

## 2.8 HARVESTED WOOD PRODUCTS (HWP)

Section 2.8 provides *good practice* guidance for estimating annual changes in carbon stocks and associated CO<sub>2</sub> emissions and removals from the Harvested Wood Products (HWP) pool (hereinafter referred to as the *HWP contribution*) to be reported and accounted for in accordance with Decision 2/CMP.7 and 2/CMP.8.<sup>106</sup> It provides guidance for selecting adequate data and methods consistent with the system boundaries of the accounting approach defined in the Decision.

Various approaches have been proposed for estimating and reporting the *HWP contribution*. They differ in the reference to the atmosphere and the treatment of HWP trade, due to different interpretations of some key terms that are relevant for the reporting framework (Winjum *et al.*, 1998, Cowie *et al.*, 2006). This situation is reflected in Chapter 12, Volume 4 of the *2006 IPCC Guidelines* which states that the guidance given “*does not prefer any of these [approaches] and does not attempt to prejudge whether these, or any other approach, should be used to account*” for the *HWP contribution* (IPCC 2006). Hence, it suggests calculating different variables that are needed to estimate the *HWP contribution* according to the different approaches (see Table 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*).

One of the implications of Decision 2/CMP.7 is that accounting of HWP is confined to products in use where the wood was derived from domestic harvest, i.e. trees harvested in the reporting country.<sup>107</sup> In principle, this is similar to basing estimates of the *HWP contribution* on changes in the pool (i.e. stock-changes) reflected by variable 2A in Table 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*, however Decision 2/CMP.7 imposes some additional constraints and limits the extent of HWP which can be included in the estimates.

### 2.8.1 Initial steps to estimate the HWP contribution

To estimate the HWP contribution and account for the changes in the HWP pool in line with Decision 2/CMP.7, it is *good practice* to follow the decision tree (Figure 2.8.1) and the steps described below.

#### **STEP 1: Check the construction of the forest management reference level (FMRL) and the availability of transparent and verifiable activity data on HWP**

According to Decision 2/CMP.7 Parties are required to account for HWP on the basis of the change in the HWP pool during the second and subsequent commitment periods, provided that transparent and verifiable activity data are available for the three HWP categories, sawn wood, wood panels and paper.<sup>108</sup> In the case that the country’s FMRL is based on a projection, accounting shall be on the basis of the change in the HWP pool (i.e. Tier 2 or 3 methods).<sup>109</sup> In order to meet the requirements of Decision 2/CMP.7 countries should:

STEP 1.1: Check whether the FMRL has been based on a projection (see 2.7.5). If this is the case, skip the next steps and go to STEP 1.4.

STEP 1.2: Check databases of international organizations, such as the public database of the Food and Agriculture Organization of the United Nations (FAO)<sup>110</sup> for the availability of production and trade statistics on the HWP categories defined in Decision 2/CMP.7. Detailed guidance is given in Section 2.8.1.1.

STEP 1.3: Check whether other activity data (i.e. country-specific) are available which fulfil the requirement to be transparent and verifiable. Further guidance is given in Section 2.8.4.1. In the case that data from STEP 1.2 and/or 1.3 are available go to STEP 1.4, otherwise apply Tier 1 (Section 2.8.2).

STEP 1.4: Ensure that HWP data represent information on the material use of wood (products in service) in order to exclude the HWP used for energy purposes and HWP in solid waste disposal sites (SWDS)<sup>111</sup> and cross-check the information with guidance given in Sections 2.8.1.1 and 2.8.4.1. If activity data represent information on material use of HWP in service go to STEP 2, otherwise apply Tier 1 (Section 2.8.2).

<sup>106</sup> References to paragraphs in this chapter refer to the Annex of Decision 2/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1, unless indicated otherwise

<sup>107</sup> Paragraph 27

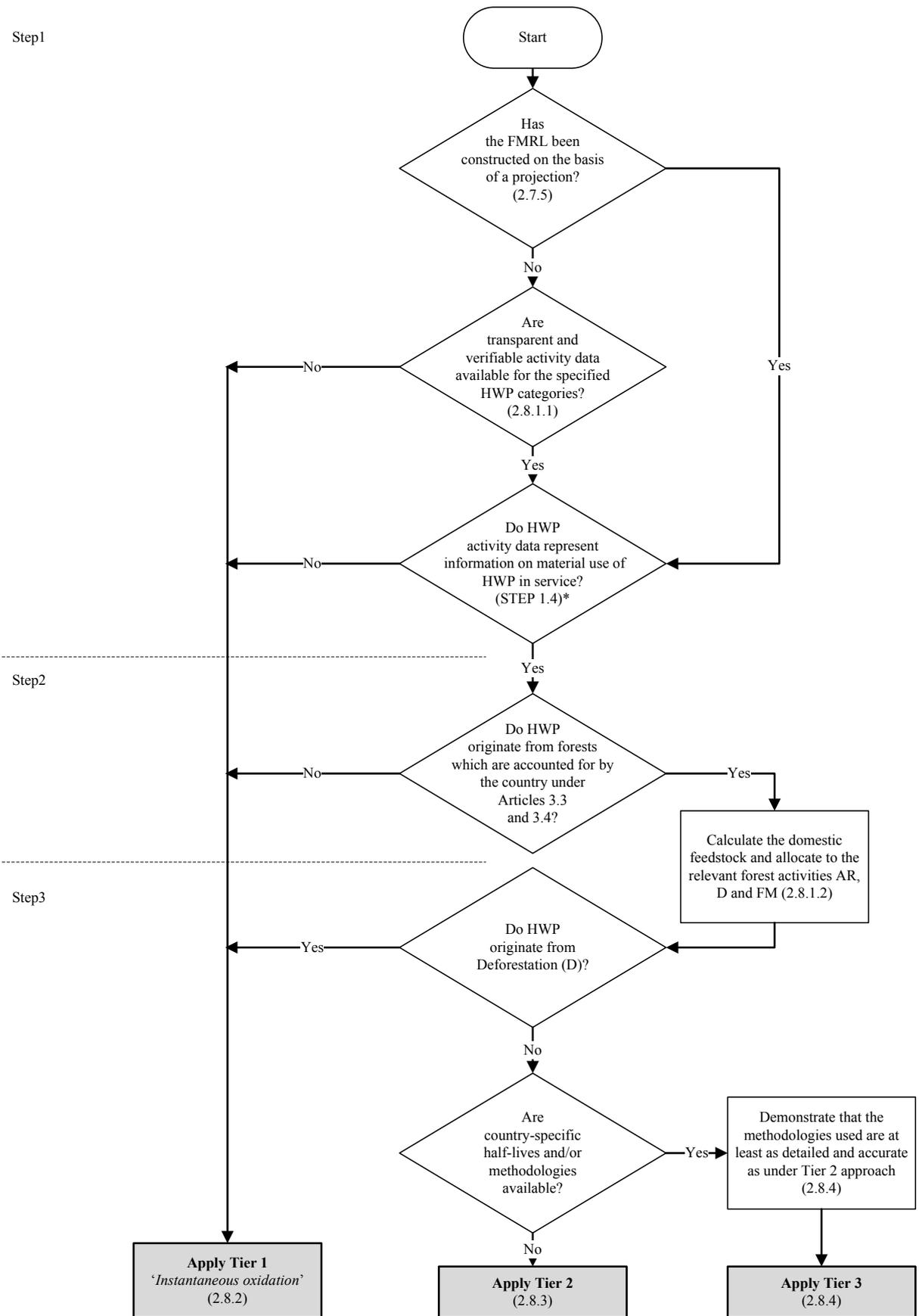
<sup>108</sup> Paragraph 29

<sup>109</sup> Paragraph 16

<sup>110</sup> <http://faostat.fao.org/site/630/Default.aspx>

<sup>111</sup> Paragraph 32

**Figure 2.8.1 Decision tree for selection of a correct tier method for estimating HWP carbon stock change**



\*This only applies to cases especially mentioned in STEP 1.4, i.e. "HWP used for energy purposes and HWP in solid waste disposal sites".

## **STEP 2: Check whether HWP categories originate from forests that are accounted for by the country and allocate HWP to the particular forest related activity**

Decision 2/CMP.7 limits the mandatory accounting to HWP originating from domestic forests which are accounted for under Article 3, paragraphs 3 and 4. Imported HWP, irrespective of their origin, are excluded<sup>112</sup>. Figure 2.8.1 shows that Decision 2/CMP.7 specifies the methods to be used for the estimation of the *HWP contribution* depending on the land of origin of HWP.<sup>113</sup>

Detailed guidance on how to implement all the following steps is given in Section 2.8.1.2.

STEP 2.1: Estimate the share of HWP originating from forests within the country. The default assumption is that domestically consumed industrial roundwood represents the domestic production feedstock for the subsequent processing of the semi-finished product categories sawnwood and wood panels. Domestically consumed wood pulp is the feedstock for paper production.

STEP 2.2: Estimate the share of HWP originating from Afforestation (A), Reforestation (R) and Deforestation (D) under Article 3 paragraph 3 and Forest Management (FM) under Article 3 paragraph 4 as the methods for estimating the *HWP contribution* will differ according to the provisions outlined in the decision tree for tier selection (Figure 2.8.1).

STEP 2.3: The amount of HWP entering the accounting framework (i.e. activity data) is obtained by combining the information from STEPS 2.1 and 2.2 with the annual production of the HWP commodity categories obtained from STEP 1.

## **STEP 3: Check the availability of country-specific information and estimate carbon stock in HWP and its annual change**

Depending on the results of STEPS 1 and 2, and on the availability of country-specific half-lives and/or country-specific methodologies, the estimation of the *HWP contribution* follows different tier methods.

Tier 1 method specifies the assumption of instantaneous oxidation and is to be used under certain circumstances and for specific parts of the HWP pool as explained further down below. The combination of HWP activity data following the international classification system of semi-finished wood products (Figure 2.8.2) with default conversion factors and default half-lives constitutes Tier 2. Under a Tier 3 method, more accurate country-specific information is applied. This includes activity data and/or emission factors (i.e. service life information of HWP), which is intended to improve the accuracy of the estimates. In order to choose the appropriate tier method, please follow all the steps presented below.

STEP 3.1: In case HWP originate from Deforestation (D) use Tier 1 method (Section 2.8.2).

STEP 3.2: Check whether country-specific HWP activity data following the international classification system outlined in Section 2.8.1.1 together with specific conversion factors are available for the country following the guidance given in Section 2.8.4.1. If this is the case, allocate HWP activity data in line with STEP 2 and apply Tier 3 (Section 2.8.4).

STEP 3.3: Check whether country-specific half-life values for the three HWP categories and/or their disaggregates (see Section 2.8.1.1) can be obtained following the guidance given in Section 2.8.4.2. If this is the case, apply Tier 3 (Section 2.8.4).

STEP 3.4: Check whether other country-specific methods are available that meet the requirements as specified in Section 2.8.1.1 and 2.8.4. If this is the case, allocate HWP activity data in line with STEP 2 and apply Tier 3 (Section 2.8.4).

STEP 3.5: In case the country is unable to apply a Tier 3 method as outlined for the STEPS 3.2 to 3.4, allocate HWP activity data in line with STEP 2 and apply Tier 2. Guidance on Tier 2 is given in Section 2.8.3.

### **2.8.1.1 AVAILABILITY OF TRANSPARENT AND VERIFIABLE ACTIVITY DATA**

A prerequisite for Parties when accounting for HWP on the basis of the change in the HWP pool is the availability of “*transparent and verifiable activity data*” for the three specified HWP categories “*paper, [...]*”

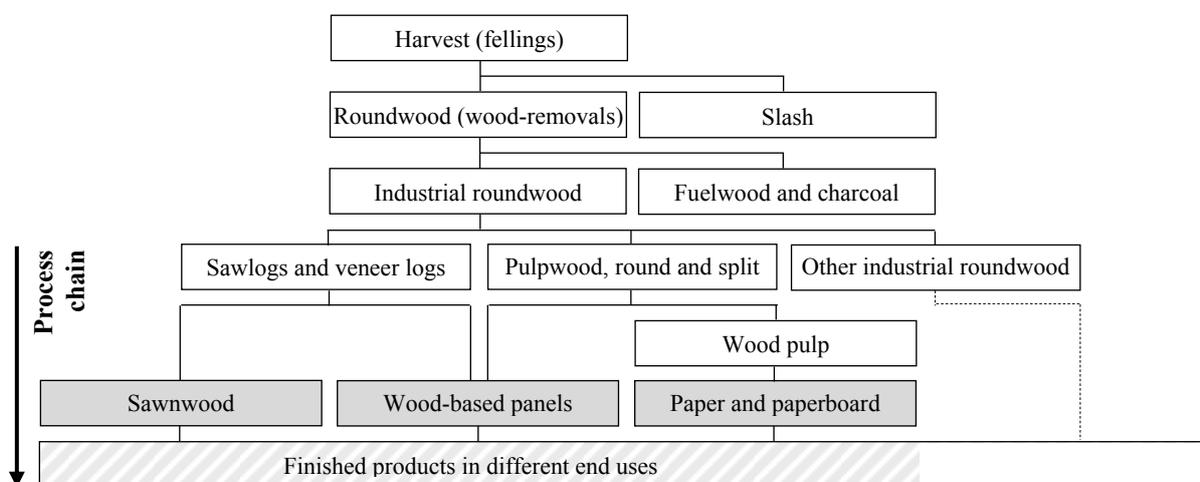
<sup>112</sup> Paragraph 27

<sup>113</sup> Paragraphs 28, 29, 31 and 32

*wood panels*, and [...] *sawnwood*” (see STEP 1).<sup>114</sup> This section provides guidance on when available data is to be considered transparent and verifiable for estimating the *HWP contribution*.

