A Comparative Life Cycle Analysis of Selected Resolute Paper Grades with North American Freesheet EXECUTIVE SUMMARY

INTRODUCTION

Resolute Forest Products commissioned a comparative life cycle analysis (LCA) to compare its Align paper grades with the North American freesheet market, because many of its customers are interested in the environmental attributes of Resolute's papers. The study was carried out according to the requirements of ISO 14044. A critical review was performed by a panel of three third-party experts.

Resolute manufactures several high brightness uncoated papers of the Align family at its paper mill in Alma, QC, with mechanical pulp and mineral fillers, which are sold as economical and ecological alternatives to uncoated freesheet (UFS). The six grades included in this study were:

- Equal Offset
- Ecopaque Offset
- Ecopaque Laser
- Ecopaque Jet
- Equal Offset Book
- Alternative Offset

In its Catawba, SC paper mill, Resolute manufactures the AbiBowMax paper grade, which is sold under the Align brand as an economical alternative to coated freesheet (CFS). AbiBowMax is made with a mix of mechanical and chemical pulps.

A ream of paper, consisting of 500 sheets of 8½ x 11 inch paper (or 30.16 m^2 of paper) was the functional unit chosen for this analysis. The function of all the paper grades analyzed is to provide a paper printing surface. Customers that print on Resolute uncoated freesheet substitute grades report that the sheets can be used interchangeably with UFS and perform at least as well under the same printing conditions. Mechanical pulp is bulkier than chemical pulp, which means that a lower-basis-weight sheet can be used to provide a sheet of the same thickness.

AbiBowMax is an 84 brightness paper grade made in Catawba, SC, containing about 15% mechanical pulp, and is sold as an economical alternative to CFS at 82 brightness and higher for the same applications. Although CFS and AbiBowMax are usually sold in rolls, the functional unit was again chosen as a 500-sheet ream, to enable easy life cycle inventory (LCI) comparisons between all products in the study.

In this cradle-to-grave analysis, inputs included wood fiber from the forest, chemicals and additives, fossil and biomass fuels and electricity, as well as all upstream inputs. Outputs included solid wastes, liquid effluent, and air emissions, as well as disposal of product at end of life. Recycling of the product was also taken into account. Transportation was included at each stage of the life cycle.

Product use by the printer and the end user was excluded from the study. Packaging of the ream was not included. In the study, Resolute paper grades were considered to have loss and recycling rates equivalent to those of the UFS and CFS they were being compared with.

A life cycle assessment of common North American paper grades was recently completed by the National Council for Air and Stream Improvement (NCASI) for AF&PA and FPAC [Ref. 1] and shared with the members of the LCA working group. Included in this study was UFS paper based on an aggregate of 31 paper mills that represent 75% of the industry. This paper is typically made with a mixture of softwood and hardwood chemical pulp, precipitated calcium carbonate filler and a surface treatment applied in a size press.

The NCASI study also looked at CFS used for catalogs. The LCI was based on 15 mills representing 80% of the industry.

Data for the Resolute paper grades were collected from each paper mill, representing the paper produced in calendar year 2010. Among the data included were data for wood supply, chemical use, energy use, environmental discharges to air, water and soil, and transportation distances and modes (truck or rail) for the ingredients.

The analysis was done with SimaPro™ 7.1 software. Potential environmental impacts were characterized with the IMPACT 2002+ impact assessment method, version 2.10 [Ref. 2], which is an internationally recognized method for LCA. The database used for the environmental impact of components was Ecoinvent, which is a model based on European inputs, but NCASI adjusted it for the North American electrical grid, using data from the International Energy Agency database to model the Canadian, Mexican, and U.S. production mix in 2005. A component was also added to calculate the carbon storage component from paper in landfill at end of life as well as the proportion of paper considered to be permanently stored due to product in use. This was included as a negative input to the Climate Change impact endpoint.

