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The Kyoto Protocol and Climate Change Mitigation: Implications for Canada's Forest Industry

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1. INTRODUCTION

The Kyoto Protocol is unique among Multilateral Environment Agreements (MEAs) in that it imposes legally binding targets and explicitly provides for the use of economic instruments to help achieve its environmental objectives. It is also significant because of its long-term and large scope - achieving the UNFCCC goal will require efforts over decades affecting all countries. Thus the likely long-term impacts of the Protocol are wider reaching and more profound than perhaps any other international treaty, environmental or otherwise.

The Canadian forest sector will be affected both because the forest resource on which it relies plays an important role in the global carbon cycle and the production of forest products is an energy intensive activity. Climate change mitigation requires reductions in Greenhouse Gas (GHG) emissions and increases in carbon sequestration and, unlike most sectors, the forest sector can make a contribution to both efforts. Companies in the forest product sector will need to adjust both over the next decade and in the long-term as changes to the economics of their business, and to government policy, occur in response to climate change mitigation goals. Canada's efforts to meet its climate change commitments in 2008-12 and beyond will induce or require changes in how energy is used and how forest carbon is managed.

While the Kyoto Protocol establishes a policy framework and certain mechanisms by which countries can seek to mitigate GHG, the Protocol leaves some key issues to be addressed. The Protocol gives countries wide latitude as to how they can proceed within the framework established by the Protocol. Governments can choose from a range of different policies for climate change mitigation, such as those related to emissions trading, carbon offset trading, taxation, energy efficiency and fuel mix choices, and innovation and technology promotion. The policy choices made will affect the forest sector. There may be requirement, pressures or incentives for change in forest management practices (including regeneration and silviculture), harvesting behaviour and utilization of wood. In mills there will be implications for investment decisions, innovation, product mix and competitiveness because of changes in direct fossil fuel energy costs, transportation costs, and the need for new capital spending.

Companies need to understand the types of changes that may be encouraged or required for climate change mitigation purposes, as well as the economic and policy issues. With this understanding they can determine how best to adapt and think strategically about how climate change issues fit into their decision-making for their forest and manufacturing operations.

1.1 Organization of Paper

This paper provides a framework under which forest companies can think about how to respond to the changes they can expect to encounter over the short to long term from the implementation of the Kyoto Protocol. In Section 2 we provide the conceptual model: we discuss the policy changes might be created by the Protocol, how those changes might impact firms, and evaluate the possible impact of different policy choices (we consider these more fully later in the paper).

In Section 3 we summarize the Protocol rules and the policy framework they establish. Protocol rules and targets set the framework in which Canadian governments will create policy, thereby directly affecting forest companies. The rules will also have an indirect effect through policies taken in other countries affecting the sector, and through the impacts on forest management abroad. We discuss the challenge that Canada faces in meeting its target. We summarize the policy choices under discussion in Canada regarding climate change mitigation, and how they may affect companies, and the proposed Canadian plan. Here we discuss in a general way various policy options, such as trading regimes, incentives and other measures that governments could use, as well as investment abroad, that could be used to help meet Canada's target.

In Section 4 we focus on the application of Protocol rules to Canadian forest product companies and forest management. We examine forest products manufacturing and review in general terms the options available to reduce greenhouse gas emissions. We then look at forest carbon (C) management. We consider options to increase carbon sequestration and carbon conservation measures that reduce emissions from forestry activities (other than from fuel consumption). We discuss the economics of such options and policy issues that arise when climate change mitigation becomes an important goal in managing Canada's forests. We describe the types of changes that may occur in management in the long run because of interest in climate change mitigation. We briefly discuss the economics of these options and then turn to a more in-depth discussion of policy issues that arise in addressing mill emissions, with a specific focus on emission trading design issues relevant to the forest sector. We describe how the economics of trading might encourage changes in investment decisions in mills. In terms of instruments for facilitating carbon management we focus on how a carbon offset trading system might influence forest management.

In Section 5 we use the conceptual model developed earlier to examine the short and long run implications for forest sector firms from a domestic trading system for GHG. We first look at the design of a baseline and credit-offset trading system and the implications of including forest C in a trading system and ask whether, over the medium to longer term the economics of C trading may be such as to encourage changes in forest management in Canada. We then consider the design of a domestic trading system for GHG, in particular the issues around allocation, transferability, and coverage, and their implications for forest product firms. In Section 6 we examine international issues raised by Kyoto, in particular the impact on firm competitiveness.

Finally, in Section 7 we conclude with general comments on the implications of climate change mitigation policy choices and economics for forest companies, including firm competitiveness, forest management, and industry structure. We summarize the key unanswered questions, both at the international level, as well as those at the national level. We finish this section with a discussion of several international issues resulting from the Protocol that may have an impact on Canada's forest management.

2. THE POTENTIAL IMPACT OF THE KYOTO PROTOCOL

The Kyoto Protocol will be implemented through national policies developed to achieve the Canadian commitment. The implementation of these policies can affect how forest companies operate in a number of different ways as shown in Figure 1. In some cases, a national policy may envision the direct application of new regulatory system (such as the proposed Domestic Emissions Trading system). In other cases, these national policies are filtered through the provinces because of their jurisdiction over forestland. These national policies are also filtered through the existing regulatory and tax structure under which firms operate. At the same time, actions at both the federal and provincial level in response to other initiatives and pressure taking place in the international arena (such as trade policies and other environmental initiatives) will also influence policy development.

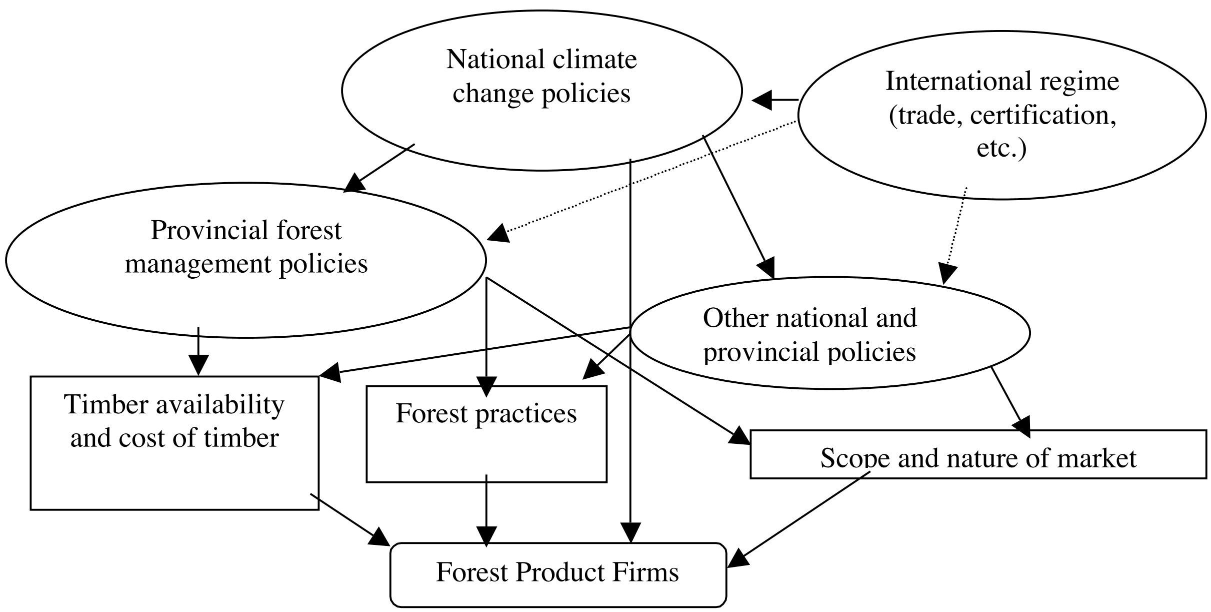

Figure 1. Potential Policy Impacts on Forest Product Firms

Forest product firms may feel the impact of these policies in four major ways. First, a new regulatory system may directly constrain how a firm operates or change the choices open to firms. Second, changes in provincial forest polices can directly affect the availability and cost of provincial timber. Third, changes in provincial forest polices (along with other policy changes) can influence forest practices through either direct regulation or changing the incentives firms face. Finally, these polices may alter the scope and nature of markets in which firms sell their products. They may affect prices and quantities in existing export and domestic markets; they may also create new markets or create barriers to existing markets. Below we describe the interaction between these policies and the business environment in more detail, in particular to the likely impacts on firms from the Protocol and how they can respond to those impacts.

2.1 Existing Policy Framework

Consideration of the impact of Kyoto involves examining two distinct sets of existing policy frameworks through which any national policies will be filtered. These policies may place constraints that limit the effectiveness of various policy approaches or conflict with existing legislation or regulatory rules.

2.1.1 Provincial Forest Management Policies

Because of their ownership of forestland, provinces have the primary role in developing forest management policies in Canada. Much of provincial forest policy operates through tenure arrangements with forest companies that govern the arrangements under which they harvest Crown timber. These tenure arrangements establish harvest levels and there may also be constraints on what is harvested through utilization standards. The government may constrain how the harvest is utilized through appurtenancy standards. The government may also mandate specific regeneration practices or efforts. All of these policies directly influence the volume of timber over the short and long-run.

The government directly affects the cost of timber through stumpage policies. Timber fees may be differentiated by end-use; they may be adjusted for particular operating conditions; and certain silvicultural practices may be eligible for reimbursement. Provincial governments also regulate harvesting practices. They may restrict the size of harvesting areas; the spatial distribution of harvests through adjacency requirements; and even the temporal patterns of harvests through variable retention and multiple-pass harvesting systems. Governments may set aside protected areas. Government regulations dictate the level of protection from fire and pests and how the financial burden is shared between governments and companies. All of these policies can affect the volume and cost of timber.

Provincial governments also regulate private forestland owners. These regulations may apply solely to harvesting practices; there may also be other regulations governing the conversion of land from one land use to another (e.g. zoning requirements that restrict the conversion of forestland or agricultural land)(Canadian Federation of Private woodlot Owners 1999).

2.1.2 Taxation and other regulatory policies

The Federal and provincial tax systems can encourage or discourage capital investments; for example, depending upon their treatment of depreciation, firms may be able to more quickly write off certain types of investments. Capital taxes discourage investment. Unfavorable tax treatment of private forestland (e.g. taxed at a higher rate than agricultural land) can discourage investment in forestry (Private forest Landowners Association of British Columbia 1998).

Governments can also modify other regulatory policies that may indirectly affect forest product firms. These can range from pollution control requirements to energy efficiency standards. Because of importance of energy (power generation), changes in energy polices (such as deregulation) can also have substantial impact on firms, especially pulp and paper manufacturers, through their impact on price levels.

2.2 Potential Impact on Firms and Firm Responses

The Kyoto Protocol will directly impact forest product firms in two major ways. First, it will raise their production costs since we are imposing additional constraints on the firm. Although there is the possibility of increased energy savings or reduced pollution from reducing GHG (a point raised by a number of ENGO's), those benefits may be financially not large enough to warrant investment, or is based on externalities that do not accrue to the firm. The expectation is that if it was profitable to undertake such actions to reduce GHGs before the imposition of the constraint the firm would have already taken those steps. However, there can be a variety of reasons why this may not be the case, as we discuss below (see NCCP 1999). We discuss the level of potential cost increases later. Second, firms will face increased uncertainty. This uncertainty comes from several sources; uncertainty as to the regulations that might be applied now and in the future; the impact of those regulations on the firm's competitiveness (relative to its peers as well as foreign competitors); and third, the market outcomes associated with the new regulation.

How can forest sector firms respond? They have several main options. First, they can attempt to further reduce absolute costs. For capital intensive businesses, this typically means seeking greater economies of scale. The opportunities to do so are greater for more capital intensive forest products manufacturers: pulp and paper manufacturers; engineered wood product manufacturers; and high volume sawmills producing standardized lumber grades.

Firms can also attempt to change their returns through altering their product mix. The regulatory outcome might be to raise costs for particular products or classes of products; reducing outputs of relatively higher-cost goods while increasing production of the other goods can reduce the overall cost impact of Kyoto. Firms may even consider reducing production where the relative return from selling carbon credits (through either curtailing production or carbon sequestration) is greater than from expanding production at the margin.

Firms may also change the location of their production; this can range from shifting output among company facilities (where there may be differences in production costs due to the technology employed, age of the capital stock, or regional operating conditions) to a relocation of production to facilities not covered by the regulatory system. The ability to relocate production either internally, regionally, or internationally will be contingent in part upon fibre availability.

Firms can invest in new technology to reduce their costs. This can take the form of fuel-saving or fuel switching technologies; switching from more GHG intensive power to less and even C-neutral (biomass). The ability to switch fuels will depend upon the availability of alternative fuel supplies.

Finally, firms can explore opportunities to benefit from new markets created by climate change policy, such as markets for emission reductions and forest carbon offsets. A chief concern here is that, as in any attempt to enter an unfamiliar market, and in particular one that is still in its formative stage, new expertise is needed and the costs and benefits may be quite uncertain.

