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eQ Insights

Life Cycle Assessment of Paper Products: Part Three — The Carbon Footprint of Sappi's Somerset Mill and the Impact of Recycled Fiber

This brief is provided to offer guidance to our customers and other stakeholders seeking information regarding Life Cycle Assessment (LCA) as it applies to the greenhouse gas (GHG) emissions (or carbon footprint) of pulp and paper products made at Sappi's Somerset Mill, and the impact of displacing Sappi's virgin kraft pulp with deinked recycled fiber. The information can be used to help make informed decisions regarding carbon footprint of paper selections when buying paper.

There are many LCA studies with published results for the carbon footprint of printing and writing paper grades, including some with results that are based on industry average data. In order to make specific product claims, primary data is required, so Sappi chose to undertake a detailed analysis of our Somerset manufacturing operations, located in Skowhegan, Maine.

The information presented herein is based on Sappi's knowledge and expertise and is supported by the studies and documents included in the reference section.

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Summary

The carbon footprint estimations in this cradle-to-gate analysis of our Somerset Mill include emissions associated with every step in the papermaking process, from material acquisition to the finished product at the mill gate. We learned that the carbon footprint of pulp and paper grades made at the Somerset Mill is significantly lower than industry average, in large part due to the high percentage (>80%) of renewable energy we use to manufacture our products. Generally speaking, kraft pulping has a lower carbon footprint than mechanical pulping or deinking processes due to their greater need for electricity (which usually does not come from renewable resources).

Sappi is committed to continuous improvement in environmental performance and supports increased recycling of all paper grades. Graphic papers made on high-speed paper machines have high cleanliness requirements so that maximum process efficiencies are maintained. Contamination that makes it through cleaning systems can cause problems in papermaking—especially in the coating process where debris can lead to scratches or simply show up as dirt specks. Due to these cleanliness requirements, recycling systems that generate deinked fiber destined for use in graphic paper have higher fiber loss and consume more energy compared to systems that generate recycled fiber for use in other paper grades with lower cleanliness requirements (e.g., paperboard manu-

facturing). Recovered fiber for use in lower-grade products undergoes minimal processing, resulting in higher fiber yield, lower energy consumption and minimal waste; overall, resulting in lower environmental impact. We encourage readers to download *eQ Journal* #5, "Rethinking Recycling" (1), where the paper recycling process and the factors that impact fiber yield and energy consumption are described in more detail.

Our analysis of the Somerset Mill shows that using recycled fiber is not a one-size-fits-all solution; incorporating recycled fiber should be analyzed on a case-by-case basis. We determined that displacing 10% of our virgin kraft pulp with an equal amount of deinked recycled fiber increases the carbon footprint of our finished paper by 16%.

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Background

This paper is the third in a series on LCA and greenhouse gas reporting, also known as carbon footprint reporting. *eQ Insights* 4.1 provided an overview of the basics of LCA: what it is, the reasons for doing an assessment, the accepted methods that generate credible results, and some examples of LCAs focused on the paper and print industries (2). *eQ Insights* 4.2 provided a deeper discussion of the details of LCA methodology, and how case-specific assumptions made by each LCA practitioner can render different studies more or less comparable to one another (3).

Sappi Fine Paper North America's sustainability strategy drives internal goal-setting for improved performance in key areas. In 2008, we set a 5-year goal for a 40% reduction in greenhouse gas emissions from fossil fuels. By 2012 (4 years later) we surpassed that goal, achieving a 53% reduction (4). This goal not only drove our reduction efforts, but also drove the desire to more fully understand and develop in-house capability to measure and monitor our carbon footprint. *eQ Insights* 4.2 described how we "did our homework," which resulted in our selection of FEFPro™ (the Footprint Estimator for Forest Products, created by the National Council for Air and Stream Improvement [NCASI]), as the calculation tool we would use to undertake the most comprehensive carbon footprint analysis to date of our Somerset Mill. This edition of the series describes our approach and what we learned.

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Goal and Scope of the Study

The first step in every LCA is to set clearly the goal and scope of the analysis. The goal defines the questions the analysis will answer, while the scope sets the system boundaries and identifies the potential environmental impacts that will be measured, which in turn determines the level of detail and data required to adequately answer the study questions. We specifically wanted to measure the carbon footprint of Somerset pulp and finished paper, and we wanted to expand beyond our historical reporting of Scope 1 and 2 emissions to also understand our Scope 3 impact. Finally, we wanted to understand the impact that displacing virgin fiber with recycled fiber has on the carbon footprint of products made at the Somerset Mill.

