Advantage

FPInnovations

NOT Restricted to Members and Partners of FPInnovations

Vol. 13 No. 10 February 2013

Contents

Emission reduction and carbon credit methodologies in forest operations: a primer

Keywords:

Emission, Greenhouse gases (GHG), Monitoring, Carbon, Carbon credits, Forest management, Canada.

Abstract:

This primer introduces forestry and other professionals to current carbon offset methodologies and presents examples of guidelines for emission reduction and carbon offset activities that forest operations in Canada can implement. It also contains numerous references to carbon emission information.

Authors

Marian Marinescu
and
Cameron Rittich

Western Region

Introduction

The Kyoto Protocol (UNFCCC 1992) was developed to provide legally enforceable targets for reducing the concentration of greenhouse gases (GHGs) in the atmosphere. The Kyoto Protocol was signed in 1997, but only entered into force in 2005. In 2007, the Intergovernmental Panel on Climate Change (IPCC) released a report describing progress in understanding the human and natural drivers of climate change with estimates of projected future climate change (IPCC 2007). The report points to the increased GHG concentrations in the atmosphere caused by human industrial activities. In recent years, programs and policies to reduce emissions in Canada have been put in place, but their benefits may not be fully felt during the Kyoto period (2005–2020), especially since Canada pulled out of the Kyoto agreement in December 2011. Currently, under the Cancun Agreement (2010), the Canadian Climate Change Plan is focused on meeting the goal of a 17% reduction in GHG emissions from 2005 levels by 2020 (Government of Canada 2011). At the Canadian forestry sector level, the Forest Products Association of Canada (FPAC) committed the goal of industry-wide carbon neutrality by 2015 (FPAC 2012). Canada has

several options to meet this target: to increase energy efficiency; to convert from fossil-fuel based to renewable energy forms; to adopt enhanced forestry and agriculture management plans; and fiscal incentives, taxes and caps on GHG-producing industries.

Because the management of Canadian natural resources (e.g., forest lands) falls under provincial jurisdictions, many of the GHG reduction programs were developed at the provincial levels. For example, in Alberta, as of July 1, 2007, the Specified Gas Emitters Regulation has required Alberta facilities that emit more than 100 000 tonnes of GHGs a year to reduce emissions intensity by 12%. The regulated emitters can either reduce their emissions below the allowed cap or purchase carbon offsets from companies that reduced their emissions below the cap. In British Columbia, companies reducing emissions earn carbon credits for each tonne of emissions they curtail. The Pacific Carbon Trust of B.C. is a Crown corporation that has a system to verify the offsets it buys, before selling them at $25 a tonne to government ministries and agencies that are mandated by the province to be carbon neutral. The trust does not disclose the per-tonne price it pays private sector companies to modernize or transform industrial processes to reduce carbon dioxide emissions.

As a result of national and provincial GHG emission reduction initiatives, increasingly more FPInnovations members are interested in innovative practices that could reduce harmful emissions and potentially generate carbon credits/offsets. For example, in Alberta there were only four forest products companies (pulp mills) that were regulated emitters under the Specified Gas Emitters Regulation in 2011. The concern of FPInnovations members is that, as the emission limits are expected to decrease to 50 000 tCO_2e (carbon dioxide equivalent[1]) per year and later to 25 000 CO_2e per year, companies will have to be ready quickly to account for their emissions and find ways to reduce them. Many companies are already making significant efforts to reduce their carbon footprint and demonstrate leadership. However, questions often arise about ways of accounting for emissions, as well as how to identify financial opportunities offered from carbon sequestration and the use of new technologies to obtain energy efficiency offsets.

The objectives of this primer are as follows:

- Identify applicable methodologies for assessing carbon footprint of forest management operations.
- Present examples of guidelines for emission reduction and carbon offset activities that forest operations in Canada have implemented.

A more detailed primer is available on the FPInnovations website (Marinescu and Rittich 2012).

[1] CO_2e is a common unit of measurement for GHGs based on their 100-year global warming potential. A list of the GHGs and their 100-year global warming potential can be found in Alberta Environment (2011), Table 2.

