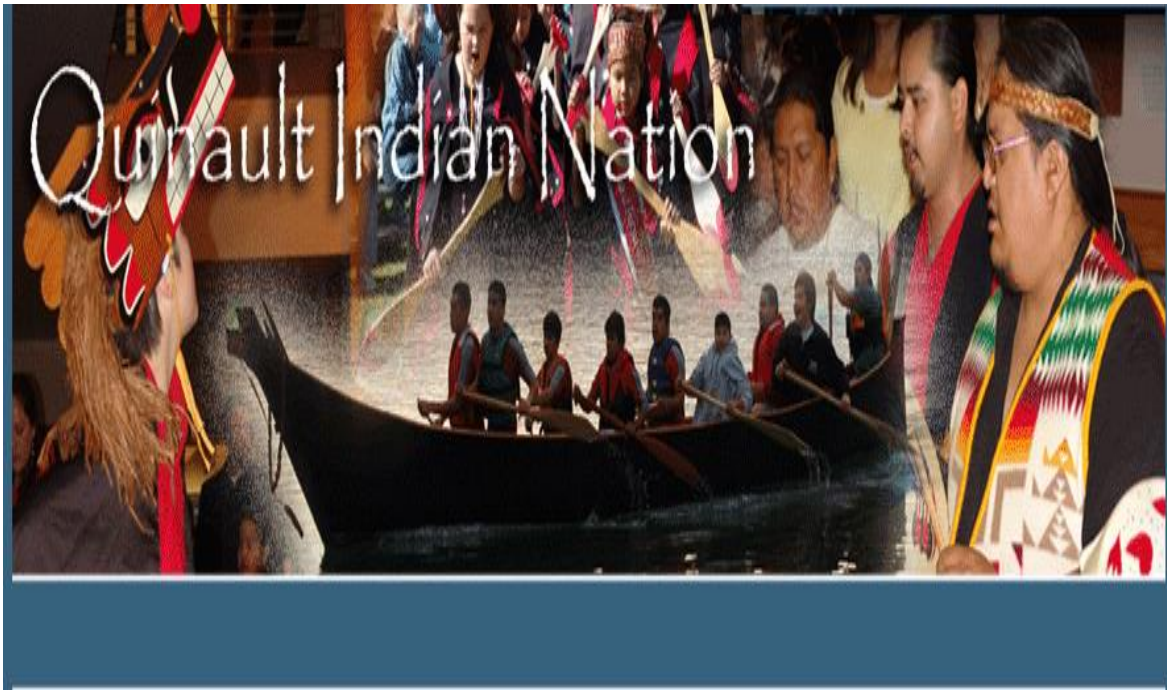




Quinault Indian Nation Comprehensive Biomass Strategy

Final Report

Contract Number DE-EE0005052

In support of:

US Department of Energy

First Steps Toward Developing Renewable Energy & Energy Efficiency

On

Tribal Lands Program

Topic Area 1: Strategic Energy Planning

Project Information

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Department of Energy Program:

First Steps Toward Developing Renewable Energy & Energy Efficiency on Tribal Lands

Topic Area 1:

Strategic Energy Planning

Department of Energy Contract Number:

DE-EE0005052

Project Period:

September 1, 2011 through December 31, 2014

Project Title:

Quinault Indian Nation (QIN) Comprehensive Biomass Strategic Planning Project

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Executive Summary

The overall purposes of the Quinault Indian Nation's Comprehensive Biomass Strategic Planning Project were to:

- Identify and confirm community and tribal energy needs
- Conducting an inventory of sustainable biomass feedstock availability
- Development of a biomass energy vision statement with goals and objectives
- Identification and assessment of biomass options for both demand-side and supply side that are viable to the Quinault Indian Nation (QIN)
- Developing a long-term biomass strategy consistent with the long-term overall energy goals of the QIN

The exploration of biomass for heat and/or energy potential has resulted in the creation of a comprehensive plan that identifies options and provides a clear path for implementing viable and sustainable biomass projects on the Quinault Reservation. This Comprehensive Biomass Strategic Planning Project is consistent with the QIN's prior two-year DOE Renewable Energy Study from 2004 through 2006. That study revealed that the most viable options to the QIN's renewable energy options were biomass and energy efficiency best practices.

