Renewing Rock-Tenn:

A Biomass Fuels Assessment for Rock-Tenn's St. Paul Recycled Paper Mill

EXECUTIVE SUMMARY




Green Institute

Carl Nelson, Principal Investigator

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City of St. Paul
St. Paul Port Authority
Ramsey/Washington County Resource Recovery Project Board
Resource Recovery Technologies (RRT)
Eureka Recycling
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Cover photos, from left to right: 1) Rock-Tenn plant workers (St. Paul Port Authority); 2) Collecting forest residues in Northern Minnesota (IATP); 3) Farmers with switchgrass crop (NREL); 4) Rock-Tenn recycled paper receiving area (St. Paul Port Authority)

Executive Summary

The Rock-Tenn St. Paul mill is the largest paper recycling plant in the Upper Midwest, recycling 1,000 tons of paper per day and employing approximately 500 people. It is also one of the largest energy users in the Twin Cities. Since the mid-1980s, Rock-Tenn has received its process steam via pipeline from the Xcel Energy High Bridge coal-fired power plant near downtown St. Paul. The High Bridge plant is closing by the end of 2007, to be replaced by an adjacent natural gas-fired power plant currently under construction. Thus this source of steam will no longer be available, and Rock-Tenn must find another energy source.

A recent study commissioned by Ramsey and Washington Counties looked at the potential for combusting processed municipal solid waste, known as refuse-derived-fuel (RDF), to meet Rock-Tenn's energy demand. Any plant would likely not come on-line before 2012, given the long lead times for permitting, finance and construction. Rock-Tenn will use its four fuel-oil/natural gas backup boilers as an interim energy source.

Helping Rock-Tenn find another viable energy source is important to maintaining a stable manufacturing jobs base, improving how our region deals with solid waste, preserving our air quality, and increasing the sustainability of our energy sources. After extensive discussions during the first half of 2006, the Green Institute was contracted by a diverse group of private industry, governmental, and nonprofit organizations to conduct an independent assessment of biomass fuels other than RDF. A technical advisory committee of top biomass experts was also assembled to assist with the project. In addition to Rock-Tenn and the Green Institute, the project was sponsored by the City of St. Paul, Ramsey/Washington Counties, the St. Paul Port Authority, Eureka Recycling and Resource Recovery Technologies (RRT).

The Green Institute is a nonprofit dedicated to sustaining the environment and communities through practical innovation. We operate a $2 million salvaged building materials enterprise known as the ReUse Center/DeConstruction Services, which reclaims for resale more than 4,000 tons of material per year that would otherwise be landfilled. We also have active green building and community energy programs. Our staff have extensive sustainable energy experience through developing the state's largest solar electric system, starting a neighborhood energy conservation program, and conducting pre-development of a 20-megawatt biomass energy project with funding from the U.S. Department of Energy.

Available Quantities and Market Dynamics

A plant large enough to meet Rock-Tenn's current energy demand would require approximately 225,000 wet tons per year of mixed biomass from the sources considered here.[1] This estimated demand is roughly 90 percent of District Energy St. Paul/St. Paul Cogeneration's current use of biomass fuel. The project team considered five broad categories of biomass fuel as described below.

Urban Waste Wood

Urban waste wood comes from the following sources:

- tree residues from tree trimming, tree removal and land clearing for development
- construction and demolition wood
- waste wood from secondary wood processors, such as cabinet shops
- waste wood in the municipal solid waste stream

[1] Actual volumes will vary from about 175,000 to 250,000 wet tons, depending upon the moisture and heat content of the fuels, and the plant's thermal demand.

Although total quantities of urban tree residues in the Twin Cities can be large, available quantities are limited and highly variable. Urban tree residue amounts fluctuate considerably, depending primarily on storm events, consumer demand for tree trimming, housing development activity, and tree diseases. District Energy St. Paul/St. Paul Cogeneration is the largest consumer of tree residues, followed by mulch wholesalers. A significant quantity of mulch is used locally as well as being exported from the Twin Cities to other markets by wood processing companies.