2.3 How Kyoto Can Create Uncertainty for Firms

There are two major areas where there is uncertainty about the potential impact Kyoto may have upon forest sector firms. The first is the implementation of Kyoto at the national level, where there are discussions over the design of a domestic GHG trading system, and the impact such a system may have at the company level. Some of this uncertainty will be resolved as policy-makers finalize the regulatory framework. The second is at the international level, where there is the uncertainty arising from the interaction of firms and country commitments with Kyoto mechanisms upon the supply and demand for forest product exports that can change overall markets for forest products.

We evaluate this uncertainty in two areas. In the first area, we examine the possible impacts from different choices open to policy-makers in the implementation of a DET and offset system and where these regulatory systems can influence firms' costs (both absolute and relative across firms). In the second area, we consider the implications of Kyoto ratification on the general competitiveness of Canadian firms in international forest product markets, including the impact of U.S. non-ratification, and whether or not Kyoto-associated trade rules might change market access for forest products.

3. THE KYOTO PROTOCOL

3.1 Overview

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992, with the objective of reducing atmospheric concentrations of greenhouse gases (GHGs) to a level that would prevent dangerous interference with the climate system. As a first step to achieve this objective, the FCCC contained a commitment that industrialized countries would reduce their GHG emissions to the 1990 level by 2000. Recognizing that this voluntary commitment would not be achieved, the Parties to the UNFCCC adopted the Kyoto Protocol to the Convention in 1997, laying out a framework for legally binding emission limitations by industrialized countries amounting to 5% below the 1990 level by the commitment period of 2008-12. Following four subsequent years of negotiations the rulebook for the Protocol, known as the Marrakesh Accords, was adopted in late 2001 (UNFCCC 2002).

The Protocol established GHG emission limitation or reduction commitments for 38 industrialized countries for 2008-12. The Protocol will enter into effect when at least 55 countries including countries accounting for at least 55% of industrialized country emissions have ratified the Protocol. By December 2002 close to 100 countries had ratified the Protocol, including Japan, the European Union and other European countries accounting for close to 40% of industrialized country emissions. The current government of the United States has said it will not ratify the Protocol, and the Australian government has expressed its intent to not ratify in the near future. Assuming that all other industrialized countries ratify, as most are expected to do, then the Protocol will cover about two-thirds of industrialized country emissions. The Protocol will enter into effect when Russia ratifies; if it does not (although it is currently expected to), the Protocol will not enter into force.

Negotiations on emission limitation or reduction commitments under the Protocol for after 2012 are expected to start around 2005. Developing countries do not have targets for 2008-12, but the future negotiations will include consideration of how they can best contribute to global efforts to reduce emissions. The major non-industrialized economies have ratified the Protocol (e.g. China, India, Brazil, Mexico, South Korea).

3.1.1 Protocol Rules

The Marrakesh Accord spells out the general framework for how forestry C can be debited (sources) and credited (sinks). A *source* is any process or activity that emits GHGs to the atmosphere, such as combustion of fossil fuels or decomposition of logging wastes. A *sink* is any process or activity that removes GHGs from the atmosphere, such as photosynthesis which results in increased C sequestration in trees.

There are two principal areas where the rules of the Marrakesh Accord are of particular importance to the forest sector (other than more general rules applied to the measurement and accounting of GHG emissions) because forestry activities and the managed forest have the potential to:

- serve as a source through harvesting a carbon-based resource, or as a result of natural disturbances, and the potential to release GHG through soil disturbance and decomposition of the resource and associated wastes; and
- as a sink because of the potential of forests to sequester (store) C in both soils and biomass (roots, bole and foliage of trees; other vegetation).

The Accord spells out the rules governing how C emissions are measured and how C credits can be established in the context of forestry activities. In addition, there is a set of rules that establish a framework for potential International Emissions Trading (IET) where countries may be able to purchase or establish credits for C sequestration where forestry activities are a potential source of credits but forestry companies (as well as others) are also potential purchasers. We review the forestry rules in Section 4; we provide a brief overview of the IET framework below.

3.1.2 International Emissions Trading

To decrease the cost of meeting targets the Protocol established three market-based "flexibility" mechanisms under the principle that the flexibility to seek low-cost contributions anywhere in the world to climate change mitigation will facilitate achieving the UNFCCC objective. International emissions trading (IET) allow trading of emission reductions among industrialized countries that have ratified the Protocol. Countries *may* allow entities within their countries to also buy and sell in the IET system. Joint implementation (JI) involves investment by an industrialized country, or entities in the country, in projects in another industrialized country to reduce emissions or sequester carbon, resulting in Emission Reduction Units (ERUs). The Clean Development Mechanism (CDM) involves investment by an industrialized country, or entities in the country, in projects in a developing country to reduce emissions or sequester carbon, resulting in Certified Emission Reductions (CERs). The Marrakesh Accords established detailed rules for the operation of each of these mechanisms with further technical details to be established, especially for the CDM. Policy choices in individual countries will affect the operation of these mechanisms. In Canada, decisions about participation of companies in IET, rules for JI investment in Canada, and policy regarding Canadian investment in CDM projects will affect forest sector company opportunities for international trading and investment in projects abroad.

3.1.3 Ongoing Commitments

Reductions in 2008-12 in GHG emissions due to the Protocol will have little appreciable impact on climate change. However, 2008-12 is meant to be only the first of many commitment periods. In these subsequent commitment periods further emission limitation targets will be negotiated and developing countries will be asked to make a contribution to efforts to reduce atmospheric concentrations of GHGs. It is this effort over the long term that will serve to achieve the objective of the UNFCCC. Nevertheless, the targets in 2008-12 are difficult and will require substantial effort to change how energy is produced and used, and how much energy is used. These efforts, and further efforts to meet future targets beyond 2012, will have a transformative impact on societies and economies.

3.2 Canada's challenge

The impact of the Protocol over the next decade on countries that have ratified will depend on a country's target and the magnitude of its required GHG emission reductions relative to its business-as-usual (BAU) emissions. They will depend on the composition of its emissions, the nature and cost of opportunities to reduce the emissions and the policy choices made to reduce the emissions.

The Protocol GHG emission limitation or reduction commitments for industrialized countries range from 92% to 110% of 1990 emissions. Canada's commitment is 94%, meaning that Canada's GHG average annual emissions in 2008-12 must be 6% below the 1990 level. The actual difficulty of achieving a commitment – its stringency – will depend on the difference or gap between the expected annual emissions in 2008-12 in a business-as-usual world compared to the commitment. BAU emissions are the emissions that would occur if no efforts were undertaken to meet the Kyoto commitments. A comparison of the gaps for industrialized countries provides the most appropriate starting point for understanding the relative levels of effort required by different countries to meet their commitments.

Table 1 shows the targets, projected emissions in 2010 and gaps for a subset of the industrialized countries including the major economies and countries with major forest product exporting sectors. The projected emissions reflect expected emissions taking into account any policies implemented up to about 2000-2001 to limit emissions. It must be emphasized that because of varying assumptions and methods of calculation of emission projections the results across countries are only roughly comparable. Nevertheless they show differences in the gap that each country must overcome to fulfill its target, in terms of the percentage reduction below projected future BAU emissions that will be required to meet the target. Canada's Kyoto target will require a 25% reduction in emissions below the current projected level by 2010, after taking into account government policies announced in 2000-2001 to reduce emissions, and ignoring for the moment the contribution of forest and agricultural sinks. These policies are estimated to reduce Canada's emissions by 50 Mt CO_2/yr in 2008-12 below what they would other wise be, leaving a gap for Canada of 190 Mt CO_2/yr (Government of Canada 2002b).

Table 1. Kyoto Protocol targets, projected 2010 emissions and emission gaps for Canada and selected industrialized countries.

Country	**Kyoto Annual Target For 2008-12**		**Projected 2010 Emissions (Mt CO_2-eq)[4]**	**Gap Between Target and Projected 2010 Emissions (Mt CO_2-eq)**	**Required Reduction to Reach Target (% Reduction)**
	(% of 1990 Emissions)[2]	**(Mt CO_2-equivalent)[3]**			
Canada[2]	94	570.8	760.0	189.2	25
Finland	100	77.1	89.9	12.8	14
France	100	545.7	577.0	31.3	5
Germany	79	953.9	978.0	24.1	2
Japan	94	1,155.3	1,320.0	164.7	12
New Zealand	100	72.4	88.1	15.7	18
Norway	101	52.5	63.2	10.7	17
Russian Federation	100	2,372.3	2,200	-172.3	-8
Sweden	104	73.3	71.0	-2.3	-3
United Kingdom	87.5	649.1	632.1	-17.1	-3
United States – Kyoto	93	5,615.5	8,116.0	2,500.5	31
United States – Bush[2]	-	7,761.0	8,116.0	355	4

[1]This takes into account steps taken to date to reduce emissions from what would otherwise be an expected gap of 240 MT under a BAU scenario with total emissions of 809 MT. The contribution of business-as-usual forest and agricultural sinks (30 Mt CO2 in 2010) is not included. Including these sinks lowers the gap to about 160 Mt CO2-eq in 2010, or a 22% required reduction.

[2]The Bush Administration has stated it will not ratify the Protocol. The target shown corresponds to the target implicit in the Administration's plan to address climate change, and the gap is calculated on that basis.
[3]Emission reduction targets are as specified in the Kyoto Protocol, and adjusted by the EU for its member states according to its internal burden-sharing arrangement. The target for the EU as a whole is 92% of the 1990 emission level.
[4]The annual emissions targets for 2008-12 are calculated by multiplying the % emission commitment times 1990 emissions. Emission estimates for 1990 are from (UNFCCC 2002a) except for France, Japan and Sweden for which more recent information in these countries' Third National Communications to the UNFCCC are used, as found on the UNFCCC website.
Sources: For Canada, Government of Canada (2002a, 2002b). Projected emissions for each country for 2010 are extracted from or calculated using the most recent publications available. Third National Communications, published in 2001 or 2002, are used for each country except Germany. The projected emissions take into account any measures that affect emissions implemented up to around 2000-2001, depending on the country.

While the gap represents the challenge each country faces, the effort required will depend not only on the magnitude of the challenge but also on the emission reduction opportunities it has available and their cost. For example, a country that already uses energy efficiently may have more difficulty in reaching a given target than would a country that uses energy inefficiency. Similarly a colder or less dense country may have more difficulty than other smaller warmer countries. Canada faces a unique challenge in meeting its Kyoto Protocol target because of the decision by the current US administration to not participate. The close inter-relationship of the Canadian and US economies, and Canada's reliance upon US markets for exports, raises important competitiveness issues for the forest products sector since Canada's climate change mitigation efforts may involve costs in the short to medium term that US industries may not face. In addition, the structure of Canada's forest products industry and regional differences also raises additional challenges in crafting mitigation policies, as we shall see.

3.2.1 Potential Importance of Forestry in Meeting National Commitments

Accounting for forest and agriculture sequestration also affects the level of effort that will be required – the rules for inclusion of forest activities are discussed more fully in Section 4. The contribution of these activities for most countries is very difficult to gage for a variety of reasons. First, there is little information on the extent of the sinks and sources associated with the activities of afforestation, reforestation and deforestation (ARD) across countries. It is expected that in some countries, including Canada, that deforestation will be greater than the combination of afforestation and reforestation so that the net effect of changes in these three land use activities will be counted as a source in 2008-12 (UNFCCC 2000). Thus inclusion of these three activities in the accounting, which is required by the Protocol, makes achieving the target more difficult for some countries. Second, there is also little good information on the potential contribution of forest management (FM) for most countries although the contribution is in any case limited by country-specific caps agreed in the Marrakesh Accords (see UNFCCC 2002 and the description of the rules below). Third, countries are allowed to include cropland management, grazing land management and revegetation activities in their accounting and for these activities there is even less good information about accountable sinks and sources. Fourth, while ARD must be included in the accounting, the other activities are optional and many countries may not include them.

Overall it seems likely that for most industrialized countries that ratify the Protocol forest and agricultural sinks will have little impact on their gap (the difference between their commitments and anticipated emissions). This is likely true, in particular, of some of the nations with large forest products sectors that are competitors for Canada, such as Norway, Sweden and Finland. Two exceptions are Canada and Japan. For Canada, business-as-usual ARD and FM are estimated to amount to a net sink of 20 Mt/yr CO_2 in 2008-12, with agricultural land management activities adding another 10 Mt/yr (Government of Canada 2002b). In Japan, ARD and FM might account for as much as 45 Mt/yr CO_2 (UNFCCC 2000).

3.3 Policy Options

The government has a choice of a wide range of policies through which it can seek to curb emissions and facilitate carbon sequestration. Broadly speaking, they fall into several distinct categories. The first consist of command and control measures such as regulations and mandatory standards that directly impose certain requirements, technologies, processes or outcomes. Another category includes market instruments, These may include direct carbon taxes or the government can create C markets and require participation through imposing emission caps on forest products firms, and allowing trading. The government may also include C sinks under the trading system. A third category is the use of indirect measures: the government may provide incentives for certain actions or remove disincentives (e.g. using the tax system) to encourage appropriate measures. The government may rely on moral suasion to persuade individuals and firms to voluntarily reduce emissions. Finally, the government can also meet its commitments, or allow companies to meet their obligations established in an emissions trading system, through the purchase of carbon credits under the IET envisaged under the Protocol.

