Submission of information on forest management reference levels by Ireland

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*

The average of the projected FM data series for the period 2013-2020 is **-206.81 Gg CO_2 eq**, including HWP and **-72.72 Gg CO_2** assuming instant oxidation of HWP (Table 1). The reported data take account of policies implemented before mid-2009 only. The projected values include estimated emissions from wild fires (reported as 12 Gg CO_2/yr, see section 5h of the July 2010 EU submission[1]), which are part of the background level of emissions and would not qualify as force majeure.

Table 1: Projected emissions/removals from Forest Management under Article 3.4 of the Kyoto Protocol, with (incl HWP) and without harvested wood products (excl HWP).

Units Gg CO2 eq

Year	Area (kHa)	Excl HWP	Incl HWP
2013	455.21	-1.53	205.72
2014	454.75	-458.34	-494.32
2015	454.29	-761.09	-870.14
2016	453.83	-140.74	-278.49
2017	453.37	-336.45	-535.57
2018	452.91	-256.06	-505.20
2019	452.45	623.88	345.86
2020	451.99	748.60	477.69
Reference level		**-72.72**	**-206.81**

Detailed emission/removals and implied emission factors for all pools are shown in Table 3.

2. *General description*

The forest management reference level was set transparently, taking into account footnote 1 of paragraph 4 of -/CMP.6:
(a) Removals or emissions from forest management as shown in greenhouse gas inventories and relevant historical data;
(b) Age-class structure;
(c) Forest management activities already undertaken;
(d) Projected forest management activities under a business as usual scenario;
(e) Continuity with the treatment of forest management in the first commitment period;
(f) The need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1.

[1] http://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/eu_lulucfwskp13.pdf.

The factors outlined above were addressed in the data submitted for Ireland in the November 2009 Forest Management reference[2] level submission, and are also addressed in the text below.

3. Pools and gases

Reference level estimates include all the following pools and gases:

i. Above and below ground biomass; gases CO_2, N_2O (biomass burning) and CH_4 (biomass burning). Emissions from fires are reported in the NIR 2010. Projected values use the 1990 to 2008 mean emission from fires.
ii. Deadwood; gases CO_2
iii. Litter; gases CO_2
iv. Soils; gases CO_2, as calculated for NIR (see NIR, 2010). An emission factor of 0.57 t C/ha/yr is applied to peat soils peat soils assuming that 38% of FM lands are peat soils (NFI, 2006).
v. HWP; gases CO_2
vi. N_20 emissions from fertiliser application are reported under Agriculture in the NIR, 2010 and are not included in LULUCF reporting (NIR, 2010)
vii. CO_2 emissions from lime application to soils only occur in deforested land converted to grassland or cropland. These are reported under ARD activities in article 3.3 forests (NIR, 2011).

4 Approaches, methods and models used

Derivation of FM harvest and activity data

The pre-1990 Coillte (state forestry company) estate was selected as a sample for the forest management areas since this accounted for 89% of the Article 3.4 pre-1990 forest in 2006 (National Forest Inventory (NFI), 2007; see NIR 2010 for a description of the NFI and sampling methods). No information on harvest and management plans for privately owned forests in the pre-1990 forest estate are available. Therefore, we apply the conservative assumption that there was no harvest from the privately owned pre-1990 forest.

Historic age-class and forest area summary statistics from previous state and Coillte forest inventory records were obtained for the years 1959, 1968, 1979, 1986 and 1998. The 2006 NFI sample plot co-ordinates were used as a random systematic sample to select Coillte sub-compartments representing 35,533 ha or ca. 8% of the pre-1990 forest. The Coillte sub-compartment and management unit forecast attribute data were obtained by GIS intersection with the point co-ordinates from the NFI permanent sample plots. This enabled a representative age-class distribution to be determined for the 2006 forest and to project the age-class distributions forward to 2020, using the harvest forecast in the 2006 management unit plans.

All harvest data was obtained from UNECE/FAO. All harvested timber was assumed to come from the pre-1990 forests until the end of 2006 (Figure 1).

The harvest forecasts for 2010 to 2020 were derived from the Coillte sub-compartment/NFI sample plot intersects as described above. The harvest forecast, as received from Coillte,

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[2] Submission by Ireland; 'Additional information to accompany the informal submission by Sweden on behalf of the European Community and its Member States on forest data' (11/2009); http://www.coford.ie/media/coford/content/toolsservices/euforestdata-nov09.pdf

from 2015 to 2020 was not smoothed (Coillte usually smoothes the harvest forecast to provide a management plan to deliver a consistent harvest and level of timber supply year on year). The forecasted Coillte harvest, post 2015, was smoothed using linear interpolation (Figure 1).

Replanting of clearfelled areas was assumed to take place 2 years after harvest. We also assumed all clearfelled forest areas were replanted unless management plans indicated a planned deforestation event.

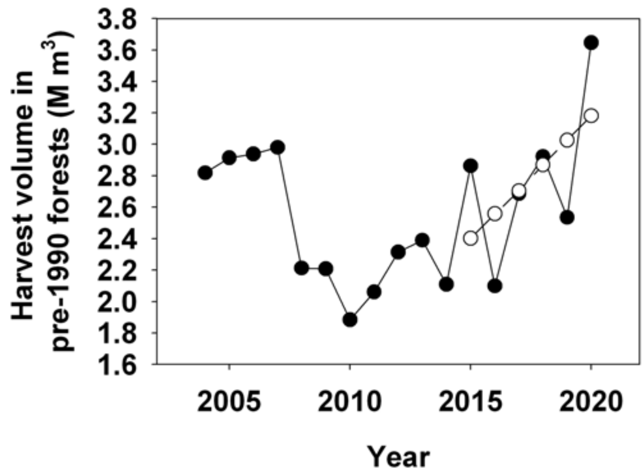

Figure 1: Historic and forecasted harvest volumes from the pre-1990 forest (black symbols). The open symbols represent the smoothed forecast data.

Roundwood harvest production forecast – projected harvest

A forecast of roundwood production is produced for each coniferous stand (sub-compartment) in Coillte's forest estate. The roundwood forecast used to compile the reference level dates from 2006, and details harvests up to 2020. The inputs to the forecasting process are as follows:

1. Inventory data provided information on species, planting year, yield class (a stand level productivity index), area, canopy percentage and stocking, at the sub-compartment level.
2. Silvicultural management prescriptions for each stand, referred to as the Thinning and Rotation Classification (TRC) are developed and quantified using:
   i. Yield models, (Forestry Commission (FC), Forest Service and Coillte modified models) together with roundwood volume assortment tables, (Irish Sitka spruce and FC assortment tables).
   ii. Each stand is assigned a Thinning and Rotation Classification (TRC). The thinning classification indicates the type and number of thinnings a stand will receive throughout its rotation. The rotation classification indicates the age at which the stand will be clearfelled. The inventory data and the TRC are used to select an appropriate yield model. The selected model is then used to produce volume and size estimates for each thinning and for clearfell.
   iii. The stand-based timber production estimates are aggregated to forest, regional and national level. The forecast is then smoothed (usually for the first 5 years of the forecast) to ensure an even pattern of roundwood supply to industry and to provide for the long-term sustainability of the forest estate.

Forecast assumptions

Correct interpretation of the roundwood harvest forecast figures is important and the following points should be noted:

i. The production shown for each year is the result of smoothing processes designed to overcome the sharp fluctuation in roundwood supply that can take place from year to year, and which relates to previous planting patterns.
ii. The estimates given are gross overbark standing volumes; harvesting losses have not been deducted. The level of these losses will depend mainly on the efficiency of the harvesting operation, the size of trees to be harvested and the species involved.
iii. The forecasted volumes are broken down into the top diameter categories: 7-< 14, 14 -<20 and 20+ cm, with a minimum log length of 3 m.
iv. The forecast data provided here represent the best estimate of likely future production, as of 2006. The gross figures are based on the summation of the impact of current management plans for each stand and as such, may be subject to change as a result of events such as windthrow.
v. Volume estimates for later years in the forecasting period are indicative only.
vi. The estimates are of material available in the forest. The absence of markets for one product such as pulpwood can reduce the availability of other products such as sawlog.

