.

Changes in ownership

Many biomass producers may be involved in a woodfuel supply chain, but the number of changes in ownership is usually few for primary woodfuels. Operators taking position of the woodfuel typically include the forest owner, possibly a biomass supplier (e.g., a forest or energy entrepreneur), and the energy producer. The situation is similar for those secondary woodfuels which are produced and used by the industry itself. Examples are black liquor and saw mill residues. The number of changes in ownership is larger for woodfuels which are processed and/or traded. Traded woodfuels are typically secondary woodfuels, but sometimes also primary or tertiary woodfuels (see also section 4.3.3). Tertiary woodfuels may have been subjected to several changes of ownerships in its previous use.

Processing and packaging

Primary woodfuels are usually only subject to cutting (whole-trees or cut to length) in the forest and subsequent comminution. Comminution is typically chipping (wood chips) or splitting (firewood). Secondary woodfuels are by-products after processing (sawing or pulping) and maybe further manufacture (furniture, doors, floors etc.) of primary wood into other products than woodfuels. They may be subject to further processing as pelletizing and briquetting. These may be sold in bulks or are packed for example in small bags for private use (about 15 kg, see Annex I). The processing of tertiary woodfuels is that of the main product they originate from (for example pallets, construction etc).

Transport

Forwarding distances for primary woodfuels directly from the forest are typically short, < 1 km. Means of transportation (and thus the amount per load) and the maximum haulage distance (for which it is profitable to transport the woodfuel) depends on the scale of use. For small scale plants, farm tractors are often used to transport the fuel to the plant, and for large scale plants (or biomass suppliers), lorries are used for bulk or container transport. Examples of load sizes are: farm trailer: 35 m^3, container: 40 m^3 (three containers per lorry), or trailer truck 85-130 m^3 (cf. also Kofman 2007). The average transport distances are circa 20 to 80 km. Pellet and briquette factories are often placed in the vicinity of their raw material sources. In Canada the transport of shavings from large scale saw mills to pellet factories is about 50-75 km (see Annex I for detailed information and its sources).

Storage

Primary forest fuels are usually stored in the forest at a landing. After chipping they may be transported to and stored at a terminal or at the plant. Storage times in indoor storage of the plant are usually very small (hours or a few days). Storage times at outdoor storages may vary from very little to a maximum of probably one year (see also Kofman 2007).

Purchased amounts, frequencies and contracts

For Danish heating plants the amount of biomass purchased at a time usually amounts to about 3-4 months of fuel consumption, sometimes up to a whole year. Usually the biomass is delivered in small amounts. As an exception amounts corresponding to one year's consumption are delivered for one plants. Long-term contracts with biomass suppliers often secure stabile supplies, but purchase of good offers on the free market is also common (Mette Hansen, Dansk Fjernvarme, Simon Skov, Forest & Landscape Denmark). Purchase on long term contracts is also common in other countries (Annex I).

Number of producers and mixing

The number of woodfuel producers delivering biomass to a plant is usually large. Often the logistics are organised by one or more contractors or biomass suppliers, and the biomass from different producers are mixed in the storages often owned by the biomass suppliers or the plant. Certified and uncertified woodfuels are not separated.

Practical and economical applicability

Aspects of practical and economic applicability are pointed out in Table 4.10. As for certification of sustainable forest management, this may also depend on the certification approaches offered; certification of more entities under one certificate decreases the administrative and economical burdens

FSC offer three main approaches to CoC certification: Small enterprises, larger companies and project certification and sub-approaches as individual or group certification and single or multi-site certification. FSC describes these approaches as follows: "*Small enterprises* may form or join a group of operations and apply for group chain of custody certification. FSC has specifically designed Group CoC certification to make CoC certification accessible to small operations for which individual CoC certification may be too costly. *Larger companies* operating at multiple locations can, if they comply with certain requirements, choose to apply for multi-site chain of custody certification. This makes use of elements of scale and thus is more economical than to seek a separate certificate for each site. Both, group and multi-site CoC certification, allow certification bodies to evaluate participating operations or sites based on samples in recognition of existing common, centrally administered and monitored control and reporting systems and thereby reduce the auditing costs. *FSC project certification* is a non-bureaucratic way to get one-off and complex products FSC certified without each involved participant having to become individually FSC certified. It has been specifically designed for building projects. In some countries FSC project certification has been a great success with the building industry." PEFC offer similar approaches, including CoC project certification.

Table 4.9 *Summary of wood fuel supply chain characteristics (based on EUBIONET2a-w, see also Annex I). L/R: At a landing/roadside, T:At a terminal, E: at the energy producer, see also Annex I*

Typical woodfuel supply chain	Typical biomass users	Typical biomass producers	Typical number supply chain links[1]	Typical number of owner shifts	Typical time between owner shifts	Storage types[7]	Mixture in storages[7,8]	Drying + storage time	Processing	Forwarding distances	Typical long distance transport
Primary residues	Energy plants at all scales	Small to large scale forest owners	2-3[2]	1-2	<1 year	L/R, T, E	T, E	<1 year[11]	Cutting in the forest and chipping near storages	< 1 km	20-100 km[9] (occasionally international distances)
Energy forest and tree crops	Energy plants at all scales	Small to large scale farmers[10]	2-3[3]	1-2	<1 year	L/R, T, E	T, E	<1 year	Cutting in the forest and chipping near storages	< 5 km (?)	20-100 km[9]
Firewood	Households		2-3[4]	1-2	<1 year (?)	L/R, T, E	T, E	<1 year (?)	Cutting in the forest and cutting and splitting in the forest or at a terminal	< 1 km	20-100 km (?)
Black liquor and milling residues	Pulp and saw mills		2-3[5]	1-2	<1 year (?)	L/R, M	M	<1 year (?)	Cutting in the forest and chemical processing	-	0 km
Pellets and briquettes	Energy plants at all scales, including households		≥4[6]	≥3	<1 year (?)	L/R, T, M, F, R, E	T, M, F, R, E	<1 year (?)	Cutting in the forest , sawing of timber and maybe further manufacture, pelletizing or briquetting	-	Local - international distances
Tertiary woodfuel sources	Incineration plants		Several	Several	Several years	Several	Yes		Cutting in the forest, sawing of timber etc.	-	Local - international distances

[1]From forest until delivery at the energy producer, including the energy producer, but excluding harvesting, chipping, cutting and splitting, and transport contractors not taking ownership of the wood. [2]1) farmer/forest owner, 2) biomass supplier, e.g. forest or energy service or entrepreneur, 3) energy producer. Sometimes entrepreneurs buy the wood and sometimes they are contractors to the forest owner or the energy producer. [3]1) farmer/forest owner, 2) agricultural, forest or energy service or entrepreneur, 3) energy producer. Sometimes entrepreneurs buy the wood and sometimes they are contractors to the forest owner or the energy producer. [4]1) farmer/forest owner, 2) cutting and splitting entrepreneur, 3) energy producer. Usually, the entrepreneurs also buy the wood. [5]1) farmer/forest owner, 2) forest entrepreneur, 3) saw mill=energy producer. [6]1) farmer/forest owner, 2) forest entrepreneur, 3) saw mill, 4) pellet producer 5) retailer 6) energy producer, including households. Both large and small scale energy producers may buy pellets directly at the factory, or through retailers (households). [7]L/R: Landing/roadside, T: Terminal, E: Energy plant, M: pulp or saw mill, F: Pellet fac-

tory, R: Retailer. [8]Possibly certified material mixed with other material, in case no chain-of-custody has been implemented[9]Longer distances for large scale than small scale local plants[10]Ny Vrå Bio-energi, Denmark, should be considered as a large scale producer with about 230 ha of willow crop land. Nordic biomass A/S, Denmark, has about 100 ha of willow. [11]Occasionally storage times may extend to several years, e.g. when large amount of wood from windthrows are stored for energy purposes. A wood chips buffer storage just outside the Herning CHP plant in Denmark must be emptied at least once per year due to requirements by the authorities.

Table 4.10 *Discussion points on challenges to supply chain control systems for some typical woodfuel supply chains. Short time' means < 1 year*

Typical woodfuel supply chain	Supply chain complexity	Some challenges to full segregation systems	Some challenges to mass balance systems	Some challenges to book and claim systems	Characteristics easing full segregation
Primary residues (whole-trees, logging residues, low quality round wood)	Relatively simple	Should not cause major problems if the biomass is delivered directly from the forest owner or farmer to the plant. If storage in terminals of for example biomass suppliers (not identical to biomass producers) is involved, these operators will need separate storage systems for segregation.	Should not cause major problems	The usually short distances (intermediate operators, transport, and time) between forest owners or farmers and end-users do not justify setting up a book and claim system. For firewood the amounts of wood per purchase will furthermore be very small.	Few operators between forest owners or farmers and end-users (often only few biomass suppliers or a similar function) and short time between harvesting and end-use. Even when independent biomass suppliers organise the purchase, the plant often receives the individual biomass load directly from a single biomass producer, weighs and registers it for later payment. The major part of the woodfuel purchase often takes place on long-term contracts with few biomass suppliers, with sometimes only four-five purchases per year.
Energy forest and tree crops					
Firewood	Relatively simple	Informal markets with free market purchase and many, often small, forest owners or farmers and many small end-users	To some extent informal markets with free market purchase and many, often small, forest owners or farmers and many small end-users		Few operators and probably short time between forest owners or farmers and end-users.
Black liquor and milling residues	Relatively simple	Often many forest owners or farmers involved, which might have different sustainability properties, and mixing in production of sawn wood and pulp.	Should not cause major problems		Few operators between forest owners or farmers and end-users and short time between harvesting and end-use.
Pellets and briquettes	Usually intermediate	Many forest owners or farmers involved, which might be certified or not, with uncontrolled mixing at the saw mill and maybe further mixing in pellet factory storages, which could be controlled, however, if saw mill or other wood manufacturer raw materials were controlled. Separate production lines or production batches needed.	Many forest owners or farmers involved, which might be certified or not, usually with uncontrolled mixing at the saw mill or other wood manufacturers producing industrial wood residues.	Not possible to distribute credits to forest owners and farmers, as the raw material is a by-product created in the next links in the supply chain.	Intermediate, but usually still controllable number of operators between forest owners/farmers and end-users.
Tertiary woodfuel sources	Usually complex	Long time and intermediate use for other purposes between biomass production and end-uses Usually uncontrollable mixing with other non-wood biomass types (waste)	Sourcing is usually very difficult	Sourcing is usually very difficult	Sourcing is usually very difficult

4.5.4 Supply chain control of woodfuels by existing certification schemes

Certification schemes relevant for verification of sustainable woodfuels were forest (FSC, PEFC endorsed schemes and LEI) and agricultural certification schemes (for example GlobelGap), schemes and standards for sustainable biomass (Green Gold Label - GGL and Laborelec). These schemes usually include a chain of custody, or links up with other systems addressing control of the supply chain. Systems for sustainable bio-energy, as ISCC, UK-RTFO and NTA 8080, also include a chain of custody.

The international FSC CoC standard and procedures are used for FSC CoC certification in all countries. The international PEFC CoC standard is used by most PEFC endorsed schemes, while some have their own CoC standards. Both FSC and PEFC CoC certification use different types of control systems corresponding to full segregation and mass balance, but not book and claim systems. The international FSC CoC standard allows two different mass balance systems; the “credit” and the “percentage” system, as does the international PEFC CoC standard: the “average percentage” and “volume credit” system. Both FSC and PEFC only have one full segregation system, the “transfer system” for FSC and the “physical separation” system for PEFC (see Annex IX for details).

Various woodfuels are currently certified by FSC, PEFC and GGL01 (Table 4.11). For FSC there are for example 15 certificates for pellets (Latvia, Sweden, Poland, Ireland, Switzerland, Argentina, Uruguay, Belarus, United States, and Croatia), while about 70-82 certificates have been issued for wood chips. Wood chips, residues, pellets and briquettes are being sold under about 95 PEFC certificates (FSC 2009, PEFC 2009, GGL 2009, product databases). No information was found, however, on the supply chain control methods used for these woodfuel products, except GGL which only uses the mass balance approach as described in the GGL 01 standard.

Table 4.11 *Certified entities occurring in FSC and GGL product databases under key words of different woodfuel product or potential woodfuel raw materials. GGL05 and GGL02 were not included in the GGL database. About 95 PEFC certificates occur in the PEFC database under woodfuel products*

Woodfuel type	FSC	GGL01
Firewood	144	-
Fuelwood	346	-
Faggots	323	-
Wood chips	82	2
Wood in particles	1,739	-
Charcoal	115	-
Sawdust	125	2
Wood wool	1,739	-
Wood flour	1,739	-
Shavings	19	-
Bark	64	-
Pellets	15	3
Briquettes	27	-
Black liquor	-	-
Pallets (wood)	226	-
Energy wood	3	-

4.6 Accessibility

Systems to document sustainable production and systems to control the supply chain should be accessible to the relevant user. Accessibility may be affected by for example:

- The size of the economic operator.
- The geographic location of the economic operator.
- The quality of institutional frameworks supporting certification.
- The existence of relevant certification schemes or standards for the country or the region.

These issues also affect the certification costs for the economic operator. For example, small businesses less frequently have quality management systems in place and in some countries there are no local branches of relevant certification businesses. Hence, relatively more resources and costs are often needed to prepare for and perform the certification. The quality of institutional frameworks (e.g. legislation and law enforcement) that support efficient certification may also differ among different countries and parts of the world. Less support by existing structures may lead to increased costs by the certified body, for example to prevent illegal logging (Purbawiyatna & Simula 2008).

Accessibility may also relate to available standards of relevant programmes. FSC, PEFC, GlobalGAP and GGL are all global certification schemes, even if they are not evenly accessible to all countries and continents. Certification by a PEFC endorsed scheme can only take place in countries that has national PEFC endorsed forest certification schemes. FSC certification also requires that a national FSC initiative exists and that this initiative has an adapted national standard accredited by FSC. Currently, PEFC have endorsed schemes in 27 countries, and FSC only have fully accredited standards in 16 countries. FSC does, however, certify forest in all countries via so-called interim standards, that needs to be developed by certifiers and national stakeholders. Generally additional resources are needed for this, even if many forest certification services already have interim standards for some countries.

Various initiatives have been taken to increase the accessibility of forest certification. Both FSC and PEFC allow group certification, and PEFC also offers a so-called regional certification at an even more aggregated level, see section 4.4. FSC also developed special standards for small and low intensity managed forests (SLIMF, normally < 100 ha) and a standard to certify controlled wood (to demonstrate that the forest holding does not supply controversial or illegal wood. The SmartWood programme developed a standard and verification service to encourage better harvesting practices of forests with low access to certification. Since 2005, the SmartWood also offered a stepwise certification service for sustainable forest management. The purpose is to provide opportunities for forest management enterprises to pursue full forest certification while gaining access to potential market benefits before achieving the actual certification.

4.7 Administrative and economic burdens

Administrative and economic burdens for proving compliance with sustainability criteria of a possibly future EC directive which also includes solid woodfuels were assessed according to the EC Standard Cost Model as described in Annex 10 (EC 2009) of the EU Impact Assessment Guidelines (EC 2005).

The EC SCM includes the following steps:

- Identification and classification of information obligations (Step 1)
- Identification of required actions (Step 2)
- Classification by regulatory origin (Step 3)
- Identification of target groups (Step 4)
- Identification of the frequency of required actions (Step 5)
- Identification of relevant cost parameters (Step 6)
- Choice of data sources (Step 7)
- Assessment of the number of entities concerned (step 8)

- Assessment of the performance of a "normally efficient entity" (Step 9)´
- Extrapolation of validated data to EU level (Step 10)
- Report (Step 11)

4.7.1 Basic assumptions and overview of data sources (Step 7)

It has been assumed that all costs originate from implementation of an EU directive with sustainability criteria for solid biomass, and that the implementation of the directive does not lead to elimination of other costs at EU or national levels (Step 3). A model was elaborated for the purpose of assessing administrative burdens of an EU verification system for sustainable woodfuels (Figure 4.6).