Along with a project overview, our Comprehensive Biomass Strategic Planning Project Final Report will provide extensive details applicable to all stages of project development in support of the utilization of woody biomass as a sustainable renewable energy resource, to be used to provide heat to existing QIN essential Tribal Facilities as well as Tribal Facilities currently in the planning stages. This includes biomass projects that were developed and implemented in parallel with QIN's Comprehensive Biomass Strategic Planning Project.

For many years the Quinault Nation (QIN) has been investigating the use of natural resources in support of renewable energy development on their Reservation. A comprehensive energy feasibility study was accomplished on the Quinault Reservation.

The objective of QIN's initial comprehensive energy feasibility study was to conduct assessments and economic analysis of all available renewable energy resources (including wind, biomass, solar, and wave energy), along with a comprehensive assessment of tribal energy requirements, and the feasibility of forming a tribal utility. As keepers of their land the QIN also completed an environmental assessment, including comprehensive bird, wildlife, and geological studies.

This comprehensive energy feasibility study was made possible through a Department of Energy, **First Steps Toward Developing Renewable Energy & Energy Efficiency on Tribal Lands Grant award.**

At the conclusion of the QIN comprehensive energy feasibility study biomass was clearly identified as the most viable renewable energy resource on the Quinault Reservation. Quinault Indian Nation forest management, harvesting and thinning accounts for 32,000 – 52,000 tons of biomass in the form of forest slash annually.

Historically QIN has disposed of vast amounts of forest slash by simply piling it up and initiating controlled burns. Although these are controlled burns, the high volume of slash piles on the Quinault Reservation renders this method unsafe and unhealthy to the environment. Diversion of forest biomass away from the traditional pile and burn fate and into a controlled combustion system with air emissions mitigation technology will likely result in a net improvement to air quality on the Quinault Reservation and surrounding communities.



Figure 1: Example of slash piles on the Quinault Reservation



Figure 2: Example of controlled slash pile burning

This has been the primary driver for the Quinault Indian Nation to pursue Biomass for Heat and/or Energy Projects focused on the use of forest slash as a renewable energy fuel feed stock.

As a direct result of the QIN comprehensive energy feasibility study, a process plan was created for the future development and implementation of biomass for heat and energy projects. The process plan included resource, hardware, personnel, and financial requirements based on the results of the energy feasibility study.



Figure 3: Ariel photo QIN Village of Taholah

As the Quinault Indian Nation's Comprehensive Biomass Strategic Planning Project Final Report will show, our biomass for heat projects were all the direct result of our renewable energy strategic planning process. This would not have been possible without the support and assistance of the Department of Energy's **First Steps Toward Developing Renewable Energy & Energy Efficiency on Tribal Lands Program**.

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Quinault Indian Nation Comprehensive Biomass Strategic Planning Project Overview:

Topic Area: The Quinault Indian Nation (QIN) selected **Topic Area 1 Strategic Energy Planning** in order to create a comprehensive tribal biomass strategy. This project is consistent with the Nation's prior two-year DOE Renewable Energy Study in 2006. That study revealed the most viable options to the Nation were biomass and energy efficiency. QIN has completed a comprehensive Biomass Inventory and Feasibility Study made possible through a partnership with the Columbia-Pacific Resource Conservation & Economic Development District (ColPac) and a grant award from the USDA Rural Business Opportunity Grant (RBOG) Program. This recent study indicates that the volume and types of available biomass throughout the Quinault Indian Reservation (QIR) will support and sustain a biomass for heat facility. This project has been designated as one of only seven Great Regions Projects in the United States by Secretary of Agriculture Tom Vilsack. Since biomass can be utilized in many ways, with both demand-side and supply-side options, the Quinault Indian Nation's leaders believe a comprehensive biomass strategy to be invaluable to their Tribal Nation.