For the question of recycling of the product after it is used, and how this affects the allocation of life cycle impact values, the "Subsequent Uses" method was adopted. This allocates impacts between the first use of fiber and any subsequent uses as it is recycled. As in the NCASI study, it was considered that 71.8% of UFS is recycled, 23% goes to landfill and 5.2% is incinerated at end of life. For CFS converted into catalogs, it was considered that 32.7% is recycled, 54.8% goes to landfill and 12.5% incinerated at end of life.

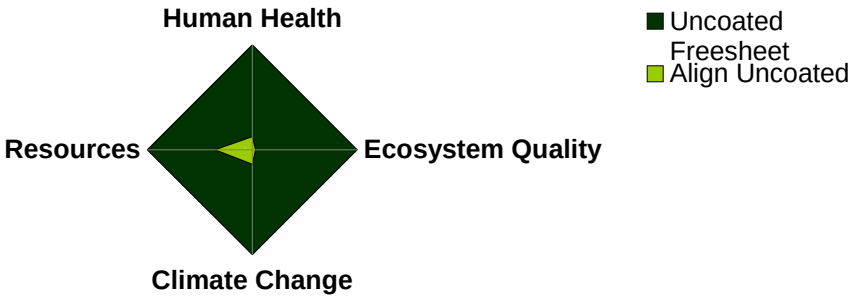
The IMPACT 2002+ methodology results in four endpoint categories of environmental impact. Scores were calculated for each of the six Align uncoated paper grades studied, and it was found that the scores were similar (±30% for climate change and ±10% for the other three endpoints) and thus an average of the six grades was used in all the graphs below.

RESULTS

Uncoated Paper

Shown in Figure 1 are the relative endpoint scores normalized to the UFS impact value for each endpoint category. The Align uncoated paper has a much lower footprint than UFS in all four categories.

Figure 1: Environmental Impact Comparison - Uncoated

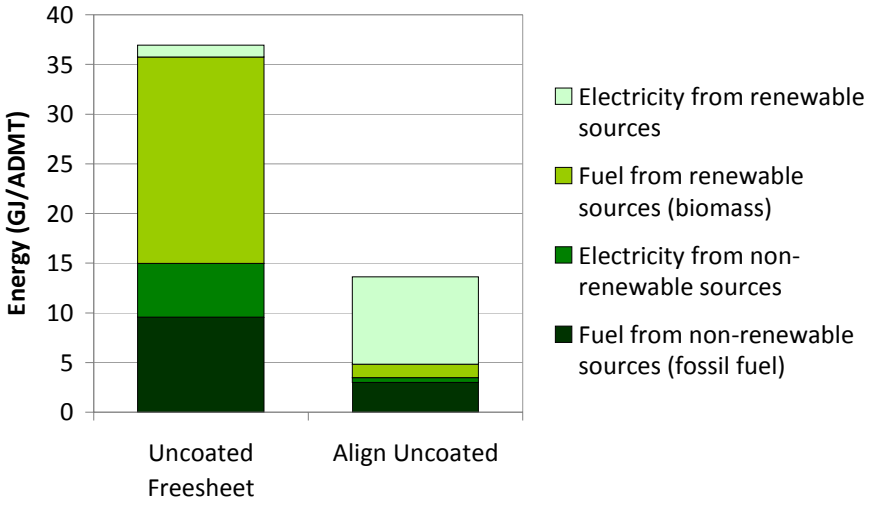


Analysis of the results shows that the principal reasons for the differences in impact scores between Align uncoated paper and UFS can be summarized as follows:

a. **Basis weight:** Align uncoated grades are lower in basis weight.
b. **Filler type:** Uncoated freesheet in North America uses calcium carbonate as a filler, whereas Align uncoated grades use a mixture of calcium carbonate and natural or synthetic clay.
c. **Pulp yield:** Kraft pulp has a yield of 45-50% from wood, compared to 93% for the mechanical pulp in Alma. This means about twice as much wood needs to be harvested and transported per ream of UFS paper.
d. **Chemicals used:** Kraft pulping and bleaching requires chemicals that are not used in mechanical pulping, such as sulphuric acid, sodium chlorate and oxygen. UFS also uses higher quantities of starch.
e. **Decomposition in landfills:** Mechanical pulp results in less methane emission and more carbon storage in the landfill.

