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NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT

**DISCUSSION OF MEASURES IDENTIFIED UNDER THE PROPOSED  
FPAC/WWF SCOPE AND METHODOLOGY FOR MEASURING  
THE GREENHOUSE GAS AND CARBON PROFILE  
OF THE CANADIAN FORESTRY INDUSTRY**

prepared for  
**Forest Products Association of Canada  
and  
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# **DISCUSSION OF MEASURES IDENTIFIED UNDER THE PROPOSED FPAC/WWF SCOPE AND METHODOLOGY FOR MEASURING THE GREENHOUSE GAS AND CARBON PROFILE OF THE CANADIAN FORESTRY INDUSTRY**

## **1.0 INTRODUCTION**

On October 30, 2007, the Canadian forest products industry jointly launched an initiative with World Wildlife Fund Canada (WWF) to achieve a reduction in the greenhouse gas and carbon profile of the sector. This partnership is based on a commitment by the members of the Forest Products Association of Canada (FPAC) to achieve industry-wide carbon-neutrality by 2015 without the purchase of carbon offset credits.

The technical foundation for this commitment was NCASI Special Report No. 07-09, entitled “*The Greenhouse Gas and Carbon Profile of the Canadian Forest Products Industry*” (NCASI 2007). This report uses accepted international carbon and greenhouse gas (GHG) accounting protocols to characterize the profile of the industry, including its GHG emissions and carbon sequestration, for two time periods (1990 and 2005). The report also provides information on the broader context of the industry, regarding other emissions that could be considered to be avoided due to activities undertaken by the sector.

An initial step for the partnership was to develop a discussion paper to frame the scope and methodology that will be used to foster action by the industry. This paper confirmed that the FPAC/WWF initiative will use the approach taken within the NCASI report as the basis for evaluating the GHG and carbon profile of the sector, and identified a series of proposed measures that could be undertaken by the industry to reduce this profile.

This report provides a discussion of the 20 measures outlined in the scope and methodology paper, and focuses on five aspects for each:

- 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.

Each measure has potential for helping reduce the GHG and carbon profile of the sector; however, some may have been implemented to a large degree or may be inherently constrained due to cost or policy barriers. That said, certain measures may warrant focus as possible opportunities for the partnership to optimize the impact on either GHG emissions or carbon sequestration.

This discussion paper is to enable FPAC and WWF to prioritize actions that may hold significant promise for reducing the industry’s carbon profile, and is not intended to be a comprehensive analysis of each potential measure.

## **2.0 APPROACH**

NCASI has examined each measure through the lens of the five aspects discussed above, to prepare a concise summary that should help FPAC/WWF better identify measures showing promise for accomplishing the objectives of this partnership. These qualitative summaries are based on NCASI’s

professional knowledge gained through the open literature, participation in various national and international technical forums on climate change science, and the output from the organization's technical studies program. Where appropriate, quantitative information is included to assist the reader in gaining an understanding of the relative potential of a given measure, or the degree to which it may already have been implemented. In many cases, the potential from a given measure is site-specific, and thus the discussions in this document may be insufficient to identify its full potential when applied to a given facility.

### **3.0 MEASURES**

#### **3.1 Direct Emissions from Forest Products Industry Manufacturing Facilities**

##### **3.1.1 *Measures to Improve Energy Efficiency***

###### **Relevance and potential scope of the measure**

Measures to improve energy efficiency range from identifying and eliminating steam or compressed air leaks to rebuilding or replacing old power boilers and recovery furnaces. Specifically, these may include improving process thermal integration, adopting energy efficient process technologies, improving maintenance and use of existing auxiliary equipment, improving maintenance and use of existing steam-producing equipment, adopting energy-efficient auxiliary technologies, implementing heat recovery processes, reducing water use oriented toward decreasing energy use, and improving recovery boiler operation, and others. Impacts on overall facility GHG emissions will vary depending upon the magnitude of the efficiency improvement achieved. For example, rebuilding an aging oil-fired boiler to eliminate air leakage to the furnace and install an economizer can increase boiler efficiency by 5%. This would result in a 5% reduction in GHG emissions from the boiler, while producing the same amount of usable process steam.

###### **Costs and benefits (financial and other)**

Costs and benefits of energy efficiency improvements vary widely, corresponding to the wide range of energy efficiency measures available to the industry. Costs include capital expenditures needed to implement efficiency improvements (e.g., boiler rebuild, piping modifications, etc.). Benefits, in addition to reduced GHG emissions, often will include reduced operating costs as fuel consumption is decreased. Additionally, if boiler rebuild results in generation of higher pressure steam (or more steam from given supplies of hogged fuel, etc.), additional self-generated electricity can result.

###### **Case studies of successful or model approaches**

There are many examples of implementing energy efficiency programs and individual technologies within the forest products industry. The suitability of these technologies and programs must be examined on a case-by-case basis.

###### **Barriers to implementation, and proposed ways to address those barriers**

The primary barriers to implementation of energy efficiency measures are economic in nature, in that capital investment is required for large items such as boiler rebuild or replacement. Some items, such as detection/elimination of steam leaks, require very little capital investment.

###### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.1.2 Fuel-Switching**

#### **Relevance and potential scope of the measure**

Fuel switching refers to substituting lower GHG emitting fuels for higher emitting fuels in combustion devices such as power boilers and lime kilns. For example, this could include replacing fossil fuel-fired combustion units with biomass-fired combustion units (opportunities in both pulp and paper and wood products facilities). Note that wood waste cogeneration, while involving fuel switching, is a more significant change that simultaneously increases direct emissions and decreases indirect emissions. It is separately discussed under Section 3.2.3. Coal is the highest GHG emitting fossil fuel commonly used, followed by residual oil, distillate oil, and natural gas. Biomass fuels are the lowest emitting, as biomass combustion CO<sub>2</sub> is not included in GHG tabulations (any changes in biogenic carbon are reflected in forest carbon tabulations).

#### **Costs and benefits (financial and other)**

Costs for fuel switching include capital costs for combustion device modifications (e.g., burner replacement for switching from oil to natural gas, major boiler and flue gas system modification for switching from coal to wood, etc.), and operating costs related to the differential price of fuels. Benefits include significantly reduced CO<sub>2</sub> emissions (e.g., switching boiler fuel from coal to natural gas can result in a 40% decrease in CO<sub>2</sub> emissions, whereas switching to biomass fuels would eliminate reportable CO<sub>2</sub> emissions).

#### **Case studies of successful or model approaches**

It is more common within the forest products industry to convert fossil fuel boilers to burn biomass than it is to implement fuel switching from higher emitting to lower emitting fossil fuels. There are several instances within the industry of fuel switching to wood.

#### **Barriers to implementation, and proposed ways to address those barriers**

In most cases equipment modification is required when employing fuel switching technologies, which can represent economic and logistical barriers in some instances. Steam production efficiencies are dependent upon fuel choice in addition to equipment design, and the lower emitting fuels tend to be associated with lower efficiencies (i.e., steam generating capacity may decrease upon fuel switching).

Fuel handling and storage facilities may also require modification. Some fuels are not available to all facilities (e.g., not all mills are located close to natural gas trunk lines). In some instances, traditional pollutant loads may increase upon fuel switching (e.g., biomass boilers may be associated with additional particulate emissions and require associated pollution control equipment). Ash handling requirements for biomass boilers are often higher than for other boilers. Conversely, switching to natural gas can decrease or eliminate some traditional pollutant concerns and ash handling considerations.

#### **Potential impacts on the conservation of biodiversity**

Increased consumption of biomass fuels may exert pressure on forest lands to produce these fuels, which would require an evaluation of potential effects on the habitat value of managed forests.

