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Scope and methodology for measuring the Greenhouse Gas (GHG) and Carbon Profile of the Canadian Forestry Industry

Forest Product Association of Canada and WWF-Canada

1 Introduction

The forest industry is directly and indirectly responsible for significant greenhouse gas (GHG) emissions from harvesting activities, manufacturing, transportation and product disposal. At the same time forests, soils, biomass and forest products all have the potential to store carbon for varying degrees of time. Activities aimed at reducing emissions, increasing carbon storage and reducing reliance on fossil fuels can positively influence the amount of CO_2 and other greenhouse gases in the atmosphere.

The Forest Products Association of Canada (FPAC) and WWF-Canada both believe that providing leadership in sustainability and environmental performance will realize some of the greatest opportunities for the future of the forest industry. With this in mind, FPAC and WWF-Canada have committed to use their collective resources and influence to effect positive change.

With the support of WWF-Canada, FPAC has committed to the goal of industry-wide carbon-neutrality by 2015 **without the purchase of carbon-offset credits** – a world first. FPAC and WWF-Canada have also agreed to use this partnership to leverage broader uptake within the forest industry, across the forest product value chain and in other sectors.

WWF-Canada and FPAC will use the best available information to inform the analysis and planning, and accounting protocols will be guided by the best relevant methods. Activities carried out in support of this initiative are not intended to presume the outcome of other related initiatives pertaining to climate change, including governmental measures and/or the development of protocols for project-specific tradable offsets.

This paper outlines the approach to be used with respect to three critical components of any strategy to reduce Greenhouse Gas emissions and/or enhance sequestration.

Scope

What should be included when measuring the carbon profile of the forest sector? As with any carbon profile it is necessary to delineate boundaries to what can be assessed. There is no single definitive boundary between different sectors of the economy. Furthermore, there are numerous possible approaches to measuring the carbon profile within a defined boundary. One approach is not necessarily more or less valid than a different approach; instead, the differences may be based in differences in the available information, or in how the profile is to be used. Two of those approaches are briefly noted below.

- The *Greenhouse Gas Protocol* published jointly by the **World Resources Institute** and the **World Business Council for Sustainable Development**[1] (WRI/WBCSD) is applicable to all types of businesses, although it does not contain specific provisions for measuring changes to forest carbon. It breaks down potential elements of an accounting protocol into three "Scopes." Scope One refers to the direct emissions produced by the entity under consideration, from facilities or vehicles that it owns. Scope Two refers to indirect emissions; emissions from facilities not owned by the entity under consideration but arising as a direct result of the activities under consideration. Scope Three refers to a broad range of other emissions that may be considered.

- The **Confederation of European Paper Industries** has published a *Framework for the development of carbon footprints for paper and board products*[2] which describes ten "toes" to that footprint, including the measurement of forest carbon.

The Canadian forest sector accounting protocol outlined in this paper is consistent with these generic international protocols.

Methodology

How will any particular component of a GHG profile be measured? There are existing precedents, examples and guidelines for measuring GHG emissions, but they need to be adapted to each specific situation. The information must be available or obtainable (including practical considerations), and it must be possible to determine with reasonable accuracy what can be reasonably allocated to the particular sector of the economy under consideration. This report provides a description of how this information is to be compiled in order to provide a profile of the forest industry in Canada, using the most rigorous, complete and accurate information available. Recognizing that measuring GHG emissions is a complex task and in virtually no case is there a "perfect" method,

[1] Available at http://www.ghgprotocol.org/
[2] Available at www.cepi.org

we have taken care to identify the assumptions and uncertainties that go into these calculations.

In 2007 the National Council for Air and Stream Improvement (NCASI) produced an initial carbon profile of the Canadian Forest Products Industry. As indicated below, in most cases the scope and methodology outlined in this paper are drawn from that work. The complete NCASI report, including baseline data for 1990 and 2005, is available at http://www.ncasi.org//Publications/Detail.aspx?id=3013

If more sophisticated or accurate methodologies emerge during the life of this project then it is expected that wherever practical we will adopt those methodologies, including where necessary steps to reassess baseline or benchmark measurements.