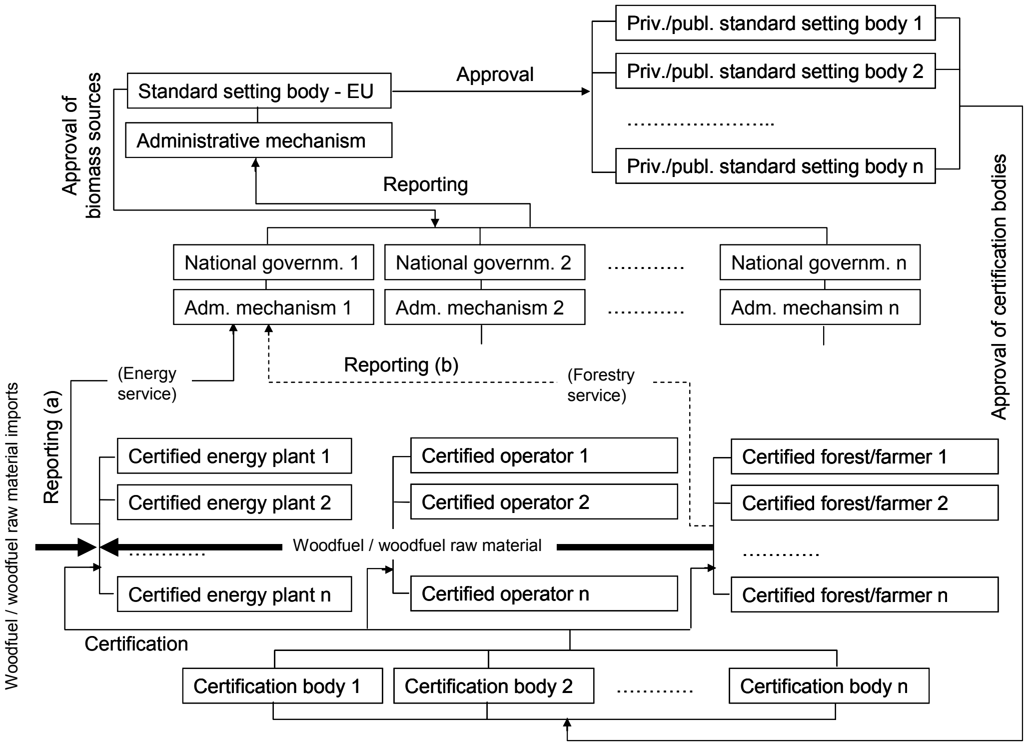

Figure 4.4 *Model of an EU verification system for sustainable woodfuels used for the purpose of assessing administrative burdens. Private or public standard setting bodies may be international or national.*

An overview of the data sources (Step 7) used to identify obligations (Step 1), required actions (Step 2), target groups (Step 3), frequency of required actions (Step 5), cost parameters and their levels (Step 6), and the number of entities concerned (Step 8), are presented in Table 4.12. An overview of key assumptions and basic data is also given in Annex II and Annex III.

Table 4.12 *Overview of data sources used for assessment of administrative burden*

Data type	Data sources
Types of obligations, required actions, frequencies (Step 1-2)	Identification of obligations and required actions related to certification (SFM, CoC and GHG) were based inputs by experts from the Control Union and technical documents of existing forest and biomass certification schemes. Obligations and required actions related to reporting obligations of economic operators towards the Member States and required actions related to reporting obligations of Member States towards the EU were based on §18 of the RES directive, and expert opinions by Henrik Duer, Cowi, and Bjarne Juul-Kristensen, the Danish Energy Agency.

Target groups (Step 4)	Target groups were distinguished based on their position in the supply chain and the resolution of the data available for the assessment, see "Number of entities concerned". (Time consumption and costs related to the performance of the required actions may depend highly on business characteristics as size and location (country), but hardly any information was available at finer resolutions).
(Step 5)	Frequencies were based on information inputs by experts from the Control Union, and technical information from forest certification schemes.
Cost parameters and their levels (Step 6)	Estimates of the most predictable time needs for required actions related to SFM, CoC and GHG certification were based on inputs by experts from the Control Union. They emphasised that estimated time needs may still vary considerably depending on the number of involved employees and experts and other factors related to the certified business. Time needs related to more variable costs as for example some direct internal costs, indirect internal costs, equipments costs etc were not estimated, see Table 4.13. Time needs related to reporting obligations of economic operators towards the Member States and required actions related to reporting obligations of Member States towards the EU were based on §18 of the RES directive and expert opinions by Henrik Duer, Cowi, and Bjarne Juul-Kristensen, the Danish Energy Agency. Wages tariffs were set from EC standard tariffs provided by DG TREN. Tariffs for two groups, professionals and technicians, were used for economic operators, and tariffs for two groups, professionals and clerks, were used for governments. For both economic operators and governments, a means of the 27 EU countries were used.
Number of entities concerned (Step 8)	Information on political targets and estimated potentials, combined with various forestry, energy and business statistics were used to set the number of entities concerned for each target group.

The assessment was performed for the four main scenarios (including two sub-scenarios) outlined in section 4.2.5. These were, resuming:

- Scenario 1: SFM+CoC (SFM for biomass producers and CoC for all)
- Scenario 2: SFM+CoC+GHG (SFM for biomass producers, GHG for energy producers and CoC for all)
- Scenario 3: CoC only (for all)
- Scenario 4: CoC+GHG (GHG for energy producers, CoC for all)

4.7.2 Target groups and basic obligation sets (Step 4 and 1)

The model shown in Figure 4.6 includes certification and reporting obligations by economic operators and reporting obligations Member States. Certification includes three main actors: the certification scheme (for example FSC, or a PEFC scheme, including PEFC international), the certifying body (for example Smart-Wood, SGS, or SQS), and the certified body (for example a forest owner, a saw mill, a pellet factory etc). Only obligations and costs of the certified body are included in this assessment. Costs of certification schemes and certifying bodies (and possible accreditation services as ASI Accreditation Services International GmbH, used by certification schemes) have not been included as these costs are assumed to be covered by the fees and services paid for by the certified body.

Four target groups and six sets of basic obligations were identified cf. section 4.2.5 and Annex II. The four target groups were, resuming:

- T1. Forest owners and farmers producing SRC
- T2. Wood processers manufacturing secondary woodfuels or raw materials for these (saw mills, pulp and paper mills, pellet and briquette factories)
- T3. Energy producers
- T4. Member States

The six obligations sets were, resuming:

- A: Sustainable forest management certification corresponding to GGL5 requirements (A1) or FSC requirements (A2). The level of GGL requirements probably compare to those of PEFC schemes.
- B: Chain of Custody certification in connection with SFM certification
- C: Chain of Custody certification using a mass balance control system (set to be equal for GGL and FSC)
- D: Certification of green house gas emissions based on default values and documentation and verification that these are being met.
- E: Reporting obligations of the economic operator towards the national government of a Member State, including collection and filing of the information used for the reporting.
- F: Reporting obligations of a Member State toward the European Commission, including collection and filing of the information used for the reporting.

Due to large variation in certification costs depending on the type of certification (individual, group, regional), the number of hectares to be certified and forest type (in case of SFM), geographical region, the current practices of the individual economic operator, the number of involved employees and experts etc. it would have been desirable to subdivide into more target groups (for example according to the size of the economic operator) and more obligation sets (for example according to type of certification), but due to insufficient availability of data it was not possible.

4.7.3 Required actions, frequencies, time needs and costs, and performance of a "normally efficient entity" (Step 2, 5, 6 and 9)

In relation to certification, typical required actions include services by the certifying company. Initial support is provided for elaboration of the certification application, offer and contracting, and further on support is provided for preparing and planning the certification process, for contacting, selection of experts, desk studies, office and field audit, report writing etc. These costs are called *direct external costs*, and may also include fixed fees to the relevant certification scheme. The certified company also needs to spent time to prepare the certification, finding and elaboration all the necessary information and otherwise supporting the process and the auditing. A consultant may also be hired to support or manage these preparations. These costs are called *direct internal costs* and may for example also include cost for establishment of quality management systems, purchase of new equipment etc. The certified body may also need to make corrective actions as a consequence of the certification. These costs are called *indirect internal costs* and may include for example changes in management, training costs, costs to prevent illegal harvesting, and opportunity costs as loss of timber sales. In practice, these costs can often be difficult to separate from general administrative and other management costs.

Required actions and costs are typically divided into *one-off costs* and *recurring costs*. One-off costs are associated with the initial certification, while recurring costs typically are associated with annual surveillance audits and periodic main audits or reassessments with several years between them (typically 3-5 years).

Included cost parameters in this assessment are time needs to complete the certification and wage tariffs. Especially time needs leading to direct external costs were included together with internal costs directly related to the auditing. Preparation costs by either own personnel or consultants were not fully included. These may vary widely, but can be substantial. A study by Cubbage et al. (2003) showed that several man months were needed to prepare for forest management certification. For CoC certification it was assumed that specific quality system items already be assessed in another setting. Possible equipment costs were not included either, nor were indirect costs for example for performance of corrective actions. Equipment costs are likely to be important in CoC certification if a full segregation control system should been introduced.

Time needs and costs were lumped into three categories leading to direct external costs, direct internal costs and indirect costs, respectively (details in Annex III and summary in Table 4.13), including also obligations by economic operators to report and make data available for the Member States, and the obligation by Member States to implement a directive with additional sustainability requirements on solid biomass sustainability (new legislation, regulation or other). Obligations by Member States also include filing the information submitted by economic actors was also included, while cost for establishing a filing system was assumed to be in place in connection with the general implementation of the RES directive (Bjarne Juul-Kristensen, the Danish Energy Agency). It was assumed that reports with aggregated information be submitted to the Commission every year, and that regular checks of background information takes place for 5% of the reporting operators every year. Used wage tariffs are shown in Table 4.14. Professional/senior official tariffs were sued for all required actions, except reporting obligations by economic operators and Member States for which tariffs for technicians/clerks were used. The imposition of different obligations on different target groups makes the scenarios specified in section 4.2.5, see especially Tables 4.3 and 4.4.

Table 4.13 *Number of hours included in the assessment of administrative burdens, distributed to external direct activities, internal direct activities (and indirect internal activities)[1]. Estimated annual time needs are also valid for the initial certification year and in years with periodic obligations (estimated periodical and one-off time needs thus being additional to annual time needs). The time needs year 1 are thus 'Annual'+'One off', for SFM-GGL year 4 they are 'Annual'+'Additional periodical', for SFM-FSC year 6 they are 'Annual+Additional periodical' etc.*

Obligation set	Frequency	Time needs (hours per entitiy)		
		External direct	Internal direct	Internal indirect
SFM-GGL	Annual	36	24	Depends
	Additional periodical[2]	10	16	Depends
	One off	6	Depends	Depends
SFM-FSC	Annual	119	74	Depends
	Additional periodical[3]	78	66	Depends
	One off	41	Depends	Depends
SFM-CoC	Annual	6	6	Depends
	Additional periodical	?	?	?
	One off	?	?	?
CoC mass balance	Annual	20	10	Depends
	Additional periodical	?	?	Depends
	One off	0	8	Depends
GHG	Annual	2	18	0
	Additional periodical	0	0	0
	One off	0	0	0
Reporting by the economic operator	Annual	-	7	-
Reporting by the Member State	Annual	-	122	-
	One off	-	320	-

[1]Estimated hours are based on inputs by the Control Union. Time needs ("depends") that are highly variable have not been estimated. Other time needs may also vary considerably depending on for example the number of employees and experts involved and number of hectares to be certified (in case of SFM).,[2]Every 3rd year, [3]Every 5th year.

Table 4.14 *Wage tariffs - Low cost scenario (independent on policy scenario). Means of standard tariffs for EU27 (EC 2009). A high cost scenario was include by multiplying these average wage tariffs with 4.*

Target group (T)	Biomass producers	Processing, manufacture, trade	Energy producers	Government
	T1	T2	T3	T4
Professionals	18.75	18.75	18.75	
Technicians and associate professionals	11.97	11.97	11.97	
Legislators, senior officials and managers				18.34
Clerks				9.74

Time needs and costs levels should be estimated for a "normal efficient entity". In this case, expert opinions have been used to determine a "standard entity". Without a thorough study of the variation among companies, it is not possible to define the "normally efficient entity" more specifically. Probably the variability of costs levels among different types and sizes of companies would make it more reasonable to work with a more refined system of target groups, cf. comment in the previous section.

Apart from the above-mentioned uncertainties and data flaws, the required actions and certification costs by a future EU verification system for sustainable woodfuels may also depend on the final set of sustainability criteria and the comprehensiveness of the auditing requirements. One of the assumptions in this assessment is that sustainability requirements, except GHG, will be contained within existing SFM certification schemes, but this is not necessarily the case (cf. results from Task 3). Furthermore, certification of GHG emissions and emission savings is only emerging and experiences are scarce, and it is therefore uncertain which specific actions and costs levels should be distributed to this kind of certification. Vice versa, it is also possible that currently not included criteria may become a part of existing SFM and CoC certification, for example criteria that disaggregated GHG emission defaults be met.

A very simple attempt to take of uncertainties and data flaws was made by using the outlined estimates as a low cost scenario and introducing a high cost scenario by multiplying average wages in Table 4.14 with 4, thus obtaining more conservative estimates of the cost ranges.

4.7.4 The number of entities concerned and extrapolation of data to EU level (Step 8 and 9)

The number of affected entities can only be estimated with great uncertainty due to inadequate business statistics and uncertainties in assumptions (for example the extent to which group certification will be used). Standard statistics only offer data at rather aggregated levels (e.g. Eurostat). National level and private statistics are scattered and needed data can often only be made available by direct contact to e.g. individual national agencies or business associations. Research-based statistics offer some information at more detailed levels, but are also often incomplete. Uncertainty may also arise as to whom exactly needs certification, for example CoC. Some specific guidance is given by FSC Canada (1996) "wood and construction" and "paper and printing", but similar guidance is not available for woodfuel supply chains (FSC Canada 1996)[5]. In this section rationales are given, however, for the used estimates of number of entities concerned for woodfuel

[5] Generally within FSC, a CoC certificate is needed for "any operation making, changing, trading, re-labelling or repackaging FSC certified products need to be CoC certified in order to use the FSC trademarks and to enable its customers to make an FSC claim about these products. Retailers were traditionally seen as the end of the supply chain; today brokers or agents, who neither take physical nor legal possession of the products, and retailers, who sell FSC products to end consumers that do not want to make an FSC claim, usually do not need to become certified (for example Do It Yourself retail outlets, trucking/transportation companies, contractors." Within PEFC, a CoC certificate is needed for "Any body harvesting, transporting, handling or processing forest based products at any stage from a forest to a final consumer (wood-processing enterprises, retailers, printers, manufacturers, traders, wholesalers or stockists)".

producers (target group 1), processors, manufacturers etc (target group 2) and energy producers (target group 3), respectively. The number of Member States (target group 4) is 27.

Woodfuel producers (target group 1)

The number of concerned biomass producing entities depends on expected contribution of forest, plantation and agricultural SRC biomass to the 20% target, and the extent to which these entities have already show compliance with sustainability criteria thought existing certification schemes.

Estimates of energy potentials from forest woodfuels and SRC woodfuels from agriculture in EU27 vary widely (see also the discussion on this in section 1.5). Ragwitz et al. (2009) estimated the energy potential from primary forest woodfuels to be circa 70 Mtoe yr^{-1} in 2020 (Table 4.15), while the potential assumed to be exploited for meeting the 20% goal in 2020 was circa 65 Mtoe yr^{-1}. Corresponding energy potentials and exploitation from agricultural SRC willow were estimated to be 6.4 Mtoe yr^{-1}, while exploitation was only 1.4 Mtoe yr^{-1}. Task 1 concludes that the GREEN-X assumptions behind these estimates are reasonable, although results are on the high side of the range in the different studies (see also Table 1.6 in Task 1).

Based on the set of conversion factors given in Table 4.15, these woodfuel potentials correspond to harvesting primary energy wood from about 129 mill ha of forest, i.e. a substantial part of the 152 mill ha of forest area in EU27 (Table 4.5). However, yield can vary a lot depending for example on species, site productivity, and the harvested amounts of crown and stem wood for energy purposes in different operations. The amount of logging residues that can be removed from a site, compared to the theoretical potential, depends on how well the material has been piled (typically about 70% of the material can be removed). If yields were set to be in average 4 m^3 ha^{-1} yr^{-1}, assuming that more stem wood will be used (see also Annex IV), residues from 80 mill ha of forest should be harvested yearly to meet expected exploitation.