Carbon offset accounting and trading

Carbon offsets (or credits) are GHG emission reductions usually associated with one tonne of CO_2e.[2] Carbon credits can be traded or used to comply with certain emission regulations or to support voluntary corporate emission reduction claims (e.g., to reduce their "carbon footprint"). Before these credits can be traded, however, they have to be validated, verified, and registered by independent organizations (Figure 1). To register carbon credits, the entire life cycle of the credits has to be tracked through a transparent process that includes documentation regarding their creation, serialization, certification, project information, credit transfers, and retirement. Also, the emission reduction projects need to be validated according to approved protocols and the emission reductions need to be verified using approved methods. These actions are needed to ensure that the emission reductions are real, quantifiable, permanent, and additional.

Figure 1. The carbon credit process.

Carbon offset validation

To generate tradable offsets/credits, the offset generators (offsetters) will have to prove that the offsets exist or will be generated within the project time frame. The offsets will also have to be measurable; usually, offsets are measured relative to a common unit of the process output (tonnes CO_2e/m^3 of timber, tonnes CO_2e/MMBF of lumber, tonnes CO_2e/tonnes of chips, etc.). The measurement unit has to be consistent throughout the whole project so that all emission sinks, sources, and pools (SSPs) are included in the calculations. Moreover, the project has to account for leakage. Leakage occurs when a carbon offset project displaces activities which create emissions outside the boundaries of the project. For example, a forest conservation project could restrict harvesting activities in the project area, but it could trigger harvesting activities in another area.

[2] GHG emissions include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulphur hexafluoride (SF_6)

Also, project developers have to demonstrate clearly their legal ownership, including contractual agreements between various participants in a joint offset project. Most of the time, the ownership is awarded to the person or entity that is undertaking the reduction activities. The burden to prove ownership belongs to the project developer. Currently, in Canada there is no clear policy regarding ownership of emission reductions originated in Crown forests.

Another condition of generating certifiable carbon offsets is that of permanence: the project has to include safeguards or risk management strategies against offset reversal due to conditions such as natural or human disturbances: fire, floods, landslides, forest clearing for development, etc. Safeguards could include issuing temporary credits (e.g., afforestation projects), withholding a pool of credits from sale until permanence is regained, establishing regeneration actions (e.g., planting trees to replace those affected by fire), and developing risk avoidance plans (e.g., fire management plans).

Moreover, the condition of additionality has to answer the basic question: holding all else constant, would the offset project have occurred if it was not implemented as an offset project? For example, offset actions in response to local, regional, national and international emission regulations are not additional. The concept of additionality is complex and difficult to demonstrate in many cases. Business as usual options, such as closing down operations or reducing output, do not qualify for carbon credits. Alternately, an increase in industrial activity that increased emissions would not necessarily mean emissions increased if they were quantified on a relative basis (i.e., normalized against a baseline year of production and expressed in the form of tonnes CO_2e per unit of output).[3] Many tools and guidelines have been developed to demonstrate additionality. The following seven principles were developed by the Pacific Carbon Trust:

- The baseline scenario is a hypothetical representation of what would be reasonably expected to have occurred in the absence of the offset project.
- For all projects, there must exist at least one baseline scenario.
- The baseline scenario must be comparable to the project scenario.
- Baselines move as high emission practices are substituted with lower emission ones or emission regulations change.
- Baseline scenario emissions must be calculated based on a holistic representation.
- Barriers must exist that prevent the project from being implemented.
- Barrier(s) to the project must, partially or entirely, be overcome by the incentive of offset recognition.

Protocol development and registration

Carbon offsets accounting is specific to each project and is described in carbon offset quantification protocols. In Canada, the Pacific Carbon Trust[4] and the Alberta Environment – Climate Change Secretariat[5] have developed protocols that outline how carbon credits are calculated. These protocols are developed based on internationally and nationally recognized guidelines. The accounting process is straightforward, involving methodologies (e.g., statistical and computer models)

---

[3] For differences between intensity and absolute emission caps, refer to http://mit.edu/globalchange/www/MITJPSPGC_Rpt100.pdf

[4] http://pacificcarbontrust.com

[5] http://environment.alberta.ca/0923.html

that quantify periodically the amount of emissions generated by the project. The offsets are the difference between the baseline and project emissions. The offsets have to be verified by third-party organizations, called verifiers, then registered in a carbon offset registry (e.g., Markit,[6] Alberta Carbon Offset Registry,[7] CSA[8]), at which point they can be traded directly to large emitters, or in carbon markets. Alberta Carbon Offset Solutions[9] provides a good list of carbon market service providers.