Measures

This paper also proposes certain measures that warrant further consideration as possible ways to reduce GHG emissions or enhance carbon sequestration. A compilation of such activities is still in a preliminary state, although the measures are ones that are already being implemented to varying degrees. It is intended to identify those measures that show the most promise for additional benefits beyond business as usual projections. FPAC and WWF will work together to compile and summarize available information about their applicability, with a view to encouraging their implementation within the forest industry as well as across the forest products value chain.

2 Scope and Methodology

The following seven items make up the key elements used to determine the carbon profile of the Canadian forest industry and its progress towards carbon neutrality.

	Element
A) Greenhouse Gas Emissions from the Forest Products Industry Value Chain	
1	Direct emissions from forest products industry manufacturing facilities
2	Indirect emissions associated with electricity purchases
3	Emissions associated with harvesting and transporting materials and products
4	Methane emissions attributable to forest products in landfills
B) Carbon Sequestration in the Forest Products Industry Value Chain	
5	Carbon sequestered in forests
6	Carbon stored in forest products in use
7	Carbon stored in forest products in landfills

Each element is outlined below, along with the measurement methodology to be used to assess it.

A) Greenhouse Gas Emissions from the Forest Products Industry Value Chain

1. Direct emissions from forest product industry manufacturing facilities

Most GHG emissions from the forest products industry are the result of fossil fuel combustion. Direct emissions occur from sources owned or controlled by the forest product industry companies. Total direct GHG emissions from stationary combustion are estimated for both the pulp and paper sector as well as the wood products sector.

Data sources (from NCASI report): The following sources were used to estimate pulp and paper sector emissions: data from an FPAC energy consumption survey, and energy consumption data from the Canadian Industrial Energy End-use Data and Analysis Centre (CIEEDAC). GHG emission factors of Environment Canada (EC 2007) were used for CO2, and emission factors for CH4 and N2O were taken from NCASI. Energy consumption data from CIEEDAC (2007) were used to estimate direct emissions from the wood products sector.

Variability and Uncertainties: The uncertainty in this study is probably somewhat higher than the EC uncertainty range of –4 to +1% used by Environment Canada in its Canadian GHG inventory for estimates of stationary combustion emissions. This is because extrapolations of incomplete FPAC and CIEEDAC data were undertaken to complete this study.

2. Indirect Emissions Associated with Electricity Purchases

Indirect emissions include emissions associated with net purchased power, which originate from a source not owned or operated by the industry but which occur due to industry's activities. Indirect GHG emissions were estimated for both the pulp and paper sector as well as the wood products sector.

Data sources (from NCASI report): Due to considerable uncertainties in indirect emissions data from CIEEDAC, only FPAC survey responses were used to calculate indirect emissions for the pulp and paper industry. For pulp and paper secondary manufacturing facilities, emissions associated with purchased power were estimated using CIEEDAC data in conjunction with Canadian national average purchased power emission factors. For the wood products sector, CIEEDAC data were used.

Variability and Uncertainties: The uncertainty in this study is probably somewhat higher than the EC uncertainty range of –4 to +1% used by Environment Canada in its Canadian GHG inventory for estimates of stationary combustion emissions. This is because extrapolations of incomplete FPAC and CIEEDAC data were undertaken to complete this study.

3. Emissions Associated with Harvesting and Transporting Raw Materials and Products

Fossil fuels are consumed in harvesting as well as the transport of raw materials and finished products. These are usually a combination of direct and indirect emissions, but in this analysis they will all be shown as indirect because the majority of emissions in this category are associated with transportation, often provided by outside firms. Because more wood fibre is used than other raw materials, this analysis focuses on wood fibre procurement and transport and the subsequent transport of products.

Data sources (from NCASI report): Emissions associated with transport were estimated for both the pulp and paper and wood products sector jointly, based on a 1999 analysis by the Forest Engineering Research Institute of Canada (FERIC). The emission factor for diesel fuelled trucks was obtained from the Canadian GHG Challenge Registry and used to calculate GHG emission from diesel consumption. Further work is needed to estimate the GHG impacts of harvesting operations, which are not included in the FERIC study, and thus omitted from the NCASI report.