Estimation of historic and projected emission/removals trends

The Irish carbon reporting system (CARBWARE v4.5), described by Gallagher et al. 2004, was initially implemented to meet reporting requirements to the UNFCCC on national forestland remaining forest (F-F) and land converted to forestland (F-L). To facilitate the 20-year transition between F-L and F-F (see Introduction), CARBWARE v4.5 was specifically designed to generate a time series estimate going back to 1970 using species distribution activity data for young (7-25 year old) and mature stands (>25 years), see Gallagher et al., 2004. The early version of CARBWARE was, however, a static model (i.e. had only two age classes) representing C dynamics for two forest type cohorts (conifers, based on Sitka spruce and broadleaves based on beech), see Gallagher et al. 2004. In addition, the old model only considered C stock changes in the living biomass and litter pools, and assumed deadwood C stock changes were in steady state. However, the original model is still used, in combination with a newer version of CARBWARE, as a hybrid model, because it is able to extend C stock change estimation back to 1970. This forms the basis for historic data estimates for both UNFCCC categories and KP Article 3.4 forests (Figure 2).

To facilitate Article 3.3 reporting requirements, CARBWARE has evolved from a tier 2 to tier 3 system, using forest inventory data, yield models and national research information (see Black and Farrell 2006, Black et al. 2009 and Gallagher et al 2004). The outputs from the model are used to generate historical and projected data for activities relating to Article 3.3 and projected data for Article 3.4 of the KP from 2008 onwards (NIR, 2010).

<u>The hybrid CARBWARE model</u>

The historic emissions/removals for forestland remaining forestland and land converted to forest (i.e. the Convention reporting format, see i. in Figure 2) were calculated using a hybrid model based on CARBWARE v4.5 (described above) and the newer dynamic model (CARBWARE v5).

Emissions/removals for F-F and F-L categories (Figure 2) were simulated using the original methodology as described in previous Convention submissions (CARBWARE v4.5; see Gallagher et al., 2004, NIR, 2004, 2005 and 2006) with the following modifications:

1. All replanted areas from since 1990 were excluded from the v4.5 of the model . These C stock changes were estimated using CARBWARE v5.
2. Mineral soil stock changes were assumed to be at steady state following a land use transition into forest. Peat soils are assumed to be a source of C (see NIR, 2010)
3. Mean accretion rate, which reallocates areas representing young forest into the old forest cohort after 25 years, was replaced by actual areas. This was performed to ensure that the there was no accretion of the Forest Information and Planning System (FIPS) data from 2014 onwards (i.e. 1989 was the last afforested and replanted area cohort moved to the old forest cohort). This effectively meant that the pre-1990 forest C stock in old forests (> 25 years) decreased from 2014, due to felling and no addition of new stocks due to replanting and reforestation. Similarly, C stocks of the new forest cohort (7-25 years old) were zero from 2006 onwards.

There may be a slight modelling bias in the projections due to inconsistencies in the time series brought about by treating younger and model forest separately in the hybrid model. This was addressed by calibration with CARBWARE v5 and adjustment of the historic data to produce a consistent time series (Figure 2). This back-extrapolation adjustment is in accordance with prescribed procedures for national adjustments and compliance under Articles 5 and 7 of the KP. There were no historic activity data available for use in the CARBWARE v5 model.

CARBWARE v5

Estimates of changes in biomass over time are based were based on the new version of CARBWARE (v5, see Appendix A), using forest growth models and research information from the present and previous COFORD funded projects (CARBiFOR, CARBWARE, FORESTSOILC, see Black and Farrell 2006, Black 2008). A common approach is used to report regional annual C stock changes or interpolate between inventory measurements involves mass-balance ($NEP_{\Delta C}$) estimates (IPCC 1996). This is normally based on models/measurements which describe the changes in biomass (${}_{\Delta}C_{b}$), litter (${}_{\Delta}C_{1itter}$), dead wood (${}_{\Delta}C_{dead\ wood}$) and soil (${}_{\Delta}C_{soil}$) C pools:

$$NEP_{\Delta C} = {}_{\Delta}C_{b} + {}_{\Delta}C_{1itter} + {}_{\Delta}C_{dead\ wood} + {}_{\Delta}C_{soil} \qquad (1)$$

Stand biomass

The dynamic CARBWARE v5 growth model describes changes in ${}_{\Delta}C_{b}$ based on tree-level allometric functions (for example diameter breast height (DBH) and top height) and stand attributes (stocking) for representative species, according to Forestry Commission yield models (Edwards & Christy 1981, Black & Farrell 2006). For this exercise, stand attributes, such as age, mean DBH, top height, stocking and timber harvested, for six species cohorts (spruce, fir, larch, pine, slow growing and fast growing broadleaves), were used as inputs for the calculation of cumulative stand biomass using species-specific allometric relationships (Black et al. 2004, Black et al. 2007, Tobin et al. 2006, Black & Farrell 2006).

A modified expo-linear growth function (Monteith 2000) was used to more accurately simulate growth during the early years of the rotation and interpolate growth over time, since neither the dynamic or static models consider growth of young forest (<10 years old).

Stand biomass (*St*) was expressed as:

$$St = Mt\left[\frac{1-e^{-k_s(k_t-t)}}{1-e^{-k_s k_t t}}\right] \tag{2}$$

where;

$$Mt = \frac{Cm}{Rm}\ln\left[1+\frac{Co}{Cm}e^{Rmt}\right] \tag{3}$$

Mt is Monteith's function where *Cm* is maximum growth rate, *C*o is initial absolute growth rate and *R*m is the initial relative growth rate and *t* is time (years). Parameters *Cm, Rm, Co,* k_s and k_t were fitted using the least squares optimisation method to estimate stand biomass values.

The current annual increment (ΔC_b) for any given year was then calculated as:

$$\Delta C_b = St_{n+1} - St_n \tag{4}$$

The same approach was used to calculate aboveground and belowground biomass changes.

CARBWARE v5 also simulates the carbon stock changes in un-thinned stands modified from Forestry Commission stand-level models (Edwards & Christy 1981). Volumes removed due to proposed thinnings were not indicated in the Coillte management plans. For this projection we assume that 50% of the pre-1990 forest was subjected to thinning as described for the specific cohorts (see Edwards &Christy 1981). The model outputs for volume removed at harvest were compared with the historic harvest and Coillte roundwood harvest forecast (2009 to 2015) for model optimisation.

Other carbon pools

The biomass model also simulates changes in other C pools, such as litter, and deadwood for different species and management scenarios, based on research information and recent UNFCCC submissions (see NIR, 2010).

Annual litter gains and losses ($\Delta C_{litter} = C_{1gain} - C_{1loss}$) were calculated based on foliar biomass functions, litter fall models (Tobin et al. 2006), estimates of harvest residue and decomposition factors:

$$C_{\lg ain} = (Fb \times Ft) + Br \tag{5}$$

where *Fb* is foliage biomass (t C ha^{-1}), *Ft i*s leaf or needle turnover rate (*Ft* = 0.2 (i.e. 5 years) for evergreen conifers, (Tobin et al. 2006) and *Ft* = 1 for deciduous species). *Br* is brash (harvest residue in the form of branches and needles) added to the litter pool. Brash (*Br* < 7cm diameter) was calculated as:

$$Br = AG_{harvest} - Tm_{harvest}, \tag{6}$$

where *AG* (total biomass–belowground biomass, BG) is aboveground biomass and *Tm* is timber cut at harvest (DBH ≥7cm, t C ha^{-1}).

Emissions from the accumulated litter pool (ΔC_{lloss}) for any given year (*n*) were calculated as a function of litter turnover rates (*Lt*) based on experimental data (*Lt* = 0.14; Saiz et al. 2007);

$$C_{lloss_{(n+n)}} = \sum\left[\left(C_{\lg ian_{(n)}} \times Lt\right), \left(C_{\lg ain_{(n)}} \times (1-Lt)\right) + C_{\lg ain_{(n+n)}} \times Lt\right] \tag{7}$$

The dead coarse wood C pool ($C_{deadwood}$) includes C gains ($C_{d.gain}$) and decomposition losses ($C_{d.loss}$).

$$C_{d.gain} = st + hr + tr + mort\,, \qquad (8)$$

where *mort* is mortality (as specified in both the static yield tables and dynamic yield model), *st* and *hr* represent stumps and roots of harvested trees (total biomass harvest - $AG_{harvest}$) and *tr* is the harvest residue of remaining wood on site after harvest (assumed to be 5 % of the biomass from the $Tm_{harvest}$ pool).

