A Value Chain Assessment of Climate Change and Energy Issues Affecting the Global Forest-Based Industry

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Introduction:

Concerns about global climate change confront the forest products industry with a variety of challenges. Forest products companies are striving to respond in ways that comply with national requirements consistent with long-term corporate and industry sustainability goals. In this discussion paper, we examine the key environmental and energy aspects of the climate change issue from the perspective of the forest-based industry value chain.

Addressing the climate change issue from different perspectives

The climate change issue has the potential to impact the forest-based industry in a variety of ways. The impacts are being defined and distributed by policies that must address critical issues like additionality, leakage, permanence and ownership of emissions or credits. These issues are resolved differently in different political and cultural settings and how they are resolved will determine the impacts on individual companies and nations.

This discussion paper attempts to examine the climate change issue from a different perspective – the perspective of the forest-based industry value chain. The value chain encompasses many nations and corporations. From the perspective of the value chain, it is relatively unimportant how impacts are distributed among the nations and companies that comprise it. As a result, value chain assessments do not have to address many of the difficult policy decisions that determine how impacts are distributed.

The value chain perspective is important because it offers insights that would not surface in studies focused on corporate assets, national boundaries, or particular climate change policy frameworks. A value chain view of the forest-based industry can reveal response strategies that enhance the sustainability of the entire value chain and the companies and nations that comprise it. It also provides an opportunity to find policy positions that can be supported by the industry and its important stakeholders.

Elements of the climate change issue along the forest products value chain

The industry’s important connections to the climate change issue can be divided into six categories.

- Sequestration of atmospheric carbon in forests and products
- Biomass as a substitute for fossil fuels
- Manufacturing emissions of greenhouse gases (GHGs)
- Combined heat and power
- Value chain emissions of GHGs (including those attributable to electricity consumption, transportation and forest products recycling)
- Choices between products based on GHG-intensity and climate concerns (substitution effects)

In the following material each of these elements is briefly explored.
Sequestration of atmospheric carbon in forests and products

Background:

An enormous amount of carbon is stored in forests and forest soils - more than 1,100 Gt (gigaton) divided between forest vegetation (approximately 350 Gt) and forest soils (approximately 800 Gt). The atmosphere contains about 800 Gt of carbon and the oceans contain almost 40,000 Gt. Carbon in tropical forests, is evenly distributed between vegetation and soils while in temperate and boreal forests, soils generally contain more carbon than the vegetation (IPCC 2000).

Compared to forests, the amount of carbon stored in forest products (harvested wood products, HWP in IPCC terminology) is relatively small and varies among countries. There is approximately twenty times as much carbon in U.S. forests as in U.S. HWP (USEPA 2003). In Finland and Canada, there is more than a hundred times more carbon in forests than in the domestic stock of HWP (Apps 1999, Pingoud 1996). Carbon stocks in forest products are important, however, because they are growing and are expected to continue to grow (IPCC 1998). More carbon is added to the forest products pool every year than is lost (i.e. returned to the atmosphere) (Winjum 1998, IPCC 2003b). The additions to the forest products carbon pool continue to be greater than the losses for two main reasons. First, the carbon in many forest products remains sequestered from the atmosphere for long periods of time. Second, on a global basis, the demand for forest products is growing so that inputs to the forest products carbon pool are increasing year over year.

When the carbon stocks in forests and HWP increase, carbon is removed from the atmosphere and when they decrease, carbon is released to the atmosphere. The balance between additions and losses of stocks of forest carbon varies at different places on the globe. Stocks of carbon in mid- and upper-latitude forests are growing. Stocks of carbon in tropical forests appear to be decreasing, primarily due to deforestation, but there is significant uncertainty in these estimates. Globally, the stocks of forest carbon are thought to be declining, but this will remain uncertain until the estimates for tropical forests are improved (IPCC 1996, 2000). Attempts to develop a global carbon budget suggest that terrestrial uptake of carbon, including forests, is in the range of –0.3 to +1.7 Gt/y. This can be compared to global emissions of carbon equal to 6.3 Gt/y (IPCC 2000).