### **3.1.3 Incorporation of Emerging Technologies**

#### **Relevance and potential scope of the measure**

Emerging technologies range from technology-intensive options, such as black liquor gasification integrated with combined cycle cogeneration, to less technological approaches, such as progressive water system closure or adoption of high intensity dryers. Black liquor gasification and cogeneration

can result in energy independence of some kraft mills, in that much more electricity can be produced from the energy in black liquor (a biofuel), such that the mill would not need to purchase electricity from the grid. However, this technology is associated with a slight steam production penalty (much more electricity and slightly less steam can be produced from the same quantity of black liquor as compared to a Tomlinson recovery furnace mated to an extraction steam turbine with generator). Since biofuel-combustion CO<sub>2</sub> is not included in GHG inventory totals, the mill could approach zero emissions of fossil-derived CO<sub>2</sub> (including both direct and indirect emissions). Water system closure typically results in a decreased need to heat process water (reducing fuel demands for steam generation) and decreased quantities of organic material sent to the wastewater treatment plant (reducing electricity demands for aeration).

### **Costs and benefits (financial and other)**

Costs of some emerging technologies (e.g., black liquor gasification) can be extremely high and prohibitive, in large part due to the fact that the technologies are still under development and must be “over designed” to ensure adequate performance in untested applications. Others, such as water system closure, while not trivial are much less expensive and can be incorporated into the process in stages, further reducing the economic burden of implementation. Once implemented, these emerging technologies would be expected to reduce operating costs due to reduced requirements for purchased fuel and electricity although the opportunities for cost savings remain highly uncertain. The wide range of emerging technology options makes it impossible to quantify the potential GHG reductions, but as stated above some technologies, such as black liquor gasification/cogeneration, have the potential to greatly reduce combustion-related CO<sub>2</sub> emissions from fossil fuels.

### **Case studies of successful or model approaches**

Full-scale black liquor gasification has yet to be implemented, though pilot scale liquor and wood gasification systems have been installed at multiple locations in North America and Europe. Other “emerging technology” projects, such as water use reduction, have been implemented at many pulp and paper mills.

### **Barriers to implementation, and proposed ways to address those barriers**

Barriers to implementation include high capital cost and equipment reliability issues for some emerging technologies (e.g., black liquor gasification/cogeneration, high intensity dryers, etc.). For these emerging technologies, government funding of demonstration projects could assist their adoption by the industry. Other barriers include process considerations, such as the potential to accumulate non-process elements when implementing progressive water system closure (which could be addressed by the development of improved water segregation, purge, or cleaning systems).

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

## **3.1.4 *Measures to Reduce Emissions from Waste Products in the Manufacturing Process***

### **Relevance and potential scope of the measure**

Waste products from manufacturing operations include organic materials discharged with process wastewaters to treatment, wastewater treatment plant residuals, wood residuals from solid wood product manufacture, grits and dregs from the kraft recovery process, and other minor constituents. Aerated wastewater treatment emits only very low levels of GHGs. However, disposal of solid residuals from wastewater treatment to either industry-owned landfills or off-site (e.g., municipal) landfills can result in methane formation and release as these materials slowly degrade in the

anaerobic conditions of the landfill. Because the global warming potential (GWP, a measure of a gas's climate change impact relative to CO<sub>2</sub>) is greater than 20 these emissions can be significant.

Wood residuals and bark, if landfilled, would also have the potential for generating methane, but these materials are typically burned for energy recovery, or used as a raw material for pulp manufacture. Kraft recovery wastes (grits and dregs) are inert and do not contribute GHGs. Therefore, the manufacturing waste stream primarily responsible for GHG emissions at forest product industry facilities is landfilled wastewater treatment plant residuals. Methods to reduce the GHG impact of these materials include decreased landfilling rates (e.g., by finding beneficial uses for the materials, such as burning for energy recovery, landspreading as a soil amendment, etc.), and landfill modification (e.g., collecting landfill gas and destroying it so that it is not emitted to the atmosphere).

The relative magnitude of these emissions, when compared to direct emissions due to fuel combustion, can range from quite small (on the order of 5% or less, based on a recent NCASI analysis of the US forest products industry GHG profile) to significant (approximately 20%, based on a recent NCASI analysis of the Canadian forest products industry GHG profile). It should be noted that the Canadian and US forest product industry GHG profile studies made use of differing methods to estimate emissions from industry landfills, due to differing types of information available in the two countries.

### **Costs and benefits (financial and other)**

Costs of diverting manufacturing wastes from landfills are minor, but there may be difficulty identifying beneficial uses for these materials. Installing landfill gas collection and destruction systems can be expensive (costs in the millions of dollars). Benefits include reduced GHG emissions and, in the case of diverting materials from landfills, increased operational lifetimes of existing landfills, and perhaps revenue if a market for the residuals can be found or developed. Reducing deposit quantities to landfills will not result in a proportional decrease in current landfill emissions because previously deposited materials will continue to emit methane for many years. Capture and collection systems, on the other hand, will have immediate emission reduction impacts (collection/destruction of 50% of the landfill methane would reduce emissions by 50%).

### **Case studies of successful or model approaches**

There have been cases of mills initiating beneficial use programs for solid residuals resulting in lower landfilling rates. It is rare for mills to install landfill gas collection and destruction systems due to the high capital cost and low methane generation rates at industry landfills relative to municipal landfills.

### **Barriers to implementation, and proposed ways to address those barriers**

Barriers to implementation tend to be financial (prohibitively high costs of installing landfill gas collection/destruction systems or additional boiler capacity for burning wastewater treatment plant residuals) and environmental (meeting regulations related to using wastewater treatment plant residuals for uses such as land application or fuel).

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

## **3.2 Indirect Emissions Associated with Electricity Purchases**

### **3.2.1 *Provision of Surplus Energy into the Electricity Grid***

#### **Relevance and potential scope of the measure**

If a mill is producing electricity using combined heat and power (CHP, also known as cogeneration) the emissions intensity of that electricity (in terms of kg GHG per MWh) will likely be less than the emissions intensity of power on the grid. This is especially true if the mill is firing the CHP system with biomass (or a combination of biomass and fossil fuels). If the mill exports this low-emission electricity to the grid, it is reasonable to assume that the utility will need to generate less electricity to satisfy customer demands for power. Therefore, export of mill-generated low-emission intensity power to the utility grid represents a type of avoided emissions. The magnitude of the benefit is dependent both upon the intensity of mill-generated power and that of utility-generated power (avoided emissions equal the difference in emission intensity between mill- and utility-generated power multiplied times the quantity of electricity exported). Note that emissions associated with generating the power will still be attributed to the mill's direct emissions total even if the power is sold to the grid. However, if the mill uses biomass to generate the power the direct emissions impact will be very low (because biomass combustion CO<sub>2</sub> is not included with direct GHG emissions e.g. from fossil fuel combustion, but is instead reflected in forest carbon accounting).

#### **Costs and benefits (financial and other)**

Costs are extremely variable due to the cost to the mill of generating power (and whether or not the mill would need to install additional generation capacity to be able to export electricity to the grid), the cost of purchasing utility-generated power, and the availability of preferential pricing for "green" power. In many instances, large industrial consumers of electricity can negotiate for attractive prices for utility power. However, other situations exist in which mills can sell "green" power at a premium price. The benefits of this would depend on the carbon intensity of the grid into which the surplus power is exported.

#### **Case studies of successful or model approaches**

Many pulp and paper mills cogenerate low-emission electricity and export at least a portion of the power to the utility grid.

#### **Barriers to implementation, and proposed ways to address those barriers**

The only known barriers to exporting mill-generated electricity to the utility grid are economic (or contractual) or those associated with environmental regulations (permitting).

#### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.2.2 *Purchase of Energy from Renewable Energy Portfolios***

#### **Relevance and potential scope of the measure**

Purchase of green (low emission intensity) electrical power via renewable energy portfolios has the potential to decrease a mill's indirect emissions profile relative to purchasing grid power from utilities. The magnitude of the impact will be directly proportional to the difference between the emissions intensity of the green power and that of grid power, along with the amount of electricity the mill purchases (i.e., a 10% difference in emissions intensity will result in a 10% reduction in indirect emissions). Purchasing green power will not impact a mill's direct GHG emissions.

### **Costs and benefits (financial and other)**

Typically green power is associated with a price premium relative to standard grid power. Therefore, it is likely that purchase of green energy will represent an increased cost to the mill.

### **Case studies of successful or model approaches**

It is not common practice for mills to purchase low-emission electricity due to the price difference relative to standard grid power.