Variability and Uncertainties: The amounts of GHGs emitted vary considerably depending on distanced involved and the mode of transport. For this reason, estimates for this part of the industry profile are quite uncertain. The non-inclusion of emissions during harvesting represents a low bias to the information presented in the NCASI report, although the GHG impact of harvesting is estimated to be relatively minor. These emissions will be estimated, based on data from *Greenhouse Gas Emissions from Forestry Operations: A Life Cycle Assessment* by E. Sonne, and published in the Journal

of Environmental Quality 35:1439–1450 (2006), to refine the industry's carbon profile for the purposes of this initiative.

4. Methane Emissions Attributable to Forest Products in Landfills

Forest products degrade in anaerobic conditions in landfills. Because the CO_2 is biogenic and is accounted for in estimations of stock changes in forests and products (section B), it is not considered here. Methane is considered because it has a Global Warming Potential of over 20 times that of CO_2.

Data sources (from NCASI report): Estimates of total CH_4 releases from municipal solid waste landfills are not appropriate for identifying the forest products industry's GHG profile as CH_4 released from these landfills results from the decomposition of a wide range of materials. CH_4 emissions were estimated using a modification of IPCC methods based on amounts of used forest products discarded yearly, where time in use of the forest product was determined using a linear relationship like that of the Carbon Budget Model of the CFS. Data regarding the fraction of landfills equipped with methane collection systems comes from the 2005 study for NRCan and EC and from EC's national inventory and from USEPA.

Variability and Uncertainties: The amount of CH_4 released from decomposition of used forest products depends on a number of factors, including amounts of discarded products, amounts of products in anaerobic conditions, rate of decomposition, and others. Estimates of discards in the NCASI study were estimated to be biased high because recovery rates in the US were assumed to be equal to Canadian rates, whereas those in the US have actually been a bit higher. Thus estimates of CH_4 generation and C storage in landfills are biased high. Overall, in their 1990 – 1995 GHG inventory, EC estimated their uncertainty associated with CH_4 emissions from used products in landfills to be in the range of –35% to +40%, which is comparable with uncertainties of the NCASI study.

B) Carbon Sequestration in the Forest Products Industry Value Chain

5. Carbon sequestered in forests

Many factors influence the amounts of carbon in Canada's managed forests, including losses of forest carbon due to decay, fire, and harvesting, and gains of carbon by tree regrowth. The balance of these determines whether forests are carbon sources or sinks.

Data sources: There is currently no single data source that tracks carbon changes on the entire forest land base affected by timber harvesting, and limited to that area (approximately 143 million hectares). However, as part of Canada's reporting requirements to the Framework Convention on Climate Change the Canadian Forest Service measures and reports on carbon changes in the "managed forest" (236 million

hectares), which also includes private forests, parks and protected areas, and areas not within forest management licenses but subject to management activities such as fire protection. FPAC and WWF will work with the Canadian Forest Service and provincial and territorial partners to explore how to develop a forest carbon model for the "industrial forest area." This collaborative partnership will ensure that we are using a methodology consistent with Intergovernmental Panel on Climate Change guidelines as well as with the Carbon Budget Model made available by CFS for use at the Forest Management Unit level. Creating a database limited to the industrial forest area will improve the responsiveness of measurements to actions undertaken by FPAC members to enhance carbon sequestration on the forests that they manage.

Variabilities and Uncertainties: Until figures specific to the industrial forest area are available we will use the "managed forest" figures that Canada prepares as part of its international reporting obligations. Since the "managed forest" includes not only area under active management by industry, but also includes forests with characteristics that are different from forests under active industry management, there are a number of likely biases introduced into this database, two of which are noted here by way of example. The inter-annual variability is likely to be greater in those regions of the managed forest that are outside of the industrial forest area and where fire-fighting efforts are limited (e.g. national parks) or less effective (remote unlicensed forests). These same forests are also more likely to be older because of reduced harvesting activities, and therefore they may have higher average volumes of carbon.