Removals of atmospheric carbon due to growth in the HWP pool have been estimated to be from 0.026 to 0.139 Gt/y (Winjum 1998, IPCC 2003b). These are small compared to the changes in forest carbon stocks, but large enough to be important to national carbon budgets. From the standpoint of the forest-based industry value chain, these removals are enormous. The growth of the HWP pool is of the same general magnitude as the manufacturing emissions of GHGs from the global forest-based industry, which are estimated to be approximately 0.072 Gt/y (derived later in this paper).

Issues for the forest products industry:

- The productivity-sequestration connection – Today’s managed forests are far more productive than those of several decades ago, and continued improvements in productivity are expected within the framework of sustainable forest management. This will allow the forest-based industry to produce more fiber on a given amount of land and allow for expanded production in the forest-based industry. In addition, increased forest productivity will enable more economical production of carbon-sequestering products. While there are carbon sequestration benefits associated with increased productivity, many of these benefits will occur in parts of the value chain that are not owned by the industry.
• Risks of focusing only on carbon in standing forests – The industry is concerned about the possibility that interest in carbon sequestration will be limited to increasing carbon in standing forests. This may turn out to be ineffective, due to so-called “leakage effects,” and even counterproductive. To the extent that harvest restrictions increase wood prices and reduce wood availability, some of the demand for wood products will be shifted to non-wood substitutes that are, in many cases, more carbon intensive on a life cycle basis. Finally, it is understood that forest sequestration benefits may “saturate” more rapidly than the forest-products-related sequestration benefits further down the value chain.

• Estimating sequestration in the forest products value chain – It is easy to spend more money measuring forest carbon than the carbon is worth. Forest inventory systems are usually focused on the merchantable fraction of the wood and incorporate sampling frequencies and locations that were not intended to generate estimates of forest carbon. Current inventory systems do not generate estimates of carbon in forest soils, a compartment that usually contains a substantial proportion of the carbon. The challenge is to build on the current inventory systems and knowledge base in a way that allows credible and transparent estimates of forest carbon at reasonable cost. At some point it will be necessary to sacrifice a certain amount of site-specific accuracy so that estimates can be developed that are consistent and transparent.

The carbon sequestered in HWP in-use is important to the GHG profile of the forest-based industry value chain. It is unlikely that individual companies or industry sectors will be able to apply national inventory methods to characterize HWP carbon sequestration because national inventory methods are very sensitive to historical production. An alternative for estimating HWP sequestration in products in-use is now being discussed internationally for examining corporate and value chain sequestration. It is based on forecasts of the amount of carbon in current production that will remain sequestered for 100 years. The value chain carbon sequestration benefits of HWP are clear but it remains to be determined whether current estimates of sequestration are sufficiently accurate for some purposes (e.g. carbon trading). For HWP carbon, as for forest carbon, it will probably be necessary to sacrifice a certain amount of site-specific accuracy so that estimates can be developed that are consistent and transparent.

For the forest-based industry to gain wide acceptance of the carbon benefits of its value chain, there is a need for the industry to develop and promote consensus methods for biomass carbon measurement, accounting and reporting.

• Carbon accounting issues – The difference between a national and a value chain view of the forest products industry is most obvious in carbon accounting. The approaches used for national-level accounting under the Kyoto Protocol are fundamentally inappropriate for value chain accounting because they are not based on comprehensive carbon accounting. The methods used to prepare national inventories under the UNFCCC do not suffer many of the constraints to comprehensive carbon accounting imposed under the Kyoto Protocol, but they do not consider important aspects and linkages within the forest and forest products sector.

International discussions have focused on two basic approaches for biomass carbon accounting - stock accounting and atmospheric flow accounting. A consensus has developed within the global forest products industry that biomass carbon accounting should be comprehensive in scope and based on stock accounting principles (CEPI et. al. 2000). This consensus is attributable to three considerations. First stock accounting recognizes the important beneficial role of renewable biomass fuels in greenhouse gas management – i.e. in stock accounting, biomass fuels must have a CO₂ emissions factor of zero to avoid double counting. In contrast, flow accounting makes no fundamental distinction between the CO₂ emissions from burning fossil fuels and biomass fuels.
Second, stock accounting acknowledges the importance of carbon sequestered in forest products. Third, stock accounting better reflects the climate attributes of the value chain as a whole and these attributes work to the advantage of all companies that are part of the forest products value chain.