Table 2. Emissions by Sector in 2010 as % of all Emissions

Transportation	Agriculture	Buildings	Landfill Gas	Industrial emitters		
				Power Generation	Mining and Manufacturing	Oil and Gas
25%	10%	10%	4%	16%	17%	18%

Source: Government of Canada (2002a).

Table 2 shows the projected source of emissions for Canada in 2010. In total, it is estimated that Canada will emit 809 MT, of which 425 MT will come from industrial emitters or slightly more than 50% of all emissions

3.4 Canada's Response

In the federal government plan to meet the Kyoto Protocol target, Canada will achieve its commitments in three sequential steps. Canada is currently engaged in the first phase (Step 1), and about to embark on the second phase. The current discussion focuses on what efforts would take place in this second phase (Step 2). Step 3 contemplates a wide range of possible actions, informed in part by the experience to date, but with no specific actions contemplated at this time

Table 3 shows Canada's overall goal of a reduction in emissions of 240 MT and where (and when) the government expects to achieve its goals. Of the overall goal of 100 MT to be achieved in the second phase, over half would come from the implementation of a DET that would reduce emissions by 55 MT from where they would otherwise be in 2010.

Table 3. Components of the Canadian Plan in emission reductions (MT)

Sector/Activity	Step 1	Step 2	Step 3	Total
Government and individual actions	15	15-20	60	
Major Industrial Emitters	25	55		
Other Industrial Emissions		15		
Agriculture, Forestry, and Municipalities	40	20-28		
International Market		Min 10		
Total	80	100	60	240

Source: Government of Canada 2002

In Step 1, industrial emitters are expected to reduce emissions by 25 MT from actions undertaken through two existing government initiatives: Action Plan 2000 and Budget 2001. The 40 MT of carbon reductions from Agriculture, Forestry and Municipalities includes 20 MT from BAU forest sinks; however, measurement tools and inventories are required to verify the carbon sequestration and receive credit – these systems are under development by the federal government in cooperation with provinces.

In Step 2, in addition to the 55 MT reduction achieved though emission trading involving large industrial emitters (including the pulp and paper sector), a further 15MT are expected come from other industrial emitters (including lumber and panel mills). Of this total, 11 MT are expected to come from greater use of renewable energy and innovative technology, and 5 MT from capturing fugitive gas and reductions by Small and Medium Size Enterprises (SME's). Step 2 also envisages potential offsets from agriculture and forestry sinks (12 MT) and the possibility of selling newly captured emissions (including flared landfill gas) into the offset system (8 MT) that would be available to help industrial emitters meet their individual targets (this is shown as the 20-28 MT from agriculture, forestry, and municipalities in Table 3). We discuss the offset system in more detail in the design of an emissions trading system.

The proposed efforts to be taken under Step 2 can be separated into four main types of policy actions with the first three aimed at directly curbing or reducing emissions:

- "Targeted measures" which combine a mix of command and control measures (such as mandatory energy efficiency standards and fuel efficiency standards);
- a Domestic Emissions Trading (DET) system;
- Incentives and support for technological innovation and moral suasion to encourage energy conservation; and
- the use of C sinks both domestically and internationally.

The industrial sector is expected to provide the bulk of the emissions reduction effort in this second phase, with BAU sinks also potentially contributing an important part of the effort. In the remainder of this paper, we focus on policies involving the use of sinks and the DET as they apply to forest product firms.

3.4 Proposed Domestic Emissions Trading (DET)

The two generic options for sectoral coverage in a DET system are upstream coverage and downstream coverage of GHG emissions. Analysis of both as applied to Canada has been conducted (Government of Canada 2002a). In the former option emission caps are assigned to energy producing firms such as those oil refineries and electricity producers. This approach achieves substantial coverage of GHG emissions since almost all energy production is covered. The federal government believes it has a number of important drawbacks and so the government has proposed to implement a system based on a downstream coverage system. In this approach only large final industrial emitters would be assigned emission caps. This achieves less coverage of GHGs (necessitating alternative measures to help achieve the Kyoto target) because it would include only the large industrial users of energy, which account for 51% of emissions in Canada (Table 2).

The federal government has also proposed to implement an offset system attached to the DET. This would be a baseline and credit system in which projects are undertaken and credits are given for emission reductions or increased C sequestration relative to a baseline representing emissions or sequestration in the absence of the project. Companies with obligations under the DET could then buy these credits. From a business perspective a key variable in a trading system is the cost of C. In Section 5 we will discuss the range of prices the government considered in its evaluation and the implications of the government commitment to cap firms costs of meeting their commitments at $15/t.

4. MANAGING MILL GHG EMISSIONS

4.1 Industry Emissions

The forest products industry is the largest industrial energy user in Canada but it is also unique in that the resource it relies on can serve as either a source or sink and that its production processes and by-products allow it to self-generate large quantities of renewable energy. In 1998-99 the Forest Sector Table of Canada's National Climate Change Process (FST) estimated that the forest products industry directly emitted 12.2 MT and indirectly emitted 9.3 MT through purchased power (or 21.5 MT total) in 1997; this would climb to 13.4 MT and 9.7 MT (23.7 MT) in 2010 in a BAU scenario. The pulp and paper sector is the largest source of direct and indirect emissions within the forest products sector.

Direct emissions from the pulp and paper sector were approximately 10 MT in 2000. Between 1990-99 direct CO_2 emissions from the pulp and paper industry declined by 19% despite large increases in production (FPAC 2002). Reductions reflect both improvements in energy efficiency and increased use of renewable biomass energy. Substitution of biomass energy for fossil fuels has been under way in Canada's forest products industry (mainly in pulp and paper mills) for several decades so that biomass energy now account for over 50% of the industry's energy consumption. Under the common convention used for calculating GHG emissions, biomass energy is assumed to have no net emissions of CO_2, provided the biomass comes from a sustainably managed source.

The FST explored options for reducing emissions in Canada's forest products mills, as part of work undertaken under Canada's national climate change process (NCCP 1999). The Table's multi-stakeholder representatives concluded that there were large opportunities to reduce emissions at low cost or even at a net saving. In particular, specific actions to improve energy efficiency and increased fuel switching were identified. The Table also identified a number of emerging technologies that with accelerated development, commercialization and deployment could be implemented to reduce emissions in 2008-12.

4.2 Economics of Emission Reductions

There are five main categories of pulp and paper manufacturers; pulp mills; newsprint mills; paper mills; paperboard mills; and converted paper mills. Table 4 shows the relative size of each of these sub-sectors measured in terms of shipment revenue; there are distinct differences across all these sectors in terms of their energy consumption and CO_2 emissions.

Table 4. Selected Statistics for the Canadian Pulp and Paper Manufacturing Industry, 1999

	Pulp	Newsprint	Other Paper	Paperboard	Converted Paper
Shipments & other revenue ($ bn)	7.8	10.2	4.9	2.4	8.7
Energy as % of operating cost	10%	18%	13%	19%	1%
CO_2 emissions (M tonnes)	3.7	4.0	1.8	1.8	0.4
Exports/Shipments	96%	85%	71%	42%	24%

Source: Industry Canada 2002

The costs of emissions reduction for a firm generally depend whether the firm plans to achieve those reductions through improvements in energy use or fuel-switching. We consider both of these in turn. Improvements in energy efficiency reduce emissions per level of output. The FST suggests that there is a correlation between emissions and the age of the capital stock. Capital investment in new technology or new capital stock or adoption of new processes can reduce energy use, which will be a financial savings to the firm (to offset the cost of the new investment) that accrue over the life of the investment. A number of specific actions to improve energy efficiency and increased fuel switching were identified by the FST. Table 5 shows actions that were identified as having a negative ***Cost Effectiveness***; in other words, emissions were reduced with net economic savings, based on a NPV calculation using a 10% discount rate and the estimated economic costs (typically the capital investment and annual operating costs) and benefits (reduced fuel costs) over the life of the equipment. For example, improving the maintenance and use of existing auxiliary equipment at pulp and paper mills would result in a savings of approximately $64 million in $1997. The FST noted that the energy efficiency options tended to be the most cost-effective.

The FST also calculated the ***Estimated Financial Incentive*** required for the firm to undertake this action; it is based on the same data and NPV calculation but instead uses a 40% discount rate. Even at this higher rate, a number of options were still potentially profitable (any calculations yielding a negative number were set at 0 to reflect the fact that there was no need for a financial contribution to offset the expected cost). The options identified by the FST suggest that there is substantial scope for GHG emission reductions that are both significant and profitable-a point echoed by other research (Jaccard and Montgomery 1996).

Table 5. Cost Effective Actions to Reduce Emissions in the Forest Sector

Action	Type of Measure	Cost Effectiveness (1997$ millions)	GHG Emission reduction in 2010 (MtCO2e)	Estimated Financial Incentive (1997$ millions)
1. Adoption of high intensity driers-paper mills	Emerging technology	-85.9	0.21	0
2. Improve maintenance/use of existing auxiliary equipment-pulp and paper mills	Energy efficiency	-64.1	0.36	0
3. Improve maintenance and use of existing steam equipment-pulp and paper mills	Energy efficiency	-61.3	0.85	0
4. Adopt high energy efficiency auxiliary technologies-pulp and paper mills	Energy efficiency	-38.5	0.65	0
5. Improve process thermal integration – pulp and paper mills	Energy efficiency	-31.8	1.25	0
6. Black liquor integrated gasification and combined cycle cogen. -pulp and paper mills	Emerging technology	-28.5	1.09	0
7. Adopt energy efficiency process technologies-pulp and paper mills	Energy efficiency	-24.1	2.68	839
8. Optimize recovery boilers-pulp and paper mills	Fuel-switching	-15.2	0.39	65
9. Increase wood waste cogeneration-pulp and paper mills	Fuel-switching	-11.1	2.45	247
10. fuel-switching-lumber and panelboard mills	Fuel-switching	-5.4	1.51	356
11. Increase use of hog fuel boilers-pulp and paper mills	Fuel-switching	-3.4	1.33	111
12. Modernization of hog fuel boilers-pulp and paper mills	Fuel-switching	-2.6	0.48	155

Five other options were identified involving positive costs ranging from $4.40 up to $47.1.

Source: Table 3.8.1, FST

The economics of fuel-switching involve the substitution of less carbon intensive fuels (natural gas) for more carbon-intensive fuels (heating oil) or even the use of biomass fuels that are carbon-neutral. There has already been a substantial increase in the use of available residues (sawdust, hog fuel, bark) by the pulp and paper industry; and the ability to further increase the use of biomass is potentially constrained by regional availability. It should be emphasized that the options considered in Table 5 were predicated on existing power prices; the relative economics of fuel efficiency and fuel switching can change substantially based upon the cost of purchased power and the opportunity cost of emissions reductions. Firms can be expected to respond to changes in energy costs; they may not to changes in opportunity costs unless they internalize those costs/benefits of emissions reduction (which can happen through a price for permits/offset credits under a trading system).

4.3 Existing Impediments to Emission Reductions

In general, the need for quick investment payoffs and limited capital resources has meant that energy-related projects have not been high on the priority list for forest sector companies. The FST identified the following barriers within the forest products industry: high hurdle rates required for investments; the low priority given achieving more efficient energy use; a lack of knowledge/information about opportunities; risk averse attitudes within the industry and long-lived technology (which reinforces risk aversion); and generally lagging R&D. The FST also identified two other impediments: the current structure of power markets and the lack of a secure fibre supply that discouraged investment in these kinds of emission reduction projects.

There have been several changes advocated in government policies to overcome (at least in part) some of these barriers: more favourable tax treatment such as accelerated depreciation, greater emphasis of technology diffusion and communication, and more funding for general R&D, especially in the case of emerging technologies that could potentially achieve significant reductions through either efficiency improvements or utilization of biomass energy (NCCP 1999).

In addition, it has also been noted in the area of energy conservation that organizational constraints-firm decision-making procedures and high hurdle rates used to allocate investment within the firm (we note that the FST used 40% hurdle rates in evaluating energy-related projects from the perspective of forest sector firms)-can lead to substantial underinvestment in energy projects even though they may be profitable to the firm (DeCanio 1998, 1994). There is the possibility that such barriers may impede efforts to achieve emissions reductions even if appropriate policies are designed and the economic incentives are right so that they are profitable (Jaccard and Montgomery 1996).

4.4 MANAGING FOREST CARBON

4.4.1 Kyoto rules on Afforestation, Reforestation, and Deforestation

The Kyoto Protocol and its Marrakesh Accords rulebook establish the overall framework for policy and climate change mitigation actions in Canada's forest. The Marrakesh Accords establish the rules for forest C accounting in the first commitment period only. Forest C accounting rules for the subsequent years will be established as negotiations occur on targets for the second commitment period, but the current rules will form the basis for these longer-term rules. Nevertheless, this lack of long-term rules does add an element of uncertainty in incorporating climate change mitigation considerations into forest management strategic planning.