The clearfell harvest residue losses were also applied to sub-compartments clearfelled since 2000 to account for the historic deadwood and litter decomposition losses in the model.

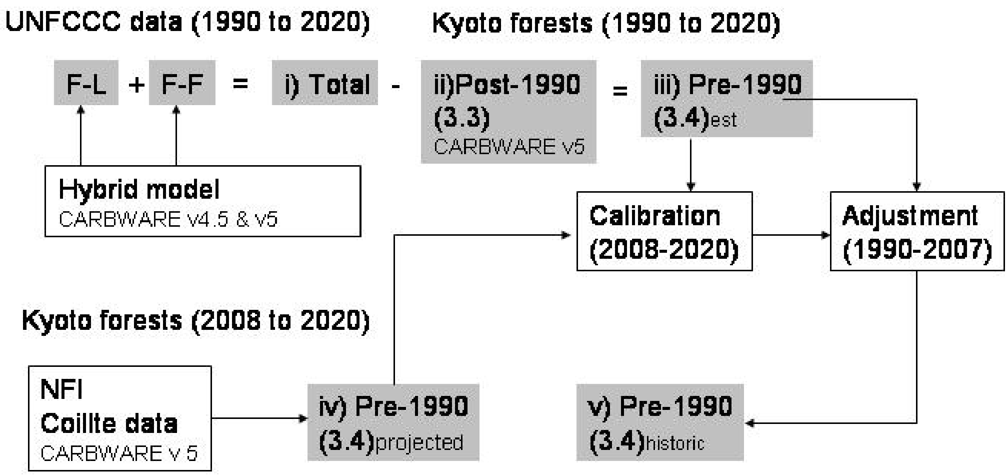

Figure 2: The overall modelling approach for carbon stock changes in Article 3.4 forests.

Figure 2 provides a schematic representation of the methodology used to generate the historic and projected time series for Article 3.4 forests. The initial estimates for Article 3.4 forests (box iii. Pre-1990 $(3.4)_{est}$) were calculated based on the difference between the sum of all forest land in the UNFCCC data (grey box i. Total) minus the Article 3.3 emission/removals (ii. Post-1990 (3.3)), for the entire time series 1990 to 2020. To reduce any potential over or under estimation bias in the data due to the use of different models in the projections, the historic Article 3.4 data were calibrated and adjusted using back-extrapolation, based on the relationship between the projected Article 3.4 data (grey box iv. Pre-1990 $(3.4)_{projected}$) and the UNFCCC derived data (grey box iii. Pre-1990 $(3.4)_{est}$). The current approach to calculate Article 3.4 projected data (grey box iv. Pre-1990 $(3.4)_{projected}$) was based on CARBWARE v5, using activity data derived from the intersected NFI and Coillte sub-compartment data (as used to derive the age class distribution for 2006 onwards).

5 Description of construction of reference levels

a) Area under forest management

Ireland's remaining forest cover at the beginning of the 20th century was 1.4% of the area of the country[3]. From the 1920s national afforestation programmes have increased forest cover to the present level of over 10% [4].

A change in the age-class distribution due to clearfell and replanting of large areas previously afforested (40 to 50 years ago) could result in a significantly lower forest volume and carbon increment due to the lower sequestration in younger crops. This is particularly relevant for the Irish forest estate, where nearly all of the current forest area has been afforested since the early 1900s and there have been significant fluctuations in the afforestation rate since the 1940s (Figure 3).

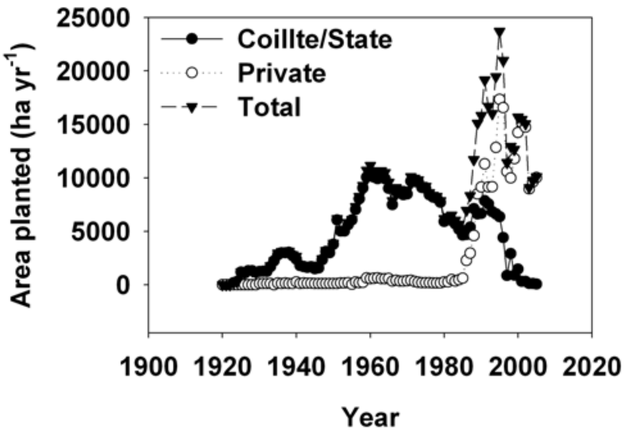

Figure 3: Afforestation rate in Ireland, 1920 to present (source Forest Service).

There are marked differences in the areas reported under the Convention and those reported under Articles 3.3 and 3.4. Under Convention reporting, forest areas undergo transitions between categories, whereby areas in *Land Converted to Forest Land (F-L)* move to the *Forest Land Remaining Forest Land (F-F)* category after a transition period of 20 years. For example, an afforested area in 1980 remains in the F-L category until 1999 and is then transferred to the F-F category in 2000. In reporting under the Protocol, Article 3.3 areas cannot move to Article 3.4 areas and deforestation areas cannot move to any other category (thus the area can only increase in time). Article 3.4 forest management areas are initially determined at 1990 levels and can, therefore, only decrease in time due to deforestation events. The mean deforestation rate of 460 ha per year, for the period 1990 to 2009 (NIR, 2010), was used for the projected FM area (Tables 1 and 3). Table 2 shows the relationship between areas for Article 3.3 and 3.4 activities and Convention forest areas reported for Ireland. The Forest Management area is much larger than the afforestation area. Ireland did not elect to account for Forest Management during the first commitment period.

[3] OCarroll, N. 2004. *Forestry in Ireland – A Concise History*. COFORD, Dublin.
[4] NFI. 2007. *The National Forest Inventory of Ireland*. Forest Service, Dublin.

Table 2: Comparison of forest areas under reported under the Convention and under the Kyoto Protocol.

Forest category areas (kHa) 2009

Year	**KP areas**			**Convention areas**			**Total area**
	FM	**AR**	**D**	**F-L**	**F-F**	**UNCL**	
1990	465.82	15.82	0.02	175.43	194.73	111.47	481.63
1991	465.77	34.96	0.04	184.46	189.26	127.00	500.73
1992	465.72	51.66	0.06	191.21	185.02	141.14	517.38
1993	465.66	67.66	0.08	197.39	183.55	152.38	533.32
1994	465.60	87.12	0.10	207.57	179.03	166.12	552.72
1995	465.23	110.83	0.44	222.08	172.75	181.22	576.06
1996	464.84	131.81	0.77	234.46	172.06	190.13	596.66
1997	464.46	143.25	1.10	237.54	181.67	188.49	607.70
1998	464.07	156.17	1.44	242.19	192.68	185.36	620.24
1999	463.67	168.84	1.77	247.00	200.90	184.62	632.51
2000	462.75	184.54	2.63	256.51	203.09	187.70	647.29
2001	461.81	200.00	3.48	265.60	209.14	187.08	661.81
2002	460.88	215.06	4.34	274.14	220.51	181.29	675.94
2003	459.94	224.15	5.20	277.21	235.62	171.26	684.09
2004	458.99	233.89	6.06	281.28	241.46	170.14	692.88
2005	458.02	243.99	6.91	286.14	248.27	167.60	702.01
2006	457.54	251.89	7.29	287.21	258.29	163.93	709.43
2007	457.19	258.90	7.63	286.03	276.45	153.60	716.09
2008	457.14	264.88	7.92	286.14	294.95	140.93	722.02
2009	457.05	271.38	8.12	272.10	325.86	130.47	728.43

*FM, Forest management, AR and D are afforested reforested and deforested areas under Article 3.3 (see **KP CRF Table NIR2, NIR, 2010**). F-L is lands converted to forest and F-F forestland remaining forestland (20-year transition) UNCL, are unclassified forest areas in the F-F category that are not reported under Convention reporting (see Chapter 7, CRF Tables). For comparison with Convention reporting, KP (3.4) **FM = (F-F + UNCL+ F-L) – AR.***

b) Emissions and removals from forest management

1) Historical emissions and removals from forest management

Table 3: Historic and projected emission/reductions from forest management and implied emission factors for all pools.