Sappi has reported Scope 1 and 2 emissions for several years in our sustainability reports, through the Carbon Disclosure Project (5) and GreenBlue's Environmental Paper Assessment Tool (6). In doing this new work, we wanted to expand our analysis outside the mill gates to include Scope 3 emissions. A key decision to make at the outset was whether we would attempt to measure or estimate the Scope 3 greenhouse gas (GHG) contributions for all parts of the life cycle of our product from cradle (material acquisition) to grave (disposal or end-of-life). There are many steps in the life cycle of paper once our product leaves the Somerset Mill. These include distribution and storage at merchants' warehouses, design, printing and finishing of printed pieces, transportation and distribution to intermediate and end users, and finally, end-of-life handling. At end-of-life, paper products can be recycled, incinerated (with associated generation of energy), composted or disposed of in landfills. Given the difficulty of modeling and measuring this complex system, we made the decision to focus our efforts on a cradle-to-gate analysis, where we could generate results with much higher accuracy and allow for comparative analysis with the industry average.

Data in our analysis includes 2010 actual consumption of raw materials and fuels, as well as transportation from our suppliers to the Somerset Mill. Within our mill gates, our internal data is very detailed, which provides high accuracy for modeling our mill activities that impact GHG emissions. In choosing to include the Scope 3 GHG impacts of upstream materials to the "cradle," we accessed the best data available at the time when incorporating emissions factors for pulping and papermaking materials (7). For allocation of recovered fiber, the cut-off method is used. That is, the burdens of emissions from our virgin fiber production are not shared downstream with recovered fiber.

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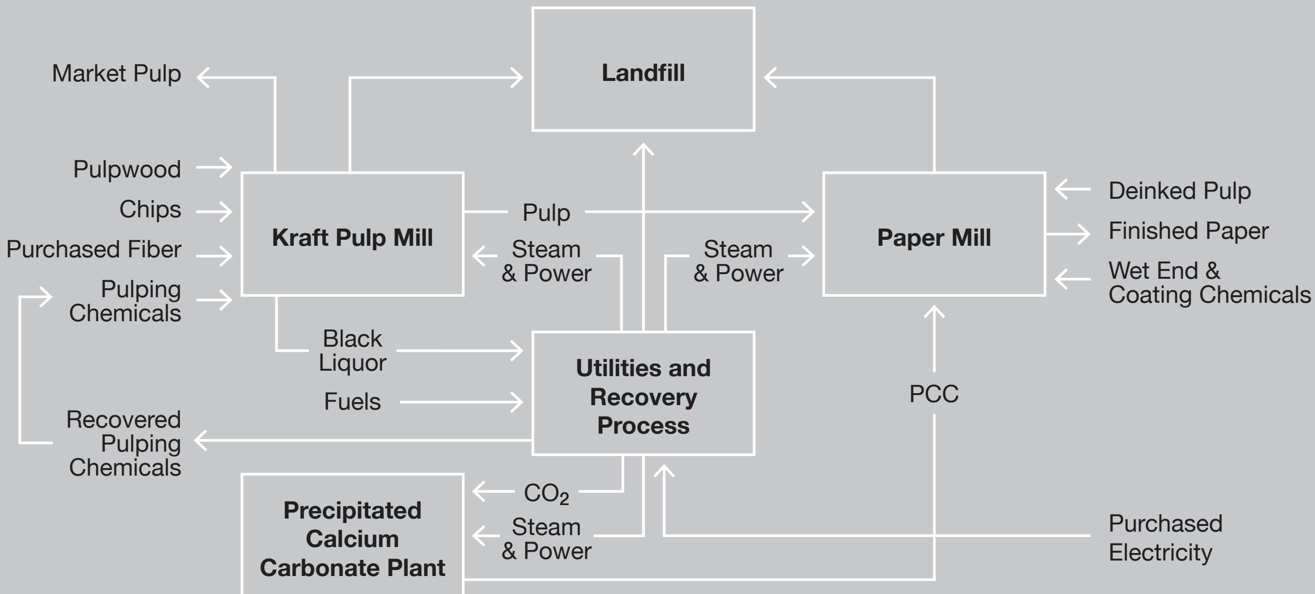
The Tool

The National Council for Air and Stream Improvement (NCASI) is an independent, nonprofit research institute that was established to provide technical assistance to the forest products industry in its quest to understand and lower its ecological impacts. NCASI scientists developed FEFPro™ to assist forest products companies in the calculation of carbon footprints for paper and paperboard products. It is an Excel®-based tool which has organized the calculations and emissions factors needed for completing a carbon footprint model. Our work with Dr. Richard Venditti of North Carolina State University, reported in *eQ Insights* 4.2, showed that results generated using the FEFPro™ modeling tool are essentially the same as those produced by NCASI using SimaPro™, an LCA software tool used by industry, research institutes and consultants internationally.