Whereas the term “harvested wood products” is based on a concept containing the two separate elements “forest harvesting” and “wood products” (Brown *et al.*, 1998, UNFCCC Secretariat 2003), the categories named in Decision 2/CMP.7 refer to the definitions of semi-finished wood products of the international classification system of forest products.<sup>115</sup> It is thus *good practice* to assume that the three HWP categories named in Decision 2/CMP.7 accord with these commodities. Other terms commonly used include “removals” (i.e. roundwood) are a subset of “forest harvesting” of biomass (i.e. fellings) at the beginning of the forest-wood chain (see definitions below). Following the forest products definitions of the FAO, Figure 2.8.2 furthermore shows the relevance of the aggregate commodity “industrial roundwood”. Its subcategories provide the feedstock for the subsequent processing of the three named semi-finished HWP commodities along the value chain (cf. FAO 2012). The international classification system for forest products can be related to the Harmonized Commodity Description and Coding System (HS) of tariff nomenclature provided by the World Customs Organization (WCO).<sup>116</sup>

**Figure 2.8.2** Simplified classification of wood products based on FAO forest products definitions



Definitions of semi-finished product commodities, which are relevant for the application of the guidance on estimating the *HWP contribution* in line with Decision 2/CMP.7, are listed below (cf. Figure 2.8.2). They are drawn from the definitions of the Joint Forest Sector Questionnaire (JFSQ) as established by the Intersecretariat Working Group on Forest Sector Statistics<sup>117</sup> and form the basis for the forest products statistics e.g. provided by FAO. The JFSQ also includes conversion factors to be used for converting e.g. from nominal to solid volume in the compilation of statistics if required.<sup>115</sup> Datasets for these aggregate product categories are freely and easily accessible, are updated on at least an annual basis with a 6-month or one year reporting lag, and time series are available for most countries worldwide.<sup>118</sup>

**SAWNWOOD** (Decision 2/CMP.7 refers to this as “sawn wood”): “Wood that has been produced from both domestic and imported roundwood, either by sawing lengthways or by a profile-chipping process and that exceeds 6 mm in thickness. It includes planks, beams, joists, boards, rafters, scantlings, laths, boxboards and “lumber”, etc., in the following forms: unplaned, planed, end-jointed, etc. It excludes sleepers, wooden flooring, mouldings (sawnwood continuously shaped along any of its edges or faces, like tongued, grooved, rebated, V-jointed, beaded, moulded, rounded or the like) and sawnwood produced by resawing previously sawn pieces. It is reported in cubic metres solid volume.”<sup>115</sup>

<sup>114</sup> Paragraph 29

<sup>115</sup> <http://www.fao.org/forestry/statistics/80572/en/> (2013/08/27)

<sup>116</sup> <http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs-online.aspx> (2013/08/27)

<sup>117</sup> Comprising the Forestry Department of FAO, the United Nations Economic Commission for Europe (UNECE), the Statistical Office of the European Communities (EUROSTAT) and the International Tropical Timber Organization (ITTO)

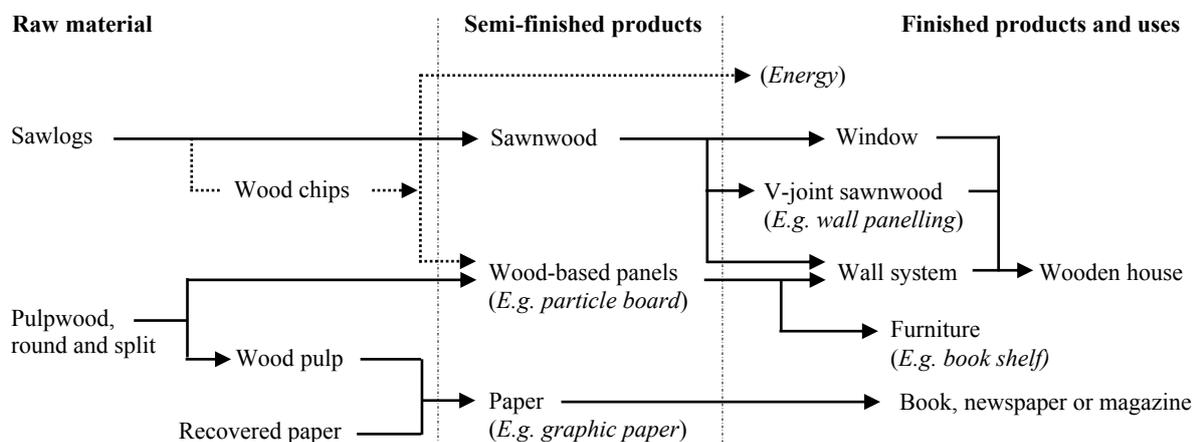
<sup>118</sup> <http://faostat.fao.org/site/630/default.aspx> (2013/08/27)

**WOOD-BASED PANELS** (Decision 2/CMP.7 refers to this as “wood panels”): “This product category is an aggregate comprising veneer sheets, plywood, particle board, and fibreboard. It is reported in cubic metres solid volume.”<sup>115</sup> For the definitions of these subcategories please see FAO.

**PAPER AND PAPERBOARD** (Decision 2/CMP.7 refers to this as “paper”): “The paper and paperboard category is an aggregate category. In the production and trade statistics, it represents the sum of graphic papers; sanitary and household papers; packaging materials and other paper and paperboard. It excludes manufactured paper products such as boxes, cartons, books and magazines, etc. It is reported in metric tonnes.”<sup>115</sup>

By definition, these three aggregate commodities of semi-finished wood products represent information on the material use of HWP and equal the default categories mentioned in Decision 2/CMP.7. All datasets are reported in cubic metres solid volume or metric tonnes, which is information that enables countries to convert the data given into carbon units. Commodities which are excluded from the definitions above (e.g. V-jointed sawnwood or laminated veneer lumber (LVL)) may be the result of subsequent processing and therefore fall under the category of finished wood products as illustrated in Figure 2.8.3. This also applies e.g. to wooden flooring that is produced from sawnwood and/or hardboard which belongs to the category of wood-based panels; wooden flooring in this case is therefore implicitly covered by the semi-finished HWP categories sawnwood and wood-based panels and included in the estimates for the *HWP contribution*. Thus, using statistical data both for sawnwood and for wooden flooring would result in double counting.

**Figure 2.8.3** Examples of different processing stages of wood products along the process and value chain



To avoid potential double counting, countries are encouraged to consult e.g. FAO for further clarification on the mass flows along the forest wood processing chain depending on the classification and definition of the relevant commodities.<sup>115</sup> The inclusion of the commodity wood pulp under the HWP category “paper” would for example result in double counting, as wood pulp by definition constitutes the feedstock for the production of paper and paperboard (cf. definition below and Figure 2.8.2). The application of information on wood pulp does, however, enter the default method to calculate the share of HWP coming from domestic forests as reflected in Equation 2.8.2. Wood pulp data may also be used in higher tier methods provided that the country can demonstrate transparently that double counting is avoided (see Section 2.8.4.1).

In order to implement STEP 2 (see Section 2.8.1), further information is needed on commodities representing the raw materials eventually used as feedstock for the production of the semi-finished HWP categories listed above (cf. Figure 2.8.2). Some possible feedstock commodities are not included in the default method to allocate HWP to domestic forest activities as described in Section 2.8.1.2 below, due to difficulties in determining sources and multiple uses, e.g. wood chips used in wood-based panel and wood pulp production as some chips come from industry co-products, others could be recycled products and others go to energy use (see Figure 2.8.3). Definitions of some key feedstocks used are provided below.

According to the 2006 *IPCC Guidelines*, “**WOOD-REMOVALS** are generally a subset of fellings”.

**ROUNDWOOD:** “All roundwood felled or otherwise harvested and removed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period, calendar year or forest year. It includes all wood removed with or without bark, including wood removed in its round form, or split, roughly squared or in other form (e.g. branches, roots, stumps and burls (where these are harvested) and wood that is roughly shaped or

pointed. It is an aggregate comprising wood fuel, including wood for charcoal and industrial roundwood (wood in the rough). It is reported in cubic metres solid volume underbark (i.e. excluding bark).”<sup>115</sup>

**INDUSTRIAL ROUNDWOOD (WOOD IN THE ROUGH):** “All roundwood except wood fuel. In production, it is an aggregate comprising sawlogs and veneer logs; pulpwood, round and split; and other industrial roundwood. It is reported in cubic metres solid volume underbark (i.e. excluding bark). The customs classification systems used by most countries do not allow the division of Industrial Roundwood trade statistics into the different end-use categories that have long been recognized in production statistics (i.e. sawlogs and veneer logs, pulpwood and other industrial roundwood). Thus, these components do not appear in trade. It excludes: telephone poles.”<sup>115</sup>

**WOOD PULP:** “Fibrous material prepared from pulpwood, wood chips, particles or residues by mechanical and/or chemical process for further manufacture into paper, paperboard, fibreboard or other cellulose products. It is an aggregate comprising mechanical wood pulp; semi-chemical wood pulp; chemical wood pulp; and dissolving wood pulp.”<sup>115</sup>

Production data on finished wood products processed from the three semi-finished product categories (see Figure 2.8.2) are not included in international databases. However, the WCO HS tariff nomenclature (see above) also includes some commodities for finished HWP (e.g. furniture, builders' joinery and carpentry of wood). Accordingly, information on such commodities could be available in national production and trade statistics (see Section 2.8.4.1). Consequently, *good practice* in providing transparent and verifiable activity data for HWP, which qualifies for the provision of Decision 2/CMP.7 to account for the *HWP contribution* on the basis of changes in the HWP pool, is achieved by the availability of data for the three aggregate HWP commodities sawnwood, wood-based panels and paper and paperboard in publicly available databases of international organizations, such as FAOSTAT (cf. *IPCC 2006 Guidelines*). It is *good practice* to report on uncertainties related to these datasets (see Section 2.8.6).

In addition, countries with available data on finished wood products produced from the default HWP categories are encouraged to use these data following the guidance given in Section 2.8.4.

### 2.8.1.2 ALLOCATION OF HWP TO DOMESTIC FOREST ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4

According to Decision 2/CMP.7, accounting for the *HWP contribution* is restricted to carbon in HWP from forests which are accounted for by the particular Party under Article 3, paragraphs 3 and 4. Carbon in imported HWP is to be excluded.<sup>119</sup> As the accounting framework differentiates between activities under Article 3 paragraph 3 and activities under Article 3 paragraph 4, it is *good practice* to allocate the carbon in HWP to these activities. Within Article 3 paragraph 3, HWP from Deforestation (D) is treated differently from HWP derived from A and R activities.

This section describes a default method on how to implement STEP 2 (see Section 2.8.1) for estimating the *HWP contribution* originating from forests that are accounted for under the particular forest activities.

#### Implementation of STEP 2.1

Firstly, the share of carbon in HWP coming from domestic forests is estimated. For this purpose, the share of feedstock from domestic sources remaining within the country as against the overall availability of feedstock used for subsequent processing within the country (i.e. apparent consumption generally computed from production data plus import minus export) is calculated. In the case of HWP categories sawnwood and wood-based panels, the apparent consumption of industrial roundwood (see Section 2.8.1.1) is assumed to equal the feedstock used to manufacture those products (Rüter 2011, Johannsen *et al.*, 2011). Some industrial roundwood can also be used for the production of pulp, serving as feedstock for the semi-finished HWP commodity paper and paperboard. As pulp is also a traded commodity, the share of pulp produced from domestic sources as against the overall availability of pulp is to be calculated in a second step. Generally, domestic consumption is computed from production data plus imports less exports.