### **Barriers to implementation, and proposed ways to address those barriers**

The only barriers to purchases of green energy are the cost differential, the availability of green power portfolios, and perhaps pre-existing long term contracts for the purchase of electricity.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management. That said, implications on biodiversity may depend on the source of the renewable energies, given that certain of these (e.g., solar and wind turbines) have known effects on biodiversity (e.g., habitat loss and impacts on bird and bat populations, respectively).

### **3.2.3 *Use of Forest Biofuels to Generate Electricity On-Site, Displacing Purchases of Electricity from the Grid***

#### **Relevance and potential scope of the measure**

Purchases of electricity are accompanied by indirect GHG emissions, which are emissions that are outside the control of the company but a result of the company's activities. The forest products industry, while energy intensive, is characterized by a) use of biofuels to satisfy a large portion of its energy demands, and b) use of CHP to efficiently generate electricity. Carbon dioxide from biomass combustion is not included with GHG totals, but is instead reflected in forest carbon calculations. Therefore, increased use of biomass in CHP systems (and stand-alone electricity generation operations) to produce electricity could enable the industry to purchase less electricity from the grid. This could decrease the industry's indirect GHG emissions profile while only modestly increasing its direct emissions profile (the net result will be a decrease in industry emissions). Taken to the extreme condition, a mill could eliminate its indirect emissions while only slightly increasing direct emissions if it uses biomass-fired electricity generation to satisfy all of its power requirements. Note that this measure does not include use of biofuels outside the forest sector, which is dealt with under section 3.8.1.

### **Costs and benefits (financial and other)**

Capital cost impacts include the need to modify boilers currently burning fossil fuels so they can burn biomass fuels, or the need to construct new CHP systems. Advanced technologies such as black liquor or solid biomass gasification enable even more electricity to be produced from biomass fuels. Operating cost savings or increases could result, depending upon the availability and costs of biofuels relative to costs of fossil fuels. Transportation costs associated with some biomass fuels might need to be considered as well. Solid biomass fuels can be associated with increased solid waste disposal costs relative to some fossil fuels. The benefits of this activity would also depend on the carbon intensity of the grid into which the surplus power is exported.

### **Case studies of successful or model approaches**

It is standard practice for pulp and paper mills to generate electricity using CHP systems fired partially with biomass fuels, such as spent pulping liquor and wood residuals. This self generation of low-emission electricity displaces at least a portion of the need to purchase grid power which is typically associated with higher GHG emission rates.

### **Barriers to implementation, and proposed ways to address those barriers**

Barriers to the increased generation of electricity from biomass fuels at forest product facilities are both economic and technological in nature. Economic issues are addressed above. Technical barriers are mainly associated with gasification of black liquor.

### **Potential impacts on the conservation of biodiversity**

Increased consumption of biomass fuels may exert pressure on forest lands to produce these fuels, which would require an evaluation of the potential effects on the habitat value of managed forests. Specific effects would vary depending on the source and type of feedstock. For example, using currently-available manufacturing residuals may have no effect on biodiversity. Using other sources, such as harvesting slash, non-commercial tree species, available unused industrial allowable annual cut, or dedicated planted forests (e.g., plantations) would each have effects that would need site-specific assessment.

## **3.3 Emissions Associated with Transporting Materials and Products**

### **3.3.1 *Wood Exchanges to Reduce Raw Material Transport***

#### **Relevance and potential scope of the measure**

Wood exchanges have the potential to reduce transportation distances associated with shipping raw materials to forest products manufacturing facilities. Transportation-related GHG emissions are typically characterized as indirect emissions because most forest products companies do not own or control the truck fleets used to transport raw materials to the manufacturing facilities. Within the Canadian forest products industry, total transportation emissions were recently characterized as representing approximately 8 to 13 percent of total energy-related manufacturing emissions (fuel combustion plus purchased electricity). A similar analysis within the US forest products industry indicates these emissions represent approximately 14 to 19% of total energy-related manufacturing emissions. Transport of wood raw material represents approximately one third of the total transport emissions, based on the recent study of the US industry.

#### **Costs and benefits (financial and other)**

Wood exchanges to reduce transportation needs would result in a cost savings due to reduced transportation fuel consumption, reduced operator hours (labour savings), and reduced mileage induced wear on transportation fleets. Emission reductions would be proportional to decreased haul distances (i.e., decreasing haul distances by 10% would reduce emissions due to this transport by approximately 10%).

### **Case studies of successful or model approaches**

NCASI is not aware of companies practicing wood exchanges.

### **Barriers to implementation, and proposed ways to address those barriers**

The barriers to wood exchanges would likely be policy-oriented, given the nature of Crown land forest management licensing and approval. This may limit the extent to which exchanges may be permissible under current licensing restrictions.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.3.2 *Improvement of Vehicle Fleet Efficiency***

#### **Relevance and potential scope of the measure**

Improving vehicle fleet fuel economy will reduce transportation-related GHG emissions. These are typically characterized as indirect emissions because most forest products companies do not own or control the truck fleets used to transport raw materials to the manufacturing facilities. Therefore, these measures are also applicable to sectors outside the forest products industry. Within the Canadian forest products industry total transportation emissions were recently characterized as representing approximately 8 to 13 percent of total energy-related manufacturing emissions (fuel combustion plus purchased electricity). Improving fleet fuel economy by 10% would therefore have an effect of reducing Canadian forest products industry's transportation related emissions by about 1%.

#### **Costs and benefits (financial and other)**

The costs to achieve increased fuel economy of vehicle fleets is not well characterized, but the result would be a fuel saving of similar magnitude to the efficiency improvement (i.e., an efficiency improvement of 10% would result in a transportation fuel cost savings of 10%).

#### **Case studies of successful or model approaches**

Vehicle fleet efficiency improvements have continually occurred over time. However, vehicles are rarely replaced solely to increase fuel efficiency. Rather, as vehicles require replacement due to age, companies typically include fuel efficiency as a metric in deciding between options for replacement vehicles.

### **Barriers to implementation, and proposed ways to address those barriers**

Barriers to implementation include capital costs to replace existing vehicles, and contractual obligations (most forest products companies contract outside firms for transportation, therefore vehicle fleet fuel economy is outside the direct control of the industry)

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.4 Methane Emissions Attributable to Forest Products in Landfills**

#### **3.4.1 *Waste Wood and Paper Diversion from Landfills***

#### **Relevance and potential scope of the measure**

Some of the carbon in wood products and paper that is disposed in landfills is converted to methane. The balance between escaping methane and carbon remaining stored in the landfill establishes the net effect of the landfill on atmospheric greenhouse gases. To estimate the long-term avoided methane emissions associated with keeping material out of landfills, one needs to consider two primary

factors: (1) the extent to which the discarded product decays in the landfill; and (2) the amount of methane that is captured before it can escape to the environment.

In NCASI Special Report 07-09 on the Canadian industry's carbon profile, it was noted that in the US inventory calculations, the US Forest Service considers 56% of paper and paperboard, and 23% of wood products in landfills to be decomposable with the remainder remaining stored. The Special Report also indicated that it was reasonable to assume that at present about 40% of landfills receiving Canada-produced wood products have methane capture systems that operate at 75% efficiency with another 10% of the methane being destroyed by natural oxidation in the landfill. These values can be used to estimate that for each tonne of paper and paperboard kept out of landfills, net emissions from landfills are reduced by about 2.1 tonnes of CO<sub>2</sub> equivalents. The same methods suggest that wood products are likely to hold more carbon in long-term storage than is released in methane when considered in terms of CO<sub>2</sub> equivalents – with the net storage amounting to about 0.2 tonnes CO<sub>2</sub> equivalents per tonne of wood products landfilled. These estimates suggest that paper and paperboard recovery is far more important than wood products recovery to reducing net landfill GHG emissions.

Focusing on paper and paperboard, NCASI's analysis for Special Report 07-09 found that approximately 30.8 million tonnes of Canada-produced paper and paperboard were discarded in 2005 with 15.8 going to landfills (51% of discards). The calculations above suggest that if the fraction of discards of Canada-produced paper and paperboard going to landfill had been 40%, 3.5 million fewer tons would have been landfilled with a net reduction in landfill GHG impacts of about 7.5 million tonnes CO<sub>2</sub> equivalents for the paper landfilled in 2005. Note that actions to reduce or recover such discards are more highly related to sectors outside the forest products industry, rather than to the industry itself. In particular, this measure requires action on the part of government to expand collection activities.

