

# Toward a Common Cause

## The Embrace of Carbon Along a Supply Chain

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**Final**

### ABSTRACT

Carbon is a convergence point for governments, corporations, NGOs and scientists. Supply chains are adjusting to this convergence and stand to become more efficient, responsible and resilient as a result. We interviewed senior managers and executives in six companies along a supply chain in the paper and publishing industry to assess pressures shaping carbon management, and predictions for future inclusions of carbon in business strategy. It emerged that carbon is acting as a catalyst for increased collaboration along supply chains and that actors were including carbon in their decision-making processes.

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## Executive Summary

Carbon is a convergence point for governments, corporations, NGOs and scientists. Governments are acting to regulate carbon as a pollutant. Corporations are anticipating this regulation, finding that managing for carbon can translate to managing for cost. Investors and insurers are catalyzing corporate efforts as they see carbon and climate change as a significant risk. They are taking the first steps to adjust their portfolios accordingly. The scientific community's stance on climate change has been focused on the role carbon emissions play in atmospheric warming. Civil society has been active in the design of mitigation and adaptation schemes. In short, a broad coalition has emerged that supports the management of carbon.

In the shadow of this consensus, businesses and supply chains are responding. By understanding carbon along the supply chain of a product, the full carbon costs of production are revealed. More efficient supply chains that take advantage of low-carbon energy and transportation are founded in this understanding. More responsible supply chains, characterized by active collaboration on environmental issues, also emerge. Through these steps towards efficiency and responsibility, more resilient supply chains result. Less exposed to regulatory and market-access risk, as well as the financial risk of monetized carbon, supply chains that measure and manage carbon will be more resilient in years to come.

This paper explores carbon through interviews with senior managers and executives from six corporations along a supply chain in the paper and publishing industries. The origins, evolution and future directions of carbon management along the chain are summarized. Origins are shaped by proximity to the marketplace. Upstream corporations, users of more energy, have a greater financial incentive for managing carbon and are exposed to stronger regulatory pressure. In contrast, downstream corporations find motives for carbon management in maintaining corporate image and responding to consumer preference. Carbon allows businesses facing these different origins to work closely together. Communication between supply chain collaborators is prominent in shaping carbon management, while regulatory pressures play a lesser role. Consumer preference for carbon management, while anticipated, remains nascent.

The interviewees agreed that a monetized carbon is probable. Although uncertainty about the specifics remains, supply chains will adjust. Physical locations of operations may change; low-energy operations may relocate, to reflect the carbon costs of transportation. High-energy operations may relocate to reflect the carbon costs of energy bottlenecks in a supply chain. Supply chain decisions for such operators will reflect the trade-offs between emissions from production and emissions from transportation. The convergence point of carbon provides corporations with a common cause, and demands critical thinking about the sustainable supply chains of the future.

## Introduction

This report explores the intersection of sustainability, supply chains and carbon<sup>1</sup>. The analysis is divided into three stages – carbon and its role in the sustainability agenda is examined; the impact of carbon on the nature and composition of supply chains is considered and finally, a case study is given. The case study was the original motive for the research here, and presents data and interview results from a supply chain in the paper and publishing industry. Initially a quantitative exercise measuring carbon emissions along the chain was planned. However, as key actors were contacted, it became apparent that there was more to be gained than just data. Discussions with senior managers and executives revealed that carbon was being embraced along the supply chain as a metric in improving performance, profitability, regulatory compliance and market access. It became clear that the supply chain was stronger, more resilient and characterized by collaboration between partners. Carbon, its measurement, management and reduction, acted as the catalyst.

Carbon has emerged as a convergence point: in sustainability, in business operations and in supply chain collaboration. Sustainability is the balance of economic, environmental and social priorities around objectives that do not compromise the needs of future generations. Carbon can be economically sustainable because it is synonymous with energy and thus cost. With the introduction of government regulation on carbon, the economic case becomes even stronger. Carbon can be environmentally sustainable, as reducing carbon parts per million in the atmosphere has been identified as fundamental to efforts to mitigate the effects of climate change. Carbon can also be socially sustainable, as a monetized carbon gives forest users another choice in their land-use decisions. Limiting carbon emissions also plays a role in abating the effects of climate change. Rising sea levels, shifts in climatic patterns and more intense weather events all pose significant threats to populations worldwide.

Carbon has the potential to transform supply chains. As carbon gains a price, energy intensive activities become more costly. Supply chains that are characterized by bottlenecks of energy – a process that consumes a large amount of energy relative to other upstream and downstream activities – will evolve to take advantage of renewable energy resources. The opposite is also possible; processes that use little energy may relocate to be closer to efficient transportation hubs and markets. Certain processes may use so little energy that any gains made by using renewable energy are offset by increased emissions from transportation.

The way companies interact along a supply chain may also be transformed by carbon. As carbon emerges as a significant variable in the operations of a business, some will be quick to adapt while others lag. Companies progressive in their management of carbon may align their business activities with partners who have

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<sup>1</sup> Note: For the sake of simplicity throughout this report, “carbon” will be used broadly as a term to refer to the regulation, management, and trade of carbon on markets.

similar sustainability priorities. Investors are at the forefront of encouraging an understanding of the carbon footprint of corporate activity – it is not inconceivable that carbon will evolve into a screen in investment decisions. The cost of lagging behind could also be high if the regulatory developments continue apace. Carbon heavy operators could quickly find themselves out-competed in a marketplace that reflects the cost of carbon. Some corporations may already be anticipating this, and considering methods to adjust their supply chain accordingly. In short, to be slow on carbon is risky.

Carbon may also help supply chains become stronger. Upstream and downstream actors face different pressures. Large energy users upstream have a small amount of direct contact with consumers, but more contact with other businesses and government. Downstream companies with a more visible presence in the marketplace interact daily with customers. As a result, these different actors end up having different priorities and policies to tackle sustainability issues. Carbon is a common thread through all these policies, and allows for an alignment that might not otherwise exist.

The convergence around carbon is thorough. Before exploring this convergence in the case study, two sections follow. The first describes the emergence of carbon as a metric in sustainability. The second presents a framework for understanding how carbon might change supply chains. In both sections, illustrative excerpts from the interviews are used to reinforce some points.

## Why Carbon Matters

Sustainability matters – it is being rewarded by the marketplace, investors, and is continuing to grow. An important part of sustainability is carbon. This is because carbon, unlike any other measure, exists in all three realms of sustainability – environmental, economic, and social. In order to understand why carbon has achieved this consensus, we must examine its roots and the consensus that supports its central role.

### *Born in Theory*

#### **Externalities, Polluter Pays and the Precautionary Principle**

Today the producer of a particular good generally pays only the private costs associated with production. The public costs, such as carbon emissions, are not captured in the price. The emergence of carbon as managed and regulated pollutant is what economists refer to as the ‘internalization’ of a negative externality. Governments are working to design regulatory regimes that include carbon in the total cost of production. Carbon is the largest attempt to date to internalize costs at an economy-wide scale, and with a pollutant that is so ubiquitous, this is a challenge. As a result, the specifics, means, and mechanisms while well grounded in theory are less understood in practice.

