Feasibility Study for Biomass Electrical Generation on Tribal Lands

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The St. Croix Chippewa Indians of Wisconsin (the "St. Croix Tribe") intends to build two biomass-fired power plant projects to be located on tribal trust land in Danbury and Hertel, Wisconsin. For nearly two years, the St. Croix Tribe has been actively examining the feasibility of constructing and operating biomass-fired power generation facilities.

The goals of the St. Croix Tribe are to develop economically viable energy production facilities using readily available renewable biomass fuel sources at an acceptable cost per kilowatt hour ($/kWh), to provide new and meaningful permanent employment, retain and expand existing employment (logging) and provide revenues for both producers and sellers of the finished product.

These projects will create urgently needed tribal employment opportunities and revenues, while providing energy in an environmentally sound manner. In addition to helping to meet area power demands, the projects will help reduce dependency on imported non-renewable energy sources.

These projects are of enormous importance to the St. Croix Tribe in terms of its economic diversification and job creation. It will also be important to the region as a whole as both Wisconsin and Minnesota are moving toward requiring increased emphasis on renewable power and there is a projected shortage of power generation in an area of increasing population and business growth. Moreover, we believe that this project (together with an additional gas-fired peaking project) can serve as a catalyst for creating an energy-producing Tribal network serving markets in Michigan, Wisconsin and Minnesota. Locating power generation facilities on tribal lands throughout the three-state region has many advantages:

- It will increase service reliability without the need for expensive and controversial new transmission lines,
- It will replace less environmentally friendly "mega-projects" in the market, and
- It will create much needed economic development opportunities, and diversification from reliance on gaming.

1.2 BACKGROUND

Among the Tribe's significant assets and resources are its political status, cultural identity, legal rights and unique opportunities for economic development as a tribal entity. Historically, tribes surviving into the 20th Century were highly adaptive in maintaining a balance between both natural resource-centered and people orientated philosophies. Maintaining a connection to the earth while transitioning into the 21st Century is a significant tribal goal. We will continue to hold to our traditional visions of community renaissance and values. Sustainable, efficient resource development requires the tribal nation to support the individual by creating

an environment in which the whole community can thrive and prosper. The continued protection and utilization of tribal rights of sovereignty and self-determination are key strategic elements to achieve a higher quality of life.

Currently, gaming operations are the primary resource and asset that most tribal governments possess to help improve the persistent poverty prevalent on Indian reservations. If the Tribes do not seek to diversify and add to these successes, their gains may be only temporary and fleeting.

Beginning in the mid-1990s, the St. Croix Tribe initiated efforts to diversify its tribal economy. After almost a decade of planning, development work and construction, the Tribe placed an aquaculture facility into operation in the fall of 2001. This facility is located on trust land at Danbury, Wisconsin (the northwestern portion of the state). This is a state-of-the-art, recirculating aquaculture facility. It is over 160,000 square feet in size and is one of the country's largest. Currently, Yellow Perch, Large Mouth and Hybrid Stripe Bass are raised to market size and thereafter sold as food products.

In the spring of 2002, to further diversify its economic base, the St. Croix Tribe began to examine the possibility of developing one or more electrical generation facilities on its tribal lands. As a result, a gas-fired peaking project has been planned for development in Hertel, Wisconsin adjacent to the tribal headquarters.

In furtherance of its efforts to diversify the Tribal economy from its primary reliance on gaming, the St. Croix Tribe applied for, and received during the spring of 2003, a grant under the U.S. Department of Energy's "Renewable Energy Development on Tribal Lands" initiative. This document is our final report to the DOE. This study includes an assessment of available biomass fuel, technology assessment, site selection, economics viability given the foreseeable fuel and generation costs, as well as an assessment of the potential markets for renewable energy.

This effort has identified two viable biomass-fueled renewable energy projects using proven technology and available and proximate fuel supplies:

- A 1 to 3 megawatt (MW) wood chip burning power generation facility located on trust land adjacent to the Tribe's state of the art St. Croix Fishery located in Danbury, Wisconsin, and
- A 1 to 3 MW wood chip burning power generation facility located on trust land near the Tribal Headquarters in Hertel, Wisconsin.

Our assessment has shown that project viability is highly dependent upon resolution of two issues:

- Market price for generated renewable power, and
- Delivered price of wood chip fuel.

From a market perspective, a combination of factors makes this an ideal time to develop the St. Croix Tribe's biomass projects:

- The Wisconsin Task Force for Renewable Energy published its recommendations in July 2004 for increasing State government

purchases of renewable energy to 10% and 20% by 2006 and 2010, respectively, and to increase statewide renewable energy use to 10% by 2015.

- Economic recovery is causing an expected and corresponding rise in total demand for electric power; and
- Sharply higher natural gas prices, supply constraints and market volatility have combined to stifle the unprecedented growth in new gas-fired generating capacity.

Because of these factors, we anticipate that the market price for renewable power will support project implementation. As the Task Force for Renewable Energy recommendations are adopted, the Danbury and Hertel projects can be available to help satisfy the State's increased demand for renewable energy in 2006.

While nearly 80 percent of Wisconsin's electricity is produced from coal and nuclear fuel, the state clearly has a sustainable supply of wood/biomass fuel to supply relatively small generating facilities such as the St. Croix Tribe is pursuing.

Potential biomass fuel sources considered included:

- wood waste from sawmills and wood products manufacturing operations;
- wood from logging operations;
- forest management waste (such as fire prevention thinning); and,
- fast-growing hybrid poplar tree farming.

We have identified 33 wood waste streams from 21 sawmills and wood product manufacturing operations that sell for $10/ton or less. Most of these waste streams are used on-site for boiler fuel or are sold or given away locally, primarily for animal bedding. These sources would be difficult to capture. However, nine of the waste streams are sold as boiler fuel with the selling companies netting very little for the material. Volumes sold as boiler fuel that are not under contract total: 7,470 tons of fines; 14,300 tons of coarse material; and 1,600 tons of bark.

We have identified 15 wood waste streams from five companies that sell for $11-$15/ton. Net profits from these sales are generally higher than the material selling for $10 and under. Volumes sold not under contract in this price range total: 14,414 tons fines; 3,849 tons coarse; and 17,882 tons bark.

Capturing about 85% of the material selling for less than $10/ton would provide the necessary fuel for a 1MW plant. To fuel a 3MW plant, all of the material available for $15/ton or less would be required. To the extent that all the material could not be acquired, the balance would have to be met with higher priced fuel.

Woody biomass from logging operations can be collected using existing logging practices where cut logs are dragged to a "landing". The logs can be chipped at the landing and delivered to the generation site in "walking-bed" trailers. Alternatively, biomass material could be sourced from whole tree chipping operations. There does

not seem to be much difference in the operational economics of chipping at the landing and whole tree chipping.

Another possibility for supplying biomass to the proposed facilities is to collect logging residue using an emerging technology. Waste residue (treetops, limbs, stumps and brush) comprises about 20% of the volume of trees now logged for the paper, wood, and wood products industry. This wood waste is unsightly and not conducive to recreational use of forests while posing a great threat for wild fire. For power production, the logging residue would be baled and cut to transportable size using new technology, and then either chipped at the landing or trucked to the generation project site for chipping. The bales are easily stored for future use. The advantages of using logging residue are that it is currently not utilized, relatively abundant, will clean-up logging cut areas, provide a value-added product to the logger and produce "green" electrical power.

Working with existing harvesters to establish a tribal chipping and/or baling operation is a possibility. Annual usage of a 3 MW plant would total 5,300,000 cubic feet or a 12 percent increase in logging harvesting in a 50 mile radius of the proposed plant site. To the extent we can utilize logging residue (treetops, limbs, stumps and brush), we will not increase harvesting.

Another option to supply a wood energy facility is tribal development of hybrid poplar plantations. While the Tribe owns no lands upon which such plantations could be established, lease arrangements with farmers could be pursued to establish the plantations. The interest in hybrid poplar plantations is fueled by reduced harvesting on some public forestlands, an age class imbalance in natural aspen which has also reduced supply, and industrial expansion of paper and oriented strand board production which increased demand. The effect of these three factors has caused stumpage prices for aspen pulpwood to skyrocket, making investment in hybrid poplar plantations more economically viable.

Europeans have been hybridizing trees a lot longer than the United States. Within North America, active hybrid poplar breeding programs exist in Maine, Wisconsin, Minnesota, Michigan and Massachusetts. The Forest Service Research Station in Rhinelander, Wisconsin has been instrumental in developing clones for the Midwest as has the Natural Resource Research Institute in Duluth, Minnesota.

The profitability of hybrid poplar for landowners, as opposed to other agricultural crops, is highly dependent on the inherent productivity of the site and whether or not cost share programs are available. Much of the land currently planted to hybrid poplar in the Midwest is enrolled in the Conservation Reserve Program (CRP) which is designed to remove marginal farmland from crop production. This program subsidizes farmers for the reserved acreage and allows the planting of trees. Without such subsidies, hybrid poplar cultivation is not competitive with agricultural production in general. Establishment of hybrid poplar plantations seems most suited to marginal farmlands enrolled in the CRP program or poor corn lands. Spacing to produce pulpwood is generally eight to ten feet within and between rows depending on the size of the machinery available for cultivation. Harvesting is typically on a 12 year cycle. Trees designated for energy production could be

planted much closer and harvested more economically, and more often with smaller equipment.

Existing commercial harvests of hybrid poplar are being used for pulpwood. Plantation establishment specifically for energy production so far has proven to be less economically viable given the high initial costs and the relatively lower costs of conventional fossil fuels. As energy prices increase, however, and if a system for optimizing harvest products from hybrid poplar plantations can be developed (i.e., shorter harvest rotation, etc.), hybrid poplar could become an important source of biomass fuel.

Locating plantations as close to the wood using facility as possible will minimize transportation costs. Ample acreage that could potentially be converted to hybrid poplar exists within the project area. Total acreage needed to supply a 1 MW plant is estimated to be just under 3,200 acres based on current pulpwood growing practices. If the wood is sorted and some is sold into pulpwood or saw log markets, acreages required would increase. Shorter rotations would have the effect of further decreasing the amount of acreage required. Shorter rotations would be feasible if the objective were production of bio fuel only.

1.3 PROJECT DESCRIPTION

A three MW plant will utilize approximately 16,000 pounds per hour (lbs/hr) of wood chips to produce approximately 45,000 lbs/hr of 450 psig saturated steam and up to 3,000 kilowatts (KW) of electricity. Waste heat can be utilized in Danbury within the adjacent Aquaculture Center and in Hertel in a variety of tribal operations.

All of the components selected have a track record of successful operation both within and outside of the United States. Preliminary Design Parameters for a 3 MW plant are as follows:

Preliminary Design Parameters for a 3 MW Plant	
Electrical Energy Output at Full Condensing	3,000 KW
Generator Power Factor Design	0.85
Generator Electrical Voltage	4,160
Maximum Steam Flow (Continuous)	45,000 lbs/hr @ 450 psig
Maximum Steam Flow (3 hour)	50,000 lbs/hr @ 450 psig
Operating Pressure	450 psig
Feedwater Temperature at Economizer Inlet	228°F
Saturated Steam Carryover Moisture	0.5%
Fuel Flow	16,000 lbs/hr

The proposed Danbury site is located adjacent to the St. Croix Tribe's state-of-the-art aquaculture facility. The aquaculture facility has an ongoing load requirement of

approximately 1½ MW and, as such, has substantial electrical facilities already established on site.

The Danbury site is within the assigned electric service territory of Northwestern Wisconsin Electric (NWE), a relatively small investor-owned entity serving retail customers in the vicinity. Access to NWE's recently rebuilt 69kV transmission system is readily available. St. Croix representatives have met with NWE's senior management and have agreed in principle that transmission access can reasonably be provided via NWE's system and subsequently interconnect to the existing transmission network.

It should be noted that NWE presently relies on Xcel Energy for bulk power purchases to meet a substantial portion of its total system requirements, and therefore, solid transmission service is well established between Xcel's control area and NWE.

The Hertel site is located on trust land adjacent to the St. Croix Tribe's Tribal Center. This site is served by Dairyland Electric Power Cooperative (DPC) through an existing 69KV line. We have completed transmission studies for a 45 MW gas-fired peaking plant for the Hertel location that demonstrates transmission access is suitable at this location.

The biomass facilities are to be built with conventional, proven technology and fueled with available biomass materials from the vicinity of the proposed sites. As such, the facilities are expected to be operational full time except for reasonable downtime for maintenance.

The project will create a number of long term jobs, in addition to the construction jobs, and will provide additional opportunities to increase production and long term employment at the Aquaculture Center. Each electrical generating facility will be staffed by one full time operator, 24-hours per day. This position will require sophisticated training to operate the mechanical and electrical components of the site. Additionally, the handling of the wood waste will require an approximate 8 hour a day, 5-day per week position. Thus, each site will require the services of approximately 4 ½ people.

The collection of the waste wood, in addition to providing environmental benefits and reducing the usage of fossil fuel, will also employ a number of new full time employees. This will include equipment operators, truck drivers and management support for those functions. In addition, the supplier (possibly a tribal business venture) will require new trucks and other equipment, which will also benefit the local and regional economy.

Costs associated with a 3 MW project have been estimated at $4.75 million as follows:

- Turbines - $1 million
- Combustion Equipment - $1 million
- Fuel Preparation Equipment - $0.25 million

- Buildings - $0.25 million
- Ancillary Equipment - $0.5 million
- Substation - $0.5 million
- Construction - $1 million
- Project Development Costs - $0.25 million

1.4 CONCLUSIONS

Project economic analysis does not justify implementing the project at this time.

Project economics are most sensitive to fuel costs and power price. Using base cost assumptions for a 3 MW plant, the importance of fuel cost is illustrated as follows:

Price of Fuel	Power Price
$10/ton	$0.054 KWH
$15/ton	$0.068 KWH
$20/ton	$0.083 KWH

Thus, without a guaranteed fuel source price in the $15/ton range, the project is not viable and a comprehensive business plan can not be developed. However, as many factors converge and develop, all indicators are that the project is "do-able" in the near term. The following sections describe efforts required to allow the project to be viable.

1.5 BUSINESS PLAN / NEXT STEPS

With the support of the Department of Energy, the St. Croix Tribe has developed two biomass-fired projects that appear to be economically viable. Technology, location, fuel supply, markets, financing and transmission issues have each been addressed to the point where the St. Croix Tribe is confident that biomass-fired power projects are "do-able" in our region. It is clear that potential power purchasers (investor owned utilities, municipal utilities, cooperatives and generation aggregators) serving the power market in the region will be required to find additional renewable based energy power supply in the near future. Facilities owned by the St. Croix Tribe can serve this increased demand. For the projects to be implemented, two things must be accomplished:

- Secure a cost effective, reliable biomass fuel supply, and
- Negotiate Power Purchase Agreements with Customers (find customers).

1.5.1 Secure Bio Fuel Supply

In order for the Tribe to be comfortable investing in biomass-fired power plants, it must be reasonably assured of a predictable, attractive fuel price and a reliable, sustainable supply mechanism. Our analysis to date demonstrates that although waste wood from sawmills and wood product manufacturing operations are the lowest price potential fuel source, volumes are insufficient to fully load a 3 MW plant and supply is uncertain over the project life (i.e., mills close). There is an ample supply of forest biomass material and numerous loggers operating in the area, but with the current collection practices and price for renewable power, costs are too high to justify investment. Hybrid poplar tree farming is a reliable long term supply, however, projected costs are also appear to be too high to justify investment at the current price for renewable power.

Additional efforts are required for further refinement of the fuel supply options. Specific activities include:

- Conduct on-site visits with sawmill and wood product manufacturing companies that have been identified to be selling waste wood for less than $15/ton (15 companies). Determine composition, heat content, potential contract length, cost, seasonal availability, tribal equipment and labor requirements, etc.
- Working with the Forestry Council Woody Biomass Task Force, determine and recommend State government initiatives and incentives to foster development of woody biomass supply. Richard Hartmann, Director of Planning and Development, has been requested to serve on the Task Force.
- Identify and meet with area loggers interested in developing and serving bio-fuel markets in addition to the pulp and wood product markets. Assess their interest in coordinating their logging operations with a tribal venture. Candidate loggers will be identified from the county forester's list of timber buyers in the four relevant counties and through the Forestry Council Woody Biomass Task Force. We expect that the annual logging conference in Wisconsin will be a good opportunity to connect with potential suppliers.
- Develop a detailed understanding of slash-bundling operations (equipment cost, productivity, financing opportunities, ancillary equipment requirements, labor issues, coordination with logging operations, etc). Verify all capital and operating costs. We will meet with equipment manufacturers, vendors and users. Timberjack, the bundling equipment manufacturer, is a sponsor of the annual logging conference.
- Verify the volumes of slash economically available to the Hertel and Danbury sites that could be chipped at the landing and/or harvested with the bundler. Determine the geographic location and seasonal availability of this slash.
- Prepare a pro-forma economic assessment and a qualitative “risk assessment” for a new tribal venture to supply wood chip fuel (to tribally

owned power plants as well as market customers). The venture could be 100% tribal owned or a joint venture with one or more loggers.

- Refine hybrid poplar cost estimates and investigate alternative rotation lengths and production scenarios (to include visits to existing plantations).
- Conduct preliminary meetings with local farmers to assess interest in participating with the Tribe in hybrid poplar plantation operations.

1.5.2 Find Customers

Implementation of the Governor's Task Force for Renewable Energy recommendations will create a demand in the market for renewable energy. Utility companies serving State facilities will be required to meet mandated targets.

Additional efforts required to develop customers for the proposed facilities are:

- Screening and ranking potential candidate customers.
- We need to understand their projected renewable power needs and alternatives available for satisfying their needs. (Who are the decision-makers?, When will the renewable power be needed?, Is the utility anticipating shortages in renewable power supply?, What State facilities and loads do the utility serve?)

Potential customers will be ranked based upon the Tribe's ability to satisfy their needs. Specific tasks for this phase include:

- Update Wisconsin and Minnesota regulatory climate and power supply / demand outlook re: renewable energy,
- Identify universe of candidate customers for St. Croix Tribe's renewable power projects,
- Prepare background file for each candidate customer (service territory, state facility customers, size, renewable energy supply/demand outlook, current renewable energy supply arrangements, recent projects, planned projects, regulatory issues, etc.), and
- Prioritize for the St. Croix Tribe's renewable power project opportunity.

We anticipate working closely with the Governor's Task Force representatives and the Wisconsin State Department of Administration officials.

For the highest priority potential customers we will develop a project "package" as a basis for negotiations with potential customers. Meetings will be required for introducing the concept and assessing interest as well as addressing technical issues and commercial issues. Specific tasks include:

- Networking with representatives of candidate customer organizations to assess interest.
- Refining costs estimates for the biomass plants by getting firm equipment/construction quotes.

- Updating project economic analysis incorporating additional fuel supply assessment results.
- Publicizing the project in media outlets targeted to power purchaser decision-makers.
- Preparing a Power Point presentation and meeting with representatives of candidate customer organizations to introduce the project.
- Developing "work teams" comprising representatives of the St. Croix Tribe, the customer organization, state Department of Administration officials, and others, if appropriate, to facilitate project development. These work teams will address project specific issues such as transmission interface, commercial terms, process for qualifying with state mandates, etc.

