Submission of information on forest management reference levels by the Netherlands

as requested by the Cancún decisions, i.e. „Consideration of further commitments for Annex I Parties under the Kyoto Protocol, Draft conclusions proposed by the Chair", contained in FCCC/KP/AWG/2010/L.8, and its Addendum: Draft decision [-/CMP.6], Land use, land-use change and forestry, contained in FCCC/KP/AWG/2010/L.8/Add.2

1. *Forest management reference level value*

Table 1. Value of proposed reference levels (Gg CO2eq).

Reference level*	
(A)	(B)
-1438	-1578

* The reported values are averages of the projected FM data series for the period 2013-2020, taking account of policies implemented before April 2009.

(A) with emissions/removals from HWP using the first order decay functions; (B) assuming instant oxidation (provided for transparency reasons only)

2. *General description*

Projections for the Netherlands are provided by the Joint Research Centre of the European Commission (JRC), based on elaboration of the results of independent EU modeling groups, coordinated by the International Institute for Applied Systems Analysis (IIASA), assisted by the JRC and funded by the European Commission Directorate General of Climate Action (DG CLIM).

When constructing the RL, all elements mentioned in footnote 1 of paragraph 4 of the decision -/CMP.6 on LULUCF were taken into account:

(a) Removals or emissions from forest management as shown in greenhouse gas inventories and relevant historical data: taken into account by adjusting results of the modeling exercise through an "ex-post processing of models results" (see section 5 "Description of construction of reference levels"). This ex-post processing also took into account the need for consistency with the inclusion of carbon pools.

(b) Age-class structure: models used the latest available country specific age-class structure data (see section 5 "Description of construction of reference levels").

(c) Forest management activities already undertaken: indirectly taken into account through the use of the latest available forest time series data (from national forest inventory or other country statistics), and the estimation of the evolution of harvest demand by 2020 based on macroeconomic drivers and the application of policies implemented in the Member States by April 2009 and legislative provisions adopted by April 2009 (see section 6, "Policies included")

(d) Projected forest management activities under a business as usual scenario: taken into account through the estimation of the evolution of harvest demand by 2020 based on macroeconomic drivers and the application of policies implemented in the Member States by April 2009 and legislative provisions adopted by April 2009 (see section 6 “Policies included”)

(e) Continuity with the treatment of forest management in the first commitment period; not relevant.

(f) The need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1. The projections included in this submission follow the general principles that govern the treatment of land use, land-use change and forestry activities.

3. Pools and gases

Table 2. C pools and GHG sources included in the reference level.

Change in C pool included in the reference level						GHG sources included in the reference level					
Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil		Fertilization	Drainage of soils	Liming	Biomass burning		
				mineral	organic	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
yes	yes	yes*	yes	no	no	no	no	no	no	no	no

* Litter is conservatively reported zero (a sink of uncertain magnitude).

Yes/No indicate if the pool or gas is included or not in the projections used to set the reference level. The information on the coverage of pools and gases is consistent with the national GHG inventory report under the UNFCCC (FL remaining FL).

For the Netherlands, it is assumed that the impact of land use in terms of loss of soil carbon is likely to be relatively small. Simulation show that large quantities of carbon accumulate in soil. We have assumed no changes in the carbon stocks due to land and soil management and cultivation practices over the period 1990–2008.
N2O emissions might occur as a result of using fertiliser in forests or from drainage. Both management practices are rarely applied in forestry in the Netherlands. Thus, it is assumed that N2O emissions are irrelevant in forests. CH4 emissions resulting from forest fires are considered to be negligible because fires seldom occur.

The carbon stock changes in soils, N2O emissions from fertilization and drainage of soils and emissions from biomass burning are not reported in the NIR2010 and are therefore excluded from the reference level.

Approaches, methods and models used

The models used to project emissions and removals from FM are G4M (from IIASA) and EFISCEN (from the European Forest Institute, EFI). Table 3 and figure 1 below provide the essential features of the main models involved and an overview of the modeling architecture.

The reference level builds on macro projections of GDP and population which are exogenous to the models used. They reflect the recent economic downturn, followed by sustained economic growth resuming after 2010. This data is entering GLOBIOM model that uses these projections to translate them into demand for timber (see main assumptions for the BASELINE scenario on pp.13-16 in Capros et al. (2010)[1] for more information). Bioenergy demand was projected by the PRIMES biomass model (see http://www.e3mlab.ntua.gr/e3mlab/PRIMES%20Manual/THE_NEW_PRIMES_BIOMASS_MODEL.pdf). The biomass system model is incorporated in the baseline scenario of the PRIMES large scale energy model for Europe (see http://www.e3mlab.ntua.gr/e3mlab/PRIMES%20Manual/The_PRIMES_MODEL_2008.pdf). It is an economic supply model that computes the optimal use of resources and investment in secondary and final transformation, so as to meet a given demand of final biomass energy products, driven by the rest of sectors as in PRIMES model. The primary supply of biomass and waste has been linked with resource origin, availability and concurrent use (land, forestry, municipal or industrial waste etc). The total primary production levels for each primary commodity are restricted by the technical potential of the appropriate primary resource.
Data on potential yields and GHG emissions and removals for diverse forest management alternatives are derived from the more detailed forestry models (G4M and EFISCEN). For baseline scenario (BAU), the economic land use models project domestic production and consumption, net exports and prices of wood products and changes in land use for EU member states and other world regions. The sector specific information from the economic models is used by the forest models to project GHG emissions and removals.

A more detailed description of modeling steps is provided in following sections. More detailed descriptions of each model are provided in the Annexes.

Table 3. Essential features of the main models involved in projection of FM emissions and removals.

G4M	The Global Forest Model (G4M) provides spatially explicit estimates of annual above- and belowground wood increment, development of above- and belowground forest biomass and costs of forestry options such as forest management, afforestation and deforestation by comparing the income of alternative land uses.
EFISCEN	The European Forest Information Scenario Model (EFISCEN) is a large-scale model that assesses the supply of wood and biomass from forests and projects forest resource development on regional to European scale, based on forest inventory data. EFISCEN provides projections on basic forest inventory data (stemwood volume, increment, age-structure), as well as carbon in forest biomass and soil.
GLOBIOM	GLOBIOM is a global static partial equilibrium model integrating the agricultural, livestock, bioenergy and forestry sectors with the aim to give policy advice on global issues concerning land use competition between the major land-based production sectors.

[1] P. Capros, L. Mantzos, N. Tasios, A. De Vita, N. Kouvaritakis (2010), EU energy trends to 2030 — UPDATE 2009, European Commission, Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG. Luxembourg: Publications Office of the European Union, 2010. ISBN 978-92-79-16191-9. Available online: http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2030_update_2009.pdf

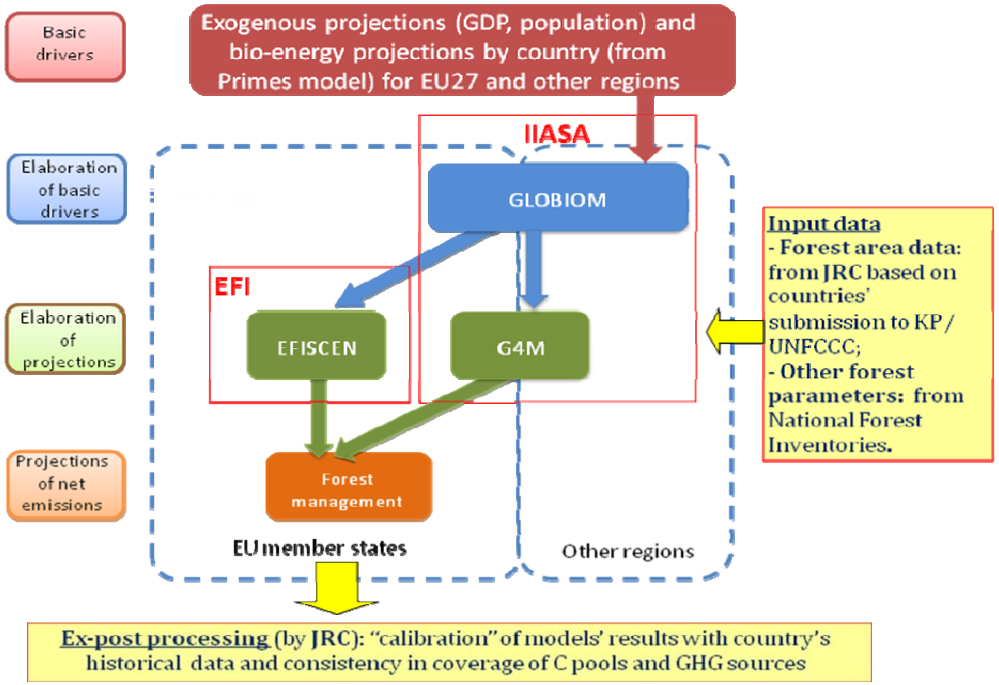


FIGURE 1: synthetic flowchart of information exchange between models.