		Implied emission factors				Removals/emissions for FM								
		Units tC/ha				Units tC						Units Gg CO_2		
Year	Area (kHa)	Biomass	Litter	Deadwood	Soils	Biomass	Harvest	Litter	Deadwood	Soils	**Sub-total**	**Disturbances**	**Total excl HWP**	**HWP**
1990	465.82	-1.15	0.00	-0.52	0.21	-537884	339530	-604	-243001	95586	**-346373**	**19.39**	**-1250.64**	**-674.69**
1991	465.77	-1.25	0.00	-0.52	0.21	-582206	349030	-1251	-240452	95575	**-379303**	**12.46**	**-1378.32**	**-995.35**
1992	465.72	-1.33	0.00	-0.48	0.21	-618047	409640	-2040	-224191	95565	**-339073**	**8.01**	**-1235.26**	**-927.12**
1993	465.66	-1.23	-0.01	-0.50	0.21	-573355	380570	-2947	-231990	95554	**-332168**	**16.15**	**-1201.80**	**-904.57**
1994	465.60	-1.25	-0.01	-0.47	0.21	-582254	421800	-4135	-220928	95541	**-289975**	**18.54**	**-1044.70**	**-861.81**
1995	465.23	-1.30	-0.01	-0.45	0.21	-604357	460560	-5595	-210529	95465	**-264455**	**25.32**	**-944.35**	**-1017.64**
1996	464.84	-1.31	-0.02	-0.44	0.21	-608761	478800	-7338	-205635	95386	**-247549**	**28.16**	**-879.51**	**-952.00**
1997	464.46	-1.20	-0.02	-0.46	0.21	-559113	455620	-9267	-211854	95307	**-229308**	**15.40**	**-825.39**	**-824.61**
1998	464.07	-1.30	-0.02	-0.45	0.21	-604416	473670	-11563	-207011	95227	**-254094**	**8.12**	**-923.55**	**-1000.29**
1999	463.67	-1.49	-0.03	-0.41	0.21	-692555	539980	-14370	-189220	95146	**-261020**	**6.63**	**-950.44**	**-1064.12**
2000	462.75	-1.40	-0.04	-0.40	0.21	-645763	558600	-17539	-184225	94957	**-193970**	**16.65**	**-694.57**	**-1133.73**
2001	461.81	-1.21	-0.05	-0.43	0.21	-560676	513000	-21081	-196459	94764	**-170452**	**33.20**	**-591.79**	**-904.72**
2002	460.88	-1.38	-0.05	-0.40	0.21	-635479	553090	-25301	-185703	94573	**-198820**	**7.63**	**-721.38**	**-1149.19**
2003	459.94	-1.63	-0.07	-0.40	0.21	-747659	560690	-29908	-183664	94379	**-306161**	**47.06**	**-1075.54**	**-1140.31**
2004	458.99	-1.37	-0.08	-0.41	0.21	-628480	535420	-35085	-190444	94184	**-224404**	**27.42**	**-795.40**	**-1153.68**
2005	458.02	-1.43	-0.09	-0.41	0.21	-654943	553470	-40786	-185601	93986	**-233875**	**9.97**	**-847.57**	**-1350.54**
2006	457.54	-1.49	-0.10	-0.40	0.21	-681360	558220	-47056	-184327	93887	**-260636**	**9.97**	**-945.69**	**-1190.05**
2007	457.19	-1.66	-0.12	-0.40	0.21	-758085	566390	-56872	-182135	93815	**-336887**	**11.21**	**-1224.04**	**-633.27**
2008	457.14	-1.15	-0.02	-0.48	0.21	-523434	420511	-10993	-221274	93804	**-241385**	**12.00**	**-873.08**	**-600.86**
2009	457.05	-1.22	-0.11	-0.19	0.21	-556318	419647	-52087	-86299	93786	**-181271**	**12.00**	**-652.66**	**-321.49**
2010	456.59	-1.19	-0.10	-0.20	0.21	-542259	357750	-45754	-92388	93691	**-228959**	**12.00**	**-827.52**	**-268.71**
2011	456.13	-1.05	-0.22	-0.33	0.21	-479628	391498	-99122	-148752	93597	**-242407**	**12.00**	**-876.83**	**37.10**
2012	455.67	-0.87	-0.16	-0.24	0.21	-395788	439672	-73387	-108005	93503	**-44006**	**12.00**	**-149.35**	**25.16**
2013	455.21	-0.85	-0.15	-0.21	0.21	-386357	454069	-67478	-97333	93408	**-3691**	**12.00**	**-1.53**	**207.25**
2014	454.75	-1.18	-0.11	-0.08	0.21	-538496	400683	-49284	-34491	93314	**-128275**	**12.00**	**-458.34**	**-35.98**
2015	454.29	-1.20	-0.17	-0.30	0.21	-547047	456364	-75861	-137517	93219	**-210842**	**12.00**	**-761.09**	**-109.06**
2016	453.83	-1.39	0.01	0.01	0.21	-630828	486005	5350	4690	93125	**-41657**	**12.00**	**-140.74**	**-137.75**
2017	453.37	-1.16	-0.18	-0.21	0.21	-524416	513795	-83130	-94311	93031	**-95031**	**12.00**	**-336.45**	**-199.12**
2018	452.91	-1.08	-0.28	-0.21	0.21	-490051	545289	-126454	-94827	92936	**-73106**	**12.00**	**-256.06**	**-249.14**
2019	452.45	-1.30	0.09	0.10	0.21	-588755	574931	41856	46003	92842	**166876**	**12.00**	**623.88**	**-278.02**
2020	451.99	-0.87	-0.04	-0.19	0.21	-394594	604573	-17631	-84203	92747	**200891**	**12.00**	**748.60**	**-270.91**

The historic emissions/removals presented in this submission (Table 3) differ from the data in the NIR 2010 due to the following:

i. Differences in the representative areas for Convention reporting (forest land remaining forest land) and areas reported as Forest Management (Article 3.4, see table 2).
ii. A different model is used to derive projected values and the time series is adjusted to maintain methodological consistency across the reported periods.
iii. The activity after 2006 differs from the data used in Ch 7 of the NIR. This dataset uses the NFI, 2006 sample plots. In contrast the NIR 2010 uses FIPS 95 (See NIR chapters 7 and 11).

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

See forest areas above (Table 2).

c) Forest characteristics and related management age-class structure

1) Age class structure

Historical inventory records and sub-compartment management forecast plans show that there was a shift in the age class distribution from a left skewed, young age-class distribution in 1959 to a near-normal distribution curve by 1998 (Figure 4). However, there was a reversal towards the younger age-class distribution by 2006, resulting from fell and replant as pre-1990 forests reached the prescribed felling age. This trend is expected to continue up to 2012, and it is projected to be followed by a re-distribution towards older age classes up to 2020.

These shifts in the age class distribution are considered to influence current and projected forest emission/removals in pre 1990 forests in two ways:

i. A decrease in biomass increment. There is evidence of a decline in gross biomass increment between 2007 and 2020 (see Biomass implied emission factor in Table 3). This is associated with a change in the mean age and age class frequency5 and a consequent decline in annual sequestration rate in younger crops, following replanting after clearfell.
ii. A decrease in the deadwood C pool, due to the residual decomposition of harvest residue following the first rotation (see deadwood implied emission factor in Table 3).

[5] Black et al. (in prep) Historic and projected carbon dioxide emission/removals for forest management under Article 3.4 of the Kyoto protocol.