1.5.3 Project Implementation

The project implementation phase includes the following activities:

- Negotiate power purchase agreement
- Negotiate fuel supply agreements
- Negotiate equipment purchase agreements
- Transmission and connectivity filings and coordination
- Environmental permitting
- Engineering, Procurement and Construction contracts

2. PROJECT OVERVIEW

During 2002, the St. Croix Tribe decided that it would explore the feasibility of developing a power generation facility fueled by locally-available biomass. The Tribe proceeded to apply for, and received during the Spring of 2003, a $250,000 grant under the U.S. Department of Energy's "Renewable Energy Development on Tribal Lands" initiative.

In areas adjacent to the tribal lands, there is a substantial amount of biomass fuel potentially available, including:

- wood waste from logging operations, sawmills and wood products manufacturing operations;
- forest management waste (such as fire prevention thinning); and
- fast-growing hybrid poplar tree farming.

This study included an assessment of available biomass fuel, technology assessment, site selection, economics feasibility given the foreseeable fuel and generation costs, as well as an assessment of the potential markets for renewable energy.

The Tribe is interested in "Green Business" development and sustainable economic development that promotes a better balance between environmental protection, jobs, and wealth distribution. St. Croix Tribal Community economic development goals are closely aligned with a "Renewable Energy Development on Tribal Lands" project. Therefore, the St. Croix is very interested in development of a bio fuel power project on tribal lands.

The feasibility study looked at siting a renewable energy power plant within the reservation communities. The St. Croix Reservation is composed of eight separate tribal communities (created as a resulted of the Indian Reorganization Act of 1934) scattered primarily over three northwestern Wisconsin Counties (Barron, Burnett, and Polk).

The St. Croix Tribal Council is composed of a five member publicly governing body of the St. Croix Chippewa Nation. The Council is composed of a Tribal Chairman, Vice-Chairman, Secretary/Treasurer, and two Council Members. They represent and conduct business on behalf of their constituency.

The St. Croix Chippewa Indians of Wisconsin is a federally recognized Tribe.

2.1 COMMUNITY PROFILE ST. CROIX RESERVATION APRIL 2004

2.1.1 Population

Population Age Distribution

Age	Male	Female	Total
Under 16	386	435	821
16 - 64	780	915	1,695
65 and Over	63	69	132
Totals	1,229	1,419	2,648

(Source: Bureau of Indian Affairs Annual Report on Service Population and the Labor Force April, 2004)

Distribution of Service Population by Reservation Associated County

County	Total
Barron	335
Burnett	1,005
Polk	426
Other Adjacent Counties (Douglas, Washburn, Pine)	882
Total	2,648

According to the St. Croix Tribal Enrollment Committee, tribal enrollment in April 2004 consisted of 1,031 people: 499 males and 532 females. There were 735 members living on or adjacent to the St. Croix Reservation.

2.1.2 Income and Employment

According to the Bureau of Indian Affairs Annual Report on Servcie Population and the Labor Force, the total number of people employed in April 2004 was 1,241. Of the total 193 were employed in the public sector and 1,048 in the private sector. Of all jobs, 1,122 of those employed earned $8,980 per year or more, while 119 people were employed but below the poverty guidelines.

Employment Divisions

Employment	Total
Available Labor Force	1,620
Number Employed	1,134
Number Unemployed	486
Percentage Unemployed	30%

2.1.3 Land Use

Classification	Acres
Trust Lands	2,126
Fee Lands	2,563
Total	4,689

2.1.4 Location of Tribally Owned Land

County	Acreage
Barron	445
Burnett	2,802
Polk	1,442
Total	4,689

2.1.5 Education

Following is a list of schools with Indian children enrolled from the St. Croix Tribal Area in 2004:

- Webster Elementary and High School K – 12
- Siren School District K – 12
- Spooner School District K – 12
- Shell Lake School District K – 12
- Cumberland School District K – 12
- Unity School District K – 12

2.2 COMMUNITY BENEFITS

Using locally available bio fuel directly supports the community, economic, social, and cultural goals of the St. Croix Tribe. A bio fuel power project leverages community assets and resources and help provide the foundation for future sustainable development.

Among the tribe's significant assets and resources is its political status, cultural identity, legal rights ands unique opportunities for economic development as tribal entities. Historically, tribes surviving into the 20th Century were highly adaptive in maintaining a balance between both earth-centered and people orientated philosophies. Maintaining a connection to the earth while transitioning into the 21st Century is a significant tribal goal. We will continue to hold to our traditional visions of community renaissance and values. Sustainable, efficient resource development requires the tribal nation to support the individual by creating an environment in which the whole community can thrive and prosper. The continued protection and utilization of tribal rights of sovereignty and self-determination are key strategic element to achieve a high quality of life standard. Currently, Indian gaming is the

best resource and asset that the Tribe's members and tribal government possesses to improve the grinding level of poverty prevalent on Indian reservations, but if the Tribe's do not seek to diversify and add to these successes the future may be bleak. Among the Tribe's major assets are the young community members, a majority of whom are under the age of 24. Recent population studies and trends project that the greatest growth in regional population is occurring among the tribal youth and Native Americans.

Collaborations and partnerships with surrounding local governments are necessary for creating and sustaining a positive and supportive environment for future tribal economic systems. Several existing partnerships between the Tribe and surrounding local governments are expected to be replicated and expanded. Primary relationships in law enforcement, public health, education, housing and social services are among the key collaboration areas. Additional partnerships regarding environmental, utilities, safety, food inspections and waste management are also anticipated as usual and customary services with enterprise development. An expectation inherent in any venture is a potential growth of private sector development and entrepreneurship. With the anticipated improvements and future capacity of tribal government, the Tribe will continue the pattern of rebuilding tribal communities, investing in social and physical health, and contributing to off-reservation community life, charities, and local governments.

The project will create needed tribal employment opportunities and revenues, while providing a needed product for the surrounding region and state in an environmentally sound manner. It will also help to reduce dependency on imported non-renewable energy sources.

3. OBJECTIVES

The goals of the St. Croix Tribe are to develop economically viable energy production facilities using readily available renewable bio fuel sources at an acceptable cost/kWh, to provide new and meaningful permanent employment, retain and expand existing employment (logging) and provide revenues for both producers and sellers of the finished product.

These projects will create urgently needed tribal employment opportunities and revenues, while providing energy in an environmentally sound manner. In addition to helping to meet area power demands, the projects will help reduce dependency on imported non-renewable energy sources.

These projects are of enormous importance to the St. Croix Tribe in terms of its economic diversification and job creation. It will also be important to the region as a whole as both Wisconsin and Minnesota are moving toward requiring increased emphasis on renewable power and there is a projected shortage of power generation in an area of increasing population and business growth. Moreover, we believe that this project (together with our gas-fired peaking project) can serve as a catalyst for creating an energy-producing Tribal cooperative serving markets in Michigan, Wisconsin and Minnesota. Locating power generation facilities on tribal lands throughout the three-state region has many advantages:

- It will increase service reliability without the need for expensive and controversial new transmission lines,
- It will replace less environmentally friendly “mega-projects” in the market, and
- It will create much needed economic development opportunities and diversification from reliance on gaming.

4. DESCRIPTION OF ACTIVITIES PERFORMED

4.1 PHASE 1 – 3

The Initial Plan was to conduct the project in four distinct phases:

- Project Initiation
- Phase 1 – Conceptual Project Definition
- Phase 2 – Detailed Project Definition
- Phase 3 – Project Feasibility Assessment and Facilitation

Specific tasks for each phase are outlined below.

Project Initiation

- Develop project schedule
- Develop work authorization procedures
- Develop invoicing procedures and requirements
- Develop Phase 1 project team assignments, budgets and deliverables
- Establish candidate region
- Conduct project initiation meeting with DOE Tribal Energy Project Manager (Lizana Pierce), Project Monitor (Henry Fowler), NREL Program Manager and Bio-mass specialist (Roger Taylor and John Scahill) Golden, Colorado
- Official DOE Contract signing

Phase 1 – Conceptual Project Definition

- Identification of potential power purchasers and assessment of level of interest
- Tribal energy usage assessment (loads, geographic distribution, daily and seasonal distribution, existing supply restrictions)
- Tribal Energy Company opportunities and restrictions assessment
- Preliminary assessment of bio fuels supply (sources, volumes, pricing, fuel value, current uses)
- Candidate technology assessment (equipment manufacturers, commercial viability, experience, capacity, fuel compatibility, impacts, site requirements, preliminary economics screening)
- Preparation of detailed site selection criteria (proximity to sales points, proximity to fuel source, transportation infrastructure, utility infrastructure, environmental considerations, land and buffer requirements, etc.)
- Quarterly Reports

Phase 2 – Detailed Project Definition

- Fuel supply strategy
- Project structure alternatives strategy (ownership, operation and staffing responsibility, etc)
- Market development strategy
- Technology Screening / Technology Selection
- Site screening / Site Selection (prime and back-up)
- DOE Program Meeting and Presentation in Golden, 4th Quarter 2003

Phase 3 – Project Feasibility Assessment and Facilitation

- Preliminary system design
- Economic modeling
- Environmental and Socio-economic Impacts and Benefits assessment
- Project implementation strategy
- Permit planning
- Quarterly Reports
- Preparation and negotiation of Memorandums of Understanding (MOUs) for fuel supply, technology transfer, purchase power agreements, project financing, etc.

Additionally, routine DOE interface and follow-up activities were conducted. These included:

- Quarterly Reports
- Final Report preparation and submission
- Project Review Meeting in Golden, Colorado, 4th Quarter 2004

As a result of our Phase 1 and 2 efforts, the scope of work for Phase 3 activities was subsequently modified. Renewable energy use mandates in Wisconsin are anticipated to be implemented in 2005. The impact of these initiatives on project revenues is still uncertain. In addition, biomass fuels supply are also uncertain. Therefore, the scope of work was expanded to work with the State Task Force representatives regarding both market development and fuel supply initiatives.

Due to the fact that State market and fuel initiatives haven't been implemented yet, we were unable to advance the project to the point where MOU development is appropriate.

4.2 WORK AUTHORIZATION PROCEDURES

All work performed by Contractors in Phases 1-3 was in accordance with approved Work Plans. All Work Plans were submitted to and approved by the Project Coordinator prior to initiation of any work.

All Work Plans, at a minimum, provided a scope of work, a schedule, a description of the work product or deliverable, and a budget to perform the work. Any changes of scope, schedule and budget were first approved by the Project Coordinator.

4.3 INVOICING PROCEDURES AND REQUIREMENTS

Invoicing was done on a monthly basis, unless otherwise approved by the Project Coordinator in the Work Plan. The Contractor invoices included:

- A one paragraph description of the activities and progress made during the month.
- An estimate of the percentage of completion of the task
- Travel expenses related to the project. Copies of receipts for expenses for items greater than $50

The Project Coordinator assembled the various Contractor invoices and submitted the combined invoice to the DOE. Payment to Contractors was made within 7 days of receipt of payment to the Tribe by the DOE.

5. MARKET ASSESSMENT

5.1 INTRODUCTION

The proposed plant is located within the reliability region defined by the Mid-Continent Area Power Pool (MAPP) area. Independent market assessments indicate significant power shortages for the MAPP region. In the Upper Midwest, specifically Wisconsin and Minnesota, forecasts indicate inadequate power supply before the end of the decade.

Regulators within the State of Wisconsin have estimated a need for an additional 7000 megawatts by 2016 to sustain electric system reliability and to accommodate population and economic growth. Likewise, the neighboring state of Minnesota projects it will need significantly more generation than is presently planned to meet demand by the end of the decade.

Also worth noting is MAPP's observation that "the ability to import power may be severely limited in the near term because of the lack of external resource availability." In other words, there is neither power plant capacity outside of the region nor transmission line capability available to alleviate developing local power supply shortages.

The advent of federally deregulated wholesale bulk power markets enables the St. Croix Chippewa Indians of Wisconsin to become an active market participant in the production of electric energy as an *independent power producer*, or *exempt wholesaler generator.*

Status as an independent power producer, or exempt wholesaler generator, provides the St. Croix with a distinct, long-term opportunity to advance tribal economic development, as well as diversify the Tribe's economic activities to promote even greater self-sufficiency and independence.

While federal law permits the St. Croix to participate in electricity production as an independent or exempt power producer, *retail* electricity markets within the State of Wisconsin are not deregulated. Wisconsin has retained a system of statewide franchised, retail areas of service that are covered by a mix of investor-owned, rural electric and municipal utilities.

Hence, the St. Croix are not permitted to establish an outright electric utility that would provide electric service to ultimate end use customers at retail, including their own reservation properties and commercial enterprises.

Consequently, the St. Croix's potential power purchasers are electric utilities that buy and sell bulk electricity at wholesale and subsequently resell to their retail electric customers within franchised service territories.

The wholesale power market is characterized by unprecedented volatility and uncertainty as a result of economic recession, changing public and regulatory policies and increasing congestion on the regional power grid.

In order to interconnect a proposed St. Croix bio fuel power plant to the existing electric transmission system will require close coordination with three principal entities: Xcel Energy, Dairyland Power Cooperative, and Northwestern Electric.

Xcel Energy - Xcel (formerly Northern States Power) is the largest investor-owned electric company serving the upper Midwest. Its franchised service territory includes large parts of Wisconsin and Minnesota. Hence, it owns many of the major transmission lines, including those serving western Wisconsin.

Dairyland Power Cooperative, through one of its subsidiaries, serves the Hertel site.

Northwestern Electric serves the Danbury site.

5.2 MARKET OVERVIEW

For purposes of this assessment/screening, we have constrained our market analysis to the states of Wisconsin and Minnesota. This self-imposed constraint is simply because the electric transmission line grid throughout the Upper Midwest, including Wisconsin and Minnesota, is itself constrained.

The power grid on a regional basis is in dire need of system upgrades to permit a greater ebb and flow of bulk power from plants to growing load centers. Lacking greater transmission line carrying capacity, it has become increasingly problematic to build new power plant interconnections without aggravating an already congested electric transmission system. Transmission lines, like interstate highways, are not keeping pace with population and economic growth.

Case in point: It has been over 30 years since there has been a major upgrade to the State of Wisconsin electric transmission system, despite dramatic increases in electric demand and population growth, especially in the southern part of the state.

Since it is not technically practical nor economically viable to attempt to transfer relatively small amounts of bulk electricity long distances, it is essential that we focus on potential electric utility customers that are either contiguous to or in geographically close proximity to the proposed biofuel generating facility.

This practical reality necessarily narrows our focus to Wisconsin and Minnesota power suppliers.

Potential utility customers fall within one of three broad categories:

- **Investor-Owned Electric Companies;**
- **Generation and Transmission Cooperatives;**
- **Municipal Electric Systems.**

Investor-Owned Electric Companies (IOUs)

IOUs tend to be the largest providers of retail electric service and serve major urban centers. They are owned by institutional and retail investors (shareholders) and are closely regulated by the State with regard to their electric services, rates and construction projects.

Investor-owned utility prospects in proximity for this project include:

- **Xcel Energy** – Minneapolis, MN
- **Minnesota Power** – Duluth, MN
- **Northwestern Wisconsin Electric** – Grantsburg, WI

Generation and Transmission Cooperatives (G&Ts)

These are relatively large quasi-public entities that generate and transmit bulk wholesale electricity to rural electric distribution cooperatives, and to a lesser extent, municipal electric systems.

In recent years, G&T's have also begun to market and sell bulk electricity to investor-owned utilities. However, their fundamental historic purpose is to generate and deliver electricity for rural America via co-ops, since rural electric cooperatives generally do not own or operate power plants. The role of rural electrics is merely to *distribute* electricity to historically rural areas, many of which have now become bustling, rapidly growing suburban areas surrounding metropolitan areas.

G&T's have access to low-cost capital to finance power plant and transmission projects via the Rural Utilities Service (formerly the Rural Electrification Administration). The federal funding/banking source is the Cooperative Finance Corporation.

Since rural electric cooperatives do not own power plants or transmission lines, they are not considered candidates for biomass power production. However, the G&T's that provide their bulk power are:

- **Dairyland Power Cooperative** – LaCrosse, WI
- **Great River Energy** – Elk River, MN

Municipal Electric Systems (Munis)

Municipal electric systems are just that. They are locally managed public utilities that own smaller power plants and distribution lines to serve customers within local communities. In many cases, municipal electric utilities purchase all or part of their electricity from other power suppliers at wholesale on a long-term contract basis. They are typically self-managed and locally funded through bonding and other revenues.

Municipal electric systems have coalesced to form buying cooperatives to acquire bulk electricity from other providers to satisfy growing electric demand that is not satisfied by local electric generation. Creation of these associations and pooling of financial resources has resulted in fractional ownership of large, base-load power

plants that are majority owned by either investor-owned companies or generation and transmission cooperatives.

The principal aggregator of electric generation assets to collectively serve Wisconsin municipalities is:

- **Wisconsin Public Power, Inc.** – Madison, WI

The market continues to evolve, and has evolved, since the initiation of this project. There have been no public policy initiatives of consequence that have materially changed the Wisconsin and regional wholesale bulk power markets; markets that permit the St. Croix Chippewa Indians of Wisconsin to participate as an Independent Power Producer.

What has changed is:

- Greater public awareness of the need to expand both generating and transmission line capacity to support economic development and growth;
- Sharply higher natural gas prices, supply constraints and market volatility have combined to stifle the unprecedented growth in new gas-fired generating capacity;
- A resurgence of utility interest in building new "clean coal" generating capacity in response to uncertain natural gas pricing/supply. (Coal is a least cost, domestic, plentiful fuel sold at a fixed price under long term contract, accounting for half of total U.S. power production.)
- Economic recovery is causing an expected and corresponding rise in total demand for electric power, particularly in Wisconsin and Minnesota;
- Renewable forms of electric power production continue to remain politically in favor in the public policy arena, but are still shunned by power suppliers due to high installed and operating costs, and low reliability, especially in the case of wind generation. Renewable electricity accounts for less than 5 percent of total generation in the region.

5.3 THE SMALL RENEWABLE NICHE

While regulated (and unregulated) utilities do not resist renewable energy in principle, in reality they are reticent to add renewable capacity, unless mandated, since "renewables" are generally unreliable (wind and solar) and tend to raise the average of embedded generation costs, and ultimately the price of power to consumers.

Both Wisconsin and Minnesota continue to rely mostly on coal-based electricity and nuclear power for the bulk of power production, and will continue to do so for the foreseeable future. This reliance is the main reason why electric rates in the two states are significantly lower than the nation at large. While relatively low electric rates are seen as a plus for the regional economy and consumers, they ironically, are a barrier to entry for most renewable generating technologies (excluding hydro production).

While nearly 80-percent of Wisconsin's electricity is produced from coal and nuclear fuel, the state clearly has a sustainable supply of wood/biomass fuel to supply relatively small generating facilities such as the St. Croix Tribe is pursuing.

Without renewable energy portfolio mandates, the blended cost of existing coal, nuclear and natural gas power production becomes the strike price, or "price to meet or beat" when pricing new renewable generation and negotiating a purchase power agreement on a long-term basis with a utility customer. Certainly, a premium is to be paid for green energy, and many consumers are willing to pay extra for renewable electricity. That's why electric companies are actively marketing "Green Power", and charging extra for the disproportionately higher cost to produce it.

Green pricing is an optional utility service that financially helps utilities defray the substantially higher cost of kilowatts produced from renewable sources. Customers voluntarily opt to purchase blocks of renewable energy at a higher price per kilowatt-hour.

Literally hundreds of utilities across the country and throughout the Upper Midwest have implemented or plan to provide "green pricing" programs that involve wind, biomass and other renewable technologies. These customer options are already well established in Wisconsin and Minnesota, though customer willingness to embrace higher priced power has been mixed, and requires considerable promotion on the part of the utility provider.