The modelling approach essentially included the following steps:

1) *Selection of relevant input data*

- Forest area used by the models is taken from national forest inventories and scaled to match the area reported in GHG inventories (EFISCEN) or from recent literature (G4M), see Table 4.
- Main forest and forest management parameters (age structure, increment, historical harvest) are taken from national forest inventories and other country statistics (see Figure 2, and Tables 9 and 11). Other forest parameters and management characteristics taken from relevant sources (see Table 10).
- Future harvest demand under a business as usual (BAU) scenario (see Table 11) was derived from key macroeconomic drivers (GDP, population), based only on policies and measures enacted by Member States up to April 2009 (the EU 2020 renewable target and the 20% GHG reduction targets are not included in this baseline). In particular, the bio-energy demand was estimated by the Primes model and the timber demand was estimated by the Globiom model. See section 6 "Policies included" and the Annex for more information.

2) *Elaboration of input data*: the input data (area, age structure, increment, management characteristics, rotation lenght, future harvest demand,...) were elaborated by the two forest models (G4M and EFISCEN) to produce estimates of emissions and removals from FM till 2020 (for the above and below ground biomass carbon pools). The two models differ in the way they allocate harvest demand to thinnings and final fellings (including rotation lenghts) with implications on emissions and removals from the forest. In general, both models follow the rules of sustainable forest management, securing sustainable yields. Further they

follow different growth concepts (EFISCEN forest growth is based in inventory data, whereas G4M estimates growth from productivity maps, i.e. NPP maps) representing alternative approaches of forest growth estimation and projection. Given the unavoidable uncertainties which characterize any projections of emissions and removals from the forest sector, we think that taking the average of two different models makes the future trend illustrated below (see table 8) more robust. Elaborations also included a simulation of the impact of +/-20% harvest as compared as BAU harvest (see sensitivity analysis in table 8). See Annex I for more details on the models.

3) *Ex-post processing of models' results*: In order to ensure consistency between models' results and historical data reported by the country, the emissions and removals estimated by the models for the entire time series (up to 2020) were "calibrated" (i.e. adjusted) using historical data from the country for the period 2000-2008 (for which we had both data from the GHG inventories and data projected by the models). To this aim, an "offset" was calculated for two components:

- biomass: offest calculated as difference between [average of country's emissions and removals from biomass for the period 2000-2008 (table 5)] and [average of models' estimated emissions and removals from biomass for the period 2000-2008 (table 8)]

- non-biomass pools and GHG sources: offset calculated as the sum of non-biomass pools and GHG sources as reported by the country for the period 2000-2008 (table 5), and not estimated by models.

The calibrated average of models, which is used for the setting of reference level, is obtained by adding the total offest (biomass offset + non-biomass pools and GHG sources offset) to the models' average. In other words, models' results were adjusted to match the average historical data provided by each country for the period 2000-2008. This ensures consistency between country data and models' data in terms of: (i) absolute level of emissions and removals from biomass, i.e. the calibration „reconciles" differences in estimates which may be due to a large variety of factors, including different input data, different parameters, different estimation methods (e.g., some country uses a „stock-change approach", while the models use a „gain-loss approach"); (ii) coverage of non-biomass pools and GHG sources. The calibration procedure automatically incorporates into the projections the average rate (for the period 2000-2008) of the GHG impact of past disturbances, not estimated by the model (e.g. emissions from fires,....).

The future trend of emissions and removals up to 2020 as predicted by the model is not affected by this calibration procedure, but only by the current forest characteristcs (e.g., age structure,...) and the future harvest demand.

It is important to note that, to maintain consistency in the future, technical corrections (as referred in para 15 quarter and 15 quinquies of the document FCCC/KP/AWG/2010/CRP.4/Rev.4) will be needed in the following cases: (i) if recalculations of emissions and removals from FM (or forest land remaining forest land) for the period 2000-2008 will be carried out in any future submission of annual GHG inventories; (ii) if any future threshold selected for "force majeure" indicates that an event in the 2000-2008 period can be considered "force majeure", the impact of event (in terms of GHG) should be removed from historical FM emissions/removals (according to provisions of any future force majeure decision) , thus affecting the calibration procedure described above. For transparency reasons, the section "disturbances in the context of force majeure" reports the emissions from forest fires from 1990-2008 (expressed in Gg CO_2-eq. and as % of 1990 total GHG emissions excluding LULUCF).

4. ***Description of construction of reference levels***

I. Description of how each of the following elements were considered or treated in the construction of the forest management reference level, taking into account the principles in decision 16/CMP.1

(a) Area under forest management

Table 4. Area for FM as used by models (kha).

	2000	2005	2008	2010	2015	2020	Source of historical data (up to 2008)	Projected data (2010-2020)
G4M	344	335	331	329	325	322	(1)	(3)
EFISCEN		352	349	346	343	339	(2)	

(1) G4M model: Gallaun, H., G. Zanchi, G. J. Nabuurs, G. Hengeveld, M. Schardt and P. J. Verkerk (2010). "EU-wide maps of growing stock and above-ground biomass in forests based on remote sensing and field measurements." Forest Ecology and Management 260(3): 252-261 (Based on CORINE and TBFRA). G4M is a spatially explicit forestry model and relies on the information from forest maps for its initialisation. This map served as a basis that was adjusted to the degree possible to data reported by countries (see points 2 and 3 below)
(2) Estimated by the JRC from UNFCCC reporting as: area of "Forest land" in 1990 (assuming that "managed forest" under UNFCCC equals to land under FM)] - [area deforested since 1990 as included in KP reporting)]
(3) Data of 2008 minus the area of Deforestation projected by G4M.

Table 4a. Historical data for area for FM consistent with current Kyoto reporting (kha).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Source
Kyoto Forest since 1990	360	358	356	354	352	350	348	346	344	342	340	338	336	334	332	330	328	326	324	(1)
Kyoto Forest including changes to Kyoto Forest from trees outside forest (cfr. NIR 2010)	360	358	357	355	353	351	349	348	346	344	342	340	338	337	335	333	331	329	327	(2)

(1) Calculated from UNFCCC reporting as: [area of "Forest land – Forest according to the Kyoto definition" in 1990] - [area deforested since 1990 as included in KP reporting)] – this is the area that would be reported under FM

(2) NIR 2010 (the difference between (1) end (2) is the total area of trees outside forest converted to Kyoto Forest

The Netherlands applies amore strict definition for forests in the Kyoto Protocol than it does for Forest land. The main difference is the application of a minimum area (0,5 ha) and a minimum width (30 m) for forests according to the Kyoto definition, criteria which are not applied for Forest land. For transparency reasons, the Netherlands has chosen to distinguish in its reporting between areas and emissions from forests that comply to the Kyoto definition (Forests according to the Kyoto definition) and from wooded areas that are forest land but do not comply to the Kyoto definition (Trees outside forest), by installing two subcategories for Forest land. See also the Dutch NIR 2010 section 7.5.3. However, to limit the number of subcategories, units of land changing from one FL subcategory to another are reported in the final one (according to source (2) in Table 4a) in the NIR 2010. Based on our own data, it is possible to distinguish Forests according to the Kyoto definition that have been Forests according to the Kyoto definition since 1990, and these are given in Table 4a (source (1)). The difference between the two values represent the cumulative conversion of Trees outside forests to Forests according to the Kyoto definition.