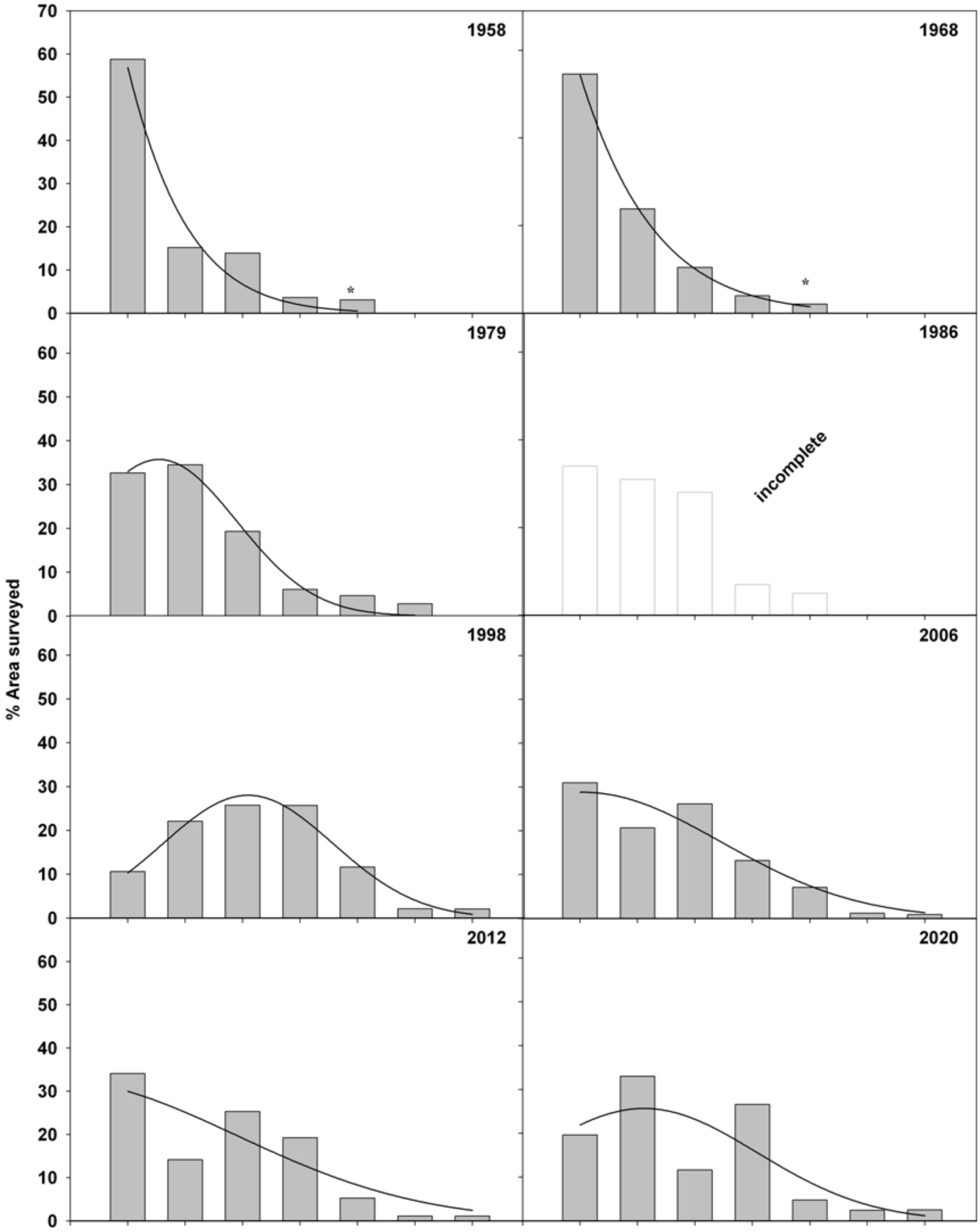

Figure 4: The age class frequency distribution based on summary statistics (grey histograms) and a fitted distribution curve (solid line) using a Gaussian function.
* The 1959 and 1968 data did not categorise age classes older than 50 years old.

2) **Increment**
There is a decline in biomass increment (Table 3) due to a shift in the age class structure as discussed above. The CARBWARE model does not provide volume increment estimates, but it is assumed that similar trends will be observed for volume increment.

3) **Rotation length**
Shifts in age class frequency are consistent with historic afforestation rates and clearfell at an age of ca. 45 years (i.e. for the major species age at maximum mean annual increment of Sitka spruce yield class 16). A large proportion of these forests were clearfelled by mid 1990s (Figure 4, Table 4). Pre 1990 forests are mainly state-owned (89 %) and are predominantly Sitka spruce and lodgepole pine, which are worked on mean rotation ages of 41 and 39 years respectively, and comprise 94% of fellings in pre 1990 forests.

Table 4: Mean rotation ages of different species from the forecasted sub compartment and management unit data for the period 2008 to 2020. Abbreviations; n is the number of sampled compartments, MMAI is maximum mean annual increment; n/a not applicable because rotation age at MMAI is applied to these species.

Species	Forecast rotation age	Age at commercial rotation	Age at MMAI
Lodgepole pine (n = 53)			
mean	39	40	57
Sitka spruce (n = 156)			
mean	41	42	52
Norway spruce (n = 17)			
mean	40	36	51
Others (n = 18)			
mean	48	n/a	59

4) **Information on forest management activities under "business as usual"** A forecast of roundwood production and increment is produced for each stand (sub-compartment) in Coillte's forest estate assuming business as usual forest management. The inputs to the forecasting process are:

i. Inventory data at the sub-compartment level comprising species composition, planting year, yield class (productivity index), area, species canopy percentage and stocking.

ii. Silvicultural management prescriptions for each stand, referred to as the Thinning and Rotation Classification (TRC) based on yield models (Forestry Commission (FC), Forest Service and Coillte modified models), together with volume assortment tables (Irish Sitka spruce and FC assortment tables).

iii. Each subcompartment is assigned a Thinning and Rotation Classification (TRC). The thinning classification indicates the type and number of thinnings a stand will receive throughout its rotation. The rotation classification indicates the age at which the stand will be clearfelled. The inventory data and the TRC are used to select an appropriate yield model. The selected model is then used to produce volume and size estimates for each thinning and clearfell.

iv. The sub-compartment based roundwood production estimates are aggregated to forest, regional and national level. The forecast is then smoothed to provide an even pattern of supply to the roundwood processing sector. The production shown for each year is designed to overcome sharp fluctuations in yield that can take place from year to year which relate to previous planting patterns.

v. Roundwood harvest estimates are gross overbark standing volumes; harvesting losses have not been deducted. The forecasted volumes from the pre-1990 estate was called up to the national level and converted to CO2 emissions using a basic density of 0.4 kg m^{-3} and a carbon content of 50 % (Black et al., 2004; Black and Farrell, 2006).

vi. The projected harvest data represent the best estimate of likely future production. The gross figures are based on the summation of the impacts of the current management plans for each stand.

d) Harvesting rates

1) Historical and forecasted harvesting rates

Historic harvest data was obtained from UNECE/FAO. All harvested roundwood was assumed to come from the pre-1990 forests until the end of 2008 (Table 2). All harvest was assumed to be derived from the pre-1990 forest up to 2006. The harvest from post-1990 forests (Article 3.3) were subtracted from the national harvest fro 2007 to 2009. Harvests from the Article 3.3 forest were derived as reported in the NIR, 2010.

2) Assumed future harvesting rates

The harvest forecasts for 2009 to 2020 were derived from the Coillte sub-compartment/NFI sample plot intersects as described above. The harvest forecast from 2015 to 2020, as supplied, was not smoothed (Coillte usually smoothes the harvest forecast to provide an even roundwood supply). The forecasted Coillte harvest, after 2015, was smoothed using linear interpolation (Table 5).
Replanting of clearfelled areas was assumed to take place 2 years after harvest. It was also assumed that all clearfelled forest areas would be replanted, unless management plans indicated a planned deforestation event.

Table 5: Historic and forecasted harvest roundwood volumes from the pre-1990 forests

Harvest volume in pre-1990 forest (M m^3)				
UNECE/FAO harvest		**Forecast harvest**		
			Smoothed	**Un-smoothed**
1990	1.787	**2009**	2.392	-
1991	1.837	**2010**	1.883	-
1992	2.156	**2011**	2.061	-
1993	2.003	**2012**	2.314	-
1994	2.220	**2013**	2.390	-
1995	2.424	**2014**	2.109	-
1996	2.520	**2015**	2.402	2.863
1997	2.398	**2016**	2.558	2.099
1998	2.493	**2017**	2.704	2.687
1999	2.842	**2018**	2.870	2.922
2000	2.940	**2019**	3.026	2.534
2001	2.700	**2020**	3.182	3.647
2002	2.911			
2003	2.951			
2004	2.818			
2005	2.775			
2006	2.803			
2007	2.160			
2008	2.056			

e) Harvested wood products

Estimation of harvested wood product production

In order to establish a basis for the inclusion of emissions from harvested wood products (HWP) arising from domestic harvest in Article 3.4 forest over the period 2013-2020 in a projected reference level, it was necessary to estimate the annual production of HWP over the same period. Production was estimated by establishing a relationship between domestic harvest in Article 3.4 forest of two top diameter assortments (pulpwood and sawlog) for the years 2005-2009 inclusive and wood-based panel and sawnwood production, respectively. This relationship was then applied to the projected level of harvest of the two assortments over the period 2013 and 2020, to arrive at an estimate of HWP production in those years (Figure 5).