Estimates of the total energy potentials in 2020 for secondary woodfuels in EU27 are largely equal to the amount assumed to be exploited for meeting the 20% objective. Secondary residues are by-products of timber and pulp wood production, and thus, exploitation of the full potential would also indicate that a large part of all forest in Europe should be certified.

Table 4.15 *Estimates of energy potentials and from woodfuels in EU27 by 2020, and associated amounts of wood in tons, m^3 and hectares*[1]

	Potential				Exploitation			
Woodfuel type	Mtoe	mill tons	mill m^3	mill ha	Mtoe	mill tons	mill m^3	mill ha
Primary forest woodfuels	70	155	344	138	65	145	322	129
Primary SRC willow	6.4	14.2	31.5	2.6	1.4	3.1	7.0	0.6
Secondary woodfuels	27	61	135	-	26	59	130	-
Tertiary woodfuels	8	19	41	-	8	19	41	-
Forestry imports	5	11	24	-	5	11	24	-

[1]Assuming 0.45 toe $tons^{-1}$ dry wood, 0.45 tons dry wood m^{-3}, an average energy wood harvest of 2.5 m^3 ha^{-1} yr^{-1} in conventional forest (see also Annex IV). An average harvest of 12 tons dry wood ha^{-1} yr^{-1} was assumed for SRC willow (Nordh & Dimitriou 2003, Eppler & Petersen 2007).

It has been estimated that there are about 77,000 holdings of forest and other wooded land in public ownership and 10.7 million in private ownership in Europe, and that the average size of public and private holdings is 1,200 ha and 10.6 ha, respectively (TBFRA 2000). Several million private owners in Europe hold less than 3 ha, and in most countries, a high proportion of the forest owners thus own only a small proportion of the total area (TBFRA 2000). With restitution and privatization ongoing in countries with economies in transaction, the overall movement is often towards smallholding (Schmithüsen et al. 2008, Lunnan et al. 2008), even if the private forest ownership structure, in terms of the number of holdings and their distribution to size (forest area), varies considerably among countries as does the distribution between the publicly and privately owned forest area (Annex V). The number and sizes of forest holdings were estimated for EU as a whole (Table 4.16).

Table 4.16 *Forest ownership structure in EU27. Forest holdings by size of their forest area (based on data from 9-11 countries)*

	Private forests[1] (Total: 10,600 thousand)[2]		Public forests (Total: 77 thousand)[2]	
Forest area (ha)	Share[3] (%)	Number (1,000)	Share (%)	Number (1,000)
0-1	60.7 (59)	6,434		
1-2	12.3 (15)	1,304		
2-5	13.0 (12)	1,378		
6-10	6.7 (6)	710		
11-20	4.0 (4)	424		
21-50	2.2 (2)	233		
51-100	0.7 (1)	74		
101-500	0.4 (1)	42		
>500	0.1 (0)	11	85.0[4]	65

[1]About 82 % owned by individuals/families, 13% by private institutions, and 5% by forest industries (Hirsch et al. 2007). [2]TBFRA 2000. It was assumed that all state forests are of more than 500 ha. Other publicly owned forests holdings include communal Ownership (14%), and provincial ownership (1%) (Hirsch et al. 2007) but no assumptions were made about their distribution to size In number they are about 12 thousand (TBFRA 2000). [3]UNECE (2007). Based on data from 9 countries: Austria, Belgium, Bulgaria, France, Hungary, Latvia, Lithuania, Slovakia, United Kingdom. [4]Schmithüsen et al. (2008). Based data from 11 countries Belgium, Bulgaria, Czech Republic, Finland, France, Hungary, Poland, Romania, Slovakia, UK, Norway.

For the purpose of this assessment we exclude small forest holdings < 5 ha, which leave about 1.5 mill forest owners in EU27. About (maximum) 73 mill ha of forest in EU27 have already been SFM certified by either FSC or a PEFC scheme (or both), see Table 4.8. The average amount of hectares certified under the current 481 FSC and PEFC certificates in EU27 is about 150,000 hectares, while the average number of participants certified under one certificate is about 800. Assuming that (i) existing forest certification is used as adequate proof of sustainable forest biomass, except GHG criteria, (ii) all non-certified forest in Europe should be certified by 2020 and (iii) group certification will be widely used, Table 4.16 suggests that 500-2,000 SFM certificates should be issued (based either on certified hectares per current certificate or number of participants per current certificate). For purpose of this assessment we assume that 1,500 SFM certificates should be issued.

Assuming a yield of 12 tons of dry biomass ha^{-1} yr^{-1} from willow SRC, about 600,000 ha should be harvested to meet the expected exploitation (see Table 4.15). Assuming in average 200 ha per certificate (cf. EUBIONET 2007t and Ny Vrå Bioenergi which both owns about 200 ha of willow SRC), about 3,000 certificates should be issued. However, certification of SRC will likely take place under standards like the GlobalGAP, which also offers group certification, and due to the higher cost efficiency, it seems likely that group certification will gain in importance. Assuming that in average 30 owners will certified under one agricultural certificate we estimate that about 100 certificates for sustainable agriculture needs to be issued.

Adding up estimates of needed SFM certificates and estimates of needed agricultural certification gives a total of 1,600 biomass producer certificates to be established.

Wood processers and manufacturing of secondary woodfuels or raw materials for these

Other economic operators in the woodfuel supply chains than biomass and energy producers include producers and manufacturers of secondary residues. Producers include for example saw mills, manufacturers of furniture, wooden floors, doors, windows and other wood products. They also include pulp and paper mills. Woodfuel manufacturers using secondary wood residues include namely pellet and briquette factories. Other relevant groups are biomass suppliers and traders.

Internet databases suggest that there are at least 472 saw mills and 503 pellet manufacturers in EU27 (Annex VI). Information compiled by EUBIONET2 on the number of installed biomass boilers at saw mills indicates that the number of saw mills in EU27 may be considerably higher (Alakangas et al. 2007, see Annex VII).

The number of major pulp and paper mills (capacity of 10,000 to more than 600,000 tons yr-1) in Europe has been reported to be 1,100 in 2006 (RISI 2006), while information from Germany suggests that there is a large number of biomass suppliers and traders (EUBIONET 2007l, see Figure VI.A, Annex VI).

If all secondary woodfuel potentials are exploited for the purpose of the 2020 goal (cf. the previous section on concerned entities of biomass producers) then all producers, manufacturers, and traders of secondary woodfuel products should be certified. For the purpose of this assessment, we assume that 4,000 operators should be certified, but due to incomplete statistics, the figure is probably considerably higher.

Energy producers

AEBIOM (2009) estimates that there are totally more than 20 million users of biomass for energy in Europe with the vast majority of these being households and small heating services, and about 25,000-40,000 being electricity and co-generation plants, district heating plants, or industrial plants for heat production (Table 4.17). These figures are well in agreement with data on municipal and industrial biomass-fuelled boiler capacities and number of biomass fuelled plants, which were collected from 19 countries in EU (Alakangas et al. 2007, see also Annex VII for detailed data from the individual countries). They estimated the total number of municipal and industrial plants in these countries to be about 27.600 (Table 4.18).

Other data also show that a large number of households or small plants generate heat from biomass and wood. Solid fuel heating systems, including fireplaces, tiled stoves are for example installed in about 9 mill households in Germany (EUBIONET 2007l). Figures from Austria and Denmark also show a large proportion of small scale users (Annex VIII) and in a study from Carinthia in Austria, the majority of biomass fired plants are small heating plants (< 100 kW_t). These small plants produce only about 1% of the energy (ca. 6,000 MWh yr^{-1}), while larger local and district heating plants produce 12% (62,000 MWh yr^{-1}) and the largest industrial players 87% (448,000 MWh yr^{-1}) of the energy (EUBIONET 2007n). The estimates by AEBIOM (2009) suggest, however, that small players are responsible for about one third of the primary energy production, and comparing data from Chalmers Power Plant Database (Göran Berndes, pers. comm., see also Annex VIII and Kjärstad and Johnsson 2007) with data from Eurostat (2009) also indicate small players are responsible for a substantial proportion of biomass-based electricity production by small players. Chalmers Power Plant Database includes 317 operative power and cogeneration plants of a total capacity of 9.4 GW. If 10,000 users of biomass for electricity and cogeneration in EU27 (AEBIOM 2009) holds a total capacity of 23.3 GW (Eurostat 2009), this suggests that about 9,700 users hold more than half of the total capacity, 13.9 GW, or in average about 1-2 MW per user.

Biomass-based heating and electricity markets thus seem to be structured in two major groups of energy producers that each hold a substantial part of the existing energy production capacity; one group which is dominated by a very large amount of households and other biomass users with rather small capacities and another group of medium- and large-sized energy producers.

Table 4.17 *Biomass use in Europe 2007 and number of players (Table from AEBIOM 2009), biofuels excluded (based on Eurostat data and AEBIOM estimates)*

Type of bioenergy	Primary energy from biomass [Mtoe]	Number of biomass users / energy producers [1,000]
Biomass by directly by households and services for heat	35.0	15,000-20,000
Biomass for electricity and co-generation	33.3	Ca. 10
Biomass used directly by the industry for heat	18.6	10-20
Biomass used by district heating plants	3.3	5-10
Total, including households and services	90.9	15,025-20,040
Total, excluding households and services	55.2	25-40

Table 4.18 *Number of municipal and industrial biomass fuelled plants in 19 countries in EU*

Type of plant	Number
Municipal biomass plants:	
Heat	15,986
CHP	3,140
Power	126
Industrial biomass plants:	
Pulp and Paper - solid	225
Saw mills	2,753
Other industry	5,413
Total	27,643

Source: Alakangas et al. 2007.

The total and average capacity of producers of biomass-based energy is likely to increase in the future. Data from Eurostat (2009) shows that biomass-based electricity generation capacities have more than doubled during the period 2002-2007 (Eurostat 2009), in 2007 reaching a total of 23.3 GW (14.1 GW from wood and wood waste, 5.5 GW from waste, and 3.7 from biogas). Data from a database at the Chalmers University (Göran Berndes, pers. comm., see also Annex VIII) indicate that this trend will continue and probably even accelerate; a total capacity of 5.8 GW has been planned in Europe, with an average capacity that far exceeds the average capacity of existing plants, even when excluding plants < 10 MW (see also Ragwitz et al. 2009).

For the purpose of this assessment we exclude households and small scale services as it is unlikely that these can be certified. AEBIOM (2009) assessed that there are 25,000-40,000 biomass-based energy producers in EU27, excluding these small scale producers. Biomass for electricity and co-generation, for district heating or for heat production directly by the industry corresponds to circa 55 Mtoe yr^{-1}. Summing up from Table 4.17, the assumed exploited wood biomass potentials in 2020 amount to 106 Mtoe which is a doubling compared to current consumption of biomass for energy in EU27 (excluding house holds and small scale services). Assuming that

- no biomass based energy producers are currently certified
- there are 32,000 existing producers
- the capacity of new energy biomass users will in average be double as large as that of existing energy biomass users.
- all users of biomass for energy use (among other) woodbased fuel
- individual certification will be used

we conclused that the number of concerned energy producer entities in 2020 will be about 48,000.

Summary of estimated entities concerned for this assessment

Estimates of the number of entities concerned, which are used in this assessment, are summarised for the four target groups (Table 4.19) and the four policy scenarios (Table 4.20). Estimates are only given at EU level, and not at Member State level, as the available information at the national level is limited.

Table 4.19 *The number of entities (certificate holders) used for each target group in the assessment of administrative burdens*

Target group (T)	Biomass producer certificates (1)	Processing, manufacture, trade (2)	Energy producer (3)	Government (4)
	T1	T2	T3	T4
Number of entities	1,600	4,000	48,000	27

Table 4.20 *The number of entities (certificate holders) used for each set of obligations defined in section 4.2.5 and 4.7.1.*

Obligation set		Policy scenarios			
		1	2	3	4
SFM	A (A1, A2)	1,600	1,600		
SFM-CoC	B	1,600	1,600		
CoC	C	52,000	52,000	53,600	53,600
GHG	D		53,600		53,600
Reporting obligation to government	E	48,000	48,000	48,000	48,000
Reporting obligation to the EC	F	27	27	27	27

4.7.5 Results (Step 11)

The results of the assessment of the administrative burdens are shown in Table 4.21-4.28. Table 4.21 shows the costs by the set of obligations (A-F).Tables 4.22 give selected literature values for SFM and CoC certification costs. Table 4.23-4.24 show costs for individual economic operators (low and high cost scenario), while table 4.25-4.26 show costs at EU level for the four target groups and whole EU. Table 4.26-4.27 especially compares scenarios with and without SFM certification.

Key results and discussion points for costs of obligation sets (Table 4.21):

- SFM: For economic operators except governments the largest one-off and recurring costs are related to SFM certification (in particular SFM certification corresponding to FSC compared to GGL), and that FSC approaches are several times more costly than GGL approaches.
- SFM: For both the FSC and the GGL approach it is crucial to consider that a substantial proportion of the internal costs are not included in the assessment (for example some preparation costs, possible introduction of quality management systems, costs to make corrective actions etc), see for example results from the study by Cubbage et al. (2003), Table 4.22. For very large forest properties, the costs may also be considerably higher, see for example the study by Savcor et al. (2005, cf. Vis et al. 2008).
- CoC: One-off and recurring costs would probably be higher if internal costs had been fully covered and substantially higher if a full segregation control system should be applied (for example due to investments of separate processing lines and storages or separate management of certified and un-certified material). The study by Vidal et al. (2005), see Table 4.22) also indicates that direct external costs the first year may be higher than in costs assessed in this study.
- GHG: It is still uncertain how this type of certification will take place and what are the costs. Pilot projects are currently performed by the ISCC-project for liquid biofuels (ISCC 2009).

- Governments: Large one-off costs by governments are due to the assumption that a larger amount of resources being distributed to implementation of new legislation or regulations. These resources may however, vary considerably, depending on political conditions.
- Generally: Recurring costs dominate over one off costs, but as mentioned internal costs are not fully included. Some costs will probably be reduced when all systems and procedures are in place, but surveillance and reassessment audits are not always less costly compared to initial certification.

Table 4.21 *One-off and recurring costs for the individual operator by set of obligations. One off costs only concern additional costs. An approximate estimate of first year costs can be obtained by addition of one-off and recurring costs.*

	Low cost		High cost	
Obligation set	One off [€]	Recurring [€ yr^{-1}]	One off [€]	Recurring [€ yr^{-1}]
A1: SFM-GGL/PEFC	154	1,760	615	7,040
A2: SFM-FSC	1,051	5,685	4,203	22,739
B: SFM-CoC	-	308	-	1,230
C: CoC	205	769	820	3,076
D: GHG	-	513	-	2,050
E: Reporting obligation to government	-	129	-	517
F: Reporting obligation to the EC	10,012	1,713	40,048	6,850

Table 4.22 *Certification costs from the literature (recalculated to €).*

Information source	Forest area	Costs
SFM certifcation		
FSC (2001), cf. Vis et al. (2008)[1]	7,800-15,800 ha	2,800-8,300 € yr^{-1} (FSC, recurring direct external + direct internal costs)
Savcor (2005), cf. Vis et al. (2008)[2]	3,700-2 mill ha	10,000-27 mill € $year^{-1}$ (recurring direct external and internal auditing costs, including loss of stumpage revenues) 4,000-1 mill € $year^{-1}$ (recurring direct external and internal auditing costs, excluding loss of stumpage revenues)
Fodgaard 2007[3]	500-2000 ha	3,000-5,000 € (PEFC first year) 1,200-1,800 € yr^{-1} (PEFC, annual surveillance audits excluding periodic reassessment costs)
Cubbage et al. (2003)[4]	13,000, 3,200 and 1,800 ha	12,000, 23,000,and 28,000 € (SFI, first year) 21,000, 16,000 and 17,000 € (FSC, first year)
CoC certification for solid wood		
Vidal et al. (2005)[5]	-	200-2,700 € (direct external costs, minimum range for the first year) 1,300-11,500 € (direct external costs, maximum range for the first year) 300-1,000 € yr^{-1} (direct external costs, minimum range for recurring costs - annual + periodic) 600-1,400 € yr^{-1} (direct external costs, maximum range for recurring costs - annual + periodic)

[1]FSC certification in Germany, [2]FSC, PEFC Sweden, FSCC (PEFC endorsed scheme for Finland) and ISO 14001/LFC certification in the Nordic countries. two types of indirect costs were included: Organisational costs: 0.02-0.81 € ha-1 yr-1, and loss of stumpage revenues: 1-19 € ha-1 yr-1., [3]PEFC Denmark, [4]SFI and FSC in USA. Part of the explanation for FSC being less costly in this case is probably that the FSC certification was performed for all three entities jointly (costs being distributed to the entities later for comparison). Another reason may be that FSC certification took place after the SFI certification, with 2-3 months between them. Smaller tracts had greater costs per hectare because the fixed costs of auditors and preparation were spread over fewer hectares, and larger

absolute costs for entities with fewer hectares are probably due to the forest types and the size and distances between the involved forests patches. The cost calculations include costs related to performing and preparing several visits and reports by certifiers and the certified body, with at least one professional at each forest entity spending 3-6 months periodically preparing the documents for the assessments, and other staff combined putting in at least an equal amount of time. [5]CoC programmes by forest certification schemes in USA. Five factors were identified in the determination of pricing: company location; the size of the company; the number of manufacturing facilities; the complexity of the manufacturing process; and annual sales revenue.