Construction and demolition (C&D) wood waste has low moisture content, which makes uncontaminated C&D wood valuable for several markets, primarily the animal bedding market. Uncontaminated secondary wood from businesses such as cabinet and millwork shops in the Twin Cities area is also in high demand, leaving very little uncommitted wood from these sources. In contrast to these "clean" sources, composite wood (such as plywood), painted wood and other wood with industrial compounds are found in large quantities in the C&D and secondary wood waste stream. Appropriate combustion and pollution control equipment would be required to destroy the compounds and reduce emissions from these types of C&D wood.

There is significant wood waste in the municipal solid waste (MSW) stream, but it is challenging to extract this wood once it is commingled with other MSW sources. Policies to encourage diverting wood before it enters the MSW stream would increase wood availability for Rock-Tenn and other purposes.

Milling Residues: Oat Hulls

Oat hulls are the primary milling residue generated in the Twin Cities that would be appropriate for boiler fuel. Although significant quantities are generated, contracts are in place for nearly all of this resource, the majority of which is destined for other biomass energy projects.

Agricultural Residues: Corn Stover

Corn stover is the residue that remains on the field after harvesting the grain. The amount that can be collected is limited by the collection efficiency and by the portion that must be left on the field for ecological and soil health reasons. Experience with collecting, baling, storing and processing corn stover for boiler fuel is not extensive, but limited research suggests that it can be a viable biomass energy source. Many energy conversion technologies (e.g., boilers) are limited in the amount of high-alkali agricultural sources, including corn stover and grasses, they can use. Because of the short harvest window for corn stover, storage is a key logistical concern. Within 50 to 100 miles of Rock-Tenn, there is more than enough corn stover to provide all the fuel needs of the plant. However, over the next 20 years, significant quantities of corn stover will likely be diverted to liquid biofuel production such as cellulosic ethanol.

Dedicated Energy Crops: Grasses

Perennial grasses are not currently grown in large quantities for crops, but farmers could convert other farmland to grasses. Because grasses provide considerable environmental benefits compared to conventional row crops, farmers might qualify for payments through an agricultural program that promotes conversion to grasses. This would reduce the cost and increase the economic viability to Rock-Tenn of this fuel source. It could also apply to other perennial crops not considered here, such as willow trees. As with corn stover, storage is a key logistical issue with grasses.

Forest Residues

Residues generated from commercial logging operations are the most accessible source of forest biomass for boiler fuel. Guidelines are currently being developed to provide for the sustainable removal of this biomass source, which consists primarily of the tops and limbs of harvested trees. Although sources of logging residues are well outside of the metropolitan area, large quantities are available.

Other forest residue sources may be available to Rock-Tenn, though less data exists on their suitability. These include forest thinning, brushland sources, and ecological restoration of state, county and regional forests in and near the metropolitan area. Further research and discussion with stakeholders is necessary to fully evaluate these sources.

Table 14 from the main body of the report, replicated below, presents a summary of the project team's assessment of availability of biomass sources. "Mean quantity generated" is the estimated total amount generated in proximity to Rock-Tenn. "Current availability" deducts from this amount quantities unrecoverable and currently destined for other markets. Because various fuels have different levels of moisture (from 10 to 50 percent), we convert to dry tons to facilitate a fairer comparison among fuel sources. The project team also considered future demand from other sources and the long-term availability to Rock-Tenn, as Rock-Tenn will need access to reliable sources of fuel for at least 20 years. The project team also conducted a subjective assessment of the uncertainty of the mean estimates (the "+/-" columns) and calculated the proportion of plant demand that could be met with long-term fuel supplies.