The HWP pool arising from domestic harvest over the period 2010-2012 was also estimated, using harvest projections previously provided by Ireland to the United Nations Economic Commission for Europe (UNECE) and, for 2011 and 2012, the same methodology as used for the period 2013-2014. A separate methodology was used to estimate the HWP pool for 2010.

Finally, the derivation of carbon contents for wood-based panels is provided.

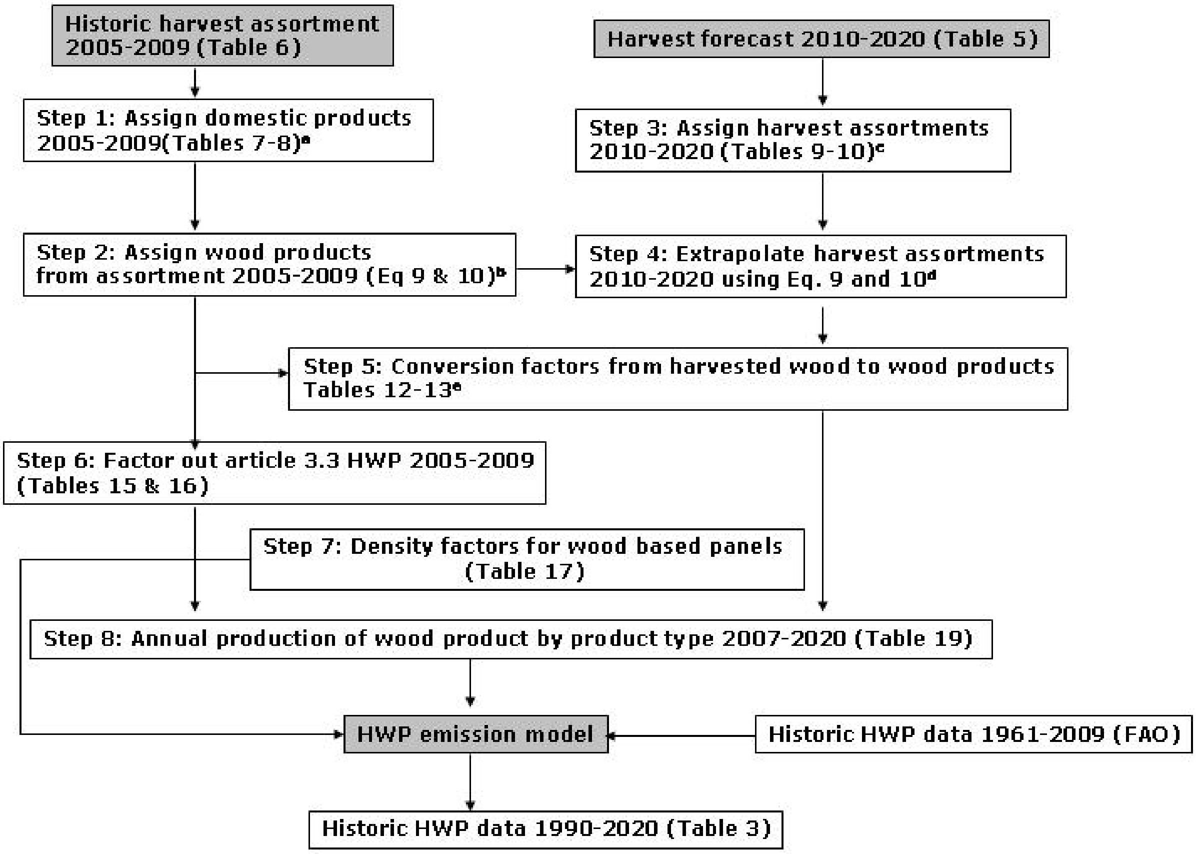

Figure 5: Flow chart of data sources (grey boxes) and methods used (clear text boxes) in deriving harvested wood products from historic and projected harvest data. The alphabetical superscripts, equations and tables are referred to in the text below.

Roundwood harvest in the Republic of Ireland, broken down by top diameter assortment, over the period 2005-2009 is shown in Table 6.

Table 6: Domestic roundwood harvest in Ireland (2005-2009) by top diameter assortment[6,7].

Year	Pulpwood (top diameter 7-13 cm OB)	Sawlog (top diameter ≥14 cm OB)	Total
	000 m^3 overbark		
	a	b	c =(a+b)
2005	835	1,940	2,775
2006	836	1,967	2,803
2007	910	1,250	2,160
2008	725	1,331	2,056
2009	746	1,646	2,392

Estimation of production of wood-based panels and sawnwood from domestic harvest in 2005-2009

[6] Domestic roundwood harvest is reported in 000 m^3 overbark (OB).

[7] Roundwood harvest data are taken from the EUROSTAT/FAO/UNECE Joint Forest Sector Questionnaire (JFSQ). Once checked by EUROSTAT, JFSQ data is then circulated to FAO and the UNECE; http://faostat.fao.org/site/626/default.aspx#ancor

The first step was to estimate the level of production of wood-based panels and sawnwood from domestic harvest alone (Figure 5 step 1). Roundwood and sawmilling residues are imputed to Ireland and are used in the manufacture of wood-based panels (WBP) and sawnwood. Likewise, these commodities are exported from domestic harvest in Ireland to Northern Ireland for the manufacture of wood-based panels and sawnwood. In order to arrive at an estimate of the amount of products manufactured from domestic harvest the additions and subtractions indicated in Tables 7 and 8 were carried out.

Firewood, wood for energy, wood biomass harvest was assumed to be instantaneously oxidised and was not included in the harvested wood product pool. Pulp or paper products are no longer manufactured from virgin fibre in Ireland.

The next step (Figure 5 step 2) was to perform regression analysis on domestic production volumes for wood-based panel products and sawnwood (column e in Tables 7 and 8,) in relation to sawlog (eq 9, $r^2 = 0.96$) and pulpwood harvest (eq10, $r^2 = 0.74$):

$$\text{Sawlog products}_{(2005\text{-}2009)} = 0.5774 \times Samp\log harest_{(2005-2009)} \cdot 140.68 \quad (9)$$

$$\text{Panel products}_{(2005\text{-}2009)} = 1.2188 \times Pulpwoodharest_{(2005-2009)} \cdot 126.15 \quad (10)$$

These linear regressions were used to convert projected roundwood harvest volumes for pulpwood and sawlog assortments[8] into wood-based panel and sawnwood outputs for the period 2011-2020 (Table 13, see Figure 5 superscript c).

Table 7: Estimation of the volume of sawnwood produced from domestic sawlog harvest in Ireland (2005-2009)[9].

Year	**Total volume of sawnwood produced in the RoI**	**Volume of sawnwood produced in NI from sawlog harvested in the RoI**	**Total volume of sawnwood produced from domestic roundwood harvest**	**Volume of sawnwood produced in the RoI from imported sawlog**	**Volume of sawnwood produced from domestic roundwood harvest**
	000 m³				
	a	**b**	**c = (a+b)**	**d**	**e=(c-d)**
2005	937	118	1,055	72	983
2006	1,095	52	1,147	142	1,005
2007	985	132	1,117	150	967
2008	702	81	783	131	652
2009	773	46	819	60	759

Table 8: Estimation of the volume of wood-based panels which were produced from the domestic pulpwood harvest in Ireland (2005-2009)[10].

[8] See also paragraph c below.