(b) Emissions and removals from forest management

1) Historical emissions and removals from forest management

Table 5. Historical emissions and removals from FM (all pools and GHGs, Gg CO2eq)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	av. 2000-2008
Biomass (1)	-2009	-2386	-2143	-2366	-2382	-2252	-2446	-2181	-2270	-2211	-1977	-2029	-2106	-2103	-2044	-1970	-1920	-1734	-1781	-1963
Non-biomass pools	-308	-307	-307	-306	-307	-307	-307	-308	-308	-308	-312	-312	-312	-312	-312	-312	-312	-312	-311	-312
GHG sources (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	-2317	-2693	-2450	-2673	-2688	-2559	-2753	-2489	-2578	-2519	-2288	-2341	-2418	-2415	-2356	-2282	-2232	-2046	-2092	-2275

(1) Above and below-ground (2) as listed in table 2.

The data in table 5 are the same data as reported in the NIR 2010, the category “Forest land subcategory forest according to the Kyoto definition” remaining “Forest land, subcategory forest according to the Kyoto definition”. This subcategory corresponds with the Kyoto activity “forest management” (see explanation below).

2) The relationship between forest management and forest land remaining forest land as shown in GHG inventories and relevant historical data, including information provided under Article 3.3., and, if applicable, Article 3.4 forest management of the Kyoto Protocol and under forest land remaining forest land under the Convention

The Netherlands has chosen to define the land-use category "Forest Land" as all land with woody vegetation, now or expected in the near future (e.g., clear-cut areas to be replanted, young afforestations). This is further stratified in:

- "Forest" or "Forest according to the Kyoto definition" (FAD), - all forest land which complies to the following (more strict than IPCC) definition chosen by the Netherlands for the Kyoto protocol: forests are patches of land exceeding 0.5 ha with a minimum width of 30 m, with tree crown cover at least 20% and tree height at least 5 m, or, if this is not the case, these thresholds are likely to be achieved at the particular site. Roads in the forest less than 6 m wide are also considered to be forest. This definition conforms to the FAO reporting and was chosen within the ranges set by the Kyoto protocol.
- "Trees outside Forests" (TOF), that is - wooded areas that comply with the previous forest definition except for their surface (=< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields. These areas comply with the GPG-LULUCF definition of Forest Land (they have woody vegetation) but not to the strict forest definition that the Netherlands applies.

The removals from the total category forest land remaining forest land are included in table 6. The data are consistent with the NIR 2010. For trees outside forests, the subcategory not included in Table 5, only biomass pools are considered. Therefore the values for non-biomass pools in tables 5 and 6 are the same.

Table 6. Historical emissions and removals from FL remaining FL (Gg CO2eq), based on latest GHG inventory submitted to UNFCCC.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Biomass (1)	-2221	-2591	-2341	-2558	-2567	-2431	-2619	-2349	-2432	-2369	-2136	-2183	-2254	-2246	-2181	-2102	-2046	-1855
Non-biomass pools	-308	-307	-307	-306	-307	-307	-307	-308	-308	-308	-312	-312	-312	-312	-312	-312	-312	-312
GHG sources (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	-2529	-2898	-2648	-2864	-2874	-2739	-2927	-2658	-2741	-2677	-2448	-2495	-2566	-2558	-2493	-2414	-2359	-2167

(1) Above and below-ground (2) as listed in table 2.

Units of land subject to Article 3.3 afforestation and reforestation are reported jointly and are defined as units of land that did not comply with the forest definition on 1 January 1990 and do so at any time (that can be measured) before 31 December 2012. Land is classified as re/afforested as long as it complies with the forest definition. Units of land subject to Article 3.3 deforestation are defined as units of land that did comply to the forest definition at in time on or after 1 January 1990, and again ceased to comply to this forest definition at any moment in time (that can be measured) after 1 January 1990. Once land is classified as deforested, it remains in this category, even if it is reforested and thus complies with the forest definition again later in time.

Table 7. Emissions and removals (Gg CO2eq) from AR, D and FM (if elected), based on latest KP reporting.

A. Article 3.3 activities			B.1 Forest management
A.1 Aff/Reforestation		A.2. Deforestation	
A.1.1 Lands not harvested	A.1.2 Lands harvested		
-547	NA,NE,NO	780	NA

3) Modeled emissions and removals from forest management

Table 8. Emissions and removals from FM as estimated by models (above and below-ground biomass, Gg CO2eq), calibration of models' results, and sensitivity analysis.

			av. 2000-2008	2000	2005	2010	2015	2020	av. 2013-2020
Step 1: models' results (only biomass)	EFISCEN (1)		-1590	-1694	-1534	-1555	-1354	-1407	-1389
	G4M		-2187	-2542	-2118	-1578	-1115	-704	-996
	Average of models		-1888	-2118	-1826	-1566	-1235	-1056	-1192
Step 2: ex-post processing	Offset (2)	biomass	-74						
		non-biomass pools and GHG sources	-312						
		total offset	**-386**						
	Calibrated average of models (3)		-2275	-2192	-1900	-1641	-1309	-1130	**-1578**
Sensitivity analysis (4)		*+20% harvest*				*-1279*	*-1297*	*-1208*	*-1286*
		-20% harvest				*-2242*	*-1827*	*-1618*	*-1779*

(1) Efiscen does not estimate data for all countries for 2000 and 2005. Backward extrapolation was applied as follow: sink in 2005 = sink in 2010 x ratio of harvest 2010/2005; this approach assumes that in the short term harvest is the main factor determining the sink.

(2) The "offset" is distinguished between:
- biomass: calculated as difference between [average of country's emissions and removals from biomass for the period 2000-2008 (table 5)] and [average of models' estimated emissions and removals from biomass for the period 2000-2008 (table 8)]
- non-biomass pools and GHG sources: calculated as the sum of non-biomass pools and GHG sources as reported by the country for the period 2000-2008 (table 5).

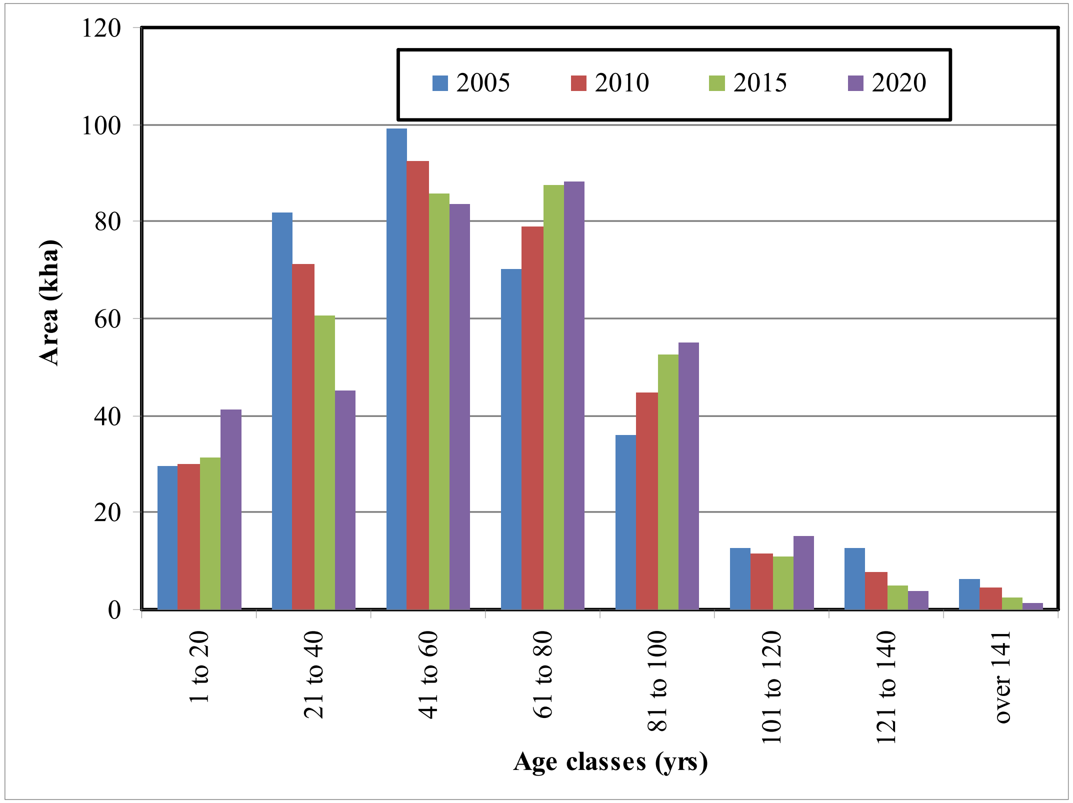
(3) The calibrated average of models, used for the setting of reference level (see grey cell), is obtained by adding the offset to the average of models. See "ex-post processing of model's results" for details.