However, commodities other than industrial roundwood and/or wood pulp can also serve as feedstock for the production of HWP and the fraction of domestic feedstock in reality differs within the different product categories (Rüter and Diederichs 2012). For example, substantial amounts of industrial wood residues including wood chips are used for the manufacture of particle board (Wilson 2010) (cf. Figure 2.8.3). If detailed and representative information on the composition of feedstock and the associated wood flows is available for these domestically produced HWP commodities, countries are encouraged to use this country-specific information to estimate the fraction of feedstock from domestic harvest for HWP production and apply Tier 3 (see Section 2.8.4.1).

<sup>119</sup> Paragraph 27

If country-specific methods and/or estimates are not available to determine the processing of feedstock coming only from domestic origin (e.g. track and trace systems), it is *good practice* to apply Equation 2.8.1 for estimating the annual fraction of the feedstock coming from domestic harvest  $f_{IRW}(i)$  for the HWP categories sawnwood and wood-based panels.<sup>120</sup>

**EQUATION 2.8.1**  
**ESTIMATION OF ANNUAL FRACTION OF FEEDSTOCK FOR HWP PRODUCTION ORIGINATING FROM DOMESTIC HARVEST**

$$f_{IRW}(i) = \frac{IRW_P(i) - IRW_{EX}(i)}{IRW_P(i) + IRW_{IM}(i) - IRW_{EX}(i)}$$

Where:

$f_{IRW}(i)$  = share of industrial roundwood for the domestic production of HWP originating from domestic forests in year  $i$ .

$IRW_P(i)$  = production of industrial roundwood in year  $i$ , Gg C yr<sup>-1</sup>

$IRW_{IM}(i)$  = import of industrial roundwood in year  $i$ , Gg C yr<sup>-1</sup>

$IRW_{EX}(i)$  = export of industrial roundwood in year  $i$ , Gg C yr<sup>-1</sup>

In consideration of the HWP process chain (i.e. paper is also produced from traded pulp) and in order to provide more reliable estimates, it is likewise *good practice* to apply Equation 2.8.2 to estimate the annual fraction of domestically produced wood pulp as feedstock originating from domestic harvest for the production of the HWP category paper and paperboard ( $f_{PULP}(i)$ ).<sup>120</sup>

**EQUATION 2.8.2**  
**ESTIMATION OF ANNUAL FRACTION OF DOMESTICALLY PRODUCED WOOD PULP AS FEEDSTOCK FOR PAPER AND PAPERBOARD PRODUCTION**

$$f_{PULP}(i) = \frac{PULP_P(i) - PULP_{EX}(i)}{PULP_P(i) + PULP_{IM}(i) - PULP_{EX}(i)}$$

Where:

$f_{PULP}(i)$  = share of domestically produced pulp for the domestic production of paper and paperboard in year  $i$ .

$PULP_P(i)$  = production of wood pulp in year  $i$ , Gg C yr<sup>-1</sup>

$PULP_{IM}(i)$  = import of wood pulp in year  $i$ , Gg C yr<sup>-1</sup>

$PULP_{EX}(i)$  = export of wood pulp in year  $i$ , Gg C yr<sup>-1</sup>

The resulting feedstock factor  $f_{IRW}(i)$  is then applied for the aggregate commodities sawnwood and wood-based panels in Equation 2.8.4 below. For estimating the *HWP contribution* of the aggregate commodity paper and paperboard, both feedstock factors  $f_{IRW}(i)$  and  $f_{PULP}(i)$  apply in order to exclude both wood pulp produced from imported industrial roundwood, and paper produced from imported wood pulp (see above and Equation 2.8.4).

### Implementation of STEP 2.2

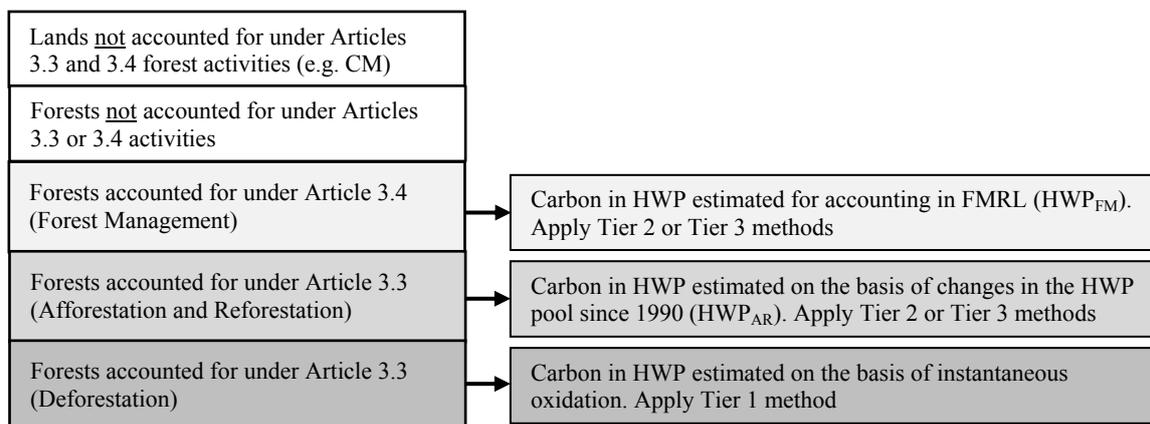
In STEP 2.2, the carbon in HWP is allocated to the particular forest activities under Article 3, paragraphs 3 and 4 (see Figure 2.8.1) as the *HWP contribution* is estimated differently depending on the origin of the wood. Under Article 3 paragraph 3, the *HWP contribution* originating from forest activities A, R and D is estimated since the

<sup>120</sup> Since the application of the equations only apply to the feedstock calculation, it does not result in the exclusion of exported HWP (see Sections 2.8.3 and 2.8.4)

base year 1990. The *HWP contribution* from HWP originating from the activity FM under Article 3 paragraph 4 is accounted for in the second commitment period consistently with the FMRL<sup>121</sup> (see Sections 2.7.5 and 2.8.5).

It is *good practice* to apply Tier 2 or Tier 3 methods for the particular fractions of HWP that are derived from domestic forests accounted for under FM and AR activities ( $HWP_{FM}$  and  $HWP_{AR}$ ) in line with the provisions set out in Decision 2/CMP.7<sup>122</sup> (see Section 2.8.1.2 and Figure 2.8.4). In both cases, guidance on estimation methods is provided in Sections 2.8.3 and 2.8.4. For HWP originating from D activities the Tier 1 method shall be applied (Section 2.8.2).

**Figure 2.8.4 Relationship between sources of feedstock for HWP, forest activities and the application of the relevant tier method for estimating the HWP contribution**



If country-specific approaches are not available to allocate domestic harvest and subsequently produced HWP therefrom to the activities AR, D and FM (e.g. by track and trace systems), it is *good practice* to apply Equation 2.8.3 for estimating the annual fraction of HWP derived from the specific forest activity ( $f_j(i)$ ) as a default. This also includes harvest that has been subject to salvage logging. The identified share of the total harvest is then assigned to the HWP associated with the particular forest activity by application of Equation 2.8.4.

**EQUATION 2.8.3**  
**ESTIMATION OF ANNUAL FRACTION OF FEEDSTOCK FOR HWP ORIGINATING FROM FOREST ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4**

$$f_j(i) = \frac{\text{harvest}_j(i)}{\text{harvest}_{Total}(i)}$$

Where:

$f_j(i)$  = share of harvest originating from the particular activity  $j$  in year  $i$

$j$  = activity FM or AR or D in year  $i$

Where countries already collect data of harvesting discriminating among different activities (i.e. lands subject to FM, lands subject to AR, lands subject to D, and any other treed land) – and among material and energy use of harvested roundwood (i.e. industrial roundwood and fuelwood, cf. Figure 2.8.2), this information can be used. This is usually the case where countries apply the gain-loss (i.e. flux data) method<sup>123</sup>.

Most countries only report industrial roundwood from forests in their statistics and the uncertainties associated with feedstock for HWP production (cf. Figure 2.8.2) originating from lands other than forests (see Figure 2.8.4) are generally expected to be insignificant. However, due to the definition of roundwood (see Section 2.8.1.1), it may be the case that the specified HWP categories are produced from industrial roundwood (or domestic feedstock), which does not originate from forests which are accounted for under Article 3, paragraphs 3 (AR and

<sup>121</sup> Paragraphs 12 and 14

<sup>122</sup> Paragraphs 16, 29 and 30

<sup>123</sup> Section 4.2.1.1, Chapter 4, Volume 4 of the 2006 IPCC Guidelines

D) and 4 (FM) (cf. Figure 2.8.2).<sup>124</sup> In the Kyoto Protocol accounting framework, activities on lands which are not considered to be forests (see Section 1.2) and which could provide industrial roundwood to the markets (e.g. short-rotation plantations), could possibly be accounted for under the activity Cropland Management<sup>125</sup> (e.g. as perennial crops including trees, see Section 2.9). Following the guidance given in Sections 2.9.1 and 2.9.2 countries are encouraged to provide information on how lands that could potentially be the source of industrial roundwood have been included in their accounting. This is relevant also for forest lands which are not subject to FM, depending on the countries' interpretation of FM (see Section 2.7.1). It is thus *good practice* to ensure that no significant amounts of biomass not originating from forests-related activities have been used as feedstock for the production of the HWP default commodities, and explain how this has been achieved.

Countries that apply the stock-difference method to estimate forest carbon stock changes as outlined in Section 2.3.3 may need to collect additional data for estimating harvest fractions associated with the particular activity *j* related to forests under Article 3, paragraphs 3 and 4 to apply Equation 2.8.3. When countries cannot track the harvested wood by the land of origin (FM, AR, D, or from treed lands, cf. Figure 2.8.4) and by different uses of wood (i.e. industrial roundwood, fuelwood), the following *good practice* applies:

For deforested lands, the starting information is the standing volume of tree before the deforestation event, which corresponds to the total harvest (i.e. fellings). The following steps apply:

STEP 1: Disaggregate the harvest into roundwood and slash by one of the following methods.

- Either multiply the standing volume by the ratio of roundwood to total harvested removals that has been calculated for other activities or at national level;
- Or divide the standing volume by the biomass expansion factors (BEF<sub>2</sub>) provided in Table 3A.1.10, Annex 3A.1 to Chapter 3 of the *GPG-LULUCF*, thereby deriving the amount of roundwood.

STEP 2: Disaggregate the roundwood into industrial roundwood and fuelwood (cf. Figure 2.8.2) by one of the following methods.

- Either multiply the roundwood by the ratio of industrial roundwood to roundwood that has been calculated for other activities or at national level;
- Or multiply the roundwood data derived from STEP 1 by the factor 0.87<sup>126</sup> in order to exclude harvest losses, bark (cf. FAO roundwood definition, Section 2.8.1.1) and fuelwood not covered by the statistics and subsequently disaggregate the result by using the proportion derived from FAOSTAT production data of the commodities industrial roundwood and wood fuel.

For AR lands, the starting information is the standing volume of trees from which fellings is derived according with the age-class structure and/or yield tables and/or information on the timing of harvesting and thinning operations for each management system. Then, STEPS 1 and 2 as described above for deforested lands apply in order to divide harvest into roundwood and slash and disaggregate roundwood into industrial roundwood and fuelwood.

For lands that are not reported under any forest-related activity (see Sections 1.1 and 1.2), and that produce significant amounts of harvest (i.e. lands from which timber is extracted, cf. Figure 2.8.4), then the country should estimate the amount of industrial roundwood annually produced from those lands in order to exclude it from the HWP estimation.

Industrial roundwood from those lands could be estimated by:

- Either by determining, for each tree species, the total amount of harvest, from which the amount of harvest originating from AR and D lands is subtracted and the remaining amount is apportioned among lands subject to FM and other lands from which significant amounts of timber are extracted based on the proportion of the total area covered by each species under FM and under those other lands; or
- Or by subtracting from the total harvest the amount of fellings originating from AR and D lands, as quantified by available data or as estimated according to above-listed guidance, and, then, apportioning the remaining quantity on the basis of the proportion of the area under FM and under those other lands.

<sup>124</sup> Paragraph 27

<sup>125</sup> Paragraph 6

<sup>126</sup> This factor represents a mass weighted average for the years 2003-2007 that has been derived from information on harvest data included in countries' FMRL submissions (<http://unfccc.int/bodies/awg-kp/items/5896.php>) and production data of the UNECE statistics for the commodity roundwood (Rüter 2011). Please note that this factor varies between countries depending *inter alia* on the national definition of volume of living stems above stump. Further guidance can be found e.g. in Lawrence *et al.*, 2010 and Karjalainen *et al.*, 2004.