Economic theory has established the “polluter pays principle”, which has appeared in academic literature and policy for over 30 years. OECD member countries agreed to the following definition: “The polluter pays principle is the principle according to which the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution” (OECD, 2001).

The nature of carbon, its accumulation and impacts on climate change alters the costs and benefits of acting to mitigate its effects. Because carbon emissions accumulate gradually, the costs of mitigation change with the passage of time. SwissRe, 2007:

“Because carbon dioxide (CO<sub>2</sub>) emissions build up slowly, mitigation costs rise as time passes and the level of CO<sub>2</sub> in the atmosphere increases. As these costs rise, so too do the benefits of reducing CO<sub>2</sub> emissions, eventually yielding net positive returns. Given how CO<sub>2</sub> builds up and remains in the atmosphere, early mitigation efforts are highly likely to put the global economy on a path to achieving net positive benefits sooner rather than later. Hence, the time to act to reduce these emissions is now.”

Climate change represents a significant source of uncertainty for society. Carbon, methane and other greenhouse gases and their cumulative effect on climate change are central to this uncertainty. The ‘precautionary principle’ suggests that rational economic actors will assume costs in the present in order to avoid significant losses in the future. SwissRe, 2007 states:

“The “precautionary principle” is useful in decision-making wherever there is uncertainty. The principle justifies incurring a small cost today to avoid a future large loss that has a reasonable chance of occurring. It allows for a decision even though future outcomes are uncertain and it disallows using uncertainty as an excuse for inaction.”

In terms of carbon and climate change, the uncertainty is the economic impacts of a destabilized climate on markets and society. The “small cost today” is the measurement and management of carbon in order to reduce the chances of the “future large loss” that may (or may not) result from climate change.

### ***Grounded in Consensus***

This section presents evidence of how governments, scientists, civil society and industry are responding to carbon. What emerges is an understanding of the broad base of support that carbon currently enjoys. The significance of such diverse stakeholders unified in their embrace of a single concept should not be underestimated.

### **Governments, Treaties and Regulations**

Government regulation of carbon is underway. Borne of international, regional, national and state-level agreements, the regimes are diverse. Exactly which regimes

will survive and how existing regimes will adapt to emerging international agreements is uncertain. However, the conclusion is clear – the regulation of carbon is here. Of central importance is the near-global acceptance of carbon regulation. Indicating that carbon regulation has reached critical mass: the Obama Administration in the United States has indicated it's intent to adopt a cap and trade system of carbon management.

### ***International Efforts – Kyoto and Beyond***

The Kyoto Protocol entered into force in February 2005, committing signatories to reduce carbon emissions to below 1990 levels by the period 2008-2012 (UNFCCC, 2009). Kyoto was not ratified by major emitters such as China and the United States, which led some to question its efficacy. The as-of-yet unnamed successor to Kyoto is currently under negotiation with major developments expected in 2009. Building on what is called the “Bali Roadmap”, significant diplomatic resources (see Times Online, 2009 and Reuters, 2009) are being directed at these climate negotiations to be concluded in Denmark in December, 2009. Writing about the lead-up to this meeting, the Minister of Environment from Denmark summarizes the atmosphere during negotiations on the Bali Roadmap:

“Even when certain countries, towards the end of the meeting, were opposing a shared decision, it was not expressed as direct opposition but rather that countries “did not prefer” the proposed text. It is becoming increasingly difficult to be a country which obstructs a shared solution and so holds the responsibility for a breakdown.” (Hedegaard, 2008)

### ***National and Regional Initiatives***

At the national and regional level, there is significant action towards the management of carbon emissions. Regionally, the EU Emissions Trading System (EUETS) has been a pioneer in establishing a cap and trade market. At the national level, the Australian Carbon Pollution Reduction Scheme has built on lessons from the EUETS, but the current economic downturn has delayed implementation. Regional initiatives such as the Western Climate Initiative and the Regional Greenhouse Gas Initiative, both in North America, have established binding targets and in the case of RGGI conducting carbon auctions for major polluters. These are only indicative examples of the regulatory schemes that exist today at the national or regional level. With the upcoming meetings in Copenhagen the development of new initiatives continues apace.

### ***Scientific Community***

It has been widely recognized that limiting carbon parts per million in the atmosphere is a central component to global efforts to mitigate climate change. Although the science is complex, what is important from the perspective of consensus is that scientists have long been, and continue to remain, at the forefront of advocacy for managing carbon emissions.

Carbon PPM levels have historically been at times higher than they currently are. However, historically, the poles of Earth have at times been ice-free and harboured vibrant and verdant forests. What is of chief importance is the rate of change in carbon levels (Stern, 2006; IPCC 2007). Since the beginning of the industrial era, the PPM of carbon has risen at relative rate that makes climatic destabilization a strong probability. Garnaut 2008 presents a detailed summary of the science and probabilities of climate change and the intrinsic role of carbon in this relationship.

### **Civil Society**

Non-governmental organizations are actively involved in promoting climate legislation that recognizes the importance of carbon. NGOs view carbon as an effective tool to advance their agenda while garnering the support of diverse stakeholders from industry and government. Although difficult to measure, the value that carbon creates as a bridge between normally detached stakeholders is something that warrants serious consideration.

The U.S. Climate Action Partnership (USCAP), a coalition of several major corporations (including Shell, General Electric and ConocoPhillips) as well as four prominent NGOs (Environmental Defense, Natural Resources Defense Council, Pew Center on Global Climate Change and World Resources Institute) have embraced carbon-oriented climate legislation as a means to “encourage innovation, enhance America's energy security, foster economic growth, improve our balance of trade and provide critically needed U.S. leadership on this vital global challenge” (USCAP, 2009). USCAP demonstrates the ability of carbon to coalesce diverse interests, from environmentalist NGOs to large energy companies, into a unified policy position.

Development NGOs have assessed the role carbon can play in advancing their agenda of social sustainability. Efforts to include Reduced Emissions from Deforestation and Degradation (REDD) are supported by NGOs and the UN's Development and Environment Programmes (UNDP, 2008), as well as major tropical countries such as Indonesia. They view REDD as a significant opportunity to harness efforts to develop and finance carbon markets in the pursuit of sustainable growth in less-developed countries.

“The opportunity to align carbon markets with sustainable development objectives seems too good to miss. [C]arbon markets could potentially be harnessed to help meet climate change mitigation objectives by supporting conservation and development efforts in tropical forests.” (IUCN, 2008)

### **Corporate World**

Carbon has received strong support in the corporate world. At a fundamental level, carbon emissions equates to energy consumed. Reducing energy consumption reduces variable costs, something profit-maximizing businesses support. The financial sector has embraced carbon – insurance companies who make decisions based on variables 50 years into the future see value in efforts to mitigate climate

change. Even corporations that were previously reluctant to admit that climate change was even occurring have now begun to include it in their strategic thinking (ExxonMobil, 2007).