Industrialized countries must include lands subject to afforestation (A), reforestation (R) and deforestation (D) since 1990 in their GHG accounting in 2008-12. A and R are defined for Protocol accounting as newly created forests. Afforestation refers to establishment of forest on land that has not held forest for at least 50 years, while reforestation refers to establishment of forest on land that did not have forest at the end of 1989. Thus regeneration of forest following harvest is not afforestation or reforestation under Protocol rules. AR results in a sink that serves to offset GHG emissions elsewhere in a Canada. They therefore make achieving Canada's Kyoto target easier. Deforestation is the non-temporary removal of forests, so that harvesting followed by regeneration of forest is therefore not deforestation. Deforestation increases the GHG emissions that Canada must account for and therefore makes achieving the Kyoto target more difficult. For some industrialized countries, including Canada, ARD will almost certainly be a net source since the emissions from D will exceed the emissions from AR, in a business-as-usual (BAU) world (i.e. no efforts are undertaken to reduce D or increase AR).

Industrialized countries have the option to include land subject to forest management (FM) and agricultural land management since 1990 in their accounting, with the decision to be made no later than 2006. FM is defined for the Protocol as a system of practices for the stewardship and use of forests, and it thus includes the harvest-regeneration cycle. FM could result in a source or a sink depending on the practices and natural disturbances – for example if the annual volume harvested exceeds the rate of growth of elsewhere in the managed forest then a net source is likely to result. Canada would decide in 2006 to include FM in its accounting only if it is projected to be a sink although there will always be a risk that unpredictable natural disturbances likes fires and insect infestations would turn the FM area into a source in the commitment period. The FM sink would be used to offset any net source resulting from ARD up to a limit of 33 Mt/yr CO_2 in 2008-12. Any further FM sink could be used up to a country-specific cap defined in the Marrakesh Accords. Canada's cap is 44 Mt/yr CO_2 in 2008-12.

To qualify as ARD or FM the activities will have to involve land that qualifies as forest. The definition of "forest" in the Marrakesh Accords is based on a definition of the UN Food and Agriculture Organization. An area will be classified as forest if it meet minimum requirements for area (0.05-1ha), crown cover (10-30%) and tree height (2-5m) - each industrialized country will have to make a choice for each of these parameters within the range specified. Young stands of trees that have not reached the minimum crown cover or tree height are considered forest, as are areas temporarily unstocked as a result of harvesting or natural disturbance, provided the area is expected to revert to forest.

Accounting for the land subject to ARD and FM is to be done by calculating the C stock changes in 2008-12 on the land. This means the land must be identified, shown to have forest, shown to have been subject to ARD or FM since 1990, and spatially delineated. All ecosystem carbon pools must be included in the accounting – trees, roots, other vegetation and soil. Carbon stored in harvested wood is not included in the accounting, meaning that, for the purposes of accounting, the rules assume that the C is emitted to the atmosphere upon harvest. In the future there may be a change in the accounting rules to recognize the fact that much of the harvested C is in fact stored for varying periods of time in wood and paper products, rather then being emitted. It is likely that this change in the rules will occur for the second commitment period but not the first. Emissions of nitrous oxide and methane associated with ARD and FM land must also be accounted for.

Both the JI and CDM project mechanisms involve forests. Subject to host country rules, JI projects could involve any ARD project and could also involve FM projects if the host country has chosen to account for FM. For the CDM the only forest projects that will be acceptable in the first commitment period are those involving afforestation or reforestation. The rules for AR projects in the CDM have not been finalized but should be agreed internationally by the end of 2003. Both JI and CDM projects require development of a baseline that reflects emissions and removals in the absence of the project. Credit is then given only for the emission reductions or increased removals that are additional to the baseline.

4.5 Sources and Sinks in Canadian Forests

Both natural factors and human management influence exchanges of C between forests and the atmosphere. In a natural forest the key influences are the rates of growth, mortality, and decomposition, and the frequency and severity of natural disturbances such as fire, insect infestations and disease. Whether a natural (unmanaged) forest is a sink or source will depend on these influences and their changes over time. Thus Canada's total forest of just over 400 million ha is estimated to have been a large sink in the 1920-75 period as growth caused more C to be added than was lost as a result of natural disturbances (Kurz and Apps 1999). An increase in fires and insect infestation in the 1970-90 period caused the forest to become a large source in the 1980s and it likely remains a source today.

4.5.1 Identifying the Managed Forest

For the Kyoto Protocol accounting, however, what matters is the area subject to FM – the forest that has been managed since 1990. Among industrialized countries this distinction between the total forest and the managed forest is of particular importance for Canada because only a fraction of the forest is managed. One proxy for Canada's managed forest is the non-reserved accessed stocked timber productive forest – that area which has road access and has forest suitable for timber extraction, an area of 134 million ha according to Canada's forest inventory (Lowe et al 1996). In any given year the FM area is made up regions that are sources due to natural disturbances or harvesting, and regions that are sinks because of growth. Canada's official estimates project that FM will result in a net sink of 35 Mt/yr CO_2 in 2008-12, although this estimate is of low confidence (UNFCCC 2000). Creation of new forests through AR is projected to result in a sink of roughly 1 Mt/yr CO_2 in 2008-12, while D is projected to be a source of 16 Mt/yr CO_2. Thus in total forest activities are projected to estimated to result in a net sink of 20 Mt/yr CO_2. These projections are based on BAU activity – they are expected to occur irrespective of any actions undertaken for climate change mitigation purposes.

4.5.2 Implication of C Sequestration for Forest Management

Canadian governments may be interested in encouraging actions to increase the net contribution of forests to climate mitigation in Canada through increased sequestration or reduced emissions in the forest. They may also be interested in changing the time profile of sequestration and emission reductions. For example, some actions may simply increase the rate of sequestration in the near term while reducing it in later periods so that in the long run there is no net change in the amount of sequestration that occurs. Such shifts in the time profile of forest C sequestration or C emission reductions are of interest because achieving climate change mitigation targets in the near term may be more difficult than in the longer term. This is because, in the longer term, technological developments and capital turnover are likely to make fossil fuel use reductions more feasible and cost effective than in the near term.

Any pressures for changes in how forests are managed to satisfy climate change mitigation goals will impact on the operations of forest companies both at the stand level (what harvesting and silvicultural practices are used) and at the landscape level (when and how much harvesting, silviculture and protection occurs). Thus climate change mitigation goals may lead over time to changes in FM, such as reductions in the area and/or timber volume harvested and changes in harvesting, silvicultural and protection practices. In this paper we refer to such actions as incremental FM to distinguish them from business as usual forest management. Incremental and business as usual FM occur on the same forest landbase, with the difference being the result of changes in decisions about how to manage the forest in order to increase C sequestration or reduce C emissions. Climate change mitigation goals may also lead over time to increases in the rate at which new forest is created (afforestation / reforestation) and reductions in the rate at which existing forest is lost (deforestation). Possibilities to increase sequestration and reduce emissions in forests in Canada and elsewhere have been assessed extensively – for example see NCCP (1999), Griss (2002), Papadopol (2002).

4.5.3 Forest Practices and Forest C

Harvesting results in large emissions because as much as two-thirds of the tree biomass is not used and the waste C will eventually be emitted to the atmosphere (Wayburn *et al* 2000). Thus the most obvious way to reduce emissions associated with Canada's forests is to reduce the area harvested, for example by protection of specific areas from harvesting. This has happened in Saskatchewan, for example, where 200,000 ha have been removed from the harvesting land-base and placed in forest C reserves (Lemprière *et al* 2002). Reductions in the area of natural forest available for harvest may not result in a reduction in the volume harvested if more intensive forest management is practiced in other parts of the forest, or if new forests are established. Increased commercial and pre-commercial thinning may be two possibilities for incremental forest management since they can allow more timber to be extracted from an area, thereby reducing the area that needs to be harvested to achieve a harvest volume target.

Interest in forest C for climate change mitigation may also lead to changes in harvesting practices to reduce emissions at the stand level. One approach is to reduce the volume harvested per unit area by greater use of alternative harvesting methods such as selection logging, or extending the harvest rotation length. Such strategies only reduce emissions if the total area harvested does not increase to offset the reduction in volume at the stand level. Alternatively, it can be possible to lower emissions or change the time-profile of emissions while maintaining the stand harvest volume through lower-impact harvesting techniques and changes in how logging residues are handled (e.g. less prescribed burning to remove logging residues).

Changes in silvicultural practices that could increase sequestration include increasing tree growth rates through fertilization or planting of faster-growing species after harvesting. Increased post-harvest planting and less reliance on natural regeneration are also of interest. An issue here is what practices actually increase ecosystem C as opposed to just shifting C sequestration around temporally. Such temporal shifts in sequestration could in fact be very useful from the point of view of being able to claim sequestration earlier, such as in 2008-12, rather than later as noted above.

4.5.4 Forest Protection

Management of some natural disturbances may change due to interest in forest C for climate change mitigation. This is because Canada's FM area faces a significant but not completely predictable risk from natural disturbances. For example, a year of severe fires, or a period of severe insect infestations, could result in such large emissions that the FM area would be a net source. In particular, efforts to predict and suppress insect infestations such as spruce budworm and others could have a large impact in terms of preventing emissions that would otherwise occur. In contrast, it is unlikely that significant additional fire suppression efforts will have much effect as the current area burned in the managed forest is due almost entirely to the small number of fires that escape containment and become large. It is in general logistically almost impossible to further suppress fires that occur, and in any case this is likely ecologically undesirable and economically prohibitive. There are actions other than increased suppression that also could be of interest in efforts to manage natural disturbance emissions. These include actions to reduce fuel loads to reduce the chance of fire, and increased use of post-disturbance salvage for forest products, which in turn would allow a reduction in the area harvested. However, these are likely to be higher cost

4.5.5 Forest Establishment

The creation of new forests is perhaps the simplest approach to increasing the net contribution of Canada's forests to climate change mitigation, although Canada, unlike many other countries, has little history in afforestation / reforestation. New forests represent a permanent increase in the forest C stock provided the forest is either never harvested, or, alternatively, the new forest could be managed for timber with the establishment of a series of plantations. With careful planning of the planting and harvesting schedules the plantations would in the long run reach a state of C balance in which harvesting emissions would be balanced by sequestration from growth. If new forest was allowed to grow and then was converted back to its non-forest state (deforestation) there would be no long-term C impact. However, the temporal pattern of early sequestration and later emissions might be useful if it is believed that offsetting those future emissions could be done relatively easily by future generations. There is a substantial amount of marginal agricultural land that may be suitable and economically accessible for creation of new forests, and aside from C a variety of other goals can be achieved with afforestation/reforestation (NCCP 1999). From the forest industry perspective plantations can provide a new fibre source, potentially allowing a reduction in harvest of natural forests. Other environmental goals such as maintenance or improvement of water quality, habitat restoration and reduction in forest fragmentation can also be served by the creation of new forests, especially where they are not meant to be harvested in the future.

Finally, reduction of deforestation could substantially increase the net contribution of forests to climate change mitigation in the next decade or two, much more than could afforestation / reforestation. This is because creation of a new hectare of forest requires at least several decades to sequester an appreciable amount of C while stopping a hectare of deforestation immediately prevents the substantial emissions resulting from the loss of a mature forest. Most deforestation is outside the control of forest managers as it results from removal of forest for agricultural, energy sector exploration development and extraction, municipal development and other purposes. However, construction of roads and landings as part of forestry operations is estimated to be the largest single source of forest loss in Canada (Robinson et al 1999). Thus climate change mitigation may lead over time to pressures on forest managers to reduce these activities, or increase efforts to rehabilitate or restore the effected areas.

The above pressures may lead to long lasting changes in how Canada's forests are managed but ultimately increasing net forest C sequestration is not a longer-term mitigation option. There is a limit to how much sequestration can be increased and how much emissions can be reduced in the forest, but such actions do serve to "buy time" to develop and implement technology solutions to reduce emissions and switch to renewable fossil fuels. Aside from helping with climate change mitigation goals, management of Canada's forests will almost certainly need to change as part of adaptive strategies to ameliorate the impacts of climate change on the forest. In the long run, these sorts of changes may prove to be of greater significance to forest companies and forest managers, if climate change impacts are severe.

4.6 Economic Incentives Where There is a Value to Forest C

Aside from regulatory requirements related to climate change mitigation, companies may take certain actions if they are financially rewarding. Some actions could result in reduced C emissions or increased sequestration that have a value as a "credit" which can be directly realized in a market. While there is currently a great deal of interest in such C credits the true potential will depend on the creation and design of a carbon offset trading system. Aside from market value, some companies may find indirect benefits, such as being viewed as environmentally friendly.

There are three ways in which the economics of forest carbon can enter into forest sector firms' decision-making. Firms will need to consider 1) the value of carbon stored over time as a result of planting a hectare of new forest (afforestation or reforestation), 2) the carbon value of not harvesting a hectare of forest, and 3) the effect of altering rotation lengths on carbon sequestered. In the latter two cases what is also of interest is the emissions that either do not occur because harvesting has not occurred (as in 2) or a change in emissions due to a change in the mix of outputs (pulpwood versus sawlogs) associated with different rotation lengths (as in 3). Because the pattern of carbon sequestration or emissions associated with these three actions differs the net present value (NPV) also differs. In all three cases the effects of the action on all ecosystem carbon pools must be considered. The calculations involved require assumptions about future growth rates as well as the life-span of products derived from harvested timber; it should be emphasized that the GHG emissions associated with a product may be quite different, depending upon the rules under which they are derived, even before costs are considered. Liski *et al*. 2001 provide an example, examining the effect of different rotation lengths for pine and spruce timber in Finland on total carbon sequestered as well as emissions (derived in manufacturing the timber and decomposition over the life of the product). They found that while that total carbon stored increased with the rotation length for pine, but decreased for the spruce so that the maximum carbon that could be stored required the <u>shortest</u> rotation length. When they incorporated emissions from manufacturing activities associated with timber outputs, and adjusted for product life span, they found that longer rotation lengths were preferable (since the shorter rotation lengths for spruce yielded pulpwood with both higher emissions associated with the manufacturing process as well as a shorter product life-span associated with paper relative to solid lumber). They also noted that this would lead to lower harvests and timber revenues for the landowner.