Once the amount of fellings has been apportioned to lands not reported under any forest-related activity from which significant amounts of timber are extracted the industrial roundwood is estimated by applying the same steps as those described for afforested/reforested lands.

Finally, the amount of industrial roundwood produced from FM lands is estimated by subtracting from the total harvest the quantity of fellings originating from AR, D and those other lands and by calculating the amount of industrial roundwood associated with FM in line with the guidance given above.

For each forest-related activity, for the years of the time series for which a ratio of industrial roundwood originated by the activity to the total produced roundwood cannot be estimated, it is *good practice* to derive missing values from the values of the ratio that have been calculated according to methods of gap-filling as provided in the *2006 IPCC Guidelines*.

Countries that use the stock-difference method to estimate forest carbon stock changes as outlined in Section 2.3.3, and that apply the above-listed *good practice* for estimating the fellings for D, AR and/or FM, are encouraged to ensure the quality of estimated values of harvesting by checking their consistency with the estimated net changes in aboveground biomass.

In case it is not possible to differentiate between the harvest from AR and FM, it is conservative and in line with *good practice* to assume that all HWP entering the accounting framework originate from FM. The reason is that the potential contribution to the reported carbon stock changes is higher if HWP originate from AR rather than from FM, as for AR, the estimates start in 1990 and AR is accounted against a benchmark value of 0 (i.e. gross-net accounting, see Sections 2.5.3 and 2.8.3). It is furthermore conservative and in line with *good practice* to assume that all harvested wood prior to the start of the first commitment period is derived from FM, since the annual fraction of feedstock for HWP originating from forest activities under Article 3, paragraphs 3 and 4 ( $f_j(i)$ ) can only be estimated from information available from the first and second commitment periods.

### Implementation of STEP 2.3

In order to obtain the annual fractions of HWP entering the accounting framework from domestic harvest associated with the particular activity  $j$  (AR, D and FM), the results of STEP 2.1 (i.e. the factors  $f_{IRW}(i)$  and  $f_{PULP}(i)$ ) from Equations 2.8.1 and 2.8.2) and STEP 2.2 (i.e.  $f_j(i)$  from Equation 2.8.3) are, as a default, to be combined with the annual production of the HWP commodity categories ( $HWP_p$ ) as specified in Section 2.8.1.1 (i.e. sawnwood, wood-based panels, paper and paperboard). In cases where no country-specific track and trace systems are available, it is *good practice* to apply Equation 2.8.4 for this purpose.

<p><b>EQUATION 2.8.4</b></p> <p><b>ESTIMATION OF ANNUAL HWP AMOUNTS PRODUCED FROM DOMESTIC HARVEST RELATED TO ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4</b></p> $HWP_j(i) = HWP_p(i) \cdot f_{DP}(i) \cdot f_j(i)$ <p>with: <math>f_{DP}(i) = f_{IRW}(i)</math> for HWP categories 'sawnwood' and 'wood-based panels'; and  <math>(f_{IRW}(i) \cdot f_{PULP}(i))</math> for HWP category 'paper and paperboard'  with: <math>f_{IRW}(i) = 0</math> if <math>f_{IRW}(i) &lt; 0</math> and <math>f_{PULP}(i) = 0</math> if <math>f_{PULP}(i) &lt; 0</math></p>
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Where:

$f_{DP}(i)$  = share of domestic feedstock for the production of the particular HWP category originating from domestic forests in year  $i$

$HWP_j(i)$  = HWP amounts produced from domestic harvest associated with activity  $j$  in year  $i$ , in  $\text{m}^3 \text{yr}^{-1}$  or  $\text{Mt yr}^{-1}$

$HWP_p(i)$  = production of the particular HWP commodities (i.e. sawnwood, wood-based panels and paper and paperboard, or their sub-categories, see Section 2.8.1.1) in year  $i$ , in  $\text{m}^3 \text{yr}^{-1}$  or  $\text{Mt yr}^{-1}$

**Note:** Equation 2.8.4 must be applied separately to each of the defined HWP commodities ( $HWP_p$ ) and separately to HWP related to activities under Article 3, paragraphs 3 and 4 ( $HWP_j$ ).

The estimates associated with the forest related activities AR, D and FM also apply in case countries provide estimates for sub-categories of the three HWP default categories (see Section 2.8.3.1), or for country-specific activity data e.g. on assemblies composed of a combination of products, such as in wooden buildings. Further guidance on how to estimate fraction of HWP originating from forests accounted for under Article 3, paragraphs 3 and 4 using country-specific activity data is provided in Section 2.8.4.1.

## 2.8.2 Tier 1: “Instantaneous oxidation”

The method presented in this section is to be applied by countries as the default method to estimate the *HWP Contribution*.<sup>127</sup> It is based on the assumption that the annual amount of carbon leaving the HWP pool is the same as the annual carbon inflow to the pool. In consequence, this method corresponds to an estimate of no change in HWP carbon stocks. It equals the assumption that all carbon in the biomass harvested is oxidised in the removal year (i.e. year of harvest) and is equivalent to reporting no net-emissions from HWP, as the annual change in carbon stock in HWP is zero (cf. IPCC 1997, IPCC 2006).

For the first commitment period, the storage of carbon in HWP was not included in the reporting since “the mere presence of carbon stocks be excluded from accounting”<sup>128</sup> and HWP “is not listed as a pool covered by the Marrakesh Accords” (IPCC 2003). Countries following the *good practice* as described in *GPG-LULUCF* (IPCC 2003) and applying instantaneous oxidation, did thus not report and/or account for emissions from HWP in the first commitment period.

Decision 2/CMP.7 establishes mandatory accounting of all changes in the HWP pool.<sup>129</sup> A prerequisite for accounting HWP on the basis of delayed emissions is the availability of transparent and verifiable HWP activity data (see Section 2.8.1.1). Consequently, it is *good practice* to apply the Tier 1 method as outlined in this section (i.e. reporting no net-emissions from HWP) only in the case that transparent and verifiable activity data for the default HWP categories sawnwood, wood-based panels and paper and paperboard as outlined in Section 2.8.1.1 are not available.<sup>130</sup> However, Decision 2/CMP.7 specifies that “the treatment of HWP in the construction of a projected FMRL (see Section 2.8.5) shall not be on the basis of instantaneous oxidation”.<sup>131</sup>

For the following HWP fractions instantaneous oxidation (i.e. Tier 1) shall be applied (see Figure 2.8.1):

- HWP resulting from D activities under Article 3 paragraph 3 (see Section 2.8.1.2);<sup>132</sup>
- HWP in SWDS<sup>133</sup>
- Harvested wood used for energy purposes.<sup>133</sup>

Following the guidance given in Section 2.8.1.2, the fraction of HWP originating from domestic forests that are accounted for under the activities AR and FM can be derived. Thereby, the fraction of HWP resulting from D is implicitly excluded from further estimation of the *HWP contribution* and which is equivalent to applying instantaneous oxidation. In line with the requirements of Decision 2/CMP.8<sup>134</sup>, it is *good practice* to demonstrate that harvested wood originating from D (i.e.  $harvest_D$ , see Equation 2.8.3) has not been included in the estimates on the basis of the change of the HWP pool. This can be done by reporting the annual share of the overall harvest originating from D ( $harvest_D(i)$ ).

By estimating the *HWP contribution* on the basis of methodologies as outlined in Sections 2.8.3 and 2.8.4, only the *HWP contribution* of HWP in use is estimated. HWP in SWDS and wood harvested for energy are thus implicitly treated on the basis of instantaneous oxidation (i.e. reporting no net-emissions from HWP). Estimates that are based on the three default commodities are by definition not derived from wood harvested for energy purposes. Where CO<sub>2</sub> emissions from HWP in SWDS are separately accounted for, it is *good practice* to include them on the basis of “instantaneous oxidation”.

## 2.8.3 Tier 2: First order decay

Provided that transparent and verifiable activity data are available for the three default HWP categories sawnwood, wood-based panels and paper and paperboard, as defined in Section 2.8.1.1, and no appropriate country-specific information required to apply a Tier 3 method are available (see Section 2.8.4), Parties are

<sup>127</sup> Paragraph 28

<sup>128</sup> Decision 16/CMP.1

<sup>129</sup> Paragraph 26

<sup>130</sup> Paragraph 29

<sup>131</sup> Paragraph 16

<sup>132</sup> Paragraph 31

<sup>133</sup> Paragraph 32

<sup>134</sup> Paragraph 2 of the Annex II of Decision 2/CMP.8 contained in document FCCC/KP/CMP/2012/13/Add.1

required to obtain estimates on the *HWP contribution* by application of the Tier 2 method as outlined in this section.<sup>135</sup>

In line with Decision 2/CMP.7, it is *good practice* to estimate the change in carbon stocks separately for each of the HWP fractions originating from AR ( $HWP_{AR}$ ) and from FM ( $HWP_{FM}$ ) as estimated from Equation 2.8.4. For this purpose, the first-order decay (FOD) function as presented in Equation 2.8.5, which is a flux data method that corresponds to Equation 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*, is to be applied:

**EQUATION 2.8.5**  
**ESTIMATION OF CARBON STOCKS AND ANNUAL CARBON STOCK CHANGES IN HWP POOL OF THE REPORTING COUNTRY**

$$C(i + 1) = e^{-k} \cdot C(i) + \left[ \frac{(1 - e^{-k})}{k} \right] \cdot Inflow(i)$$

$$\Delta C(i) = C(i + 1) - C(i)$$

Sources: IPCC 2006 ; Pingoud and Wagner 2006

Where:

$i$  = year

$C(i)$  = the carbon stock in the particular HWP category at the beginning of year  $i$ , Gg C

$k$  = decay constant of FOD for each HWP category ( $HWP_i$ ) given in units  $yr^{-1}$  ( $k = \ln(2)/HL$ , where HL is half-life of the HWP pool in years (see Section 2.8.3.2).

$Inflow(i)$  = the inflow to the particular HWP category ( $HWP_i$ ) during year  $i$ , Gg C  $yr^{-1}$

$\Delta C(i)$  = carbon stock change of the HWP category during year  $i$ , Gg C  $yr^{-1}$

It is *good practice* to apply Equation 2.8.5 with activity data for the semi-finished wood product categories sawnwood, wood-based panels and paper and paperboard that have been assigned to the particular forest activities ( $HWP_{AR}$  and  $HWP_{FM}$ ) (see Section 2.8.1). In combination with semi-finished wood product commodities, FOD implicitly includes finished HWP in the pool estimates, and it is assumed that “immediate losses of the HWP pool due to final processing along the processing chain (cf. Figure 2.8.2) are described realistically by the exponential decay pattern” (Pingoud and Wagner 2006). The timing of emissions from wood processing residues used for energy purposes along the process chain of HWP are also well described by FOD (cf. Rüter and Diederichs 2012).

Whereas Equation 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines* suggests to start with  $i = 1900$ , application of FOD in the context of the Decision 2/CMP.7 necessitates a differentiated approach to enable HWP accounting associated with the different forest activities (see Section 2.8.1.2).

In order to produce an estimate of the existing HWP carbon pool by means of Equation 2.8.5, and based on the subsequent changes of this pool to produce an estimate of the *HWP contribution*, the historical wood use (i.e. the accumulation of the historic *Inflow* to the HWP pool) has to be included. This procedure is needed as this also includes the historic and current discard from the HWP pool, which is also termed “inherited emissions” (IPCC 2006). This is reflected in Decision 2/CMP.7, which states that “*emissions that occur during the second commitment period from harvested wood products removed from forests prior to the start of the second commitment period shall also be accounted for.*”<sup>136</sup> The term “emissions” from HWP (which are defined as a pool<sup>137</sup>) thus refers to the “decay” from that pool, which is the discarding of HWP from end uses described e.g. by FOD (i.e. Equation 2.8.5). Discarding, thus, does not mean that the carbon in the products is oxidized, but describes the release of HWP from the HWP pool in use (or in service) from where the products are potentially recycled, burned, composted or transferred to solid waste disposal.<sup>138</sup> The discard from the pool of HWP in use (comprising wood products in service), therefore depends on the historic level of Inflow (see Section 2.8.1) and the particular service life and/or half-life of the HWP commodities (see Sections 2.8.3.2 and 2.8.4.2).