The cost of developing protocols and projects could be significant. For example, in Alberta, protocol development costs accrue to the first project developer and can range from $65 000 to over $250 000 depending on complexity. Subsequent project developers can use developed protocols at no cost. In addition, quantification costs vary with project type, complexity, and size ranging from several thousand to tens of thousands of dollars. Verification costs vary with the same parameters as quantification costs and range from $20 000 to $30 000 (Mihajlovich et al. 2011).

Aggregating small projects into a larger package of emission reductions under the same protocol can lower verification and transaction costs and make small projects economically viable. However, similarly to the large projects, the aggregated projects must demonstrate all the conditions described above. The aggregation of small projects is usually done by a third party, called an aggregator.

Carbon quantification methodologies and models

To quantify offsets, each project developer can utilize one or a combination of internationally and nationally recognized guidelines. For example, the Alberta and B.C. offset systems use the internationally recognized ISO 14064-2 platform for establishing and quantifying GHG emission projects.[10] Protocols and offset projects in these provinces must be developed and implemented according to this standard, which promotes a detailed and transparent peer-review process. However, where practical, the protocols and projects may utilize other international and national guidelines, such as the following:

- Clean Development Mechanisms (CDM)[11]
- The World Resources Institute (WRI)[12]
- World Business Council on Sustainable Development (WBCSD)[13]
- The Intergovernmental Panel on Climate Change (IPCC)[14]
- The National Inventory Report: Greenhouse Gas Sources and Sinks in Canada[15]
- Climate Change Technology Early Action Measures (TEAM) Requirements and Guidance for the System of Measurement And Reporting for Technologies (SMART)[16]

---

6 http://www.markit.com
7 http://carbonoffsetsolutions.climatechangecentral.com/offset-registry
8 http://www.ghgregistries.ca
9 http://carbonoffsetsolutions.climatechangecentral.com/resources/market-service-providers
10 http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=38382
11 http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php
12 http://www.wri.org
13 http://wbcsd.org
14 http://ipcc.ch
15 http://climatechange.gc.ca
16 http://carbonoffsetsolutions.climatechangecentral.com/files/microsites/OffsetProtocols/ProtocolReviewProcess/1stCycleProtocolReview/Biofuel/86BiofuelsProtocol_mod.pdf

The following are forestry specific guidelines:

- Protocol for the Creation of Forest Carbon Offsets British Columbia (2011)[17]
- Climate Action Reserve Forest Project Protocol (Version 3.2)[18]
- Voluntary Carbon Standard: Tool for Agriculture, Forestry, and Other Land Use (AFOLU) Methodological Issues[19]
- Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination[20]
- Draft North American Forest Carbon Standard[21]
- IPCC 2006 Guidelines for Forest Land[22]
- American Carbon Registry - Improved Forest Management Methodology[23]

A large variety of carbon and/or GHG emissions accounting methodologies/tools exist that could be used in various Canadian forest operations projects. The most popular models in Canada are: CBM-CFS3 developed by the Canadian Forest Service (CFS), FORECAST developed by the University of British Columbia for BC projects, FORCARB-ON developed by the Ontario Ministry of Natural Resources for projects in Ontario, FPInterface developed by FPInnovations for woodlands operations carbon balance, and FICAT developed by the National Council for Air and Steam Improvement (NCASI) and the International Finance Corporation (IFC) for national and international projects. These and other models are listed in Table 1 and described in an extended version of this document (Marinescu and Rittich 2012).

The use of carbon accounting models in carbon offset projects is not mandatory, but it is recommended in most projects, especially in those involving carbon sequestration and carbon emission associated with complex biological systems (e.g., forest ecosystems). Conversely, in projects where carbon offsets are easier to calculate (e.g., fuel switch projects), simpler accounting methods can be used (e.g., ledgers, spreadsheet tools). Project development agencies should have modelling methodologies and documentation templates appropriate to each type of project.[24]

Forest operations companies should exercise due diligence when selecting a project development agency by verifying their credentials: registration within the province where the project is to be developed, number of years in business, references, a forestry specialization, examples of similar projects, and a registered professional forester on staff. The bottom line for selecting a project development agency or professional is that they should be able to employ rigorous scientific and practical methodologies that address thoroughly and undoubtedly all the conditions presented in Figure 1. Forest operations companies are strongly encouraged to be actively involved in the development of these projects because they will ultimately be responsible for guaranteeing that these conditions are met throughout the duration of the projects, which for forestry projects can be decades.