The St. Croix Biomass Project is better served by marketing to native utility companies in Wisconsin – regulated and unregulated – because all retail power suppliers are under state mandate to meet increasing renewable thresholds by certain dates under Wisconsin law.

In neighboring Minnesota, only one utility – Xcel Energy – is under legislative mandate to meet a renewable portfolio standard, and only as result of legislation allowing expanded waste storage at a major nuclear facility. All other Minnesota utilities are operating under an "expectation" that they will reach a voluntary 10-percent renewable standard, but it is not a requirement, as of now.

Renewable Energy and Public Policy

The public policy debate over deriving greater electric production from renewable fuels has escalated in recent years to a point where both federal and state policy proposals contemplate *mandating* renewable portfolio standards on electric utilities versus *voluntary* compliance with stated goals.

Minnesota Overview: Current Minnesota law requires that all electric utilities make a good faith effort to generate or buy electricity from renewable sources to reach a goal of 10-percent of their respective loads by the year 2015.

The Minnesota Public Utilities Commission plans to issue an order to regulated utilities defining criteria and standards by which to measure this *voluntary* objective. If success in meeting this objective is lacking, a number of Minnesota lawmakers

have publicly advocated a legislative mandate to require electric companies to meet the 10-percent target.

Wisconsin Overview: The State of Wisconsin has adopted, as part of its comprehensive *"Reliability 2000"* legislation, a renewable portfolio standard that mandates all electric utilities provide an increasing proportion of their total electricity sales from renewable sources (including biomass).

A progressive phase in mandates that all electric companies (regulated and unregulated), based on total annual retail sales, provide the following proportion of renewable energy in their mix of generation:

- 0.5% by 2001
- 0.85% by 2003
- 1.2% by 2005
- 1.55% by 2007
- 1.9% by 2009
- 2.2% by 2001

Each Wisconsin electric company is required to submit annually a report to the state documenting its compliance with the present renewable portfolio standard. Noncompliance exposes the electric company to administrative actions and fines ranging between $5,000 and $500,000.

Wisconsin also allows electric companies to fully recover the costs of complying with the standard through their electric rates.

Renewable energy quotas apply to *all* electric utilities – even those companies that may not fall under the regulatory purview of the Wisconsin Public Service Commission, such as generation and transmission cooperatives.

Based on the public policy trends across the country, one can easily construe that the 2.2% mandate by 2011 is a modest target.

The Wisconsin Task force for Renewable Energy published its recommendations in July 2004 for increasing State government purchases of renewable energy to 10% and 20% by 2006 and 2010, respectively, and to increase statewide renewable energy use to 10% by 2015. Wisconsin Governor Jim Doyle immediately endorsed the recommendations of the Task Force.

Wisconsin utilities that do not produce adequate renewable energy to meet these anticipated State mandates will need to purchase "green power" from other utilities with surplus green credits, or from independent power producers, such as the St. Croix Tribe.

Since our biomass project is of relatively small size, it makes operating and technical sense to sell to a local Wisconsin-based utility that can claim the green (renewable) credits without complex transmission interconnection issues.

State Incentives to Foster "Renewables"

From a tactical standpoint, the Tribe is advocating State legislation that would provide a direct operating credit (subsidy for green power) that is similar to credits adopted elsewhere to advance the ethanol industry for transportation fuels. Project economics relative to the strike price and other barriers to entry would significantly improve depending on the size of the credit.

A strong public policy case could be made that the State of Wisconsin would be well served through making more productive use of otherwise wasted forest biomass.

5.4 SYSTEM CONNECTION

The proposed bio-mass power plant site in Danbury is within the assigned electric service territory of Northwestern Wisconsin Electric (NWE), a relatively small investor-owned entity serving retail customers in the vicinity.

Access to NWE's recently rebuilt 69kV transmission system is readily available. St. Croix representatives have met with NWE's senior management and have agreed in principle that transmission access can reasonably be provided via NWE's system and subsequently interconnect to Xcel's existing transmission network.

It should be noted that NWE presently relies on Xcel Energy for bulk power purchases to meet a substantial portion of its total system requirements, and therefore, solid transmission service is well established between Xcel's control area and NWE.

Other transmission owners in the project area include Dairyland Electric Power Cooperative (DPC) with whom the St. Croix have also had ongoing discussions regarding transmission access relative to a separate peaking power plant project to be built in nearby Hertel, Wisconsin, site of the St. Croix Tribal Headquarters. Detailed transmission studies in support of the Tribes 42MW gas-fired peaking project have demonstrated that the 69kV transmission line serving Hertel is more than adequate to serve a 3MW Biomass plant in Hertel.

5.5 XCEL ENERGY RENEWABLE DEVELOPMENT FUND

Xcel Energy is the largest electric company serving Wisconsin and Minnesota. The Minneapolis-based IOU has established a Renewable Development Fund (RDF) as part of 1994 state legislation regarding nuclear waste storage at its Prairie Island nuclear plant.

In late-2003, Xcel announced a second request for proposals to provide up to $25 million in funding assistance for renewable energy projects, including biomass generation.

The RDF Board that oversees grant-making process preferred projects that are located in Minnesota. However, projects located within Xcel's electric service

territories in North and South Dakota, Wisconsin, or Michigan may be considered. The St. Croix applied for $2M in funding assistance for development of a 3MW facility in Danbury. Although our project scored well in the competition, ultimately it was not selected for funding. We understand from Xcel that the selection process was discretionary and favored Minnesota based projects.

6. BIO FUELS ASSESSMENT

6.1 BACKGROUND

Wisconsin has a substantial volume of forest byproducts, last estimated at nearly four million dry tons per year; logging residues and new harvesting could more than triple this amount, and agricultural timber potential is almost limitless. Despite this, there is no current data base for byproduct availability information. The most recent statewide study was completed in 1996.

Fortunately, current U.S. Forest Service and Wisconsin Division of Energy research describes many aspects of the byproduct supply and use outlets. However, available data does not provide the prices paid nor does it describe current supplier-user relationships or output from secondary manufacturers. Therefore, original primary research was conducted as part of this feasibility study.

Project electricity can be generated using one of two, or both, relatively new and emerging renewable fuel types. The first is the use of "hog chipped" scrub oak. Scrub oak, according to State, County and private foresters would be an ideal renewable fuel source for generating power. It is currently underutilized with no market, has a high BTU output when burned, is abundant for the foreseeable future and is widely available near the proposed project site. Chipping would be conducted at the landing and chips delivered to the plant site in "walking bed" trailers.

The second renewable energy fuel source using a new emerging logging technology, is "baled" logging residue (tree tops, limbs, stumps and brush). This waste residue comprises about 30% of the volume of trees now logged for the paper, wood, and wood products industry. This wood waste is unsightly and not conducive to recreational use of forests while posing a greater risk for wild fire.

For power production the logging residue would be baled and cut to transportable size using new technology, and then either chipped (along with scrub oak) or trucked to the generation project site for chipping. The bales are easily stored for future use.

The advantages of using this fuel are that:

- it is currently not utilized,
- it is abundant,
- it will clean-up logging cut areas, and
- it provides a value-added product to the logger.

6.2 INTRODUCTION

This project investigated wood residue market dynamics within possible procurement areas for wood energy projects at Danbury, Hertel and Turtle Lake.

Generators of wood residue were contacted to determine volumes of residue currently generated, the nature of that residue and existing markets within which the residue is traded. These confidential interviews also included prices received for the wood residue, where it was sold and how far (and at what cost) it was transported.

Four possible sources of wood residue were investigated including:

- primary forest products firms,
- secondary forest products firms,
- urban tree care companies and
- loggers/whole tree chippers.

In addition, the economics of producing biomass from hybrid poplar were also investigated as a long-term source of supply. As the project proceeded, the focus of the investigation evolved with more emphasis placed on those sources of material which seemed most promising. Results identify target waste streams and approaches to access those waste streams given the dynamics of existing markets.

6.3 SURVEY DESIGN

Wood residue is not a high value resource and consequently is most economically traded in a fairly local market area which minimizes transportation costs. In the areas closest to the proposed project sites, forest products industries are the largest single, readily accessible source of wood residue. A phone survey was developed to assess waste streams from these industries.

Three types of industries were surveyed.

- Primary Industries process logs or pulpwood into products such as lumber, veneer, pulp or waferboard.
- Integrated Industries process logs into final consumer products.
- Primary and Integrated industries generally generate the highest volumes of wood waste per unit of production and consequently received the greatest attention.
- Secondary Industries use lumber and other intermediate wood products to produce final consumer products.

Typical waste streams include sawdust and course material consisting of chunks and strips. On a production unit basis, Secondary Industries generally generate considerably less wood waste than Primary and Integrated sectors of the industry and, consequently, received less focus.

Whole-tree chippers are logging contractors with specialized equipment that reduce entire trees to chips. These chips are sold for boiler fuel. Although the numbers of these types of operators have declined over time, some still exist and were contacted as part of the study.

Mailing lists, contacts and phone numbers of target companies within 100 miles of any of the three project sites were compiled. Target companies included:

- sawmills producing one million or more board feet of lumber annually;
- all board and specialty primary mills;
- secondary and integrated mills employing ten or more; and
- all whole tree chippers.

This target list yielded approximately 200 firms. A survey, and a spreadsheet to analyze the results, were designed and, with an introductory letter, were mailed to the target firms. A copy of the survey instrument, letter and structure of the data base are included in Appendix A.

Several considerations were factored into the design of the survey.

- The nature of wood residue waste streams is highly variable and, therefore, an important consideration in wood energy projects when selecting an appropriate energy technology.
- Different types of residue also trade in different markets and are used for different purposes all of which would compete for supply with a new energy facility at any one of the proposed project sites.
- Where the residue is generated, where it is used and how far it must be transported are also important considerations in defining the dynamics of the market place given is relatively low value. These geographic dimensions, prices received and transportation costs incurred help in identifying which actual waste streams should be targeted for maximum success and at lowest cost.

Primary and Integrated industries were surveyed first. Since these industries generate the greatest volume of wood residue, this initial focus would establish a general picture of existing residue markets, competitors within those markets and other attributes concerning markets gleaned from conversations outside the scope of the survey instrument.

Secondary industries within 60 miles of proposed project locations were surveyed next. This survey was less complete than the primary and integrated operations due to less responsiveness by the firms and the fact that it soon became clear that only the largest secondary operations would generate sizes of waste streams that might be attractive to target for wood energy development.

In speaking with the whole-tree chippers and loggers, it also became clear that additional attention beyond the scope first proposed, should be devoted to this possible source of supply.

As a picture of the wood residue markets in the project area began to emerge, calls were made to Xcel Energy (the electricity provider in Minneapolis/St. Paul), one line clearing operator and two large tree trimming operations in Minneapolis/St. Paul. These calls confirmed information uncovered in the Primary Industry survey which suggested that an energy facility at any one of the three proposed project site would

not be able to compete for wood residue produced from urban tree operations. As a result, this part of the project was scaled back.

The last part of the project investigated the feasibility of growing hybrid poplar to provide fuel over the long term. Members of the hybrid poplar cooperative were contacted and information collected on the economics of this possible source of supply, site requirements, operational considerations, etc.

6.4 GENERAL WOOD RESIDUE MARKET

Wood residues generated in the proposed project area are traded in a variety of markets and ultimately used as:

- paper furnish;
- composite products;
- landscaping/mulch;
- boiler fuel;
- on-site boiler fuel; and
- animal bedding.

Any energy facility at one of the three project locations would have to be compete for supply within these markets. Any residue that is not used in products is disposed of in landfills.

Many people unfamiliar with wood residue markets are most concerned about simple availability. While the amount of the resource is finite, this should be of little importance except for the largest projects. The more pertinent question is how much can the project pay and will this be enough to attract sufficient volumes. Within all wood residue markets, the generators of the wood residue are price takers. Since generation of the wood residue is a normal part of the production process and must be disposed of, the industries will send the material to any purchaser who pays the highest price after transportation costs are deducted. The one exception is in the case of an industry selling both their chips and their bark to a mill in Tomahawk. In this case, producers are reluctant to separate these two waste streams.

Paper Furnish

The strongest markets are for chips used as paper furnish. Chips used as paper furnish must be free of bark and are supplied to pulp mills to supplement existing supplies of roundwood. A total of 15 of surveyed firms sell chips for paper furnish. Nearly all of the chips are sold in Tomahawk at delivered prices ranging from $21 to $28 dollars per ton. The average is about $25/ton. Net prices received, once transportation costs are deducted, range from $12 to $18 per ton.

Comparing haul distances to Tomahawk and haul distances to Danbury, Hertel and Turtle Lake, among these 15 firms, there are four firms that might be willing to accept a lower delivered wood price at these locations compared to what they are

receiving at Tomahawk although it is unlikely to be much below $20. This is highly dependant on a significant reduction in transportation costs due to shorter haul distances.

There are two components of transportation costs. One is the fixed rate for simply loading the trucks, which ranges from $150 to $200/truck. The other is based on haul distance. Given this cost structure, the total cost per loaded mile decreases the further the material is hauled. Coarse material available from these four industries totals just under 15,000 tons annually.

Another significant factor concerning these industries is the fact that their bark residues are not traded with Tomahawk for boiler fuel, but enter other markets. Many of the firms which sell both chips and bark to Tomahawk expressed great reluctance to sell their bark elsewhere for fear that Tomahawk would subsequently refuse to take their chips. Two of the industries are under contract with Tomahawk for their chips but the terms of contract are unknown and may not be a significant obstacle if they are annual contracts. It is suggested that contact with these firms be made after it is determined, through the economic model, the maximum price which could be paid to make the project feasible.

Where no city is indicated, the material could go to any of the proposed project sites. In other words, haul distances would be roughly comparable. Where a city is indicated that is the location where the material could be delivered at lowest cost.

Composite Products

Composite product markets are also very strong, but unlike paper furnish markets, no single firm dominates the market in the project area. Of the firms surveyed, eight sell wood residue as a feedstock for composite products. These residues are sold to firms in Duluth and Phillips where they are used to make hardboard, and Marshfield were they are used to make door cores. This market is much more tolerant of a mix of residue types. It is the only market which will accept all types of residue including fines, coarse material, bark and mixed residue streams. The only requirement seems to be that all of these wastestreams be green material and free of contaminants.

The hardboard plant in Phillips pays the highest delivered wood price of the three firms which purchase residue for production of composite products. Delivered residue prices are $25/ton at Phillips, between $13 and $19/ton at Marshfield and $17/ton in Duluth. Net prices received for material sent to these locations from surveyed firms range from $9/ton to $21/ton.

Comparing existing haul distances to current competitors and haul distances to Danbury, Hertel and Turtle Lake suggests that the residue streams from only two firms might be diverted to an energy facility at these locations at delivered wood prices under $20/ton. The total potential volume of fine and coarse material from these two sources would total less than 5,000 tons annually.

Landscaping/Mulch

Comparing previous work done in Wisconsin with the results of this survey indicates that landscaping/mulch markets have strengthened considerably over time. Discussions with surveyed industries confirm this. Bark and, to a much lesser extent, coarse material is traded within this market. Twelve of the firms surveyed were active in this market. Several firms indicated that the increasing strength of landscaping/mulch markets is a result of four factors.

- Colorant technology, which allows customized coloring of bark, has advanced and has become more inexpensive on a per unit basis which adds value to the bark and results in market expansion.
- The establishment of a large wood energy facility in St. Paul has changed the dynamics of the market in the project area. Large volumes of urban wood waste, which previously were traded in this market, now go to this energy facility. As a result, companies purchasing material for the landscaping/mulch market have had to expand their procurement radii, strengthening markets and increasing markets in more distant areas.
- Urban growth automatically increases markets for this type of material. The landscaping/mulch market also increases due to the need to reapply the material every few years. Unlike wood residue that is used in paper or composite product production, wood residue in landscaping/mulch markets creates its own market expansion as the material rots and re-application becomes necessary.
- Fashion trends in landscaping are toward less lawn and more plantings in chipped beds as a means of decreasing annual maintenance. This trend has also strengthened landscaping/mulch markets.

Wood residue generated by surveyed firms primarily goes to Minneapolis/St. Paul, however several firms indicated that this material also enters markets in Milwaukee and as far away as Iowa. Unlike residues which are traded in paper furnish, composite products, and sold boiler fuel markets where the generating industry must arrange and absorb transportation costs, a large volume of material generated for the landscaping/mulch market is picked up on-site by the purchaser who assumes the transportation costs.

A total of 37,500 tons of bark annually is traded in this market by surveyed firms. Of this total, 22,900 tons is picked up by the firm purchasing the material at a cost ranging from $8 to $24/ton at the site of generation. For those firms which pay to have their bark delivered to market, gross per ton prices are highly variable ranging from $12 - $40/ton.

A total of 9,300 tons of coarse material annually is traded in this market by surveyed firms. Of this total, 3,000 tons are picked up by the company purchasing the material at a cost of $24/ton. For those firms which pay to have their coarse material delivered to market, gross per ton prices range from $14 - $24/ton.

Prices paid and volumes generated annually at industries where the purchaser picks up the material are as follows:

- 3,900 tons @ $8/ton
- 1,300 tons @ $12/ton
- 1,300 tons @ $14/ton
- 5,640 tons @ $15/ton
- 8,200 tons @ $16/ton
- 5,850 tons @ $24/ton

Given these prices and the fact that transport would have to be arranged, it is unlikely any of this material could be secured at reasonable cost to new energy production facilities in the project area. Over time, these prices will only climb as the landscaping/mulch market expands. Comparing existing haul distances to current competitors and haul distances to Danbury, Hertel and Turtle Lake suggests that the residue streams from only two firms might be diverted to an energy facility at these locations within this market at delivered wood prices under $20/ton. The total potential volume of fine and coarse material from these two sources would total less than 6,000 tons annually.

Sold Boiler Fuel

Sold boiler fuel is traded in a relatively small geographic market area. Of the 12 companies which sell residue as boiler fuel, seven are within 60 miles from the user and four are 60 – 100 miles from the user. There are many competitors for this material in the market. Residues sold as boiler fuel are shipped to industries in Tomahawk, Ashland, Phillips, Park Falls, Duluth and Whitehall. Prices paid are highly variable ranging from a low of $8/delivered ton to a high of $18/delivered ton. The average appears to be $10 - $12/delivered ton. Eight companies reported that they make money on these sales but the amount is low, usually under $5/ton.

All types of residue are sold as boiler fuel. Excluding two of the largest generators, 7,470 tons of fines are sold in the project area for boiler fuel, 24,964 tons of coarse material, and 16,542 tons of bark. There is some evidence that pressure is being exerted on this market, concerning bark, by the increasing strength of the landscape/mulch market which is the alternative market for bark residues.

In the course of conducting the Survey, several companies stated that they had investigated adding wood burning facilities to their existing mills and concluded it would not be feasible. These companies ranged in size from relatively small sawmills to a pulp mill.

On-Site Boiler Fuel

Material used in on-site boilers would not be available for use in the project. Residue burned in on-site boilers by surveyed firms are located at Drummond, Spring Valley, Independence, Hayward, Springbrook, Grantsburg, Luck, and Birchwood. Two of these firms also buy additional boiler fuel in the winter.

Animal Bedding

Animal bedding markets are the weakest markets in terms of salable products but one of the strongest at the local level. From the surveyed firms, only one actually purchases wood residue to manufacture animal bedding from surveyed firms. The rest of the animal bedding market consists of farmers, generally picking the material up on-site for use at local farming operations. Unlike markets for paper furnish, composite products, landscaping/mulch, and sold boiler fuel, animal bedding markets consist of many generators and many purchasers within very small geographic areas.