Corporations are beginning to move beyond the traditional models, placing greater emphasis on the creation of long-term shareholder value. They are keen to identify long-term threats to their business operations, and to formulate responses (see McKinsey, 2009). Climate change, strongly supported by scientific evidence, has been identified by business as a significant threat. Employing the previously discussed ‘uncertainty principle’, businesses are assessing the risks of carbon emissions and climate change (see Investors’ Network on Climate Risk, 2008, Stevenson 2009.)

**Making the Business Case for Sustainability – The Need for Environmental Objectives to Align With Economics**

*Burlington Northern Santa Fe*

"BNSF has been tracking carbon emissions since 1995, long before it became common for companies to do so. We spent approximately \$4.5 billion on fuel in 2008, which produced over 96% of our carbon emissions. With a single gallon of diesel, we can haul a ton of freight 470 miles, making rail the most fuel efficient method of surface transportation available - and the method with the lowest emissions. Understanding our carbon footprint is an effective measure from both a cost and environmental perspective."

For BNSF, a major rail operator with approximately 32,000 route miles in 28 states and 2 Canadian provinces, understanding carbon makes good business sense. Each dollar spent for fuel translates directly into carbon emitted, so every emission reduction translates into a dollar saved. For BNSF, a carbon constrained economy is also an opportunity to further promote their inherent fuel and carbon efficiency advantage over trucking and enhance its share of the shipping business. So not only does carbon make economic sense for BNSF, they see it as an opportunity to differentiate themselves from an environmental perspective.

Carbon also represents a possible source of savings (or perhaps even revenue) for business. As discussed, regulatory regimes managing carbon are coming online. As businesses are forced to pay for the carbon they emit, those that are able to emit less save money. Under a cap and trade system where not all allowances are auctioned, corporations that are able to operate at carbon levels below their allowance can sell additional credits to which they hold title. Corporations are also aware of the existing carbon regulation, and of the probability that additional legislation will be enacted. They are inclined to accept reducing carbon emissions in order to be well positioned to adapt to new legislation, while also benefitting from energy savings and the possible creation of revenue streams in carbon markets.

One corporate initiative that deserves mention is the Carbon Disclosure Project (CDP). CDP has been collecting data from corporations since 2003 on efforts to understand carbon emissions. The project is focused on disclosure of emissions, not necessarily reductions. This neutral stance has allowed CDP to encourage a wide variety of industries to participate, including reluctant sectors such as shipping. Recent findings from CDP indicate that over 80% of signatory investors (investor's who participate in CDP and manage over USD55 trillion in assets) use data on carbon emissions submitted to CDP when making investment decisions (CDP, 2009a). Currently, over 3700 companies from across the globe participate in the annual call for information released by the CDP (CDP, 2009b).

### **Investors and Insurers**

Investors have begun to include environmental and social governance (ESG) criteria in their assessment of a corporation. The United Nations Environmental Program Financial Initiative (UNEP FI) has developed "Principles for Responsible Investment." Signatories to the PRI currently control over USD56 trillion in assets. The PRI includes clear language about ESG criteria – including carbon emissions. The logic is clear; corporations that perform better on sustainability indicators perform better on financial indicators. The degree of interest demonstrated indicates that environmental indicators, carbon included, are being actively used by investors as screens, and are positioned to grow.

Investors are not interested in environmentally responsible corporations simply because they tend to produce better financial results. There is also a significant mitigation of risk, both to a specific investment in a corporation as well as an institution's investments more broadly, when environmentally responsible behaviour is rewarded. Premiums are beginning to reflect this, with major insurers offering discounts to green certified clients (Fireman's Fund, 2009). Currently investors, insurers, reinsurers and the research firms that provide analysis for these actors are focused on environmental indicators inside a company. However, given the fragility and scope of global supply chains it is likely that investors will begin to look at the risks a corporation is exposed to along its supply chain (CDP, 2009c). Given recent trends in investment, corporations that have a better understanding of the carbon emissions along their supply chain will be more attractive to investors.

### **The Intersection of Carbon and the Supply Chain**

In a globalized economy with diverse, long and complex supply chains, corporations can mitigate disruptions and unanticipated risk along their supply chain by putting in place the systems for a deeper understanding of their supply chain. The supply chain stands to be redefined by the emergence of carbon. If carbon has a price, economic decisions are fundamentally altered. If carbon has a price, the physical logistics of a supply chain will change. If carbon has a price, suppliers who are managing their emissions will out-compete those who are not. It is important to note that the price of carbon will dictate the degree to which actors consider carbon.

This section will explore potential changes in the supply chain by looking at three issues: resilience, responsibility and efficiency.

### **Efficient Supply Chains**

Carbon emissions, for all intents and purposes, are analogous to energy used. As such, reducing carbon emissions reduces energy consumed. Of course, there are exceptions; low-carbon options might involve using the same amount of energy but from renewable sources. Energy markets are some of the most volatile, and a reduced exposure to this volatility is a benefit. Orienting a supply chain around carbon is therefore a means of orienting a supply chain around energy. When energy is cheap, this may make the supply chain less cost competitive. But as energy prices rise, the supply chain is able to weather the variance.

#### **Operational Excellence and Environmental Performance – The Happy Coincidence of Efficiency and Carbon**

*Catalyst Paper Corporation*

“Unless we can create products with authentic attributes, desired by the marketplace, the sustainability agenda is just a nice pipedream.”

Catalyst Paper, with mills on the west coast of B.C., strives for operational excellence. In an industry that consumes a lot of energy, this means trying to reduce use as much as possible, while making use of waste residues to generate additional electricity. Catalyst invested heavily in the right equipment to turn waste into energy for their operations, and as they did, their reliance on fossil fuels decreased to almost zero. It took a senior executive new to the company to realize that what Catalyst had done in the spirit of operational excellence made for a carbon light product. After developing relationships with an offset provider and continuing to reduce energy consumption, Catalyst was able to offer some of the first manufactured carbon neutral paper in the world.

There are two ways efficiency may manifest along supply chains. First, corporations that are energy efficient may become preferred suppliers and gain market-share as a result. Second, supply chains themselves may reorient around minimizing the carbon emissions of the entire chain. This first point builds on the risk and responsibility ideas that have already been discussed. Energy efficient business will be less exposed to carbon risk. They will also be seen as more responsible in their management of carbon. These strengths may translate into advantages as the low-carbon economy matures. The idea that supply chains may reorient around carbon has significant implications for where business is conducted. Supply chains may evolve to recognize energy bottlenecks. Energy intensive processes, such as aluminum smelting or paper manufacturing, may become more competitive in areas with access to renewable energy resources (such as hydroelectric power). Conversely, low energy processes may relocate to be close to the most efficient

transportation networks or to major markets, in order to minimize the emissions from shipping.