6. Carbon Stored in Forest Products in Use

Forest products remain in use for periods ranging from days to centuries. Thus measurement of the carbon stored in forest products varies by product type. In order to track forest carbon through the forest products value chain we are using the Production Accounting approach, which looks at stock changes that are associated with the wood that originates within national boundaries, regardless of where those stocks reside. This approach is aligned with available data, allows examination of the role of carbon along the value chain, and focuses on the source of production rather than national boundaries. It is the most appropriate method for carrying out a country-specific forest sector profile. The international community is currently reviewing possible accounting methods for harvested wood products, and will decide on the accounting method most appropriate for an international accounting regime, which may very well turn out to be different from the Production Accounting method.

Data sources (from NCASI report): Stocks of carbon were estimated using FAO data and modified IPCC methods, as well as parameters similar to those used in the Carbon Budget Model of the CFS and IPCC.

Variability and Uncertainty: In a recent analysis, USEPA estimated their uncertainty of estimates in carbon storage in harvested wood products as +/-40%, which is comparable with uncertainties of this study.

7. Carbon Stored in Forest Products in Landfills

After use, products are discarded and placed in landfills. The net effect of landfills on GHG emissions includes: storage of non–degradable carbon; temporary storage of degradable carbon; conversion of C to CH_4; destruction of CH_4 by oxidation. When forest products go into landfills, they immediately store carbon, but this storage dissipates over time until only non-degradable carbon remains. Conversely, methane releases start off small but become significant over time.

Data sources (from NCASI report): The NCASI report uses a modification (use of a linear decay relationship similar to that of the CFS) of IPCC-endorsed methods to estimate the accumulation of carbon in landfills. In this profile the measurement of carbon stored in landfills is measured and reported separately from the methane released through the decay of those products.

Variability and Uncertainty: In a recent analysis, USEPA estimated their uncertainty of estimates in carbon storage in landfills as +/-40%, which is comparable with uncertainties of this study.

8. Elements not included

There are some elements that are not included in the scope for this initiative. They are listed below, along with the reasons for excluding them.

- **Emissions from non-fibre inputs to the manufacturing process.** There are numerous chemicals, glues and other materials that are added to the manufacture of papers and composite products. Each of these inputs will have its own unique carbon profile, and it is not possible to make any valid generalizations to cover all additional inputs. In future refinements of this profile we will explore possible approaches to including these inputs where feasible.

- **Forest company emissions not related to product manufacturing.** The scope outlined above does not include categories of emissions that are unrelated to product manufacturing, such as the emissions from heat and electricity in head office buildings. Neither have we included emissions such as the transportation emissions from employees commuting to work. The exclusion of these emissions is not intended to diminish their significance, nor the importance of separate initiatives to reduce emissions in these and all other workplaces.

- **Indirect emissions from fossil fuel use.** The emissions resulting from burning fossil fuels are included in Element 1, but the indirect emissions from producing and transporting those fossil fuels are not included, since the indirect emissions in Element 2 are restricted to the indirect emissions from electricity generation. Estimating these additional indirect emissions would only be meaningful if manufacturers have significant influence in the specific sources of the fuels they

purchase, which is not typically the case. The scope and methodology used in this initiative does retain focus on incentives to switch to cleaner fuels (e.g., from fossil fuels to natural gas) or to renewable fuels.

- **Emissions from the use of forest products.** For some types of products (e.g. automobiles) their use results in significant emissions (and is therefore identified as the 8th "toe" in the CEPI framework). For forest products, however, product use does not require greenhouse gas emissions, so these can be assumed to be zero for forest products.

- **Avoided emissions.** There are some steps that the forest sector can undertake that may reduce emissions in other sectors of the economy. For example, the sale of electricity from a forest industry biomass cogeneration plant into the local electricity grid will presumably reduce emissions in provinces where fossil fuels are used in electricity generation. Although the cogeneration plant is included within the forest industry facility's carbon profile, the implications beyond the facility (displacing electricity in the provincial grid that would have otherwise been produced using fossil fuel) are not accounted for. These types of initiatives are included in the measures to be considered by the industry for enhancing GHG profile (see below) but are not included in measuring the GHG profile of the forest sector. This is because these "avoided emissions" are emissions that would need to be compared with baselines outside the forest sector, and therefore outside the scope of this initiative. They are, however, useful in providing context regarding the sector's connection with greenhouse gas emissions.