Costs and Procurement Strategy

Rock-Tenn expects to use natural gas and fuel oil as interim fuel sources, but believes that a plant operation based solely on natural gas fuel is not economically viable. However, the economics of a natural gas plant provide a reference point for considering the economic viability of a biomass-fueled plant. Industrial natural gas prices are projected to be in the range of $5.50-$9/MMBtu[2] over the next 20 years, with significant potential for volatility from year to year. In comparing biomass with natural gas, it is necessary to consider the cost of non-fuel expenses (such as operation, maintenance, capital, and financing) as well as the fuel costs. The project team conducted a screening analysis of a several plausible scenarios for non-fuel costs for a Rock-Tenn biomass and natural gas plant, summarized in Figure 11 of the main report, and replicated below. For natural gas, non-fuel expenses are estimated to be near $1/MMBtu. Thus the reference price that a biomass plant would need to outperform is $6.50-$10/MMBtu (non-fuel costs + estimated fuel costs).

Non-fuel costs for a biomass plant are heavily dependant on financing assumptions, as well as assumptions regarding required pollution control equipment, involving both capital and operating costs. Total non-fuel costs for biomass are estimated to range from $6 -$13/MMBtu. Thus, to meet the test of beating natural gas generation cost, biomass fuel costs must range from a negative fuel cost to $3.50/MMBtu, depending on assumptions of natural gas costs and biomass non-fuel costs. The lower range of the biomass non-fuel costs assumes a project with secure fuel access and other factors reducing project risk and allowing access to low-cost financing, as well as limited pollution control equipment. The upper range assumes the use of advanced pollution control equipment, such as would be required for combusting RDF, contaminated C&D, and possibly other biomass fuels depending upon natural or human-caused contamination. Financing and other variables, such as grants or lower interest rates, may have potential for reducing costs (or increasing costs) from those presented here.

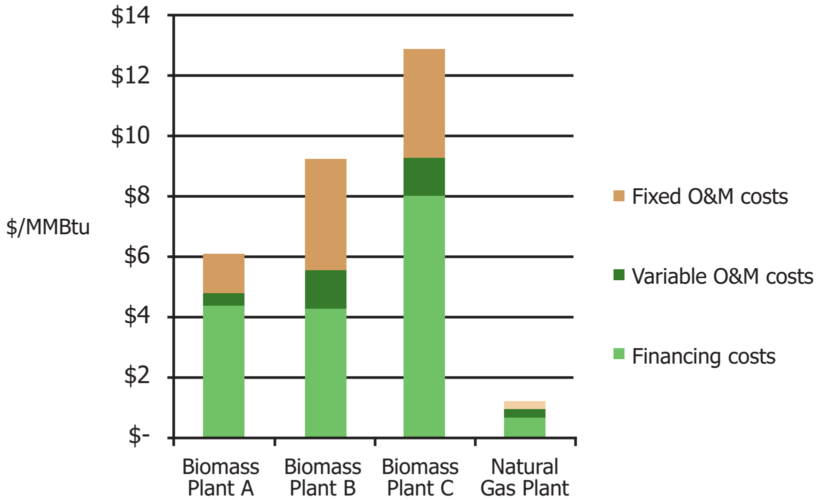
[2] MMBtu = million British thermal units, a measure of heat content. For reference, 1000 cubic feet of natural gas contains the heat equivalent of approximately one MMBtu.

Table 14: Summary of estimated quantities of non-RDF biomass available to Rock-Tenn