Monetized carbon may operate along supply chains in unintended ways that provide no reward or perhaps even punish carbon efficient actors. Supply chains are long, global in reach and complex; it is unlikely that all competing suppliers or supply chain collaborators will fall under the same emissions reduction scheme. There is a danger that a company that makes strides in reducing their carbon emissions will not be able to pass on the costs required to make these gains because competitors in the marketplace have not equivalent gains. Reductions are not always savings; at the outset they may represent costs. Currently, renewable energy has a cost premium over carbon-heavy fossil fuels. In a commodity market, such as paper, a low-carbon producer cannot sell their product at a significant premium to customers. Customers are not inclined to pay premiums for green products, although they prefer them. Further, because carbon does not have a standardized price, being low-carbon can in some circumstances be a cost rather than a savings. In the end, the question of who pays for carbon will depend on the universality of regulations and the willingness of consumers to pay more. Although carbon efficient generally means energy efficient, policy and the marketplace have not yet adapted to making carbon cost efficient.

**Consumer Awareness of the Environment – The Challenge of Environmentally Preferable Paper**

*Quebecor World Printing*

“Many of our customers, who want environmentally preferable paper, face the current challenges of poor information and cost premiums for such paper.”

Quebecor World plays a unique role in the supply chain. Quebecor World transacts with a large number of both larger and smaller clients. Often times these clients are looking for environmentally preferable paper. Customer interest in environmental options can vary based upon their level of knowledge about the environmental aspects of paper, and the availability of additional funds to support the cost premiums. Some customers have researched the options, from certification to recycled content to carbon-light, but often times they look to Quebecor World for guidance on which paper choices meet their environmental preferences. One of the challenges is being able to match customer preference to the right paper at an affordable price level.

**Responsible Supply Chains**

The emergence of corporate social responsibility (CSR) is not a fad. It is considered good business. The peripheral benefits of understanding the non-economic impacts of business operations are evident. As carbon emerges as a tenet of sustainability, it may become a key component of CSR. Carbon management has the potential to be considered a prerequisite for responsible corporations. The prevalence of the

Carbon Disclosure Project indicates that corporations already understand this. How this will impact supply chains is less certain.

For an example of how responsible supply chains benefit corporations, the textile industry offers a lesson. A major U.S. clothing retailer was getting a significant amount of bad press around the use of child labour in its factories. As a result, the corporation partnered with NGOs and third party auditors to adjust its supply chain to make sure no child labour was in use. Going from a laggard to leader, the retailer began to receive positive rather than negative coverage. It then emerged that one of their factories was using child labour and that the owner had bribed the third party auditor into nondisclosure. As this news broke, rather than receive negative coverage, the retailer was praised for putting in place the systems for ensuring better labour practices along their supply chain. In a roundabout way, the discovery of the bribery was proof the system worked. By taking the steps to build a more responsible supply chain the retailer strengthened its brand. Translating this lesson to carbon – if carbon continues its rise in the consumer conscience, products that are shown to have a large carbon footprint relative to the competition will fall out of favour, and corporations that can demonstrate they've taken steps to understand and reduce the supply chain footprint of their products (as opposed to simply their internal footprint) will benefit.

**Sharing the Seaways – How Public Exposure Leads to Best Practices**

*Washington Marine Group*

“People don’t recreate where trucks or rail cars are. It’s not uncommon to find ourselves near people who are sailing, fishing, recreating. We immediately become noticed visually, so we concentrate on that image.”

Leisure boaters, fishermen, and recreational property owners consistently see barges and tugs in their backyard. This public exposure leads to increased scrutiny, and as a result, the corporate strategy revolves around making sure to do the right thing. As a result, the company has adopted best practices in its safety and environmental policies. WMG has industry leading safety results, an environmental policy developed to ensure low impact on the seaways, and is actively collaborating with WWF and BC Hydro to manage and reduce its carbon emissions.

Third party auditing and verification may become widespread as carbon management along the supply chain grows. Creating an accountable, low-carbon supply chain will involve an additional layer of measurement and monitoring to ensure compliance. While at first costly, the outcomes of this monitoring may lead to stronger relationships between supply chain collaborators, as well identify areas where further improvements can be made. The idea of auditing the supply chain for carbon has several implications:

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- These audits can serve as a foundation for comparison over time to identify where improvements in energy efficiency can be made.
- By engaging in this greater degree of information sharing, over time stronger relationships between supply chain actors may emerge. What started off as a narrow relationship oriented around the monitoring of a supplier may evolve into more active collaboration, where suppliers and customers work together.
- In order to satisfy the monitoring requirements of one customer, a supplier may change its entire operations. As a result, all customers will benefit from the demands of just one. This implies that pursuing best practices in a supply chain can have significant dispersion and trickle-down effects.
- Creating a monitoring system for carbon may reveal other risks along a supply chain. For example, as auditors assess the carbon footprint of a supplier, they may discover undisclosed issues around hazardous materials or toxic waste.
- The creation of an auditing system would require standards to ensure the consistent measurement of carbon. These standards will require collaboration and information sharing and would help resolve some of the current uncertainty around actual emissions.

### **Resilient Supply Chains**

Efficient and responsible supply chains include metrics, methods and relationships that build more resilient connections between supply chain collaborators. The emergence of carbon is introducing a new metric in business, a metric that can indicate risk. Looking at the issue from a perspective of categorical risk (risk that is not quantified) allows businesses to understand how their supply chains can be made more resilient. When looking both upstream and downstream, 'carbon risk' may emerge as a tool for evaluating the resilience of a supply chain and the actors along it.

Resilience is the ability of a business to control short-term operating expenses, maintain long-term profitability and reduce exposure to shocks. The current economic downturn indicates that managing these risks more aggressively will characterize future economic growth. The emergence of carbon as an operating cost portends that carbon will be included in risk management strategies. The types of risk identified by this project were: regulatory risk, financial risk, and market access risk. All of these in turn, can be considered supply chain risks. Each type of risk will be explored in abstract, to convey how it may impact supply chain operations.

Regulatory risk is simple in concept – it is the changes a business will face in its operating environment as carbon is subject to government control. The emergence of a priced carbon due to markets created and governed by regulators will impact business significantly. Those that anticipate this impact, and are prepared to participate in these markets efficiently, either through reducing their own emissions or creating strategies to purchase offsets, are in a less risky position. Those that currently emit large amounts of carbon, and have not begun adjusting their price

structures and purchasing policies to reflect the pending monetization are exposed. Already, the U.S. bond market is putting a premium on corporate bonds for new coal-fired power plants. This premium reflects the anticipated cost of participating in a cap and trade system.

There is another type of regulatory risk that revolves around how regulations are deployed. Cap and trade systems are typically based around baseline emissions being used to set an allowance-level for a business or industry. Sectors that have made progress in reducing their carbon footprint may be put in a more difficult position. The cost for further reductions may be high; in fact, in many situations there may be no scope for further internal reductions at all. Progressive companies that have already made gains in reducing their emissions are aware of this risk, and are lobbying to include grandfathering clauses in regulatory schemes. In short, they hope to ensure that good behaviour already underway is not punished by the definition and allocation of allowances. This grandfathering risk also implies that some businesses must start to look beyond their internal carbon footprint towards their supply chain. If they do so, they may find reductions that are more cost effective. This makes regulatory risk of carbon very much a supply chain issue.