Key discussion topics for the *number of concerned entities* (Table 4.19 and Table 4.20):

- It was assumed that biomass producers make widely use of group certification, and that energy producers do not have this possibility. This means that costs related to energy producers are high at EU level compared to the individual operator level.

Key results for *costs of individual operators* (Tables 4.23-4.24) show:

- For economic operators, except governments, recurring costs dominate over one-off costs, see however comments to Tables 4.21 and 4.22.
- For biomass producers (T1), the recurring costs related to the FSC approach (A2) are about 2.5 times higher than those related to the GGL approach (A1). If biomass producers only need certification similar to other operators, costs are less than one third of those related to SFM/CoC certification. Something similar is the case for one-off costs.
- For processers, manufactures, traders and energy producers (T2 and T3), the recurring costs are 60-70% higher when GHG certification imposed compared to CoC certification alone. One-off costs are unaffected. The reporting obligations by energy producers increases the costs by 10-20% compared to processers, manufacture, traders etc.
- For individual governments one-off costs dominated over recurring costs due to assumptions that relatively large resources are needed for implementation of new legislation or regulations.

Table 4.23 *Cost of individual operators, low cost scenario*

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Combination of obligation set	*A+B*	*A+B+D*	*C*	*C+D*
T1 - one off (€)				
A1	154	154	205	205
A2	1,051	1,051	205	205
T1 - recurring (€ yr^{-1})				
A1	2,067	2,580	769	1,281
A2	5,992	6,505	769	1,281
Combination of obligation set	*C*	*C+D*	*C*	*C+D*
T2 - one off (€)	205	205	205	205
T2 - recurring (€ yr^{-1})	769	1,281	769	1,281
Combination of obligation set	*C+E*	*C+D+E*	*C+E*	*C+D+E*
T3 - one off (€)	205	205	205	205
T3 - recurring (€ yr^{-1})	898	1,411	898	1,411
Combination of obligation set	*F*	*F*	*F*	*F*
T4 - one off (€)	10,012	10,012	10,012	10,012
T4 - recurring (€ yr^{-1})	1,713	1,713	1,713	1,713

Table 4.24 *Cost of individual operators, high cost scenario*

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Combination of obligation set	A+B	A+B+D	C	C+D
T1 - one off (€)				
A1	615	615	820	820
A2	4,203	4,203	820	820
T1 - recurring (€ yr^{-1})				
A1	8,270	10,320	3,076	5,126
A2	23,969	26,019	3,076	5,126
Combination of obligation set	C	C+D	C	C+D
T2 - one off (€)	820	820	820	820
T2 - recurring (€ yr^{-1})	3,076	5,126	3,076	5,126
Combination of obligation set	C+E	C+D+E	C+E	C+D+E
T3 - one off (€)	820	820	820	820
T3 - recurring (€ yr^{-1})	3,593	5,643	3,593	5,643
Combination of obligation set	F	F	F	F
T4 - one off (€)	40,048	40,048	40,048	40,048
T4 - recurring (€ yr^{-1})	6,850	6,850	6,850	6,850

Key results and discussion points for costs of *individual target groups at EU level and whole EU* (Tables 4.25-4.26) show:

- For whole EU27, including all target groups, one off costs were 10-50 mill € while recurring costs amounted to 50-330 mill € yr-1.
- 80-90% of the total costs were carried by the energy producers, due to the larger assumed number of concerned entities for this target group. Cost carried by biomass producers amounted to 5-15% percent of the total costs depending if the FSC or GGL approach was used. When no SFM certification was used, biomass producers carried only 3% of the costs. This shows that the use of individual or group certification (for all economic operators, biomass or energy producers, processors etc) may be a crucial point for the level of the administrative burdens at EU level.
- If the FSC approach was used, recurring costs were 10-15% higher compared to the GGL approach.
- Results on relative costs at the individual operator level are also valid at for the individual target groups at EU level.

Table 4.25 *Total costs in EU27 by target group and for whole EU27, low cost scenario*

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Combination of obligation set	*A+B*	*A+B+D*	*C*	*C+D*
T1 - one off (mill €)				
A1	0.2	0.2	0.3	0.3
A2	1.7	1.7	0.3	0.3
T1 - recurring (mill € yr^{-1})				
A1	3.3	4.1	1.2	2.1
A2	9.6	10.4	1.2	2.1
Combination of obligation set	*C*	*C+D*	*C*	*C+D*
T2 - one off (mill €)	0.8	0.8	0.8	0.8
T2 - recurring (mill € yr^{-1})	3.1	5.1	3.1	5.1
Combination of obligation set	*C+E*	*C+D+E*	*C+E*	*C+D+E*
T3 - one off (mill €)	9.8	9.8	9.8	9.8
T3 - recurring (mill € yr^{-1})	43.1	67.7	43.1	67.7
Combination of obligation set	*F*	*F*	*F*	*F*
T4 - one off (mill €)	0.3	0.3	0.3	0.3
T4 - recurring (mill € yr^{-1})	0.0	0.0	0.0	0.0
Whole EU				
EU - one off (mill €)				
A1+B+C+D+E+F	11.2	11.2	11.3	11.3
A2+B+C+D+E+F	12.6	12.6	11.3	11.3
EU - recurring (mill € yr^{-1})				
A1+B+C+D+E+F	49.5	77.0	47.5	74.9
A2+B+C+D+E+F	55.8	83.3	47.5	74.9

Table 4.26 *Total costs in EU27 by target group and for whole EU27, high cost scenario*

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Combination of obligation set	*A+B*	*A+B+D*	*C*	*C+D*
T1 - one off (mill €)				
A1	1.0	1.0	1.3	1.3
A2	6.7	6.7	1.3	1.3
T1 - recurring (mill € yr^{-1})				
A1	13.2	16.5	4.9	8.2
A2	38.4	41.6	4.9	8.2
Combination of obligation set	*C*	*C+D*	*C*	*C+D*
T2 - one off (mill €)	3.3	3.3	3.3	3.3
T2 - recurring (mill € yr^{-1})	12.3	20.5	12.3	20.5
Combination of obligation set	*C+E*	*C+D+E*	*C+E*	*C+D+E*
T3 - one off (mill €)	39.4	39.4	39.4	39.4
T3 - recurring (mill € yr^{-1})	172.4	270.9	172.4	270.9
Combination of obligation set	*F*	*F*	*F*	*F*
T4 - one off (mill €)	1.1	1.1	1.1	1.1
T4 - recurring (mill € yr^{-1})	0.2	0.2	0.2	0.2
Whole EU				
EU - one off (mill €)				
A1+B+C+D+E+F	45	45	45	45
A2+B+C+D+E+F	50	50	45	45
EU - recurring (mill € yr^{-1})				
A1+B+C+D+E+F	198	308	190	300
A2+B+C+D+E+F	223	333	190	300

Key results and discussion points when scenarios with or without SFM certification are compared (Table 4.27 and 4.28):

- At EU level, costs when only CoC certification of forest owners is required more or less equals the costs when SFM certification using the GGL approach is required. Costs are 10-20% higher if the FSC approach is used. However, this because the costs of energy producers dominate at EU level. Among other things, this shows that the use of individual or group certification may be a crucial point for the level of the administrative burdens at EU level.
- If for example 20,000 SFM certificates were needed instead of 1,600 this would increase the recurring costs at EU level to 60-200 mill € yr^{-1} for the low cost scenario (scenario 1 and 2) and 350-810 mill € yr^{-1} for the high cost scenario (scenario 1 and 2) compared to 50-80 and 200-330 mill € yr^{-1}, respectively. Costs of biomass producers would then constitute 40-70% of all costs at EU level (scenario 1 and 2).
- For forest owners, the recurring costs are 3 and 8 times higher when SFM GGL and SFM FSC are imposed compared to CoC certification. One-off costs are at the same level of SFM GGL, but about 5 times higher for SFM FSC. SFM one-off costs are possibly under-estimated as internal costs for preparation of the certification etc. were not adequately included in the assessment.

Table 4.27 *Total costs by scenarios in whole EU27 (including all target groups and Member States), for forest owners in EU27, and for the indivudal forest holder. Scenarios show costs with and without forest management certification when GHG certification of all economic operators is not included.*

		Low cost		High cost		Relative difference
		Without SFM (Scenario 3)	With SFM (Scenario 1)	Without SFM (Scenario 3)	With SFM (Scenario 1)	With SFM:Without SFM
		Recurring costs				
EU27 (mill € yr^{-1})	GGL	47	50	190	198	1.0
	FSC		56		223	1.2
Forest owners in EU27 (mill € yr^{-1})	GGL	1.2	3.3	4.9	13.2	2.7
	FSC		9.6		38.4	7.8
The individual forest owner/group (€ yr^{-1})	GGL	769	2,067	3,076	8,270	2.7
	FSC		5,992		23,969	7.8
		One- off				
EU27 (mill €)	GGL	11	11	45	45	1.0
	FSC		13		50	1.1
Forest owners in EU27 (mill €)	GGL	0.3	0.2	1.3	1.0	0.8
	FSC		1.7		6.7	5.1
The individual forest owner/group (€)	GGL	205	154	820	615	0.8
	FSC		1,051		4,203	5.1

Table 4.28 *Total costs by scenarios in whole EU27 (including all target groups and Member States), for forest owners in EU27, and for the individual forest holder. Scenarios show costs with and without forest management certification when GHG certification of all economic operators is not included.*

		Low cost		High cost		Relative difference
		Without SFM (Scenario 4)	With SFM (Scenario 2)	Without SFM (Scenario 4)	With SFM (Scenario 2)	With SFM:Without SFM
Recurring costs						
EU27 (mill € yr^{-1})	GGL		77		308	1.0
	FSC	75	83	300	333	1.1
Forest owners in EU27 (mill € yr^{-1})	GGL		4.1		16.5	2.0
	FSC	2,1	10.4	8,2	41.6	5.1
The individual forest owner/group (€ yr^{-1})	GGL		2,580		10,320	2.0
	FSC	1,281	6,505	5.126	26,019	5.1
One- off						
EU27 (mill €)	GGL		11		45	1.0
	FSC	11	13	45	50	1.1
Forest owners in EU27 (mill €)	GGL		0.2		1,0	0.8
	FSC	0.3	1.7	1,3	6,7	5.1
The individual forest owner/group (€)	GGL		154		615	0.8
	FSC	205	1,051	820	4,203	5.1

4.8 Conclusions

Efficient documentation of sustainable production

- Experiences from existing forest certification systems as FSC and PEFC endorsed schemes show that a large range of sustainability criteria can be verified for sustainable forest management.
- Experiences from existing agricultural schemes as GlobalGAP show that a large range of sustainability criteria can be verified for integrated agricultural production systems, including perennial trees crops as Christmas tree production. Credible verification of sustainable SRC is likely possible, but probably a testing period and subsequent adaptation of standards will be needed.
- Secondary woodfuels are being certified under existing certification systems, including FSC and PEFC, GGL and Laborelec (the latter two mainly addressing secondary woodfuels). This shows that credible verification of sustainability of secondary woodfuels is possible, including also verification of sustainability at the biomass producer level; FSC and PEFC require that the supplier be identified at each step in the supply chain.
- Certification of controlled wood may be an option if avoiding illegal and controversial sources of woodfuels is adequate as sustainability criteria.
- GGL and Laborelec find that existing forest management certification systems are useful as proof of sustainable biomass production, even if they also use their own preliminary standards or reporting requirements as proof of sustainable biomass production.

Efficient supply chain control

- Experiences from existing CoC programmes of forest certification schemes show that full segregation is possible for a range of wood products, while mass balance approaches are more appropriate for others. Characteristics of wood fuel supply chains show that mixing normally takes place for all woodfuels at different stages along the supply chains (processing, storage transport etc.). Requirements that full segregation be implemented will induce costs of separate logistic chains. These costs would probably be considerable for the individual operator. Full segregation might be feasible when only few purchases take place per year through long-term contracts with only one or few biomass suppliers. Generally, however, a mass balance approach seems more suitable; it fits a large range of supply chains for different woodfuel types and sources.

- For primary woodfuels, the usually short distances (intermediate operators, transport, and time) between forest owners or farmers and end-users do not seem to justify setting up a book and claim system. For secondary woodfuels, it is not possible to distribute credits to forest owners because the raw material is a by-product created in the next links in the supply chain.
- Existing certification schemes dealing with woodfuels such as FSC, PEFC endorsed schemes, GGL, Laborelec and NT 8080 already use various kinds of mass balance approaches. GlobalGap only addresses agricultural production (full segregation), but links up with other systems addressing the supply chain (cf. Task 3).

Willingness of authorities and businesses to carry the administrative and economic burdens

- For individual economic operators, except governments, one off costs were 200-4,200 €, while recurring costs were 800-26,000 € yr^{-1}. For scenarios which included SFM certification, costs were largest for biomass producers. The same cost level was assumed for all types of economic operators for CoC and GHG certification.
- At EU level, the economic burdens was estimated to range from 10 to 60 mill € for one off costs, while recurring costs was estimated to range from about 40 to 340 mill € yr^{-1}. Energy producers carried the largest part of this burden (80-90%) due to the larger number of needed certificates: 48,000 compared to 1,600 for biomass producers and 4,000 for other economic operators. It was assumed that group certification will be used for certification of biomass producers, but not for other operators. It was also assumed that the costs of a group certificate were the same as those of an individual certificate, and that the costs of certificates were generally independent of for example the number of hectares to be certified.
- For all Member States (governments) in EU as a whole, one off and recurring costs were about 0.3-1.1 mill € and 0.05-0.2 mill € yr^{-1} respectively, i.e. small compared to those of other target groups (<0.01%).

Accessibility

- FSC, PEFC, GlobalGAP and GGL are all global certification schemes, even if they are not equally accessible to all countries and continents. Currently, PEFC endorsed schemes in 27 countries, and FSC has fully accredited standards in 16 countries. FSC certifies forest in all countries but an interim standard must be elaborated for countries with no fully accredited standard.
- Forest certification services more often have local offices in developed countries than in developing countries. This increases the costs of certification in developing countries due to increased travel and accommodation costs of the certifier. Possibly this is also the case for some countries with economies in transition.
- Institutional frameworks and capacities (including legislation) supporting forest and other certification varies around the world. Strong institutional frameworks may decrease the costs related to certification as some criteria may already be met due to for example legislative requirements or compulsory best practice guidelines for sustainable forest management.