[9] Sawnwood production data is taken from the EUROSTAT/FAO/UNECE JFSQ;

Year	Total volume of wood-based panels produced in the RoI	Volume of wood-based panels produced in NI from pulpwood & from sawmill residues from the domestic roundwood harvest in the RoI	Total volume of wood-based panels produced from domestic roundwood harvest	Volume of wood-based panels produced in the RoI from imported pulpwood and wood residues	Volume of wood-based panels produced from domestic roundwood harvest
	000 m^3				
	a	b	c = (a+b)	d	e=(c-d)
2005	875	41	916	16	900
2006	937	31	968	16	952
2007	918	50	968	17	951
2008	779	35	814	17	797

Estimation of production of wood-based panels and sawnwood from domestic harvest in 2011-2020 (Figure 5, step 3)

Projected roundwood harvest rates from Article 3.4 forest for the period 2011-2020 were as included in the EU LULUCF submission of November 2009[11] (Table 5). However the harvest data in this submission were not broken down by assortment categories. Therefore, the relationships established for the period 2005-2009 could not be directly applied. An assortment breakdown was obtained from the later *All-Ireland Forecast of Roundwood Production 2011-2030* (Phillips 2011), referred to hereafter as the '2011 forecast') as follows:

i. Standing volumes in publicly-owned forests[12] in Ireland were taken from the '2011 forecast'
ii. A special forecast was then run to ascertain the standing volume in public forests for crops which were afforested over the period 1990-2008. This used the officially published figures for public afforestation for the period (1990-2008)[13]. The species breakdown in this forecast model assumes the national average for the particular year. The forecast assumes an average rate of production and a normal rotation of 40 years.
iii. The forecast for post-1990 crops was then subtracted from the total forecast to produce a forecast of harvest volumes from pre-1990 crops over the period 2011-2020. This forecast includes top diameter assortments by year from 2011 (Table 9).
iv. The same proportionate allocation of assortments in the '2011 forecast' by year, were used to arrive at the assortments in the harvest forecast used in the November 2009 submission. These are presented in Table 9.

[10] Production data for wood-based panels are taken from the EUROSTAT/FAO/UNECE JFSQ; http://faostat.fao.org/site/626/default.aspx#ancor

[11] Submission by Ireland; 'Additional information to accompany the informal submission by Sweden on behalf of the European Community and its Member States on forest data' (11/2009); http://www.coford.ie/media/coford/content/toolsservices/euforestdata-nov09.pdf

[12] Public forests in Ireland are owned and managed by Coillte; www.coillte.ie

[13] http://www.agriculture.gov.ie/forestservice/forestservicegeneralinformation/foreststatisticsandmapping/afforestationstatistics/

Table 9: A forecast of the standing volume in Article 3.4 (pre-1990) forest in public ownership in Ireland by top diameter assortment class (2011-2020).

Year	Standing volume by top diameter assortment class			
	7-13 cm OB	14-19 cm OB	≥20 cm OB	Total
	000 m^3 overbark			
2011	344	831	1,584	2,760
2012	349	733	1,444	2,525
2013	328	710	1,545	2,584
2014	527	777	1,467	2,771
2015	434	728	1,455	2,617
2016	554	805	1,507	2,866
2017	486	683	1,413	2,582
2018	542	709	1,404	2,654
2019	600	784	1,422	2,806
2020	580	759	1,424	2,763
Total	4,743	7,520	14,665	26,928

<u>Estimation of production of wood-based panels and sawnwood from domestic harvest in Ireland in 2010</u>

As the new '2011 forecast' does not include 2010, and as 2010 data are not yet available from the national JFSQ (EUROSTAT/FAO/UNECE) reporting process, the average assortments for the years 2008, 2009, 2011 and 2012 (Table 10) were used to estimate an average roundwood harvest by top diameter assortment class from Article 3.4 forest in 2010 (Table 10, highlighted in grey). The estimated total roundwood harvest from Article 3.4 forest in 2010 was taken from the roundwood forecast harvest for 2010 (Table 13), as included in the EU LULUCF submission of November 2009[14].

Table 10: Historic and forecast roundwood harvest by top diameter assortment class from Article 3.4 (pre-1990) forest in Ireland for the period up to the end of 2012[15].

Year	Pulpwood (top diameter 7-13 cm OB)	Sawlog (top diameter ≥14 cm OB)	Total	Pulpwood (top diameter 7-13 cm OB)	Sawlog (top diameter ≥14 cm OB)
	000 m^3 overbark			% of annual harvest	
2008	671	1,250	1,921	34.93	65.07
2009	742	1,510	2,252	32.95	67.05
2010	443	1,440	1,883	23.54	76.46
2011	257	1,804	2,061	12.47	87.53
2012	320	1,994	2,314	13.83	86.17
Average annual assortment				23.54	76.46

[14] http://www.coford.ie/media/coford/content/toolsservices/euforestdata-nov09.pdf

[15] An increasing volume of the roundwood being harvested and which is forecast to be harvested from forests in Ireland is being and will be supplied from post-1990 forest.

Likewise, an average conversion factor of sawnwood output divided by sawlog harvest input for the period 2005-2009 was used to forecast the volumes of sawnwood produced from domestic sawlog harvest in Ireland in 2010 (Table 11).

Table 11: Derivation of a conversion factor to estimate the volume of sawnwood produced from domestic sawlog harvest Ireland in 2010[3].

Year	Item		
	Domestic sawlog harvest in the Republic of Ireland	Annual output of sawnwood produced from domestic harvest in the Republic of Ireland	Conversion factor showing the volume of sawnwood produced per m^3 of sawlog harvested
	000 m^3		
	a	b	c=b/a
2005	1,940	983	0.51
2006	1,967	1,006	0.51
2007	1,897	967	0.51
2008	1,331	652	0.49
2009	1,646	759	0.46
Average conversion factor			0.50

Similarly, an average conversion factor of wood-based panel product output divided by the pulpwood harvest input for the period 2005-2009 was used to forecast the volumes of wood-based panel products produced from domestic pulpwood harvest in Ireland in 2010 (Table 12).

Table 12: Derivation of a conversion factor to estimate the volume of wood-based panels produced from domestic pulpwood harvest in Ireland in 2010.

Year	Item		
	Domestic pulpwood harvest in the Republic of Ireland	Annual output of wood-based panel products produced from domestic harvest in the Republic of Ireland	Conversion factor showing the output of wood-based panels per m^3 of pulpwood harvested
	000 m^3		
2005	835	900	1.08
2006	836	952	1.14
2007	910	951	1.05
2008	725	797	1.10
2009	746	708	0.95
Average conversion factor			1.06

<u>Estimation of wood-based panels and sawnwood production from domestic harvest in Ireland, 2010-2020 (Figure 5 step 4)</u>

Table 13 presents the time series of sawnwood and wood-based panel production from the domestic roundwood harvest in Article 3.4 forest in Ireland for the period 2010-2020, estimated using the methodologies outlined.

Table 13: Forecast of the volume of roundwood which will be harvested from Article 3.4 forest in Ireland and an estimation of the forest products which will be produced therefrom (2010-2020).

Year	Estimated annual harvest of		Total harvest	Forecast annual production of	
	Pulpwood (top diameter 7-13 cm OB)	Sawlog (top diameter ≥14 cm OB)		Wood-based panels	Sawnwood
	000 m^3				
2010	443	1,440	1,883	470	720
2011	257	1,804	2,061	187	691
2012	320	1,994	2,314	264	901
2013	303	2,087	2,390	243	1,064
2014	401	1,708	2,109	363	846
2015	398	2,004	2,402	359	1,016
2016	494	2,064	2,558	476	1,051
2017	509	2,195	2,704	494	1,127
2018	586	2,284	2,870	588	1,179
2019	647	2,379	3,026	662	1,233
2020	668	2,514	3,182	688	1,311

Netting off the HWP derived from Article 3.3 harvest for 2007-2009

In order to estimate emissions from HWP originating from Article 3.4 forest harvest in 2007-2009 it was necessary to net off HWP originating from Article 3.3 forest in the same years. Volumes of wood-based panels and sawnwood produced from the roundwood which was harvested from Article 3.3 forest in Ireland for the period 2007-2009 (Table 14) were estimated using the volumes of pulpwood and sawlog harvested for those years and using the sawnwood and wood-based panel conversion ratios in Tables 11 and 12.

Table 14: Volume of roundwood which was harvested from Article 3.3 forest in Ireland and the type and volume of forest products manufactured therefrom (2007-2009).