	Mean Quantity Generated			Current Availability	Long-term Availability		
Biomass Source	**Wet Tons**	**Dry Tons**	**+/-**	**Dry Tons**	**Dry Tons**	**+/-**	**Proportion of Plant Demand**
Urban waste wood							
Urban tree residue							
Tree trimming and removal	300,000	195,000	25%	--	--		
Land clearing	150,000	97,500	100%	--	--		
Subtotal Urban Tree Residue	*450,000*	*292,500*	*40%*	*26,000*	*5,000*	*200%*	*3%*
Secondary wood sources	132,000	118,800	30%	9,000	3,000	200%	2%
C&D wood							
Clean wood	77,500	69,750	25%	12,000	5,000	100%	3%
Other wood (composites/painted/treated)	313,000	281,700	25%	140,000	70,000	50%	45%
Subtotal, C&D wood	*390,500*	*351,450*	*25%*	*152,000*	*75,000*	*60%*	*48%*
Clean wood in the MSW stream	84,000	67,200	20%	0	0		0%
Other wood in the MSW stream	48,000	40,800	20%	0	0		0%
Subtotal all urban wood sources	*1,104,500*	*870,750*	*30%*	*187,000*	*83,000*	*60%*	*53%*
Milling residues: oat hulls							
Twin Cities	80,000	72,000	10%	9,000	4,500	200%	3%
Imported from Canada	25,000	22,500	20%	22,500	11,000	200%	6%
Subtotal	*105,000*	*94,500*	*15%*	*31,500*	*15,500*	*200%*	*9%*
Agricultural residues: corn stover	6,000,000	4,900,000	30%	400,000	60,000	50%	38%
Dedicated energy crops: grasses (assuming corn conversion)	0	0		0	60,000	50%	37%
Subtotal[3]	*6,000,000*	*4,900,000*	*30%*	*400,000*	*90,000*	*50%*	*56%*
Forest residues							
Logging residues	207,000	103,500	50%	90,000	30,000	75%	20%
Forest thinning/ecological restoration	n/a	n/a		n/a	n/a	--	--
Brushlands	95,000	47,500	100%	n/a	n/a	--	--
Subtotal forest residues	*302,000*	*151,000*	*75%*	*0*	*30,000*	*150%*	*20%*
Total, all sources	**7,511,500**	**6,016,250**	**40%**	**618,500**	**218,500**	**50%**	**138%**

[3] Subtotals of corn stover and grasses are not the total of their individual estimates, because some corn land is assumed to be converted for grass production, thus limiting the amount of corn stover available when totaled with grasses.

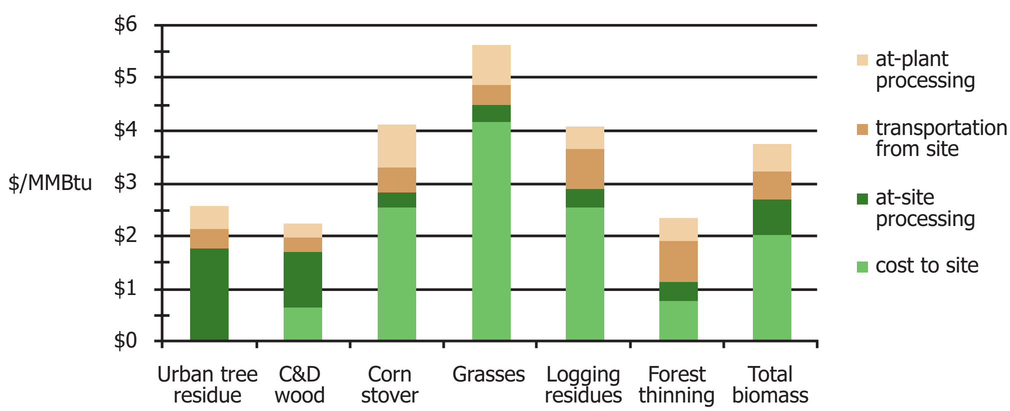
Figure 11: Comparison of estimated biomass and natural gas non-fuel operating and maintenance costs



Although it is beyond the scope of this study to consider financing issues, a cursory analysis suggests that several financing issues will be critical to the plant's success, including securing a long-term energy purchase agreement perhaps with several parties, securing fuel supply contracts, having an experienced operator, and access to low-cost debt financing. Recent state increases in renewable energy requirements for utilities and federal steps toward a carbon dioxide cap and trade program could help improve the financing outlook for the plant.

The project team developed a cost model for biomass fuels. The purpose of the model is to provide a rough estimate of the delivered cost of fuel under a given set of assumptions. The model is limited in that it does not consider supply and demand dynamics that can affect pricing, and is dependant upon a particular set of assumptions. Scenarios were developed from this model for providing 15 percent, 30 percent, 60 percent and 100 percent of the fuel needs of Rock-Tenn with biomass. Figure 20 from the text of the report, reproduced below, presents the results of the 100 percent biomass scenario.