The vast majority of material traded in this market is sawdust. The volume of fines used in this market generated by surveyed firms totals 38,100 tons annually. Of this total, only 2,800 tons are transported by the generator at a cost to them. For the rest of the volume, the purchaser either picks the material up or pays for the transportation costs. An additional 16,200 tons of mixed material is also generated and used as animal bedding which the purchaser picks up. A total of 19 surveyed firms supply wood residue to animal bedding markets.

The highest net prices paid for this material range from $10-$30/ton. For the rest of the material, prices are quite low, averaging about $4/ton. To access the resource at low price requires the buyer to pick the material up. There is also a strong seasonal dimension to animal bedding markets. Demand is strongest in the winter and weakest in the summer, spring and fall.

Several firms trading in this market expressed great reluctance to divert their wastestreams to other uses despite receiving very low prices for the material. Their reluctance stemmed from long standing relationships with users of this material and the fact that the users were fellow community members and neighbors.

Diverting any portion of wood residues from animal bedding markets from these or other industries will require setting up a collection system utilizing tribe owned trucks and labor to accomplish the transport. For the largest generators of material trading in this market, this will require a number of trailers and scheduling of pick-up at the convenience of the generator. Typically, the purchaser leaves a trailer at the generators location and picks it up when full. The timing of pick-up is critical to prevent interference with the generators operations.

Landfilling

Less than 2,000 tons annually are landfilled by surveyed firms. Landfilled material is generated exclusively by secondary forest products industry and the vast majority of it is contaminated with resins, glues, stains, etc.

6.5 SURVEY RESULTS

Survey Results are broken out geographically, primarily to account for transportation costs, which are dependent on the distances from the generation of the material to the point of use. Two specific areas were assumed for the survey:

- Danbury
- Turtle Lake

6.5.1 Danbury Survey Results

The survey database contains 32 forest products industries within 60 miles of Danbury that produce wood residue, or could possibly produce chips, for use at an energy facility there. Four of these are loggers that might supply chips, seven are primary mills, 19 are secondary mills, and two are integrated operations.

Loggers

Three of the four loggers were contacted. One is no longer in the chipping business but the other two were willing to quote a price. The two source the wood to produce chips using two different methods. One stated that he would bid on and buy sales with a heavy component of oak specifically to supply the facilities and that he could deliver pure oak chips. The other works with other loggers and has them separate out logs on the landing that they normally would not bring out of the woods or for which they have little market. This is likely to result in chips of mixed species.

For chip delivery to a 1 MW facility, two trucks/day of green chips with delivery by live bottom trailer (ie., self-unloading) was specified. This represents 25 tons/truck x 2 trucks/day x 365 days/year = 18,250 tons annually. The one quote received is $20/ton FOB Danbury.

To offer some perspective on how the annual fuel requirements of an energy facility at Danbury would compare to current wood volumes and existing growth and removal rates, 50 mile circular plots of growing stock volume, growth and removals by species group were run from the Forest Inventory and Analysis database. Growing stock consists of all live trees 5 inches or more in diameter. Net growth is total growth less mortality not due to logging. Removals are volumes removed due to logging.

Table 1 – Total cubic feet volumes of growing stock, net growth and removals from growing stock within 50 mile circle retrieval with latitude 46.11 degrees north and longitude of 92.2 degrees west. Danbury, Wisconsin. (Source: Minnesota 2002 cycle 12 annual inventory and Wisconsin 1996 cycle 05 periodic inventory)

Species Group	Total Growing Stock Volume, cu.ft.			
Other yellow pines	1,139,960	66,095	0	N/A
Eastern white & red pine	374,686,867	16,212,936	1,812,859	11%
Jack pine	149,128,882	2,099,879	2,932,899	140%
Spruce & balsam fir	174,231,177	5,721,159	865,854	15%
Eastern hemlock	8,025,384	58,375	0	N/A
Other eastern softwoods	92,601,485	1,670,615	132,278	8%
Select white oak	137,658,627	3,273,797	870,901	27%
Select red oak	459,969,468	12,411,010	5,713,831	46%
Other red oak	44,917,450	932,931	92,452	10%
Hickory	5,649,036	231,275	0	N/A
Yellow birch	12,805,138	284,587	159,732	56%
Hard maple	208,096,881	6,124,586	1,165,219	19%
Soft maple	301,501,119	13,990,566	2,106,575	15%
Ash	174,150,896	2,701,846	293,505	11%
Cottonwood & aspen	748,635,505	25,820,973	20,727,826	80%
Basswood	162,067,555	4,181,120	1,206,560	29%
Black walnut	765,007	22,314	0	N/A
Other eastern soft hardwoods	230,695,509	1,715,369	4,724,760	275%
Other eastern hard hardwoods	572,542	(45,195)	0	N/A
Total	**3,287,298,490**	**97,474,237**	**42,805,252**	**44%**

Many factors can influence the utilization percentage such as insect outbreaks (which explains the high utilization in jack pine), age class distribution (a factor in the high utilization of cottonwood and aspen), high amounts of mortality (the primary factor for high utilization of Other eastern soft hardwoods where net growth is only 0.7 % of volume compared to eastern white and red pine where net growth is 4.3% of volume) and the strength of markets. In general, a low utilization percentage indicates weak markets for a particular species.

Annual usage of 1 MW plant would total approximately 1,800,000 cubic feet (90 yards/truck X 27 cubic ft./yard X 2 trucks/day X 365 days/year) or a four percent increase in removal volumes. Annual usage of a three megawatt plant would total 5,400,000 cubic feet or a 12 percent increase in removal volumes. The fuel for a one megawatt plant could be supplied entirely from the oak resource. Supplying a 3 MW facility with oak alone is probably not feasible over the long term.

In addition to capturing a portion of existing harvest volumes and increasing harvest levels within certain species groups, part of the fuel supply to a facility in Danbury could be met by utilizing rough and rotten material within existing harvest units. Such material is currently left in the woods and is not included in the net growing stock volumes listed above.

Technology to utilize material sourced from logging operations should be selected which allows for bark, leaves and wood of various species (especially white oak, red

oak, hard maple and soft maple in the case of Danbury); relatively uniform chip sizes; and some tolerance for dirt and other contaminants.

Primary Industries

Four of the seven primary industries responded to the phone survey. One of these refused to answer any questions. Of the three that did not respond, two were fairly small mills.

The vast majority of the bark residue generated by these firms is used as sold boiler fuel. The largest volumes are sold to the NSP plant in Ashland under contract. Some bark is also sent to the Minneapolis/St. Paul landscaping market with the purchasing company absorbing the freight costs. Given the size of the firms that did not respond, it is estimated that less than 8,000 tons annually of bark might be captured from the primary industries that are not currently selling the bark under contract. Net profits from bark sales are very low. In all cases, under $10/ton.

Another complication in capturing the bark which is not under contract is that much of what is currently produced and could possibly be available is not transported by the firms that generate it. The user of the material picks the material up and absorbs all transportation expenses. To compete for this bark, the Danbury facility would have to absorb the transportation costs which would likely push the cost per delivered ton over $15.

Chips produced within a 60 mile procurement radius are being shipped to Tomahawk for paper furnish and Phillips for use in composite products. Despite the long transportation distances, 124 and 79 miles respectively, the companies shipping to these locations are already netting over $10 or $15/ton. Even if the Danbury facility could beat these net prices, there is insufficient chip volume produced in the region to supply the facility for even six months. Fines residue identified in the survey is burned on-site and would be unavailable.

The only way to source sufficient residue within a 60 mile procurement radius of Danbury from primary industries would be from the largest producers. A minor diversion of supply from their existing markets would easily supply the facility at Danbury. These residues are attractive because they are single species for the most part (aspen bark), plentiful and could probably be had for under $20/ton delivered wood cost. Haul distances are comparable to where they are going now. Unfortunately follow-up calls to one of the target firms confirmed that their existing contract with Xcel would not allow for such a diversion.

Expanding the procurement radius to 80 miles does not result in the addition of many mills that might supply a facility at Danbury. In fact, an 80 mile radius includes the Georgia Pacific mill in Duluth which is a competitor for wood residue in this area for use as a feedstock for production of composite products. Prices paid for residue used for this purpose are relatively high and it is unlikely that an energy facility at Danbury could compete within this market.

Integrated and Secondary Industries

Of the 21 secondary or integrated forest products firms within 60 miles of Danbury, 15 were contacted and nine responded. Five of the six which did not respond are secondary industries and all employ 50 or more people and as such are more likely to generate larger volumes of wood residue. These firms are included in the priority contacts listed below. The integrated facilities generated the most wood waste, by a wide margin, compared to the secondary manufacturers despite their size.

Of those that responded, only two had contaminated waste streams, and those waste streams were small totaling only 91 tons annually. A modest amount (498 tons) was landfilled, for which the companies had to pay to have the material hauled away and disposed of. Fines and mixed residues totaled approximately 1,200 tons annually all of which was used locally for animal bedding with the user generally picking the material up at the generating plant.

Under 4,000 tons of bark were generated annually from these integrated and secondary firms, all of which was used for landscaping/mulch (and like the animal bedding) was picked up at the generating plant by the purchaser. Given the average price received per ton for this material, the delivered price of bark per ton at Danbury would have to equal or exceed $20/ton.

A significant volume of fines and coarse material was sold as boiler fuel by these firms that could potentially supply a facility at Danbury. All of this material is green and uncontaminated although there would be some seasonal variations with delivery.

To source fuel from integrated and secondary industries, the biomass technology would have to accommodate a more variable waste stream compared to that from logging operations – namely a mixture of green and dry fines; variable coarse material containing non-uniform chunks; and pieces of varying species. The incoming material is also likely to be less uniform from load to load compared to chips, especially if sourced from multiple suppliers. Suggested follow-up contacts were included in the previous section.

It is likely that sourcing fuel from these five companies will result in a highly variable combination of dry waste streams. It is also likely that multiple companies would be needed to supply the needed volumes further complicating the dynamics of fuel consistency and delivery.

Wood Waste Volumes and Cost

From the database of information, 33 waste streams from 21 companies that sell for $10 or less have been identified. Twenty-two of these waste streams used on-site for boiler fuel or are sold or given away locally primarily for animal bedding. These would be difficult to capture. Nine of the waste streams are sold as boiler fuel with the selling companies netting very little for the material. Volumes sold as boiler fuel that are not under contract total: 7,470 tons of fines; 14,300 tons of coarse material; and 1,600 tons of bark.

Fifteen waste streams from five companies sell for $11-$15 dollars. These sell in a variety of markets. Net profits from these sales are generally higher than the material selling for $10 and under. Volumes sold not under contract in this price range total: 14,414 tons fines; 3,849 tons coarse; and 17,882 tons bark.

The total available material is approximately 59,000 tons per year.

6.5.2 Turtle Lake Survey Results

Loggers

The forest resource situation within 50 miles of Turtle Lake is distinctly different than that within 50 miles of Danbury. Growing stock volume and growth are approximately 2/3rds of the amount growing around Danbury. Removal volumes, however, are slightly higher. Consequently, utilization percentages as a proportion of growth are much higher both in total and for most species groups. Five species groups show utilization rates above 90 percent. Overall utilization is 66 percent of growth in vicinity of Turtle Lake compared to 44 percent in the vicinity of Danbury.

Target species groups near Danbury and their respective utilization percentages include red and white oaks (40%), hard maple (19%), and soft maple (15%). Utilization percentages near Turtle Lake are red and white oaks (49%), hard maple (37%), and soft maple (33%). These differing utilization percentages across species groups are an indication of the relatively stronger market near Turtle Lake due to higher quality stands as a result of moister and richer soils and closer proximity to major markets. Stumpage prices will be higher as a result further increasing the cost of delivered chips to a facility in Turtle Lake compared to Danbury. The one quote received is $24/ton FOB Turtle Lake.

Focus on hybrid poplar may be more appropriate in Turtle Lake (and Hertel) given farmland acreage close to these areas. This is discussed in a following section devoted exclusively to hybrid poplar resources as a long-term source of supply.

Table 2 – Total cubic feet volumes of growing stock, net growth and removals from growing stock within 50 mile circle retrieval with latitude 45.44 degrees north and longitude of 92.2 degrees west. Turtle Lake, Wisconsin. (Source: Minnesota 2002 cycle 12 annual inventory and Wisconsin 1996 cycle 05 periodic inventory)

Species Group	Total Growing Stock Volume, cu.ft.			
Other yellow pines	1,708,829	28,837	0	N/A
Eastern white & red pine	240,356,003	11,830,938	1,742,576	15%
Jack pine	84,805,159	1,769,450	1,610,895	91%
Spruce & balsam fir	23,094,776	723,285	242,585	34%
Other eastern softwoods	38,684,697	1,183,817	0	N/A
Select white oak	227,462,135	5,230,422	1,285,255	24%
Select red oak	447,597,510	11,250,110	7,125,730	63%
Other red oak	66,197,652	1,298,786	404,978	31%
Hickory	19,179,670	681,004	301,493	44%
Yellow birch	8,485,466	110,639	350,726	317%
Hard maple	148,986,785	4,243,601	1,574,186	37%
Soft maple	187,713,333	8,222,010	2,711,016	33%
Ash	138,274,321	4,047,085	1,829,257	45%
Cottonwood & aspen	413,380,578	12,324,097	16,798,751	136%
Basswood	152,585,031	2,479,078	3,735,410	151%
Black walnut	1,092,796	48,017	0	N/A
Other eastern soft hardwoods	126,825,900	737,692	3,758,041	509%
Other eastern hard hardwoods	620,067	(31,798)	0	N/A
Total	**2,327,050,707**	**66,177,072**	**43,470,899**	**66%**

Primary and Secondary Industries

A total of 67 primary or secondary forest products industries are located within 60 miles of Turtle Lake. Of these, 17 are primary or integrated operations and 40 are secondary operations. Thirteen of the 17 primary or integrated operations were surveyed. All were contacted but four did not respond.

Only ten of the forty secondary industries were contacted or responded. Recommendations regarding those that did or did not respond located within 60 miles of Danbury are included in the previous sections. As was stated previously, it became clear early on that while wood residue generated by secondary industries was the most likely to be traded in weak residue markets and to be had at the lowest prices, it was also generated in the lowest volumes.

Wood Energy Harvester

Traditionally it has been un-economical to utilize logging residue as a bioenergy source of fuel due to the logistics of collection and transport. The one exception is where logging slash is concentrated at the landing, primarily from tree length harvesting operations. In this case, such residue is chipped directly, blown into trucks and transported directly to the end user. Tree length logging operations are

more common in Minnesota than in Wisconsin where cut-to-length operations predominate.

Slash management techniques are used in Wisconsin and Minnesota including distribution across the site, rollerchopping, broadcast burning, and pile and burning. An economical method of collecting some of this material could make it useful as a wood energy resource.

One of the leading manufacturers of cut-to-length equipment is Timberjack, a John Deere Company. Reacting to demand, primarily in Scandinavia, for greater use of logging slash in energy production, Timberjack recently unveiled an energy wood harvester. Dubbed the 1490D, the unit consists of a bundling unit secured to the normal hauling cradle of the 14100 Forwarder. From the vehicle's cab, the operator feeds logging slash into an input chute where a series of rollers advance the slash through the machine, compressing it into tight fuel wood "logs". The logs are wrapped with a thick twine, cut-to-length, transported by a second forwarder to a landing, and transported to a mill using conventional logging trucks. The bundles are converted to hog fuel at the receiving mill. Approximately 50 systems are operating in Scandinavia.

The existence of this technology offers another possible source of fuel to supply a wood energy facility at Hertel, Danbury or Turtle Lake. While more detailed analysis would be needed before investment in such a unit were undertaken, preliminary information is available and reviewed below. In work to date, the most critical issue concerning the technology has been the initial capital cost ($500,000), the operational costs versus the value of the biomass, and lack of markets for the bundled material.

The USDA Forest Service has undertaken studies of this technology since 2003 and Timberjack has done numerous demonstrations of the technology throughout the country. The machine's productivity is affected by steep slopes, residual stand spacing, and down fuel loading. A 40 percent slope is the maximum slope on which the machine can operate.

Stated advantages over direct chipping are that, given the compressed nature of the bundle, it is more economically transported. Also, unlike chips, the bundles can be stockpiled as needed to accommodate the demand for fuel and the different harvesting seasons. The machines can work in any type of wood and are not hindered by snow.

Harvesting in conjunction with a cut-to-length system or where the slash ends up in piles or rows appears to be most efficient. Use of the bundler will moderately alter the pattern of harvest and will slow the efficiency of the cut-to-length machine. Evenly spaced slash rows to accommodate boom reach distances, between an operating slash matt, is an ideal set-up. The bundler does not utilize the slash in the slash mat because of the high dirt content. Typically, 60 percent of the slash is bundled and removed and 40 percent remains on-site.

Production has ranged from 6.5 bundles per hour to over 10 bundles per hour. When bundling landing slash piles, nearly 20 bundles per hour can be achieved. Bundle characteristics are as follows:

- Bundle diameter – 2 ft. 3 in to 2 ft. 7 in.
- Bundle length – typically 10 ft. to 11 ft.
- Bundle weight – typically 882 lb to 1,323 lb

Operational Assumptions

Scenario 1 – Base Scenario

- Stumpage price is unaffected by the existence of the bundler operation.
- No reimbursement is made to the timber seller for the slash removed.
- Forgone slash management costs are not included in the analysis.
- Logger owns the bundler and arranges for truck transport to final destination.
- Truck transport costs average $200/truck plus $1.50/loaded mile with an average haul distance of 30 miles for an overall average of $245/truck.
- Not included in the capital costs is an estimated $500,000 chipper which would be a necessary capital investment at the receiving plant if bundles were received instead of chips.

Capital costs

- Capital costs of bundler - $500,000
- Capital costs of second forwarder - $400,000
- Finance cost of bundler and second forwarder– 20 years @ 9% = $8,097.53/month or $97,170/year

Operating assumptions and variable costs

- Operating time - 2,060 hours annually
- Bundles produced/hour – 10 Bundles produced/year – 20,800
- Labor – 2 people X $15/hour X 2080 hours = $62,400/year
- Fuel for bundler and second forwarder – 16 hours/day X 5 days/week X 52 weeks/year = 4,160 hours. Estimated 4,160 hours X 5 gallons/hour X $2/gallon = $41,600. (This equates to $80/unit/day)
- Maintenance costs - $1,000/week X 2 machines X 52 weeks = $104,000/year
- Insurance – $17,000/year

Fuel assumptions

- Mixed species at 44 % moisture content.
- Specific gravity = .50
- Btu/oven dry pound = 8,500

- Average Btu/green pound = (8,500 X .5) = 4,250
- Average weight/bundle = 1,200 lb.
- Number of bundles transported/load = 65
- Daily volume of fuel required for a 1 MW plant = 2 green tons/hour X 24 hours = 48 tons (96,000 lbs., or 80 bundles/day).