---

17 http://env.gov.bc.ca/cas/mitigation/pdfs/Forest_Carbon_Offset_Protocol_v1_0_Web.pdf
18 http://www.climateactionreserve.org/how/protocols/forest/dev/
19 http://v-c-s.org/methodologies/VT0001
20 http://v-c-s.org/program-documents/afolu-non-permanence-risk-tool-v32
21 http://forestcarbonstandards.org
22 http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf
23 http://americancarbonregistry.org/carbon-accounting
24 For examples of consulting agencies, see http://www.ghgregistries.ca

Table 1. Summary of carbon accounting methodologies

MODEL	Carbon cycle aspects covered	Strengths	Limitations
CBM-CFS3	Carbon stock dynamics	- Most utilized in Canada to calculate net carbon stocks - Stand or landscape levels - Free	- Emissions from harvested wood products not explicitly included
FORECAST	Carbon stock dynamics	- Incorporates harvesting and silvicultural treatments - Can deal with multiple objectives	- Forest estate level modelling requires a separate timber supply model
FORCARB-ON	Carbon stored in harvested wood products	- Approach recommended by IPCC	- Emissions from production activities (harvesting, transportation, etc.) not included - Specific to Ontario - Carbon stocks dynamics not modelled
FICAT	Carbon stored in harvested wood products	- Approach recommended by IPCC - Calculates overall GHG, not just CO_2 - Free	- Carbon stocks dynamics not modelled
ToSIA	Carbon stored in harvested wood products	- Can incorporate sustainability criteria other than GHG emissions	- Carbon stocks dynamics not modelled
CO2FIX	Stand level carbon stock dynamics	- Harvested wood is tracked until end of life - Contains a bioenergy module and a carbon credit calculator - Free	- Not easily applied to ecosystem projects.
PWP	Carbon sequestered in forested woodlots	- User friendly - Default settings for new users - Free	- Not easily applied to ecosystem projects. - Fifty ecosystems maximum
TimberCAM	Full cycle of carbon stored in trees through disposal	- Covers entire chain from forest to end of life - Free	- Emissions from production activities (harvesting, transportation, etc.) not included - Australian conditions modelled
FPInterface	CO_2 emissions in forest operations and carbon stored in harvested wood products	- Operational tool - Default settings for various harvesting/processing equipment	- Does not consider explicitly stand carbon dynamics
GHGenius	Emissions associated with traditional and alternative transportation fuels	- Can perform Life Cycle Analyses for specific regions of Canada, the United States, and Mexico - Currently approx. 200 vehicle, fuel, and feedstock combinations possible	- Carbon stocks dynamics not modelled
BioFleet	Emissions associated with traditional and alternative transportation fuels	- On line tool	- Carbon stocks dynamics not modelled
Volvo EFC	Emissions associated with traditional and alternative transportation fuels	- On line tool	- Carbon stocks dynamics not modelled

Examples of emission reduction/carbon sequestration projects

This section contains summaries of selected Canadian carbon emission and/or sequestration projects. They were grouped according to the forestry sub-sector in which they originated. For more detailed descriptions, please refer to the extended version of this document (Marinescu and Rittich 2012).

Silviculture/forest management projects

Saskatchewan Forest Carbon Sequestration Project

This is the first forest carbon sequestration project to be formally reviewed and approved in Canada (Lemprière et al. 2002). It consists of carbon sequestered in white spruce plantations and forest carbon reserves. The carbon offsets generated in this project were planned to be sold to the provincial electrical utility, but no records were found that offsets were generated and/or sold.

Global CO_2 Reduction, Inc. - Northern Ontario Forestry Offset Pilot Project

The project is located in Kapuskasing, Ontario and consists of carbon sequestered in planted Jack pine (*Pinus banksiana*) and willow trees on unproductive municipal land. Unfortunately, due to the small size of the project, revenues from potential carbon offsets were not able to offset the plantation and maintenance costs. Therefore, the project is seeking additional funding/incentives to break even.

Community Ecosystem Restoration Project (CERP) in Maple Ridge, B.C.

The project consists of selectively removing existing red alder (*Alnus rubra*) and brush vegetation, planting long-lived, site-matching, high-productivity native tree species, and enhancing the growth and survival of these trees through silvicultural best practices. The project is active but no carbon credits have been retired from this project to date.