f. **Energy:** The kraft process requires much more steam to drive the process than the mechanical pulping process. Although about half of this energy comes from the wood itself, the amount of fossil fuel and hog fuel used are also much higher. Mechanical pulp uses more electricity than kraft pulp, but some of the electrical energy is used to generate steam in the process, which offsets the purchase of other steam fuels. The electricity grid in Quebec is about 95% from hydro-electric power, which has a very low carbon footprint, compared to the average power grid for the production of UFS in this study, which uses more fossil fuels such as coal. (See Figure 2)

Figure 2: Energy Analysis for Align Uncoated Paper vs. UFS



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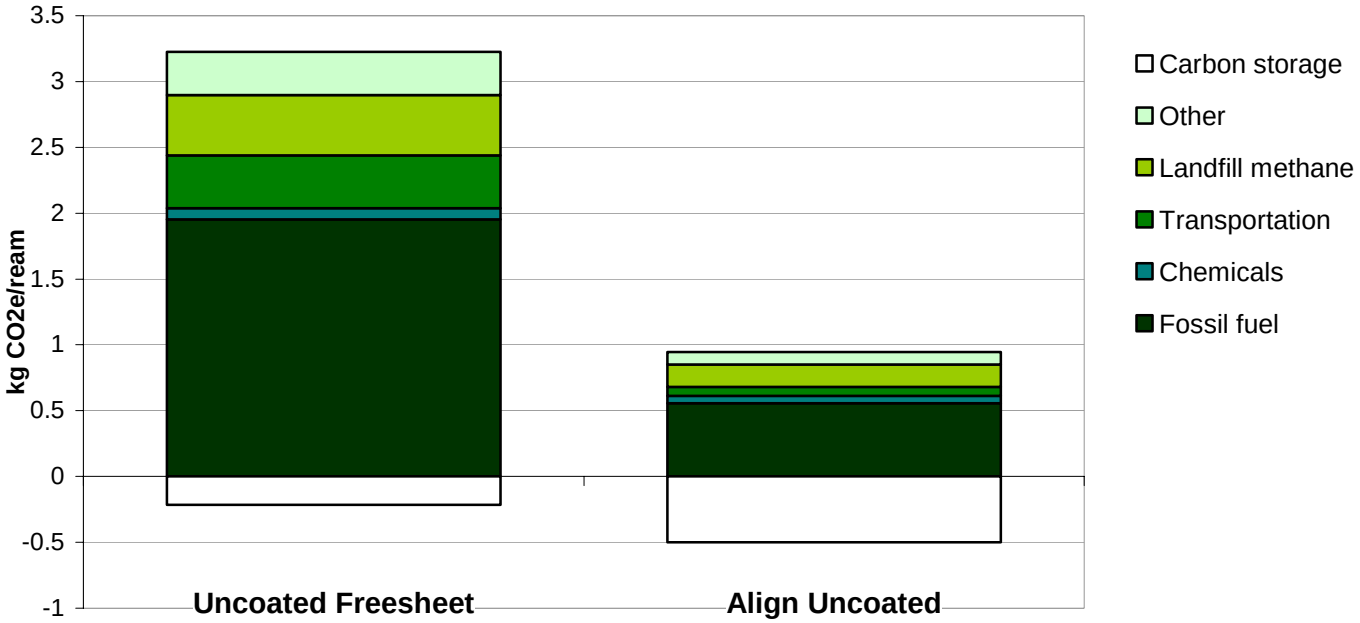
The climate change impact data were analyzed further to determine what individual processes in the life cycle contribute to the impact scores. The results of this analysis are shown in Figure 3. There are significant differences in carbon footprint from each process depicted in the life cycle. The overall carbon footprint for UFS (emissions minus storage) is 3.0 kg CO_2 equivalent for a ream of UFS paper and 0.44 kg on average for Align uncoated paper.