- Allocating biomass carbon benefits and risks along the value chain – Although the forest products value chain is clearly part of the solution to rising levels of atmospheric CO₂, the advantages of being in the business of managing sequestered atmospheric carbon will be distributed unevenly along the forest products value chain. The distribution of these advantages will be determined through political negotiation, with implications for both national and corporate accounting. Value chain accounting can help provide a factual basis for negotiations, but does not determine the solutions. Examples of key allocation issues include: (a) equitable treatment in national accounting of stock changes associated with imports and exports of HWP; and (b) development of carbon credit and trading schemes that recognize, measure and allocate the benefits and risks of carbon sequestration and biomass energy along the forest products value chain.

- Managing for multiple objectives - The forest products industry is adept at managing forestland to protect and enhance multiple forest values while increasing wood production. Companies develop optimized management strategies that address the value of the harvested wood and the need to protect wildlife habitat and other conservation areas while meeting various clear cut size, adjacency and “green-up” requirements. If the value of carbon is known, this can also be incorporated into the optimization analysis.

- Carbon as an integral part of sustainable forestry and corporate sustainability – The concerns about climate change do not exist in a vacuum. The industry has an opportunity to showcase the attributes of the forest value chain in the context of sustainable forestry and corporate sustainability. The benefits of the forest products value chain to climate considerations, expanded employment opportunities (especially in rural communities) and improved corporate financial performance also fit nicely within the framework of corporate sustainability.

Biomass energy as a substitute for fossil fuels

Background:

When fossil fuels are burned, the transfer of carbon from geologic storage into the biosphere is permanent. As a result, when biomass is used instead of fossil fuel, the avoided fossil fuel CO₂ emissions are considered permanent benefits to the atmosphere. Studies of the global carbon cycle often identify biomass energy as being among the most important potential benefits associated with the forest industry value chain (IPCC 2000).

Approximately 11% of world’s total primary energy requirements are met with biomass. In the developed countries, most biomass is burned to generate steam and electricity while in the developing world, the majority of biomass is used for cooking and heating. Africa uses about one-quarter of the world’s biomass to provide one-half of the continent’s energy. Among OECD countries, biomass represents about 3% of the primary energy requirements. Global biomass energy use in the last decade grew at 1.5% per year while total energy demand grew at a rate of 1.4% per year. The global technical potential for biomass energy production has been estimated to be as much today’s total energy demand (IEA 2003a, IEA 2003b, IPCC 2001). The forest products industry derives a greater fraction of its energy requirements from biomass than any other (OECD/IEA 1999 and 2003).

The forest-based industry may be positioned to participate in the development of additional supplies of biomass energy. The industry is at the center of the infrastructure needed to sustainably produce forest-
based biomass, collect and transport virgin and recovered fiber, and to produce both useful products and renewable energy.

Issues for the forest products industry:

• Competition for wood fiber and recovered fiber – One of the key challenges for the forest products industry will be maintaining access to affordable wood and recovered fiber supplies in the face of competition for these materials as biomass fuels. The industry and its stakeholders will need to respond to a number of issues to meet this challenge. These include;
  – market-distorting public policies that disproportionately favor the use of these materials for their fuel value,
  – public policies that fail to recognize the direct and indirect economic and social benefits associated with using biomass as a feedstock for forest products manufacturing, and
  – unintended substitution effects – i.e. the possibility that higher raw material costs might cause forest-based products to become less competitive vis-a-vis alternatives that are more carbon intensive.

• Opportunities to develop forest crops and increase paper recovery to meet the increased demand for wood products and biomass energy – Increased demand for fiber as a source of biomass energy may provide incentives to increase biomass production and help justify investments in improved forest productivity. These would help counteract the effects of competition for biomass for energy. Although the direct benefits of increased forest productivity would tend to accrue to forest owners, the overall climate profile of the forest based industry value chain would be improved by these investments. It may be possible to use the interest in biomass energy to promote policies that expand the scope of paper, paperboard, and wood products recovery programs. However, in many cases recovery rates are already reaching practical maximums, so it is unlikely that recovery rates for many grades would increase adequately to compensate for competition resulting from policies that disproportionately favor the burning of used forest products for energy.