(4) Simulation of the impact of +/-20% harvest as compared as BAU harvest on the emissions and removals from FM. Data are calibrated averages of models' results.

(c) Forest characteristics and related management

1) age class structure

Figure 2. Evolution of the forest age class structure (in yrs) as modelled by EFISCEN.



2) Increment

Table 9. Increments as estimated by models (m^3 ha^{-1} yr^{-1})

	2000	2005	2010	2015	2020
G4M	8,7	8,9	7,9	6,8	5,7
EFISCEN			8,1	8,0	7,9

Table 9 gives the increment data as estimated by the models. The Dutch national forest inventories that were used to calculate carbon stock changes in forests result in an average increment of 7,6 m^3 ha^{-1} yr^{-1} (1988-1992) and 8,4 m^3 ha^{-1} yr^{-1} (2001-2005). The average increment over age classes for a number of common tree species in The Netherlands in the last inventory (2001-2005) is provided in Table 9a.

Table 9a. Average increment over age class for a number of important tree species over (m^3 ha^{-1} yr^{-1})

Main_tree_species	0 to 20	21 to 40	41 to 60	61 to 80	81 to 100	101 tot 120	121 tot 140	over 140
Alnus rubra	8.1	10.4	9.3	6.9				
Betula spp	4.8	7.3	7.2	6.6	5.2	6.6		
Fagus sylvatica	10.2	15.5	14.1	11.2	9.0	8.0	7.0	6.8
Fraxinus excelsior		14.2	9.6	8.7	7.8			
Larix kaempferi	17.7	14.9	10.9	8.5	7.6			
Picea abies	24.7	18.6	12.2	8.4	6.0			
Pinus nigra		15.2	10.3	7.1	7.5	6.7		
Pinus sylvestris	18.4	10.8	8.2	6.1	4.9	4.7	4.8	4.0
Populus other		14.5	15.7					
Pseudotsuga menziessii	7.8	17.2	16.4	9.8	8.0	7.4		7.2
Quercus robur	4.1	10.6	8.8	7.2	6.1	5.6	5.1	4.9
Quercus rubra	8.3	13.8	11.1	8.8	6.2	5.7	6.3	

3) rotation length

See information in table 8.

4) information on forest management activities under "business as usual"

See information in table 8.

5) other relevant information

Table 10. Source of the main forest parameters and characteristics as used by the models.

Model/country	**Forest parameters and characteristics** **Area (ha)** by species group and age class	**Growing stock (m^3)** by species group and age class	**Increment (m^3 ha^{-1} y^{-1})** by species group and age class	**BEF**, root/shoot ratio, **wood density** by species and age-class BEF and R/S ratio (dimensionless)	Wood density (t dry matter/ m^3 fresh volume)	**Management regime** (rotations, thinning…) by species (years, …)
EFISCEN	We used data collected by (10) based on data provided by national correspondents during the European Forest Sector Outlook Study in 2001		Increment functions are generally based on national forest inventory data. In case increment data was not available, yield tables have been used.	Species-specific and age-dependent BEFs have been developed for selected number of countries for EFISCEN by Vilén et al. 2005 (2) and national reports (12) and are applied to neighbouring countries	Basic wood densities are based on IPCC defaults (1)	Management regimes have been derived from a country-wise compilation of guidelines, handbooks and personal communication (3).
G4M	Input data for all countries: for area GLC 2000 (15) and for forest area (16, scaled to JRC data to the degree possible); for the increment NPP (17, scaled to MCPFE 2005); BEF and root/shoot ratio are assumed to be constant; carbon in biomass, soil, litter and dead trees are from Kindermann et al., based on FAO and GLC 2000 (18); the age structure is desumed from NFI.					
GLOBIOM	Same input data of G4M					Input data from G4M
The Netherlands	13, 14, 16, 17, 18			Spruce, Fir, Douglas Fir: 4 Pine, Larch: 5 (stem, branches and foliage); 19 (roots) Beech, Oak, Hardwood: 6 (<30 cm) and 7 (>30 cm) (stem, branches and foliage); 11 (roots) Birch, Softwood: 8 (stem, branches and foliage); 9 (roots)	1 (IPCC default values)	Expert assessment (no reference); rotation ages based on German data
references	**1**					

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	3	Nabuurs, G., Pussinen, A., van Brusselen, J., Schelhaas, M., 2007. Future harvesting pressure on European forests. European Journal of Forest Research 126, 391-400.
	4	Wirth, C., Schumacher, J. and Schulze, E.-D. 2004. Generic biomass functions for Norway sprucein Central Europe - a meta-analysis approach toward prediction and uncertainty estimation. Tree Physiology 24: 121-139
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(d) Harvesting rates

1) Historical harvesting rates

Table 11. Historical harvest rates (roundwood overbark 1000 m3)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1613	1276	1423	1221	1185	1254	1081	1260	1162	1186	1180	983	953	1186	1165	1261	1257	1161	1161

Harvested wood was calculated based on FAO values, applying a correction from underbark to overbark of 6% on average. Harvested wood includes both loss from deforestation and harvesting in forests. It is assumed that harvesting occurs only in Kyoto forests, not in trees outside forests. For the NIR 2010, the value for 2008 was copied from 2007.

2) Assumed future harvesting rates

Table 11a. Historical harvest rate and projected BAU harvest demand used by models (roundwood overbark 1000 m3)

2000	2005	2010	2015	2020	ratio (av. 2013-2020)/2005	Source of historical data (till 2007)
1090	1204	1188	1171	1155	0,97	FAO June 2010

Notes: values in the table express 5-yrs average (e.g. 2000 is the average 1998-2002, 2005 is the average 2003-2007). Till 2007, data are from national statistics or other country data. Data for 2020 were estimated by the models Primes (wood for bioenergy) and Globiom (timber). Data between 2008 and 2020 are interpolated. The harvest rate used by each model may slightly deviate from harvest demand (e.g. if the model did not "find" all the wood in the forests).

A general assumption has been done that all the harvest predicted till 2020 is allocated to FM, i.e. it was assumed that the harvest till 2020 on areas afforested/reforested or deforested after 1990 is negligible as compared to the harvest of forest areas which qualify as FM.

(e) Harvested wood products

The contribution of HWP to the reference level of the Netherlands amounts to 0,140 Mt CO2.

It was calculated using the C-HWP-Model, which estimates delayed emissions on the basis of the annual stock change of semi-finished wood products as outlined in the 2006 GL (Rüter, 2011). The estimation uses the product categories, half lives and methodologies as suggested in para 27, page 31 of FCCC/KP/AWG/2010/CRP.4/Rev.4.

The activity data (production and trade of sawnwood, wood based panels and paper and paperboard) is derived from the TIMBER database (UNECE 2011) (time series 1964-2009).

In order to achieve accurate results, the HWP numbers have been calculated applying the sub-categories of sawnwood, wood based panels and paper and paperboard as specified in Table 12. Sawnwood includes the Items 1632 and 1633, wood based panels comprising of Items 1634, 1640, 1646, 1647, 1648, 1649 and 1650, and paper and paperboard corresponds to Item 1876.