3 Potential measures for enhancing GHG performance in the forest industry and throughout the forest product value chain

In this section we describe various measures that could be undertaken to enhance GHG mitigation, above and beyond "business as usual." The next step in this project will be to review existing information about these measures and make some general qualitative assessments as to which of these measures have the most potential to offer GHG-reduction options to forestry companies as well as other actors in the forest product value chain. Measures showing the highest potential will be analyzed in greater detail, with assessments of specific actions, including information on:

a) relevance and potential scope of the action(s);
b) costs and benefits (financial and other);
c) case studies of successful or model approaches;
d) barriers to implementation, and proposed ways to address those barriers; and
e) potential impacts on the conservation of biodiversity.

For each element of the scope outlined above we first list measures directly relevant to the forest industry, followed by measures more broadly relevant along the forest product value chain. Some of these "value chain" measures are also relevant to the forest industry; others are not. Likewise, activities undertaken at other stages in the forest product value chain may or may not contribute towards meeting FPAC's carbon-neutral goal but they are included for consideration because they do help to mitigate climate change.

Some measures include examples of one or more potential actions that describe how this measure might be implemented. These actions are provided for illustrative purposes only, and the lists are not intended to be comprehensive.

A) Greenhouse Gas Emissions from the Forest Products Industry Value Chain

1. Direct emissions from forest products industry manufacturing facilities

(Measures in this section apply to forest product manufacturers; measures applicable to other actors in the forest products value chain are dealt with in subsequent sections.)

1.1 Measures to improve energy efficiency, e.g.:
- Improve process thermal integration;
- Adopt energy efficient process technologies;
- Improve maintenance and use of existing auxiliary equipment;
- Improve maintenance and use of existing steam-producing equipment;
- Adopt energy-efficient auxiliary technologies
- Implement heat recovery processes
- Reduction in water use oriented toward decreasing energy use
- Improve recovery boiler operation

1.2 Fuel switching, e.g.:
- Replace fossil fuel-fired combustion units with biomass-fired combustion units (opportunities in both pulp and paper and wood products facilities)
- Wood waste cogeneration;

1.3 Incorporation of emerging technologies, e.g.:
- Black liquor integrated gasification and combined cycle cogeneration;
- Adoption of high intensity dryers;

1.4 Measures to reduce emissions from process waste sent to landfill

2. Indirect emissions associated with electricity purchases

2.1 Provision of surplus energy into the electricity grid

2.2 Purchase of energy from renewable energy portfolios

Measures applicable throughout the forest products value chain:

2.3 Use of forest biofuels in applications displacing fossil fuels

3. Emissions associated with transporting materials and products

3.1 Wood exchanges to reduce raw material transport

Measures applicable throughout the forest products value chain:

3.2 Improvement of vehicle fleet efficiency

4. Methane emissions attributable to forest products in landfills

Measures applicable throughout the forest products value chain:

4.1 Waste wood and paper diversion from landfills

4.2 Methane gas capture

B) Carbon Sequestration in the Forest Products Industry Value Chain

5. Carbon sequestered in forests

5.1 Increasing the area of forests, e.g.:
- Creating new forests or plantations;

5.2 Increasing the volume of carbon stored in existing forests, e.g.:
- Enhanced fire, insect and disease control;
- Lengthening the rotation age;
- Site restoration and rehabilitation;
- Reduced soil disturbance;
- Avoidance of slash or broadcast burning
- Thinning;
- Reducing harvesting levels

Measures applicable throughout the forest products value chain:

5.3 Reducing deforestation and forest degradation, e.g.:
- Reducing impacts of roads and other forest removals
- New logging deferrals or protected areas

6. Carbon stored in forest products in use

6.1 Production of longer-lived products

Measures applicable throughout the forest products value chain:

6.2 Forest product reuse

6.3 Substitution of forest products in place of other materials

7. Carbon balance of forest products in landfills

No measures are proposed for this category, since deliberately landfilling forest products as a GHG mitigation strategy is not seen as appropriate. Measures aimed at *reducing* forest products in landfills are dealt with in section 4.

8. Other measures relevant in the forest products value chain

8.1 Forest-based bioproducts

8.2 Using non-recyclable discarded products for bio-energy, displacing fossil fuels

8.3 Working with suppliers of non-fibre inputs to help reduce upstream emissions