Financial risk around carbon revolves around the ability for business to continue to secure sufficient capital and credit in the long term. Current illiquid markets notwithstanding, investors have indicated that they intend to consider the carbon in their investment decisions (Carbon Disclosure Project, 2008). The reasoning is simple: if a corporation emits a lot of carbon, then they will be obligated to pay for these emissions. Obviously some industries must emit – if this is the case, investors will seek to support projects and companies that at the very least have an understanding of their total emissions and the beginnings of a strategy for reduction. Carbon may therefore emerge as an impediment to securing capital if corporate and supply chain emissions are not understood.

Closely related to financial risk is market access risk. Market access risk has two components: first, understanding carbon emissions may become mandatory for participating in supply chains, as businesses seek to collaborate with partners who understand this component of their operations; second, consumers may demand that carbon footprint information be available for the products they purchase. A measured and managed carbon footprint may emerge as a non-tariff trade-barrier. For example, a nation could introduce a trade policy that places a levy on products that are produced using carbon-intensive energy, such as coal. Or more simply, trade policies could require that the carbon footprint at least be disclosed. Although such policies do not yet exist, there is a strong likelihood that they may emerge. Consumers may begin to behave similarly. Although the appetite to pay a premium for sustainably produced products is small, consumers have a preference for goods that are cost competitive but also demonstrate a commitment to reducing the environmental and social impacts of production. Carbon, given its current prevalence, could emerge as criteria in consumer choice.

These trends in risk – regulatory, financial and marketplace – could reshape supply chains. Businesses that disclose their carbon emissions and have stated policies on how they intended to achieve reductions may achieve preferred supplier status. Businesses that hide their footprint may find it difficult to remain competitive, either in finding supply chain collaborators or gaining access to markets. Carbon may evolve into a prerequisite for participating in business: orienting operations around the management of carbon may become the norm rather than the exception. Supply chain resilience, therefore, may be enhanced as actors upstream and downstream move to understand the carbon component of their operations.

### **Emissions, Products and Carbon Accounting – The Complicated Role of Forests**

#### *Western Forest Products*

“At the end of the day our carbon footprint from an emissions perspective is relatively small compared to the carbon opportunity associated with the products.”

Raw material producers face unique challenges in a low-carbon economy. This is particularly true for a forest products company. Forests store carbon – the trees, the foliage, and the soil. Forests sequester carbon as trees grow, and forests release carbon through fire and rot. Forests also release carbon through natural disturbances and harvesting for wood products. The scope for complexity is immense – if a tree is felled, converted to lumber and used to build a house that stands for 75 years, does the carbon in this timber count as an emission? To address this difficult question requires the development of standards so that the emissions/sequestration from harvesting operations are compared rationally with those from another. Forest products are also substitutes for other building materials, such as steel and concrete which typically consume high levels of fossil fuels in production, while offering no sequestration benefits. How the complexity of forest products carbon is reflected in regulatory regimes will be central in rebuilding a successful industry.

### **From the Forest to the Newsstand**

Researchers from the University of British Columbia and WWF Canada set out to understand the supply chain implications of a product – Catalyst Cooled paper. Produced in British Columbia, Catalyst Cooled is the paper on which Rolling Stone Magazine is printed. The project sought to understand not only what, but also why. Quantitative data is provided on the carbon footprint of this supply chain but constitutes only part of the story. As the data was gathered and the map drawn, it became apparent that figures alone would not explain everything. If examining data is the art of looking backwards, the project decided to look forward and interview key managers and executives along the supply chain. Snapshots from along the supply chain have been mentioned throughout this report, highlighting how this case study embodies trends in sustainability and supply chains that are reshaping business today. This section will present a map of supply chain emissions, as well as interview results.

The companies interviewed were:

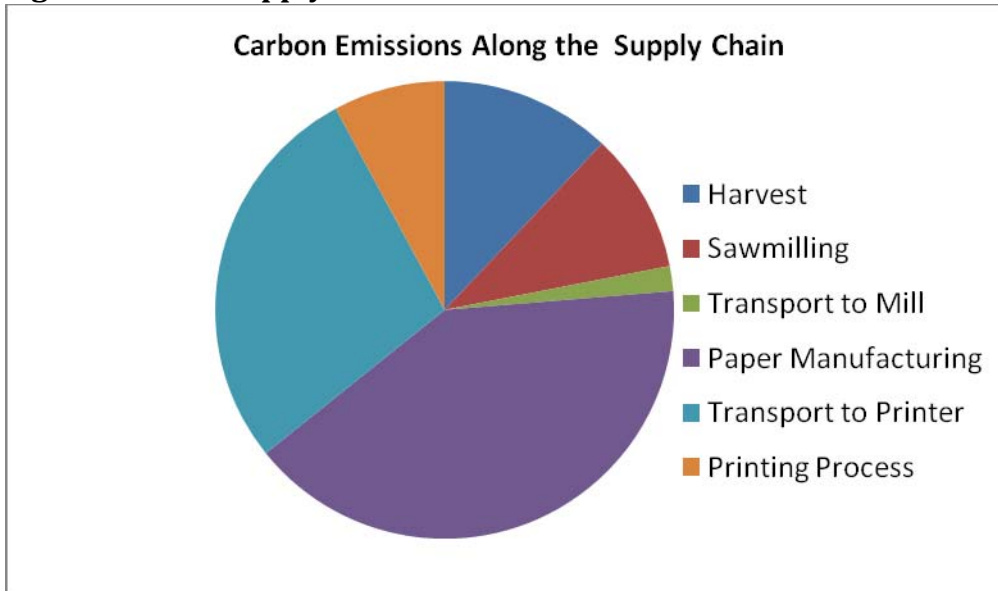
- **Burlington Northern Santa Fe Railways**  
General Director, Environmental
- **Catalyst Paper Corporation**  
Vice-President, Corporate Relations and Social Responsibility
- **Quebecor World Inc.**  
Director, Environmental Affairs  
Director, Paper Procurement, Environmental Affairs
- **Washington Marine Group**  
Chief Executive Officer  
Vice President, Health, Safety and Environment
- **Wenner Media Incorporated**  
Vice-President, Manufacturing
- **Western Forest Products**  
Chief Operating Officer

Catalyst Paper gets fibre from Western Forest Products (WFP). Residual fibre from WFP’s operations on Vancouver Island are shipped to Catalyst’s mill in Port Alberni by truck. The mill uses 89% renewable energy. The additional 11% of energy comes from fossil fuels – Catalyst offsets these fossil fuel emissions completely by sponsoring urban park reforestation projects. After the paper is manufactured, it is shipped by truck and then barge to Catalyst’s distribution center in Richmond. From here it is shipped by Burlington Northern Santa Fe Railways (BNSF) to Quebecor World’s printing plant in Merced, California. Here, Rolling Stone Magazine is printed and distributed across North America. See Figures 1 and 2 for a map and summary of emissions along the supply chain. See Annex One – Emissions Factors for more details. Distribution data after printing was not available, and attempts at estimation proved extremely sensitive to assumptions made.