In support of this tribal project QIN entered into a service contract with the Columbia-Pacific Resource Conservation & Economic Development District (ColPac) and American Community Enrichment who in coordination with QIN were responsible for accomplishing key objectives, project tasks and project related activities.

Columbia-Pacific Resource Conservation & Economic Development District (ColPac) Background Information:

ColPac is a 501 © (3) nonprofit organization in good standing since its creation in 1972 as a Resource Conservation & Development (RC&D) Council. ColPac is highly experienced in carrying out economic, community, and environmental development projects; planning, implementing, and administering projects of all sizes throughout a 4-county district for nearly 4 decades; facilitating and coordinating the required collaboration of organizations to successfully accomplish project goals and objectives; and the conservation of our natural resources – all of which are essential to this QIN project and partnership. ColPac develops a regional economic development strategy, works to implement that strategy, and provides technical assistance to local communities. This work places them in constant touch with counties, cities, port districts, public development authorities, public utility districts, economic development councils, and tribes within its district – all crucial for attracting private sector investments for regional project development. Access to, established working relationship, and partnership with these business and community development resources will ensure the success of this project.

American Community Enrichment Background Information:

American Community Enrichment, Inc. is a 501c3 not-for-profit corporation whose important mission is to promote sustainable economic and community success in rural communities. Their purpose is to partner with rural communities to provide needed leadership, resources, funds, tools, education, plans and projects to revitalize their communities and enrich the lives of their citizens.

American Community Enrichment is highly experienced in the strategic planning and carrying out of economic, community and environmental development projects by providing needed technical assistance in support of rural development. American Community Enrichment assists and cooperates in implementing local and regional development plans with other organizations, agencies and community groups. They strive to create awareness of the need for orderly balanced, sustainable development and conservation of resources.

American Community Enrichment joined this project to assist with solutions regarding environmentally friendly uses of the abundant volumes of biomass available on Quinault Indian Reservation (QIR). These efforts led to grants from USDA Rural Development, US Forest Service and the Department of Energy in support of Biomass for heat and energy study projects on the QIR.

The Quinault Indian Nation is proud to be in partnership with these two organizations and the Nation benefits from their combined years of project development and management experience.

Project Location



Figure 4: Map of Quinault Indian Reservation in Washington State

Project Objectives Overview: The key objectives for this project included the following:

1. Identify and confirm community and tribal energy needs.
2. Conduct an inventory of sustainable biomass availability.
3. Develop a biomass energy vision statement, goals and objectives.
4. Identify and assess the biomass options, both demand-side (those that reduce energy consumption) and supply-side (those that generate energy), that are viable to the QIN.
5. Develop a long-term biomass strategy consistent with the long-term overall goals of the QIN.

Project Methodology Overview:

The methods ColPac utilized to complete this project included tribal community outreach dinner meetings in the two primary native villages on the Quinault Indian Reservation, Taholah and Queets, WA, to solicit community input. ColPac researched past QIN energy studies, particularly biomass, visited biomass producers and users on and close to the reservation, and interviewed key stakeholders in order to understand the inventory and future trends of biomass quantity and availability – information that is vital to determining the technology, size, and scope of any biomass project. Methods to create a vision statement, goals, and objectives included strategy sessions with key stakeholders, sub-committees, and reports to the Quinault Business Committee (Tribal Council) members. ColPac identified and analyzed biomass project options based on parameters set by the community and stakeholder meetings – meetings that helped determine the Nation’s energy needs, and based on the biomass inventory report. Summary “options matrix” were developed that highlight the costs and benefits of each proposed option. Options included energy consumption and energy producing options.

The QIN Economic Development Sub-committee and the Land & Natural Resources Sub-committee members provided input and review of key project documents and provided recommendations to the Quinault Business Committee for final approval.