#### **Costs and benefits (financial and other)**

The cost to divert more paper from landfills depends on many factors, including the value of recovered paper in the market, the amount of paper already covered, the method used to recover the paper, transport distances and other factors. In many cases, most of these costs (and potential profits) will be borne by entities other than pulp and paper companies.

Other benefits that accrue when paper is diverted from landfill include (a) extended landfill life, (b) potential additions to recovered paper available for recycling, and (c) potential use of diverted paper and wood not suitable for recycling as a source of biomass energy.

#### **Case studies of successful or model approaches**

There are many examples of paper recovery programs, but their suitability needs to be examined on a case-by-case basis.

#### **Barriers to implementation, and proposed ways to address those barriers**

The primary barrier to increased diversion of paper from landfills is cost. Barriers to the increased use of recovered paper as a raw material for paper and paperboard production include both cost and product quality. In some cases, attempts to collect used paper at reduced cost can make it less useful as a raw material in paper manufacturing (e.g. when combined with other recyclables at the curb). Barriers to the use of non-recyclable paper as a biomass fuel include cost and in some cases, societal concerns about the environmental effects of burning waste.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.4.2 Methane Gas Capture**

#### **Relevance and potential scope of the measure**

In NCASI Special Report 07-09 it is estimated that the forest products put in landfills in 2005 will eventually release methane equivalent to a total 61 Tg CO<sub>2</sub> eq. to the atmosphere if the extent of use of landfill gas capture systems remains unchanged (not considering carbon storage attributable to non-decomposing material). One of the primary means available for controlling these releases is the use of systems to capture and destroy methane releases from landfills. In NCASI's analysis in SR 07-09, the best estimate available was that 40% of Canada-produced paper that was landfilled was placed in landfills with methane capture and burning systems. If this could be increased, even though capture systems are only, on average, 75% efficient, the methane emissions could be reduced significantly.

In specific, using the factors applied in the calculations in NCASI Special Report 07-09, long-term methane releases attributable to decomposing paper from 2005 Canadian production could be reduced by 6.5 Tg CO<sub>2</sub> eq. if the fraction of landfills with methane capture systems was 50% instead of 40%. If the fraction was 60% instead of 40%, methane emissions could be reduced by 13 Tg CO<sub>2</sub> eq. (Note, these reductions cannot be added to those in section 3.4.1 because the reductions estimated in section 3.4.1 assume that 40% of the landfills have capping systems. If more landfills have capping systems, the benefits of keeping paper out of landfills diminish.) Note that actions to capture landfill methane are more highly related to sectors outside the forest products industry, rather than to the industry itself.

#### **Costs and benefits (financial and other)**

The costs for increased capping of landfills will likely be borne by landfill owners. In some cases, the quantities collected are adequate to provide an economical source of biomass energy, displacing fossil fuels. Carbon credits may be available for the entity reducing the methane releases.

#### **Case studies of successful or model approaches**

Landfill gas collection and burning (both with and without energy recovery) are now common throughout North America. There are many resources available to landfill owners interested in examining the costs and benefits of capping landfills to capture and burn methane.

#### **Barriers to implementation, and proposed ways to address those barriers**

The primary barrier to increased use of methane capture systems is cost. Some of this can be overcome through the availability of carbon credits for methane reduction and, in some cases, biomass energy production.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.5 Carbon Sequestered in Forests**

#### **3.5.1 *Increasing the Area of Forests***

##### **Relevance and potential scope of the measure**

Managed forest lands (i.e., those under active management by industry) can be considered to be essentially managed within a cycle of continuous harvest and re-growth. There are additional non-forested lands in Canada, however, that may be capable of supporting growth of forest to augment the existing forested land base. The new growth of forests on these lands through creating new forests or plantations would be considered to be afforestation (usually defined as lands where no forest has existed for a period of 50 years or more) or reforestation (where a forest previously existed at one time). Creating these new forests can be done in a variety of ways (e.g., by developing a plantation of relatively fast-growing trees on marginal farmland) and would add to the carbon sequestered in forested areas. These activities could be undertaken by sectors outside the forest products industry, rather than by the industry itself, for example through municipal or regional planting activities.

NCASI's analysis in Special Report 07-09 referenced Canada's Greenhouse Gas inventory, prepared by Environment Canada (EC 2007), where all Canadian afforestation and reforestation activities were estimated to contribute a total of 185,000 ha between 1990 and 2005, averaging about 12,000 ha per year. To the extent that there are opportunities to increase the amount of non-forested land converted to forest, this could contribute to forest carbon sequestration.

According to information from the Canadian Forest Service related to the development of the federal government's "Forest 2020" afforestation initiative in 2003 (which has since been shelved), an estimated 11 million hectares of non-forested land were considered to have been suitable at that time for afforestation. CFS anticipated planting 10,000 hectares over the first two years of the program and that, if the rate of planting had proceeded as intended, 65 MT of carbon would have been accrued through the first reporting period of the Kyoto Protocol (2008–2012).

##### **Costs and benefits (financial and other)**

Given that most harvesting operations are licensed within Crown forested lands, there would be a cost related to purchasing or licensing non-forested lands for reforestation. Alternatively, there may be other approaches (e.g., re-launching Forest 2020, tax measures, or technical support for farmers) that may significantly reduce or eliminate these costs. Silvicultural costs for creating these new forests may exceed current silvicultural costs, since most regeneration in Canada (over half) is through natural regeneration. Also, to the extent that non-forested lands may require planting of tree species with which the industry is less familiar, there may be costs related to optimizing growth and harvesting, along with any necessary manufacturing adaptations that may need to be made to incorporate these new raw materials. In certain areas of Canada, there may be opportunities for these new forests to compensate for reduction in harvest elsewhere on the landscape and/or enable an increase in harvesting.

##### **Case studies of successful or model approaches**

There are a number of companies that have planted forests using species such as poplar, on non-forested lands (e.g., marginal farmland). In addition, the Canadian Forest Service has undertaken detailed studies to examine the potential for new planted forests to augment the forest management land base.

### **Barriers to implementation, and proposed ways to address those barriers**

New planted forests can augment existing forest lands; however, it is unlikely that their growth will approach that of the current significant extent of Crown forest land managed in Canada in the near term, given the rate at which non-forested land could realistically be planted. Concerns raised previously related to the federal government's Forest 2020 program included those related to risk of long-term survival of new planted forests and availability of government funding to support planting activities. In terms of potential technological barriers, the degree to which existing forest products manufacturing operations are dependent on certain tree species and physical dimensions has led to research seeking products and/or manufacturing approaches that can be used to accommodate species most likely to be grown in these new forests.

### **Potential impacts on the conservation of biodiversity**

In some cases, the lands to be considered for new planted forest opportunities would have increased biodiversity when planted; in others there may be no change or a decrease. Depending on the type of planted forest and the previous conditions, new forests may be an approach to help enhance conservation of biodiversity in terms of a broader landscape that incorporates various land use types.

### **3.5.2 *Increasing the Volume of Carbon Stored in Existing Forests***

#### **Relevance and potential scope of the measure**

The role of this measure is to maximize the carbon within actively-managed forests without compromising the principles and practices of good forest management. It is thus directly dependent on identifying approaches that shift the carbon in the managed forest landscape, over time, towards a larger volume than it currently holds. Given that the large part of Canada's forest industry harvest is on Crown land (roughly 93%, primarily owned by provincial governments), relevant measures must be acceptable within this legal structure and would need to be "carbon positive" over the long term.. Such measures could include enhanced fire, insect and disease control; lengthening rotation age; site restoration and rehabilitation; reduced soil disturbance; avoidance of slash or broadcast burning; thinning; reducing harvesting levels; or implementing harvest deferrals or new protected areas.

It should be noted that the wealth of information available on this topic and the qualitative nature of this current report do not permit extensive review of each measure. Also of note is that the FPAC/WWF initiative is independent of domestic and international climate change obligations, and thus measures appropriate for application in the context of this initiative may or may not result in quantitative carbon benefit within the various policy-related GHG targets, commitments and timeframes.