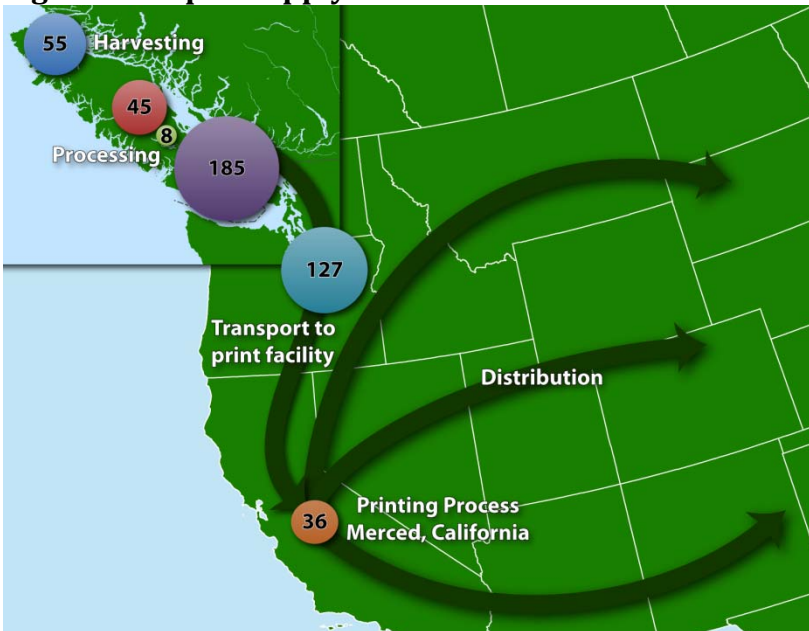
<b>Activity</b>	<b>Carbon Emissions (CO<sub>2</sub>e/ADt)<sup>2</sup></b>	<b>Percentage of Total</b>
Harvesting, road-building, felling, transport to sawmills	55kg	12%
Sawmilling into dimensional and residual products	45kg	10%
Transport of chips to mill	8kg	2%
Paper manufacturing process	185kg	41%
Transportation to print facility	127kg	28%
Printing process	36kg	8%
<b>Total</b>	<b>456kg</b>	<b>100%</b>

<sup>2</sup> Carbon dioxide equivalent per air dried tonne.

**Figure 1: Total Supply Chain Emissions**



**Figure 2: Map of Supply Chain Emissions**



Circles represent relative contribution to supply chain emissions. Figures represent kg of CO<sub>2</sub>e per air-dried tonne of paper.

Discussion of the interview results will be organized in three sections: Origins, Evolution and Current Status, and Future Direction. Each section will synthesize the interview results, highlighting the common themes and important differences.

## Origins and Evolution of Carbon Management

The embrace of carbon, either as a performance metric, a basis for product differentiation, a strategic priority or a corporate goal, has diverse origins. The embrace is influenced by three variables: the proximity of the corporation to the end consumer, the degree of compliance required by government regulations, and the need to enhance corporate branding. These diverse origins result in varying responses, which weigh each variable according to pressures faced by the corporation. Responses are also shaped by anticipated risks, regulations and market conditions related to carbon. Each response is characterized by the obvious – it has something to do with carbon. This is a key finding of the case study: diverse corporations facing different pressures are able to work together in a shared understanding of carbon.

The origins fall into two categories: internal or external. Internal origins might be efforts to achieve operational excellence, deemed to be necessary to remain competitive or to maintain market share. External origins can take several forms. They may be shaped by the need to comply with government regulation, or in response to pressure from NGOs to better report on carbon emissions. Finally, and most prominently in this case study, external origins might be a corporations contact with a collaborator along a supply chain. The Washington Marine Group (WMG), for example, cites a meeting with senior executives of Catalyst Paper as the origin of its carbon management strategy. In 2004 the CEO of WMG met with the then-CEO of Catalyst Paper to discuss their business relationship (Catalyst was, and is, WMG's largest customer). WMG quickly learned that Catalyst was considering the market for carbon-light products, and recognized the potential strengths of sea-based shipping in a low-carbon economy. In short, a conversation between business leaders proved to be the first step to a corporation embracing carbon.

### Rethinking Sustainability – When the Right Thing to Do Isn't the 'Right Thing to Do' **Wenner Media Group**

"We did our homework, this wasn't a flippant decision, and we feel it's the right thing to do."

Catalyst Paper approached Wenner Media Group with the idea of printing on manufactured carbon neutral paper. Wenner considered the proposition carefully, conducting due diligence and consulting with WWF and other third parties to examine the benefits of Catalyst's offering. Wenner decided to use Catalyst's product based on the environmental benefits of the manufacturing process, a decision that represents an increasing sophistication in the understanding of "environmentally preferable". While some hold recycled content to be the paramount metric in measuring environmental responsibility, this was not the approach Wenner decided to take. The carbon reduction associated with Catalyst's product, in addition to the quality and consistency of sheet, convinced Wenner this was the right course. As the first major publication to print on manufactured carbon neutral paper, Wenner felt they were taking a positive step and hoped for commensurate recognition.

However, the day after the first issue was released, an article appeared in the New York Times criticizing Wenner for using paper from virgin fibre instead of recycled sources. The negative coverage is indicative of the lag that exists between scientific and social acceptance.

Origins are diverse. They can be simple – a conversation between two CEOs. They can be economically driven, such as a desire to reduce fuel costs (which BNSF states is one obvious key driver for managing their carbon emissions). Origins can be complex, such as Catalyst’s push for operational excellence that almost by coincidence resulted in a carbon-light manufacturing process. Origins can be proactive, as business meets the demands of the market place. Origins can be regulatory. For example, in Canada major emitters are required to report to federal government on their annual emissions. In the United States, the EPA has suggested it intends to implement a similar mandatory reporting scheme.

The other important dynamic in the origins of carbon management is the location of the corporation along the supply chain. Upstream and downstream actors face different pressures. Upstream suppliers often consume significantly more energy than downstream actors, but are less visible in the marketplace. As a result, they are more likely to undertake carbon management in order to benefit from cost savings or to comply with regulatory schemes. Downstream suppliers, in contrast, do not use as much energy and have less financial incentive to embark on energy saving policies. However, they do face pressure from consumers that increasingly demand carbon-light products. Quebecor World, for example, suggested that despite the current economic downturn, there was still a strong interest in sourcing environmentally preferable paper. Granted, environmentally preferable does not necessarily mean carbon-light (as recycled content and certification must also be considered), this nonetheless shows that the marketplace is growing more sophisticated in its purchasing decisions. Catalyst provides further evidence of this – their sustainability department has seen a marked increase in the number of customers asking for data on carbon emissions. This is a recent development, attributed in part to the Obama administration taking office, and the resulting heightened awareness of carbon regulation.

What needs reiteration is how carbon allows businesses facing these different origins to continue to work together. It is, in a way, a universal metric, that resonates at all levels of the supply chain (for different reasons) and satisfies diverse corporate strategies.