Project Objectives and Methodology Overview:

1. Identify and confirm community and tribal energy needs:

ColPac, the contractor organization for this project, in coordination with QIN, conducted community meetings in the two key villages on the reservation –Taholah and Queets - to solicit community input into the Nation’s energy needs. ColPac reviewed past studies and plans in order to gather past research on tribal energy needs. Finally, ColPac met with key land and natural resources staff, economic development staff, Economic Development and Land & Natural Resources Sub-Committees, and the Quinault Tribal Council (Quinault Business Committee) to further identify tribal needs and resources.

2. Conduct an inventory of biomass availability:

ColPac in coordination with QIN conducted a survey of biomass in the form of forest slash that is available within and near the Quinault Indian Reservation (QIR). Availability of biomass is important in determining the type and scale of project(s) that may be viable. Past studies have indicated biomass quantities on or near the reservation, but conditions change.

Until recently, a paper mill (Grays Harbor Paper) used wood waste to fuel its energy-producing turbines. The City of Forks, WA now has a Biomass for Heat Facility built specifically to heat two schools that uses approximately 28 bone dried tons of woody biomass every three weeks.

Also impacting wood waste supply is the declining timber industry and fewer mills in production. Federal restrictions on timber harvesting further impact biomass supplies. A comprehensive inventory report was produced by TSS Consultants as a result of this objective. Key portions of the TSS Consultants QIN Biomass Inventory Report has been included in this final report.

3. Develop a biomass energy vision statement, goals and objectives:

ColPac conducted strategy sessions with key representatives from the community, staff and council in order to develop biomass energy vision statement, long-term goals and objectives. The results were presented to the two sub-committees for their approval. ColPac in coordination with QIN sub-committee then reported the vision statement, goals and objectives to the full Quinault Business Committee for council approval.

4. Identify and assess viable biomass options:

ColPac in coordination with QIN, evaluated biomass technology and identified potential options. The options identified the technology, size and scale of each option, proposed location(s), estimated cost, and benefits to the Nation and its communities. Benefits included number of jobs created, potential revenues generated, and opportunities for private entrepreneurs. ColPac developed a summary table of all options, and the costs/benefits of each option. ColPac in coordination with Richmond Engineering, recommended the top options for both energy efficiency and energy production to each sub-committee, and to the Quinault Business Committee for council approval.

5. Develop a long-term biomass strategy consistent with the long-term overall goals of the Quinault Indian Nation:

ColPac in coordination with QIN developed a long-term biomass strategy that is consistent with the QIN's long-term goals. The strategy addressed the first four objectives, and included the approved options. ColPac in coordination with QIN and Richmond Engineering developed a plan for implementing a biomass for heat facility as well as a tribal pellet manufacturing facility.