From the company perspective decisions to voluntarily engage in planting, not harvesting, or any other potential carbon management activity for climate change mitigation purposes will at a minimum require that the NPV of the action is positive. Given capital constraints facing forest sector companies there may also be a requirement for a return on the investment within a certain (short) time period. The ability to realize the value of the investment will require access to a carbon trading system – issues around carbon trading are discussed below. Even if the economics of such actions make sense, and the ability to realize the value of the carbon exists, the fact remains that C management would be a whole new line of business for forest companies, and they will face learning curve costs.

4.7 Existing Policy Constraints to Forest Management for C

Increasing C sequestration or reducing emissions through changes in the ways in which forests are managed in Canada will depend on biological potential, economic feasibility and the policy environment. Governments affect the latter two factors.

The extent of such changes, and the speed with which they occur, will depend on the importance that governments and markets attach to forest C sequestration, and the degree to which such changes are consistent with other public goals for managing Canada's forests. Any changes would have to be consistent with provincial forestry and other regulation, as well as in compliance with tenure agreements, although these institutional arrangements can be expected to be adjusted over time as climate change mitigation becomes embedded as yet another socially valuable objective of forest and land management.

While incremental FM activities may be both biologically and economically feasible all such activities will have to occur in the context of a FM regime that is evolving to serve a variety of societal goals including government revenue, employment and community stability, and habitat and biodiversity conservation. Policies, regulations and institutions designed to further these goals may sometimes deter or conflict with actions to promote incremental FM activities meant to mitigate climate change.

A primary objective of forest management is and will remain timber but as with many other environmental objectives, climate change mitigation is likely to sometimes be incompatible with management for timber at both the stand and landscape level. At the stand level, C storage may sometimes be promoted through actions that increase the amount of merchantable timber available for harvest over time, but this is certainly not always true. An example where both occur might be commercial thinning that produces more volume over time as well as increasing sequestration. Conversely, management to reduce emissions in a stand may be most easily achievable through actions that reduce the amount of merchantable timber harvested. At the landscape level changes in harvesting patterns and amounts are likely to be in conflict with an interest in timber, though some other landscape level actions such as increased protection against insects and greater use of salvage may contribute to timber management objectives.

Provincial governments typically establish tenure agreements with forest companies with conditions creating both a minimum and maximum AAC, and often requiring the operation of a mill. These conditions are meant to maintain employment and resource-dependent community stability, as well as stability of government revenue. Changes in FM undertaken for C and which have the effect of reducing harvest volumes could conflict with these goals. This would be the case with forest protection, for example, although if provincial governments can realize a C value through forest protection then such conflicts might be reduced. On the other hand, some changes in FM that reduce harvest volumes may not impact on employment if, for example, they require greater labour intensity. In such a case, however, the ability to realize a C value may be crucial to make the change economically feasible.

FM changes that increase sequestration while still maintaining a given volume of harvest could still conflict with other policy objectives if they work by not allowing an *increase* in the harvest volume. For example, the use of commercial thinning and other silvicultural activities could contribute to climate change mitigation in some parts of country by allowing a reduction in the total area harvested while still maintaining a given volume of harvest. However, given pressures to increase wood supply, activities that increase the intensity of merchantable timber production on a given area often result in an increase in the harvest volume over the total forest rather than reduction in the area harvested.

Some potential incremental forest management activities for C are likely to be in direct conflict with forest certification standards. For example, the FSC Maritimes Standard does not condone regeneration of harvested areas by planting. Thus increasing the rate of C sequestration through increased planting to reduce regeneration delay would not be allowed.

On the other hand, FM for C could in many instances reinforce goals of governments and society. For example, where managing for C increases forest area or forest age, or results in less soil disturbance, then habitat, biodiversity and watershed maintenance objectives will benefit. A shift to greater use of winter harvesting in parts of Canada, for example, reduces soil disturbance and hence reduces associated emissions.

Provincial governments will need to decide on the priority that C sequestration will be given relative to other goals of FM. For example, choices may have to be made between increasing (or even simply maintaining) current harvest levels on some areas of the forest and managing in part for greater sequestration or reduced emissions. Similarly, choices will be needed about how and whether to incorporate C considerations into FM regulations and guidelines. In turn these decisions will likely depend, at least in part, on the indirect or direct economic benefits that C provides to land managers, relative to the costs of obtaining the carbon. In certification schemes, greater attention to the tradeoffs between climate change mitigation (sequestration or reductions in emissions) and other goals may be warranted.

5. IMPLICATIONS OF A TRADING SYSTEM

5.1 Economics of Carbon Trading

The Kyoto Protocol is the first international environmental agreement to utilize economic instruments in a major way in helping achieve its goals. It contemplates the use of trading systems as a means to control greenhouse emissions through the creation and sale of credits in an international marketplace. At the same time, countries are also considering the adoption of similar systems within their country and many countries (such as the U.S.) have used such systems internally within their own countries. Below we consider the economics of carbon trading systems in terms of how they are designed and the issues they may raise for Canadian forest products firms. We then examine the proposed Canadian Domestic Emissions Trading (DET) system.

The appeal of such systems is that they can achieve policy goals, such as reduced pollution, at lower costs of compliance than traditional command and control measures such as standards and regulation. The economic logic of trading systems is straightforward-permits will flow towards the highest valued uses therefore leading to economic efficiency. The principal use of trading systems has been in fisheries management, water supply, and air pollution control (Tietenberg 2002).

Policy makers can choose between two different types of trading systems. "Cap and trade" systems involve the determination of an aggregate limit allocated between users who then trade allowances between each other. Credit systems involve the establishment of user-specific limits or benchmarks based on technological standards. Users that exceed that required by the benchmark can then sell or trade those credits to others that either do not meet their requirements or find it cheaper to purchase the credits. The principal difference between these two systems is that: (1) credit systems require the establishment of baselines (typically based on technological standards) that are not necessary for a cap and trade system; and (2) cap and trade systems establish an aggregate limit on use of the resource: there may be an increase in aggregate use under a credit system if there is no control over the number of users. The International Trading System is primarily a credit-based system (ITE; JI; CDM) while the Canada's proposed DET involves components of both an aggregate limit and the utilization of credits derived through activities outside of the DET.

Trading systems will not work well where there is market power, high transaction costs, insufficient monitoring and enforcement, or the presence of large externalities not captured in the system. The presence of the first two factors reduces economic efficiency but generally has limited environmental impact, especially where there is a cap and trade system in place since aggregate limits restrict the overall use of the resource. The latter three factors are general issues for any policy used to limit or control access to the resource; insufficient monitoring and enforcement mean that policy makers may not be able to ensure that aggregate use is limited (such as not properly reporting emissions or harvests), while the presence of large externalities means that the environmental impacts from users response on resources outside the system (such as switching to catching species outside of the trading system) might be sufficient to offset any gains achieved through limiting the use of the resource.

The design of the trading system can also determine how well it will achieve its objectives. The design depends on how policy makers define rights under the system and the effectiveness of those rights, where those choices fall into the following four areas:

- The determination of the limit;
- The allocation of that limit across users;
- Transferability (across participants and time); and
- Monitoring and enforcement.

We review each of these in turn in the following section.

5.2 Design of DET

In its November 2002 climate change plan the Federal government provided the general outline for a DET that would involve downstream coverage of large industrial emitters, with targets to negotiated on a sector-by-sector basis (Government of Canada 2002b). The 125 pulp and paper establishments in Canada account for 1/3 of industrial energy use and would therefore be included in the DET system as currently proposed. Wood product manufacturers-lumber and panel board mills-would not be included as they use far less energy and emit less GHG (1.89 MT and 1.2 MT in 1998, expected to grow to 2.03 MT and 2.0 MT in 2010 respectively) (NCCP 1999).

5.2.1 The Determination of the Limit

Canada's overall commitment for GHG fixes emissions for the country. However, this limit does not necessarily directly translate into that used for the proposed trading systems. The experience with the SO_2 trading system in the U.S. suggests that political negotiation can lead to some modification so that all sectors may not necessarily receive a proportionate share of allowances (or conversely some sectors might face disproportionate reductions).

Based on projected GHG emissions in 2010, the Canadian government estimates that a DET will achieve an overall reduction of 55 MT from industrial emitters relative to BAU (see Table 3). It will be implemented through a cap system on individual allowances. We discuss this more fully in the next section. While there will also be trade, it is unclear as to whether or not there may be any limits imposed upon trading; we discuss this more fully in the following section on transferability.

5.1.3 Allocation

There are several possibilities for the allocation of rights: on an historical basis; through an auction; based on administrative rules; or by lottery. The most common approach has been on an historical basis since it enhances political adoption and reduces the financial burden to firms relative to an auction. Economic theory suggests that in the long run there will be no economic difference so long as permits can freely move from one party to another (Tietenberg 2002).

While all pulp and paper mills in Canada are capital intense and use substantial quantities of energy they are nevertheless quite diverse. At one extreme, the pulp and paper sector includes old and relatively inefficient mills that have higher operating costs but low debt loads. At the other extreme are new and very efficient mills with lower operating costs but high debt loads. The product mix and technologies of mills vary substantially. These differences suggest that calculation of caps for individual mills in the pulp and paper sector could be challenging. The application of a single broad cap determination approach to all mills may not be possible.

Establishment of the cap is a key process for any sector and company and the federal plan proposes that sectoral negotiations be undertaken to determine what these caps will be (through the negotiation of covenants). The cap applied to each mill will determine the extent to which it must reduce emissions. Whether it chooses to reduce emissions or buy emission reductions or offset credits will depend on the cost of internal emission reduction opportunities, versus the cost of purchasing emission reductions or offsets from other companies. Aside from the aggregate limit, the tightness of the limit from a company perspective will depend not only upon the initial allocation but also what happens to other regional participants in the DET. For example, the economics of fuel-switching *ex ante* may be quite different *ex post* if it turns out that all industrial emitters choose to reduce emissions by simultaneously trying to use biomass. Alternatively, exit or curtailment by firms may reduce power demand.

In addition, there is also a second cap that has to be determined if offset activities (the use of carbon sinks and other measures that result in emissions credits) can be used within the trading system. This cap determines the overall limit on credits that can be sold into the system to help parties meet their emissions targets.

5.1.4 Transferability

To the extent coverage of all emissions is restricted under the scope of DET, policy makers may be forgoing opportunity for more efficient reductions (although transaction costs may limit the extension to other sectors). If DET restricts trading across sectors or regions, it also reduces potential gains from a trading system. The possibility of restrictions is not unlikely: for example the 1996-2001 Softwood Lumber Agreement prohibited transfers of quotas between provinces; and quota transfers were only officially allowed intra-company within a province. From a company perspective, such limitations reduce flexibility in dealing with emissions if they operate in several provinces; they may need to pursue different strategies depending upon regional circumstances if there are regional restrictions.

5.1.5 Monitoring and enforcement

Monitoring and enforcement costs are not likely to be a major issue where, as proposed, the DET is confined to large, fixed plant facilities, and there a limited number of permittees that reduce the costs of monitoring. Emissions can be expressed as a function of fuel consumption that exists as an identifiable item on company's financial statements. Potential issues may arise in terms of developing a system to measure GHG emissions. For example, establishing historic emissions may be more problematic if they become important in determining the initial allocation. Another issue for forest sector firms under the DET is the definition of firm boundaries in determining firm emissions; one proposed measurement protocol involves defining what activities on site versus off site count towards GHG emissions, including indirect emissions associated with purchased power, and how to incorporate entities that may be controlled or jointly held (Climate Change Working Group 2002).

5.1.6 Need for Flexibility

Policy makers want to ensure that they can accommodate innovation. One problem they face in establishing new regulations is how to ensure they do not become a barrier to entry. There are design features that can be incorporated into the system such as zero-sum auctions where the government retains a small percentage of the permits granted to permittees and auctions them off, with the proceeds returned to the permittees. This overcomes fears that entrenched firms might refuse to sell permits to new entrants. This does not appear to be a significant issue in the pulp and paper sector given the unlikelihood of new greenfield mills appearing in Canada.

From the perspective of established companies, a related issue is growth: where industry may be expanding rapidly, the imposition of emissions rights based on historic patterns may be perceived as inequitable if there are again regional differences as in the case of the SLA. This is less likely to be a problem for pulp and paper industry given that regional shares of production have remained relatively constant. In negotiations on a pulp and paper covenant to establish a sectoral target, the sector should have an opportunity to address issues around growth and new entrants.