Following conversion factors have been used:

Table 12: Conversion factors of considered commodities*

Classification		Description of commodity	Air dry density	C conv. factor	Source
FAO	UNECE		[g/cm³]	[Gg C/1000m³]	
1866	1.2.C	Industrial roundwood, coniferous	0,450	2,250E-01	Kollmann (1982), (oak, beech)
1867	1.2.NC	Industrial roundwod, non-coniferous	0,670	3,350E-01	Kollmann (1982), (oak, beech)
1632	5.C	Sawnwood, coniferous	0,450	2,250E-01	Kollmann (1982), (oak, beech)
1633	5.NC	Sawnwood, non-coniferous	0,670	3,350E-01	Kollmann (1982), (oak, beech)
1634	6.1	Veneer sheets	0,590	2,950E-01	IPCC (2003)
1640	6.2	Plywood	0,480	2,402E-01	IPCC (2003)
1646	6.3	Particle board	0,630	2,898E-01	Hasch (2002), Barbu (2011)
1647	6.4.1	Hardboard	0,850	4,165E-01	Kollmann (1982), Barbu (2011)
1648	6.4.2	Medium density fibreboard	0,725	3,190E-01	Hasch (2002), Barbu (2011)
1649	6.4.x	Fibreboard, compressed	0,788	3,504E-01	(50 % hardboard / 50 % medium density fibreboard)
1650	6.4.3	Other board (Insulating board)	0,270	1,148E-01	Kollmann (1982), Barbu (2011)
1876	10	Paper and paperboard	0,900**	4,500E-01**	IPCC (2006)

* Items 1866 and 1867 are needed for methodological reasons only (see following section), ** in [g/g] and [Gg C/1000t]

In order to only estimate emissions from HWP removed from forests which are accounted for by the Netherlands under Article 3, in a first step, the annual share of carbon in HWP coming from domestic forests has been calculated.
Following equations were used as industrial roundwood is assumed to serve as raw material for the production of HWP.

(1) $$ratio_{INDRW\ consumption\ from\ dom\ harvest} = \frac{(Production_{INDRW} - Export_{INDRW})}{(Production_{INDRW} + Import_{INDRW} - Export_{INDRW})}$$

(2) $$Production_{HWP\ from\ dom\ harvest} = Production_{HWP} \cdot ratio_{INDRW\ consumption\ from\ domestic\ harvest}$$

The ratio (Equation 1) was calculated both for coniferous and non-coniferous industrial roundwood (*INDRW*, Items 1866 and 1867). For coniferous sawnwood and paper and paperboard, the ratio for coniferous industrial roundwood was applied. For non-coniferous sawnwood the ratio for non-coniferous industrial roundwood was applied. For the other HWP, the ratio of the annual mass weighted average of coniferous and non-coniferous industrial roundwood was applied.

As a result, this share of HWP produced from domestically harvested timber is presented as a percentage in Table 13.

The presented approach follows the initial assumption that all forests in the Netherlands are managed, and in order to simplify matters, it is presumed that all harvest is allocated to forest management. This assumption is to be verified and corrected where necessary. The final allocation of carbon in HWP to forests which are accounted for under Article 3 shall be part of a technical correction as suggested in para 15 quater, page 27 of FCCC/KP/AWG/2010/CRP.4/Rev.4.

Table 13: Historic time series of amounts and share of accountable carbon Inflow to the HWP pool [in 1000t C and %]

1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
179	386	376	381	410	388	387	418	591	353	285	327	434	404	462	380	334
46,9%	49,8%	47,3%	48,6%	47,1%	43,5%	44,0%	49,9%	69,3%	38,8%	30,5%	45,7%	50,1%	46,3%	50,9%	42,6%	37,0%

1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
405	532	595	540	556	610	578	793	804	888	764	728	711	788	882	941	1061
48,3%	63,6%	66,1%	56,2%	54,6%	56,2%	52,1%	63,2%	61,0%	63,3%	53,1%	51,3%	50,1%	52,9%	59,8%	63,9%	68,9%

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
920	1111	1239	672	650	658	726	891	510	18	517	555
59,6%	70,2%	76,5%	44,6%	41,1%	41,7%	44,5%	54,4%	32,2%	1,2%	36,7%	45,0%

The annual carbon Inflow (= carbon in produced HWP) to the HWP pool prior to the year 1964 (first year for which activity data from TIMBER database (UNECE 2011) is available for the Netherlands) has been calculated from the 5 years average from 1964 to 1968 and was assumed to be the constant carbon pool Inflow for the time period 1900-1963.

In order to provide a projection for the development of the HWP pool consistent with the assumptions on the future harvest, the rates of change of the Projected harvest (Model GLOBIOM) as compared to the last 5 years average of historic harvest, for which up-to-date data is available, was calculated (cf Table 14).

These projected growth rates as cp. to the average of the years 2003-2007 for the Netherlands were applied to the same 5 years average of historic carbon Inflow to the HWP pool in order to receive the future Inflow to the HWP pool.

Table 14: Projection of carbon Inflow to the HWP pool

Average of historic harvest (2003-2007) [in 1000m3]	1.204										
Average HWP pool Inflow* (2003-2007) [in 1000t C]	561										
years	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Projected harvest rate [in 1000m3]	1187,98	1184,68	1181,38	1178,07	1174,77	1171,47	1168	1165	1162	1158	1154,95
Change as cp to historic harvest (2003-2007) [in %]	-1,37%	-1,65%	-1,92%	-2,19%	-2,47%	-2,74%	-3,02%	-3,29%	-3,56%	-3,84%	-4,11%
Projected carbon Inflow to HWP pool [in 1000t C]	552,829	551,292	549,755	548,218	546,681	545,144	543,607	542,07	540,533	538,996	537,459

*a similar approach was chosen by Kangas and Baudin (2003): ECE/TIM/DP/30

For calculating the pool of HWP in use, three half-lifes for application in the first order decay function have been used as suggested by para 7, page 31 of FCCC/KP/AWG/2010/CRP.4/Rev.4.

- Sawnwood: 35 years
- Wood based panels: 25 years
- Paper and paperboard: 2 years

The projected net-emissions are calculated from the annual stock change estimates following the calculation method provided in IPCC 2006, Vol.4, Ch. 12 (Equation 12.1).

Table 15: Historic (up to 2009) and projected net-emissions from HWP pool [in 1000t CO2]

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
-682	-103	37	85	-172	-416	-482	-712	-63	-622	-829	1197	964	709	348	-213	1080

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2348	167	89	82	105	121	131	137	141	142	143	142	141	140

(f) Disturbances in the context of force majeure

The calibration procedure described above automatically incorporates the average rate of past disturbances (for the period 2000-2008) into the projections. See further comments in section „Ex-post processing of models' results" on the need of future consistency. For transparency reasons, the tables below report the emissions from forest fires from 1990-2008 (expressed in Gg CO2-eq. and as % of 1990 total GHG emissions excluding LULUCF).

Table 16. Emissions from forest fires (Gg CO2eq and % of 1990 total GHG without LULUCF)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	av. 2000-2008
GgCO2eq (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% 1990 GHG	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

(1) Data are taken from the last available CRF tables, rows "wildfires" of Tables LULUCF 5(V) (Biomass burning). Some countries reported CH4 and N2O in this table but did not explicitly included CO2 emissions (i.e. CO2 is implicitly included in tab 5A); in these cases, the JRC indirectly derived CO2 emissions from CH4 and N2O reported emissions, using default factors from IPCC Good Practice Guidance for LULUCF (IPCC GPG 2003, table 3A.1.16)

(g) Factoring out in accordance with paragraph 1(h) (i) and 1(h) (ii) of decision 16/CMP.1

Factoring out was not applied. The Netherlands have used the managed land proxy for estimating national anthropogenic emissions and removals.

II. Description of any other relevant elements considered or treated in the construction of the forest management reference level, including any additional information related to footnote 1 in paragraph 4 of decision [-/CMP.6]

5. Policies included

I. Pre-2010 domestic policies included

Policy assumptions are made in the baseline scenario of the PRIMES model which underpins the projections for the construction of the Reference Level. For the purpose of this submission, policies and measures included are those implemented by April 2009 and legislative provisions adopted by April 2009 that are defined in such a way that there is almost no uncertainty how they should be implemented in the future. An inventory of legal measures and EU financial support included in the PRIMES model is reproduced from Capros et al. (2010) in Annex II to this submission. However more details are provided on pp.17-21 ("BASELINE") of the publication *EU energy trends to 2030 - UPDATE 2009*.[2]

II. Confirmation of factoring out policies after 2009

No post mid - 2009 policies are included in establishing the reference level.