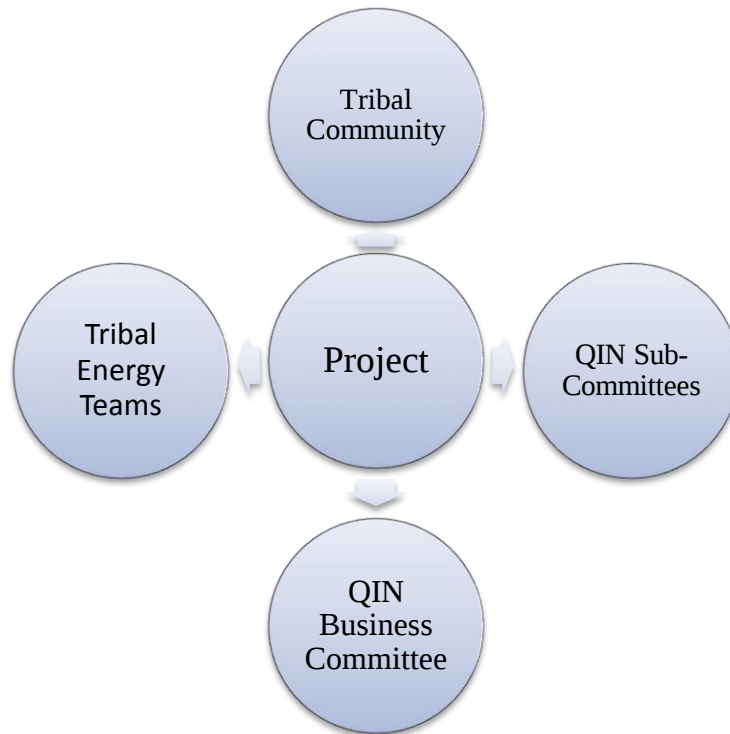


Figure 5: Project Methodology Model

Accomplishment of Project Objectives:

The following information will be dedicated to providing specific details in support of the development of QIN's biomass for heat strategies as well as objective accomplishments.

1. Identify and confirm community and tribal energy needs:

The energy needs of the Nation are modest. The reservation itself uses an average of approximately 24 megawatts per day. Use at the Casino/Hotel is about 15 megawatts per day. The resources necessary to support QIN tribal needs are available to the QIN in the form of woody biomass in the form of forest slash.

Entry-level commercial energy production would require resources sufficient to produce five megawatts or more continually. These resources are not available to the QIN for electrical energy production. However QIN forest slash resources are more than sufficient in support of development of a biomass for heat facility.

The biomass for heat facility would use fuel pellets manufactured from QIN forest slash being generated from forest operations conducted on the QIN reservation as the primary feedstock. The QIN reservation has over 207,000 acres of highly productive forestland that is managed sustainably under the guidance of an Integrated Resource Management Plan (IRMP). The biomass for heat facility would supply distributed heat to public buildings proposed for relocation, as well as existing buildings (QIN Administrative Complex and QIN Health Clinic) near the proposed relocation site. The new and/or proposed tribal facilities include a school (currently being planned), community center, elder's center and the emergency services/justice center.



Figure 6: QIN Administrative Complex to be heated by Biomass for Heat Facility



Figure 7: QIN Roger Saux Health Clinic to be heated by Biomass for Heat Facility

Table 1. Estimated Savings from Electric to Wood Biomass Heat Conversion

Estimated Savings by Heating Existing Buildings with Wood					
Existing Buildings	Electricity Usage (kWh/Yr)	Electricity Cost (\$/kWh)	Cost (\$/Yr)	Heat Required (MMBtu/Yr)	Percent of Total Heat
Administration	846,240	0.07	\$59,237	1,661	31%
Health Center	959,760	0.07	\$67,183	1,884	35%
TOTAL	1,806,000		\$126,420	3,545	66%
Total Wood Heating			\$72,576		
Existing Buildings			\$47,548		
Savings			\$78,872		
PROPOSED					
School	204,095	0.07	\$14,287	697	13%
Emergency Services	342,814	0.07	\$23,997	1,170	22%
TOTAL	546,909		\$38,284	1,867	35%
Total Wood Heating			\$25,041		
SAVINGS			\$13,242		
Existing and Proposed Bldgs.					
TOTAL			\$92,114		

The QIN Reservation consists primarily of commercial forestland. An estimated 196,700 of the total 207,300 is comprised of forested cover (95% of the reservation). Woody biomass material from forest operations within the reservation is to be the primary feedstock source for the biomass for heat facility. Table 2 provides an overview of potentially and practically available woody biomass volumes from forest operations conducted by either QIN or the Bureau of Indian Affairs (BIA). The standard unit of measure for woody biomass is bone dry ton (BDT).

Table 2. Biomass Material Potentially and Practically Available on the QIN Reservation

LAND MANAGER	POTENTIALLY AVAILABLE BDT/YEAR	PRACTICALLY AVAILABLE BDT/YEAR
QIN	13,100	5,460
BIA	20,650	8,600
TOTALS	33,750	14,060

Table 3 summarizes the estimated costs of collection, processing and transport to deliver biomass material to the Taholah site employing biomass recovery alternative operating models.