Integrated Kraft Pulp and Paper Mill

Figure 1



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Results for Pulping

The Somerset Mill is an integrated pulping and papermaking facility with a shared utilities and recovery process that operates using a high percentage of renewable fuels (primarily woody biomass and black liquor)(Figure 1). The shared utilities area provides steam and power for both the pulping and papermaking operations at Somerset. Since we wanted to be able to measure the carbon footprint of our pulp separately from the finished paper product, we allocated the shared utilities between pulp and paper manufacture so our analysis would reflect actual process GHG impacts as closely as possible.

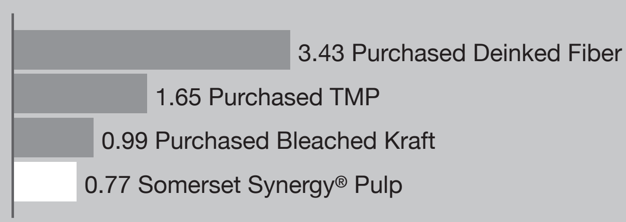
The Somerset Mill utilizes a continuous digester and a five-stage elemental chlorine-free bleaching process. Chlorine dioxide is generated on-site. The mill also hosts a precipitated calcium carbonate plant that supplies material for paper fillers and coatings.

In the cradle-to-gate study of Somerset Synergy® pulp, fuels combusted in our recovery and power boilers represent Scope 1 emissions, purchased electricity is Scope 2, and roundwood, chips, and pulping and bleaching chemicals are all Scope 3 materials. Results of this analysis (Figure 2) revealed that our mill generates virgin kraft pulp with a footprint of 0.77 kg of CO_2 eq per dry kilogram of pulp. This is roughly 20% lower than emissions factors provided for purchased bleached kraft, 50% lower than thermo-mechanical pulp and 77% lower than purchased deinked fiber (7). Integrated pulp and paper mills have a carbon emissions advantage compared to market pulp mills due to the fact that pulp doesn't have to be dried for transportation; it is pumped from the pulp mill to the paper mill on-site. Integrated mills also have a carbon emissions advantage compared to deinked fiber mills due to the ability to burn renewable fuels to generate steam and power, as opposed to using purchased electricity, which often is generated by burning coal.

Cradle-To-Gate Carbon Footprint of Common Wood Pulps Used in Papermaking (kg CO_2 eq/dry kg of pulp)

Figure 2

These life cycle estimations illustrate the carbon footprints of different pulp sources. Industry averages are not necessarily representative of specific suppliers and in all cases we recommend seeking out primary data sources.



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Results for Finished Paper

Our model for finished paper incorporates pulp manufactured on-site, purchased virgin and deinked pulps, and pigments, binders and papermaking chemicals used for developing sheet properties and improving process efficiency. Our analysis revealed that coated paper from Somerset has a significantly lower carbon footprint compared to North American industry average catalog-grade coated freesheet paper (Figure 3) modeled by Dr. Venditti using NCASI industry data and FEFPro™ v1.3 (8). We analyzed both the Somerset total mill production and 60# Somerset Web Gloss manufactured on #3 Paper Machine. Recycled fiber represents 3% of the total fiber weight in the industry average and 1.6% of the total yearly production at Somerset.

Cradle-to-Gate Carbon Emissions of Finished Paper (kg CO_2 eq/dry kg paper)

Figure 3

In an effort to better understand the data, we then looked at the subcategories of fuel, materials, purchased electricity and manufacturing waste. Table 1 shows that using renewable fuels in the power and recovery boilers at the Somerset Mill results in significantly lower carbon emissions compared to the industry average. When we take into account the electricity we don't have to purchase to meet our power requirements, the Somerset Mill's carbon emissions are 43% lower than the industry average.

In reviewing chemical consumption we found that our usage of sodium chlorate is higher than industry average. This usage is likely a reflection of the fact that the mill does not use extended delignification and thus relies more on bleaching stages to reach the final product specifications required to produce premium offset printing papers. Our pulping chemical inventory is also more expansive. We reported usage and emissions from 13 chemicals, whereas the industry average reflects only three.

Table 1

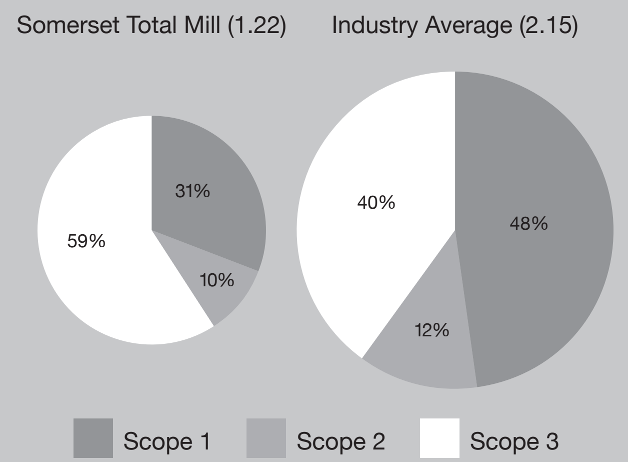
Emission Contributor	Somerset Emissions Compared to Industry Average
Wood and Fiber	-27%
Pulping Chemicals	101%
Papermaking Chemicals	-9%
Fuels	-68%
Purchased Electricity	-54%
Manufacturing Wastes	-40%