In conducting the interviews, it became clear that most actors were in the early stages of developing a carbon management policy. The evolution, therefore, was not fully understood because most had just started taking the first steps. The exceptions were two upstream companies – Catalyst and BNSF. Both had been measuring their carbon emissions for a significant period of time. That they had done so can be attributed to the large amount of energy they consume; for example, BNSF in 2008 spent approximately \$4.6 billion on diesel fuel . Catalyst had begun measuring its carbon emissions in 1993, and had continued to make gains as they realized that

their efforts at operational excellence provided them with significant product differentiation.

Communication between supply chain collaborators emerged as a significant component of the evolution of carbon management. Indicative of this – Catalyst has communicated actively and over a period of time with all the supply chain partners, with the exception of BNSF, on issues of carbon. Catalyst being at the fore in understanding carbon has been able to inform and shape the thinking of its collaborators. Catalyst also has a strong working relationship with World Wildlife Fund (WWF) Canada. After seeing WWF's work with Catalyst, WMG also began collaborating with the NGO to help shape its sustainability policies.

The current status of carbon management is defined by awareness, but a lack of specificity. All the actors interviewed agreed that managing and understanding their carbon footprint was important. All had begun to take the first steps to do so. However, most were still in the stage of formulating policy. Specific reduction targets were the exception rather than the norm. This speaks to the current regulatory uncertainty that exists in North America. National-level schemes are evolving, while regional initiatives, such as the WCI and RGGI may impact some of the corporations interviewed, they are not significant regulatory priorities. B.C. is an exception, as companies operating there (most prominently Catalyst in this case) are subject to a carbon tax on their fossil fuel use.

### **Future Directions of Carbon Management**

When asked where they thought the future of carbon management lay, each respondent gave an answer specific to their own corporation and industry. The current economic downturn also influenced answers, as most actors are focused on simply surviving. It must be noted that four of the corporations interviewed were engaged in the print industry (WFP, Catalyst, Quebecor World, and Wenner Media); because this industry is suffering particular hardship, looking forward ten or fifteen years was difficult.

Evident in all the interviews was the agreement that business in the future must consider sustainability and carbon more closely. Businesses recognize that carbon will become a cost, a potential risk, and an opportunity. The marketplace has a growing appetite for sustainably produced products, but is unwilling to pay a significant premium for such goods. If carbon continues along its current trajectory and obtains a price, it will affect the cost structure of produced goods. This presents an effective method for sustainably produced goods to compete on cost.

Interviewees identified the ability for carbon to create differentiated products. This is likely to be the first step carbon-light products take in gaining market share. When consumers are willing to bear additional cost for sustainably manufactured goods, carbon-light products will benefit. In the longer term, carbon-light products may have the potential to out-compete on cost if markets set the price of carbon high. Again referring to the monetization of carbon, if a product's price reflects the carbon costs associated with production, this will begin to change the products that

win and lose in the marketplace. However, interviewees saw this development (carbon competing on cost) to be further away – in the medium-term, carbon gaining market share because of differentiation was the expected outcome.

It was also suggested that carbon has the potential to change the value of existing industrial assets. This was particularly true for three companies – BNSF, Catalyst and Western Forest Products. These assets, and their productive value, may change as time passes. Catalyst identified the possibility of transforming underutilized mills (so called “brownfield assets”) into power generation stations, producing electricity using biomass, and thus transforming into a “greenfield asset”. Western Forest Products saw enormous potential in the recognition of solid wood products as sinks of carbon, instead of simply emissions. Given that dimensional lumber can exist as a carbon sink in a home for over 75 years, and then be recycled, this may eventually change how dimensional timber is priced. BNSF saw significant opportunities in the future for increased use of rail capacity, as the carbon benefits of shipping by rail are enhanced by monetized carbon.

These same three firms also expressed concern about the specifics of carbon regulations. Catalyst moved early to reduce its carbon emissions. If its allowances under a cap and trade system are calculated using an average of their previous 10 years emissions, they will find themselves in a position where further reductions in order to comply with shrinking allowances are almost impossible. In short, they could be punished for good behaviour. BNSF identified the risks of cap and trade for the rail industry as potentially significant. Because rail is already so carbon efficient there is little scope for large reductions without some form of technological breakthrough. If carbon becomes costly, and upstream fuel producers or BNSF is forced to purchase allowances, their operating costs will rise. Again, good behaviour could be punished. Western Forest Products see risk in how carbon stored in the products they produce is counted. For every tree that is felled, another is planted – how this impacts the terrestrial carbon cycle, and how it is measured are key questions. Further, the harvested timber is converted into solid wood products (which store carbon), pulp which is in turn converted to paper and can be recycled, or wood residue which can be burned, offsetting fossil fuel use. To therefore consider a tree cut down a carbon emission oversimplifies the science.

## Conclusions

The common cause of carbon is apparent. Less clear is how this will induce change – in purchasing decisions, in the design of supply chains and in the definition of sustainability. Through interviewing senior managers and executives, producing a supply chain profile, and summarizing the trends shaping the role of carbon, this project has helped define the impacts of carbon. Setting aside debates on the merits and legitimacy of a carbon-centric view, the existence of such a broad consensus has implications for how business will be done. The sustainability agenda, with often conflicting environmental, economic and social goals, has found common ground in carbon. Businesses trying to balance short-term costs, long-term profitability and

the maintenance of a corporate brand have identified carbon as a means for progress on all three fronts. Supply chains composed of different actors facing different pressures have been able to align corporate strategies around a common variable – carbon. Some prioritize operational excellence, others anticipate the need for regulatory compliance, others respond to consumer demand. All are able to use efforts to manage and reduce their carbon emissions to further these goals.

Sustainability is due for a rethink, both broadly, and in the paper sector in particular. Often decisions are labeled ‘good’ or ‘bad’ based on the presence of a title, a percentage, or a logo. As useful as standards are in encouraging wider adoption and better behaviour, the application of general values to specific situations doesn’t always make sense. To illustrate this point, two hypothetical examples are given below. The object is not to debate the particulars of each hypothetical, but to demonstrate how environmentally preferable choices need to be grounded in comparison.

*Hypothetical One – Where to locate a mill*

A publication is trying to decide on which paper to print. It has two choices – paper from a mill located in British Columbia, or a mill in Arizona. The mill in B.C. gets its pulp from a sustainably managed forest, where second growth timber is harvested. The mill in Arizona uses 100% percent post-consumer waste. The mill in B.C. is run on hydroelectric power and fuel from biomass. The mill in Arizona gets its power from a coal-fired plant. The mill in B.C. uses water from a nearby river – the other users of this river are a nearby town and wildlife. Water purification is conducted on all effluents. The mill in Arizona gets its water from the Rio Grande. This river supports millions of people, agricultural operations and in the summer months no longer reaches the ocean because of the volume of water drawn. Based on absolute numbers, the mill in Arizona consumes less energy and less water per tonne of paper than the mill in B.C. However, the mill in B.C. is powered exclusively by renewable energy, and sources water with a low opportunity cost.