Under these assumptions, one bundler could not produce sufficient volume to supply a 1 MW plant. It could supply the plant for five days but not seven. Given the costs and production efficiencies outlined above, delivery cost per green ton is estimated as follows:

Total Annual Cost Summary

Annual financing charges ($8,097.53 X 12)	$97,170
Labor	$62,400
Machine fuel	$41,600
Maintenance costs	$104,000
Insurance	$17,000
Truck transport ($3.97/bundle X 20,800 bundles)	$82,576
Total Annual Cost	$404,746

Total Annual Revenue Summary

20,800 bundles @ $10/bundle delivered ($16.67/gr.ton)	$208,000
20,800 bundles @ $15/bundle delivered ($25.00/gr.ton)	$312,000
20,800 bundles @ $20/bundle delivered ($33.33/gr.ton)	$416,000

Under Scenario 1, the price required per delivered green ton to break even would have to exceed $25.00.

Using the above as the base scenario, various assumptions can be changed to estimate their effect on the break even price a receiving mill would have to pay for delivered bundles. A change in many additional assumptions beyond the four identified below are possible, however, the financing charges and production rates appear to be the most sensitive to change and probably the most uncertain to estimate given individual circumstances and the difference in amounts of slash from site to site.

Scenario 2 – Grant received for ½ of the capital cost of the bundler

This would reduce annual financing charges to $70,179. If all other assumptions remained the same, annual operating costs would be reduced to $377,755, still above $25/green ton delivered wood cost to break even.

Scenario 3 – Existing support forwarder is used which would incur no finance costs

This would reduce annual financing charges to $53,984. If all other assumptions remained the same, annual operating costs would be reduced to $361,560, still above $25/green ton delivered wood cost to break even.

Scenario 4 – Production of bundler averages 12 bundles per hour rather than 10

This would increase annual production to 24,960 bundles. This increase in production would increase annual truck transport costs to $99,091 and total costs to $421,261. At $10/bundle, delivered revenue would be $249,600 for a shortfall of $102,489 in meeting operating costs (at $16.67/gr. ton). Delivered revenue at $15/bundle ($25.00/gr. ton) would be $374,400, still a substantial shortfall.

Scenario 5 – Chipped by a logger at the landing

As part of this project, quotes were obtained from several loggers who indicated they would chip slash deposited at a landing and deliver the chips to a mill for approximately $20/green ton. This is a different production system than one that would utilize a bundler. This alternative production system has the advantage (compared to a bundler type system) of lower capital and operating costs for the logger but also may result in lower availability of logging residue since cut-to-length systems are the norm in Wisconsin and such a production system is less adaptable to harvest of slash left in the woods. On the other hand, it may reduce costs at the receiving mill for such things as a bundle chipper and chip storage facilities.

Further Research Questions

To develop a firm and commercially viable proposal to utilize a bundler system to process slash into bundles for use as a biomass fuel, additional research into the following areas is needed:

- Verification of all capital and operating costs.
- Verification of the volumes of slash economically available which can be harvested utilizing such a system.
- Geographic location and seasonal availability of this slash in relation to proposed user location and needs.
- Identification of loggers willing to partner with the Tribe in development of the project.
- Negotiation of supply contracts with such loggers.
- Development of contingency plans in the event of a change in assumptions/planned activities and actions.

6.6 HYBRID POPLAR

Another option to supply a wood energy facility is tribal development of hybrid poplar plantations. While the Tribe currently owns no lands upon which such plantations could be established, lease arrangements with farmers could be pursued to establish the plantations. Following is a brief description and economic analysis of this supply option.

Widespread interest in hybrid poplar as a source of wood supply began in the 1980's and 1990's in the Midwest. Small scale research and experimental plantings were conducted until 1994 when the first large scale commercial plantations were established on Conservation Reserve Program (CRP) lands near Alexandria, Minnesota. This effort was led by a number of industries and agencies which joined together and formed the Hybrid Poplar Research Cooperative. The interest in hybrid poplar plantations was fueled by reduced harvesting on some public forestlands, an age class imbalance in natural aspen which has also reduced supply, and industrial expansion of paper and oriented strand board production which increased demand. The effect of these three factors has caused stumpage prices for aspen pulpwood to skyrocket making investment in hybrid poplar plantations more economically viable.

Hybrid poplars are crosses between native North American Eastern Cottonwood and poplars and European poplars and willows (Asian species are also used). Plant breeders have created hybrids of many crop and ornamental plants to improve both yield and appearance. Tree breeders select parents with desirable characteristics, cross pollinate the trees, and evaluate the resulting seedlings in field trials. Those crosses which exhibit desired parental traits and enhanced growth rates may be further crossbred. Through this process, hundreds of hybrid poplar clones have been developed and tested for use in the Midwest on different soil types. Hybrid vigor is key – rapid growth rate, insect and disease resistance and superior climatic adaptation. These clones are commercially available. A clone is a group of genetically identical plants that result from vegetative reproduction of a single tree. Most clones are sterile or male and, consequently, pose no risk of pollinating with native species. It is not clear when, if ever, hybrid poplar clones might reach sexual maturity if unharvested.

Europeans have been hybridizing trees a lot longer than the United States. Within North America, active hybrid poplar breeding programs exist in Maine, Wisconsin, Minnesota, Michigan and Massachusetts. The Forest Service Research Station in Rhinelander, Wisconsin has been instrumental in developing clones for the Midwest as has the Natural Resource Research Institute in Duluth, Minnesota.

6.6.1 Site Selection

Proper site selection is critical to achieving maximum growth rates of hybrid poplar. Hybrid poplar grows best on loams, sandy loams and clay loams with a pH of 5.5 to 7.5. Relatively fertile soils are recommended. Full sun is required and slopes greater than 8 percent should be avoided.

The profitability of hybrid poplar for landowners, as opposed to other agricultural crops, is highly dependant on the inherent productivity of the site and whether or not cost share programs are available. Much of the land currently planted to hybrid poplar in the Midwest is enrolled in the CRP which is designed to remove marginal farmland from crop production. This program subsidizes farmers for the reserved acreage and allows the planting of trees. Hybrid poplar cultivation on agricultural acreage capable of producing 119 bushels of corn per acre or less is competitive with agricultural production if CRP subsidies are available. Without such subsidies, hybrid poplar cultivation is not competitive with agricultural production in general.

Changes in agricultural commodity and pulpwood prices will change this dynamic as will changes in yields of either product but for the most part, establishment of hybrid poplar plantations seem most suited to marginal farmlands enrolled in the CRP program or poor corn lands.

6.6.2 Site Preparation

Hybrid poplar are very sensitive to vegetative competition for sunlight, moisture and nutrients. Before planting in the spring, existing vegetation on the site must be eliminated. In the case of an existing agricultural site this could involve disking or plowing under annual weeds or crops and application of a post emergent herbicide if perennial weeds are present.

Fields in grass require more intensive preparation beginning in the summer prior to planting. Brush cutting, mowing or burning and application of a post emergent herbicide should be done in late summer followed by deep plowing if possible. Herbicide applications to kill all existing weeds and grasses are crucial to ensuring spring planting success. In all cases, the field should be tilled 10 inches deep prior to planting and cultivated as would be done if corn were being planted. Very heavy use of herbicides should be anticipated on sites not currently cultivated.

6.6.3 Planting

Hybrid poplar is established from “cuttings” which are sticks 9 or 10 inches long, 3/8” – ¾” in diameter with at least two viable buds on the upper 4” of the cutting. Cuttings are collected in the winter from one year old tree stems and stored at or below freezing to keep them dormant. All the cuttings will be genetically identical originating from a single selected tree clone. Choice of an appropriate clone is crucial. A number of different clones are commercially available that can be matched to specific sites. Each also exhibits different disease and insect resistances.

About a week before planting, the cuttings are refrigerated to allow them to thaw. They are also soaked in cool water with the buds pointing upward. When the buds elongate and turn a bright green color they are ready for planting and must be planted before the buds open. Planting is done in early spring when soil temperature is greater than 50 degrees F. The soil must be moist with only one bud remaining above ground with one inch of the cutting exposed. Spacing is generally eight to ten feet within and between rows depending on the size of the machinery available for cultivation and the final use of the material (closer for trees designated for energy production and wider for trees designated to produce pulpwood).

6.6.4 Cultivation

Hybrid poplar do not compete well with weeds for nutrients, water and light. Such a plantation must be cultivated more as an agricultural crop than a forest. A pre-emergent herbicide labeled for hybrid poplar should be applied following planting. Mechanical cultivation to a depth of two to three inches is used to maintain weed free conditions without damaging the new tree roots. Repeated tilling and herbicide applications will be needed for the first two to three years after plantation

establishment or until the canopy fills in. Hybrid poplars are nutrient-demanding so fertilization during the course of the rotation is likely to promote optimum growth. Under optimal conditions, pulpwood sized material will be produced in 10 to 12 years.

6.6.5 Harvest/Regeneration

Harvesting can be done using conventional logging equipment. Hybrid poplar reproduces via a coppice system (from stump sprouts) and therefore additional planting is not required after initial plantation establishment. Weed control and fertilization will still be necessary, however, for subsequent rotations.

Comparing short rotation hybrid poplar to native aspen:

- Hybrid poplar produces 3 to 5 cords/acre/year compared to 0.4 to 1.6 cords/acre/year for native aspen.
- Rotation age for hybrid poplar pulpwood is 10 to 12 years compared to 40 to 50 years for native aspen.
- Weed control is mandatory with hybrid poplar and no weed control is necessary for native aspen.
- Hybrid poplar stumps will coppice after harvest, while native aspen will regenerate naturally via root suckers.

Existing commercial harvests of hybrid poplar are being used for pulpwood. The market price of this higher valued forest product has made hybrid poplar plantations, with their high initial establishment and maintenance costs, economically viable. Generally, markets for the wood harvested from hybrid poplar plantations are identified prior to the plantations establishment.

Plantation establishment specifically for energy production has proven to be less economically viable given the high initial costs and the relatively lower costs of conventional fossil fuels. As energy prices increase, however, and if a system for optimizing harvest products from hybrid poplar plantations can be developed (selling part of the harvest as pulpwood and part as a biomass energy fuel), hybrid poplar could become an important source of biomass fuel.

6.6.6 Economics

A considerable amount of work has been done on the economics of hybrid poplar plantations. For the purposes of this project, a break even analysis follows. Locating plantations as close to the wood using facility as possible will minimize transportation costs. Acreages of land (as of 1997) that could potentially be converted to hybrid poplar by county within the project area are as follows:

County	Hay, alfalfa, wild, silage, ac.	Corn for silage, ac.
Barron	1,106	14,983
Burnett	18,858	2,743
Polk	67,817	11,190
Washburn	248	1,925

Those acreages in hay, alfalfa, wild or silage or in corn for silage were deemed the most likely targets for conversion to hybrid poplar. More fertile sites currently producing corn for grain, potatoes, soybeans or oats are not likely to be more profitable if converted. As the table above indicates, Burnett and Polk Counties have the most acreage that could possibly be targeted for conversion to hybrid poplar suggesting a facility at Turtle Lake would be the best location if hybrid poplar supplied the plant. Total acreage needed to supply a 1 MW plant at Turtle Lake is just under 3,200 acres derived as follows:

- Fuel needed – 50 green tons/day
- Weight of a cord of aspen – 43 lbs/cubic foot X 80 cubic feet/cord = 3,440 lbs/cord
- Annual wood needed – 50 tons/day X 2,000 lbs/ton = 100,000 lbs/day
- 100,000 lbs/day divided by 3,440 lbs/cord = 29 cords/day
- 29 cords/day X 365 days/year = 10,585 cords/year
- 10,585 cords/year divided by 40 cords/acre = 265 acres/year
- 265 acres/year X 12 year rotation = 3,180 acres of plantation

These calculations assume that all of the wood harvested from the plantations is used for energy. If the wood is sorted and some is sold into pulpwood or sawlog markets, acreages required would increase. Shorter rotations would have the effect of decreasing the amount of acreage required. Shorter rotations would be feasible if the objective were production of bio fuel only. Trees designated for energy production could be planted much closer and harvested more economically, and more often with smaller equipment.

The majority of costs in establishing hybrid poplar plantations occur in the first three or four years. Following is a comparison of results from several studies to determine costs incurred in establishing hybrid poplar plantations. Only Study 5 estimates costs of tending the plantations through a 12 year rotation. The numbers in this study are fairly comparable with those in the other studies through years 0 and 1 will be used in subsequent analysis.

Year	Activity	Study 1	Study 2	Study 3	Study 4	Study 5
0	Site Preparation					
	Mowing					9.00
	Soil Test					12.00
	Offset disk and plow	15.00				
	Tandem disk	8.00				
	Disk/chisel	15.00				
	Plowing total					14.00
	Fall site prep complete		35.00	26.00	12.00	
	Round-up application	19.00	18.00	17.00		16.00
	Tandem disk cultivate/harrow	8.00	10.00			
	Burn and herbicide	10.00				
	Land rent					12.00
1	Planting Year					
	Apply herbicide	34.00	20.00	26.00	26.00	15.00
	Tree/stock/ship/store	73.00	82.00	92.00	92.00	100.00
	Planting cost (8X8 spacing)	49.00	38.00	55.00	55.00	38.00
	First cultivation	10.00	10.00	8.00	8.00	10.00
	Second cultivation	10.00	10.00	6.00	6.00	7.00
	Third cultivation	10.00	10.00	6.00	6.00	
	Fourth cultivation		10.00	6.00	6.00	
	Herbicide application	15.00				6.00
	Land rent					12.00
	Total Costs Years 0 and 1	276.00	243.00	242.00	211.00	251.00
2	Year After Planting					
	Cultivation			20.00	20.00	7.00
	Land rent					12.00
	Herbicides			31.00	31.00	21.00
3	Second Year After Planting					
	Herbicides			31.00	31.00	21.00
	Land rent					12.00
4	Third Year to Harvest (at age 12)					
	Fertilizer					45.00
	Insect and disease control					45.00
	Other maintenance					45.00
	Land rent					108.00
	Total Estimated Expenses					567.00

- Study 1 involved 13 sites, 1,000 acres total in 1994 prices/acre on acreage covered in grass.
- Study 2 involved 5 sites, 870 acres total in 1995 prices/acre on acreage covered in grass.
- Study 3 involved an unknown number of sites and acres in 1998 prices/acre on acreage covered in grass.
- Study 4 involved an unknown number of sites and acres in 1998 prices/acre on acreage formally planted to agricultural crops.
- Study 5 involved an unknown number of sites and acres in 2000 prices/acre on acreage covered in grass.

To invest in hybrid poplar plantations, the St. Croix Tribe would need to enter into long-term lease contracts with individual farmers since they currently have no tribal land on which to establish such plantations. Given this fact and the fact that only study 5 tracked costs through the entire rotation, the total estimated expenses from study 5 will be used in subsequent analysis.

Most estimates of yield from hybrid poplar plantations are between 3.0 and 3.5 cords/acre/year. Over a 12 year rotation this would yield 36 – 42 cords/acre. Assuming a yield of 40 cords/acre at the end of the 12 year rotation, a purchaser of stumpage from a hybrid poplar plantation would have to pay a minimum of $14.18 per cord just to cover the out-of-pocket expenses associated with the plantation's establishment and maintenance. Costs for logging (estimated at $20/cord) and transportation would raise delivered wood price beyond $35 per cord.

At existing delivered pulpwood prices this would be a bargain for a receiving mill but for energy production it is not economically feasible. Shortening the rotation may improve the economics of hybrid poplar plantations for biomass energy production since initial establishment costs associated with purchase of planting stock and planting costs represent approximately a quarter of the total costs throughout a rotation which would not reoccur in subsequent rotations.

6.6.7 Further Research Questions

In order to more fully evaluate hybrid poplar plantations as a possible source of fuel for a biomass energy plant at Turtle Lake, additional research is needed into the following areas:

- Refinement of all cost estimates.
- Refinement of rotation length.
- Preliminary discussion with local farmers regarding leasing arrangements.
- More in-depth investigation of and site visits to existing plantations.
- More extensive investigation into subsidies that might be utilized to defray initial establishment or annual costs for the plantations.

6.7 SUMMARY AND CONCLUSIONS

There appears to be sufficient wood residue produced by primary forest products industries to fuel a 1 MW energy facility in any of the three locations. This material is already traded in existing markets. Such material could supplement other sources of fuel if the burning technology selected can accommodate a mix of fuels of different sizes, species and moisture contents. Secondary forest products industries produce much less wood residue that primary industries and much of that residue is often contaminated with glues, laminates and other materials.

The emergence of the bundler technology creates the opportunity to re-examine the possible use of logging slash as a source of fuel. The initial economic analysis of this technology does not appear to be favorable for producing low cost bioenergy fuel. Subsidies of various types could improve the economics of this technology and further investigation of costs and production efficiencies seems warranted.

Hybrid poplar plantations also offer an opportunity for production of bioenergy fuels on marginal agricultural lands. Such plantations are, at present, being managed and harvested for pulpwood used in making paper and other composite wood products. Given the current price of pulpwood delivered at the mill, such plantations are an economically viable option as a source of supply compared to native aspen. They do not appear to be economically viable as a source of bioenergy fuel without some sort of subsidy to defray high initial establishment costs. As with the bundler technology, further investigation seems warranted.

7. SITE SELECTION

7.1 INTRODUCTION

A three-step process was utilized to ensure that all of the site criteria deemed to be necessary for the successful completion of the project were considered. The three steps are:

- Develop Detailed Siting Criteria
- Site Screening
- Detailed Site Analysis

We developed a list of screening criteria for a bio mass power plant facility location. The screening criteria were used as the basis for evaluating location alternatives. These criteria describe the ideal location's attributes. Siting criteria include items such as:

Land

- preference for land held in trust
- at least 3 to 10 acres in size
- relatively level, rectangular parcel
- no industrial land use prohibitions
- geology suitable to support construction (>2500 psi load bearing capacity)

Utilities and Support Services

Access to power line corridors, gas, water, sewer, wastewater discharge.

Transportation

Highway access with minimal seasonal weight restrictions.

Labor

6 to 10 total employees (operators, material managers, and maintenance)

Environment and Community

- Surrounding land use compatible with industrial development (sensitivity to truck traffic, noise, visual impacts)
- Buffering adequate for residential and recreational use areas
- Community receptive to industrial development
- Anticipated air emission and wastewater discharge permits available for prospective site

Utilizing the siting criteria, candidate sites within the St. Croix Chippewa Indians of Wisconsin Tribal lands were identified and compared. The candidate site list was reduced to three prime sites in an evaluation consisting of site inspections, review of community data, interviews with community leaders, etc.

The prime sites identified were:

- Danbury (adjacent to the St. Croix Fishery)
- Hertel (adjacent to Tribal Center)
- Turtle Lake (near casino)

A more detailed evaluation of the three prime candidate sites was completed. Pronounced differences in each site's relative ability to satisfy siting criteria were evaluated and ranked.

Based upon this assessment, the Turtle Lake site was eliminated from further consideration. Proximity to community and casino development and potential future use of the property for hotel and golf course development were considered inconsistent with power plant development. Further, the Turtle Lake site is not yet held in Trust.

The Hertel and Danbury sites have been identified to be the prime candidate locations for the proposed biomass power plant. The pertinent information concerning each site is listed below.