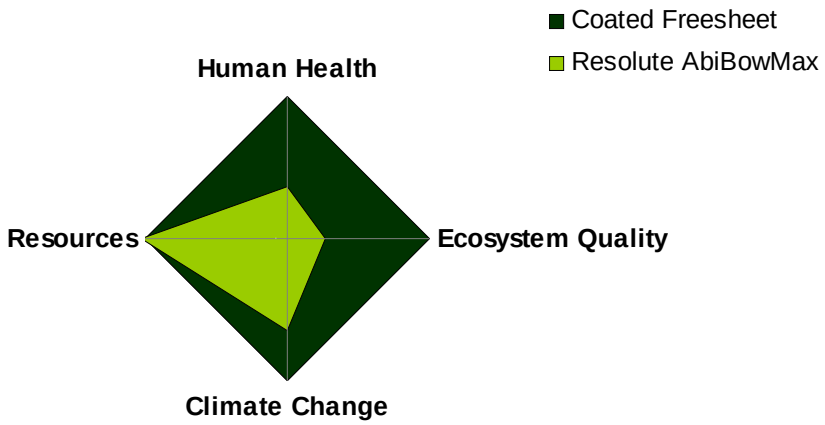
Figure 3: Detailed Carbon Footprint of UFS and Align Uncoated Grades



Coated Paper

In Figure 4, the endpoint impact scores are seen for Catawba's AbiBowMax sheet, compared with CFS. The impact scores are significantly lower for Human Health, Ecosystem Quality and Climate Change, but are about equal for Resources.

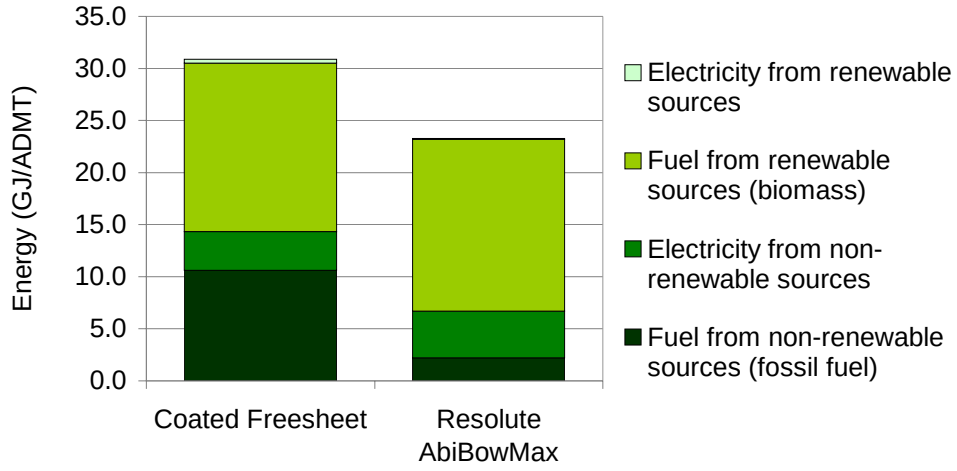
Figure 4: Environmental Impact Comparison - Coated



The principal reasons for the difference in impact scores between Align coated paper and CFS can be summarized as follows:

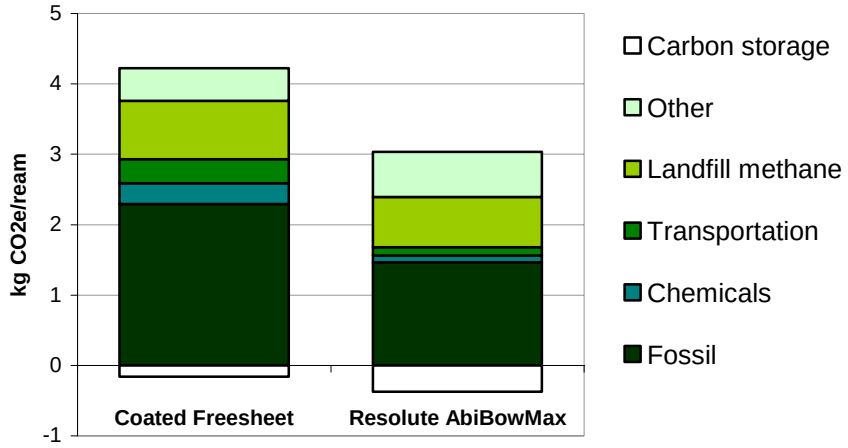
a. **Basis weight:** The Align coated grade used for the comparison was a lower basis weight (45# vs 50# CFS). Customers usually make the substitution of CFS at this basis weight due to higher bulk.
b. **Mechanical pulp:** The presence of 15% mechanical pulp in the Align coated paper - as well as enabling the basis weight reduction - means less wood harvesting and transport, and less emissions, resulting in lower Human Health and Ecosystem Quality scores.
c. **Energy:** As shown in Figure 5, the amount of biomass fuel is about the same for the two products, but Align coated paper manufacture uses significantly less fossil fuels at the mill site. Overall Align coated uses about 10% more purchased electricity. The Resources score in Figure 4 is related to the total amount of non-renewable energy. The South Carolina electrical grid is about 97% from non-renewable sources such as nuclear, coal and gas, whereas the mills in the UFS sample have on average only 81% non-renewable electricity sources. Combining all these factors gives a Resources score that is about equal.

Figure 5: Energy Analysis for CFS and Align Coated Paper



The climate change impact data for Align coated paper were analyzed in detail, and the results are shown in Figure 6. Fossil fuel use (both for steam and in the electrical grid) is significantly lower, as are emissions associated with chemicals and transportation. Carbon storage is also higher for Align coated paper, resulting in a decrease in climate change impact.

Figure 6: Detailed Carbon Footprint of Align Coated vs. CFS



GENERAL REMARKS

Life cycle analysis is not an exact science. Certain assumptions were made during this study, using expert judgment. This can affect the uncertainty of the results. The most uncertainty is associated with toxicity-related releases and releases from landfills, since measurements are made infrequently, and reporting requirements are different in the U.S. and Canada. The most accurate input data are associated with amounts of pulp, minerals and chemicals used in the sheet and the amount and types of energy used. Several sensitivity studies were performed to ensure that the assumptions made in the study were valid, and to better understand the results. No significant changes were found to the results presented above.

The UFS and CFS grades referred to in these conclusions are calculated aggregates of UFS and CFS manufactured in North America. Some individual mills would have higher impact scores and some would have lower impact scores than this calculated average.

A critical review was carried out by a third-party expert panel. The panel commented that “the report was clearly written, easy to understand and well illustrated, data sources were mostly clearly explained and no major inconsistencies or issues with the results, analysis and conclusions were found.”

The panel also made suggestions for improvement of the study to improve transparency and satisfy ISO 14044 compliance. In response to these comments, more details were added on the sources of data and the calculations involved, and six sensitivity analyses were added to the study.

REFERENCES

1. *Life cycle assessment of North American printing and writing paper products, Final Report*, prepared for AF&PA and FPAC by NCASI, June 18, 2010.

2. O. Jolliet, M. Margni, R. Charles, S. Humbert, J. Payet, G. Rebitzer, R. Rosenbaum, Impact 2002+: A new life cycle impact assessment methodology, International Journal of Life Cycle Assessment 8 (6) (2003) 324–330.

CONTACT INFORMATION

For details, please refer to the *LCA Report to Third Parties*, which is available on the Resolute website at www.resolutefp.com/LCA. You can reach us at eco.info@resolutefp.com with any questions or comments.