[2] P. Capros, L. Mantzos, N. Tasios, A. De Vita, N. Kouvaritakis (2010), EU energy trends to 2030 — UPDATE 2009, European Commission, Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG. Luxembourg: Publications Office of the European Union, 2010. ISBN 978-92-79-16191-9. Available online: http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2030_update_2009.pdf

ANNEX I – Description of models

GLOBIOM

GLOBIOM is a global static partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with the aim to give policy advice on global issues concerning land use competition between the major land-based production sectors. Concept and structure of GLOBIOM are similar to the US Agricultural Sector and Mitigation of Greenhouse Gas (ASMGHG) model (Schneider, McCarl and Schmid 2007). The global agricultural and forest market equilibrium is computed by choosing land use and processing activities to maximize the sum of producer and consumer surplus subject to resource, technological, and political restrictions, as described by McCarl and Spreen (1980). Prices and international trade flows are endogenously computed for 28 world regions.
The market is represented through implicit product supply functions based on detailed, geographically explicit, Leontief production functions, explicit resource supply functions (land and water), and product demand functions.

Land and its characteristics are the key elements of our modeling approach. In order to enable global bio-physical process modeling of agricultural and forest production, a comprehensive database has been built (Skalsky et al., 2008), which contains geo-spatial data on soil, climate/weather, topography, land cover/use, and crop management (e.g. fertilization, irrigation). The data are available from various research institutes (NASA, JRC, FAO, USDA, IFRPI, etc.) and significantly vary with respect to spatial, temporal, and attribute resolutions, thematic relevance, accuracy, and reliability. Therefore, data were harmonized into several common spatial resolution layers including 5 and 30 arcmin as well as country layers. Consequently, Homogeneous Response Units (HRU) have been delineated by including only those parameters of landscape, which are almost constant over time. At the global scale, we have included five altitude classes, seven slope classes, and six soil classes. In a second step, the HRU layer is merged with other relevant information such as global climate map, land category/use map, irrigation map, etc. to delineate Simulation Units, which are actually input into the Environmental Policy Integrated Climate model (EPIC, Williams 1995, Izaurralde et al. 2006). This HRU concept assures consistent aggregation of geo-spatially explicit bio-physical impacts that are simulated with EPIC (e.g. crop yields, nitrogen leaching, soil carbon sequestration).

Currently, two major land cover types are represented in the model: cropland and forest. Crop production accounts for about 20 globally most important crops. The data are taken from FAOSTAT, where national averages over the years 2001-2005 are used to define base levels for yields, harvested areas, prices, production, consumption, trade, and supply utilization. Irrigated crop yields, crop specific irrigation water requirements, and costs for five irrigation systems are derived from a variety of sources as described in Sauer et al. (2008). For selected crops (corn, sugarcane and wheat), management and land quality specific yields have been estimated with EPIC. Four management systems are currently represented which correspond to the IFRPI crop distribution data classification (irrigated, high input - rainfed, low input - rainfed and subsistence management systems). The number of crops, systems, and parameters (especially environmental parameters like soil carbon, erosion, and nutrient leakage) estimated with EPIC is being expanded.
Crop supply can enter one of three processing/demand channels: consumption, livestock production or biofuel production. Consumption is modeled by constant elasticity demand functions parameterized using FAOSTAT data. Only a preliminary regional livestock production representation is applied in the present version of the model where a bundle of livestock products is assimilated to a generic commodity - "animal calories". Feed requirements have been calculated from the Supply Utilisation Accounts, FAOSTAT. Demand for livestock products is represented through upward sloping demand curves. Biofuel options from crops include first generation technologies for a) ethanol from sugarcane or corn, and b) biodiesel from soya or rapeseed. The processing data are based on Hermann and Patel (2007) for ethanol and Haas et al. (2006) for biodiesel. Market demand for ethanol and biodiesel is represented through vertical demand functions.
Primary forest production is characterized also on the basis of HRUs and the resulting Simulation Units. The most important parameters for the model are mean annual increment, maximum share of sawlogs in the mean annual increment, and harvesting cost. These parameters are shared with the G4M Model – a successor of the model described by Kindermann et al (2006). More specifically, mean annual increment for the management, is obtained by downscaling the biomass stock data from the Global Forest Resources Assessment (FAO, 2005) from the country level to the grid using the method described in Kindermann et al. (2008). This downscaled biomass stock data is subsequently used to parameterize the increment curves Kindermann (2008). Finally, sawnwood share is estimated by the tree size which in turn depends on yield and rotation time. Harvesting costs is adjusted for slope and tree size as well.
Five primary forest products are defined: sawlogs, pulplogs, other industrial logs, firewood, and energy biomass. Sawlogs, pulplogs and energy biomass are further processed. Sawnwood and woodpulp production, and demand parameters rely on the 4DSM model described in Rametsteiner et al. (2007). FAO data and other secondary sources have been used for quantities

and prices of sawnwood and woodpulp. For production cost estimates of these products, for example, mill costs, an internal IIASA database and purchased data were used. The energy biomass can be converted into methanol and heat or electricity and heat, where processing costs and conversion coefficients are obtained from Leduc et al. (2008), Hamelinck and Faaij (2001), Sørensen (2005), and Biomass Technology Group (2005). Demand for woody bioenergy production is implemented through minimum quantity restrictions, similarly as demand for other industrial logs and for firewood.

The final model calibration, supposed to correct data imperfections and get the baseline solution close to the observed values, is done by adjusting the cost parameters of selected activities so that for the baseline activity levels, their marginal cost equals to their marginal revenue, as assumed by the microeconomic theory. The controlled activities are crop areas, primary forest products supply and animal calories supply.

Input

- Baseline prices and quantities of considered products
- Supply and demand elasticities
- Ressource requirements (land, water,…)
- Production cost
- Transformation cost
- Transport cost
- Conversion coefficients from primary to final products
- Initial land use

Output

- supply and demand quantities
- equilibrium prices
- volumes traded between the regions
- land use change
- water consumption

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EFISCEN

The European Forest Information Scenario (EFISCEN) model (Sallnäs 1990; Schelhaas et al. 2007) is a large-scale model that assesses the supply of wood and biomass from forests and projects forest resource development on regional to European scale (Eggers et al. 2008; Ťupek et al. 2010).. The core of the model was developed in the late 1980s, as a forest resource projection model for Sweden.
EFISCEN uses forest inventory data as an input, including:
• area (ha);
• average standing volume of growing stock (m3/ha);
• net annual increment (m3/ha/y).
Based on this data, the state of the forest is described as an area distribution over age- and volume-classes in matrices. During simulations, forest area moves between matrix cells, describing different natural processes (e.g. growth and mortality) and human actions (e.g. forest management). Growth dynamics are simulated by shifting area proportions between matrix cells. In each 5-year time step, the area in each matrix cell moves up one age-class to simulate ageing. Part of the area of a cell also moves to a higher volume-class, thereby simulating volume increment. Growth dynamics are estimated by the model's growth functions whose coefficients are based on inventory data.

Management scenarios are specified at two levels in the model. First, a basic management regime defines the period during which thinnings can take place and a minimum age for final fellings. These regimes can be regarded as constraints on the total harvest level. Thinnings are implemented by moving area to a lower volume class and final fellings by moving area outside the matrix to a bare-forest-land class, from where it can re-enter the matrix. The applied management regimes are based on a country level compilation of management guidelines (Nabuurs et al. 2007). Second, the demand for wood is specified for thinnings and for final felling separately and EFISCEN may fell the demanded wood volume if available. If wood demand is high, management is intensive and rotation lengths are close to the lower limit defined in the management regimes. If wood demand is low, rotation lengths are longer, because less fellings are needed to fulfill the demand.