*Hypothetical Two – Where to print a book*

A customer wants to reduce the carbon footprint associated with the printing of a book. As a result, they approach a printing company who has operations across North America, inquiring about facilities that use renewable energy. The printer is has a facility that is powered by hydroelectric energy, but it is located far away from target markets. Also available is a coal-powered facility that is close to markets and transportation hubs. The total carbon footprint of producing the book at the facility powered by renewable energy is higher than printing at a facility powered by coal. Because the printing process uses little energy, any gains made by printing with renewable energy are offset by increased emissions from transportation.

These two examples demonstrate some of the insights gained by examining supply chains, carbon and sustainability in parallel. The choice of what is good, and what is

not, isn't always clear. Post consumer waste might not always be the best raw material for a particular product. Certified pulp might be shipped thousands of kilometers before arriving at a mill. There are trade-offs, between depletion of natural capital, water use, energy intensity, and energy type that should be considered. Understanding the supply chain of a product sheds light on these complications.

Location matters if reducing carbon emissions is a priority – the energy intensity of a particular process relative to the total carbon footprint of a product should be considered. Printing contributes a small amount to the total footprint of a product, and is best done close to markets and transportation hubs to reduce emissions. Papermaking contributes a large amount to the total footprint of a product, and is best done where there are abundant supplies of renewable energy and efficient transportation networks. Understanding not just the supply chain, but its carbon footprint, allows for decisions that reflect the trade-offs associated with sustainability decisions. In short, a more nuanced version of sustainability emerges.

There is, of course, a downside to this nuance. It may make for poor marketing – consumers need a simple measure to inform purchasing decisions. Carbon is currently less persuasive in the marketplace than certification or recycled content, but the growing awareness of carbon and its important role in climate change may alter perceptions. It is possible that carbon emissions will emerge as a third-tier in paper decisions, a development with two implications: carbon-light producers would stand to gain, and the supply chain and its footprint would gain new prominence.

As sustainability evolves, so might business. Carbon may change the structure of businesses in fundamental ways. Even today, when carbon is without a price companies are finding that reducing their carbon footprint reduces their fuel costs, offering significant savings. As carbon gains a price, these companies will derive multiple benefits from their advances – not only will they save on fuel, their emissions will cost less. There are also positive gains to be made. Businesses already market their products on the basis of the carbon footprint; this trend is expected to continue. New opportunities, new markets and new collaborators may emerge.

Evolving businesses inexorably lead to evolving supply chains. While current trends in carbon management are predominantly internal in orientation (steps to reduce employee travel, more efficient office spaces, etc.) there is a limited scope and diminishing returns from such efforts. More sophisticated policies to manage and reduce emissions will look at suppliers, logistics and operations – or in other words, the supply chain. The supply chain isn't just a source of carbon opportunity, but carbon risk. If carbon changes the cost structures, operating environments and resilience of businesses, supply chain collaborators will be aware of each others progress in adapting to a low-carbon economy. Progressive business, tackling the challenge of emissions reductions, will cluster together. Financial institutions, keen

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to mitigate the long-term costs of climate change adaptation, will favour investments that are carbon-light.

Supply chains will also better reflect the carbon costs of transportation. Physical locations of operations may change; low-energy operations may relocate, to reflect the carbon costs of transportation. High-energy operations may relocate to reflect the carbon costs of energy bottlenecks in a supply chain. Supply chain decisions for such operators will reflect the trade-offs between emissions from production and emissions from transportation. Regions with renewable energy bundles may become increasingly competitive; regions reliant on carbon-heavy energy may find themselves at a disadvantage.

Underlying the discussion thus far are some significant assumptions. It is assumed that carbon will have a price. It is assumed that monetized carbon will be around for decades to come, regulated, valued and traded. It is assumed that businesses around the world will be forced to consider carbon seriously. These assumptions are not guarantees. But this paper has shown that actors from all walks are embracing the idea of carbon; at the corporate level, energy efficiency, long term profitability and responsible branding have converged on carbon; at the political level, all forms of government, from cities to nations to international bodies, have begun forming policies to regulate carbon; and at the supply chain level, sustainable decisions, collaboration between partners and the physical design of the supply chain is poised to evolve. In short, betting against carbon is risky. This convergence toward a common cause demonstrates the potency of carbon, and demands critical thinking about the sustainable supply chains of the future.

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## **Annex One – Emission Factors Explained**

### **Harvesting, road-building felling, transport to sawmills**

The data used here was based on a study by the Forest Engineering Research Institute of Canada (FERIC, 1997) that found that 6.9L of diesel is used per m<sup>3</sup> harvested. This is equivalent to 18.5 kg CO<sub>2</sub>, 0.000816 kg CH<sub>4</sub>, and 0.000466 kg N<sub>2</sub>O, which expressed in CO<sub>2</sub> equivalency, is 18.66 kg CO<sub>2</sub>e per m<sup>3</sup> harvested wood converted to dimensional lumber

The Western Forest Products Alberni Pacific Division generated 269,000m<sup>3</sup> dimensional wood, 175,000m<sup>3</sup> chips, 307,000m<sup>3</sup> hog in 2008. The effective carbon footprint on all products is  $18.66 \times 269000 / (269000 + 175000 + 307000) = 6.7$  kg CO<sub>2</sub>e / m<sup>3</sup> chips. The final carbon footprint from harvest is  $6.7 \times 8.2 \text{m}^3 / \text{ADt} = 55$  kg CO<sub>2</sub>e / ADt

### **Sawmilling fibre into dimensional and residual products**

Based on WFP 2008 carbon footprint, APD scope I & II emissions = 5.5 kg CO<sub>2</sub>e / m<sup>3</sup> chips. At 8.2 m<sup>3</sup> chips per ADt, sawmill carbon footprint on paper basis = 45 kg CO<sub>2</sub>e / ADt.

### **Transport of chips to mills**

Estimate average return trip of chip trucks between Western Forest Products operations and Catalyst's mill is 100 km. Using IPCC emission factor of 1.02 kg CO<sub>2</sub>e/km from IPCC EF ID 19043, Carbon delivery of chips = 102 kg per truckload (at 3500 ft<sup>3</sup> equal ~ 100 m<sup>3</sup>) = 1.0 kg CO<sub>2</sub>e/m<sup>3</sup>. At 8.2 m<sup>3</sup> chips per ADt, carbon delivery footprint = 8 kg CO<sub>2</sub>e / ADt.

### **Conversion of chips to paper at Catalyst**

Based on Catalyst 2008 carbon footprint, Alberni scope I & II emissions = 185 kg CO<sub>2</sub>e / ADt.

### **Transport of paper to Quebecor World in Merced**

Based on supply chain logistics and recognised emissions factors, transport footprint = `

### **Printing of paper at Quebecor World in Merced**

Based on Heinz, 2006 study, surveyed printing facilities (Table 2) carbon footprint is 36 kg CO<sub>2</sub>e / ADt

### **Distribution of Paper from Merced to Retail Outlets**

Data is forthcoming. Total truck mileage will be divided by total print tonnage to derive kg CO<sub>2</sub>e per ADt.

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