TimberWest - Strathcona Ecosystem Conservation Project

This is the first forest project to use the newly developed and implemented B.C. Forest Carbon Offset Protocol. Reduced emissions are planned from conserving a forested area on private land that would otherwise be harvested under an existing harvest plan. Additional emissions reductions come from avoided use of fossil fuel in operating trucks and logging equipment. Pacific Carbon Trust is committed to purchase 600 000 tonnes of CO_2e from TimberWest in the next three years.

Nature Conservancy Canada - Darkwood Forest Carbon Project

The project is located near Creston, B.C. and generates carbon offsets from a low level of timber removal as part of conservation management activities for ecosystem/habitat enhancement and risk management. The Pacific Carbon Trust has purchased 450 000 tonnes of carbon offsets from the carbon sequestered during 2008–2010.

Transportation

Bison Transport

Bison Transport, a Manitoba company specialized in the transportation of goods is the first Canadian transportation company to register carbon offsets through the CSA Clean Project Registry and to sell them. The offsets traded are the result of fuel-efficient strategies including aerodynamic improvements, speed and driver management, truck idling control strategies, intermodal transportation, long combination vehicles strategy, and tire efficient technology. The company sold 10 737 carbon offsets.

Energy

Tolko - Heffley Creek Biomass Gasification Project

Located in Kamloops, B.C., at the Tolko plywood mill, this project generates offsets through newly installed biomass gasifiers that produce syngas from woody residues. The syngas displaces the natural gas used at the mill to dry veneer and to produce hot water for log conditioning. The use of biomass in place of fossil fuels achieves a reduction in anthropogenic GHG emissions. Between 2005 and 2010, this project generated 50 262 tCO_2e.

Neucel Specialty Cellulose Fuel Switch GHG Project

The project is located in Port Alice, B.C. and generates offsets by replacing a proportion of the electric and thermal energy produced on-site using a fossil fuel (oil) with renewable energy produced using hog fuel from process and harvesting residues. The project generated 31 131 tCO_2e between 2008 and 2010.

INTERFOR - Adams Lake Biomass-fired Energy System

This project is located in Adams Lake, B.C. and generates offsets by turning wood waste from the Interfor sawmilling operation into heat for drying lumber and building heat for the mill during cold winter months. The project diverts wood waste from landfills and results in improved air quality in the area. Between 2008 and 2010, the project generated 24 842 tCO_2e.

Forest operations

DMI - Forest Harvesting Direct GHG Reduction Project

The project is located in Alberta and consists of the application of portable chipping technology that replaces centralized wood room chipping, requires less wood handling, and results in 20% uplift in tree utilization with a corresponding reduction in harvest residue disposal. All offsets are a result of direct reductions in energy use (primarily diesel fuel) resulting from increased efficiencies attributable to the project condition. The project generated 421 043 tCO_2e between 2005 and 2010; the credits are pending retirement.