Major weaknesses of the assessment

The major weaknesses of the study are related to the assessment of the administrative burdens:

- The assessment of administrative burdens only includes the most predictable costs, typically the external direct costs and the internal direct costs directly related to the auditing, while other internal costs related preparation of the certification, and indirect costs are not included. Studies from the literature indicate that even costs of the high costs scenario are too low is some cases, especially for SFM certification.
- The assessment is largely based on expert evaluations, with no real data being used.
- Assumptions related to type of certification (individual, group, regional) for different target groups introduce a large uncertainty to the estimates of the number of entities concerned, the total size of the administrative burdens and their distribution to different target groups.

- Assumptions that costs related are independent of type and size of the economic operator introduce a similar uncertainty to the estimates of the economic burdens.

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Annex I. Overview of supply chain characteristics for woodfuel supply chains analysed in EUBIONET2

Table I.A. *Examples of woodfuel supply chains. The number refers to Fact Sheet Number among the Supply Chain Fact Sheets published by EUBIONET2 (EUBIONET2 2007a-k). Continued on the next page*

No	Country and fuel category[1]	Type and size of the energy producer	Fuel type and amount	Biomass producer and distribution	Type of sales	Harvesting and forwarding[2]
1a	Finland (P)	Energy cooperative with three heating plants (0.3, 0.7 and 1 MW_t)	6,000 m^3 chipped wood (about 70% whole-trees and 30% stem wood)[4]	Owners of the energy cooperative (1/3 of the woodfuel) Private forest owners (2/3)	Stumpage and roadside delivery	Contractors or farmers themselves. By farm tractors
1b	Finland (S)		700 tons of briquettes[4]	Industrial wood residues from a door factory	-	-
2	Finland (P)	Large scale CPH and industrial plants	Chipped wood from final fellings and early thinnings[5]		Stumpage	Entrepreneurs (contractors) (Typical FD 250 m)
3	Finland (P)	Households	Firewood from various species, lengths, fresh or dry, chopped	Private forest owners (sales through internet site administered by the Regional Forestry Centre)	S (buyer: firewood entrepreneur)	Firewood entrepreneur
4	Finland (P)	Private entrepreneur responsible for two heating plants owned by a municipality (0.8 MW_t and 2 MW_t)	10,000 bulk m^3 of wood chips (mostly forest chips, a minor part is industrial wastes and recovered wood)	Private forests (65%), municipality forests (20%), companies (15%)		The private entrepreneur, minor part: private forest owners for roadside delivery, municipal subcontractors (buys the wood) (FD: < 400 m)
5a	Finland (P)	Heating plant owned by a energy entrepreneur (0.4 MW_t)	Chips from especially thinnings (whole-trees and crowns - about 80% of the fuel)[6]	Local forest owners, heat entrepreneur	Roadside delivery, occasionally stumpage	Local forest owners, heat entrepreneur
5b	Finland (S)		200 loose m^3 of wood chips from a local saw mill (from surface boards - about 20% of the fuel)[6]	Saw mill		
6	Finland (P)	District heating plant (10 MW_t)	Chips from logging residues, whole-trees, stem wood[7]	Local forest owners?	Stumpage sales by large scale supplier	Subcontractors to a large woodfuel supplier operating at the national scale. FD: < 300 m
7	Sweden (P)	Municipal heat and power plants, including CHP	Chips from early thinnings[8]	Forest owners from Central Sweden		Large scale woodfuel producers / suppliers[11]. FD about 300 m
8	Sweden (S)	Plants of different sizes (boilers in buildings and households in Central Sweden)	Wood pellets, 80,000 tons $year^{-1}$	Sawmill residues		
9	Netherlands (T)	Private and municipal incineration plants of different sizes	Waste	From households, industries, construction and demolition etc. Part of this is wood waste[9]		
10	Europe (S)	Domestic stoves mainly in Austria and Switzerland, and local CHP plants and industrial boilers mainly in Denmark and Sweden	Wood pellets from Canada	Residues from the saw milling industry using wood from Canadian forests	Stumpage	FD: about 300 m
13	Germany (P)	Mainly households, public buildings	Wood chips[10]	Forest owners: private (57%), state (30%), corporations (10%), federal (<2%). Distribution by forest owners, forest owner associations, timber traders etc		See "initial processing and storage" next page.

Table I.A. *continued from the previous page…..*

No	Initial processing and storage	Transport of the woodfuel to energy producer (long distance haulage)	Transport distances	Other processing and storage
1a	Roadside chipping by contractor to the energy cooperative	Undertaken by the energy cooperation or farmers by tractor.	In average 20 km	850 m^3 storage owned by the energy cooperative
1b	Briquette factory			
2	Roadside chipping	Undertaken by energy producer or contractors. Full-trailer rigs which can take a volume of 110-130 loose m^3	In average 80 km	
3	Chopping of the wood by the firewood entrepreneur	Undertaken by firewood entrepreneur or private persons buying the firewood		Private storages for own use
4	Roadside chipping by the private entrepreneur	Undertaken by private entrepreneur	10-15 km	Smaller plant has 3 x 60 bulk m^3 storages
5a	Subcontractors to the heat energy entrepreneur	Undertaken by heat energy entrepreneur	In average 20 km	Storage capacity at the plant (50 m^3), silo at the heat energy entrepreneurs property (250 m^3), containers which can be left at the plant as a buffer storage
5b	Chipping of saw mill residues at the mill			Silo at the sawmill yard (400 m^3)
6	Roadside chipping by subcontractors to the national scale woodfuel supplier	Undertaken by woodfuel supplier or contractors	In average 50 km, up till 100 km	Daily deliveries up to about 1000 m^3, maximum daily use 400 m^3. Inside storage of 400 m^3 loose wood, outside buffer storage of 10,000 m^3 loose wood.
7	Roadside chipping	Container transport by lorry (3 container per lorry)	10-100 km	
8	Pellet factory			
9				
10	Transport of timber to saw mills (e.g. standing dead wood due to Mountain pine beetle attacks) direct to pellet factories, transport of shavings from saw mill to pellet factory (50-75 km). Drying is taking place at the pellet factory which is located near world class saw mills.	Railway or truck to export ports. Ship loading to Europe.		
13	Interim roadside storage during spring or early summer for drying of wood for roadside chipping. Chipping in the stand with direct transport of fresh chips to the energy producer.	Container transport by lorry	Up till about 70 km	

[1]Fuel categories: P: Primary, S: Secondary, T: Tertiary. [2]FD: Forwarding distance. [4]Also uses 450 bulk m^3 of sod peat, and 32 tons of reed canary grass (either mixed with briquettes or wood chips).[5]200-300 MWh (720-1080 GJ) per 2-3 ha (logging residues of spruce), payments based on MWh (i.e. moisture contents are measured). [6]Saw mill and forest chips are mixed for better combustion. Reed canary grass is available, but is currently sold to others. [7]Hardly any industrial residues are used (these go rather into pellet production). Milled peat about 5 MW annually. Unmanned heating plant, weighing and sampling for measurement of moisture content done by the truck drivers. Plans to build a new 7 MWt boiler. [8]Single deliveries and long-term contracts (several years).[9]Contracts for waste delivery of 5, 10 or more years. [10]Often based on contracts, at least 25% of the supply must come directly from forestry or agriculture to get subsidies (Bavaria). [11]These suppliers supply various types of woodfuels, including secondary and tertiary woodfuels.

Table I.B. *Examples of woodfuel supply chains. The number refers to Fact Sheet Number among the Supply Chain Fact Sheets published by EUBIONET2 (EUBIONET2 2007l-w). Continued on the next page…*

No	Country and fuel category[1]	Type and size of the energy producer	Fuel type and amount	Biomass producer and supplier type	Type of sales	Harvesting and forwarding[2]
14	Germany (S)	Heating in industry, heating plants, and households (0.97, 0.03 and 0.23 mill tons dry wood, respectively[16]	Wood pellets	Residues from wood processing and wood converting industry (about half of the produced residues are used for energy		
15	Greece (P)	Large scale CHP unit with two biomass fired boilers (Megalopolis)	Mainly oak logs from managed as coppice[13]	Forest in the municipality	Roadside delivery	Forest owners, cutting and splitting in the forest. Forwarding by mule or agricultural tractors.
17	Austria (P)	84 heating plants in the Carinthia province in Austria. Heating and power plants. Industrial plants (use 34% of the wood chips), local plants (16%) and district plants (50%)[3]	Small dimensioned wood and wood of low quality	Forest ownership in Carinthia: < 200 ha - 78%, 200-1000 ha - 8%, >1000 ha - 13%, public forest - 1% (sometimes biomass and energy producers are identical)[5]		
18	Austria (P + S + T)	Households (about 500,000 tile stoves of in average 15kW, about 3600 and 900 boiler plants < 30 kW and > 30 kW respectively)	Wood logs (oak and beech tops, wood from meadows and pomiculture), pellets, demolition wood etc (no statistics, a large part is unrecorded)			Chain saw felling, forwarding by cable winch
19	Belgium (P)	Private households, public authorities (small district heating), companies using wood to produce heat (some times identical to the land owner) (examples: $80kW_t$ and $100kW_t$)	Forest residues and materials from nature reserves, supply zone of about 50 km (sometimes biomass and energy producers are the same)	Forest owners and farmers	End-user delivery	Whole-trees forwarded to the roadside
20	Belgium (S)	Households and plants	Wood pellets, small scale pellet production	Saw mill residues. Saw mills are located within 50 km from the factory. Demolition wood is not used[12]		
21	UK, Wales (SRC)	1 Power plant (gasifier, 2.88 MW_e + heat)	Short rotation coppice			
24	Portugal (P)	1 Power plant (9 MW_e)	Forest residues, mainly of eucalypt and maritime pine - about 109,000 tons in 2006 (96.4% of the used fuel).[7]	Local forest owners	Stumpage	Contractors. Average FDs: 200-1200 m
25	Ireland (P, SRC & S)	Boilers at institutions, schools, new office blocks, business complexes, groups of domestic dwellings	Forest thinnings, residues (up to 60% of the raw material), willow (20% of the raw material, 200 ha, average yield of 15 tons of dry mass ha^{-1} yr^{-1}), industrial residues (about 20% of the raw material)	Willow owned by biomass supplier company, and willow grown on contract with farmers		Whole rod harvesting.
28	France (S)	Several	Wood pellets	Saw mill residues (pellet factory also buys wood for the saw mill)[14]		
30	France (P)	59 plants. Totally 23,234 MW (Focus of forest owner cooperative system)	Logging residues, use of about 13,850 tons[15]	Forest owners		
31a	France (P, S & T)	15 district wood boilers + 2 industrial wood boilers	Industrial by-products, pallets, wood chips (33,000+45,000 tons of wood products respectively)[11]			Chipping, sifting and transport is subcontracted
31b	France (S & T)	District Heating Plant (one of the above)	Saw mills residues (3,000 tons), wood from landscape management			

Table I.B. *continued from the previous page…..*

No	Initial processing and storage	Transport to the plant or private producer/long distance haulage	Transport distances	Other processing and storage
14	Pellet factories, currently from less than 5000 to more than 100.000 tons per year.[4]	Vicinity as well as other parts of the region		
15	Interim roadside storage, transport by truck to supplier. Storage at the supplier.	Trucks with a loading capacity of about 50 m^3	< 50 km (trader to heating plant)	Chipping and storage at the plant
17	Two months storage to dry the wood (roadside storage). Small storages have capacities of about 10,000 solid m^3 and 25,000 loose m^3. Roadside chipping directly onto a truck load.	Bulk freight truck	About 40 km	
18		Middle-sized tractor drawn trailer		Splitting at the end-user. Typical storage needs for 15 kW output: pellets: 11 m^3, stacked hardwood: 15 m^3, stacked softwood: 22 m^3, loose wood chips; 39-47 m^3.
19	Roadside chipping by contractor, chipping directly into farm trailer (35 m^3), container (40 m^3), or trailer truck (85 m^3). The contractor occasionally buys surplus wood chips and brings them to own storages.			Storage of chips at the end-users or at the contractor. Two storages systems of the contractor: bulk storage outside for wet wood chips and a indoor bulk storage for dry wood chips
20	Pellet factory (capacity of 15.000 tons per year)[6]. Direct purchase from the pellet factory by households or through retailers	By private households (15 kg bags) or delivery to retailers (bulk delivery) by truck owned by the pellet factory.	20 km or more	
21		Raw wood chips will usually be delivered to the power generation facility in standard bulk tipping lorries		The wood has to be unloaded, screened, dried and store to ensure a constant supply to the correct specification
24	Roadside chipping		Average distance 28 km	Plant storage equipped with weighbridge, humidity buckets, industrial chippers, mobile crane and loader
25	Storage of forest residues after chipping (takes place every two weeks). Material transported to a depot for drying (about 20 km from the sources - eight depots of up till 400 m^3 owned by the supplier).			Chipping at the depots? Supplier have contracts with harvesting and transport contractors, fuel depot owners, chips storage owners and delivery contractors, and with end-users
28	Pellet factory, annual production 65.000. Storage of saw dust at the pellet factory	Sales involves whole-sales and retailers, domestic and exports (direct sales from the plant 30%, large scale sales 10% and independent distributors 60%)		
30	In forest chipping			
31a				The company uses several dumps of about 30-40 solid m^3
31b				

[1]Fuel categories: P: Primary, SRC: Short Rotation Coppice, S: Secondary, T: Tertiary. [2]FD: Forwarding distance. [3]The smallest heating plants (< 100 kW_t) are biggest in number, but produce only about 1% of the energy. [4]Planned up to 5000-240,000 tons per year. Pellet supplier examples: 1) Wood centre (consortium including forest owners, saw mills, pellet boiler company and the city of Olsberg). Sales in 15 kg bags, big bags of 1 tons, or by tank-lorries, 2) Pellet producer with numerous partner distributors (regional traders of solid biofuels, see also figure xx). [5]In the whole area, the theoretically available amount is 2.3 m^3 ha^{-1} yr^{-1} (there is not much different between enterprises <200 ha compared to those >200 ha). In case of increasing demands, it will be necessary to optimise supply chains including temporary storage places. Only 2% of the wood chips are checked for weight and moisture, no paying according to energy content. Possibly weighing, otherwise just classification into light, middle or heavy weight wood types. Saw mill by-products are also used as fuel. [6]In Wallonia there are currently four producers with a capacity of 200,000 tons and a current production < 100,000 tons. [7]Residuals removed to prevent forest fires and after thinning and logging operations: tops and branches, and trees with no commercial value.[11]Contracts with wood energy operators (sometimes 20 years).[12] Three year contracts with some saw mills. Wood fuels are used as an energy source for the production.[13]Also olive prunings and exhausted olive cakes can be used (alternative to roadside burning). Today used at a small scale to cover energy needs in the agroindustry, house heating, green house heating, and other industries. [14] Supply guarantee from saw mills (e.g. 12 years). Consider using also miscanthus, and other new raw materials.[15] The company also performs PEFC SFM and CoC certification and it is thus possible to certify products. [16]About 9 mill solid fuel heating systems in German households (including fireplaces, tiled stoves etc.).