<sup>135</sup> Paragraph 29

<sup>136</sup> Paragraph 16

<sup>137</sup> Paragraph 26

<sup>138</sup> For more information see IPCC FAQ, Q4-29 (<http://www.ipcc-nggip.iges.or.jp/faq/faq.html>)

In order to account for the *HWP contribution* from AR activities, estimates are to be based on activity data since the base year 1990. It is thus *good practice* to include inherited emissions from the pool that has been established from  $HWP_{AR}$  since 1990. This is implemented by the use of Equation 2.8.5 starting with  $i = 1990$  and  $C(1990) = 0$ .

For HWP from FM activities, the inclusion of inherited emissions in the estimates of the HWP carbon pool depends on the Party's approach used for FMRL construction. In case the FMRL is based on a projection which represents a 'business as usual scenario' (see Sections 2.7.5.1 and 2.8.5), Parties may exclude inherited emissions from before the start of the second commitment period in their estimates.<sup>139</sup> In this case, the estimation by means of Equation 2.8.5 starts with  $i = 2013$  and  $C(2013) = 0$ . If the Party's FMRL is not based on a projection representing a 'business as usual scenario', it is thus *good practice* to include inherited emissions from the pool.

As reflected by Equation 2.8.4 ( $HWP_j(i)$ ), it is also *good practice* to separately estimate and report using the above procedure the annual *HWP contribution* for:

- HWP from AR activities ( $HWP_{AR}$ ) and for HWP from FM activities ( $HWP_{FM}$ )
- HWP for each of the particular commodities (i.e. sawnwood, wood-based panels, paper and paperboard or their subcategories)

The availability of activity data series (i.e.  $Inflow(i)$ ) varies. For most countries the FAO statistics provide data on the HWP commodity categories since 1961.<sup>140</sup> However, for some countries activity data are available only since their independence or foundation (e.g. in 1991). Further guidance on the activity data to be used for the Tier 2 method is provided in Section 2.8.3.1.

As a proxy in the Tier 2 method it is assumed that the HWP pools are in steady state at the initial time  $t_0$  from which the activity data start. This means that as a proxy  $\Delta C(t_0)$  is assumed to be equal to 0. This steady state carbon stock  $C(t_0)$  for each HWP commodity category is approximated by means of Equation 2.8.6 based on the average of  $Inflow(i)$  during the first 5 years for which statistical data are available. By substituting  $C(t_0)$  in Equation 2.8.5, the  $C(i)$  and  $\Delta C(i)$  in the sequential time instants can be calculated. In the Tier 2 method, it is *good practice* to use Equation 2.8.6 for estimating the stock at  $t = t_0$ .

**EQUATION 2.8.6**  
**APPROXIMATION OF THE CARBON STOCKS IN HWP POOLS AT INITIAL TIME, I.E. SINCE WHEN**  
**ACTIVITY DATA ARE AVAILABLE**

$$C(t_0) = \frac{Inflow_{average}}{k}$$

With:  $Inflow_{average} = (\sum_{i=t_0}^{t_4} Inflow(i))/5$

Only in case a projected FMRL is applied (see Section 2.8.5), other methods could also be used. Further estimation methods for calculating the carbon inflow to the  $HWP_{FM}$  pool ( $Inflow(i)$ ) back to the year 1900 are provided by the *2006 IPCC Guidelines* (i.e. on the basis of estimated annual rates of increase for industrial roundwood production that are based, inter alia, on the annual per cent change of population growth) or in Rüter 2011 (i.e. calculate missing activity data since the year 1900 on  $HWP_{FM}$  carbon pool inflow from the average of the first five years for which activity data are given for the country).

In case the FMRL has been based on a projection representing a 'business as usual scenario' (see Section 2.7.5 and 2.8.5), in line with Decision 2/CMP.8, it is *good practice* to provide information whether and how inherited emissions have been included in the HWP estimates. Otherwise, if the inclusion of HWP in the countries' FMRL is not based on a projection, it is *good practice* to explain that the approach chosen to include inherited emissions in the estimates of the HWP carbon pool reflects best the countries' circumstances (e.g. data availability). Further guidance on the consideration of HWP in the FMRL is provided in Section 2.8.5.

<sup>139</sup> Paragraph 16

<sup>140</sup> <http://faostat.fao.org/site/630/default.aspx>

The carbon stock change in all the HWP pools of the commodities associated with the particular activities is obtained by summing the stock changes  $\Delta C$  of each commodity category. The carbon stock change is then converted into Gg CO<sub>2</sub> yr<sup>-1</sup> by multiplying by  $-44/12$ .

Under the Tier 2 method, Equation 2.8.5 is equally applied for domestically consumed as well as for exported HWP together with the same half-life parameters (see Section 2.8.3.2). Therefore, it complies with *good practice* not to differentiate between domestic consumption and exports in the reporting of the *HWP contribution*. In order to increase transparency and facilitate potential changes in the methodology used to estimate the *HWP contribution* (e.g. by application of country-specific half-lives following the guidance provided in Section 2.8.4), however, Parties are encouraged to report separately for domestically consumed and exported HWP.

### 2.8.3.1 ACTIVITY DATA

Activity data include the carbon stock of the HWP pool at the beginning of each year ( $C(i)$ ) and the inflow to the HWP pool during each year ( $Inflow(i)$ ) for each HWP category. In order to apply Equation 2.8.5, it is *good practice* to determine  $C(i)$  and  $Inflow(i)$ .

<b>HWP categories</b>	<b>Density (oven dry mass over air dry volume) [Mg / m<sup>3</sup>]</b>	<b>Carbon fraction</b>	<b>C conversion factor (per air dry volume) [Mg C / m<sup>3</sup>]</b>	<b>Source</b>
Sawn wood ( <i>aggregate</i> )	0.458	0.5	0.229	1
Coniferous sawnwood	0.45	0.5	0.225	2
Non-coniferous sawnwood	0.56	0.5	0.28	2
Wood-based panels ( <i>aggregate</i> )	0.595	0.454	0.269	3
Hardboard (HDF)	0.788	0.425	0.335	4
Insulating board (Other board, LDF)	0.159	0.474	0.075	5
Fibreboard compressed	0.739	0.426	0.315	6
Medium-density fibreboard (MDF)	0.691	0.427	0.295	4
Particle board	0.596	0.451	0.269	4
Plywood	0.542	0.493	0.267	7
Veneer sheets	0.505	0.5	0.253	8
	<b>(oven dry mass over air dry mass) [Mg / Mg]</b>		<b>(per air dry mass) [Mg C / Mg]</b>	
Paper and paperboard ( <i>aggregate</i> )	0.9		0.386	9

<sup>1</sup> Calculated from the weighted average of coniferous and non-coniferous sawnwood production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7

<sup>2</sup> IPCC 2003, Appendix 3a.1

<sup>3</sup> Calculated from the weighted average of included subcategories of the production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7

<sup>4</sup> Rüter and Diederichs (2012)

<sup>5</sup> Derived from Environmental product declarations EPD-GTX-2011111-E, EPD-KRO-2009212-E and EPD-GTX-2011211-E provided by IBU e.V. (<http://bau-umwelt.de/hp550/Insulating-materials.htm>)

<sup>6</sup> Calculated from 50% of HDF and 50% of MDF

<sup>7</sup> Derived from Wilson and Sakimoto (2005) and basic density for non-coniferous species listed in the table above

<sup>8</sup> Calculated from 50% sawnwood (Coniferous) and 50% of sawnwood (Non-Coniferous)

<sup>9</sup> Calculated from the weighted average of included subcategories of the production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7, including information derived from Fengel and Wegener (1984), Paulapuro (2000), Gronfors (2010) and industry information.

For this purpose, Tier 2 uses forest products data from the FAO or other international organizations, such as the United Nations Economic Commission for Europe (UNECE), for semi-finished HWP commodities as set out in Section 2.8.1.1. As a default, the annual *Inflow*(*i*) to the HWP pool comprises of the three default HWP commodity categories, i.e. sawnwood, wood-based panels, paper and paperboard), separated by the particular activity ( $HWP_j(i)$ , see Section 2.8.1.2).

In order to estimate carbon amounts in HWP, default conversion factors are provided in Table 2.8.1. In fact, the conversion factors for the HWP default commodities (i.e. aggregates) are largely dependent on the composition of countries' production amounts of the particular subcategories (e.g. particle board). If Parties have disaggregated data on subcategories of semi-finished wood products as listed in Table 2.8.1, it is thus *good practice* to apply Equation 2.8.5 to the disaggregated subcategories.

In order to reduce uncertainties associated with assumptions on the conversion factors of activity data (i.e. data on semi-finished wood product commodities derived from statistics) (see Section 2.8.6), Parties are encouraged to use country-specific activity data comprising further items of the HWP subcategories as listed in Table 2.8.1. More information can be obtained in Section 2.8.4.1.

### 2.8.3.2 EMISSION FACTORS

The rate at which carbon in the default HWP categories is removed from the HWP pool in service in a given year is specified by a constant decay rate (*k*) expressed as half-life in years. The 2006 IPCC Guidelines define the half-life as “the number of years it takes to lose one-half of the material currently in the pool”. As the half-life in the context of Decision 2/CMP.7 refers to HWP in use (see Section 2.8.1.1), the half-life to be applied is a function of the adjusted estimated service life (ESL) of the particular HWP commodities (with  $HL = \text{Adjusted ESL} * \ln(2)$ , see Section 2.8.4.2).

When applying the Tier 2 method, Decision 2/CMP.7 requires countries to use the default half-lives of the three HWP categories as specified in Table 2.8.2. The same half-lives apply for the particular subcategories of the aggregate HWP categories as specified in Table 2.8.1.

HWP categories <sup>142</sup>	Default half-lives (years)
Paper	2
Wood panels	25
Sawn wood	35

In order to reduce uncertainties associated with the assumptions on the half-lives of the HWP commodities (see Section 2.8.6) Parties are encouraged to use country-specific half-lives, both for the domestic use of HWP categories, as well as country-specific half-lives as being applied by the importing country for the exported HWP categories. Further guidance on how to use and obtain country-specific half-life information (i.e. Tier 3) for the relevant HWP categories is available in Section 2.8.4.2.

## 2.8.4 Tier 3: Country-specific methods

This section provides *good practice* guidance on the use of country-specific methods to estimate the HWP carbon pool and its changes in order to estimate the *HWP contribution*. They may include country-specific half-lives and/or methodologies and may be applied by Parties where sufficient data are available, in line with requirements as outlined in Section 2.8.1 and the Decision 2/CMP.7<sup>143</sup> covering the three semi-finished HWP categories. It complies with *good practice* to apply country-specific methods “provided that verifiable and transparent activity data are available and that the methodologies used are at least as detailed or accurate”<sup>143</sup> as those described in Section 2.8.3 (Tier 2). *Good practice* thus includes a verification of the Tier 3 methods used,

<sup>141</sup> See footnote of paragraph 29 of Decision 2/CMP.7: Half-lives are based on Table 3a.1.3 of the *GPG-LULUCF*.

<sup>142</sup> HWP categories as defined in paragraph 29 of Decision 2/CMP.7 refer to the commodities sawnwood, wood-based panels, paper and paperboard, acc. to the international classification system for forest products (see guidance in Section 2.8.1.1)

<sup>143</sup> Paragraph 30

e.g. by comparing the results derived using the Tier 2 method (see Section 2.8.3), and by providing all relevant information in a transparent and verifiable way to demonstrate how the *HWP contribution* has been estimated. More information on how to verify Tier 3 methods can be found in IPCC FAQs on HWP.<sup>144</sup>

Two key Tier 3 methodological pathways allow for estimating changes in the HWP carbon pool in line with the requirements as outlined in Decision 2/CMP.7, comprising (i) flux data methods, and (ii) combinations of stock inventory and flux data methods.

## FLUX DATA METHODS

In flux data methods HWP carbon pool and its changes are basically calculated from the difference of the production (i.e. carbon inflow to the HWP pool) and decay/discard rate. There are comprehensive international activity databases on the production and trade of HWP (see Section 2.8.1.1), whereas information on the discard from the HWP pool is incomplete. Using this incomplete discard information (e.g. from waste statistics) to calculate the above difference would lead to an overestimation of the HWP carbon pool and its changes. Thus practicable flux data methods that comply with *good practice* rely on service life information of HWP. They are based on the use of decay functions and dynamic models ensuring the continuity of mass so that all HWP carbon entering the pool will be discarded eventually.