• New technologies to more efficiently convert biomass into usable energy
  – Increasing the heat value of biomass by higher dry solids content
  – The potential uses for biomass would be expanded if cost effective methods were available to produce gaseous or liquid wood-derived fuels that could be burned in equipment designed for fossil fuels.

• Increased use of forest residues – One clear opportunity for increasing supplies of biomass fuels is to recover more material from the forest during harvesting. There may be long-term implications to nutrient balances in the forest that will need to be addressed. The return of wood ash to the forest would appear to be one means of addressing this issue.

• Access to markets for excess biomass energy – With current technologies, the industry often has the technical capability to generate more biomass-derived electricity (usually in highly efficient CHP systems) than it now produces. In many countries, the gap between current practice and technical potential is due to market and regulatory barriers to generation and export of electricity. The removal of these barriers is critical to optimizing the GHG benefits of the forest industry value chain.
Manufacturing emissions of greenhouse gases (GHGs)

Background:

The forest products industry uses fossil fuels that generate GHGs when burned. Based on information from industry associations and government agencies, it can be estimated that the direct GHG emissions\(^1\) from the pulp and paper industry in Australia, Canada, the EU (plus Norway and Switzerland), Japan, and the United States total approximately 41 million tons of carbon (APIC 2003, FPAC 2002, CEPI 2002, JPA 2003, EIA 2001). FAO statistics indicate that these regions produce approximately 63% of the paper and paperboard in the world (FAO 2003). This suggests that the GHG emissions from the global pulp, paper and paperboard industry are approximately 65 million metric tons of carbon.

GHG Emissions from wood products manufacturing in OECD countries are approximately 5 million tons of carbon per year\(^2\). FAO statistics indicate that the OECD produces about 70% of the sawn wood and wood panels, suggesting that global GHG emissions from wood products plants are approximately 7 million tons of carbon per year (OECD/IEA 1999 and 2003, FAO 2003).

In total, the direct GHG emissions from the forest-based industries are approximately 72 million tons of carbon per year. This is approximately one percent of global GHG emissions (IPCC 2001).

Issues for the forest products industry:

- The industry has opportunities to reduce manufacturing emissions through improved efficiencies – The energy required to produce forest products has been reduced significantly in recent decades (ICFPA 2002). In some cases, there are opportunities to make additional improvements that will further reduce emissions of GHGs but many of these are not currently economical. The forest products industry will be able to pursue more of these opportunities if policies are developed that provide incentives to continue to improve operational efficiencies.

- Because the forest products industry is energy intensive, energy prices have an important effect on the industry - Higher energy costs resulting from national GHG reduction requirements present a challenge to all industries, especially energy-intensive industries and industries operating in competitive international markets. The structure and scope of GHG policies will determine the impacts of higher energy prices on the forest-based industry.

- Recycling mills have different opportunities than virgin fiber mills – In most cases, recycling mills have less opportunity to use biomass fuels. The GHG profiles of virgin and recycled production are very grade- and mill-specific and it is unwise to generalize about the relative GHG benefits of recycled vs. virgin paper and paperboard. In addition, environmental profiles consist of more than carbon emissions. Recycling and virgin production have different environmental profiles, making direct comparisons of environmental “friendliness” difficult and controversial.

- Forest products manufacturing is highly capital intensive - As the industry continues to modernize its manufacturing operations, its GHG emissions intensity will improve, but the required investments must be made without distorting the normal turnover of existing capital.

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\(^1\) Direct emissions do not include emissions associated with purchased electricity.

\(^2\) Wood product manufacturing emissions have been estimated from OECD/IEA statistics, which exclude fuels used to produce electricity. Unlike pulp, paper, and paperboard mills, however, few wood products facilities produce electrical power from fossil fuels.
Combined heat and power

Background:

When steam is used to produce electrical power and then used to provide heat to a manufacturing operation or district heating system, far more usable energy is obtained from the fuel than is possible when producing only electrical power. As a result, combined heat and power (CHP) systems are more efficient and less carbon intensive than conventional fossil fuel systems for generating electricity. Moreover, in the forest products industry, much of the fuel is biomass, and CHP systems help extract the maximum usable energy from this carbon-neutral energy source.