We also analyzed the impact of displacing 10% of our own virgin kraft pulp with deinked recycled fiber, and found that the inclusion of recycled fiber raises the carbon emissions of 60# Somerset Web Gloss by approximately 16%. This is a modest estimate because for some grades we found the increase in carbon emissions to be as high as 21%. Had we chosen to use a recycling allocation method that shared the environmental burden downstream with subsequent life cycles, such as recovered fiber, our results would have been even lower. As stated earlier, we chose to use the cut-off method in the analysis and assigned the entire environmental burden to our virgin pulp and paper production.

Figure 4 shows the summary of our results in accordance with the Greenhouse Gas Protocol scopes of reporting. The carbon emissions advantage from using renewable fuels can be seen again when comparing the Scope 1 and 2 emissions of the Somerset mill with the industry average. Again, this is due to our use of renewable fuels, resulting in lower purchased electricity consumption. Figure 4 also shows that the upstream emissions from Scope 3 materials make up the majority of the cradle-to-gate emissions associated with Somerset's pulp and paper production. This analysis has provided us with an understanding of the carbon footprint of our supply chain from raw material acquisition to finished paper at our mill gate.

Emissions by Scope (kg CO_2 eq/dry kg paper)

Figure 4



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Discussion

In the calculation of the overall carbon footprint of a product, service or system, the emissions factors for individual materials and the amounts of those materials consumed are combined and reported as CO_2 equivalents (eq) per the relevant unit of study; in this case kg CO_2 eq per dry kg of pulp or paper. This analysis and these results are specific to the materials consumed and the products made at Sappi's Somerset Mill using 2010 actual mill consumption data. Other key data for the analysis are (a) the emissions factors for each material which were compiled by NCASI in the FEFPro™ calculation tool (7), and (b) the industry average, North American coated free sheet data supplied by NCASI to Dr. Venditti. The industry average data is from 2006 paper industry participants reporting to the American Forest and Paper Association (AF&PA) and the Forest Products Association of Canada.

Manufacturers and the suppliers to our industry continue to evolve in the use of LCA and the reporting of material emission factors. Performance improvements (reduction in emissions) also continue to emerge. In fact, in the period 2005–2010, AF&PA member companies reduced GHG emissions by 10.5% (9).

In completing this analysis, we used what we believe to be the best available data. We have primary emissions data from our pulp suppliers that gives us confidence in the results of our analysis, yet we have agreed not to disclose specific supplier data as part of this study. Our experience tells us that most suppliers are very forthright in providing data to their customers, yet few are willing to share data publicly. Increased transparency across the supply chain in the form of updated material emission factors is necessary for improved accuracy over time. This is especially true in regard to emissions factors for deinked recycled fiber, as this is a critical element for understanding the carbon emissions impact of that fiber.

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Recommendations

A cradle-to-gate analysis allows us to measure the carbon footprint of our products, thereby providing the GHG emission factors that others downstream from our mill can use to measure the impact of their products made with our paper. By selecting an industry-accepted tool and providing insights to our methodology, paper buyers can request other paper suppliers conduct similar studies for comparative analysis.

We are working within our supply chain to increase discussion and measurement of carbon footprint, and believe other cradle-to-gate analyses from virgin and deinked pulp suppliers are needed. Analysis drives understanding, and understanding drives improvement.

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Next Steps

We've undertaken the same cradle-to-gate analysis of our integrated pulp and paper mill in Cloquet, Minn. We will use this information to update the eQ Tool and to incorporate the impact of recycled fiber on product carbon footprints.

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Conclusions

Ultimately, we have a deeper understanding of the significant contributors in our processes to the overall carbon footprint of Somerset coated graphic papers. We learned that Somerset Synergy® virgin pulp has a low carbon footprint when compared to some other pulping technologies, including deinked, recycled fiber. Displacing 10% of our own pulp with purchased deinked recycled fiber increases the carbon footprint of our paper by about 16%.

Recycling is a sound economic, social and environmental practice. Sappi encourages users to recycle as the preferred end-of-life option for paper. For grades that are difficult to recycle, composting and incineration with energy generation are preferable to landfilling. As consumers become more aware of end-of-life options, we envision a future where no paper is sent to landfills. Processing recycled fiber for use in lower-grade paper products is more cost-efficient and has a lower environmental impact than processing the same fiber for use in higher-grade paper products.

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All Web links valid as of September 25, 2013.

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We invite you to share your thoughts so that we can all benefit from innovative thinking and best practices. For questions and comments on this document, please email us at eQ@sappi.com.

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