The following alternatives under a Tier 3 method could be used:

- The Tier 2 FOD function (see Equation 2.8.5) is a special case of flux data methods and could also be applied under Tier 3 with:
  - (i) Default half-lives in combination with country-specific activity data for disaggregated commodity items (e.g. HS code 440792 sawnwood made of beech (*Fagus* spp.) of a certain dimension) included in the three HWP commodities that follow the HS nomenclature system as explained in Section 2.8.1.1 (see Section 2.8.4.1)
  - (ii) Country-specific half-lives to be based on national information on service life of the default HWP commodities or their sub-categories (see below and Section 2.8.4.2).
- Other country- or product-specific decay functions could be applied. Examples of different decay functions include logarithmic decay (e.g. Karjalainen *et al.*, 1994), retention curves (e.g. Skog and Nicholson 1998) and distribution functions (e.g. Marland *et al.*, 2010). They could be used in combination with:
  - (i) Default half-lives (see Table 2.8.2), or country specific half-lives as specified in Section 2.8.4.2
  - (ii) Country-specific activity data (see Section 2.8.4.1).

Furthermore, it is with *good practice* to separately estimate and report the *HWP contribution* of the HWP pool for the domestic market (i.e. reporting Party) and for export markets, in case:

- Country-specific half-lives or decay functions, and/or
- Country-specific activity data (i.e. other than specified in Section 2.8.3.1) are used.

In the case HWP pools of both semi-finished and finished products are included in Tier 3 calculation models it is *good practice* to eliminate any overlapping of the HWP pools and thereby to avoid any double-counting of HWP carbon stock changes.

## COMBINED HWP STOCK INVENTORY AND FLUX DATA METHODS

HWP stock inventory methods use HWP carbon pool data for two or preferably more separate points in time to estimate changes in the pool. Their application is basically relevant for HWP pools in the reporting country alone (see Section 2.8.4.1) and could be used to estimate the annual change in carbon stock of some specific finished HWP pools (cf. Figure 2.8.3) such as buildings. Examples of such inventories are reported in Gjesdal *et al.*, (1996) for Norway, in Pingoud *et al.*, (2001) and Statistics Finland (2011) for Finland.

In the case of inventory methods, no procedure for adding up wood use data from historical data is needed to estimate the existing HWP stock or annual change in stock, which is an advantage compared to the flux methods (IPCC 2006). However, a fundamental problem in the application of inventory methods alone for the present accounting purpose is the identification of the proportion of the HWP carbon stock originated from domestic forests and being thus accountable (see Section 2.8.1). Furthermore, in line with Decision 2/CMP.7, imported HWP must be excluded from the estimated HWP pool, therefore increasing the uncertainties.<sup>145</sup>

<sup>144</sup> <http://www.ipcc-nggip.iges.or.jp/faq/faq.html>

<sup>145</sup> Paragraph 27

Since in practice inventory data are not available for all finished HWP for domestic and export markets covering the HWP categories sawnwood, wood-based panels, paper and paperboard (e.g. wooden houses, furniture, newspaper), it is *good practice* to apply inventory methods only in combination with flux data methods.

In cases where a Party applies inventory methods for specific HWP end uses (e.g. the housing sector), it is thus *good practice* to estimate the *HWP contribution* for the remaining fraction of the three HWP default commodities in combination with the flux-data method under Tier 2 or 3. For this purpose, the three HWP categories being used in the housing sector must be factored out from the flux-data calculation to avoid double-counting and to meet the requirements of Decision 2/CMP.7.

### 2.8.4.1 COUNTRY-SPECIFIC ACTIVITY DATA

Section 2.8.1.1 introduces the international classification system of forest products following HS nomenclature, which is also relevant for activity data used for a Tier 3 method. Whereas data for semi-finished HWP can be obtained from national statistics as well as from international databases, HWP activity data other than outlined in Section 2.8.3.1 (see Table 2.8.1) are available from national sources only. In the case of Parties using country-specific activity data as described in this section, it is *good practice* to disclose the source of data and provide in a transparent and verifiable manner additional information for items that make up subcategories and/or final products produced from the three default HWP categories as defined in Decision 2/CMP.7<sup>146</sup> (cf. Figure 2.8.2).

Country-specific HWP activity data that could be used for Tier 3 include:

#### 1. Item data following the international HS nomenclature and classification system

These data could be available from country-specific statistics containing further disaggregated items of the subcategories as specified in Table 2.8.2. Examples would be coated particle board, fibreboard with specific density or surface, or coniferous sawnwood made from specific tree species (e.g. larch). Introducing disaggregated item data using appropriate carbon conversion factors e.g. based on information on wood densities can contribute to considerably improve the accuracy of the HWP estimations. Further information could be obtained e.g. from Forest Products Laboratory (2010).

In some cases, the aggregated datasets for the specified HWP categories available from national statistics are different from available databases of international organizations (e.g. FAO or UNECE). In order to reduce uncertainties associated with the use of these datasets (see Section 2.8.6) and in order to provide country-specific activity data in a transparent and verifiable way, Parties are encouraged to explain the differences between data used from national sources from data provided in international databases.

#### 2. Finished HWP not containing components with different service lives

These types of activity data refer to finished HWP that do not contain components with different potential half-lives. They are made up from at least one of the (default) semi-finished HWP categories (see Figures 2.8.2 and 2.8.3). This group of products comprise e.g. doors, flooring systems, books or furniture, which could also be obtained from national production statistics (e.g. furniture production statistics).

#### 3. Data on buildings with different wooden construction components with different renovation intervals

These types of products rather represent a market segment where finished products (see above) are used (see Figure 2.8.3). Wooden houses are composed of different construction components with different renovation intervals, e.g. long lived roof construction made of beams, wall systems, and comparatively short-lived wooden flooring systems. Country-specific activity data for buildings could again be derived from the production statistics (e.g. Building Construction Starts Statistics) or from inventories and surveys.

Some of the above mentioned country-specific activity data (1, 2 and 3) may be available from annual statistics being applicable for flux data methods. Other activity data might be available only at the start and at the end of the commitment period for use in combined HWP stock inventory and flux data methods. Whereas data derived from inventories (e.g. for buildings, see 3) could not be used for the share of exported HWP, data from production and export statistics for finished product categories, such as books or furniture, could be used to estimate the contribution of exported HWP.

In order to allocate the carbon in HWP to the particular forest activities under Article 3, paragraphs 3 and 4 (see Section 2.8.1.2) Parties could apply the relevant equations as suggested in Section 2.8.1 for use in Tier 3 methods. Nevertheless, Parties are encouraged to estimate carbon in HWP originating from domestic forests using more country-specific information, including e.g. detailed data on the use of timber assortments for the subsequent processing of HWP categories (e.g. wood pulp, recovered wood pulp from recovered paper, etc. for

<sup>146</sup> Paragraph 30

paper and paperboard). Provided country-specific approaches are available for this purpose, it is *good practice* to demonstrate and report how the allocation has been done to meet the requirements as set out in Decision 2/CMP.7.

When using country-specific activity data, information on carbon conversion factors (see Table 2.8.1) may not be readily available. In particular, HWP activity data representing finished commodities (see Figure 2.8.2) or market segments of wood use (e.g. wooden building components, see Figure 2.8.3 in Section 2.8.1.2 and Table 2.8.3 in Section 2.8.4.2) often include mixes of wood and other materials. In this case, specific conversion factors could be obtained from statistics or from life cycle inventory (LCI) information, which forms the basis for life cycle assessment (LCA) according to ISO 14040:2006 (ISO 2006a) and 14044:2006 (ISO 2006b). Information on the average amount of wood content per unit could be provided e.g. per square meter of floor space (Tsunetsugu and Tonosaki 2010). Examples of representative LCI information are reported e.g. in Rüter and Diederichs (2012) for Germany.

When using such specific conversion factors, it is *good practice* to demonstrate and report how conversion factors have been derived and provide information on the representativeness of associated data with regard to time, technology and geographical scale (see e.g. European Union 2010).

## 2.8.4.2 COUNTRY-SPECIFIC EMISSION FACTORS

This section gives guidance on the concept of service life and half-life information to estimate the *HWP contribution* on the basis of flux data methods.

In general, national values for service- or half-life could be derived for the three default HWP categories and their subcategories (see Section 2.8.1.1). But also other HWP categories could be established and combined with the respective service life information. However, in order to ensure that the methodology used is at least as accurate as the one described in Section 2.8.3, Parties are encouraged to make those HWP categories broad enough to capture significant carbon volumes contributing to the HWP pool. As a guide, the volumes of HWP categories are deemed significant if they represent at least 5% of the total HWP production.

Potential data providers and sources for national service life information are national and industry agencies, technical literature and direct consultations (i.e. surveys of experts, industry and the general public). It is important to note that service- and half-life values representing the material use of wood can differ notably among and within countries depending on factors such as construction practices, culture, fashion, and climate. Thus, in case country-specific information is used, a national quality control system is encouraged in order to provide transparent and verifiable data.

Several approaches can be used to derive country-specific service- and half-life values based on transparent and verifiable data:

- Following the ISO 15686 standard series approach, since this is an already established system for service life estimation on a case specific level. A modified approach is used here on a national level (see Box 2.8.1) in combination with obsolescence on national level,
- A combination of production and trade statistics data with building stock inventory information in order to estimate more realistic country-specific service and half-life values through this calibration, and/or
- National surveys on the final market use of wood.

Below examples on how to improve service life estimates based on the ISO 15686 series are shown, and an example of HWP half-life calculation for HWP categories is given based on its ESL (see Section 2.8.3.2), in combination with an obsolescence factor and information on its market share.

In order to adequately apply flux data methods based on information on country-specific HWP service life (i.e. time carbon is held in HWP pool in use before they are disposed or recycled), apart from the concept of half-life (see Section 2.8.3.2), the following terms and concepts are to be differentiated:

- ISO 15686-1:2011 defines the reference service life (RSL) as the service life of a product, component, assembly or system which is known to be expected under a particular set, i.e. a reference set of in-use conditions;
- The ESL on the other hand is the service life that a wooden or wood based component would be expected to have in a set of specific in-use conditions. It is determined from RSL data after taking into account any differences from the reference in-use conditions (ISO 15686-1:2011);
- The factor method is used to calculate the ESL. It is a modification of RSL by seven factors to take account of the specific in-use conditions (ISO 15686-8:2008); and

- Obsolescence arises (according to ISO 15686-1:2011) when a facility no longer can be adapted to satisfy changing requirements. Obsolescence tends to result from unexpected changes, often unrelated to the construction, and includes:
  - (i) Functional obsolescence: the function is no longer required.
  - (ii) Technological obsolescence: new alternatives can offer better performance, change the pattern of use.
  - (iii) Economic obsolescence: Fully functional but less efficient, more expensive than alternatives. This also includes replacement due to changing fashion or taste.

ISO 2011 states that estimates of obsolescence should be based on the designer's and clients experience, and, if possible, documented feedback from practice. In order to estimate the carbon storage of HWP in use and its impact on emissions/removals by means of flux data methods using country-specific service life information, it is thus *good practice* to take into account obsolescence and to distinguish replacement of HWP in use due to e.g. a defective performance from obsolescence (cf. ISO 2011).

*For example:*

In northern Europe a wooden decking can last for 50 years or more given proper construction and choice of material. But the same decking is likely to be replaced already after 20 years (or less) e.g. due to aesthetical reasons. Hence, for calculating country-specific ESL or half-life values an obsolescence factor is needed in Tier 3 estimates of the *HWP contribution* to reflect the time actually spent in the HWP carbon pool, not the potential full service life of a wooden component given by ESL.

In this guidance document the ESL is applied for estimates on a national level and not for a specific case as suggested in the ISO 15686 standard series. To include the effect of obsolescence:

- Either an additional factor (O) is included, with
  - (i) Obsolescence = 1 when there is considered to be no significant effect of obsolescence compared to RSL
  - (ii) Obsolescence is given a value < 1 based on the intensity of obsolescence
  - (iii) Obsolescence can never be larger than 1.
- Or a decay function to be assigned that uses the service life data to estimate the decay profile (based on products leaving the pool, not only biological decay and not a biological decay profile) or the actual time path that products take to go out-of-use.<sup>147</sup>

An example of how to derive national service life estimates by means of the factor method is given in the box 2.8.1 below.

<sup>147</sup> For more information see IPCC FAQ, Q4-29 (<http://www.ipcc-nggip.iges.or.jp/faq/faq.html>)

**BOX 2.8.1****EXAMPLE ON THE CALCULATION OF NATIONAL ESL BY MEANS OF FACTOR METHOD**

A theoretical example with wooden claddings in Norway is given based on ISO 15686-8:2008, but elevated from the case specific level given in the standard to a national level. Details about RSL and service life estimation are in ISO 15686-8:2008.

A factor of “1” is used when the factor does not deviate from the RSL conditions. A higher value ( $x > 1$ ) is given if the national performance is better than RSL conditions; a lower value ( $x < 1$ ) is given if the national performance is lower than the RSL conditions. Non relevant factors are excluded from the equation.