The pulp and paper industry is among the world’s leaders in the production of combined heat and power. Opportunities exist for the industry to greatly expand its use of CHP and generate enough power to export to the grid.

Issues for the forest products industry:

• Regulatory and market barriers – An array of regulatory and market barriers exist in many jurisdictions that discourage mills from taking fullest advantage of combined heat and power opportunities, especially where they involve the export of electrical power to the grid. The removal of these barriers would to improve the GHG benefits of the forest industry value chain.

Value chain emissions of GHGs

A variety of upstream and downstream GHG emissions occur that can be important to the overall climate profile of forest products. Non-manufacturing value chain emissions are often outside of the control of the forest products industry. None-the-less, there are certain emissions that the industry probably needs to understand to adequately address the climate change issue.

Issues for the forest products industry:

• Emissions from the forest - “Natural” forests are considered by IPCC to be sources of N₂O and sinks for CH₄ (IPCC 2003a). Forest management activities affect the net emissions of GHGs from forests. Fertilizers, for instance, may increase N₂O emissions and reduce the uptake of CH₄ (IPCC 2003a). Available information suggests these effects are small compared to the improved carbon sequestration but better information is needed to define the effects of these and other forest management alternatives.

• Transportation emissions - Transportation emissions along the forest products value chain can be significant. A life cycle study of paper in the US suggests that raw material transportation emissions of GHGs may be in the range of 5 to 15% of manufacturing emissions (Paper Task Force 2002). Another study estimated that wood transportation accounts for more than half of the forest product industry’s fossil fuel consumption in Canada (Apps 1999). Product distribution emissions may also be significant. For mills that use little fossil fuel (e.g. modern market pulp mills and many wood product operations) the GHG emissions associated with transportation can be a significant fraction of total value chain emissions.

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3 In part, this is because wood products mills, which consume very little fossil fuel, are responsible for 2/3 of output from the Canadian forest products industry (FPAC 2003).
• Emissions from purchased power - The industry’s value chain includes indirect emissions from purchased power, which may be a significant component of value chain emissions. For the pulp and paper industry in Europe, emissions associated with purchased power are approximately 30% less than the industry’s direct emissions (from data in CEPI 2002 and PWC 2002). In the United States, they are about 40% less than direct emissions (EIA 2001). In the wood products sector, these indirect emissions may exceed the direct emissions from manufacturing facilities, although they are still less than the emissions attributable to electricity purchases by pulp and paper mills (for instance, see EIA 1994).

• Emissions associated with non-wood raw materials – Forest products companies often use chemicals, additives, coatings and other materials. GHGs may be emitted in manufacturing these materials. In most cases, these emissions are very small compared to the direct emissions from the mills because only small amounts of these materials are used and few of them are energy-intensive to produce. The non-wood raw materials with the largest impact on the industry’s indirect GHG emissions are probably chemicals for pulp bleaching that require large amounts of energy to produce.

• Emissions from product reuse or disposal - End-of-life emissions are an important part of the value chain GHG profile for forest products. Used forest products can be managed in a variety of ways and the emissions implications are variable depending on the management option selected and the type of forest product.

Forest products deposited in landfills decompose over time, releasing climate-neutral CO₂ and methane (which is not climate-neutral). Current data suggest that wood products (e.g. lumber and wood panels) and lignin-containing or coated paper and paperboard products degrade very slowly (USEPA 2002, Gardner 2002). Increasingly, OECD countries are directing organic wastes away from landfills. This has the advantage of reducing landfill methane emissions. Where organic waste is burned for energy, there is a benefit from displacing fossil fuels and avoiding the related GHG emissions.

In the future, bioenergy from landfill methane and organic waste combustion may become a clear benefit of the forest products value chain.