Annex II. Key assumptions for assessment of the administrative and economic burden

Target groups

	T1	T2	T3	T4
Target groups	*Biomass producers*	*Processing, manufacture, trade*	*Energy producers*	*Governments*

No of entities

	T1	T2	T3	T4
Number of entities in EU27	1.600	4.000	48.000	27

Wages

Wage tariffs - low cost (€ hour-1)	T1	T2	T3	T4
Professionals	26	26	26	
Technicians and associate professionals	18	18	18	
Legislators, senior officials and managers				31
Clerks				14

Obligations by target group and scenario

Obligations sets	T1	T2	T3	T4
Scenario 5 (new scenario 1)	A+B	C	C+E	F
Scenario 2 (new scenario 2)	A+B	C+D	C+D+E	F
Scenario 6 (new scenario 3)	C	C	C+E	F
Scenario 3 (new scenario 4)	C	C+D	C+D+E	F

Target groups by scenario and obligations

Set of obligations	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*
A (A1, A2)	T1	T1		
B	T1	T1		
C (C1, C2)	T2+T3	T2+T3	T1+T2+T3	T1+T2+T3
D (D1, D2)		T1+T2+T3		T1+T2+T3
E	T3	T3	T3	T3
F	T4	T4	T4	T4

No of entities by scenario and obligations

Set of obligations	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*
A (A1: GGL S5, A2: FSC)	1.600	1.600		
B	1.600	1.600		
C	52.000	52.000	53.600	53.600
D		53.600		53.600
E	48.000	48.000	48.000	48.000
F	27	27	27	27

Frequency of checking by Member States	5%

Annex III. Detailed information on obligations and required actions for assessment of administrative burdens

Cost type 1	*Cost type 2*	*Hours*	*Description of required actions*
SFM-GGL			
One off	External direct	6	Application, offer and contracting
	Internal direct		
	Internal indirect		
Recurring annual	External direct	36	Time for preparation of the audit, office and field audit, reporting
	Internal direct	24	Audit
	Internal indirect		
Recurring periodic (3rd year)	External direct	10	Additional time for preparation of the audit, office and field audit, reporting, issue of certificate
	Internal direct	16	Audit
	Internal indirect		
SFM-FSC			
One off	External direct	41	Application, offer and contracting, preparing, planning, contacting, selection of experts, desk study, office and field audit, report writing
	Internal direct		
	Internal indirect		
Recurring annual	External direct	119	Preparation, planning, contacting, selection of experts, stakeholder identification, contacting, meeting and information, desk study, office and field audit, report writing, certification, administration.
	Internal direct	74	Audit
	Internal indirect		
Recurring periodic (5th year)	External direct	78	Preparation, planning, contacting, selection of experts, stakeholder identification, contacting, meeting and information, desk study, office and field audit, report writing, peer review, certification, administration.
	Internal direct	66	Audit
	Internal indirect		
SFM-CoC			
Recurring annual	External direct	6	
	Internal direct	6	Audit
	Internal indirect		
CoC			
One off	External direct	8	Introduction of quality management system, division of responsibilities, procedures, training and records' keeping (assumed is that COC certification is additional to a GGL or FSC certification and isn't performed on its own, i.e. that specific quality system items are already assessed in another setting
	Internal direct		
	Internal indirect		
Recurring annual	External direct	20	Preparing, planning, contacting, office and on-site audit, mass balance calculation, report writing administration, and possible certification
	Internal direct	10	Audit
	Internal indirect		
GHG			

Recurring annual	External direct Internal direct Internal indirect	2 18	Audit Retrieving information for documentation that default is met
Reporting by economic operator			
Recurring annual	Internal direct	5	Retrieving existing information and submitting it to the Member State
Recurring periodic (20th year)	Internal direct	2	Make available to the Member State, on request, the data that were used to develop the information
Reporting by Member State			
One off	Internal direct	320	Establishment of relevant legislation
Recurring annual	Internal direct	122	Filing information submitting by economic operators, aggregating data and submitting reports to the Commission

Annex IV. Estimates of annual woodfuel yields from Norway spruce forest of low to medium productivity.

Table IV.A. Average annual yield of woodfuel from Norway spruce stands on sites of poor to relatively high productivity, assuming that 0 and 15% of the biomass is left on the site, respectively (based on Møller 2001)

Production class[1]	Rotation age	Biomass 100%		Biomass 85%	
$m^3\ ha^{-1}\ yr^{-1}$	yrs	$ha^{-1}\ yr^{-1}$	$m^3\ ha^{-1}\ yr^{-1}$	$ha^{-1}\ yr^{-1}$	$m^3\ ha^{-1}\ yr^{-1}$
Logging residues + whole-trees from thinnings with mean square diameter < 15 cm					
4	90	0.9	2,0	0.8	1,8
8	80	1.4	3,1	1.2	2,7
12	70	2.2	4,9	1.8	4,0
Logging residues					
4	90	0.3	0,7	0.2	0,4
8	80	0.7	1,6	0.6	1,3
12	70	1.2	2,7	1.0	2,2

[1]Maximum average annual growth.

Annex V. Details on forest ownership strutures

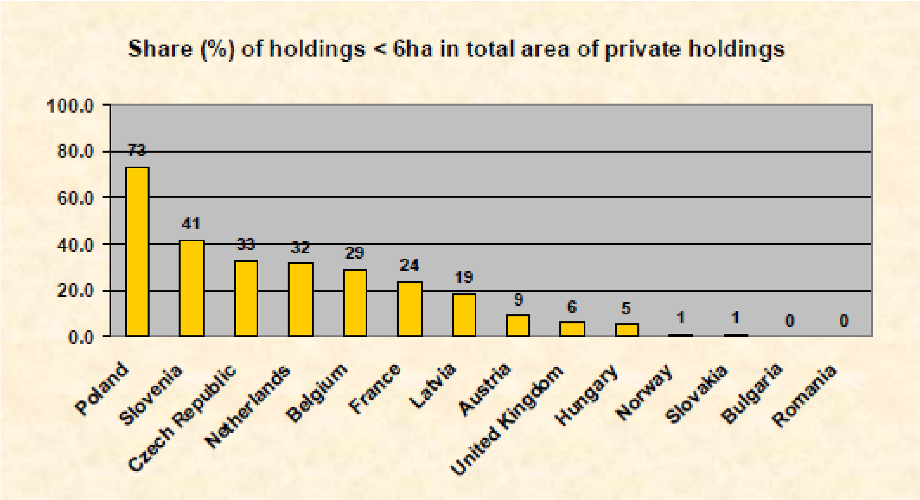


Figure V.A. *Share of forest holdings < 6 ha by country (illustration from Schmithüsen et al. 2008). The private forest ownership structure in terms of size of holdings varies considerably among countries*

Table V.A . *Distribution of forest and other wooded land area by country in EU27 to publicly and privately owned land (FAO 2005). The forest ownership structure in terms of forest area varies considerably among countries*

Country	Forest area				Other wooded land area			
	Total 1,000 ha	Public %	Private %	Other %	Total 1,000 ha	Public %	Private %	Other %
Austria	3,838	19.6	80.4	0	117	19.7	80,3	0
Belgium	667	43.5	56.5	0	27	38.9	61,5	0
Bulgaria	3,375	91.6	8.4	0	105	94.3	4,8	0
Cyprus	173	61.2	38.8	0	214	23.7	76,3	0
Czech Republic	2,637	76.7	23.3	0	0	-	-	-
Denmark	486	28.4	71.6	0	136	-	-	-
Estonia	2,243	37.5	22.4	40.0	94	8.5	37,2	54,3
Finland	22,475	32.1	67.8	0.1	830	68.9	31,0	0,1
France	15,351	26.0	74.0	-	1,814	9.6	90,4	-
Germany	11,076	52.8	47.2	0	-	-	-	-
Greece	3,601	77.5	22.5	0	2,924	86.5	13,5	0
Hungary	1,907	60.5	39.5	0	0	-	-	-
Ireland	609	64.0	36.0	0	41	16.1	83,9	0
Italy	9,447	35.0	65.0	0	992	-	-	-
Latvia	2,885	54.0	45.1	0.9	120	16.7	70,8	12,5
Lithuania	2,020	77.3	22.7	0	83	69.9	30,1	0
Luxembourg	87	45.7	54.3	0	1	10.7	89,3	0
Malta	n,s,	100.0	0	0	0	-	-	-
Netherlands	360	49.7	50.3	0	0	-	-	-
Poland	9,059	83.2	16.8	0	-	-	-	-
Portugal	3,583	7.3	92.7	0	84	22.6	77,4	0
Romania	6,366	94.3	5.7	0	234	0	100,0	0
Slovakia	1,921	52.4	43.2	4.4	-	-	-	-
Slovenia	1,239	27.7	72.3	0	44	4.5	95,0	0
Spain	16,436	30.0	67.9	2.1	11,016	22.3	74,9	2,8
Sweden	27,474	19.7	80.3	0	3,246	55.7	44,3	0
United Kingdom	2,793	36.2	63.8	0	20	0	100,0	0

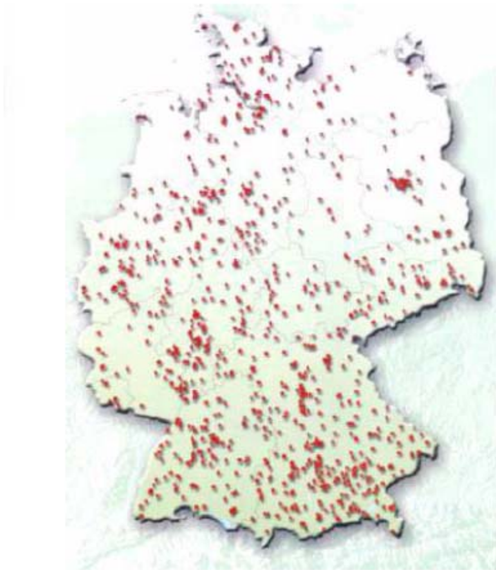
Annex VI. Details on the number of concerned entities in target group 2

and type of ucers Tables on biomass users in EUBIONET partner and subcontractor countries

Table VI.A. *Preliminary data for the number of saw mills and pellet manufacturers in EU27*

Country	Saw mills[1]	Pellet manufacturers[2]
Austria	36	30
Belgium	2	10
Bulgaria		19
Cyprus		
Czech Republic	3	8
Denmark	10	9
Estonia	7	18
Finland	85	23
France	51	21
Germany	58	55
Greece		9
Hungary		13
Ireland	1	1
Italy	2	93
Latvia	15	21
Lithuania	1	32
Luxembourg		
Malta		
Netherlands	1	2
Poland	9	57
Portugal		8
Romania		9
Slovakia	3	15
Slovenia		3
Spain	1	17
Sweden	179	13
United Kingdom	8	17
EU27	472	503

[1] http://www.sawmilldatabase.com/countries_sawmills.php, [2] http://www.pelletcentre.info/.



Pellet traders in Germany. Source: Solar Promotion GmbH, 2006 (illustration not completed).

Figure VI.A. Pellet traders in Germany. Figure from EUBIONET (2007l)

Annex VII. Tables on energy biomass users in EUBIONET partner and subcontractor countries from Alakangas et al. (2007)

Table VII.A.

Table 6. Municipal biomass users in EUBIONET II partner and subcontractor countries: biomass-fuelled boiler capacities (MW_{th}, MW_e) and number of plants (pcs.).

COUNTRY	DISTRICT HEATING		COMBINED HEAT AND POWER (CHP)			SEPARATE POWER PRODUCTION	
	MW_{th}	pcs.	MW_{th}	MW_e	pcs.	MW_e	pcs.
Austria	822	694	N.A.	83	32	N.A.	N.A.
Belgium	0	0	N.A.	N.A.	N.A.	N.A.	4
Czech Rep.	94	62	0	0	0	1 227	37
Denmark	474	125	298	120	11	517	5
Estonia	518	85	N.A.	N.A.	N.A.	N.A.	N.A.
Finland	900	170	3 500	1 380	45	154	1
France	380	110	0	0	0	0	0
Germany	N.A.	350	2 000	1 464	3 000	N.A.	40
Greece	14	1	N.A.	N.A.	N.A.	N.A.	N.A.
Hungary	27	6	4	0	1	189	6
Ireland	0	0	8	2	1	0	0
Latvia	N.A.	1 485	56	2	2	N.A.	N.A.
Netherlands	0	0	95	26	2	200	7
Poland	400	156	600	205	5	N.A.	11
Portugal	N.A.	N.A.	1 400	371	9	119	5
Slovak Republic [1]	96	91	150	N.A.	1	1	
Spain	0	0	0	0	0	344	10
Sweden	N.A.	169	N.A.	1 442	31	N.A.	N.A.
United Kingdom	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
TOTAL	3 731	3 504	15 986	5 095	3 140	2 751	126

[1] DH plants: municipal sector includes 88 DH-plants (78 MW_{th}).

Table VII.B

Table 7. Industrial biomass users in EUBIONET II partner and subcontractor countries: biomass-fuelled boiler capacities (MW_{th}, MW_e) and number of plants (pcs.).

	P&P INDUSTRY Solid biomass			P&P INDUSTRY Recovery boilers for waste liquors		SAWMILLS			OTHER INDUSTRIES		
	MW_{th}	MW_e	pcs.	MW_{th}	MW_e	MW_{th}	MW_e	pcs.	MW_{th}	MW_e	pcs.
Austria	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Belgium	30	N.A.	1	N.A.	N.A.	154	N.A.	46	39	N.A.	11
Czech Rep.	133	N.A.	5	0	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0	0	69	30	2
Estonia	N.A.	N.A.	1	45	9	54	0	24	93	0	34
Finland [1]	4 240	1 111	40	4 100	680	450	12	57	4 200	900	95
France [2]	550	N.A.	N.A.	N.A.	N.A.	325	5	275	1 100	185	728
Germany	N.A.	N.A.	160	N.A.	N.A.	N.A.	N.A.	2 200	N.A.	N.A.	N.A.
Greece [3]	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	488	0	2 404
Hungary	N.A.	0	1	N.A.	N.A.	N.A.	N.A.	N.A.	250	N.A.	2 080
Ireland	0	0	0	0	0	245	0	10	0	0	0
Netherlands	40	11	2	N.A.	N.A.	12	2	2	35	7	12
Poland	140	50	5	480	150	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Portugal	500	332	7	N.A.	N.A.	44	8	2	318	119	5
Slovak Rep.	20	N.A.	2	N.A.	N.A.	300	N.A.	136	68	N.A.	34
Spain	N.A.	25	1	N.A.	3	N.A.	4	1	N.A.	72	8
TOTAL	5 653	1 529	225	4 625	841	1 584	31	2 753	6 660	1 313	5 413

[1] Cofiring plants which use biomass fuels and peat (only biomass capacity is reported)

[2] 725 biomass-fuelled plants in wood industry (1 100 MW_{th}, 0 – 5 MW_e), Three plants in other industries (180 MW_e)

[3] Data for 64 wood industry actors.

Source: Alakangas et al. 2007

Annex VIII. Details on energy producers

Table VIII.A. *Number of players in biomass based energy production in Austria (Lebensministerium 2006) and Denmark (Danish Energy Agency 2009)*

Austria Type	Number	Denmark Type	Number
Electricity:		*Cogeneration (CHP);*	
		Straw and wood chips - decentralised plants	10
Solid biomass	164	Biomass and other fuels - centralised plants	6
Liquid biomass	80	Waste	18
Biogas	323	Biogas	30
Heating[1]*:*		*Heating:*	
Output < 100 kW[2]	91,365	Wood-burning stoves	500,000
Output 100 kW - 1 MW	5,963	Wood-burning boilers	70,000
Output > 1 MW	781	Wood-pellet furnaces	30,000
		Straw furnaces	9,000
		District heating (DH) - straw and wood chips[3]	120
		District heating (DH) - waste	12
		Heat, cogeneration, power plants owned by the industry	200

[1]Automatic wood-fired plants built between 1980-2006, total output 6,860 MW. [2]47,377 of these are pellet-fired central heating systems [3]About half of them wood chips fired.

Table VIII.B *Energy capacity at European power and CHP plants for biomass fired (including also waste and biogas) plants, which are included in the Chalmers University Dbase (Göran Berndes, Chalmers University, pers. comm.). Generally, plants < 10 MW are not included*

	Existing biomass fired plants		Planned biomass fired plants	
Capacity MW	Power and CPH plants MW_e	Estimated number of plants[3]	Power and CPH plants MW_e	Estimated number of plants[3]
< 10	228.3	46	22.5	5
10-19.9	1314.4	88	178.3	12
20-49.9	3732.6	107	815.9	23
50-99.9	2506.5	33	1149.0	15
100-299.9	1588.9	8	1805.0	9
300-500			1850.0	5
Total capacity	9370.7	317[1]	5820.7	82[2]
Average capacity	29.6		71.0	

[1]of which 127 are CHP plants. [2]Of which 34 are CHP plants.[3]Estimated from total capacity within a certain size class, by assuming an average size of plants which corresponds to the middle of the capacity interval.

Annex IX. Details on supply chain control systems by forest certification schemes.

FSC supply chain control systems:

Credit system: A Chain of Custody system applied at the product group level which allows a proportion of outputs to be sold with a credit claim corresponding to the quantity of FSC and postconsumer inputs. Considering the applicable conversion factor(s), FSC and post-consumer inputs can be accumulated as FSC credit on a credit account.