Implementation

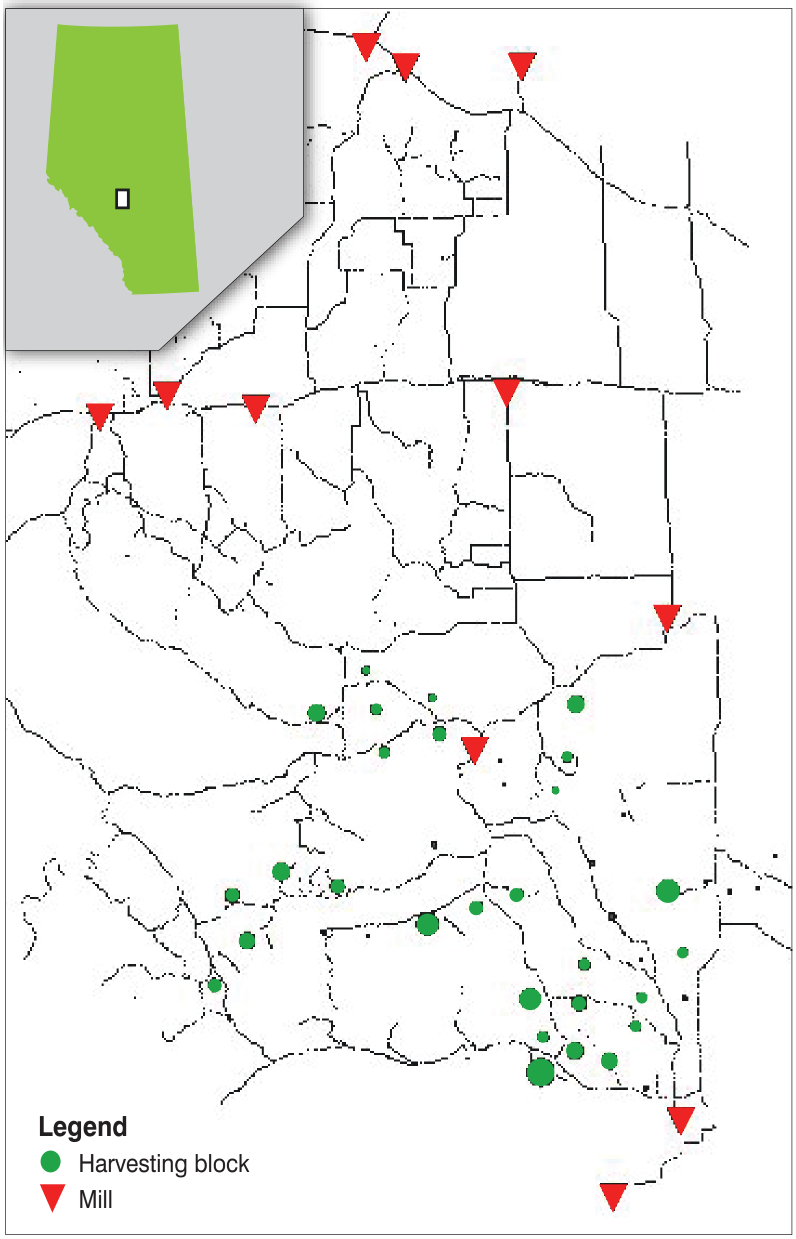
Example of carbon accounting using FPInterface™

While numerous models have been developed to help for accounting carbon (Table 1), FPInnovations is proposing a detailed tool for managing forest operations. FPInterface™ is a decision-making support tool that calculates the costs and productivity of forest operations directly on the forest map. This software uses FPInnovations equations and forest company GIS data and takes into account all spatial data to quickly create harvest scenarios. Several add-on modules—Maxtour, BiOS-Map, Operational Planning, Carbon, and Value Chain—are also available to enhance planning in terms of strategy and operations.

The carbon module estimates the fossil fuel consumption and subsequent emissions generated in the forest operations and transportation activities. It also calculates the amount of logging residues and carbon generated by the harvesting scenario. Consequently, scenarios can be built with FPInterface™ that could reveal the emission differences between a base case and emission offset projects. An example of a case study done in Alberta follows.

The study area consisted of 44 harvesting blocks with a total area of 14 600 ha (Figure 2). FPInterface™ ran a harvesting schedule that generated 3.3 million m^3 of merchantable aspen (39%), lodgepole pine (37%), white spruce (16%), black poplar (4%), and black spruce (4%) timber. About 290 000 odt of harvesting residues could be available at the roadside, while 246 673 odt of harvesting residues could be transported and utilized. The timber and the harvesting residues could be transported to 11 mills located in the region.

Figure 2. Map of a carbon analysis case study done in Alberta



The FPInterface™ model (carbon module) calculated and listed the amounts of carbon sequestered in the merchantable timber and harvesting residues and the carbon emitted during the harvesting and transportation operations (Figure 3). Based on these amounts, the carbon module calculated a carbon ratio that indicated how many tonnes of carbon were stored in the biomass for each tonne of carbon released in the atmosphere.

Challenges and opportunities of participating in the emission reduction and carbon offset initiatives

The methodological complexity of the examples presented varies widely depending mostly on where along the forest to product value chain the project originated and how much of the chain it encompassed. Of the four types of carbon offset projects presented, the first type (Silviculture/Forest Management Projects) requires the most rigorous and complex methodological approaches and has generated the most debate. These projects involve established or planned forest ecosystems and span across long time horizons; consequently, there is an inherent risk associated with guaranteeing their permanence. Also, because they involve complex natural systems, ex ante ("before it happens") methodologies are utilized; consequently, it is challenging to fully guarantee that the carbon offsets are "real". In addition, avoiding leakage is difficult and sometimes it is not clearly regulated (e.g., a harvest reduction is proposed, but no reduction of the AAC). But most challenging is proving the condition of additionality, because it is very difficult and in some cases impossible to prove "scientifically" what the project proponents would have done in the absence of carbon offset activities.