Table 3. Biomass Material Collection, Processing and Transport Costs

BIOMASS RECOVERY METHOD	LOW RANGE \$/BDT	HIGH RANGE \$/BDT
Alternative 1	\$32	\$52
Alternative 2	\$42	\$63

Alternative 1 represents biomass recovery from only those harvest units and/or slash piles determined to be easily accessible, minimizing contractor processing and transport costs. Alternative 2 represents complete biomass recovery from within units, including isolated material or units with access challenges.

Feedstock specifications and quality are an important issue for the thermal energy systems as well as value-added biomass utilization enterprises considered. In general, these smaller thermal energy units require consistent feedstock sizing, moisture content (<40%) and are impacted more significantly by contaminants (e.g., dirt) than larger, industrial-scale boilers.

The use of biomass to meet the thermal energy needs of the existing QIN Administrative Complex, Health Clinic and tribal facilities in the planning phase has two distinct advantages. First, the resource is readily available within the Quinault Reservation and second, the energy in biomass is stored in a form, such as fuel pellets that can be stored and used at any time. Unlike other renewable resources whose availability may be seasonal or weather- dependent, biomass can be converted into thermal energy to match the needs of the QIN as they vary from day to day and seasonally.

2. Conduct an inventory of sustainable biomass availability:

There is sufficient feedstock to fulfill the woody biomass feedstock requirements for a thermal energy facility for the tribal facilities subject to relocation at Taholah, as well as the existing Administration and Health Center buildings. In fact, these facilities are estimated to use only 400 BDT of woody biomass fuel per year. Forest harvest operations on the reservation, from both QIN and BIA operations, will generate, in terms of gross volume, an estimated 33,750 BDT per year.

The following information is specific to the QIN biomass inventory project resulting from our renewable energy strategic planning.

Timber harvest residuals can provide significant volumes of woody biomass material. Typically available as limbs, tops and unsaleable logs, these residuals are byproducts of commercial timber harvesting operations. As such, these residuals can be a relatively economic raw material fuel supply. Once collected and processed using portable grinders, this material is an excellent biomass fuel source.

Woody biomass fuel review studies traditionally rely on data regarding historic timber harvest levels. This information can provide insight in determining historic trends and benchmarks to show actual forest harvest activities over time, activities that generate volumes of byproducts (as noted above) potentially available as biomass fuel.

As shown in Table 4, the QIN own and manage approximately 44,260 operable acres (28%) within the reservation boundaries. The ownership is comprised primarily of scattered parcels rather than a block of contiguous parcels. Table 4 also shows acres by forest cover species within the QIN ownership.

Table 4. QIN Forest Cover Primary Species and Operable Acres

QIN PRIMARY FOREST SPECIES	OPERABLE ACRES	PERCENT OF TOTAL
Western hemlock	15,518	35%
Western red cedar	6,043	14%
Mixed Conifer	9,772	22%
Douglas-fir	9,463	21%
Hardwoods	1,862	4%
Lodge-pole pine	1,602	4%
TOTALS	44,260	100%

It is important to note that 91% of the QIN ownership consists of forestland and approximately 68% consists of operable forestland. The scattered nature of the ownership combined with the existing road system present challenges relative to woody biomass fuel recovery from timber harvest operations. Small parcels may provide limited quantities of recoverable biomass from harvest operations, which can result in increased recovery costs. Scattered parcels can present problems for effective biomass recovery as well, increasing mobilization cost of equipment employed in biomass recovery, and occasionally road systems designed solely for single parcel access and saw log recovery can present logistical challenges for biomass recovery (poor chip truck access).