7.1.1 Hertel

- Adjacent to Tribal headquarters and community water tower
- Well buffered from community development
- Tribal Center and associated operations represent potential waste heat customer
- Close proximity to power line along State Highway 70
- Located on Highway 70 and not subject to weight restrictions on a seasonal basis

7.1.2 Danbury

- Adjacent to Tribal fishery (potential waste heat customer)
- Developed site (access road, parking, security, etc.)
- Closest to biomass resource
- Well buffered from community
- Environmental impacts already studied in development of fishery
- Utility infrastructure developed with fishery (powerlines, gas, water, septic)
- No seasonal weight limits on area highway and county roads serving site

St. Croix Waters Fishery, West Side

St. Croix Waters Fishery, Southwest Corner

8. TECHNOLOGY ASSESSMENT

8.1 INTRODUCTION

The outcomes of the bio fuel assessment and site evaluation portions of our feasibility study were determining factors for selecting the most appropriate technology. In order to avoid redundant effort and to capitalize on existing expertise and databases, we sought information and advise from engineering contractors, DOE representatives and equipment manufacturers. Technologies were evaluated based upon how well they were suited to the bio fuel available; and how well available sites satisfy operation requirements, environmental impacts, community impacts, economic viability and reliability.

The purpose of the technology assessment was to determine the most technologically feasible method of utilizing locally available biomass to produce power. The resources available were numerous, and included:

- U.S. Department of Energy and the National Renewable Lab (NREL), including personnel interviews, computer models, and research literature and documents available on the internet.
- State of Wisconsin Energy Bureau personnel and data.
- Great Lakes Regional Biomass Energy Program personnel.
- Equipment and power plant contractors and consultant engineers such as McBurney Biomass Boiler Systems, Sebesta Blomberg & Associates, Broad Street Resources, Biomass Combustion Systems, Energy Performance Systems, International Applied Engineering, Inc., Community Power Corporation, Colorado State University's Engineering and Energy Conversion Labs, and Itasca Power Company.
- Users of biomass systems such as, Webster Industries and the Burlington Vermont Electric Department.
- Miscellaneous reports and studies, primarily available on the internet.

The study was conducted using three steps:

- Identifying Candidate Technologies
- Screening the Potential Technologies
- Selecting Technology and Preparing a Cost Evaluation

A copy of HOMER was provided by NREL personnel and was used to screen criteria for the St. Croix project. HOMER is a computer based optimization model that evaluates designs of off-grid and on-grid power systems. The model was an invaluable reference and provided considerable input concerning:

- The influence of various thermal loads and electrical needs of the Aquaculture Center,

- Providing relative BTU values for the type of fuel being considered,
- Establishing the relative cost of the power produced at various fuel prices, and
- Ensuring the power grid system was balanced.

8.2 CANDIDATE TECHNOLOGIES

It was determined that the chosen technology would have to be practical and successfully utilized in other similar situations in order to provide a reasonable assurance of commercial viability. Technologies that are currently on the cutting edge of technology for similar situations were reviewed (eg. gasification). The selected biomass project would have to have a reasonable chance of economic success in order to justify the investment of the Tribe's resources.

The initial screening included a wide variety of options. Some technologies such as fuel cells and Stirling Engines were quickly dismissed from further consideration. However, a host of other options were considered.

Other candidate technologies were quickly eliminated due to inherit impracticalities and problems. It was determined that many technologies have performed well in laboratory and pilot studies, but commercial applications in the size range appropriate for the St. Croix tribe are limited.

While the size of the facilities and the ultimate consumer of the power had not been determined when the project was initiated, it became apparent that size was a critical factor in determining the ultimate technology. Some of the potential technology choices were limited to a range of sizes, primarily for efficiency reasons. In order to focus the technology review, an initial range between 1 megawatt (MW) and 20 MW was selected. This range also appeared to represent the largest number of proven facilities.

There are a number of existing and proposed systems, smaller than 1MW. One particularly attractive system is currently being utilized for smaller applications, in the range of residential sizes. There is also discussion of mobile gasification units that could be used in forest clearing operations. However, these systems can not meet the economic and practical needs of the St. Croix tribe.

Two primary techniques are utilized in the conversion of fuel to power. These are:

- Direct Combustion
- Pyrolysis/Gasification

8.2.1 Direct Combustion

Direct Combustion is the most extensively used technology for existing biomass systems. Literature searches and interviews indicate that over 500 facilities currently utilize direct combustion. These are predominately owned and operated by the industrial sector and are combined heat and power (CHP) facilities.

Additionally, the existing successful direct combustion facilities primarily utilize lumber and wood waste, where the fuel is generated as a result of other industrial activity such as milling waste, wood furniture scraps, etc. These materials are produced as the result of some manufacturing process on the raw lumber used onsite; such as cutting, trimming, sanding, etc. If not used as a source of fuel, the material would have to be handled as a waste and disposal costs would be incurred. Thus, the cost of fuel is significantly reduced as opposed to purchasing biomass from a forest setting.

The average size of the existing direct combustion facilities reviewed is 20MW and the efficiency of converting the biomass material to electricity is approximately 20%. The literature indicate that the average cost to generate the electricity is in the $0.08-$0.12 per kilowatt hour ($/kWh).

One method of increasing the efficiency of such facilities is to use the waste heat generated. When electrical power is produced, a low-pressure thermal load that is not efficient for additional electricity generation is also produced. Additional energy in the form of cooling must be provided to remove this excess heat from the system. Thus, this thermal load is typically wasted, or lost, energy. CHP facilities take advantage of this waste to provide needed thermal load such as space heating for buildings or the pre-heating of raw materials.

A CHP facility would be an attractive option for the St. Croix tribe. The aquaculture facility requires space heating for the fish processing and administrative buildings. Additionally, the makeup water for the fish tanks is heated prior to introduction into the fish tanks.

8.2.2 Co-Firing

Another current application of biomass is co-firing the material in existing coal fired power plants. This process is used in a number of areas and has at least one attractive feature. Some of the literature indicates that there is a concurrent reduction in oxides of nitrogen (NOx) in the air emissions from power plants that utilize a small percentage of biomass to augment the coal used as the primary fuel. An additional benefit is that existing facilities can be used without major modifications. Also, since the larger coal fired plants are more efficient, the biomass is converted to electricity with efficiencies of 33% to 35%.

8.2.3 Pyrolysis/Gasification

Gasification is the process of converting biomass into a combustible gas. Any carbon-containing material can be converted into a gas composed primarily of carbon monoxide and hydrogen. This gas can then be utilized as a source of fuel such as that used to drive a combined cycle gas turbine.

The gasification process controls the temperature and pressure to convert biomass into low or medium BTU gas in a reducing, or oxygen starved, environment. Gasification has been used for almost two hundred years. Early gasification development utilized coal as the source of fuel to make a gas referred to as town

gas. Today, there are many research and test projects using wood wastes, forest cuttings, and manufacturing wastes.

The process generally has two steps: pyrolysis and char conversion. The pyrolysis step releases volatile components from the fuel when it is heated in an environment where the air in the reaction is typically much less than that found in the fire box of a boiler. The temperature is generally maintained between 400 C and 600 C to release a complex gas called syngas, producer gas, woodgas, etc.

The fixed carbon and ash remaining from the fuel source is referred to as char. The char is converted in a steam or combustion process. The resultant heat energy is typically used in the pyrolysis step and to fuel the conversion process.

Gasification appears to offer the most promise in the future; as systems are developed and improved. A great deal of research has been conducted in the recent past, but overall cost to create power compared to contemporary power sources is still not practical.

One of the larger and more publicized gasification units is the FERCO SilvaGas system. In the late 1990s and early 2000s this system received considerable funding from the U.S government. The first commercial scale demonstration of this indirectly fired process was installed in Burlington, Vermont when a 200-ton per day gasifier was added to an existing wood fired electrical power plant. When contacted, the manager at Burlington indicated that the gasifier unit had technological and economic problems and the system had been shut down for over two years. Additional demonstration and tests were being considered, but these may be up to 5-years away. Even with massive funding, an already developed infrastructure and a highly technical staff and management, this system has not been able to produce an economically viable power supply.

Smaller units have been tested in research settings and show great promise. However, due to the currently unproven commercial nature, these units would not be applicable for the St. Croix tribal needs.

8.3 SELECTED TECHNOLOGY

It was determined that direct combustion was the most practical method of utilizing the available fuel source. Due to technology and economic factors, a pyrolysis/gasification system would not be appropriate for the current situation. However, it must be said, that the future may rest on gasification. But, the proven and practical methods for today are direct combustion.

It was determined that an electrical power generation unit of 3MW would be appropriate for the conditions in the St. Croix region. The amount of biomass to support the system is available, local needs would consume a portion of the electrical and the thermal load, and readily available distribution systems were sized, or could be readily modified, to handle the remaining electrical load.

Facility Description

The 3MW electrical generating facility will convert energy in biomass into high quality steam which acts as the driving force for a turbine driven generator. The following items and processes will be included in the project:

- All of the main components and equipment required to move the wood residue into the combustion cell,
- efficient combustion of the wood residue,
- remove the ash from the components and move it to a storage container,
- remove particulate from the flue gas stream,
- produce steam to feed a steam turbine,
- to drive an electric generator to produce electrical energy, and
- the protective equipment required by the generator and the associated control and monitoring equipment for the plant.

The system will utilize approximately 16,000 pounds per hour (lbs/hr) of wood residue, which could consist of bark, shredded wood or sawdust, to produce approximately 45,000 lbs/hr of 450 psig saturated steam and up to 3MW of electricity for use and sale. Some of the waste heat (thermal load) and electricity produced will be utilized within the tribal aquaculture facility. The remaining power will be supplied to an electric grid.

The plant will be designed around a reliable and efficient control system. The integration of the control system with the instrumentation, equipment and remote interface will provide a trouble-free and automatic system that requires minimal operator involvement. Once the plant is commissioned and the start-up is complete, the operators will be able to monitor and interrogate equipment to understand the state of equipment life. This provides a clear tool to plan maintenance and schedule repairs rather than reacting to equipment failures and breakdowns.

The facility will also have the capability to be operated off-site. This feature provides the on-site staff with a degree of reliability and safety that will be state-of-the-art for a biomass-fueled electric generating plant.

All of the components and subsystem modules selected will have a track record of successful operation both within and outside of the United States. The integration of the components into a complete plant system will provide for reliability and ease of long term operation.

Design Requirements

The following Design Requirements will be utilized:

Electrical Energy Output at Full Condensing	3 MW
Generator Power Factor Design	0.85
Generator Electrical Voltage	4,160
Maximum Steam Flow (Continuous)	45,000 lbs/hr @ 450 psig
Maximum Steam Flow (3 hour)	50,000 lbs/hr @ 450 psig
Operating Pressure	450 psig
Feedwater Temperature at Economizer Inlet	228°F
Saturated Steam Carryover Moisture	0.5%

Specific Performance Guarantees

Specific performance guarantees will be required. These will be based upon the following when firing at 100% of continuous maximum steam flow:

Steam Output	450 psig
Steam Temperature (Temp.)	459°F Saturated Conditions
Steam Flow	45,000 lbs/hr
Steam Purity	0.5%
Gas Stack Temp.	325°F
NO_X Emissions	19.7 lbs/hr
CO Emissions	10.6 lbs/hr
Particulate Emissions	1.2 lbs/hr
Feedwater Temp. – Economizer Inlet	228°F
Generator Voltage	4,160 volts
Power Factor	0.85
Fuel Flow	16,000 lbs/hr

Fuel Description

An initial fuel analysis has been prepared; however, the following are general guidelines. The proposed fuel source also presents a number of technological challenges that must be overcome. These include variability in:

- Composition,
- Energy content, and
- Physical characteristics

Some of the proposed biomass materials considered as a fuel source contain alkali metal species which can cause mechanical problems with deposition and corrosion in the piping and equipment surfaces. While not a critical problem to overcome, this introduces a requirement that must be addressed on a site specific basis. Current

information about the chemical characteristics of the biomass source available in the St. Croix area will need to be addressed as the project continues.

Prior to finalizing the design, a formal fuel analysis will be prepared. The available fuel will be typical hogged clean fuel sized to the requirements indicated below:

Wood Residue Size Distribution	
Minimum Size:	Sawdust Particle (1/8" minus)
Maximum Size:	100% <4"
Size Distribution:	95% < 3" 90% <2"

The dry basis Higher Heating Value (HHV) is 8,700 BTU/lb. It is assumed that the moisture content (MC) is typically between 45 to 50 percent with a maximum MC not to exceed 55 percent. The density of the wood is approximately 18 pounds per cubic foot (lbs/ft3).

The following table provides the Ultimate Fuel Analysis used for initial equipment design:

Biomass Wood Residue Ultimate Analysis	
Carbon	51.0%
Hydrogen	6.0%
Nitrogen	0.3%
Oxygen	40.7%
Sulfur	<0.05%
Chlorine	<0.05%
Ash	2.0%
HHV @ 55% MC	4400 BTU/lb

The ash softening temperature is greater than 2,400°F. The fuel will not contain tramp metal or rocks, nor abnormal quantities of other materials such as silica, sodium, calcium or potassium other than which would normally form part of the wood cellular structure.

On-site storage will be designed for approximately 5 to 7 days. Conceptual design calls for the wood residue to be delivered in van type trailers complete with integral walking floors. The rear trailer doors will be opened and the truck will discharge the wood residue into a Fuel Storage Bin located below grade. Final design will be based on actual operations confirmed with fuel supply contractors.

8.3.1 Basic Components

Fuel Infeed System

The fuel infeed system accepts fuel from the fuel supply contractor's trucks and moves the fuel in an environmentally acceptable and controlled manner into the combustion system.

Combustion System

The wood residue fuel which is conveyed from the storage bin discharges into the combustion storage bin. The combustion storage bin will contain a screw conveyor directly feeding the combustor. Discharge from the combustor will be through a pneumatically actuated fuel isolation gate directly into a combustion chamber leveling screw.

The combustion chamber floor will be constructed of high temperature alloy cast grates arranged in an inclined step fashion. The grates will be reciprocating in nature, and will continually and gently roll the wood residue and provide for complete carbon burnout.

All of the combustion controls required to provide operator interface both locally and remotely to monitor and efficiently control the combustion of the wood residue will be included.

The combustion process transforms the waste wood into two products: ash and hot exhaust gases. The hot exhaust gases exit the combustion chamber and discharge directly into the steam generator. The ash will be handled for offsite disposal.

Steam Generation System

The hot combustion gases will enter into the bottom of an "A" type open bottom steam boiler. The steam boiler will be supplied in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code – Section 1, and will remove heat from the gases as the gas flows through the unit. After exiting the boiler, the hot gases will enter an economizer which further removes thermal energy from the gas stream and transfers the heat into the inlet water. The gases then enter a flue gas system.

Flue Gas System

The cooled flue gases discharge from the economizer and enter a multiclone where the ash particles are removed from the gas stream and collected within a hopper. The cleaned gases will then be pulled into an induced draft fan which will exhaust the gases into the stack. The conceptual design provides for a multiclone; however, as the project commences additional particulate control such as a bag house or scrubber may be required.

Electrical Generation System

The saturated steam from the boiler outlet will be connected through piping to a steam turbine inlet control valve. The exhaust steam will exhaust vertically up and into a condenser located adjacent to the turbine skid. The condenser cooling water is interconnected with a cooling tower.

A 3,500 kVA generator and exciter will be self-regulated and generate electricity. The generator output in full extraction operation will be approximately 1,500 kWe. The generator will automatically synchronize with the plant bus and will load follow. The functions and data required for operation and monitoring the turbine generator will be interconnected with the main plant control system.

Ash Disposal System

The ash from the combustion of the wood residue fuel will come from three locations throughout the plant:

- the combustion chamber,
- the boiler and economizer hopper, and
- the flue gas emission control system.

The three sources of ash will be connected together within one final transfer conveyor which conveys the ash into a standard dumpster for removal by truck. Final disposition of the ash has not be determined, but it is likely to be a local municipal or commercial landfill authorized to handle such materials.

Technical and Documentation Supply

Initial design calls for the suppliers to provide up to 30 days of Engineering Assistance for resolution of the plant inter-face issues.

A complete set of design drawings and documents are to be provided as follows:

a. Foundation Outline and Loadings

b. General Equipment and Arrangement Drawings

c. Detail Equipment Sectional Drawings of all Major Field Interfaces

d. Electrical One Line and Three Line Drawings

e. Control Logic Diagrams

f. Hydraulic Logic Diagrams

g. Equipment Data Sheets

h. Process Flow Diagrams

i. Instrument Data Sheets

j. ASME Code Component Drawings

k. Ductwork Drawings

l. Insulation and Lagging Requirements

m. Detailed Project Schedule

On site staff training will be provided both prior to start up and during the start up and commissioning activities of the plant. The total training period will be approximately five (5) eight-hour days, of which one day will be in-class discussions of equipment covering operational theory and maintenance of the equipment. The Aquaculture Center has been operating a boiler for over two years and the training period is expected to reinforce existing experience in the operations of boilers.

Schedule

An approximate schedule of activities is:

- Equipment should be on site within 26 weeks from approval date of the engineering submittals.
- The erection of the equipment should be completed within 100 days after initial equipment delivery.
- The commission of the plant will require an additional 21 days to complete.
- All equipment will be scheduled for just-in-time delivery consistent with field erection scheduling. This minimizes field handling and aids in an efficient construction process.

9. PROJECT ECONOMIC VIABILITY ASSESSMENT

Net Present Value analysis and power production cost analysis was conducted to evaluate economic viability of a 3 MW plant at the Danbury site. Economic model results were compared to similar analysis conducted for a proposed natural gas fired power plant planned for St. Croix tribal lands. Over 50 cases were modeled to assess project sensitivity to various conditions:

- Capital Costs
- Project Financing Terms (interest rate, term)
- Waste Heat Recovery Credits
- Fuel Costs
- Capacity
- Investment Subsidy
- Power Price (capacity charge, energy charge)

The following assumptions were made for the economic modeling:

- On-line factor – 90%
- Plant operation labor force – 4 ½ operators
- Total investment - $4.75 Million
- No depreciation tax credits
- Minimal revenues from capacity charge
- 25% equity financing
- 75% debt financing
- 12% rate of return on 25% Tribal equity investment

Our assessment has shown that project viability is highly dependent upon resolution of two issues:

- Market price for generated renewable power, and
- Delivered price of wood chip fuel.

Implementation of the Governor's Renewable Energy Task Force recommendations is anticipated to increase demand for renewable energy supply and support a "green premium" price for renewable energy. However, a dependable fuel supply at a price below $15/ton will still be necessary for the project to be economically viable.

Advances in utilizing logging wastes and/or short cycle hybrid poplar tree farming have potential to provide a reliable bio fuel supply suitable for our project in the required price range. However, neither source has been demonstrated yet to satisfy project economics for bio fuel application.

9.1 SENSITIVITY CASES

Over 50 sinsitivity cases were modeled. Project economic sensitivity to financing terms, capital costs, fuel costs, power costs, byproduct heat credit, etc. were tested.

Inputs to the financial models were varied to ascertain the key factors. Over 60 variations were run. The variables included;

- Size of Plant
- Fuel Costs
- Financing costs and length of service
- Potential sources of grants to reduce financing requirements
- The Tribes equity position and expected return on investment
- Revenue potential based on sales price of electricity produced
- Thermal loads availability
- Capacity charges

Size of Plant

The fuel supply assessment determined that transportation is a significant component of fuel costs. It became readily apparent that the fuel supply from existing sources to viable plant sites would likely not support more than a 3.0 or 4.0 MW plant. Therefore, four sizes of plants were initially modeled. This included 1.0, 1.5, 3.0 and 4.0 MW facilities. Our analysis shows that project economics are not particularly sensitive to plant size over this range. For example, with all other factors remaining equal, increasing the plant capacity from 3MW to 4MW, reduces the necessary sales price by only $.003/KwH..

Fuel Costs

The data collected as part of this investigation suggest that current fuel costs from readily available local sources are in the range of $20/ton. Fuel costs are the overwhelming variable in the economics, and almost disproportionately affect the viability of the project. Significant improvements in the ability to efficiently collect fuel are necessary for project viability.