In addition to methodological challenges, in the last few years, the legislative and market climate for carbon offsets have been volatile. As this primer was being drafted, Canada pulled out of the Kyoto Protocol.

In Europe, carbon offsets have been recalled and penalties have been applied to fraudulent project proponents. The lure of capitalizing on carbon credits in many cases turned into a trap. To minimize the risk of failure to generate or guarantee carbon offsets, serious efforts should be put into addressing the conditions presented above. In some cases, more should be done than is required by current regulations. The general rule is that carbon offset projects should rely on most current scientific methodologies and provisions should be put in place to adapt to the ever-changing scientific and legislative environment.

The following are the most common challenges and opportunities of generating carbon offsets in the forestry sector today:

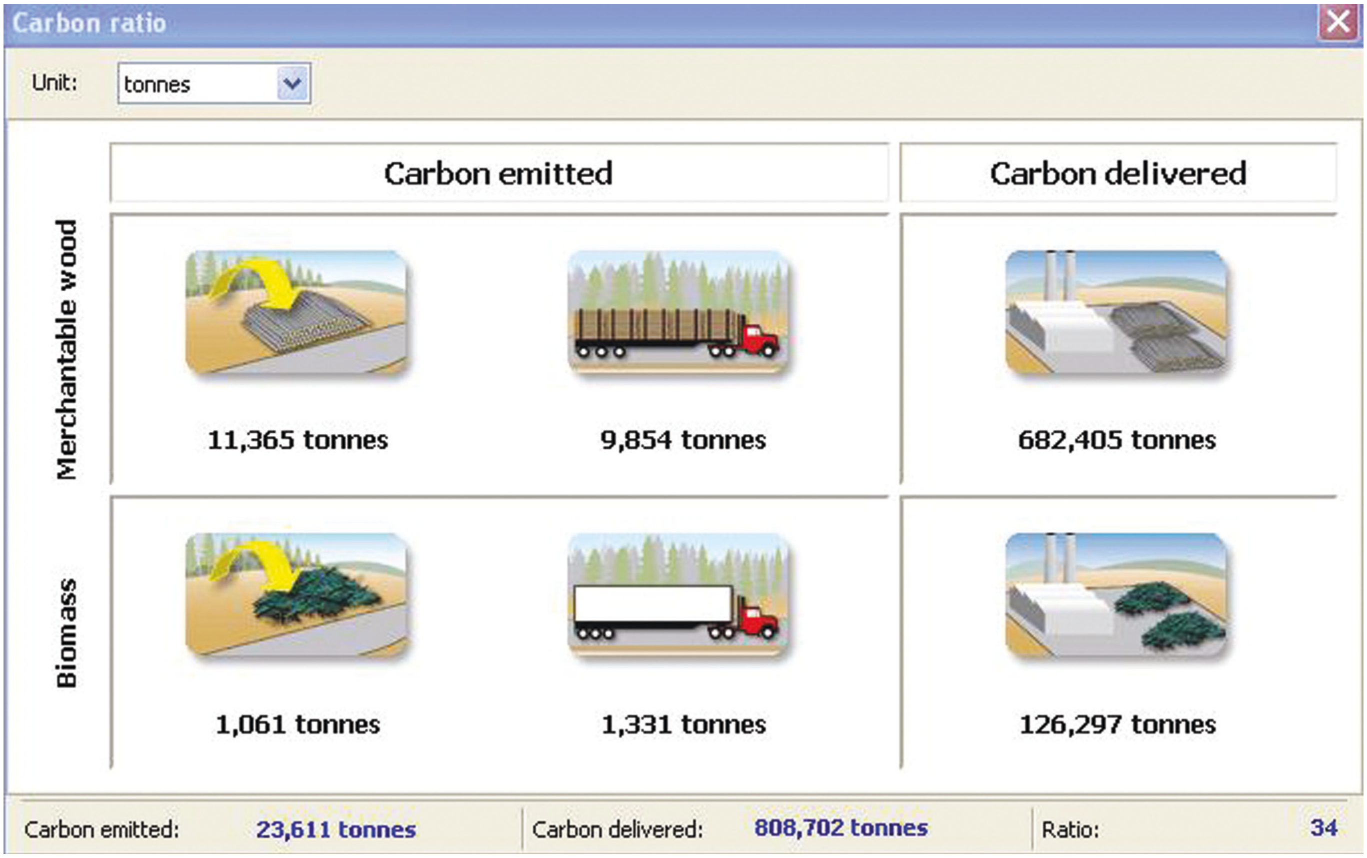
Challenges

- Complexity of the subject matter and detail required for quantification and verification
- Unintended long-term consequences on forest ecosystems due to management for carbon
- Balance between utilization and conservation is difficult to strike
- Lack of rigorous protocol development and implementation
- High costs of protocol development and verification
- Lack of chain of custody to account for carbon stored in harvested forest products
- Lack of policies regarding the ownership of carbon offsets generated on Crown lands.

Opportunities

- Some projects, especially the energy and fuel switching types, could bring immediate and faster returns than the ones in forest management.
- Climate change mitigation strategies can be achieved at the regional and local level for specific forest characteristics (disturbance levels, species composition, age distributions, etc.).

Figure 3. Carbon emitted and sequestered in the carbon accounting example.



Conclusions

This carbon primer presented methodologies in forest management operations and examples of guidelines for emission reduction and carbon offset activities that some forest operations implemented in Canada. The one underlying conclusion of this primer is that, because carbon offsets are not yet a commodity, carbon offset methodologies, policies, and markets in Canada are unpredictable. As a result, it is challenging to recommend a recipe that forest operations in Canada can adopt to take advantage of carbon offset opportunities. However, FPInnovations is dedicated to keeping its members abreast of the latest value opportunities and will continue to be an "issue watch" in carbon offset developments in Canada and worldwide. Consequently, FPInnovations will inform its members at any time on carbon offset issues and guide them toward the sources of expert advice (carbon project development agencies, government organizations, etc.).