The Bureau of Indian Affairs (BIA), as trustee for QIN, control and manage forest operations on 116,440 mapped acres or 56% of the total area within the reservation. This ownership is comprised of more contiguous parcels than the QIN ownership. Table 5 shows acres by forest cover primary species within the BIA trust lands.

Table 5. BIA Trust Lands Forest Cover Primary Species and Operable Acres

BIA PRIMARY FOREST SPECIES	OPERABLE ACRES	PERCENT OF TOTAL
Western hemlock	35,459	38%
Western red cedar	22,978	25%
Mixed Conifer	17,241	19%
Douglas-fir	8,421	9%
Hardwoods	5,478	6%
Lodge pole pine	3,213	3%
TOTALS	92,790	100%

BIA trust lands consist of 97% forest cover, primarily western hemlock and western red cedar at nearly 60% of the total, and approximately 80% of the trust lands are considered operable. The ownership pattern is more favorable for biomass recovery than the QIN ownership; however, BIA trust lands still have challenges from the existing road systems and individual unit access for effective biomass recovery.

The QIN and BIA trust lands together comprise 137,050 operable acres or 87% of the total operable area within the reservation. Table 6 shows the operable acres by primary forest cover species.

Table 6. QIN Ownership and BIA Trust Lands Forest Cover Primary Species and Operable Acres

PRIMARY FOREST SPECIES	BIA OPERABLE ACRES	QIN OPERABLE ACRES	TOTAL OPERABLE ACRES	PERCENT OF TOTAL
Western hemlock	35,459	15,518	50,978	37%
Western red cedar	22,978	6,043	29,020	21%
Mixed Conifer	17,241	9,772	27,013	20%
Douglas-fir	8,421	9,463	17,884	13%
Hardwoods	5,478	1,862	7,340	5%
Lodge pole pine	3,213	1,602	4,815	4%
TOTAL	92,790	44,260	137,050	100%

As noted earlier, 95% of the total acreage within the Reservation owned by QIN or managed in trust by the BIA consists of forest cover. Western hemlock comprises 37% of the total. Approximately 75% of the QIN owned and BIA managed lands are considered operable.

QIN and BIA Forest Operations Biomass Volumes

This analysis has focused upon recovery of suitable biomass material (for thermal energy production) primarily from timber harvest operations. Though biomass material may be generated through other forest operations, such as pre-commercial thinning, this biomass is typically not economically recoverable. Timber harvest operations generally provide large volumes of recoverable material in the form of limbs, tops and unsaleable material. In ground-based yarded units, this material is usually located within 100 feet on either side of roads. The intent of pre-commercial thinning operations is to reduce the number of trees on each acre to mitigate inter-tree competition and increase growth on those trees selected to remain. Not all trees are removed, as in a typical regeneration cut harvest unit.

Also, the trees are typically cut by hand, with the intent to leave on-site to decompose or are piled for burning. The low volume per acre of available material due to small tree size coupled with the difficulties of removing the material mechanically without damaging the remaining trees renders biomass recovery from pre- commercial thinning operations too expensive for use as biomass fuel on the reservation.

For both QIN and the BIA-managed lands, the byproduct from timber harvest operations represents the most viable opportunity to operationally and economically recover woody biomass material suitable as fuel for a thermal energy facility.

Based upon estimates of timber harvest volumes for QIN and the BIA, and adjusted to reflect past performance, Table 7 shows the estimated biomass material generated annually for the next ten-year period. The gross recovery factor estimate for biomass fuel processed from timber harvest residuals is approximately 0.99 bone dry ton (BDT) of woody biomass (tops, limbs, unsaleable material) that could be generated from each thousand board feet (MBF) of timber harvested.

Table 7. Ten-Year Annual Harvest and Gross Biomass Volume Forecast

LAND MANAGER	TEN-YEAR ANNUAL ESTIMATED HARVEST VOLUME (MBF)	TEN-YEAR ANNUAL ESTIMATED BIOMASS VOLUME (BDT)
QIN	14,550	13,100
BIA	22,940	20,650
TOTALS	37,490	33,750

Estimates from the QIN Biomass Inventory analysis indicate 13,100 BDT are potentially available from QIN forest operations annually and that 20,650 BDT are potentially available from BIA forest operations annually, predicated upon forecast timber harvest levels for each over the next ten-year period.