The RSL is based on accelerated field trials and the threshold for failure was defined when the mean decay rating reached 2 (on a scale from 0–4 where 0 is no decay and 4 is failure).

National ESL =  $55(\text{RSL}) * 1(\text{A}) * 1(\text{B}) * 1(\text{C}) * 1.2(\text{E}) * 1(\text{F}) * 0.9(\text{G}) = 59.4$  years

Factor D ‘indoor environment’ is excluded because it is not relevant. It is good practice to include factors that do not deviate from the RSL even if they do not contribute in changing the RSL since they are given the value 1. A more detailed explanation for the choice of factors used is to be provided in the countries’ annual reporting.

A = Inherent performance level represents the grade of the component as supplied.

- Here equals the RSL.

B = Design level reflects the component’s installation in the building/constructed asset and is typically based on the level of shelter and protection from agents provided by the design of the building/constructed asset.

- Here equals the RSL.

C = Work execution level considers the level of skill and control in sitework.

- Here equals the RSL.

D = Indoor environment considers the exposure of the object to indoor agents of degradation and their severity.

- Not relevant in this example.

E = Outdoor environment considers exposure to outdoor agents of degradation and their severity.

- In this example the climate on a national level is less harsh than at the test sites included in RSL.

F = Usage conditions reflects the effect of the use of the building/constructed asset.

- Here equals the RSL.

G = Maintenance level reflects the level of maintenance assumed. For certain components that are inaccessible or require special equipment for access, a particularly low maintenance level should be considered.

- Here slightly lower than RSL intervals.

Another example in Table 2.8.3 shows how to derive country-specific half-life values for the three aggregate HWP categories (see Section 2.8.1.1) as a function of information on market share of the use of wood (see above), ESL and obsolescence. The use of composed HWP categories in different markets, such as in the construction sector, can be divided further into different segments (e.g. wall systems, flooring, and roof construction). These different segments normally have different service lives and obsolescence factors. Hence, Parties are encouraged to allocate the contribution of the different HWP categories or subcategories (e.g. coniferous sawnwood) to markets and their segments in order to obtain improved service life estimates for the particular HWP categories. Thereby, it is important to note that the assumed service life is driven by the products technical properties and, depending on this, its particular application area (e.g. load-bearing beam or wood panelling, both made of sawnwood). Thus, in order to calculate a country-specific emission factor (i.e. service- or half-life), different sources of information, e.g. on the market use of different HWP categories, could be combined as illustrated in Table 2.8.3.

The definition of half-life and also guidance on how to calculate half-life for Tier 2 is provided in Section 2.8.3.2.

<b>HWP categories (here: aggregates)</b>	<b>Markets*</b>	<b>Market share of HWP category</b>	<b>National estimated service life (ESL), years</b>	<b>National obsolescence factor (O)</b>	<b>Adjusted ESL of HWP category (=ESL*O* market share adjustment)</b>	<b>Half-life (=Adjusted ESL* ln(2))</b>
Sawn wood	construction	60%	70	0.9	41.0	28.4
	furniture	10%	45	0.6		
	packaging	30%	6	0.3		
	paper	0%	-	-		
Wood-based panels	construction	50%	60	0.7	30.5	21.2
	furniture	45%	35	0.6		
	packaging	5%	6	0.3		
	paper	0%	-	-		
Paper and paperboard	construction	0%	-	-	1.5	1
	furniture	0%	-	-		
	packaging	50%	3	0.3		
	paper	50%	10	0.2		

\* As the use of the HWP categories in different markets, such as the construction sector, consists of different end uses (e.g. wall systems, flooring, roof construction), Parties are encouraged to allocate the contribution of the different end uses to the relevant HWP category or subcategory (e.g. non-coniferous sawnwood used for windows).

## HALF-LIFE DATA TO BE USED FOR EXPORTED HWP

“In the case of exported HWP, country-specific data refers to country-specific half-lives and HWP usage in the importing country.”<sup>148</sup> Thus, if country specific half-life information should be used also for the exported HWP categories, the half-life information from the importing country must be used. For this purpose, it is necessary to quantify export activity data within the three HWP categories and/or sub categories. Furthermore, in order to ensure that the country-specific half-life information from the importing country complies with the categories of the activity data for the exported HWP, it is *good practice* to only apply country-specific half-life information in case the same categories of activity data for the exported HWP both in the exporting and importing country are used. Otherwise the default values (Tier 2) are to be used. When transparent and verifiable activity data are available, the categories should be broad enough to capture significant volumes contributing to the pool. The amount of exported and domestic wood should be separately reported.

## 2.8.5 Consideration of the HWP pool in FMRLs

In this section, guidance is given on the relation of HWP originating from FM as described in Section 2.8.1 and its consideration in the FMRL as outlined in the Decisions 2/CMP.6<sup>149</sup>, 2/CMP.7 and 2/CMP.8. Guidance on the FMRL is provided in Section 2.7.5.

### APPROACHES AND METHODS FOR CONSIDERATION OF HWP IN FMRL

Decision 2/CMP.6 requested Parties to *inter alia* submit descriptions of how HWP were considered in the construction of the FMRL.<sup>150</sup> In line with the different approaches and methods used by Parties to construct the FMRL as listed in Section 2.7.5.1, two general approaches on how to treat HWP in FMRL can be differentiated:

#### 1. Instantaneous oxidation

In this case, Parties only presented values for a FMRL which do not contain estimates on the *HWP contribution*.<sup>151</sup> Similar to the treatment of HWP in the first commitment period as described in *GPG-LULUCF*,

<sup>148</sup> Paragraph 30, Footnote 6

<sup>149</sup> Paragraphs 2, 4 and 9 of Appendix II contained in document FCCC/KP/CMP/2010/12/Add.1

<sup>150</sup> See submissions by Parties on FMRL as requested by Decision 2/CMP.6 (<http://unfccc.int/5896.php>) and document FCCC/KP/AWG/2011/Inf.2

as result of the assumption of instantaneous oxidation, changes in the HWP carbon pool are not reported (cf. Section 2.8.2). This approach mirrors the HWP Tier 1 estimation method as described in Section 2.8.2.

## 2. Inclusion of the HWP pool on the basis of modelled projections under a ‘business as usual’ scenario

In this case, Parties presented values for the FMRL that include estimates of the *HWP contribution* based on changes in the HWP pool.<sup>152</sup> This approach was chosen by Parties following the FMRL approaches 1a) and 1b) as described in Box 2.7.3. Many countries derived the values for the projected *HWP contribution* by means of FOD as specified in Section 2.8.3 for the Tier 2 HWP estimation method (Equation 2.8.5) applying default half-lives as listed in Table 2.8.2 for the HWP categories sawnwood, wood panels and paper (see Section 2.8.1.1).<sup>153</sup> However, different approaches had been used in regard to the consideration of HWP originating from forests prior to the start of the second commitment period<sup>154</sup>, as indicated in the application of HWP activity data (i) since 1900, or (ii) since 1990.

### BOX 2.8.2

#### EXAMPLE ON THE ESTIMATION OF THE *HWP CONTRIBUTION* AS PRESENTED IN PARTIES’ FMRL

The following example is intended to show, how estimates of the projected *HWP contribution* based on changes in the HWP pool could be derived that are consistent with the assumed harvesting rates following a ‘business as usual’ scenario in case no country-specific information on assumed future production of HWP and/or ‘track and trace’ models were available (cf. Rüter 2011).

In line with the guidelines for the submission and review of information on FMRL contained in the Appendix II of Decision 2/CMP.6, Parties had been requested to provide information on historic and assumed harvesting rates following a ‘business as usual’ scenario for FM.

STEP 1: Calculation of the rates of change of the projected harvest as compared to the last five years’ average of the historic harvest, for which up-to-date data were available.

*Numeric example:*

- (i) *Average historic harvest for the years 2005-2009: 50 Mm<sup>3</sup> yr<sup>-1</sup>*
- (ii) *Projected harvest (in Mm<sup>3</sup> yr<sup>-1</sup>): in 2013=52, in 2014=53, in 2015=55 ...*
- (iii) *Rates of change as compared to historic average: in 2013=4%, in 2014=6%, in 2015=10%*

STEP 2: Application of these annual change rates to the same five year average of historic carbon inflow to the HWP pool, which has been calculated from HWP production (see Section 2.8.3), in order to project the future carbon inflow to the HWP pool.

*Numeric example:*

- (i) *Average production of sawnwood for the years 2005-2009: 10 Mm<sup>3</sup> yr<sup>-1</sup>*
- (ii) *Projected production of sawnwood (in Mm<sup>3</sup> yr<sup>-1</sup>): in 2013=10.4, in 2014=10.6, in 2015=11 ...*

As a result, it is assumed that the same average proportion of harvested timber used as feedstock for the subsequent production of HWP in the chosen historic five year period will also apply in the projection period.

A five year average was chosen, in order to reduce the uncertainties associated with the considerable variability in the proportions of harvested timber being used for HWP production from year to year. A similar approach had been proposed by Kangas and Baudin (2003). In case of substantially varying time series, they suggest to use a ‘fixed constant’ as the projection that is an average over the last five years.

Besides these two basically different methodological approaches in the treatment of HWP in the FMRL, further distinction between Parties’ estimates on the *HWP contribution* to the FMRL can be recognized for (i) the applied models that have been used (including activity data, carbon conversion factors, etc.), and (ii) the applied underlying assumptions regarding the projected *HWP contribution* and/or its relation to particular projected

<sup>151</sup> See FMRL values in column ‘*Reference level*’ in the table of the Appendix of the Annex to Decision 2/CMP.7

<sup>152</sup> See FMRL values in column ‘*Applying first-order decay function for HWP*’ in the table of the Appendix of the Annex of Decision 2/CMP.7

<sup>153</sup> Paragraph 27 of Chapter II, Annex I contained in document FCCC/KP/AWG/2010/18/Add.1.

<sup>154</sup> Paragraph 15 *sexies*, *ibid.*

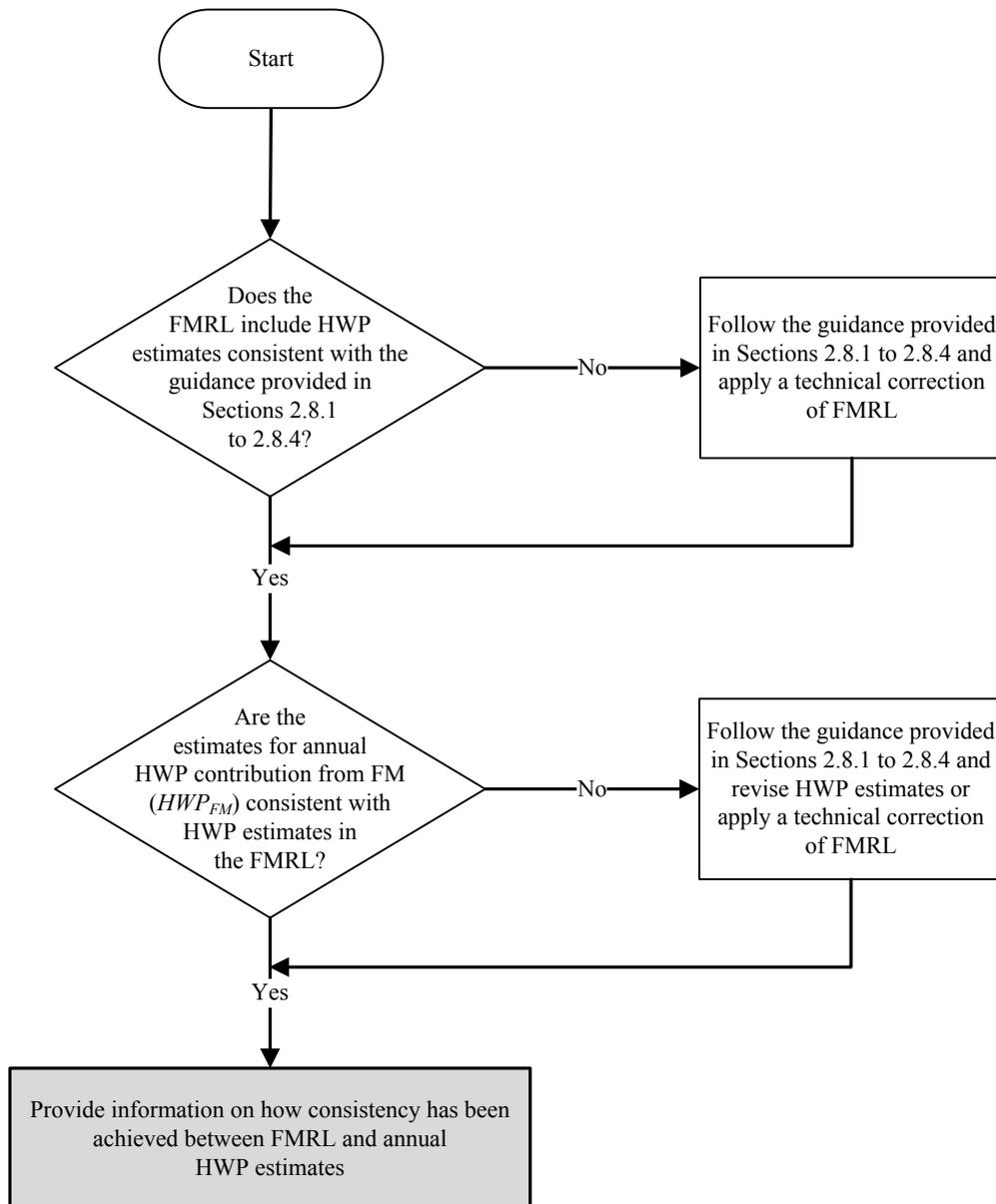
harvest rates of Parties. An example of how estimates of the *HWP contribution* in the FMRL could be derived is listed in Box 2.8.2.