Figure 20: Estimated fuel costs ($/MMBtu) for Scenario D, 100 percent urban wood waste, agricultural fuels and forest residues



It is important to remember that the fuel costs shown in the figure above must be added to non-fuel costs to estimate the ultimate cost of producing steam from these biomass sources.

Conclusions and Recommendations

The following conclusions and recommendations were developed by the project team in collaboration with the technical advisory committee (see Appendices A and B).

Availability of biomass:

- There are sufficient quantities of biomass fuel sources within 75 to 100 miles of Rock-Tenn to provide all of Rock-Tenn's energy needs. However, considering current and projected future demand for these sources, no single source of biomass considered in this study could supply all of Rock-Tenn's long-term fuel needs. The one possible exception is agricultural sources, which could be sufficient if a long-term fuel contract were signed with an entity (or entities) with the necessary capabilities and assets to securely back up a 20-year contract.
- All biomass options will necessitate highly controlled combustion practices and appropriate pollution control technology.
- Uncommitted urban tree residues are extremely limited, and in some years may be able to provide about 15 percent of Rock-Tenn's fuel needs, but annual availability fluctuates considerably and supplies cannot be relied upon.
- There is enough C&D wood to supply a significant proportion of Rock-Tenn's fuel needs, but the use of some C&D wood will trigger a higher threshold of environmental review and the possible need for additional pollution control equipment.
- Agricultural sources could provide at least one-third of Rock-Tenn's fuel needs (potentially more if long-term contracts were in place to offset the risk of increasing demand for biofuel production).
- There is increasing demand and pricing pressure for agricultural milling residues such as oat hulls, so this should not be considered a significant fuel source for Rock-Tenn.
- There is sufficient wood from logging residues and other forest sources within 100 miles to provide a significant portion of Rock-Tenn's fuel needs; but because of the distance, only a portion of this resource should be used.

Costs and Procurement Strategy:

- Obtaining low-cost financing will be critical to the success of the project.
- Maintaining supply-chain control over at least one-third of the plant's biomass fuel requirement will be essential.
- Conversion technology alternatives should be evaluated in part for their ability to use a wide range of biomass sources.
- Our modeling of fuel costs suggests that a 100 percent biomass option using a blend of the fuel sources considered in this study might cost approximately $4/MMBtu. Based on our screening analysis of non-fuel costs of biomass, this may be too expensive for the project to bear, even in our low-cost scenario of biomass non-fuel costs. This suggests that further work is necessary to find the ideal fuel mix and technology choice combination for a financeable project. In addition, some biomass sources, such as C&D wood, may incur other costs such as pollution control upgrades.

Recomendations

Ultimately, the development team will need to decide on a fuel mix and conversion technology that will result in a plant that can be financed and built. The information provided here is expected to help with that decision, but a broader consideration of issues as well as a comparison with the previous RDF study will be necessary. The following are recommended next steps for the development team:

- Conduct further analysis of C&D sources, including an assessment of pollution controls required and discussions with policymakers on future C&D policy changes.
- Consider the viability of a C&D source separation program.
- Work with other stakeholders who are convening a forest-thinning task force to develop a framework for capturing benefits of forest thinning while providing an additional biomass source for Rock-Tenn.
- Work with policy makers, environmental and conservation groups, and other stakeholders to further evaluate perennial grasses and other perennial crops and the potential for state or federal dollars providing a co-benefit payment to improve the economic viability of this source.
- Consider financing energy-efficiency upgrades at Rock-Tenn as part of the plant financing package.
- Begin discussions with farm organizations that may be able to contract for agricultural biomass fuels.
- Continue to refine urban tree availability estimates.
- Consider using innovative conversion technology such as gasification for meeting all or a portion of Rock-Tenn's thermal needs.