A technical and economic assessment was made of the technical feasibility and economic impact of producing ethanol by extracting hemicellulose from loblolly pine chips and converting the extracted hemicellulose to ethanol. The analysis was based on a biorefinery scenario in which an extraction and fermentation plant is integrated with a kraft pulp mill for mass and energy exchange. The wood chips are pulped after extraction of hemicellulose to produce fiber for paper or paperboard production.

Extraction conditions, extract yields and composition, and pulping conditions versus fiber yield and residual lignin content (kappa number) were based on data from three sources. Yield and kappa versus pulping conditions were taken from Elmore.[1] The amounts of wood biomass extracted versus extraction conditions were taken from Rydholm.[2] The composition of the material extracted was taken from recent data obtained by Ragauskas.[3] A numerical model was developed that relates extraction and pulping yields, extract composition, and pulp composition to extraction and pulping conditions. This model became the basis for calculation of mass and energy balances around the extraction and ethanol plant and the pulp mill. Based on this and other information,[4] raw materials, energy, and the size and cost of capital equipment were estimated. A profitability analysis and an analysis of the sensitivity to key process and economic parameters were performed for different operating scenarios.

Because there are two major products, the profitability of a biorefinery that produces both cellulose fiber and ethanol depends upon the selling price of each. The results of this analysis indicate that, at reasonable selling prices for cellulose fiber, co-production of ethanol from hemicellulose from loblolly pine can be profitable when wholesale bulk ethanol prices are as low as ~$1.25/gal. Other key variables that impact profitability are the ratio of hemicellulose to other biomass removed during extraction, the change pulp yield from wood chips after extraction versus without extraction, the value of electrical power, and the cost of biofuel.

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[1] Elmore, Carl L., "Method of Producing Kraft Pulp Using an Acid Prehydrolysis and Pre-Extraction" Inventor: United States Patent No. 4,436,586 March 13, 1984. Assignee: Kamyr Inc.

[2] Rydholm, S.A., *Pulping Processes*, John Wiley & Sons, New York (1965), p. 649-672.

[3] Ragauskas, A.J., unpublished research results.

[4] R. Wooley, R. J. Sheehan, K. Ibsen, H. Majdeski, A. Galvez*, Lignocellulosic Biomass to Ethanol: Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis - Current and Futuristic Scenarios.* NREL/TP-580-26157, National Renewable Energy Laboratory, Golden, CO, July 1999.