Year	Roundwood harvest from Article 3.3 forest by top diameter assortment (cm overbark)		Forest products which were manufactured from the roundwood harvested from Article 3.3 forest	
	Pulpwood (top diameter 7-13 cm OB)	Sawlog (top diameter ≥14 cm OB)	Wood-based panels	Sawnwood
	000 m^3			
2007	87	58	92	29
2008	165	81	175	41
2009	168	136	178	68

The volumes of sawnwood and wood-based panels which were produced from the roundwood harvested in Article 3.3 forest over the period 2007-2009 were deducted from the total volume of sawnwood and wood-based panels produced from overall domestic harvest in the same years to arrive at the net Article 3.4 HWP pool for the years concerned (Tables 15 and 16).

Table 15: Estimation of the net volume of sawnwood produced from domestic sawlog harvest in Article 3.4 forest in Ireland (2007-2009).

Year	Total sawnwood production	Volume of sawnwood produced from the domestic sawlog harvest in Article 3.3 forest	Volume of sawnwood produced from the domestic sawlog harvest in Article 3.4 forest
	000 m^3		
	a	b	c = (a-b)
2007	985	29	956
2008	702	41	661
2009	773	68	705

Table 16: Estimation of the volume of wood-based panels produced from the domestic pulpwood harvest in Article 3.4 forest in Ireland (2007-2009).

Year	Total production of wood-based panels	Volume of wood-based panels produced from the pulpwood harvest in Article 3.3 forest	Volume of wood-based panels produced from the pulpwood harvest in Article 3.4 forest
	000 m^3		
	a	b	c = (a-b)
2007	918	92	826
2008	779	175	604
2009	709	178	531

Calculation of densities of wood-based panel and panel product segregation to estimate carbon content

Densities of wood-based panel products manufactured in Ireland (Table 17) were used to convert historic and projected wood-based panel output in cubic metres to dry matter.

Table 17: Densities of wood-based panel products manufactured in Ireland by product type[16].

Wood-based panel product	Panel density kg/m^3
Medium density fibreboard (MDF)	740
Oriented strand board (OSB)	630
Particleboard	625

Neither the historic output nor the forecast output of the wood-based panel sector produced from pulpwood which was harvested or which will be harvested from Article 3.4 forest is segregated by wood-based panel type. In order to segregate output and to provide more accurate estimates of carbon content, the historic output data for the wood-based panel sector in Ireland for the period 2005-2009 (Table 18 -broken down by wood-based panel type) was used to establish a relationship between total production and MDF production (Eq 11, r^2 = 0.95):

[16] Wood-based panel product densities are taken from the report on forest product conversion factors for the UNECE region; http://timber.unece.org/fileadmin/DAM/publications/DP-49.pdf

Annual MDF production = $0.5083 \times ATWPP \div 10.933$, (11)

where ATWPP is annual wood-based panel production.

Table 18: Annual production of wood-based panels in Ireland by product type (2005-2009)[17].

Year	Annual production of wood-based panels by product type		
	Particleboard including OSB	MDF	Total
	000 m^3		
2005	435	440	875
2006	437	501	938
2007	440	479	919
2008	377	401	778
2009	329	380	709

The relationship in Eq 11 was applied to the estimated total wood-based panel production from domestic pulpwood harvest in Article 3.4 forest over the period 2007-2009 to estimate annual MDF production. Particleboard production was obtained by difference (Table 19).

Table 19: Estimation of the volume and type of wood-based panels produced or to be produced from the volume of pulpwood which was harvested or forecast to be harvested from Article 3.4 (pre-1990) forest in Ireland (2007-2020).

Year	Annual production of wood-based panels by product type		
	Particleboard including OSB	MDF	Total
	000 m^3		
2007	395	431	826
2008	286	318	604
2009	250	281	531
2010	220	250	470
2011	81	106	187
2012	119	145	264
2013	108	135	243
2014	167	196	363
2015	165	194	359
2016	223	253	476
2017	232	262	494
2018	278	310	588
2019	314	348	662
2020	327	361	688

17 Wood-based panel production data is taken from the EUROSTAT/FAO/UNECE JFSQ;

http://faostat.fao.org/site/626/default.aspx#ancor

Carbon factors (tonnes carbon per m^3) of MDF, particle board and OSB were calculated by converting the product density (from kg/m^3 to $tonnes/m^3$, then by multiplying each product density (Table 17) by the default carbon fraction 0.468 (tonnes carbon per oven dry tonne of wood material, average for wood panels[18]). Default carbon factors for saw[n] wood (coniferous and non coniferous), fibreboard, hardboard, insulating board, veneer sheets, and plywood[19] were applied to the secondary HWP categories in FAO data available for Ireland from 1961-2009.

Emissions from the historic and projected HWP C pool
Forestry production and trade data from 1961-2009 from FAO[20] were used to estimate harvested wood product (HWP) emissions/removals in Ireland 1990-2020 using a hybrid model based on Pingoud's HWP model[21] and Skog's WOODCARBII model[22].

Production, import, and export HWP data (Table 13 and 19), first order decay rates and half lives of wood products were used to estimate HWP pools and emissions on a yearly basis. Historic consumption rates from 1900-1960, using a growth rate of 1.15% y^{-1}, were used to estimate emissions from products entering the system prior to 1961. Default half-lives of two years for paper, 25 years for wood panels, and 35 years for saw[n] wood[23] were used to estimate emissions resulting from products coming out of use.

Estimates of HWP arising from domestic harvests of Article 3.4 forest only were used to derive estimates of emissions/removal from the HWP pool for the period 2010-2020 (Table 1 and 3). Emissions/removals estimates include emissions from the historic HWP pool going back to 1900, using the methodologies outlined in IPCC Guidelines for National Greenhouse Gas Inventories 2006[24].

f) Disturbances in the context of force majeure

Ireland has included natural disturbances in its Forest Management reference level to maintain consistency between the reference level and accounting in the commitment period (see national reports to the UNFCCC (NIR, 2010). Projected emissions from fires were estimated using the mean annual emission for fires from 1990 to 2008 (0.12 Gg CO_2).

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

The indirect effect of elevated carbon dioxide concentrations above the pre-industrial level and indirect nitrogen deposition was not factored out when using the reference level approach as these effects cancel out when substracting the reference level from net emissions/removals occurred during the commitment period. The data therefore implicitly include indirect effect of elevated carbon dioxide concentrations above the pre-industrial level and indirect nitrogen deposition in its proposed reference levels.

18 IPCC Guidelines for National Greenhouse Gas Inventories 2006, Table 12.4.

19 IPCC Good Practice Guidance for LULUCF, Appendix 3a.1, Table 3a1.1.

20 http://faostat.fao.org/site/626/default.aspx#ancor

21 HWP calculation tool, Chapter 12. Harvested Wood Products. 33 p.+ HWP Worksheet MS Excel. In: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, Agriculture, Forestry and Other Land Use. http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm).

22 Skog, K. E. (2008) Sequestration of carbon in harvested wood products for the United States, Forest Products Journal, 58, 56-72.

23 Product categoires, half lives and methodologies outlined in para 27, page 31 of FCCC/KP/AWG/2010/CRP.4/Rev.4

24 IPCC Guidelines for National Greenhouse Gas Inventories 2006 Chapter 12, pg 17-19.

6 *Policies included*

I. *Pre-2010 domestic policies included*

The Coillte 2006 forecast of roundwood production to 2020 is the policy basis for the harvesting assumption in the projected reference level. As outlined the forecast is driven by silvicultural considerations, mainly thinning and rotation age. The main impact of market considerations in the forecast is the smoothing applied (bringing forward and holding back harvest in individual stands) to provide for an even level of wood supply to industry. Increased demand for wood energy is envisaged in national policies that post-date the projected harvest levels used to construct the reference level. Wood for these uses is, however, forecast to come mainly from Article 3.3 post-1990 forests (Phillips, 2011).

II. *Confirmation of factoring out of policies after 2009*

As described construction of the Forest Management reference level is based on the 2006 Coillte harvest and rotation policy for pre-1990 forests. The reference level includes no assumptions about changes to domestic polices adopted or implemented after mid-2009, nor includes new domestic policies.

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Abbreviations

f	Forecast
HWP	Harvested wood products
JFSQ	Joint Forest Sector Questionnaire
LULUCF	Land use, land-use change and forestry
m^3	Cubic metre
MDF	Medium density fibreboard
NI	Northern Ireland
OB	Overbark
OSB	Oriented strand board
PCRW	Post-consumer recovered wood
RoI	Republic of Ireland
TC	Timber Committee (of the UNECE)
UNECE	United Nations Economic Commission for Europe