The role of recycling is complex and difficult to quantify. The effects of recycling on the industry’s value chain climate profile are highly dependent on the types of products being recycled and a variety of site-specific factors. Recycling reduces flows of organic material to landfills, thereby reducing both landfill methane emissions and landfill carbon sequestration. As a result of increased recycling, carbon sequestration in the forest is expected to increase as incremental demand for fiber is satisfied with a greater proportion of recovered fiber, but the amount of additional sequestration in the forest is very difficult to quantify. It is clear that some of the potential forest sequestration is lost via leakage attributable to a number of factors including increased conversion of forest to non-forest land. While it is clear that there is less than a ton of carbon saved in the forest for each ton of carbon recycled, the magnitude of this leakage remains uncertain, albeit too important to ignore. In examining the role of recycling it is also important to consider the emissions profiles of the manufacturing operations. The differences in emissions are highly dependent on the types of products being manufactured. Fossil fuels are used to collect and transport fiber to both virgin and recycling mills with the quantities and types of fuels being highly dependent on a number of local, regional, and national factors.

**Choices between products based on GHG-intensity and climate concerns (substitution effects)**

**Background:**
GHG emissions are reduced when a product that is less carbon intensive replaces one that is more carbon intensive. The benefits, like those of burning biomass, are generally considered to be permanent and as a result, these positive substitutions represent some of the most important opportunities for controlling the increase in atmospheric CO₂ via the forest products value chain.

Some forest products, especially building products, have been examined in numerous life cycle studies wherein they are compared to alternative products, usually in terms of life cycle energy requirements but often also in terms of life cycle GHG emissions. A number of studies have found the life cycle energy and GHG profiles of wood-based building materials to be superior to steel, brick, and concrete alternatives. These studies have addressed a range of geographical and cultural settings including Australia (Glover 2002), Canada (Trusty 1999), Europe (Scharai-Rad 2002), and the United States (CORRIM 2002). The relative life cycle advantages of wood-based materials are affected by the use of forest residuals and end-of-life management practices (Borjesson 2000).

Issues for the forest products industry:

- Policy makers and the public need to better appreciate the substitution effects involving the forest products value chain - Although many studies have been performed, it is fair to ask whether they have affected purchasing decisions or public policy. This lack of practical impact may be due in part to the cynicism that has developed about the manipulation of life cycle studies to generate a predetermined result. It may also reflect the lack of consistency between the studies in terms of the analytical frameworks used, the boundaries of the studies, and the geographical and political scopes of the analyses.

- Opportunities for improving the understanding of substitution effects – The relative lack of practical impact of past work may reveal a need to perform a meta-analysis of these studies – one that attempts to identify the common and robust findings from all of the past work in this area internationally. This would help the industry develop a more effective message on the GHG benefits of products from the forest industry value chain.

- Dealing with ambiguous results – When the environmental profiles of products are compared, they are usually compared with respect to a variety of different environmental metrics. In most cases, these comparisons show that the products have profiles that are difficult to compare. While products from the forest industry value chain may generally have superior carbon balance attributes (for instance, see Glover 2002, Trusty 1999, Scharai-Rad 2002, CORRIM 2002, IPCC 2000) they will not necessarily be superior in all environmental attributes. This is an outcome the industry needs to anticipate as it works to gain recognition for the carbon benefits of forest-based products.

- New biobased products from the forest – The forest industry has infrastructure in place to serve as the platform to support the manufacture of new biobased products to substitute for more carbon intensive alternatives. At some time in the future, we may see pulp mills that reside at the center of bio-refineries, producing a range of bio-based products that serve the needs of a less carbon intensive world.

Closing observations

The physical connections between the forest industry value chain and the atmosphere are numerous and complex. A myriad of political and market complexities have been introduced over time that greatly complicate the task of developing a rational and coherent approach for the forest-based industry to address the climate change issue.
Companies are concerned with anticipating and complying with requirements imposed by national
governments to meet Kyoto Protocol commitments and other political realities. The issue is immediate
and the stakes are high. At the same time, however, the climate change issue is also playing out on a
different level – a level involving the broader and longer-term interests of the industry and its important
stakeholders. A value chain-based assessment of the forest-based industry can uncover insights into the
challenges that face the industry in this larger arena.

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