Key to identifying the feasibility and the potential for implementing a given measure is recognizing the relevance of a given measure to a given stand, and considering each within a broader landscape context to achieve an overall landscape carbon volume increase. Note that activities that view increasing forest carbon storage in isolation of the other aspects of the industry's carbon profile (i.e., fossil fuel reduction, products in use and landfills) may lead to an overall net negative effect (i.e., increase in the industry's carbon profile) if the cascading effects to other elements of the profile are not simultaneously considered.

Under current legislation, managed forest lands under Crown ownership must be promptly regenerated after harvest (whether naturally or by planting). Thus, forest products companies are uniquely positioned to leverage this requirement towards optimizing future carbon volume increase. When the managed forest landscape is examined in its entirety over a measurement period, it is

possible to document an overall estimated movement of forest carbon to and from the atmosphere (for example, by using the Carbon Budget Model of the Canadian Forest Service (CBM-CFS3)). The CBM-CFS3 has been used by the federal government to estimate the status of above- and below-ground carbon in the managed forest for international reporting purposes, and is now available for use by forest companies in making these determinations on smaller areas of land. This model incorporates an accounting of the forest carbon that is ultimately returned to the atmosphere via decay, harvesting (also including wood that is ultimately burned (e.g., in the industry's wood-fired boilers)), and wildfire, as well as new carbon gained through tree growth. As such, it can be used to estimate the forest carbon component of the industry's carbon profile, and to identify the estimated quantitative value of measures to increase carbon in the managed forest.

While there is a constantly-moving flow of carbon into and out of the managed forest related to the aspects discussed above, published studies show that over the long term certain of these flows are more significant than others. For example, industry harvesting and related re-growth within the managed forest landscape retains a relatively constant level of carbon. A more significant effect on forest carbon volume in the managed forest landscape is natural disturbances such as fire and insects (CFS 2007). The effects of fire are somewhat mitigated on the component of the managed forest landscape that is licensed to the industry due to harvesting and fire suppression activities; however, there remains a significant portion of the managed forest landscape that is not accessed by industry and which does not receive fire suppression or insect management. To the extent that the industry may be able to implement techniques that can reduce carbon emissions related to harvesting, there may be opportunities to increase managed forest carbon sequestration.

A related but separate consideration applies to decisions about whether or not to carry out forest management activities in particular regions that have had no prior intensive activities, since various studies and models show that there can be a significant one-time reduction in on-site forest carbon when previously unmanaged forests are converted over time to managed secondary forests. This change in on-site carbon should be considered in light of the forest products, forest health, and other socio-economic benefits that result from forest management, and in any case this is primarily a question of land use planning and designation, and in Canada's publicly owned forests is first and foremost a public policy decision.

At the time of Canada's analysis of the Kyoto Protocol, a report was prepared by the Canadian Forest Service to document the results of consultations and research related to opportunities to increase the volume of carbon stored in the managed forest (CFS 2003). Activities such as insect control, fire suppression, enhanced on-site harvesting residue management, thinning, and avoiding site degradation were examined for their potential to enhance the accrual of forest carbon. Table 1 provides a summary of the estimated potential scope, cost and benefit of each approach. This report is the synthesis of a variety of studies, and clearly shows the site-specific nature of the applicability of various activities designed to enhance forest carbon volume.

Other actions identified in the FPAC/WWF Scope and Methodology paper that could be undertaken by the industry include lengthening the rotation age of a given stand or reducing harvest levels. These could increase the carbon storage, maintain maximum storage potential, or somewhat reduce storage depending on the age and characteristics of a given stand. These actions, similar to some of those listed in Table 1 (e.g., pre-commercial thinning), require site-specific analysis to evaluate whether their execution would be consistent with increasing carbon stocks. Altering harvesting practices to reduce soil disturbance is another action that may be undertaken, and for which research has led to the development of machinery with a "lighter footprint" and new approaches to access the landscape during harvesting. While no national estimate of the carbon potential from these three activities is available, each could be further examined to identify the potential quantitative scope of their use in avoiding CO<sub>2</sub> emissions related to harvesting.

### Costs and benefits (financial and other)

Estimated financial costs, as well as potential social and environmental impacts, have been briefly summarized for the actions listed in Table 1. Each action carries a unique combination of costs, benefits, and risks, and would thus need further analysis to conclude whether it would be a viable approach for a given area. Note that when used together, techniques to reduce the effects of disturbances such as fire and insects, as well as those related to industry land management (e.g., lengthened rotation age, site restoration and rehabilitation, reduced soil disturbance, avoidance of slash or broadcast burning, thinning, and reducing harvest levels) may simultaneously increase or decrease the ability of certain of these activities to enhance forest carbon storage. Therefore, a given forest area may show more or less promise for increasing carbon storage through any one or a combination of these approaches, and thus a site-specific evaluation would be required.

**Table 1.** Summary of Analyses of Potential Incremental Forest Management Activities<sup>1</sup>

CO <sub>2</sub> Emission Avoidance Action	Net Carbon Storage 2008 – 2012 (MtCO <sub>2</sub> /yr)	Total Net Cost (\$Million/yr)	Long-term Carbon Potential	Other Impacts (Social & Environmental Impacts, Likelihood of Success)
Insect Control (spruce budworm)	36.8	256.8	High	Increases wood supply, could have environmental concerns or public resistance
Increased Fire Suppression	Estimate unavailable	Estimate unavailable	Increased number of fires expected in future & increased suppression required	Increases wood supply, could have ecological impacts, increased fire fuel build-up, likelihood of success is low
Avoiding Site Degradation	Variable – site-dependent	Variable – site/system-dependent	Medium	Increases wood supply, relatively high likelihood of success
Managing Residues On-site	0.26	-7.38 to 1.48	Low	Mostly positive impacts but disrupts fire cycle, medium likelihood of success
Commercial Thinning	0.03	0.6	Medium	Wood supply benefits, potential positive for forest health, moderate likelihood of success
Pre-Commercial Thinning	0.0	6.3	Low to Medium	Stand-specific benefits, low likelihood of success

### Case studies of successful or model approaches

<sup>1</sup> Adapted from CFS 2003.

Most of the actions considered in this section of the report have been executed on individual stands, and certain (e.g., fire suppression) have been broadly supported through government- and industry-funded programs.

### **Barriers to implementation, and proposed ways to address those barriers**

A number of information and research gaps were noted by CFS in their analysis of actions that might be undertaken to avoid CO<sub>2</sub> emissions related to harvesting. While these may be considered technical barriers to implementing certain activities, there remain potential site-specific barriers to implementing a given action on a given forest stand. Overall, it may be most effective to consider examining whether a range of activities may be identified, where individual land managers could identify the optimal suite of actions for their given management area. Cascading effects on other aspects of the carbon profile would need to be simultaneously considered, in identifying optimal actions.

### **Potential impacts on the conservation of biodiversity**

Consideration of the viability of each approach discussed in this section of the report would necessitate evaluation of implications on wildlife and biodiversity. FPAC member companies have all implemented Sustainable Forest Management certification programs that provide a framework for undertaking this sort of evaluation, and which could be leveraged for reviewing these activities to identify those that hold promise for an individual stand. Note that the carbon stored within the broader Canadian managed forest landscape may benefit from a range of actions undertaken within individual stands to enhance carbon storage while concurrently sustaining biodiversity.