EFISCEN projects (i) stemwood volume, (ii) increment, (iii) age-classes and (iv) wood removals for five year time-steps. To assess biomass carbon stocks, stemwood volume is converted into carbon in stems, branches, foliage, coarse and fine roots, using basic wood densities, a generic carbon content, and age-dependent biomass distribution factors. Felling residues and litter production of trees, due to turnover and natural mortality, are used as input data for the dynamic soil model YASSO (Liski et al., 2005) and incorporated as independent module.

The soil model **YASSO** is used to estimate changes in the soil C pool by EFISCEN model. YASSO consists of three litter compartments and five decomposition compartments. For the soil carbon module, the litter is grouped as non-woody litter (foliage and fine roots), fine woody litter (branches and coarse roots) and coarse woody litter (stems and stumps). Each of the litter compartments has a fractionation rate determining the proportion of its contents released to the decomposition compartments in a time step. For the compartment of non-woody litter, this rate is equal to 1 which means that all of its contents is released in one time step, whereas for the woody litter compartments this rate is smaller than 1. Litter is distributed over the decomposition compartments of extractives, celluloses and lignin-like compounds according to its chemical composition. Each decomposition compartment has a specific decomposition rate, determining the proportional loss of its contents in a time step. Fractions of the losses from the decomposition compartments are transferred into the subsequent decomposition compartments having slower decomposition rates while the rest is removed from the system. The fractionation rates of woody litter and the decomposition rates are controlled by temperature and water availability and are based on litterbag data across Europe (Liski et al., 2003).

The model is especially suited for simulating managed, even-aged forests at large scales. The model has been validated for Finland (Nabuurs et al. 2001) and Switzerland (Thürig and Schelhaas 2006) by running EFISCEN on historic data. Other validations have been performed by by comparing its growth functions against growth functions of other models and by comparing projections against projections of other models (e.g. Ťupek et al. 2010).

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GLOBAL FORESTRY MODEL -G4M

General description

The Global Forest Model (G4M) is applied and developed by IIASA and estimates the annual above ground wood increment and harvesting costs. By comparing the income of managed forest (difference of wood price and harvesting costs, income by storing carbon in forests) with income by alternative land use on the same place, the decision of afforestation or deforestation is made. As G4M is spatially explicit (currently on a 30"x30" resolution) the different deforestation pressure at the forest frontier can also be handled. The model can use external information (like wood prices, prescribed land-use change) from other models or data bases, which guarantee food security and land for urban development or account for disturbances. As outputs, G4M produces estimates of land-use change, carbon sequestration/emissions in forests, impacts of carbon incentives (e.g., avoided deforestation), and supply of biomass for bio-energy and timber.

The model handles age classes with one year width. Afforestation and disasters cause an uneven age-class distribution over a forest landscape. The model performs final cuts in a manner, that all age classes have the same area after one rotation period. During this age class harmonization time the standing biomass, increment and amount of harvest is fluctuating due to changes in age-class distribution and afterwards stabilizing.

The main forest management options considered by G4M are variation of thinning and choice of rotation length. G4M does not model species explicitly but a change of species can be emulated by adapting NPP, wood price and harvesting costs. The rotation length can be individually chosen but the model can estimate optimal rotation lengths to maximize increment, maximize stocking biomass or maximize harvestable biomass.

Adjustments and harmonisation

An EU-wide forest/ non-forest map was generated, consistent with the Temperate and Boreal Forest Resource Assessment –TBFRA 2000 (UNECE-FAO, 2000) at the national level. For areas where CORINE land cover data are available, the CORINE dataset was aggregated from the original 100 meters to 500 meters spatial resolution. Firstly, the number of forest pixels within each 5 by 5 pixel aggregation unit was calculated. Secondly, a threshold with the minimum number of forested pixels within the aggregation units was determined for each country. This threshold was selected accordingly, to generate a forest map in agreement with the total forest area given by TBFRA 2000 at the national level. For areas not covered by CORINE data, a similar approach was applied with Vegetation Continuous Fields (VCF) data (Hansen et al. 2003). The area covered with woody vegetation in the VCF data is given in percent. A percentage threshold of the minimum area covered by woody vegetation was defined for each country to match total forest area from TBFRA 2000. Based on FAO data the map distinguishes between managed and unmanaged forest. Criteria of wilderness and remoteness where used to locate the unmanaged forest areas on the map. The initial growing stock per grid cell was taken from the European forest biomass map from Gallaun et al. (in press). For countries outside Europe the forest biomass map compiled by Kindermann et al. (2008) was used.

Increment is determined by a potential NPP map (Cramer et al. 1999) and translated into mean annual increment (MAI). At present this increment map is static but can be changed to a dynamic growth model which reacts to changes of temperature, precipitation or CO2 concentration. For the purpose of this study the increment map was scaled at country level to match either MCPFE or reported country data. Age structure and stocking degree are used as additional information for adjusting MAI. If stocking degree of forest modelled with a given age structure (country average) in a cell is greater than 1.05 age structure of the modelled forest is shifted iteratively by a few age classes towards older forest. If stocking degree of forest modelled in a cell is smaller than 0.5 age structure of the modelled forest is shifted iteratively by a few age classes towards younger forest. It is required that the shifts are symmetrical to keep country average age structure close to statistical value. If the age structure shift distribution within a country is skewed towards older forest, the country's average MAI is increased iteratively. If the age structure shift distribution within a country is skewed towards younger forest country MAI is decreased iteratively.

The model uses external projections of wood demand per country to calculate total harvest iteratively. The potential harvest amount per country under a scenario of rotation lengths that maintain current biomass stocks is estimated. If total harvest is smaller than wood demand the model changes grid per grid (starting from the most productive forest) management to a rotation length that optimizes forest increment and thus allows for more harvest. This mimics the typical observation that managed forests in Europe are currently not managed optimally with respect to yield. The rotation length is changed at maximum by 5 years per time step. If harvest still too small and unmanaged forest is available the status of the unmanaged forest will change to managed. If total harvest greater than demand the model changes management to maximum biomass rotation length, i.e. manages forests for carbon sequestration. If wood demand is still lower than potential harvest managed forest can be transferred into unmanaged forest. Thinning is applied to all managed forests. The stands are thinned to maintain a stocking degree specified (between 0.5 and 1.05), i.e. thinning mimics natural mortality along the self-thinning line. The model can consider the use of harvest residues e.g. for bioenergy purposes.

Despite the harmonization efforts to reproduce observed data on increment, area and harvest, the forest carbon balance as described in the model might still deviate from the observed forest carbon sink or source. This might be due to differences in forest management or forest disturbances. The model cannot account for such effects. To compensate for processes affecting the carbon balance that cannot be modelled, an adjustment algorithm has been introduced. Rotation length of unmanaged forest is set to the value that yields constant biomass (equal to observed biomass in 2000). If modelled carbon sink/source from forest management (averaged over 1990-1995) is smaller/larger than reported by a country, the rotation length of unmanaged forest is changed to maximizing biomass. The procedure is applied cell by cell within the country's unmanaged forest until the reported stock change is matched.

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<u>The PRIMES Energy Systems Model</u>

General Description

A summary description of the energy systems model for is provided on http://www.e3mlab.ntua.gr/e3mlab/PRIMES%20Manual/The_PRIMES_MODEL_2008.pdf and of the biomass system model, which is incorporated in the large scale model, on http://www.e3mlab.ntua.gr/e3mlab/PRIMES%20Manual/The_PRIMES_MODEL_2008.pdf.

ANNEX II – Description policies and measures included in the Reference Level

This table has been extracted from pp.17-19 in P. Capros, L. Mantzos, N. Tasios, A. De Vita, N. Kouvaritakis (2010), EU energy trends to 2030 — UPDATE 2009, European Commission, Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG. Luxembourg: Publications Office of the European Union, 2010. ISBN 978-92-79-16191-9. Available online: http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2030_update_2009.pdf.