Percentage system: A Chain of Custody system applied at the product group level which allows all outputs to be sold with a percentage claim that corresponds to the proportion of FSC and postconsumer input over a certain period in time.

Transfer system: A Chain of Custody system applied at the product group level, which allows outputs to be sold with an FSC claim that is identical to the material category and, if applicable, the associated percentage claim or credit claim with the lowest FSC or post-consumer input per input volume."

PEFC supply chain control systems:

The organisation applying *average percentage* method shall use the certification percentage for all the products covered by the production batch for which the calculation has been carried out.

The organisation applying *volume credit method* shall transfer the certification percentage into the volume credit in the single measurement unit of the output products of the production batch. The volume credit shall be distributed to the output products in a way that the certified products will be considered as including 100 % of certified raw material.

The organisation applying the *physical separation* method shall ensure that the certified raw material is separated or clearly identifiable at all stages of the production or trading process." For both FSC and PEFC certified products, the identity of the biomass supplier can be tracked by moving backwards in the supply chain, regardless of supply chain control method used.

(source: FSC and PEFC CoC standards)

5. Task 5: summary, integration

Marc Londo, ECN, with contributions from all co-authors of earlier chapters.

5.1 Review of GREEN-X assumptions on biomass availability and costs

The first question was to what extent the EC Renewable Energy Road map and its impact assessment are based on reasonable assumptions regarding availability and cost of biomass by 2020. For this analysis, the underlying assumptions by GREEN-X were taken, using the most recent analyses as performed in EMPLOYRES and FUTURES-E (which do not fundamentally differ from the GREEN-X versions as used for the impact assessment, and these assumptions were compared with a broad range of studies addressing future biomass availability and costs).

5.1.1 Biomass availability and costs by 2020

An extensive comparison and analysis of the available literature on EU-domestic biomass led to the following conclusions (see also Table 5.1):

- As for *dedicated crops*, the GREEN-X assumptions on 2020 biomass availability lie in the (lower part of the) range of other studies. However, this range is extremely wide, which indicates that this future potential is still highly uncertain and is influenced by many factors external to the energy domain. Detailed data on projected costs are only available in one reference (REFUEL). The GREEN-X cost assumptions lie in the higher end of the range in this reference. However, the reference calculated costs, not prices, and focuses on supply potential in Central and Eastern European Countries, which may explain this.
- For *agricultural residues*, the GREEN-X availability assumptions also seem in a realistic range compared with other studies. Here again, there is still a wide variation between the studies, illustrating significant uncertainties. The cost assumptions are close to the one reference found for this feedstock type.
- For *forest products*, the comparison of GREEN-X availability data with other sources indicates that the former are achievable, though in the higher part of the range. The comparison is difficult, however, as many subcategories are defined in several references. The GREEN-X cost assumptions are considerably lower than those in the EEA study (the only reference found). This can partly be explained by differences in definitions, e.g. whether pre-treatment and transport have been taken into account.
- The GREEN-X availability assumptions on *forestry residues* may be more optimistic than those on agricultural residues, but still lie within the (higher part of the) range in the references. Again, this range is considerable, indicating major uncertainties. The GREEN-X cost assumptions are several tens of percents lower than the (one) reference found for this, which is possibly caused by differences in oil price assumptions
- For *black liquor* and (the biodegradable fraction of) *municipal waste*, GREEN-X availability assumptions are very close to the (one) reference source considered. References for the costs of these categories were not found.

For the availability of ex-EU imports of biomass we found the following (see also Table 5.1):

- The availability and costs of *forestry imports* depend on a manifold of factors mostly exogenous to the EU and the energy sector. However, the GREEN-X assumptions are consistent with other assessments of this resource.

- Also, the availability and costs of *biofuel imports* is difficult to assess, also because the competition between EU-produced and imported biofuels is subject to trade policy. Given the current body of literature however, the GREEN-X assumptions seem realistic.

Table 5.1 *Overview of the comparison of GREEN-X assumptions on biomass availability and costs by 2020 with a wide range of references from the literature. For full details see Chapter 1 of this report*

		Assessment of GREEN-X assumptions: how high or low are they compared to other studies?			
		Availability		Costs	
Feedstock category	Code		Remarks		
Agricultural crops	AP1-7	Within range	Reference studies vary widely, major uncertainties	Within higher end of range in (one) reference	Problematic comparison, reference calculates costs, not prices, and focuses on CEEC
Agricultural residues	AR1-2	Within range, possibly overestimated	Slightly on the low end, wide range., but possibly overestimated if various constraints are considered	Very close to (one) reference	
Forestry products	FP1-3	Reasonable, but in high end of range	Many subcategories of materials, considerable ranges.	Considerably lower than (one) reference	Potentially explained by differences in definitions (pre-treatment, transport) and future increases in prices are ignored.
Black liquor	FR1	Very close to (one) reference		n.a.	
Forestry residues	FR2-5	Within higher part of range	Again considerable range between studies	Considerably lower than (one) reference	Possibly caused by differences in oil price assumptions
Municipal waste	BW1	Very close to (one) reference		n.a.	
Forestry imports	FR6	Consistent with other references		Consistent with other references	
Biofuel imports	-	Realistic	Considerable uncertainties about global availability and competition between EU-domestic and foreign feedstocks	Realistic to underestimated	Considerable uncertainties about global availability and competition between EU-domestic and foreign feedstocks.

Concluding, one could generally state that most GREEN-X assumptions are generally reasonable given the other literature sources assessed, but that GREEN-X may be on the optimistic side when it comes to availability and (particularly) costs of forestry products, forestry residues and agricultural residues. To what extent a correction of these assumptions would lead to higher overall costs for the biomass needed to meet the 20% RES target for 2020 lies beyond the scope of this assessment.

5.1.2 Key factors causing the wide ranges in and between the different studies

Of the different types of feedstock, uncertainties on availability seem highest for agricultural crops. However, almost all feedstock types are still highly uncertain in their potential availability and costs. Key factors determining biomass availability are:

- The Common Agricultural Policy (CAP). Agricultural markets in Europe are protected by, among others, import tariffs and export subsidies. This influences the self sufficiency ratio of the EU, and correspondingly the amounts of land potentially available for bioenergy. The CAP is also a very influential factor in the overall climate for technology improvement, intensification and other factors that determine overall yield developments.
- The development of technology. The development of technologies for the production of 2nd generation biofuels can have a large impact on the availability of biomass, because of the higher yields of lignocellulosic energy crops compared to conventional starch, sugar and oil energy crops. Also the use of breeding technology, improved management systems and eventually genetic modification can greatly enhance the future yields of energy crops, lignocellulosics in particular.
- The price of biomass and other agricultural commodities, oil and carbon credits, as they strongly determine the competition between different uses of land and different applications of feedstock
- The demand for land for other uses, such as urbanisation, forest expansion, and also the potential use of land for carbon sequestration.

5.1.3 Biomass availability in the EU beyond 2020 towards 2050

All studies indicate that between 2020 and 2050 the availability of land for biomass energy in the EU will (continue to) increase. Underlying reasons are that the population in Europe is projected to decrease and the consumption of food is saturated, while the efficiency of agriculture is projected to increase. Studies that predict otherwise were not found. Also the availability of forest biomass is projected to increase.

5.1.4 Global biomass availability

Assessments of global biomass availability on the longer term (2050-2100) vary widely, but the most critical parameters affecting biomass potential have been identified, the main factor being further modernisation of agriculture and improvement of productivity. Scenarios that take into account a number of uncertainties and sustainability constraints lead to a global biomass potential of 200-500 EJ/yr by 2020, split up into:

1. Residues from forestry and agriculture and organic waste, including Municipal Solid waste (MSW). In total, this category represents between 50 and 150 EJ/yr, with a mean estimate of around 100 EJ/yr. This part of the potential biomass supply is relatively certain.
2. Surplus forestry, i.e. apart from forestry residues an additional 60-100 EJ/yr of surplus forest growth could be available.
3. Biomass produced via cropping systems, of which a lower estimate is in the range of 120 EJ/yr, which can be significantly increased by a potential contribution of water-scarce, marginal and degraded lands for energy crop production (ca 70 EJ/yr) and faster development of agricultural technology (adding some 140 EJ/yr).

5.2 The RED sustainability criteria and biomass availability and costs

Objective of this task was to assess to what extent the RES sustainability criteria affect availability and costs of biofuels. These criteria can be grouped as:

- The greenhouse gas emission reduction thresholds (article 17.2 in the RED)
- The land exclusion criteria (articles 17.3-17.5)

The other obligations on good agricultural practice and reporting on other issues (articles 17.6-7) are assumed not to have any impact.

5.2.1 Impact of the GHG thresholds

For this criterion, the approach was as follows:

- First, chains that do not meet the different thresholds (35% for 2010, 50% for existing installations by 2017 and 60% for new installations by 2018) by their typical values were listed
- Subsequently, baseline improvements to these typical values were assessed, and foreseen typical values for existing installations by 2017 and new installations by 2018 were calculated
- For the chains that did not meet the thresholds by baseline developments, additional measures were proposed and analysed on their impacts on the typical value
- Given a baseline scenario for the biofuel mix leading to a 10% biofuels share by 2020, the costs related to these additional measures were assessed.

Additional costs are summarised in Table 5.2. Depending on the development pathway of biodiesel production capacity, additional costs vary between ca 40 en 60 million Euro.

Table 5.2 *Summary of biofuel chains not meeting the 60% threshold by 2018, improvement options and related costs*

Biofuel chain	Autonomous GHG emission reduction	Improvement option	Resulting GHG emission reduction	Additional costs for the year 2020 (linear baseline)	Additional costs for the year 2020 (2015 biodiesel peak)
Ethanol from wheat (NG boiler)	54% (2018)	Shift to NG CHP	62% (2018)	0	0
Biodiesel from rapeseed	55% (2018)	Biomethanol in processing	62% (2018)	13 M€	0
Biodiesel from soy	43% (2017)	Biomethanol in processing	50% (2017)	18 M€	23 M€
Biodiesel from soy	44% (2018)	Shift to rape, sunflower	>62% (2018)	15 M€	0
Biodiesel/HVO from palm (p.n.s.)	45/47% (2017) 43/47% (2018)	Methane capture	> 62/68%[1] (2018)	15 M€	15 M€
Total additional costs				61 M€	38 M€

[1]: 62% and 68% are the current typical values for respectively biodiesel and HVO from palm with methane capture at oil mill. 2017 and 2018 values have not been calculated but will be above these values.

5.2.2 Impact of the land exclusion criteria

In order to assess the impact of the land exclusion criteria, we checked the studies that were used in Task 1 on whether they respected the no-go areas of article 17.3 and only used residues to the types of land in articles 17.4 and 5 without changing the status of the land.

On the basis of the material reviewed, it is unlikely that the land exclusion criteria will substantially affect availability and costs of EU domestic biomass and biomass imports as assumed in GREEN-X.

- For EU-produced biomass, this conclusion is better supported by the studies reviewed, as they are more explicit on e.g. the types of land available for crop production. Furthermore, it can be safely assumed that current management practices of e.g. nature reserves, forests and wetlands provide sufficient compliance with the land exclusion criteria.
- For ex-EU imports, a straightforward assessment could not be made, as e.g. global biomass potentials are still very uncertain. However, given the size of projected imports and the considerably larger order of magnitude of global potentials, it seems reasonable to conclude that this demand can also be met by feedstocks that meet the land exclusion criteria. This, however, does *not* mean that current and future trade flows of e.g. palm and soy are free from product batches that are e.g. grown on no-go areas; it means that the biofuels industry will be able to purchase sufficient quantities of feedstock grown outside such areas provided a verification system is in place.

The directive criteria in Articles 17.2 to 17.5 do not go into *indirect* land conversion or expansion into no-go areas: land that is currently used for food cultivation starts being used for energy while e.g. other forest land is converted to arable in order to produce food. In our analysis, most studies assessing biomass potentials focus on agricultural lands, thereby also preventing indirect intrusion into no-go areas. However, as indirect effects are extremely complicated to assess, our conclusions do not fully cover all possible impacts of indirect land use change.

5.3 Applicability of existing certification schemes

The objective of this task was to assess to what extent national and international certification schemes (existing and under development) would be applicable for safeguarding the sustainability criteria as mentioned in the RES directive. This applicability has several dimensions:

- Whether the schemes include the criteria in the RES directive
- If the criteria are translated into practically applicable, and possibly quantifiable indicators. How compliance is monitored
- How compliance information is linked to the biomass through the chain

Furthermore, the schemes were checked for their attention to several issues on which the Commission will have a reporting obligation according to the RES directive, viz. monitoring soil, water and air protection, and the restoration of degraded land.

The certification schemes were selected in consultation with the commissioner. They include existing schemes and schemes under development to guarantee the sustainability of forestry (natural forests and plantations), agricultural production (ranging from commodities, tropical products and agricultural products in general) and bioenergy (biofuels and bioenergy for heat and power).

Main approach in the schemes: Meta-standards

Most bioenergy schemes assessed focus on biofuels. Only NTA 8080 is developed to guarantee the sustainability of bioenergy for heat and power. The schemes that are developed to guarantee the sustainability of bioenergy mainly follow the meta-standard approach. This means that existing schemes for sustainable forest and agricultural production can be used (partly) to cover the required sustainability criteria, providing that they are compatible.

A similar approach already exists for forestry certification schemes. PEFC, based on ITTO/ATO and PEOLG, is an umbrella organization to evaluate and endorse national forestry schemes around the world. National forestry schemes under PEFC are for example MTCC, CERTFOR and SFI. FLO is an umbrella organization for agricultural products to endorse national FLO schemes around the world.

Governance and organization of the schemes

A certifying body is a body which is responsible for verifying that a product sold or labelled as "sustainable" is produced, prepared, handled and processed according to the standard. There are 3 main ISO standards that are developed to ensure the competency of the certifying body (and its auditors):

- ISO 62: General requirements for bodies operating assessment and certification / registration of quality systems.
- ISO 65: General requirements for bodies operating product certification systems.
- ISO 66: General requirements for bodies operating assessment and certification / registration of environmental management systems.
- ISO 19011: General criteria for Quality Management System Auditors or Environmental Management System Auditors

Organizations that issue credentials or certify third parties against official standards are themselves formally accredited by accreditation bodies. This accreditation process ensures that their certification practices are acceptable, typically meaning that they are competent to test and certify third parties, behave ethically, and employ suitable quality assurance. An accreditation body is an organization delegated to make decisions, on behalf of the higher education sector, about the status, legitimacy or appropriateness of an institution, or programme. ISO 61 is developed to ensure the competence of accreditation bodies and sets general requirements for assessment and accreditation of certification / registration bodies.

The analysis shows that most schemes have certification schemes that are ISO certified and recognized on a national level. This is in most cases accredited by accreditation bodies. Various "new" schemes (e.g. Roundtable Initiatives) are still developing their organizational structure including the establishment of accreditation procedures. Sustainability standards as included in UK-RTFO and NTA8080 are (partly) embedded in the national policy and will most probably require a (partly) different type of organizational structure.

Some schemes do not show a clear picture if there was a balanced participation of stakeholders in the standard setting process. It must be noted that the presence of a "balanced stakeholder process" is partly subjective and the opinion is depending on the information source. Especially some forestry certification schemes, recognized by PEFC (MTCC, Canadian SAFM, CERFLOR), show opposite opinions on this topic in literature.

Verification and assessment procedures

External audits are implemented on a regular basis to check if the sustainability criteria are met at the production unit. In case a scheme has included a Chain of Custody (CoC) certificate, verification procedures also have to be developed to check if the required procedures are followed in the further chain as well.

FSC and forestry schemes recognized by PEFC apply in general the mass balance system and track-and-trace system to trace the products from the production unit to the end-user of the chain. RSPO and NTA 8080 (only for biomass for electricity and heating) recognize three systems to trace products from the production unit to the end-user of the chain: Mass balance, track and trace or book and claim). NTA 8080 mentions that the three models are all acceptable but in combination with different sustainability claims. For all counts that certain verification requirements have to be met.