An additional design feature that can be incorporated is the safety valve- a limit in case the price of permits exceeds some specified level. This offers some certainty to firms in developing internal policies by reducing the risk associated with the regulatory system. The government's commitment to cap the costs of compliance at $15/t introduces a safety valve into the system.

5.2 Incorporating Offset Credits into a Trading System

C already has value as a result of an informal market that has developed. This market is informal because the demand on which any market must be based is still very speculative in the case of the carbon. In Canada no company has been assigned GHG emission reduction target so as yet there is no strong or explicit driver for demand, and no government in Canada has guaranteed it will recognize any trade. Thus companies that have engaged in purchases are doing so as part of a risk management strategy and to learn about C trading. They have been seeking low cost C credits that might be useable in the future against any emission reduction obligation they are assigned. Most trades have involved purchase of options to buy in the future. Few trades involve actual outright purchases and almost no trades have involved forest C. One forest C trade in Canada for which information is known is the trade between Saskatchewan Environment and SaskPower, the provincial electric utility (Lempriére *et al*. 2002).

There have been a number of international purchases of credits at prices ranging from US$1 to US$7 per t; however, these purchases have been made between firms outside of any officially agreed upon framework to date. The first purchase that can be considered under the IET involves a Japanese purchase of international credits from Slovakia. The credits are attributed to the difference between anticipated emissions in Slovakia in 2010 and their commitment under the Kyoto Protocol. (These credits are sometimes called *hot air*-the gap between the target and projected emissions; see Russia, for example, in Table 1). The broker that facilitated the transaction believes that such credits will become the "gold standard"; they are low risk since they are derived from credits assigned to governments (Chow 2002) and are acknowledged as being valid under the existing rules. Projected prices of C permits under IET depend significantly on which countries participate; Russian supply of permits to the marketplace is expected to be an important factor in reducing the price and overall costs of compliance for Kyoto parties.

A necessary pre-condition for development of real market for forest C in Canada is the creation by governments of a trading system that imposes emission reduction obligations that can be met through purchase of C offset credits including C credits from forest projects. Until then, a potential buyer is likely to consider purchasing C forest sequestration or emission reductions only under special circumstances. These included low transaction costs and a straightforward activity that results in high quality credits with a high probability of being accepted as part of any future trading system.

The federal government proposal to establish at DET and a C offset trading system involving forest carbon will increase interest on the part of buyers in forest carbon. This provides forest companies with potential opportunities for sale of forest carbon. The rules for an offset system will take some time to be elaborated but forest companies may wish to begin considering opportunities they may have to sell carbon credits. In doing so they should undertake a rigorous and realistic examination of what might be possible within their forest operations. There are a large number of issues that need to be considered in creating high quality and relatively low cost forest carbon credits that may of interest to buyers. Many of these issues were discussed for reforestation and forest protection activities in the review conducted by the Greenhouse Gas Reductions Trading (GERT) Pilot of the SaskPower trade (Lempriere *et al*. 2002).

Any such credits would have to be created, measured and verified in accordance with the measurement, monitoring and verification protocols established for forest C in an offset trading system. Only credits that satisfy offset system rules would be useable within the system. This would likely include rules related demonstration of ownership, establishment of project baselines, evaluation of leakage (effects of a project that occur outside the project), and measurement methods. In any actions on Crown land to increase sequestration or reduce emissions companies will need to negotiate with provincial governments the issue of ownership, taking into account existing regulatory requirements for operations on Crown land.

5.2.1 Kyoto Cap

As noted above, Canada has a cap on the forest management sink that it can claim – the cap is 44 Mt CO_2 /yr in 2008-12, while an additional 33 Mt CO_2/yr can be used to offset any net debits from the sum of afforestation, reforestation and deforestation. Step 1 of the federal plan includes a net BAU forest management sink (after accounting for afforestation, reforestation and deforestation) of 20 Mt CO2/yr, meaning that if another 24 Mt CO2 could be developed it could be used. In theory, then the potential scope of forest sink offsets is substantial, especially if one includes the possibilities for afforestation, reforestation and reducing deforestation. It should be kept in mind that the 20 Mt estimate is quite uncertain.

5.2.2 Determination of Benchline and Transaction Costs

An offset trading system will have transaction costs, perhaps significant ones at least initially as the system is developed. These transaction costs would be a function of measurement, monitoring and verification requirements, as well as the process of trading itself (contracting, brokers, and insurance). As currently envisaged, the international trading mechanisms are credit-based where the amount of GHG reduction (or absorption through sinks) will be measured relative to a baseline. One potentially large issue is how the benchlines will be defined and hence measured. Repetto (200X) has suggested that a lack of credibility may hamper the use of the CDM in IET since it will be difficult to measure and certify whether or not claimed credits are meaningful. Given that the current definitions revolve around business as usual, there is a potentially arbitrary demonstration of what would have happened relative to what did happen. This adds potential uncertainty and risks, expressed in greater transaction costs, when third parties attempt to enter into market exchange for C credits derived under an offset system. The onus on proving the validity of the baseline is likely to lie with project developers and prices for credits may reflect that uncertainty until the rules are established.

5.2.3 Relationship Between DET and IET

There is no explicit relationship between the domestic trading systems and IET under the Protocol. Linking the DET to the IET can help to minimize some transaction costs through reducing the need for different measurement systems and the required verification and validation. The proposed EU domestic trading system appears to be similar to the proposed Canadian system, with coverage of the major emitters. The emergence of such a system, in turn, while it offers the potential to reduce such costs also creates pressure for harmonization of the rules between the two system through any trading under IET. The potential implications depend upon the proposed rules developed elsewhere; they may be crafted in such a way that they do not necessarily reflect Canadian circumstances (for example, the predominance of government land). It will be up to the government to determine compatibility (certification has been suggested as one possibility of serving as verifiable mechanism). Finally, it should be noted that in the Marrakech Accords countries agree that domestic action would constitute a significant portion of the their effort to meet their targets. This is commonly interpreted as meaning that 50% or more of a target would be achieved through domestic action, as opposed to reliance on IET, CDM or JI (this is also known as supplementarity). Recently, concerns have been raised over the ephemeral nature of C sinks associated with forest growth since the C eventually returns to the atmosphere (either through harvesting activities or when the trees die and decay). Depending upon the rules crafted by different countries, this may reduce interest in forest sinks as a means of generating C credits under the IET system.

5.2.4 When Do Credits Vest?

The value of credits will clearly be linked to the volume of C sequestered; one issue under a DET will be how that is captured in a system where the C is accumulated over time, as would be the case for C stored in trees or forest. Discounting the value reduces the attractiveness of creating credits; however, if the anticipated credits are brought forward, there is a risk that they are not realized. It is likely that there will be some form of discounting, at least in IET, favoring offset activities that that can store C early in the time period. As is often the case, this may discriminate against some forestry activities, especially where discount rates are high. The current approach involves only counting the credits that are actually sequestered.

A related issue is that capital investments can create hostage problems; private firms will be reluctant to invest in any long-lived project without some kind of guarantee that there is no change in regulatory rules.

5.3 Implications of Proposed DET System

Under the proposed DET pulp and paper emissions are captured in the system but not other wood product manufacturing emissions (although they are still counted). Parties engaged in forestry activities are also not subject to emissions limits under DET (although they are also counted) but may be able to trade offset credits. There are no rules yet for activities on Crown land as opposed to private land. Given provincial jurisdiction over Crown lands and their potential to generate credits and offset the imposition of constraints on industry through the federal process, determining who receives the benefits from activities on Crown land is likely to be a point of political contention. This creates the possibility that different firms might have a range of options open to them in dealing with emissions reductions, depending upon their circumstances as shown in Figure 2. Figure 2 shows five different forest product companies, each different in terms of the scope of their operations that in turn affects the type of regulations each faces under the DET and the options they face. Company A is a woodlands owner/private landowners with only forestry operations. Company B is an integrated producer (pulp and paper and solid wood products) with woodlands operations. Company D is a solid wood products manufacturer with woodlands. Company E is a pulp and paper manufacturer with solid wood operations but no woodlands. Company F is a solid wood products manufacturer with no woodlands.

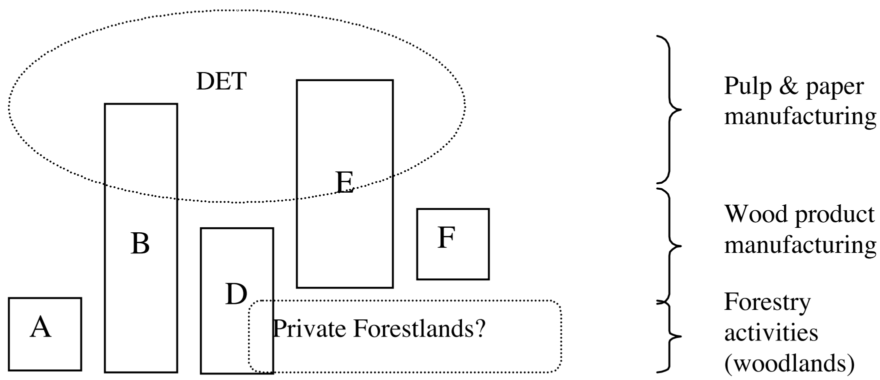

Figure 2. Proposed DET Coverage Relative to Company Operations

If offset activities are allowed then firms may be able to generate credits from forestry activities (in addition to any credits generated through emissions reductions in excess of their cap). In our example above, this is only open to firms A, B, and D. Firm B is in a position to apply those credits internally. The firm may be able to sell those credits in the domestic market at C_c (the price of C in Canada). Finally, there may be a global market so that there is a price C_w (the price of credits in the world under IET). In general, the price of C will be highest in the most constrained market. Market prices may not necessarily equalize if there are barriers to trade between the two markets; for example, under the Kyoto rules, countries determine which domestic entities can participate in IET and also determine the rules for their own domestic trading regime.

Depending upon the rules established, there could be a number of different prices to consider in evaluating C prices. The DET could create different prices (this could arise if there are any restrictions on transfers of permits between sectors or regions). Characteristics of the transaction (risk, uncertainty, perhaps even the time path of when credits can be applied against emissions) could also influence the price. All of these outcomes will be dependent in part upon the rules that are established.

In addition, firms will use different internal values in considering their options so that the supply of credits will be dependent upon price. Firm B will evaluate the marginal abatement cost of reducing its emissions (installing new technology, etc) against any credits it can generate internally. It will only supply those credits so long as it can abate the required amount of emissions more cheaply than it can supply or sell those credits. The Canadian price will then reflect the interplay of domestic supply and demand. If the DET and IET are not linked then the Canadian price and the international price will differ (we consider why this might be the case in the next section).

What other factors will determine supply and demand? It depends upon in part the rules that will be established governing the DET. Under the DET the potential buyers of credits are the pulp and paper firms (companies B & E) and other covered industrial sectors. Under IET there are also potentially foreign purchasers. Solid wood manufacturers are not buyers at this stage (companies D & F) nor is forestry company A. The potential sellers of credits under DET are offset activities that may qualify; these could be companies A, B, & D with woodland operations that may be able to generate C credits through activities resulting in C sinks. Firms B & E also have the option to reduce emissions and sell credits.

Assuming a C-constrained world, all of these firms have a clear set of options. Firm A will look to see whether it may make differences in its practices if it can sell its credits either domestically or internationally, assuming it is allowed to sell internationally. It is a pure seller of credits, as is Firm D, since emissions from firm D's manufacturing facilities are irrelevant to its decision-making progress. From Firm F's perspective, there is nothing gained or lost from not participating in the system, since it has neither the opportunity to sell credits nor the need to purchase credits. Firm B and E have somewhat more interesting choices. Firm E has two choices: reduce emissions or buy credits from a third party. This third party could be domestic (under the DET) or, if permitted, international (through IET). Firm B has even more options: it can reduce emissions, purchase credits from a third party, or create and apply those credits internally. We discuss the implications of this in the following section.

There is a sharp divergence between buyers and sellers interests since buyers would like to minimize prices paid while sellers would like to see prices increased. In the context of DET, this implies sellers of credits would like to limit supply of credits. Alternative suppliers of offset credits include two domestic sources in addition to those that might be derived from forest sinks: agricultural sinks and the capture of emission from landfills; and one international source: the potential purchases of emissions allowances under IET. However, it is not clear whether international credits could be applied to emissions under the DET (although they could be applied to aggregate emissions from Canada). Buyers would be interested in ensuring that the potential pool of suppliers of credits is as wide as possible and that the overall cap allowed offset activities is set high.

What else does the buyer want? Aside from the lowest cost, they want to minimize risk and transaction costs. One way to accomplish this would be to use any credits generated internally; this would favour in-house projects if there were not substantial price differentials.

Finally, we note that under such a system of partial coverage, there is every incentive for a company to shift as much as possible its GHG emissions to uncovered sections of the company where such efforts will be dictated by the rules of attribution discussed earlier. For example, where a company has a pulp and paper plant situated next to a solid wood processing facility, it would have an incentive (to posit perhaps a somewhat unrealistic example) to dedicate the power generated from all of its carbon-friendly fuels to the pulp and paper operation while substituting the portion of power generated from less carbon-friendly fuels to its other manufacturing operation. Alternatively, companies may consider creating subsidiaries (such as contracting out to satellite chipping operations) that could at least shelter some of the burden.