TABLE: INVENTORY OF LEGAL MEASURES AND COMMUNITY FINANCIAL SUPPORT INCLUDED IN PRIMES

Measure	**How the measure is reflected in PRIMES**
Regulatory measures	
Energy efficiency	
Eco-design implementing measures	
Eco-design Framework Directive 2005/32/EC	Adaptation of modelling parameters for different product groups. As requirements concern only new products, the effect will be gradual (marginal in 2010; rather small in 2015 and up to full effect by 2030). The potential envisaged in the Eco-design supporting studies and the relationship between cost and efficiency improvements in the model's database were cross-checked.
Stand-by regulation 2008/1275/EC	
Simple Set-to boxes regulation 2009/107/EC	
Office/street lighting regulation 2009/245/EC	
Household lighting regulation 2009/244/EC	
External power supplies regulation 2009/278/EC	
Other energy efficiency	
Labelling Directive 2003/66/EC	Enhancing the price mechanism mirrored in the model
Cogeneration Directive 2004/8/EC	National measures supporting cogeneration are reflected
Directive 2006/32/EC on end-use energy efficiency and energy services	National implementation measures are reflected
Buildings Directive 2002/91/EC	National measures e.g. on strengthening of building codes and integration of RES are reflected
Energy Star Program (voluntary labelling program)	Enhancing the price mechanism mirrored in the model
Energy markets and power generation	
Completion of the internal energy market (including provisions of the 3rd package)	The model reflects the full implementation of the Second Internal market Package by 2010 and Third Internal Market Package by 2015. It simulates liberalised market regime for electricity and gas (decrease of mark-ups of power generation operators; third party access; regulated tariffs for infrastructure use; producers and suppliers are considered as separate companies) with optimal use of interconnectors
EU ETS directive 2003/87/EC as amended by Directive 2008/101/EC and Directive 2009/29/EC	The ETS carbon price is modelled so that the cumulative cap set for GHGs covered by the ETS is respected[3]. The permissible total CDM amount over 2008-2020 is conservatively estimated at 1600 Mt. Banking of allowances is reflected. The model endogenously calculates carbon prices clearing the ETS market that allow to match cumulative emissions over the period 2008-

[3] For the allocation regime for allowances in 2010, the current system based on National Allocation Plans and essentially cost-free allowances is assumed, with price effects stemming from different investment and dispatch patterns triggered by need to submit allowances. For the further time periods, in the power sector there will be a gradual introduction of full auctioning, which will be fully applicable from 2020 onwards, in line with the specifications of the amended ETS directive. For the other sectors (aviation and industry), the baseline follows a conservative approach which reflects the specifications in the directive on the evolution of auctioning shares and the provisions for free allocation for energy intensive sectors based on benchmarking.

	2030 with cumulative allowances assuming the maximum permissible use of CDMs. Resulting carbon prices in the baseline 2009 are: 25 €’08/t CO2eq in 2020 and 39 €'08/t CO2eqin 2030.
Energy Taxation Directive 2003/96/EC	Tax rates (EU minimal rates or higher national ones) are kept constant in real term. The modelling reflects the practice of MS to increase tax rates above the minimum rate due to i.e. inflation.
Large Combustion Plant directive 2001/80/EC	Emission limit values laid down in part A of Annexes III to VII in respect of sulphur dioxide, nitrogen oxides and dust are respected. Some existing power plants had a derogation which provided them with 2 options to comply with the Directive: either to operate only a limited number of hours or to be upgraded. The model selected between the two options on a case by case basis. The upgrading is reflected through higher capital costs.
IPPC Directive 2008/1/EC	Costs of filters and other devices necessary for compliance are reflected in the parameters of the model
Directive on the geological storage of CO2 2009/31/EC	Enabling measure allowing economic modelling to determine CCS penetration
Directive on national emissions' ceilings for certain pollutants 2001/81/EC	PRIMES model takes into account results of RAINS/GAINS modelling regarding classical pollutants (SO2, NOx). Emission limitations are taken into account bearing in mind that full compliance can also be achieved via additional technical measures in individual MS.
Water Framework Directive 2000/60/EC	Hydro power plants in PRIMES respect the European framework for the protection of all water bodies as defined by the Directive
Landfill Directive 99/31/EC	Provisions on waste treatment and energy recovery are reflected
Transport	
Regulation on CO2 from cars 2009/443/EC	Limits on emissions from new cars: 135 gCO2/km in 2015, 115 in 2020, 95 in 2025 – in test cycle. The 2015 target should be achieved gradually with a compliance of 65% of the fleet in 2012, 75% in 2013, 80% in 2014 and finally 100% in 2015. Penalties for non-compliance are dependent on the number of grams until 2018; starting in 2019 the maximum penalty is charged from the first gram.
Regulation EURO 5 and 6 2007/715/EC	Emission limits introduced for new cars and light commercial vehicles
Fuel Quality Directive 2009/30/EC	Modelling parameters reflect the Directive, taking into account the uncertainty related to the scope of the Directive addressing also parts of the energy chain outside the area of PRIMES modelling (e.g. oil production outside EU).
Biofuels directive 2003/30/EC	Support to biofuels such as tax exemptions and obligation to blend fuels is reflected in the model The requirement of 5.75% of all transportation fuels to be replaced with biofuels by 2010 has not been imposed as the target is indicative. Support to biofuels is assumed to continue. The biofuel blend is assumed to be available on the supply side.
Implementation of MARPOL Convention ANNEX VI - 2008 amendments - revised Annex VI	Amendment of Annex VI of the MARPOL Convention reduce sulphur content in marine fuels which is reflected in the model by a change in refineries output
Financial support	
TEN-E guidelines (Decision 1364/2006)	The model takes into account all TEN-E realised infrastructure projects
European Energy programme for Re-covery (Regulation 2009/663/EC)	Financial support to CCS demonstration plants; off-shore wind and gas and electricity interconnections is reflected in the model. For modelling purposes the following amounts for CCS power plants were assumed, following as-sumptions of summer 2009: Germany: 950 MW (450MW coal post-combustion, 200MW lignite post-combustion and 300MW lignite oxy-fuel), Italy 660 MW (coal post-combustion), Netherlands 1460 MW (800MW coal post-combustion, 660MW coal integrated gasification pre-combustion), Spain 500 MW (coal oxy-fuel), UK 3400 MW (1600MW coal post-combustion, 1800MW coal integrated gasification pre-combustion), Poland 896 MW (306MW coal post-combustion, 590MW lignite post-combustion).
RTD support (7th framework pro-gramme- theme 6)	Financial support to R&D for innovative technologies such as CCS, RES, nuclear and energy efficiency is reflected by technology learning and economies of scale leading to cost reductions of these technologies
State aid Guidelines for Environmental Protection	Financial support to R&D for innovative technologies such as CCS, RES, nuclear and energy efficiency is reflected by technology

and 2008 Block Exemption Regulation	learning and economies of scale leading to cost reductions of these technologies
Cohesion Policy – ERDF, ESF and Cohesion Fund	Financial support to national policies on energy efficiency and renewables is reflected by facilitating and speeding up the uptake of energy efficiency and renewables technologies.
National measures	
Strong national RES policies	National policies on e.g. feed-in tariffs, quota systems, green certificates, subsidies and other cost incentives are reflected
Nuclear	Nuclear, including the replacement of plants due for retirement, is modelled on its economic merit and in competition with other energy sources for power generation except for MS with legislative provisions on nuclear phase out. Several constraints are put on the model such as decisions of Member States not to use nuclear at all (Austria, Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Luxembourg, Malta and Portugal) and closure of existing plants in some new Member States according to agreed schedules (Bulgaria 1760 MW, Lithuania 2600 MW and Slovakia 940 MW). The nuclear phase-out in Belgium and Germany is respected while lifetime of nuclear power plants was extended to 60 years in Sweden. Nuclear investments are possible in Bulgaria, the Czech Republic, France, Finland, Hungary, Lithuania, Romania, Slovakia, Slovenia and Spain. For modelling the following plans on new nuclear plants were taken into account: Bulgaria (1000 MW by 2020 and 1000 MW by 2025), Finland (1600 MW by 2015), France (1600 MW by 2015 and 1600 MW by 2020), Lithuania (800 MW by 2020 and 800 MW by 2025), Romania (706 MW by 2010, 776 MW by 2020 and 776 MW by 2025), Slovakia (880 MW by 2015). Member States experts were invited to provide information on new nuclear investments/programmes in spring 2009 and commented on the PRIMES baselines results in summer 2009, which had a significant impact on the modelling results for nuclear capacity.