#### **3.5.3 *Reducing Deforestation***

##### **Relevance and potential scope of the measure**

This measure relates to reducing deforestation impacts of roads and other forest removals, and thus is also applicable to sectors outside the forest products industry. Deforestation is a relatively minor issue in Canada, according to data from the FAO and Environment Canada. As noted in NCASI Special Report 07-09, the annual change in Canada's forested area lies within the range used by FAO to describe countries with stable forests, a range encompassing changes in forested area from +0.5% per year to -0.5% per year (FAO 2006; EC 2007). That said, deforestation in Canada due to all causes was roughly 55,000 hectares per year between 1990 and 2005, predominantly as a result of conversion to agriculture and urban development (EC 2007). Of this total, approximately 5,000 ha/yr were related to activities by the forest products sector, primarily associated with the construction of permanent and secondary roads. To the degree that this figure can be reduced over time, there would be an avoidance of CO<sub>2</sub> emissions related to forest harvesting. In addition, there may be opportunities for communities, both urban and rural, to foster activities that would reduce forest degradation in their region through avoidable impacts from agriculture and urban development. There may also be opportunities for other industries (e.g., oil and gas, hydro) to further minimize their contribution to deforestation by streamlining and minimizing the harvesting related to their activities. Finally, to the extent that in some areas converting forest from a natural disturbance regime to a management regime may result in a one-time reduction in carbon stocks prior to their overall stabilization (as discussed in 3.5.2), there may be opportunities to reduce such effects via optimized road construction, modified harvesting approaches or reduced harvesting.

### **Costs and benefits (financial and other)**

The primary benefits of these activities could be enhancing the opportunities to meet biodiversity objectives for a given forest area. Financial costs related to reducing deforestation associated with the sector would largely centre on the costs for recovering areas within a forest management unit that have been cleared to enable access for harvesting. To the degree that road decommissioning would be possible (where not prohibited by law or depending on the timing anticipated for future access), the cost for these activities would be borne by the company holding the forest management license.

### **Case studies of successful or model approaches**

Road decommissioning is undertaken throughout the forest sector's harvesting operations, and usually occurs for access points which are no longer to be used once the forest management plan in that area has been completed. There may be model approaches that could be examined to identify cost-effective or optimally-designed ways to undertake this action. In addition, there are examples within other industries (e.g., oil and gas) where they have worked to reduce necessary harvesting and/or collaborated with forest products companies to minimize biodiversity implications.

### **Barriers to implementation, and proposed ways to address those barriers**

Provincial regulations stipulate road building and decommissioning requirements in a manner that may limit the flexibility for forest products companies to reduce related deforestation. For example, the province of Quebec prohibits decommissioning of certain roads and mandates that road maintenance be continued into the future by the company that originally constructed the road. To the degree that these policies could be re-shaped based on science and on optimizing the approach for attaining a region's biodiversity objectives, these barriers may be able to be overcome.

### **Potential impacts on the conservation of biodiversity**

There are a number of technical resources the industry has produced to aid in mitigating potential biodiversity effects due to road construction. In some cases, the lands affected under this activity would have increased biodiversity when regenerated or restored; in others there may be no change or a decrease. Depending on the type of regenerated forest and the previous conditions, reduction in deforestation along with forest restoration may be an approach to help enhance conservation of biodiversity in terms of a broader landscape that incorporates various land use types.

## **3.6 Carbon Stored in Forest Products in Use**

While carbon stored in forest products in use is recognized as a part of the forest products industry carbon profile, it is currently included in international policy commitments only as a voluntary reporting requirement. Also, it should be noted that the measures discussed in this section are largely applicable to sectors outside the forest products industry, as they are outside the industry's control.

### **3.6.1 Production of Longer-Lived Products**

#### **Relevance and potential scope of the measure**

There are many products made by the Canadian forest products sector. Some products are not intended for long times in use and the additions to carbon storage during use attributable to these products are small and unlikely to be increased significantly. Wood products, however, are responsible for significant net additions to carbon stocks in use and these can be increased further by designing wood-based building materials and structures that survive for longer periods without maintenance requiring replacement of wood-based building materials.

In the calculations performed for NCASI Special Report 07-09, the Canadian Forest Service values for time-in-use were used. Wood was taken out of use at a rate of 1% of the remaining material per year, which corresponds to a first order half-life of about 70 years. If construction methods or wood properties were improved to increase the half-life to 80 years, equivalent to a loss of 0.86% per year, the net effect would be a reduction of 1.3 Tg CO<sub>2</sub> equivalents. (Note: This estimate includes not only increased carbon storage in use, but also reduced methane releases from discarded wood and reduced landfill carbon storage from reduced discarded wood.)

The Canadian Forest Service value for time-in-use for panels corresponds to a removal of 5% of the remaining amount per year, which corresponds to a first order half-life of about 13 years. If this was increased to 20 years (a removal of panels at a rate of 3.35%/yr) the net effect would be a removal equivalent to 0.9 Tg CO<sub>2</sub> eq./yr.

Note that in NCASI Special Report 07-09, the expected times in use for various types of forest products were described using a modification of IPCC's method, using a linear decay rate determined by coefficients used in the Canadian national inventory that vary by product type rather than by the IPCC default first order decay relationship based on half-lives.

### **Costs and benefits (financial and other)**

The costs for developing and deploying longer-lived wood products are impossible to estimate. The potential benefits include not only the additional carbon storage but also improved performance resulting in wood-based building materials gaining market share, which would also result in substitution effects relative to more GHG-intensive building materials (see section 3.6.3).

Characterizing the carbon benefits of longer-lived products is complicated by the inability to directly measure time-in-use. The estimated benefits are based on modeling so it will be necessary to carefully examine the way the models respond to extended product life to assess whether the projected benefits are likely to occur.

### **Case studies of successful or model approaches**

There are a number of research programs in North America and globally that are attempting to improve the performance of wood-based building materials. Some of this effort is focused on making these materials more durable. There are few examples, however, of new wood-based building materials gaining favour due to increased durability. Indeed, a challenge facing the industry is competition from materials that are more durable than wood-based materials.

### **Barriers to implementation, and proposed ways to address those barriers**

Although it is difficult to generalize because of the many different types of products that might be involved, clearly one important barrier to improved durability of wood products is cost. Another barrier, in cases where durability is achieved by imparting resistance to decay, is the potential environmental effects associated with some of the treatments. Research continues into ways to impart decay resistance to wood-based materials using methods that reduce or eliminate these concerns.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.6.2 Forest Product Reuse**

#### **Relevance and potential scope of the measure**

The reuse of forest products has complex effects on carbon storage and greenhouse gas emissions. Of particular importance are the type of reuse involved, what would have been done with the used product had it not be reused, and the relative effects of reusing forest products compared to meeting that demand with newly produced products. There are so many products and potential reuses to consider that it is impossible to generalize. Several common situations can be examined, however.

In some cases, the recovery and reuse of paper as a raw material can reduce life cycle GHG emissions by reducing methane emissions from landfills and reducing manufacturing-related emissions. The effects, however, vary by the type of paper involved and, perhaps more importantly, by the performance of the specific facilities making both the virgin and recycled paper.

#### **Costs and benefits (financial and other)**

Paper recovery rates have increased substantially over the past two decades, including the construction of dedicated deinking and recycled paper manufacturing operations. Further increases to current paper recovery rates would require additional collection infrastructure along with additions and/or modifications to existing deinking and recycled paper manufacturing capacity. Current market conditions for paper products would preclude the likelihood of any additional industry investments to expand mill recycling capacity.

Tools are available for examining the average impacts of substituting recovered fibre for virgin fibre (e.g., WARM in the US and the analysis described in a recent report to the Canadian federal government (ICF 2005)).

The output of these tools has been found to be extremely sensitive to the assumptions embedded in the tools regarding the modeling of forest carbon. The assumptions about accumulation of carbon in the forest overwhelm all other factors in the analysis. There is reason to be very cautious with these models given the uncertainty surrounding the assumptions about forest carbon. For example, one of the factors that strongly affects the modeled impact of increased paper recovery on forest carbon includes the fraction of domestic recovery that is exported. Between 2001 and 2006, essentially all of the increases in domestic paper recovery were consumed by exports, meaning that the increased recovery had no effect on the demand for wood by Canadian mills.

The importance of forest carbon assumptions is shown in Table 2 below, which includes estimates of net greenhouse gas emissions associated with recycling (including displaced virgin production) with and without considering the impacts of carbon sinks (forests and landfills). It is important to note that the estimates in the table include reduced methane emissions and landfill carbon storage attributable to diverting materials from landfills. Therefore, these estimates cannot be added to those associated with diversion as this would constitute double counting.

Due to the uncertainty associated with forest carbon impacts and the very large effect they have on the estimated benefits, NCASI recommends that these tools (or more specifically the factors within them) be used so that estimates can be developed with and without including forest carbon.