5.4 Uncertainty About Firm Costs Under DET

There are two ways in which firms' costs may change form the introduction of a DET (and a focus on emissions reductions in general). First, there are the direct constraints firms may face in meeting company or firm specific limits on emissions. Second, firms will face changes in the costs of inputs, such as power, as their suppliers have to meet their own targets. Implementation of the Kyoto Protocol may lead to circumstances under which the required reduction in emissions will be greater than that currently estimated. This may be because the gap was larger than projected (due to greater than expected economic growth), or that other measures to reduce emissions were unsuccessful (since part of Canada's plan involves the use of voluntary measures and an intention to seek credits for clean energy exports to the US, a position not supported by other countries (Baker and Mackenzie 2002).

In its original analysis the federal government assumed that C will have a value in the international market of \$10-50 / t CO_2 with an expectation it will be at the lower end. Within Canada, the government has recently made a commitment to cap the costs of compliance at \$15/t in order to provide more certainty for firms (although it has not provided details on how the cap will be implemented). Estimates of marginal abatement costs to reduce GHG in Canada have ranged from \$24/t upwards, depending upon the assumptions and model employed (AMG 2000).

In general, the more restrictive emissions limits, the higher the price of credits and other costs to the firm, include the cost of power. The FST in its analysis assumed that the price of power would stay constant and relative prices would not change; this is unlikely as emissions become more important in determining power outputs (for example, investments in future generating facilities). This is in contrast to other work undertaken under the NCCP; another group identified substantial increases in costs and abatement costs associated with implementing measures to reduce GHG emissions (AMG 2000). They showed fossil fuel costs rising significantly (and with substantial relative differences across different fuels). This will accentuate differences in costs across firms where there are differences in the level of energy use (as well as the source). In addition, if indirect emissions through purchased power are attributed to pulp and paper manufacturers, such firms will also find less C-friendly fuels more costly (since they count against their limit). Hirshorn (1999) notes that fuel and electricity costs for Canadian pulp and paper are high relative to other industrial sectors in the Canadian economy. These changes can also impact other sectors that supply the industry, such as chemical suppliers and transportation services; all of them will face cost increases that they will attempt to pass on to pulp and paper manufacturers.

These higher costs will also induce more investment in emissions-reducing technology as the economics of looking for opportunities within the firm for energy efficiency expand as the price of credits increases. Even if a firm has sufficient coverage, there is an inducement for additional investment since there is also an opportunity cost: a firm might be able to free up additional credits that it can sell. Given the government commitment, prices for credits would not exceed $15/t (since government either presumably pays the cost of additional costs to meet the emissions reduction or the firm pays a penalty based on excess emissions capped at $15/t).

At a lower price, these incentives are correspondingly diminished; however, the overall cost pressure will be reduced as well.

From company specific perspectives, each firm will look at the options open to it under the DET and offset trading system. Company B will evaluate its marginal abatement costs versus C_c in making its decisions. Company D will look at C_c to see whether sale of credits is sufficient to lead to a change in harvesting and the potential induced change in manufacturing so it will look at the opportunity cost of forgone product output. Company A will look at C_c to see whether sale of credits is sufficient to lead to a change in harvesting so their opportunity cost is the forgone sawlog/pulplog production.

From an international perspective, the price of credits will reflect the aggregate demand and supply among countries that ratify. Russia is expected to be a significant contributor of credits to the international marketplace; however, they have not yet ratified, and changes in their energy outputs may reduce their future supply. The two markets (IET and DET) may not necessarily be linked (it is up to each country to determine the rules which apply to which domestic entities can participate in the IET). Discussions within Canada have revealed a general unwillingness to rely on the purchase of credits under IET to meet its commitments although there is interest in the sale of credits. This creates two possibilities. First, if the international price is higher than \$15/t, then $C_w > C_c$ and the government will subsidize the difference and firms would not be interested in participating in purchasing credits in the international market (although they may sell if they are permitted to do so). Alternatively, if firms were prevented from purchasing credits in the international market and $C_c > C_w$, they would be incurring higher costs attributable to the difference.

5.5 Evidence from Existing C Markets

As noted earlier, a number of different C-markets have recently emerged or are in the process of being developed. These include voluntary schemes (as in the U.S.); national systems as in the U.K. and Denmark; Canada's proposed DET, and proposed international systems (as in the E.U.). All of these markets, which involve the purchase and sale of Emission Reductions (ER) permits, have to address issues of verification (what is required to certify the ER which involves the credibility and cost of validating the reduction) and when the ER can be credited (an important consideration where a project may involve sequestration over time). Evidence suggests that an increasing number of transactions within the markets that have been established to date involve ER generated by changes in energy practices, principally fuel switching, energy efficiency, and the use of biomass to replace fossil fuels (Lecoq and Capor 2002). This likely reflects the fact that GHG emissions reductions from these actions can be more easily verified (measurement and validation are simplified since changes in fuel consumption or the composition of fuel used are easier to ascertain) and the reductions occur immediately (as opposed to some C sequestration projects that may involve more uncertain estimates of C to be stored over some future span of time). These characteristics of ER associated with changes in energy practices are likely to place an increased emphasis upon fuel efficiency and fuel substitution to generate emissions, especially as Canada moves to implement its own DET. Prices within these markets have generally been low, but this has been attributed in part that many of these transactions reflect projects which have been undertaken for other reasons (environmental benefits or to meet other regulations) and that the sale of C credits was secondary to the project (Ball 2003). In general, the trend has been away from projects generating credits through the use of sinks (primarily under the CDM) (Lecoq and Capor 2002).

5.6 General Considerations

In general, a DET will favour large, well-capitalized companies, especially if the price of C is significant. Regional cost differences may be accentuated, especially if there are restrictions on trading across sectors or regions (since it will limit the availability of low-cost firms to reduce emissions and sell to others, regardless of sector or location). However, the impact on firms can be considerably different, depending upon their opportunity to generate credits for sale.

One issue that the industry faces it that it can lower its costs through achieving economies of scale. This typically means expanding the size of the plant. There is some scope for investing in new technology to reduce emissions; however, firms will have to consider where they may be able to secure the credits to cover expanded emissions in considering their investment decisions.

Finally, there is the regulatory risk to consider. Of all the measures announced to date under Step 1 and Step 2, the DET is the only policy currently under consideration that involves "hard" limits through the introduction of individual and aggregate limits on emissions from all industrial emitters. If the other "soft" measures (defined as voluntary) fail to achieve their targets (e.g. emissions increase or are not reduced to a sufficient degree), it is possible that the rules may be revised or new rules introduced. Given that many of the technologies under consideration to reduce emissions are long-lived, this risk increases the uncertainty firms face in making their investment decisions. Capping the cost at $15 per t will reduce the uncertainty for firms by providing an upper limit to their costs; at the same time, it reduces the amount to which firms will pursue emission reductions or engage in carbon sequestration and thereby increases the likelihood that emissions targets will not be met, raising the questions of whether Canada will be able to meet its commitments. Takahshi *et al*. 2001 noted that in general voluntary efforts by industry in general suggested that they would reduce emissions below 1990 levels by 1-2%, well below Canada's target of 6%.

6. IMPACT ON COMPETITIVENESS

6.1 Impacts on Domestic Timber Supply

Countries that ratify the Kyoto Protocol take on targets that will be achievable only through significant effort. Developing countries that do not have targets will not have to undertake the same efforts, at least in the first commitment period. If the decision is made to include FM in Canada's accounting, then maintenance of forest C stocks (i.e. reducing emissions due to harvesting or deforestation) will be of interest to governments as they seek ways to achieve Canada's target. The importance of maintaining C stocks will create an opportunity cost to harvesting. The magnitude of this opportunity cost will depend on how much of the FM cap can be filled through the business-as-usual FM sink. The opportunity cost of harvesting in Canada and other countries that ratify the Kyoto Protocol creates a potential for a reduction in harvest in industrialized countries and a corresponding increase in harvesting in developing countries, a possibility referred to as inter-annex market leakage (Niesten *et al*. 2002). There is also the possibility of leakage between industrialized countries, because of differences in the impact of the FM caps. While most industrialized countries have FM caps that are quite small, Canada's cap is relatively large. For most other industrialized countries, therefore, a reduction in emissions due to harvesting is likely to have no impact on how much of a FM sink they can claim in their accounting. Thus there will be no opportunity cost of harvesting in terms of carbon emissions, and in fact harvesting could increase.

In contrast, current estimates suggest that in Canada there may be an opportunity cost of harvesting. Current estimates for FM C stock changes suggest Canada will not fill its FM cap in a business-as-usual world, implying that any action that increases the sink will be of benefit to Canada. In terms of FM, the net sink can be increased through new actions that increase sequestration or through actions that reduce the emissions that would otherwise occur, such as a result of harvesting. In turn, this suggests that, at least in the period to the end of the first commitment period, a reduction in harvests in Canada could indeed be of value. This could provide opportunities for competitors in other countries, both industrialized and developing, to increase harvesting (in plantations or natural forests) and production of forest products, with corresponding impacts on the Canadian forest products sector.

However, there are important qualifiers to this concern. First, it must be noted that the current estimate for Canada's FM sink is quite uncertain so that the usefulness of reducing harvesting in order to contribute to Canada's Kyoto goals is not yet clear. Second, if harvesting in Canada were to be reduced as a result of C premiums the value of the C would at least in part offset the value of harvesting. Finally, rules for after the first commitment period have not yet been negotiated. In the future, under different rules, the opportunity cost faced by Canadian harvesting is likely to more generally faced by other countries, both developing and industrialized. This would be the case for example if developing countries accepted targets in the second commitment period and there were no caps on FM.

6.2 Impacts on Foreign Timber Supply

An important issue for Canada's forest companies is the effect of fast-growing industrial plantations in developing countries on global timber supply and the competitive implications for the Canadian sector. It is possible that afforestation and reforestation (A/R) projects established in developing countries, to obtain Certified Emission Reductions (CERs) under the CDM, will similarly affect global timber by adding an incentive for creation of industrial plantations. However, such fears are unfounded for a number of reasons relating to the rules surrounding the CDM. Negotiators are expected to agree on rules for A/R CDM projects until late 2003. However, existing rules for other project types indicate what the likely minimum requirements for A/R projects will be, and it is possible that A/R project rules will be somewhat more stringent.

Growth in industrial plantation area in developing countries has been significant and there is no reason to expect that that will stop. At present, the global rate of plantation development in developing countries is 4.3 million hectares per year, over 50% of this development occurs for industrial purposes and this proportion is growing (FAO 2001). However, to qualify for sequestration CERs, plantations in the CDM will have to be "additional" to this amount. In effect this means the only plantations that would qualify for the CDM will be those that would not have occurred in the absence of the CDM, a condition that could be hard to demonstrate (Chomitz 2002, Niles *et al.* 2002). CDM plantations will also have to demonstrate that there is no "leakage" – GHG emissions or reduction in sequestration outside the project boundary as a result of the project. If leakage does occur then estimates of net C sequestration would have to be reduced. Leakage could be a particular problem with industrial plantation development under the CDM because it could simply serve in large part to replace plantations that would have been developed elsewhere (Schwarze et al. 2002). The net effect of the projects would therefore be far less because of the foregone sequestration outside the projects.

Transaction costs associated with projects for the CDM will lower the attractiveness of undertaking "additional" commercial plantations in developing countries. There will be costs associated following CDM procedures; establishing the baseline, proving additionality and addressing leakage; analyzing environmental impacts; engaging in local and stakeholder consultation; measurement and monitoring C in vegetation and soil; implementing C risk management plans; and other costs not borne by non-CDM plantations.

These requirements and costs will serve to limit industrial plantation projects under the CDM although the interest in such projects will depend on the value of the C benefit relative to costs associated with involvement with CDM. Even where CDM project rules are satisfied, and the economics of an CDM industrial plantation project makes sense, the rules for CDM A/R projects will limit the total CERs that can be accounted in the first Kyoto commitment period. The limit is 1% of 1990 GHG emissions for each industrialized country, or a total of about 24 Mt C per year (excluding the US). This upper limit on A/R CERs for 2008-12 could be reached quickly. For example, the establishment of 400,000 ha of plantations in 2005 using fast-growing species with a peak MAI of about 25 m3/ha (this calculation is based on a growth curve not the MAI) would result in 24 Mt C per year in 2008-12. This crude estimate includes aboveground and belowground C. A peak MAI of 25 m3/ha is roughly typical for species commonly used in industrial plantations in developing countries (see the summary of plantation MAIs in FAO 2001).

Not all A/R projects will be for industrial purposes – forest restoration and agroforesty projects are likely - implying that the total area of industrial plantation under the CDM would be lower. On the other hand, only the net sequestration above the baseline for the plantations would be eligible for CERs implying that a greater area of industrial plantations would be needed to reach the upper limit. In any case, the area will be small compared to future industrial plantation development in the next decade. This implies that industrial plantation projects under the CDM in the next decade will have a negligible impact on global timber supply compared to the impact that plantation development outside the CDM will have. Whether there will be limits on A/R CERs in subsequent commitment periods will not be known for some time but it remains likely that the long-term effect of the CDM on the rate of industrial plantation establishment will not be significant.