In no cases can electricity be economically produced and sold, given a reasonable market price for electricity, without a stable supply of fuel being economically available. All of the other factors play a minor role in the overall economics compared to the price of fuel. The price of fuel must be in the range of $12-14/ton to provide economic viability (based upon the anticipated price for renewable power in our area).

Using base cost assumptions for a 3 MW plant, the importance of fuel cost is illustrated as follows:

Price of Fuel	Power Price
$10/ton	$0.054 KWH
$15/ton	$0.068 KWH
$20/ton	$0.083 KWH

Project Financing Sensitivity Costs

We considered project financing sensitivity cases where debt financing was as low as 4 ½ % and as high as 8 % and for a period varying from as short as 8 years to as long as 30 years. While longer financing periods and lower rates certainly showed positive impacts on the project, they were not as important as obtaining fuel costs at a rate less than what is currently available.

For the case of financing 75% ($3.325 million) of a 3MW plant, obtaining financing for a 15 year period as opposed to a 10-year period reduced the required power sales price by $0.005KwH.

Grants

We considered the potential impact of grants, or other aid money. Xcel Energy has a program to support renewable energy projects that offers up to $2.0 million in grant support for selected projects. A For a 3MW plant, reducing capital requirements from $4.75 million to $2.75 million, reduces the required sales price by $0.007/KwH.

Tribal Equity Position

Although we considered various debt/equity ratios and expected returns on investment (ROI), we set the rate of return for the Tribes equity contribution at 12% and set the Tribes equity contribution at 25% of total project costs. These decisions were based upon Tribal return on investment expectations and anticipated lender requirements.

Waste Heat Recovery Credit

Utilizing waste heat to lower fuel costs at the Aquaculture Center (in Danbury) or at the Tribal Center (in Hertel) could save up to $10,000 per month. This credit reduces the required power sales price by $0.005KwH.

Capacity Charge

The capacity charges modeled varied from $2 -$4 per Kilowatt Month. Applying a $4 per Kilowatt Month charge reduces the required power sales price by $0.006KwH.

Revenue Potential

Various sales prices for produced electricity were modeled. This, included on-peak and off-peak pricing, as well as a blended price. The blended price range was obtained through analysis of potential market conditions. Our approach to the economic modeling was to set basic assumptions for the myriad of variables (investment, fuel cost, return on investment, debt financing terms, capacity charge, waste heat credit, etc.) involved and solve for the price required to satisfy the basic assumptions. Required price for cases models ranged from $0.045 to $0.083 per kilowatt hour and, by far, the required power sales price is most sensitive to fuel cost.

10. PERMITTING AND ENVIRONMENT ASSESSMENT

The proposed Biomass Project will be located on Tribal trust land in either Danbury, Wisconsin directly adjacent to the St. Croix Tribe's Aquaculture Center or in Hertel, Wisconsin adjacent to the Tribal Government Center and other Tribal development. The proposed use would be complimentary to the aquaculture facility, and many environmental issues for that site have already been considered during development of the aquaculture facility. Some of the specific environmental issues unique to the Biomass Project are discussed below.

10.1 REQUIRED PERMITS AND APPROVALS

The proposed biomass facility would be located on Tribal Trust land. Therefore, the facility would be under the direct jurisdiction of the Environmental Protection Agency (EPA) – Bureau of Indian Affairs (BIA). As a result, the facility would obtain environmental permits from the U.S. EPA rather than the Wisconsin Department of Natural Resources (WDNR). The following is a list of potential permits or approvals for construction and operation of the proposed facility. Some of the county and state permits may not be required because of the trust status of the land.

Agency	Activity	Type of Approval
U.S. Environmental Protection Agency	Construction of air emission source	PSD permitting applicability determination request (40 CFR 52.21)
	Operation of air emissions source	Part 71 operating permit (40 CFR 71)
	Construction and operation of NSPS source	Notice of construction, anticipated startup, and actual startup (40 CFR 60.48c)
	Excavation, grading, and construction site storm water management	NPDES storm water construction permit (includes generating construction storm water pollution prevention plan)
	Wastewater discharge	NPDES industrial discharge permit
	Facility storm water management	Storm water permit
	Solid waste generation	Solid waste facility license
U.S. Army Corp of Engineers	Construction in wetlands	Dredge and fill permits, Section 404 wetland permit
U.S. Fish and Wildlife Service	Construction and operation	Threatened and endangered species review
Historical Preservation Office	Construction	Approval of archeological surveys
Public Service Commission	Building and operating generating units and electric distribution lines	CPCN (Wis. Stat. X 196.49 and 196.491)
	Construction	Threatened and endangered species review
Department of Commerce	Installation of combustion equipment	Approval of safety mechanisms and plans (Wis. Stat. 101.17)
	Construction of building and structures	Approval of plans and specifications (Wis. Stat. 101.02)
	Installation of dust filter and HVAC equipment	Approval of plans and specifications (Wis. Stat. 101.12)
Department of Health and Social Services	Construction of plumbing facilities	Approval of plans and specifications (Wis. Admin. Code H 62.25)
County	Road crossings	Road crossing permits
	Construction of plumbing facilities	Septic system permit
	Construction	Zoning
	Construction	Conditional use permit
	Construction	Building permit

The technical preparation for these permit applications and approvals has begun. A plan for submitting each application or plan approval has been identified below.

10.2 AIR QUALITY

10.2.1 EPA Determination Request for Non-major Air Emission Source Construction

The St. Croix Tribe would submit a request for applicability determination to allow the EPA several months to respond prior to the anticipated comment of construction. This approval is not required for the facility construction; however, it would serve as a notice to the EPA of intent to construct the facility as a non-major source that does not require a prevention of significant deterioration (PSD) permit.

10.2.2 Part 71 Operating Permit

The St. Croix Tribe would submit a Part 71 operating permit application within 12 months of commencing operation as required by 40 CFR 71.5 unless required otherwise by the U.S. EPA.

10.2.3 Combustion Emissions

The proposed biomass power generation facility would consist of a 1-3 megawatt (MW) steam turbine driven by a wood biomass-fired boiler. The steam generated by the biomass boiler would be used to turn the steam turbine. Once through the turbine, the steam would be used to process heat at the adjacent fish plant which would decline their costs. The woody biomass boiler would burn approximately 8 tons of wood waste per hour for a 3MW plant. The heat input into the boiler is approximately 82 million British thermal units per hour (MMBtu/hr). The boiler would be equipped with a baghouse for particulate matter (PM) control. The boiler potential to emit (PTE) for PM, sufur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), mercury (Hg) and hazardous air pollutants (HAPs) are summarized below.

Emissions from Biomass Power Generation Facility

Pollutant	Uncontrolled PTE		Controlled PTE			
	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr	(lbs/MMBtu)	(lbs/kWh)
Particulate Matter (PM)	47.1	206.4	1.2	5.3	0.01	4.00E-04
PM less than 10 microns (PM10)	42.2	185	0.9	4.1	0.01	3.10E-04
PM less than 2.5 microns (PM2.5)	36.5	159.9	0.8	3.7	0.01	2.80E-04
Sulfur Dioxide (SO2)	2	8.9	2	8.9	0.03	6.80E-04
Oxides of Nitrogen (Nox)	19.5	85.4	19.5	85.4	0.24	6.50E-03
Carbon Monoxide (CO)	10.6	46.4	10.6	46.4	0.13	3.50E-03
Volatile Organic Compounds (VOCs)	1.4	6.1	1.4	6.1	0.02	4.60E-04
Lead (Pb)	3.90E-03	1.70E-02	3.90E-03	1.70E-02	4.80E-05	1.30E-06
Mercury (Hg)	2.90E-04	1.30E-03	2.90E-04	1.30E-03	3.50E-06	9.50E-08
Hazardous Air Pollutants (HAPs)	3.2	14	3.2	14	0.04	1.10E-03

The boiler uncontrolled PTE for PM, NO_x, and CO are below the major source thresholds for prevention of significant deterioration (PSD) construction permits (250

tons/year); however, the PTE for PM is greater than the Title V operating permits threshold (100 tons/year). Therefore, the facility would obtain a Part 71 (Title V) operating permit. The boiler would be subject to the new source performance standards (NSPS) Subpart Dc for small industrial-commercial-institutional steam generating units. Under NSPS Subpart Dc, the boiler would be subject to a PM emission limitation of 0.10 lb/MMBtu.

10.3 WATER RESOURCES

10.3.1 Water Supply

Water would be obtained from the existing well used by the adjacent aquaculture facility. The inlet water quality and the boiler efficiency would directly affect the water use of the proposed facility. The total water necessary for the boiler is estimated to be 144,000 gallons per day or 52,560,000 gallons per year for a 3MW plant. This is a preliminary water use estimate and further engineering must be performed to determine a precise water balance for the system. The water would be heated by the boiler and routed through a steam turbine. Upon exiting the steam turbine the steam would be sent to the adjacent aquaculture facility to supplement the plant's current hot water demand. This water would be treated and reused.

10.3.2 NPDES Storm Water Construction Permit

The St. Croix Tribe would submit a notice of intent (NOI) to the EPA for the storm water construction permit at least 7 days prior to commencing construction, as required. In combination with the NOI preparation, the Tribe would prepare a construction storm water pollution prevention plan that would be maintained on site during construction of the facility.

10.3.3 NPDES Industrial Wastewater Discharge Permit

The St. Croix Tribe would submit an application for a NPDES industrial wastewater discharge permit 180 days prior to commencing operation of the facility.

10.3.4 Storm Water Permit

The St. Croix Tribe would submit an application for a storm water permit in accordance with EPA guidelines. If the facility qualifies for a multi-sector permit, the application would be submitted no later then 48 hours prior to commencing operation. If the facility does not qualify under the multi-sector permit, the application would be submitted no later than 180 days prior to commencing operation.

10.3.5 Wastewater

Wastewater from the facility would be limited to reverse osmosis (RO) reject and boiler blowdown. Both the RO reject and boiler blowdown would contain concentrated ions that would make up the total dissolved solids (TDS) concentration. The RO reject TDS concentration can be controlled by adjusting the

reject volume split, and the boiler blowdown TDS concentration can be adjusted by regulating the number of recirculation cycles in the boiler. A higher RO reject volume split and/or lower boiler blowdown recirculation cycles generally will result in a lower TDS concentration. The RO reject and boiler blowdown utility water would be permitted for discharge to the adjacent Loon Creek through the National Pollutant Discharge Elimination System (NPDES) permitting process. The NPDES permit would limit the discharge concentration of TDS, phosphorus, total residual chlorine, carbonaceous biological oxygen demand (CBOD), pH, temperature, and chloride concentration. Temperature adjustment and/or chlorine removal may be required prior to discharging to Loon Creek.

10.4 SOLID WASTE

The solid waste generated by the boiler would be in incombustible material in the wood (known as ash). Wood typically contains 1 to 3% ash by weight. This equates to approximately 2,100 tons of ash generated per year (or 0.16 pounds per kilowatt-hour) for a 3MW plant. The ash would contain small quantities of regulated compounds such as lead and mercury. The concentrations of the contaminants are not known at this time. The St. Croix Tribe plans to gather additional information to determine the concentrations of regulated compounds in the ash. If it is determined that the ash as a solid waste, the Tribe would obtain a solid waste facility license and dispose of the ash by an approved method such as those identified under NR 500.08 of the Wisconsin Administrative Codes and 289.43 of the Wisconsin Statutes. The St. Croix Tribe plans to pursue a land application method of disposal, if possible

10.5 TRAFFIC

The Biomass Project would utilize up to 16,000 pounds per hour of wood residue, which consists of bark, shredded wood and sawdust for the 3MW plant. The annual usage of wood residue, expected to be harvested from within a 50-mile radius of Danbury, would total 5,321,700 cubic feet. It is anticipated that there would be six truck trips per day to haul the wood residue to the proposed facility.

10.6 LAND RESOURCES

Because the site is flat, extensive grading, filling or other alteration of the topography to accommodate the project would not be required. Due to the soils present at the site, soil correction to provide a solid foundation for building structures is not anticipated. There are no mineral deposits known or suspected to exist on the site.

10.7 LIVING RESOURCES

The development of the aquaculture facility reduced the habitat for wildlife such as deer, foxes, skunks, rabbits, raccoons and other rodents. Wildlife relocation has

already occurred. Threatened and endangered species were evaluated as part of the development of the aquaculture facility. The vegetation has already been disturbed on the site. There are no unique ecosystems present. The entire site is currently fenced

10.8 RESOURCE USE PATTERNS

The proposed site is currently in trust status, and being utilized for a similar land use. The proposed project would not affect hunting, fishing and gathering due to the development of the aquaculture facility on the site. There is no agriculture present, and timber harvest is precluded due to the aquaculture facility. Recreational uses would not be affected.

10.9 PUBLIC HEALTH AND SAFETY

Other than the increased truck traffic the biomass facility is not expected to affect public health and safety. The biomass facility would coordinate with local emergency providers to assure that they are equipped and trained to handle emergencies at the plant.

10.10 CONCLUSIONS

At this stage of the planning process for the biomass facility there do not appear to be any environmental issues that would have a significant adverse impact on the environment.

11. SOCIO ECONOMIC IMPACTS

The intent and purpose of the project is to generate financial support and continue the diversification of the Tribe's economy and revenue in order to increase, enhance, and improve the quality of life of Tribal and community members. The Tribe is proposing to develop an economically viable energy production facility using readily available, acceptably priced renewable biomass fuel sources. The project would provide new meaningful permanent employment, retain and expand existing employment (logging and fishery), and provide revenues for both producers and sellers of the finished product. The Tribe's goals are those of economic stability, economic growth, and economic development.

The most recent Labor Force Report and Tribal Profile indicated a Tribal enrollment of 1,031 and a service population of 2,648. The potential Indian labor force is 1,620 with an unemployment rate of 30%. Among employed Tribal members, 10.6% earned below the poverty guidelines. The Tribal labor force in the past 4 years has increased by 53%, and the reservation unemployment rate continues to be higher than state and national averages. There is a need to provide permanent full-time employment opportunities in a diversified Tribal economy. The project would contribute to Tribal employment and income. This project would have a positive effect on reservation economics, stimulating employment by creating construction and long-term jobs, while stabilizing the existing logging and fishery operations in the area. In addition, the project would provide career paths to some Tribal people who choose to pursue them.

As is typical of most Indian reservations, the relocation program of the 1950s and the continued lack of local economic opportunities forced many enrolled St. Croix Tribal members to leave their home communities in search of employment. Recent successes in gaming, and the resulting support of added Tribal programs, have provided more employment opportunities for young people, permitting them to support themselves and their families on the Reservation. In addition, some mature experienced members have been able to return, bringing with them the skills acquired in their off-reservation jobs. In the past decade the population has increased within the St. Croix Tribe Reservation boundaries, and the median age has dropped to the mid-20s.

The estimated cost of a proposed 3MW biomass facility is $4.75 million. After subtracting the cost of specialized equipment, it is anticipated that construction would cost $1.5 million. A significant portion of that cost would be for labor to construct the facility. We anticipate approximately 15 full-time equivalent construction jobs during the anticipated 1-year construction period. Many of these jobs would be filled by people who live in or travel to the area. The increased purchases from area suppliers and added income generated in the vicinity of the project would certainly have a beneficial impact on the economy.

The project is expected to create long-term employment, in addition to the construction jobs, and would also help sustain the long-term employees at the Aquaculture Facility. The biomass facility would be staffed 24 hours per day. Operators will require sophisticated training in operating the mechanical and

electrical components of the facility. Additionally, handling of the wood waste would require an approximate 8 hours per day, 5 day per week position. The site would require the services of approximately 4 ½ people.

The construction and operation workforce associated with the project is expected to consist of people who already live in or travel to the area, with tribal members receiving a preference, and as such is not expected to place a strain on local housing.

The project would utilize approximately 16,000 pounds per hour of wood residue expected to be harvested from within a 50-mile radius of the project site, with an associated cost of over $700,000. This would be a beneficial addition to the local economy and provide additional employment in the logging industry.

The collection of the waste wood, in addition to providing environmental benefits and reducing the usage of fossil fuel, will also employ a number of new full time employees. These employees will work for the wood waste suppliers. It is estimated that this will include loggers, truck drivers and management support for those functions. In addition, the supplier will require new trucks and other equipment, which will also benefit the local and regional economy. The actual number of jobs created has not been estimated. This may also provide the impetus for new business development opportunities for the Tribe. Economic developers generally use a multiplier of 4-7 jobs for every base manufacturing job created.

The effect on the level of state and local sales, property and income taxes can not definitively be estimated. Additionally, the wages and benefits to the power plant operators are estimated to be in the range of $140,000 per year.

If we assume that a 3MW facility will generate 23,652 mWh/yr and that the price for energy sales will be $.068 per kWh, then the estimated annual revenue from the facility would be $1,600,000.

The benefits to the Tribal communities, both on the Reservation and in the surrounding communities, are substantial. The development of the Biomass Project would provide stable sources of new revenue and increase employment opportunities for the Tribe. The revenue generated would be used for badly needed improvements in Tribal health care, housing, education, social services, community development, human resources, other Tribal services, and necessary infrastructure.

For the past several years, the Tribe's involvement and participation in all spheres of regional civic, governmental, economic and cultural activities have remained strong and have contributed greatly to the surrounding community's joint efforts in planning and development. The Tribe's culture of community well-being and quality of life supports the surrounding community. The Tribe is a major service provider in many areas, ranging from environmental, health, social services, early childhood education, public housing, public transit to sports, burial costs, and performing arts. In communities adjacent to successful Tribal enterprises, there has been an increase in community support for Tribal operations and recognition that the Tribe contributes a great deal to help improve the quality of life in the region.

The project is clearly in the best interests of the St. Croix Tribe. The project will provide new jobs and economic activity to the Tribal government and the communities surrounding the Reservation. It is clearly not detrimental to the surrounding communities; instead, it would be economically beneficial to them.

12. LONG TERM SUSTAINABILITY AND REPLICABILITY

12.1 TRIBAL COUNCIL RESOLUTION PLAN

Tribal Council fully supports implementation of a woody bio fuel power generation project on tribal lands. A project of this type is consistent with tribal objectives to diversify their economic base and create economic opportunities. It is also consistent with the Tribe's concerns regarding environmental stewardship and maintaining cultural values. The Tribal Council Resolution, included in Part F of Volume 2, (see Appendix C.) of the grant application demonstrates the Tribe's commitment. Tribal Council has been fully informed of developments that have occurred throughout the feasibility study period.

12.2 PROJECT IMPLEMENTATION FUNDING

Project implementation funding will comprise a 25% equity position by the Tribe with the remaining 75% provided through tax exempt bonding. The facility will either be operated by the Tribe or leased to an Independent Power Producer, who will also be the plant operator.

12.3 ANTICIPATED BENEFITS AND ASSESSMENT PLAN

The potential benefits to the Tribe and its members include meaningful employment, revenues, reliable energy, diversification of economic base and infrastructure improvement. A bio fuel power plant is a good fit environmentally, socially, economically, and culturally.

12.4 TRAINING, OPERATION AND MAINTENANCE PLANS

Training, Operation and Maintenance plan details will be determined once financing and operations plans have been established. We anticipate the equipment vendors being heavily involved. The Tribe is currently contacting major area power producers including: (large generator and transmission cooperatives, small independent utilities, large Investor Owned Utilities, and Municipal Providers).