## METHODOLOGICAL CONSISTENCY BETWEEN HWP IN THE FMRL AND THE REPORTING DURING THE SECOND COMMITMENT PERIOD

General guidance on methodological consistency in relation to the FMRL is provided in Section 2.7.5.2.

In line with Decision 2/CMP.7, it is *good practice* to demonstrate methodological consistency between the treatment of HWP in the FMRL and the reporting for FM during the second commitment period.<sup>155</sup> Since the final agreement on HWP, included in the Decision 2/CMP.7, was reached after the FMRL submissions, a technical correction for accounting purposes as described in Section 2.7.6 might be needed in the estimation of the *HWP contribution* to the FMRL to reflect the changes in the applied methodological elements as described below and in the relevant Sections 2.8.1, 2.8.2, 2.8.3 and 2.8.4. In order to check methodological consistency it is *good practice* to follow the decision tree provided in Figure 2.8.5.

**Figure 2.8.5** Decision tree for consistency check of HWP estimates with FMRL



<sup>155</sup> Paragraph 14

Provided that Parties comply with the requirements as outlined in Section 2.8.1 to estimate the *HWP contribution* on the basis of changes in the HWP pool following a Tier 2 or Tier 3 method (see Sections 2.8.3 or 2.8.4), methodological consistency between the treatment of HWP in the FMRL and the reporting as explained in Section 2.7.5.2 can be demonstrated by providing following information in the annual greenhouse gas inventory in accordance with Article 5, paragraph 2, of the Kyoto Protocol, which shall be submitted starting with the annual inventory for the first year of the second commitment period<sup>156</sup>:

- Time series of  $HWP_{FM}$  separately for the included HWP categories ( $HWP_p$ ), including historic information as appropriate (see Sections 2.8.3, 2.8.4 and below), in order to also demonstrate that
  - (i) the method(s) to be used for estimating HWP contribution following the different tiers have been applied consistently including the treatment of inherited emissions (see Sections 2.8.2, 2.8.3 and 2.8.4);
  - (ii) the method to determine the fraction of HWP originating from FM has been applied consistently (see Section 2.8.1.2);
  - (iii) the same HWP categories ( $HWP_p$ ) have been applied (see Sections 2.8.1.1, 2.8.3.1 and 2.8.4.1);
  - (iv) the same carbon conversion factors have been used (see Sections 2.8.3.1 and 2.8.4.1)
- Emission factors (i.e. service- or half-life information) associated with the particular HWP categories ( $HWP_p$ )

Further general guidance on the detection of the need for, the procedures of performance and documentation of, and the timing of the application of a technical correction is provided in the relevant Section 2.7.6.

## 2.8.6 Uncertainty assessment

This section provides information on potential sources of uncertainty associated with the estimates of the *HWP contribution*. The uncertainties can be divided into uncertainties associated with the methods as well as parameter uncertainties.

### METHOD UNCERTAINTIES

In the Tier 2 flux data method the basic model uncertainties are related to the assumption of FOD (Equation 2.8.5). A model is always a simplification of real world inducing method based uncertainties. The reason for using decay models instead of just counting the inflow minus outflow from the HWP pools is that there are no extensive and reliable statistics on the real discard flows (unlike on the inflows of semi-finished products), but some knowledge on the service life of wood products. Although FOD decay is assumed to be a good proxy for the decay of semi-finished products, other types of distributions could also be used to describe the true decay process. However, the real world is even more complex. The service life and decay pattern of wood products are not just a technical issue, but are also related to socio-economic factors (see Section 2.8.4.2). For instance, the demand for wood products is likely to grow during economic booms resulting simultaneously in increasing replacement of old HWP with new ones. Thus also discards of HWP correlate with their increasing consumption. This is not reflected in the FOD pattern, where the discard rate is a constant fraction of the HWP pools in use over time. As a result of FOD the annual change of carbon stock in HWP is steered too strongly by the instantaneous production rate of HWP of domestic origin.

In the Tier 2 method another uncertainty is associated with the initialisation of the FOD model. Due to lack of long historical data series on semi-finished HWP – for some countries data series are only available since the early 1990s – the initial stocks of the HWP categories ( $C(t_0)$ ) are approximated by assuming that the stock change was zero at the initial time. This proxy slightly overestimates the inherited emissions within the second commitment period from the long-lived HWP categories sawnwood (with half-life of 35 years) and wood based panels in case their stock in reality was growing at initial time, particularly when the calculation in Equation 2.8.5 is started only from the early 1990s. Depending on the accounting of HWP under Article 3 paragraph 4, this could thus potentially increase the uncertainties of the *HWP contribution* provided especially from products with high half-life values. In case the accounting approach for FM is based on a projected FMRL, however, this source of uncertainty is of no relevance and consequence for the accounting of the *HWP contribution*.

Another model uncertainty is related to the number of HWP categories in the model. In the simplest Tier 2 method there are three HWP sub-pools for the main categories: sawnwood, wood-based panels and paper and paperboard, each of which follows the FOD pattern but with different half-lives. The uncertainty could basically be lowered by introducing disaggregated sub-pools (e.g. for sawnwood) with differing half-lives based on their

<sup>156</sup> This information includes methodological elements as used in the estimation of the *HWP contribution* to the FMRL and the reporting during the second commitment period as defined in Annex II to Decision 2/CMP.8

end-use (cf. Table 2.8.3) or based on subcategories (e.g. wood-based panels disaggregated to particle board, fibreboard etc., see Table 2.8.1).

In Tier 3, direct inventories of HWP in service (e.g. in the construction sector) could also be used to reduce the uncertainties associated with the flux data based method of Tier 2. The advantage of direct inventories is that they remove the need for idealised models with uncertain assumptions on decay pattern and whose verification and validation could be questioned. The inventory method could in principle provide more robust and less uncertain estimates for the carbon stock changes of the included HWP pools. Sequential direct inventories could also be applied in the calibration of the flux-data models and their half-life parameters (see Box 2.8.1) and thus reducing their uncertainties. However, the limitation of the method is that the statistics, if available, contains only some major pools such as the housing sector of the reporting country: but there is no information e.g. on the use of wood for furniture or packaging. Inventory methods cannot be applied for HWP in export markets by the reporting country either. Thus it must always be combined with flux data methods, inducing double-counting risks of semi-finished and final products. Furthermore, it is applicable only in those few countries from which relevant and sequential statistics are available.

## UNCERTAINTIES OF ACTIVITY DATA

Uncertainties related to activity data on HWP from international databases (e.g. FAO) and the associated uncertainties of the estimates of the level of the *HWP contribution* could arise due to:

- Lack of time series: some Annex I countries were founded in the early 1990s and thus older activity data might not be available (see above).
- Definitional uncertainties (i.e. data provided do not conform to what has been requested). Removals data e.g. tend in fact to be only commercial forestry operations or planned cuts, sawnwood production is being provided in nominal, not solid m<sup>3</sup>, and pulp is only market (commercially sold) pulp.
- The scope of data collection, as not all information is collected, particularly in the informal sector and from small operators. This tends to affect especially the sawmilling industries, as limits to collect statistical data might be linked to business volume or number of employees.
- Double counting (e.g. final products counted in semi-finished commodities, such as cut paper being added to paper in rolls).
- Reporting errors in providing correct data; that is numbers are put into the wrong category or incorrectly processed by reporter or collecting agency.
- Uncertainties associated with aggregate HWP commodities (e.g. wood-based panels): in general, the sum of the subcategories accords with the value for the aggregate commodities, but some categories may underreport because of missing subcategories (e.g. missing data on veneer sheets result in an underestimate for wood-based panels).

Concerning data on the feedstock of production of semi-finished HWP categories (i.e. industrial roundwood and wood pulp as proposed in Section 2.8.1.2), uncertainty could be caused by unreported sources, by-product use or trade data.

The semi-finished HWP categories (i.e. sawnwood, wood-based panels and paper and paperboard) are also subject to the above mentioned conditions. An overall estimate of these factors results in an estimated uncertainty of the reported values between -25% to +5% (based on the authors' expert judgement).

All of these sources of uncertainty together tend to result in an under-reporting of HWP commodity data in international databases, that is, actual figures are usually higher. As this is particularly the case in roundwood (i.e. wood-removals, see Figure 2.8.2) the allocation of the HWP categories to forest activities as described in Section 2.8.1.2 should be fairly conservative.

Further uncertainties associated with activity data are caused by conversion factors. The provided conversion factors (see Table 2.8.1) are highly generalized and reflect averages which may not correct for species and specific items.

In order to reduce uncertainties around conversion factors for carbon, Parties are encouraged to use sub-categories under Tier 2 (see Section 2.8.3.2) or use a Tier 3 approach where they can make use of commodity specific conversion factors linked e.g. to various wood species of the particular items (see Section 2.8.4.2).

Aside from reviewing the data to check if it fits with a general understanding of the forest products supply in a country, it is most useful for reducing the uncertainties relating to activity data to cross-check if the amount of domestic production of HWP categories balances with the available supply of wood. Other validation methods could include a review of trade unit values and determination of per capita apparent consumption.

## UNCERTAINTIES ASSOCIATED WITH EMISSION FACTORS (SERVICE- AND HALF-LIFE ESTIMATES)

The half-life parameters are in general the most uncertain part of the Tier 2 calculation method. The scientific evidence behind the default values given in Table 2.8.2 is not robust<sup>157</sup>. Nor do they present a conservative estimate that would rather lead to underestimation than overestimation of the carbon stock changes in HWP. For decreasing uncertainty, countries are strongly encouraged to adjust the Tier 2 half-life parameters by calibrating the FOD model either a) with direct inventories of HWP in use, or b) with market information as shown in Table 2.8.3. The application of stock inventory information, however, due to the lack of appropriate statistics is not practical for most countries. Furthermore, it does not cover export markets of the reporting country. Two specific calibration studies (Pingoud, *et al.* 2001, Statistics Finland 2011) indicate that the true half-life of sawnwood and wood-based panels in Finland is likely to be much shorter than the default half-lives (Table 2.8.2). Thus, in this particular case the use of default half-lives would substantially overestimate the HWP pool in use. The results of such calibration studies could possibly be generalised to obtain better estimates for default half-lives.

Even though the uncertainty associated with Tier 2 estimates using default data could be high, working through such estimates can be the first step in identifying ways to improve them. Initial improvements can be made using country-specific data with country-specific half-lives instead of the default half-lives in Tier 3.

To decrease uncertainties in Tier 3 Parties are encouraged to use direct inventories of HWP in use, to develop more realistic decay patterns for HWP and use more sub-pools in case transparent information is available. However, the model calibration procedure to direct HWP inventories requires in practice a model with very few adjustable parameters.

### 2.8.7 Quality Assurance/Quality Control

Detailed steps to improve estimates of HWP activity data are already described in detail for Tiers 2 and 3 methods in Sections 2.8.3 and 2.8.4, and also in Section 2.8.6 (as it relates to uncertainties). These steps include the use of country-specific data and half-lives for Tier 2 methods (Sections 2.8.3.1 and 2.8.3.2) and the application of potential steps to derive improved Tier 3 estimates (Sections 2.8.4.1 and 2.8.4.2). Therefore, this section does not provide a separate, detailed sub-section on Quality Assurance and Quality Control.

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<sup>157</sup> Paragraph 29



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