#### **Case studies of successful or model approaches**

There are many examples of programs aimed at increased recovered fibre utilization.

### Barriers to implementation, and proposed ways to address those barriers

Collection rates of certain paper grades (e.g., newspapers and corrugated boxes) are approaching their realistic maximum, while others (office papers) may show additional promise. In certain cases, demographic constraints (e.g., available paper located in remote cities far away from recycling mills) may inherently limit the business case for increasing collection. The cost of establishing recycling programs for low-rise office buildings and apartment buildings may be prohibitive given that many of these buildings won't have the space to handle recyclables. In addition, most of the "low-hanging" fruit has been picked; communities that still do not have recycling programs, and where recovered paper may be available, may be too far from the mills that need recovered paper, making it cost prohibitive to ship the fibre and increasing transport-related emissions.

**Table 2.** Net Greenhouse Gas Emissions Associated with Recycling with and without Carbon Sinks

	Net Emissions Associated with Recycling (tonnes CO <sub>2</sub> eq. / tonne recycled)		
	Without Carbon Sinks	With all Carbon Sinks	Attributable Only to Forest Carbon Sink
Newsprint	-0.30	-2.75	-2.45
Fine Paper	-0.36	-3.20	-2.84
Cardboard	-0.21	-3.26	-3.04
Other Paper	-0.25	-3.27	-3.02

From "Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update - Final Report - Contract No. K2216-04-0006 - Submitted to: Environment Canada and Natural Resources Canada by ICF Consulting, October 31, 2005"

### Potential impacts on the conservation of biodiversity

To the extent that this measure is not dependent on a change in forest management, this aspect may not be relevant. However, the forest-related implications from shifts in recovered fibre utilization are highly complex as noted above, and thus may warrant further review before developing a specific initiative and/or fostering certain actions by the industry.

#### 3.6.3 *Substitution of Forest Products in Place of Other Materials*

##### Relevance and potential scope of the measure

There are many different places in commerce where forest products compete with alternative materials. Few of these product substitutions have been examined to determine whether the selection of one type of product over another is accompanied by significant effects on greenhouse gas emissions. In the case of construction materials, however, the substitution effects have been examined extensively. One study comparing steel-stud single family homes with steel-stud walls to a comparable home with wood-stud walls found that the greenhouse gas savings was almost 10 tons of CO<sub>2</sub> equivalents per year (Lippke et al. 2004). Embodied energy savings were estimated to be 113 GJ per home.

In a recent review undertaken by NCASI, the studies identified that were designed to compare embodied energy in systems with comparable thermal performance, wood-based wall systems and buildings were almost always found to have lower embodied energy and CO<sub>2</sub> emissions than comparable building systems using concrete, steel, or brick (Borjesson and Gustavsson 2000; Athena 2004; Scharai-Rad and Welling 2002; Pierquet, Bowyer, and Huelman 1998; Lenzen and Treloar 2002; Gustavsson and Sathre 2006; Richter and Sell 1993; Gustavsson, Pingoud, and Sathre 2006; Consortium for Research on Renewable Industrial Materials (CORRIM) studies described in Lippke et al. 2004, Perez-Garcia et al. 2005a, Puettmann and Wilson 2005). In one study, the wood-based system contained more embodied total energy than the steel-based system, but embodied non-renewable energy and CO<sub>2</sub> emissions for the wood-based system were lower than for steel-, brick-, or concrete-based systems (Sarri 2001). In most, but not all, of these studies thermal performance was measured in terms of conventional insulation properties, i.e., steady-state R or U values.

Most homes in North America are already built with wood-stud construction (approximately 90% in the US) but a large amount of commercial construction is done using steel studs. The extent of the opportunity to displace steel (or concrete) would need to be determined based on market studies.

#### **Costs and benefits (financial and other)**

The costs for displacing non-wood-based construction are not known but it can be assumed that wood-based structures would to be essentially the same cost as, or slightly more expensive than, commonly used alternatives (given that alternative materials are probably being used as a result of a cost advantage).

#### **Case studies of successful or model approaches**

With wood-based construction being widespread, there is no need for case studies. What is lacking are examples of programs intended to provide incentives for wood-based construction based on the expected substitution effects.

#### **Barriers to implementation, and proposed ways to address those barriers**

Wood is generally used for wall systems and in other construction applications where it is the least cost alternative. Alternatives are used, it is assumed, in situations where they are less costly, representing a barrier for increased use of wood-based materials.

#### **Potential impacts on the conservation of biodiversity**

If increased substitution of wood products in place of other materials were to result in an increased requirement for raw materials, this may exert pressure on forest lands, which would require an evaluation of the potential effects on the habitat value of managed forests.

### **3.7 Carbon Balance of Forest Products in Landfills**

This measure is not included in this report because increased landfilling is not a strategy that FPAC or WWF cares to pursue. In addition, it is assumed that FPAC and WWF do not wish to pursue carbon storage strategies that would involve actively landfilling of harvested wood.

### **3.8 Other Measures Relevant in the Forest Products Value Chain**

#### **3.8.1 Forest-Based Bioproducts**

##### **Relevance and potential scope of the measure**

There are many different types of forest-based bioproducts that could assist in reducing atmospheric levels of greenhouse gases. In almost all cases, these bioproducts achieve their benefits by substituting either directly for fossil fuels or indirectly for more GHG-intensive alternatives. The discussion here will focus on the production of liquid transportation fuels from forests because these bioproducts have been studied more extensively than most others and because the market is so large. Other bioproducts may ultimately be more important to the industry, however, so it is important not to limit these other opportunities.

In a recent Canadian government report (Industry Canada 2006), it is noted that “the single largest total commodity demand is fuels: motor gasoline (\$15.1 billion), diesel and fuel oil and aviation (\$12.7 billion), liquid petroleum gases including natural gas (\$4.6 billion) and lubricating oils and greases (\$1.2 billion)... Even a 15-percent market share for the first two of these fuels represents a \$3 – 4.5-billion market opportunity for ethanol or other fuel substitutes, made larger by price shifts since 2002, provided that safe bio-based substitutes can be produced in an energy-efficient, cost-effective manner to meet market demand in a cold climate.”

##### **Costs and benefits (financial and other)**

The costs for producing forest-based transportation fuels are still larger than those for producing fossil fuels and many other bio-based fuels. These costs are expected to come down, however, as the remaining technical barriers are addressed. It is not possible to predict how these cost declines will compare to changes in costs for non-forest feedstocks for biofuels.

The benefits derive from the displacement of fossil fuel-based transportation fuels. On a life cycle basis, current research indicates that forest-based (i.e., woody biomass-based) biofuels will accomplish far greater displacement of fossil fuel than many agriculture-based biofuels; ethanol from corn, for instance. In addition, forest-based biofuels have the advantage of not displacing crops used for food.

Until a suitable and commercially viable technology for producing forest-based biofuels is identified, the potential costs and benefits can only be estimated with great uncertainty.

In a recent report regarding the Canadian potential for biofuels (Mabee 2006), model results were presented suggesting that “an overall range of potential 2nd-generation biofuel production in 2100 that is quite large. This range extends from about 0.1 EJ (the equivalent of about 2.2 billion litres of fuel annually) to about 3.6 EJ (about 45.2 billion litres annually). NRCan has estimated the demand for refined petroleum products for transportation to be about 2.6 EJ in 2005, so the results of our model may be taken to describe a range between 4% and 139% of 2005 petroleum demand.”

##### **Case studies of successful or model approaches**

There are several high visibility research programs focusing on developing commercially viable technology to produce forest-based biofuels and other bio-products from forest biomass.

##### **Barriers to implementation, and proposed ways to address those barriers**

The main barrier to implementation is a commercially viable technology. Intensive research is underway globally to overcome this barrier.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management. Increased consumption of biomass fuels may exert pressure on forest lands to produce these fuels, which would require an evaluation of the potential effects on the habitat value of managed forests. Specific effects would vary depending on the source and type of feedstock. For example, using currently-available manufacturing residuals may have no effect on biodiversity. Using other sources, such as harvesting slash, non-commercial tree species, available unused industrial allowable annual cut, or dedicated planted forests (e.g., plantations) would each have effects that would need site-specific assessment.