13. CONCLUSIONS

This effort has identified two potentially viable biomass-fueled renewable energy projects using proven technology, and readily available and proximate fuel supplies:

- A 1 to 3 MW wood chip burning power generation facility located adjacent to the Tribe's state-of-the-art St. Croix Fishery located in Danbury, Wisconsin, and
- A 1 to 3 MW wood chip burning power generation facility located near the Tribal Headquarters in Hertel, Wisconsin.

Our assessment has shown that project viability is highly dependent upon resolution of two issues:

- Market price for generated renewable power, and
- Delivered price of wood chip fuel.

From a market perspective, a combination of factors makes this an ideal time to develop the St. Croix Tribe's biomass projects:

- The Wisconsin Task Force for Renewable Energy published its recommendations in July 2004 for increasing State government purchases of renewable energy to 10% and 20% by 2006 and 2010, respectively, and to increase statewide renewable energy use to 10% by 2015. Wisconsin Governor Jim Doyle immediately endorsed the recommendations of the Task Force;
- Economic recovery is causing an expected and corresponding rise in total demand for electric power; and
- Sharply higher natural gas prices, supply constraints and market volatility have combined to stifle the unprecedented growth in new gas-fired generating capacity.

The Tribe strongly supports the recommendations of the Wisconsin Task Force for Renewable Energy, particularly its recommendation for increasing purchases by the State government of renewable energy. An increase to 10% renewable by 2006 would potentially give rise a near-term customer for the Tribe's generated capacity.

Because of these factors, we anticipate that the market price for renewable power will support project implementation. While utilities do not resist renewable energy in principle, in reality they are reticent to add renewable capacity, unless mandated, since "renewables" tend to raise the average of embedded generation costs, and ultimately the price of power to consumers. In October 2004, we met in Madison, Wisconsin with representatives (including the chairman) of the Wisconsin Task Force for Renewable Energy. As the Task force recommendations are adopted, the Danbury and Hertel projects can be available to help satisfy the State's increased demand for renewable energy in 2006.

While nearly 80-percent of Wisconsin's electricity is produced from coal and nuclear fuel, the state clearly has a sustainable supply of wood/biomass fuel to supply relatively small generating facilities such as the St. Croix Tribe is pursuing.

Our analysis to date demonstrates that there is an ample supply of fuel material and numerous loggers operating in the area. In order for the Tribe to be comfortable investing in biomass-fired power plants, it must be assured of a predictable, attractive fuel price and a reliable, sustainable supply mechanism. Potentially viable fuel supply alternatives that have been identified include:

- Contracting with area loggers for delivery of wood chips to on-site chip storage.
- Contracting with area loggers for delivery of baled logging residue (treetops, limbs, etc.) to on-site chipping operations.
- Developing a tribal venture to supply either deliver baled logging residue to on-site chipping operations or deliver chips directly to the site.

The current price paid for bio fuel materials that are suitable for fuel use in areas near tribal lands ranges from a low of $8/ton to over $25/ton. The Tribe is hopeful that it could obtain an average fuel cost of less than $15/ton. Even at that cost level, the Tribe would need to sell the capacity for $.068 KWH. However, this is higher than Minnesota and Wisconsin utilities are currently paying.

14. LESSONS LEARNED

14.1 NORTHWEST WISCONSIN RENEWABLE ENERGY MARKETS

Currently, in Wisconsin and Minnesota, there are insufficient renewable energy portfolio mandates to create a price premium for renewable energy necessary to justify our project. However, proposed renewable energy portfolio mandates in Wisconsin may create a viable market with price premiums for renewable energy sufficient to justify biomass-fired power generation.

Although transmission constraints are a problem in the region, transmission system "fixes" have been identified that can easily resolve transmission constraints for a small project such as ours.

14.2 NORTHWEST WISCONSIN BIOMASS FUEL SUPPLY

There are ample supplies of suitable biomass fuel from existing logging operations. Select trees are used in the region's pulp and paper plants and sawmills. A market hasn't fully developed yet for less valuable species. These less valuable species are plentiful, under utilized and quite suitable for biomass fuel applications. In addition, slash (limbs and tops) account for about 20% of the trees harvested. This material is also a viable biomass fuel. With current logging practices, this slash material is left in place. Since a steady market for these materials doesn't exist, area loggers have not focussed on utilizing the less valuable species and the slash material. If a steady market for these materials existed, such as our biomass power plant, we believe that area loggers would adapt harvesting practices and invest in necessary equipment to more efficiently and economically collect and deliver these materials.

Much research has been done in our region on hybrid-poplar tree farming. To date the research has focussed on growing woody biomass suitable for pulp and paper applications. Alternative growing practices (denser planting, shorter harvesting cycles) have potential to generate woody biomass with economics favorable for fuel applications.

14.3 APPLICABLE BIOMASS-TO-POWER TECHNOLOGY

For the plant capacity and market price range viable in our area, proven boiler/generator technology makes the most sense. Gasifier/engine power production technologies are not proven for the our size, fuel and market price range.

14.4 SITE OPPORTUNITIES

St. Croix Tribe has two sites that are ideal for a biomass power project. Land, buffer, access to the power grid, proximity to logging operations, and proximity to waste heat users are favorable attributes of both the Danbury and Hertel sites.

14.5 PROJECT ECONOMICS

Fuel price and market price for power sales are the two most important factors effecting project economics. Capital costs, project financing terms, return on investment, and waste heat utilization are also important factors. However, there is little uncertainty associated with these secondary factors.

At current biomass fuel prices (based upon quotes from area loggers) and power prices our project can not be justified. However, economic modeling of scenarios with higher power prices (reflecting a premium for renewable energy that we expect as proposed state renewable energy portfolio mandates are implemented) and lower fuel costs (reflecting development of supply chain for slash and lower value species) demonstrates that our project is viable.

Our expectation for the next year is that implementation of proposed renewable energy portfolio standards in Wisconsin will result in a firm market premium for biomass-fired power. This, in turn, will provide a basis for negotiating will area loggers, tree farmers and mills to secure a reliable supply of biomass fuel at a price that justifies Tribal investment in the project.

15. PROJECT DEVELOPMENT PLANNING

The St. Croix Tribe has developed two biomass-fired projects that appear to be potentially economically viable. Technology, location, fuel supply, markets, financing and transmission issues have each been addressed to the point where the St. Croix Tribe is confident that biomass-fired power projects will be "do-able" in our region. It is clear that potential power purchasers (investor owned utilities, municipal utilities, cooperatives and generation aggregators) serving the power market in the region will be required to find additional renewable based energy power supply in the near future. The demand for renewable energy and economics of bio fuel are likely to improve as a result of State initiatives mandating renewable energy and advances in harvesting and utilizing woody biomass. Facilities owned by the St. Croix Tribe can serve this increased demand. Before a comprehensive business plan can be developed, the implications of these changes must become more clear and defined. Although our project clearly has promise, it is too soon to move forward with implementation. The proposed Project Development Plan including four distinct tasks, denoted herein as Phases 1-4, has been designed to position our project to capitalize on developing opportunity in the marketplace.

Phase 1 – Detailed Market Assessment

Implementation of the Governor's renewable energy task force recommendations will create a demand in the market for renewable energy. State facilities will be required to use renewable energy for 10% of their energy needs by 2006 and 20% by 2010. Utility companies serving state facilities will be required to meet this mandated target. In addition, utilities in the state will be required to increase renewable energy to 10% of their total by 2015.

Phase 1 will involve screening and ranking potential candidate customers. We need to understand their projected renewable power needs and alternatives available for satisfying their needs. Who are the decision-makers? When will the renewable power be needed? Is the utility anticipating shortages in renewable power supply? What state facilities (and loads) do the utility serve? Potential customer will be ranked based upon the Tribe's ability to satisfy their needs. Specific tasks for this phase include:

- Update Wisconsin and Minnesota regulatory climate and power supply / demand outlook re: renewable energy,
- Identify universe of candidate customers for St. Croix Tribe's renewable power projects,
- Prepare background file for each candidate customer (service territory, state facility customers, size, renewable energy supply/demand outlook, current renewable energy supply arrangements, recent projects, planned projects, regulatory issues, etc.), and
- Prioritize for the St. Croix Tribe's renewable power project opportunity.

To accomplish this phase, we anticipate working closely with the Governor's Task Force representatives and the Wisconsin State Department of Administration officials.

Phase 2 – Fuel Supply Planning

In order for the Tribe to be comfortable investing in biomass-fired power plants, it must be assured of a predictable, attractive fuel price and a reliable, sustainable supply mechanism. Our analysis to date demonstrates that although waste wood from sawmills and wood product manufacturing operations are the lowest price potential fuel source, volumes are insufficient to fully load a 3-MW plant and supply is uncertain over the project life (i.e., mills close). There is an ample supply of forest biomass material and numerous loggers operating in the area, but with the current collection practices and price for renewable power, costs are too high to justify investment. Hybrid poplar tree farming is a reliable long term supply, however, projected costs are also appear to be too high to justify investment at the current price for renewable power.

Phase 2 will involve further refinement of the fuel supply options. Specific activities will include:

- Conduct on-site visits with the sawmill and wood product manufacturing companies that have been identified to be selling waste wood for less than $15/ton (15 companies). Determine composition, heat content, potential contract length, cost, seasonal availability, tribal equipment and labor requirements, etc.
- Working with the Forestry Council Woody Biomass Task Force, determine and recommend state government initiatives and incentives to foster development of woody biomass supply.
- Identify and meet with area loggers interested in developing and serving bio-fuel markets in addition to the pulp and wood product markets. Assess their interest in coordinating their logging operations with a tribal venture. Candidate loggers will be identified from the county forester's list of timber buyers in the four relevant counties and through the Forestry Council Woody Biomass Task Force. We expect that the annual logging conference in Wisconsin will be a good opportunity to connect with potential suppliers.
- Develop a detailed understanding of slash-bundling operations (equipment cost, productivity, financing opportunities, ancillary equipment requirements, labor issues, coordination with logging operations, etc). Verify all capital and operating costs. We will meet with equipment manufacturers, vendors and users. Timberjack, the bundling equipment manufacturer, is a sponsor of the annual logging conference.
- Verify the volumes of slash economically available to the Hertel and Danbury sites that could be chipped at the landing and/or harvested with the bundler. Determine the geographic location and seasonal availability of this slash.
- Prepare a pro-forma economic assessment and a qualitative “risk assessment” for a new tribal venture to supply wood chip fuel (to tribally owned power plants as well as market customers). The venture could be 100% tribal owned or a joint venture with one or more loggers.

- Refine hybrid poplar cost estimates and investigate alternative rotation lengths and production scenarios (to include visits to existing plantations).
- Conduct preliminary meetings with local farmers to assess interest in participating with the Tribe in hybrid poplar plantation operations.

Phase 3 – Project Development

For the highest priority potential customers identified in Phase 1, we will develop a project "package" as a basis for negotiations with potential customers. We expect this phase to include a series of meetings with candidate customers. Meetings will be required for introducing the concept and assessing interest as well as addressing technical issues and commercial issues. Specific tasks for this phase include:

- Networking with representatives of candidate customer organizations to assess interest.
- Refine costs estimates for the biomass plant by getting firm equipment/construction quotes.
- Update project economic analysis incorporating Phase 2 (fuel supply planning) results.
- Publicizing the project in media outlets targeted to power purchaser decision-makers.
- Preparing a Power Point presentation and meeting with representatives of candidate customer organizations to introduce the project.
- Developing "work teams" comprising representatives of the St. Croix Tribe, the customer organization, state Department of Administration officials, and others, if appropriate, to facilitate project development. These work teams will address project specific issues such as transmission interface, commercial terms, process for qualifying with state mandates, etc.

Phase 4 – Project Implementation

The project implementation phase includes the following activities:

- Negotiate power purchase agreement
- Negotiate fuel supply agreements
- Negotiate equipment purchase agreements
- Transmission and connectivity filings and coordination
- Environmental permitting
- Engineering, Procurement and Construction contracts

Schedule:

The Tribe believes that the time line for the project is as follows:

Phase 1 - Detailed Market Assessment	January – March- 2005
Phase 2 - Fuel Supply Plan	January – September - 2005
Phase 3 - Project Development	April – December- 2005

It is not possible to project an accurate timetable for Phase 4 (Project Implementation) activities since they are highly dependent upon results of phases 1 through 3 efforts. Phase 4 activities could begin as early as mid-2005.

16. APPENDICES

A. BIO FUEL SURVEY INSTRUMENT

Appendix A

Resource Analytics

November 8, 2003

«Contact_Title» «First_Name» «Last_Name»
«Firm_Name»
«Address»
«City» «State» «Zip_Code»

Dear «Contact_Title» «Last_Name»:

My company has been hired to conduct an analysis of wood residue resources generated by primary and secondary forest products industries in parts of Wisconsin and Minnesota. The purpose of the analysis is to determine resources available for possible use in a new energy production facility. Such a facility could improve markets for the wood residue generated by your firm.

I will be conducting a phone survey within the next month to determine the volumes and types of wood residue generated by surveyed firms, how and where it is currently used and a range of prices received for various types of material. Given the sensitivity of some of the information sought, SURVEY RESPONSES FOR INDIVIDUAL FIRMS WILL BE KEPT STRICTLY CONFIDENTIAL. Any reports on survey results will contain only aggregations of survey data designed to protect firm confidentiality. Information on individual firms will be limited to that which is already publicly available through various business/forest products industry directories.

To help you prepare for the interview (and make it as fast as possible) I have printed the survey form on the back of this letter. Some of the questions might be modified slightly as the survey proceeds. I anticipate the survey will take about ten minutes.

I look forward to speaking with you soon.

Sincerely,

Jan J. Hacker
President, Resource Analytics

«Record_» «Firm_Name», «Contact_Title» «First_Name» «Last_Name»«Phone» «State»«PSIWT»

1). Wood residue information

Tons of material generated annually [1]	**Green or dry & approximate moisture content**	**Clean or contaminated [2]**	**How used [3] (as a percent of each wastestream)**	**Where used [4] (city or county)**	**Sale price [5] (not including transportation cost) ($/ton)**	**Transportation cost as a percentage of sale price**
Bark:						
Coarse:						
Fines:						
Mixed:						

[1] Course materials include slabs, chips,etc. Fines include sawdust and sanderdust. Mixed materials are waste streams that contain a mix of bark and/or course and/or fines which can not be separated from one another. If your firm's residues in each category are sold in different markets, there will be multiple entries in each category.

[2] Clean materials and wastestreams contain wood residue that has not been painted, glued, etc. Contaminated materials and wastestreams include wood residues that have been painted, glued, stained, etc. but do not include non-wood residues.

[3] Percentage of each wastestream used for: On-Site Boiler Fuel; Sold Boiler Fuel; Animal Bedding; Liquid Smoke; Paper Furnish; Composite Products (such as particleboard); Stockpiled; Firewood; Landscaping/Mulch; Landfilled; Other.

[4] Where material that is moved off-site is transported to for each use indicated.

[5] The economics of wood residue disposal involve two important components: the price received per ton and the cost to deliver it to markets. This column and the next are an attempt to separate these two components. If respondents are uncomfortable with stating an exact price, a range of prices in $5.00 increments would be most welcome.

2). Are there any seasonal variations of the above wastestream information?_____

3). Are any of the above wastestreams sold under contract? _____

Spreadsheet Description

Coding and Explanation for Columns

Col. A: Response – Yes, Refused to Answer, OOB (Out of Business), NonD (Non Deliverable)

Col. B: Record #

Col. C-K: Business Name, Address & Contact and Title

Col. L: Phone #

Col. M: County where business is located

Col. N: Type of firm. P=primary industry. S=secondary industry. I = vertically integrated industry which does both. WT=whole tree chipper.

Col. O: Production level is in million board feet and only applies to primary or integrated operations.

Col. P: Number of employees. Only applies to secondary or integrated operations.

Col. Q, R & S: Actual one-way distance to each location (Danbury, Hertel and Turtle Lake) in 5 mile increments.

Col. T: Type of waste stream. G=green, D=dry, M=mixed meaning the individual waste stream consists of green and dry material mixed together. Conservative approximation of moisture content of green material is 45% and 10% for dry material.

Col. U: Nature of waste stream. C=clean meaning no substances such as glues, resins, etc. are in the waste stream. Con=contaminated which means glues, resins, etc. have contaminated the waste stream.

Col. V-Y: Annual volume on a ton basis. It will be green tons if the entry in Column P is G, dry tons if the entry in Column P is D and somewhere in between if the entry in Column P is M. Fines include sanderdust and sawdust. Coarse includes chips, blocks & pieces, strips, pallets, etc. Bark is bark and mixed in this column means that the waste stream consists of a mixture of size of material mixed together (contrast this with the definition of mixed in Column P.) General conversion factor used – 25 tons/semi & 80 yards/semi.

Col. Z: How used. Entries include: Sold Boiler Fuel, On-site Boiler Fuel, Animal Bedding, Paper Furnish, Composite Products, Liquid Smoke, Stockpiled, Firewood, Landscaping/Mulch, Landfilled, Other. Each of these uses have different raw material

requirements and trade in different markets. Competing supplies and distance to the site of final use determine prices paid.

Col. AA: City were used.

Col. AB: Actual one-way distance to user.

Col. AC: Price received/ton gross

Col. AD: Transportation cost gross

Col. AE: Price received/ton net

Col. AF: Transportation cost/loaded mile (formula AD/AB)

Col. AG: Sold under contract

Col. AH: Seasonal variation

Col. AI: Notes

Markets and prices paid for wood residue are defined by existing supplies of the type of material purchased and their location relative to the final user. It is the net price (defined as gross price minus transportation cost that is an important variable. Other factors also matter - most particularly, the relationship between supplier and purchaser. For example, a company may be willing to accept a lower price for its bark from a paper mill given the fact that it can rely on that same paper mill to also take its chips. If suspending bark sales will jeopardize its chip sales to the same mill, the company is not likely to switch even if it could net more from its bark sales by switching to a new purchaser. Separating gross price from transportation cost seeks to evaluate some of these dynamics. Also, a company may be willing to accept a lower price for its bark than it is now getting if transportation costs are lower because their new customer is closer.

The dropdown boxes in each column heading allow the data to be filtered including or excluding rows as desired. The data button on the upper tool bar lets the data be sorted which arranges each row in a certain order. For example, if I want to arrange the companies in alphabetical order, I click on a column heading, click on Data in the upper tool bar, click sort, where it says sort by, click on the down arrow and choose Firm Name ascending or descending. Repeat using sort by Record Number to return the spreadsheet to its original condition.

Any combination of sorts and filters is possible. For example, lets say we want to know how much residue is within 40 miles of Turtle Lake. We go to column S (Dist. To TL), click the down arrow button on the column header, pick custom, click down arrow button in the first blank, pick “is less than or equal to” and type in 40 in the next blank, click ok.

All the records that do not satisfy this condition disappear and the down arrow turns blue indicating a filter is in place. Of these records, lets say we only want volumes of green residue. We go to column T, click on the down arrow, and click on G. Suppose further that we want to know just how much of this is fines and how much is bark. So we go to column V or X, click on the first (non-column) cell, hold shift and scroll down the column and after proceeding on cell beyond the last entry, click the sum symbol on the toolbar which sums the volumes. Once this is determined, the summed value can be deleted and all the steps reversed choosing “all” in the drop down boxes to restore the spreadsheet to its original state.

In the entered company data, each row is a separate waste stream based on the data entered in subsequent columns. If a company sends two waste streams to different industries in different cities, a row would need to be added.