Compatibility of the criteria in the schemes to the RED criteria

The “new” schemes (e.g. Roundtables, Greenergy, and ISCC) have included a requirement on *GHG reduction* in their principles. Some existing schemes as SAN or AFS also recognize the importance of reducing GHG emissions in their production chain. SAN has for example included as principle “Practices to reduce GHG emissions and promote carbon dioxide sequestration are required”.

The RED excludes specific areas with a *high biodiversity and/or carbon content* as areas for biomass production. Within this context, the need to protect primary forests and biodiverse grasslands is specifically mentioned. All schemes recognize the importance of conserving areas or high biodiversity. However, the translation of this general recognition to principles and, even more specific, criteria and indicators, vary strongly from scheme to scheme.

Most schemes have not defined explicitly a criterion to protect primary forest or biodiverse grasslands. However, it should be noted that the protection of these areas is indirectly covered by:

- Recognition of international regulations (CBD, Ramsar)
- National laws and policies on protected areas
- The formulation of High Conservation Value (HCV) areas.

Various schemes follow the approach that HCV areas are defined in a participatory process (on a national or regional level). The HC values are interpreted in a stakeholder context leading to a certain subjectivity of the defined high conservation value areas (this can differ from country to country). It must be noted, however, that the level of protection and monitoring of compliance will also differ from country to country.

International agreements, regulations and conventions (as IUCN, Ramsar or CBD) provide relevant databases to define the location of recognized protected areas. Assessments made ten years or more ago are annotated as being out of date and users are requested to use them with caution. Updates on statistics of the Red List take much time and not all country data are of high quality. Beside, it must be recognized that satellite images cannot provide all required detailed information on (for example) the quality of ecosystems. This type of information has to be combined with or can only be obtained at a national level or at a project level.

Most mature schemes have developed a list of definitions as a guidance to meet the defined criteria and principles. The definitions related to biodiversity are listed below for the various schemes.

Only a few schemes have included a specific principle or criterion on *air pollution*. More schemes have included a general principle or criteria on waste management in general. It must be recognized that minimizing air pollution, although indicated in Table 22 as not compatible to the RED, can still be covered in the scheme through:

- Minimization of burning in the field (which will reduce the air emissions on the field);
- National legislation or international conventions: most schemes require that the national legislation is met which will include legislation on air emissions.

However, the two points mentioned above do not provide the required data to meet the reporting obligation to the European Commission.

A similar remark about the reporting obligation for the *water and soil impacts*: Although most schemes require improvements in soil and water conservation, the type of records to monitor the progress may differ strongly from scheme to scheme. For example, NTA 8080 request for water conservation measurements in relation with use of irrigation water in liter/ha/year, origin of the irrigation water and surface water level according to BOD on and near the production unit. The Better Sugarcane Initiative request information on the net water consumed per unit mass of product. Both schemes request, in addition, information on soil properties and characteristics. Also, various schemes require the availability of water and soil management plans.

Social impacts (counteracting negative impacts and promoting positive impacts) are included in most schemes by a translation of the ILO standards into a principle or a set of criteria. The level of detail of these criteria and indicators can, however, differ per scheme.

5.4 Verification options and administrative costs for forest, plantation and agricultural SRC biomass

The objective of Task 4 was to identify and analyse feasible options to verify compliance with biomass sustainability criteria, in the case of forest biomass. Supply chain control systems as ‘book and claim’, ‘mass balance’, and ‘track and trace’ were assessed for scenarios where the obligation to show compliance with sustainability criteria is on for example the energy producers in the EU or the biomass producers in the EU. Various sub-options were also assessed.

Feasibility of a verification system has at least four overall dimensions:
- That sustainable production can be efficiently documented
- That the supply chain can be efficiently controlled
- Accessibility to the system (geographical and institutional)
- That authorities and businesses are able and willing to endure the administrative and economic burdens that this documentation and control implies

These issues were analysed and/or discussed by use of the following approaches and data sources, respectively:
- Technical documentation, statistics and experiences from existing certification schemes, including results presented in chapter 3.
- Results and experiences described in the literature, especially case studies from the EUBIONET2 project, and technical documentation and product databases from existing certification schemes.
- EC SCM methodology, with data from the Control Union, available statistics and information SFM and CoC certification generated by chapter 4.
- Standards, approaches and services offered among existing certification systems and certifiers.

Efficient documentation of sustainable production

Efficient documentation of sustainable production is indicated by standards including all relevant PC&I for sustainable biomass production (as defined by the RES directive and some additional requirements), the quality of the auditing, the practical and economical applicability of the scheme, and consistent use of adequate verifiers.

Task 3 results showed that only ISCC, UK-RTFO and NTA 8080 cover all examined sustainability criteria and that these schemes also address forestry biomass. Their quality varies, however, with regard to the different auditing processes examined and the extent to which the governance and organisation is based on ISO standards. Specific schemes for sustainable forest management generally address most relevant criteria adequately, but for example the GHG criterion is not included by any of them. Schemes for certification of sustainable biomass do include the GHG criterion.

Schemes as ISCC, UK-RTFO and NTA 8080 are still new, while forestry certification systems have existed since the mid-90ties with an increasing amount of certified forests. Currently, about 8% of the global forest area is SFM certified according to either PEFC schemes (67%) or FSC (33%). GGL for sustainable biomass have also existed for more than 5 years, but GGL05 is only for temporary use.

The variables or processes that are actually checked for different criteria and indicators in the field and in the office may vary between schemes and within schemes (between different certifying companies and auditors), even if most schemes have regular harmonisation meetings to correct the latter.

Efficient supply chain control

The supply chain control method should fit the supply chain characteristics and complexity to be efficient, meaningful and resistant to fraud and other irregularities. Supply chain complexity is indicated by the number of links in the supply chain, the number of operators in the individual links and the complexity of the interaction between them. Other important issues are the number of processes needed to produce the fuel, if it is a main or a by product, the number, size, and distances of transports, the number and sizes of storages and length of storage periods, the amounts of biomass per purchase and the frequency of the purchase, if purchases are small or large and if they occur on a free market or according to long-term contracts, and finally the degree of mixing in relation to processing, manufacturing, storage, and transport.

Supply characteristics differ among woodfuel types as does the feasibility of different supply chain control systems. For *primary residues* the distance between forest owner and the end-user is usually short (in terms of intermediate operators - usually 0-1, transport distances - usually < 100 km, and time - usually < 1 year from harvesting). The number of involved forest owners may be large, but usually one forest owner only deliver biomass to one or maybe few plants. Long-term contracts with biomass suppliers are common, sometimes with only four-five purchases per plant per year. Such biomass suppliers are often management and harvesting contractors to a large number of the involved forest owners. Even when independent biomass suppliers organise the purchase, the plant often receives the individual biomass load directly from a single biomass producer, and weighs and registers it for later payment. The major part of the woodfuel purchase often takes place on long-term contracts with few biomass suppliers. Such simple supply chains hardly justify setting up a *book and claim* system that might even anonymise the biomass. If storages, apart from forest owner and end-user storages are involved, *full segregation* would require that certified and non-certified can be physically separated. *Mass balance* approaches should not cause major problems, but will only require that mass balance calculations be performed. It is also an indication of feasibility of mass balance and possibly full segregation that wood chips occur in FSC, PEFC and GGL databases over certified products.

The situation for supply chains for *black liquor and milling residues* used directly by the industry producing them should also be fairly simple. *Mass balance* approaches should not cause problems, while *full segregation* would require supply of only sustainable biomass, separate production lines or production batches for certified and non-certified sawn wood and processing of pulp.

Firewood is purchased and distributed on markets with many, often small, forest owners or farmers and household end-users, which are partly informal. The number of intermediate links, transport distances and time periods between harvesting and end-use are still low, in principle making both *full segregation* and *mass balance* feasible. However, the small scale production and end-use poses a challenge to both SFM certification and supply chain control. It is a question if group certification approaches can be developed to be attractive even at this level, and if the used amounts of firewood (in the future) justifies it.

Supply chains of *processed secondary woodfuels as wood pellets and briquettes* usually suffer from uncontrolled mixing of raw materials. As the raw material is a waste from sawing and other processing of timber, mixing takes place already in sawing and other processing. Even when the saw mill or wood product manufacturer produces certified goods, systems are not necessarily designed to separate the woodwaste. As the raw material for pellets and briquettes is a by-product created in the previous links of the supply chain, it will hardly be possible to distribute credits to forest owners and farmers and thus use book and claim system. The occurrence of pellets and briquettes in product databases of FSC, PEFC and GGL is an indication of the feasibility of mass balance, and possibly full segregation systems. Pellets are also being certified by Laborelec.

Sourcing of *tertiary woodfuels* is usually very difficult, due to intermediate other use and long time spans from production of the biomass until its last end-use as woodfuel. As a less long-lived wood product pallets might be a tertiary source of woodfuel. Certified pallets exist in the FSC and PEFC product databases, even if it is not clear if such products occur in larger amounts as FSC certified when they are used as woodfuel. Municipal and industrial waste may contain significant amount of wood, but it is uncontrolled mix with other types of organic waste has taken place.

Administrative and economic burdens

The key results of the assessment of administrative burdens are summarised in Table 5.3. Total recurring EU administrative costs are in the range of 50-330 million Euro year^{-1} for all woody biomass. Key factors that cause the range are:

- Low and high cost scenarios (the difference being defined by different level of wage tariffs with a four doubling of the costs in the high cost scenario compared to the low cost scenario).
- If GHG certification is included or not (The number of concerned entities is high: 53,600. Administrative burdens for whole EU are 50-60% higher for scenarios that include GHG certification.
- If SFM-FSC certification is used. For whole EU, the administrative burdens were estimated to be 10-15% higher (the increase when using the GGL approach was only 3-4%).

The reason that GHG certification influences the administrative burdens for whole EU more than SFM certification is the much higher number of entities concerned. It was assumed that group or regional forest management certification will be widely used in future forest management certification, while individual certification will be used by other operators. Subsequently, the number of concerned entities is relatively high for GHG (53,600) and relatively low for SFM (1,600). For the individual forest entity SFM certification is more expensive than CoC certification (without SFM) or GHG certification. For the individual forest management entity, the administrative burdens were estimated to be 3-8 times higher when SFM certification is imposed compared to only CoC certification, and correspondingly 2-5 times higher when both CoC and GHG certification are imposed.

SFM was estimated to contribute to the recurring administrative burdens in whole EU with about 3-10 mill € yr^{-1} for the GGL approach and about 10-40 mill € yr^{-1} for the FSC approach. GHG contributed with 30-110 mill € yr^{-1}, while CoC contributed with 40-160 mill € yr^{-1}. The largest costs are from CoC certification (40-90%) which was assumed to concern all target groups. The reporting obligation to national authorities by economic operators contributed about 6-25 mill € yr^{-1}, while the reporting obligation of Member States to EC contributed less than 0.2 mill € yr^{-1} (see also Table 5.4).

Table 5.3 *Summary of administrative burdens to proof compliance with sustainability criteria. An approximate estimate of the costs for the first year can be obtained by adding one off and recurring costs.*

		Unit	Low scenarios costs	High scenario costs
Individual operators				
Economic operators	One off	€	150-210	620-820
	Recurring	€ yr^{-1}	800-6,500	3,000-26,000
Member States	One off	€	10,000	40,000
	Recurring	€ yr^{-1}	1,700	6,900
Individual target groups at EU level				
Economic operators	One off	mill €	0.2-1.7	3-6.7
	Recurring	mill € yr^{-1}	1-10	5-42
Member States	One off	mill €	0.3	1.1
	Recurring	mill € yr^{-1}	0.05	0.2
EU				
All	One off	mill €	11-13	50-80
	Recurring	mill € yr^{-1}	50-80	190-330

[1]: assuming one-off costs only at the initial certification, while reassessment costs for renewal of the certificate every 3rd or 5th year are included in recurring costs with a yearly weight of 1/3 and 1/5, respectively (cf. EC SCM methodology).

Accessibility

Accessibility of market based certification may be affected, for example, by the size and geographical location of the economic operator, which again affects the certification costs. For example, small businesses less frequently have quality management systems in place and in some countries there are no local branches of relevant certification businesses. Hence, relatively more resources and costs are often needed to prepare for the certification and to perform the certification. The quality of institutional frameworks (e.g. legislation and law enforcement) that support efficient certification may also differ among different countries and parts of the world. Less support by existing structures may lead to increased costs by the certified body, for example to prevent illegal logging

Accessibility may also relate to available standards of relevant programmes. FSC, PEFC, GlobalGAP and GGL are all global certification schemes, even if they are not evenly accessible to all countries and continents. Currently, PEFC have endorsed schemes in 27 countries, and FSC only have fully accredited standards in 16 countries. FSC certifies forest in all countries but an interim standard must be for countries with no fully accredited standard. This increases the costs, even if many forest certification services already have interim standards for some countries. Both FSC, PEFC and GGL holds several types of woodfuels or woodfuel raw materials in their product databases, while GlobalGAP has not yet been applied to SRC. Lately, it was, however, tested and recommended for Christmas tree production, which in some regards is comparable to SRC for energy.

Various initiatives have been taken to increase the accessibility of forest certification to forest entities of small scale, with low management intensity, and/or low capacity. Both FSC and PEFC schemes offers group certification and PEFC schemes also offers a so-called regional certification at an even more aggregated level. FSC also developed special standards for small and low intensity managed forests (SLIMF, normally < 100 ha) and a standard to certify controlled wood (to demonstrate that the forest holding does not supply controversial or illegal wood). The SmartWood programme developed a standard and verification service to encourage better harvesting practices of non-certified forests, and since 2005, the SmartWood also offered a stepwise certification service. The purpose is to provide opportunities for forest management enterprises to pursue full forest certification while gaining access to potential market benefits before achieving the actual certification. However, accessibility for small scale, low capacity and low intensity management forest and forest in developing countries is still a problem for forest certification.

5.5 Overview of costs related to the sustainability criteria

This subsection summarises the costs assessed in the study. They have been aggregated in Table 5.4. Although major uncertainties occur in all estimations, administrative costs seem to dominate over 'real' costs. Some remarks on the dominant factors causing the uncertainties:

- Key factor that influences the range in technical costs is capacity growth pathway of biodiesel
- Key factors influencing range in administrative burdens are:
  - whether GHG certification is imposed or not (30-40% of the administrative burdens, with individual certification being used in all other sectors than forestry/agriculture leading to high number of entities concerned)
  - whether the SFM-FSC certification is imposed on forest entities (10-15% of the administrative burdens, assuming that a group and regional forest management certification will be widely used, leading to a relatively low number of entities concerned).
  - The degree to which individual, group or regional certification can be used among various types of economic operators (effects on administrative burdens were not assessed).
- For reference: as additional costs of biofuels are in the order of magnitude of several Euros per GJ biofuel and a 10% target requires ca 1.5 EJ of biofuels, related additional costs can be up to 10 billion Euros (see also the indications in the background information of the biofuels progress report[6]. Compared to this, the additional costs of the sustainability criteria are in the order of several percents of the additional costs related to the biofuels objective itself.

Table 5.4 *Overview of additional costs related to the sustainability criteria in the RED*

Cost type	Type of feedstock	Criterion	Low cost scenario [M€/yr]	High cost scenario [M€/yr]
Technical changes to biofuels chains	Liquid biofuels	GHG	40-60	40-60
		Other	0	0
Administrative	EU woody biomass	GHG	30	110
		SFM	3 / 9[1]	10 / 40[1]
		CoC	40	160
		R-MS[2]	6	25
		R-EC[3]	0.05	0.2
		All	50-80[1]	190-330[1]
	EU Agricultural crops, residues	All	n.a.	n.a.
	Ex-EU Biomass, biofuel imports	All	n.a.	n.a.
Total of costs assessed in this study			170-230	540-730

[1]Depending if an FSC or a GGL approach is used. PEFC would be more similar to GGL than to FSC.
[2]Reporting obligation of economic operators towards the Member States.
[3]Reporting obligation of the Member States toward the EC.

[6]: EC (2007): Review of economic and environmental data for the biofuels progress report; accompany-ing document to the biofuels progress report. Brussels, Commission of the European Communities.