### **3.8.2 Using Non-Recyclable Discarded Products for Bio-Energy, Displacing Fossil Fuels**

#### **Relevance and potential scope of the measure**

The ability to reduce atmospheric greenhouse gases via burning of non-recyclable paper depends on (a) how much is available, (b) whether waste-to-energy facilities are available, (c) how efficiently the material is burned and converted to steam (and electricity), and (d) which fossil fuels are displaced as a result.

There are large quantities of Canada-produced used forest products going to landfills in the US and Canada that could be used for fuel. NCASI's analysis in Special Report 07-09 suggested that 27.7 million metric tonnes of Canada-produced forest products were being landfilled in 2005. It is uncertain how much capacity exists to use this as fuel in North America.

#### **Costs and benefits (financial and other)**

If the 27.7 million metric tonnes of forest products going to landfills in 2005 were burned for energy, displacing natural gas (energy in steam basis), the reduction in greenhouse gas releases would be 17.8 Tg CO<sub>2</sub> eq. Even if the waste-to-energy plants were burning only the wood products component of this 27.7 million metric tonnes (amounting to 11.9 million metric tonnes) the greenhouse gas emission reduction would be 7.6 Tg CO<sub>2</sub> eq.

Another benefit associated with keeping the material out of landfills would be extended landfill life.

Care would need to be applied to prevent creating competition for fibre that is a useful raw material at recycle paper and paperboard mills.

#### **Case studies of successful or model approaches**

Waste-to-energy facilities are commonplace throughout the world. In Europe, they are far more readily accepted than in North America.

#### **Barriers to implementation, and proposed ways to address those barriers**

In addition to cost, public acceptance is the major barrier to greater use of waste-to-energy in North America.

### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

### **3.8.3 Working with Suppliers of Non-Fibre Inputs to Help Reduce Upstream Emissions**

#### **Relevance and potential scope of the measure**

Companies that provide goods and services to the Canadian forest products industry (not including electricity producers which are discussed elsewhere) contribute to its carbon footprint. These suppliers can partner with the forest products companies to achieve greenhouse gas reductions via using less GHG-intensive processes to manufacture inputs needed by the industry.

The opportunities here are likely fairly limited for several reasons. First, there are limits to changes that can be made to the processes used to make the chemicals and other inputs needed by forest products facilities. Second, many of these upstream emissions are associated with the extraction and processing of fossil fuels. An individual forest products company would have very little ability to influence these upstream emissions. Finally, the emissions associated with transport of non-fibre inputs are relatively small compared to other elements of the industry's footprint, being equal to between 10 and 15% of Scope 1 plus Scope 2<sup>2</sup> emissions according to a recent NCASI study of the US forest products industry.

#### **Costs and benefits (financial and other)**

It is not possible to estimate the costs or benefits associated with less GHG-intensive input chemicals and materials for making forest products.

A reasonable starting point for study by the paper sector might be sodium chlorate, a chemical used in bleaching that is known to be energy-intensive. For the wood products sector, resins are a major source of upstream emissions.

#### **Case studies of successful or model approaches**

No known case studies other than the studies of “green design” in the literature.

#### **Barriers to implementation, and proposed ways to address those barriers**

Suppliers of inputs to the industry are using processes based on cost and performance. The primary barrier, therefore, is the availability of processes that are lower in cost while being at least equally effective.

#### **Potential impacts on the conservation of biodiversity**

Not relevant, to the extent that this measure is not dependent on a change in forest management.

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<sup>2</sup> “Scope 1” emissions refer to direct emissions from operations owned by the company. “Scope 2” emissions refer to emissions from purchased electricity consumed by the company.

## REFERENCES

- Athena Sustainable Materials Institute (Athena). 2004. Comparative environmental impact assessment. In *Energy and the environment in residential construction*. Sustainable Building Series, No. 1. Canadian Wood Council. <http://www.cwc.ca> (June 4, 2005).
- Borjesson, P., and Gustavsson, L. 2000. Greenhouse gas balanced in building construction: Wood versus concrete from life-cycle and forest land-use perspectives. *Energy Policy* 28(2000):575-588.
- Canadian Forest Service (CFS). 2003. *Potential options to increase sequestration through incremental forest management actions: key data and research needs for analysis*. Prepared by Peter Graham, NRCan CFS. Ottawa, ON.
- \_\_\_\_\_. 2007. *Does harvesting in Canada's forest contribute to climate change*. Science Policy Notes. Natural Resources Canada. Ottawa, ON. [www.bookstore.cfs.nrcan.gc.ca](http://www.bookstore.cfs.nrcan.gc.ca)
- Environment Canada (EC). 2007. *Canada's greenhouse gas inventory 1990-2005*. [http://www.ec.gc.ca/pdb/ghg/inventory\\_e.cfm](http://www.ec.gc.ca/pdb/ghg/inventory_e.cfm) (September 19, 2007).
- Food and Agriculture Organization (FAO). 2006. *Global forest resource assessment 2005*. Rome: United Nations Food and Agriculture Organization.
- Gustavsson, L., Pingoud, K., and Sathre, R. in press. Carbon dioxide balance of wood substitution: Comparing concrete- and wood-framed buildings. Accepted for publication in *Mitigation and Adaptation Strategies for Global Change*. Springer Netherlands.
- Gustavsson, L., and Sathre, R. 2006. Variability in energy and carbon dioxide balances of wood and concrete building materials. *Building and Environment* 41(2006):940-951.
- ICF Consulting (ICF). 2005. *Determination of the impact of waste management activities on greenhouse gas emissions: 2005 update - final report - contract no. K2216-04-000*. Submitted to: Environment Canada and Natural Resources Canada. Ottawa, ON.
- Industry Canada. 2006. *Towards a technology roadmap for Canadian forest biorefineries – capturing Canada's natural advantage*. Ottawa, ON: Publishing and Depository Services, Public Works and Government Services Canada.
- Lenzen, M., and Treloar, G. 2002. Rejoinder to: Greenhouse gas balanced in building construction: Wood versus concrete from life-cycle and forest land-use perspectives. *Energy Policy* 30(2002):249-255.
- Lippke, B., Wilson, J., Perez-Garcia, J., Bowyer, J., and Meil, J. 2004. CORRIM: Life-cycle environmental performance of renewable building materials. *Forest Products Journal* 54(6):8-19.
- Mabee, W. 2006. *Economic, environmental and social benefits of 2<sup>nd</sup>-generation biofuels in Canada*. Vancouver, BC: University of British Columbia.
- National Council for Air and Stream Improvement (NCASI). 2007. *The greenhouse gas and carbon profile of the Canadian forest products industry*. Special Report No. 07-09. Research Triangle Park, NC: National Council for Air and Stream Improvement.

- Peirquet, P., Bowyer, J., and Huelman, P. 1998. Thermal performance and embodied energy of cold climate wall systems. *Forest Products Journal* 48(6):53–60.
- Perez-Garcia, J., Lippke, B., Briggs, D., Wilson, J., Bowyer, J., and Meil, J. 2005a. The environmental performance of renewable building materials in the context of residential construction. *Wood and Fiber Science Corrim Special Issue* 37(2005):3-17.
- Puettmann, M., and Wilson, J. 2005. Life-cycle analysis of wood products; Cradle-to-gate LCI of residential wood building materials. *Wood and Fiber Science Corrim Special Issue* 37(2005):18-29.
- Richter, K., and Sell, J. 1993. Life-cycle analysis: A useful approach to promote wood as a construction material. *Wood Focus Design* summer 1993:14-17.
- Sarri, A. 2001. *Environmental specifications of building parts and buildings* (in Finnish). TKK Rakentamistalous [Helsinki University of Technology, Construction Economics and Management]. Published by Rakennustietosaatio RTS [Building Information Foundation RTS], Helsinki. Sponsored by Rakennustieto Oy [Building Information Ltd.].  
<http://www.rts.fi/Ymparistoselosteet.pdf>.
- Scharai-Rad, M., and Welling, J. 2002. *Environmental and energy balances of wood products and substitutes*. Food and Agriculture Organization of the United Nations (FAO).  
<http://www.fao.org> (June 4, 2005).