6.3 The Impact of Kyoto on Firm Competitiveness

Jaccard and Montgomery (1996) survey a number of different models that estimate the cost to reduce GHG emissions in Canada and the U.S. They note that "bottom-up" models, which are based on improvements in energy efficiency and changes in energy use, predict that a significant amount of emission reduction can be achieved at a net savings (as suggested by the options in Table 5), while "top-down" reports involving macro-economic modelling suggests that there can be significant economic costs associated with meeting stricter environmental regulations.

There have been several reports written about the impact of Kyoto on the general competitiveness of Canadian firms. One set of reports suggest that there are economic benefits from engaging in Kyoto, even without taking into account any of the environmental co-benefits associated with reducing pollution associated with a reduction in fossil fuel use (see, for example, Boustie *et al*. 2002 and Tellus Institute and MRG & Associates 2002). Generally, these reports adopt the "bottoms-up" perspective that there are large potential gains from investment in energy efficiency (the increased capital cost is offset by energy savings) and make the general argument (first advocated by Porter) that stricter environmental regulation can induce innovation and create a competitive advantage for firms. The Analysis and Modeling Group (AMG) conducted a macroeconomic analysis on the economic impact of adopting Kyoto, using both macroeconomic models as well as models that incorporated changes in energy use (AMG 2000). The two energy use models suggested that there would be little change in forest sector output, while the macroeconomic model suggested that the pulp and paper sector would be significantly impacted through higher mitigation costs.

Hirshorn (1999) provides a framework for examining the impact of GHG-reduction policies on industrial competitiveness. In addition to the direct cost impacts, he notes that policies that affect industry productivity, along with the degree of foreign competition and competitiveness of markets, will determine the affect to which firm competitiveness' is affected. He also suggests that, unless there are strong location specific advantages associated with producing in Canada, perceived negative impacts on competitiveness can lead to a reduction in future investments.

6.3.1 Export Orientation of the Forest Products Industry

The Canadian industry is highly export reliant (see Table 4) with two commodity products-market pulp and newsprint-accounting for 88% of the value of all pulp and paper exports ($9.9 billion and $95. billion respectively in 2000). We do not review solid wood products at this time as they are not included under the proposed DET system and therefore, impacts (at least initially) will be negligible.

Table 6 shows the destination of those exports, where the U.S. is the largest market. Therefore, changes in the relative competitiveness or access to these markets will be critical to the impact of Kyoto on Canadian firms.

Table 6. Distribution of Canadian Pulp and Paper Exports by Product and Destination (measured as % of value of all exports)

	Market Pulp	Newsprint	Other Paper	Paperboard
US	41.4	84.5	90.3	80.6
EU 15	25.6	4.9	1.7	5.9
Japan	11.0	2.2	0.5	0.5
Non-Annex B	20.9	8.3	7.4	12.9
Other Annex B	1.2	0.3	0.1	0.1

Source: Table 5, Industry Canada 2002

Below we review the implications if the U.S. does not participate in Kyoto (as it has currently indicated), and whether participation in Kyoto might create differential access to export markets for countries that have ratified versus those that have not.

6.3.2 The Impact of US Non-Ratification

It was anticipated that the U.S. (as seen in Table 1) would have had the largest gap to close in reducing GHG emissions, which was seen as mitigating competitiveness concerns for Canadian participation. Given the recent U.S. position, non-ratification means that the Canadian industry will be assuming higher costs-what are the impacts likely to be? Table 7 shows the apparent supply of pulp and paper products to the U.S. in 1999 (apparent supply because it ignores inventory changes).

Table 7. Apparent Supply to US Market in 1999 (US$ billions)

Market Pulp	Newsprint	Other Paper	Paperboard
5.6	10.1	44.4	21.2

Source: Table 6, Industry Canada 2002

Canadian exports are concentrated in market pulp and newsprint. Within the U.S. market, Canada is the second largest supplier of market pulp and the largest supplier of newsprint (see Table 8). The U.S. is largely self-sufficient in terms of other paper and paperboard; it meets over half of its domestic needs for pulp and nearly half of its newsprint needs.

Alternative suppliers (with the exception of Brazil for market pulp) have a small presence in the market. The industry has been characterized by excess capacity for several years, especially in the pulp business; therefore, one would expect that in the commodity business any significant increases in costs would directly translate into reductions in Canadian market share in the U.S. market. The problem is somewhat mitigated for newsprint manufacturers; their large share of the U.S. market may mean that some of the cost increases can be passed on to customers (since the supply curve may be more inelastic). In the long run, firms may seek to invest their capital in the U.S. given that it is the largest market and that they will face fewer restrictions.

The competitiveness of other suppliers will be conditioned in part by their participation in Kyoto (e.g. Brazil and non-Annex B countries are not subject to Kyoto rules); other Annex B countries can be expected to grapple with cost issues, but again Canada has the largest gap (Table 1) so that Canadian producers may face more stringent restrictions. Hirshorn (1999) notes that Scandinavians make greater use of renewable energy in their forest products sector that may give them a short-term cost advantage but that the Canadian sector may have the potential to increase its use of renewable energy in the long-run, thereby offsetting that advantage.

Table 8. US Sources of Pulp and Paper Products (measured in % share of apparent supply)

Source	Market Pulp	Newsprint	Other Paper	Paperboard
US	55.1	46.9	96.9	97.5
Canada	37.1	47.6	2.5	1.7
EU 15	0.7	2.8	0.3	0.3
Brazil	5.9	-	-	0.1
Other non-Annex B	0.9	1.1	0.2	0.3
Annex B	0.3	1.4	-	-

Source: Table 6, Industry Canada 2002

There is clearly an incentive for firms to try and win greater share of the two larger markets in the U.S.-other paper and paperboard (interestingly enough paperboard is more GHG intensive). This is consistent with a more value-added strategy that has long been advocated for Canadian forest product firms (see Industry Canada's Sector Competitiveness Framework Reports on the industry).

6.3.3 Uncertainty About Trade Rules

Finally, we consider the impact if the introduction of the Kyoto Protocol leads to trade rules that create differential access to markets (e.g. restricting imports from countries that do not participate). This may arise for several reasons. First, there are initiatives to build in trade sanctions intro Kyoto directly. Second, countries that do ratify and assume higher costs to implement measures to reduce emissions are unlikely to view non-ratification favourably; U.S. non-ratification may therefore lead to trade measures (e.g. border tax adjustments or tariffs) that attempt to equalize any perceived cost advantages firms within countries gain from non-ratification. Concerns have been raised about this possibility although the likelihood of such moves appears low at this time (USCIB 2002).

If such trade rules did arise, would Canada benefit from an improved competitive position in other markets? Canada's other significant export markets are principally the EU and Japan. Table 9 shows the import share for the EU and Japan where the U.S. has a significant share of market pulp in those two markets. If there are trade restrictions, this would potentially broaden the scope of those markets for Canadian producers. However, this depends upon their ability to gain share against other producers-Scandinavian countries and Non-Annex B countries such as Brazil that have been in general expanding their production; at the same time, any redirection of U.S. exports back into the U.S. market will increase the competitive pressure on all pulp and paper firms competing in that market, potentially further displacing Canadian pulp.

Table 9. Import Sources of Market Pulp and Newsprint in the EU and Japan from Different Countries (% share)

	EU		Japan	
Source	Market Pulp	Newsprint	Market Pulp	Newsprint
Canada	31.0	n.a.	43.3	n.a.
US	24.6	n.a.	28.7	n.a.
Non-Annex B	31.6	n.a.	20.9	n.a.
Annex B	12.9	n.a.	7.1	n.a.

Source: Industry Canada 2002

In general, Canadian pulp and paper manufacturing firms are highly exposed to foreign competition in markets that, for the most part, are commodity markets. Increased costs will require greater investments in technologies that not only help reduce emissions but also increase productivity.

7. **CONCLUSIONS**

Climate change mitigation cannot be achieved without GHG emission reductions, which in turn cannot be achieved without reduction in energy use, and fuel switching to low-emission or no-emission energy sources. Governments will implement policies to foster these changes. There will be differential cost competitiveness implications across sub-sectors within the forest sector, and across mills within each sub-sector. We first review the major ways in which Kyoto can affect forest product firms that we discussed in this paper.

7.1 Impacts of Kyoto

First, Kyoto will directly impact firms through the regulation of emissions and emissions trading. Forest sector firms will have to pay attention to new variables in their business and investment decisions. Trading and other rules could create a potentially complex situation for many companies in the forest sector. The DET proposed by the federal government would only cover a portion of the company – the large energy intensive pulp and paper mills. The role of other parts of the company in reducing emissions or sequestering C, and how such efforts would figure in the trading system, create new strategic issues for company managers as they allocate capital investments across the company.

Second, we are likely to see changes in forest management policies and forest practices that have implications for the availability and cost of timber. C stock maintenance (reduction in emission of forest carbon) and C sequestration will be of great interest to governments. Where or not companies see any value from management to forest C depends upon how governments craft their strategies (and who claims the credits for changes in such activities). Regardless of who receives the credit, we would expect to see, over the medium to long term the following directions in Canadian forest management. These include less harvesting in natural forests and a shift in fibre supply sources – greater protection of natural forests accompanied by more creation and reliance on plantations. This means less extensive forestry and more intensive forestry that could (at least in the short term) reduce the availability of timber and/or increase the cost of timber. We are likely to see more harvesting practices that lower C impacts (e.g. more winter logging to reduce soil C impacts). There may be other changes in the extent and type of silvicultural practices, with the changes varying according to regional and local conditions. There will be more emphasis on the use of waste from harvesting (but balanced by environmental considerations for leaving C in the ecosystem) and production of biomass to generate power.

In terms of C markets, firms are unlikely to realize values significantly high enough to engage in sink activities, especially with a cap that will limit the price of permits in the domestic market. Instead, activities that the firms is undertaking for other reasons-variable retention to promote biodiversity –may yield C credits that help enhance the financial aspects of such activities.

Third, Kyoto can change the scope and nature of markets in which Canadian firms compete. The changes induced by Kyoto here are inherently more speculative since they involve the impact on the competitiveness of Canadian firms in foreign markets (which depend in part upon the policies adopted by other countries), rules yet to be developed under the Kyoto framework, and finally how the trade regime may evolve in response to circumstances where the two largest consumers and suppliers of forest products in the world-Europe and the U.S.-take opposite approaches to Kyoto. Clearly, however, Kyoto will lead to increased costs for firms and and sharpen the focus on productivity-enhancing investments.

Finally, all of these potential changes create uncertainty for firms; uncertainty associated with the regulatory framework and the outcomes it will produce for individual firms; the uncertainty associated the regional impact over such critical variables over timber availability and energy costs; and uncertainty over the long-run competitiveness of the industry in export markets.

7.2 Firm Strategies

We now turn to the ways in which forest sector firms can respond to the changes induced by Kyoto and the uncertainty it creates. We can summarize the strategies they can adopt that we have discussed into three major approaches. First, they can alter their product mix. Second, they can change where they produce the good. Finally, they can utilize technology. We briefly review these strategies below.

Firms will consider shifts in product mix toward greater emphasis on products that require less energy. This could imply for example, more emphasis on wood products as opposed to energy intensive pulp and paper products. Firms are also likely to place greater emphasis on exploring the use of biomass for power generation. Forest sector firms also have the option of reducing production or engaging in forestry activities (through promoting greater tree growth) to create marketable carbon credits that become part of the “product mix” of the firm.

Companies may also consider shifting manufacturing operations toward regions of the country where energy supplies are less carbon intensive, although the requirements of a fibre supply will mitigate that trend somewhat (although the location of particular processing activities may change) In addition, companies may also consider investing abroad where they will not be subject to such restrictions.

Firms can also look for technological solutions. First, the increased emphasis on fuel efficiency will favour newer firms that already have an advantage because of the capital intensive nature of the business. It will also lead to greater priority assigned to energy-related investments. This could be manifested in several major ways. We will see shifts in production technologies toward low-energy or low emission machinery and equipment. Firms will first seek those opportunities that offer greater energy efficiency that offer the benefit of reduced fuel costs and GHG emissions. There may also be opportunities to develop new technologies and to market those technologies, although this is less likely. Canadian R&D in the forest sector is generally low, reflecting the small size of firms relative to their global competitors, and the nature of the industry is such that technological innovation is quickly imitated so that firms are unlikely to be able to privately capture the benefits of their investments thereby reducing their incentive to invest. Given their low R&D, an increased emphasis on investment required to meet environmental regulation will likely put Canadian firms more at a disadvantage to their peers, contrary to the idea that it will induce innovation.

Many of these steps require decisions over potentially long-lived investment. Increased uncertainty reduces the willingness of firms to undertake investments, and firms have an incentive to drive costs down to remain a low cost producer in the presence of such uncertainty (to try and be at the bottom of the cost curve). A trading system, while it may initially engender uncertainty, can offer firms a great deal of flexibility in cost-effectively reducing emissions; the incorporation of a cap can also reduce some of the uncertainty associated with such a system.

All of the changes suggested above are of course speculative and would occur within the context of a broad range of influences on forest company operations and decision-making. Nevertheless, forest companies need to consider how changes of the sort discussed could impact on their operations, and adjust proactively.

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