References

Alberta Environment. 2011. Technical guidance for offset project developers, Version 2.0, January 2011. http://environment.gov.ab.ca/info/library/7915.pdf [accessed October 2011]

FPAC. 2012. Collaboration and partnerships - carbon neutral initiative. www.fpac.ca/index.php/en/collaboration/ [accessed April 2012]

Government of Canada. 2011. A climate change plan for the purposes of the Kyoto Protocol Implementation Act. www.climatechange.gc.ca [accessed August 2011]

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: The physical science basis. Summary for policymakers. www.ipcc.ch [accessed August 2011]

Lemprière, T.C.; Johnston, M.H.; Willcocks, A.J.; Bogdanski, B.E.C.; Bisson, D.; Apps, M.J.; Bussler, O. 2002. Saskatchewan forest carbon sequestration project. Forestry Chronicle 78:843–849.

Marinescu, M.; Rittich, C. 2012. Emission reduction and carbon credit methodologies in forest operations – a primer. FPInnovations, Vancouver, B.C. Internal report IR-2012-10-23. http://feric.ca/en/index.cfm?objectid=93A6BC78-956F-4A87-AAADCC8E0B186713

Mihajlovich, M.; Christian, B.; Blanton, S. 2011. Assisting Alberta's forest industry to engage in the carbon economy. Report available from Incremental Forest Technologies Ltd., Edmonton, Alta. (iftech.ca)

United Nations Framework Convention on Climate Change (UNFCCC). 1992. Kyoto Protocol. www.unfccc.int [accessed August 2011]

Acknowledgements

This work is possible through integrated research along the entire forest sector value chain at FPInnovations in partnership with Natural Resources Canada. The author would like to thank the following collaborators who provided valuable information and reviewed the report: Jim Stephenson – Chief Forester, Alberta Operations, Canadian Forest Products Ltd.; Dave Beck – Divisional Forester, Grand Prairie, Ainsworth Engineered Canada LP; Milo Mihajlovich – Senior Consultant, Incremental Forest Technologies Ltd.; David Muter – Managing Director, Strategic Acquisitions, Pacific Carbon Trust; and Richard Briand – Planning Coordinator, West Fraser Mills Ltd., Hinton, Alberta.

FPInnovations

Eastern Region
570, boul. Saint-Jean
Pointe-Claire, QC, H9R 3J9
☎ 514 630-4100
514 694-4351
publications@fpinnovations.ca

Western Region
2601 East Mall
Vancouver, BC, V6T 1Z4
☎ 604 224-3221
604 228-0999
publications@fpinnovations.ca

ISSN 1493-3381