Biomass Recovery

The distinction between harvest units appropriate for ground-based yarding and those requiring cable yarding is important because methods to recover woody biomass and processing costs differ for each. On both QIN and BIA harvest units suitable for ground-based yarding, the timber harvest contractors typically utilize excavators (also known as “shovels”) to yard or swing whole trees from within the unit to the roadside.

The manufacture of trees into logs occurs adjacent to the roads, and the majority of slash material suitable for woody biomass fuel lies within 100 feet on each side of these roads for the length of the road where log processing occurs.

On those units requiring cable yarding equipment, whole tree yarding also occurs at a central landing point where the cable yarder is situated, and processing occurs adjacent to this landing, depositing unsaleable material (slash and small logs) on the slope below. Though this slash remains somewhat consolidated, it is typically not piled on the landings.

While the majority of both QIN and BIA-managed lands are suitable for ground-based yarding, each contains some areas requiring cable yarding. An operability analysis of QIN and BIA-managed lands was conducted to separate timbered ownership suitable for ground-based yarding as opposed to areas requiring cable yarding. Table 8 shows the allocation of operable acres by QIN and BIA-managed lands.

Table 8. QIN and BIA Operable Acres Suitable for Ground-Based Harvest and Cable Yarding Harvest

LAND MANAGER	ACRES		PERCENT	
	GROUND	CABLE	GROUND	CABLE
QIN	36,769	7,491	83%	17%
BIA	86,480	6,331	93%	7%
TOTALS	123,249	13,822	90%	10%

Table 8 indicates an estimated 90% of operable acres within QIN owned and BIA-managed lands are suitable for ground-based yarding.

There are a number of biomass recovery methods currently employed in western and northwestern Washington on ground-based yarding units. Some contractors consolidate and recover slash material for transport to a central processing site for conversion (grinding or chipping) to suitable boiler fuel.

Transportation costs (especially diesel fuel) and biomass fuel market prices limit these contractors' operating areas. Other contractors process the slash material on the harvest site. This material is either loaded directly into trucks for delivery to market or moved to a central location (collection site) suitable for depositing additional processed biomass and accessible by larger chip vans. These contractors are able to transport more weight as processed material as opposed to hauling unprocessed slash, and typically have a larger sourcing area, as hauling costs are more cost effective.

The similarity between these two approaches is employing shovels to consolidate slash material alongside the roads in harvest units suitable for ground-based yarding equipment (ahead of loading or processing and loading).

For units requiring cable yarding, harvest logistics, road system and topography within both QIN and BIA-managed lands present challenges for the cost effective removal of biomass material. On some harvest settings there is insufficient room to configure processing equipment (tub grinder or horizontal grinder) and a conventional 40 to 48 foot chip van. On some settings the topography and road alignment preclude any option for a truck turnaround for anything less than a log truck with bunked trailer. In some instances, the road systems have a turning radius which is too tight for conventional chip vans, or the curve is immediately followed by road grade (slope) in excess of that operable for an empty conventional chip van and tractor.

Successful contractors operating in such conditions utilize a combination of methods to effectively recover biomass. These include deployment of an additional shovel below the landing itself, swinging material up to the shovel positioned adjacent to the grinder; utilizing trucks with adjustable or radio-controlled rear axles; utilizing containers or off-road dump trucks to move unprocessed material to the grinder or collection site. An additional option is deployment of military 6 X 6 type truck or similar powered tractor to haul shorter 26' chip vans into the unit for loading of processed material. Two of these 26' trailers may be loaded and delivered to a location on a road system suitable for conventional tractors to haul the tandem trailers to a delivery point for unloading. These contractors indicate recovery volumes are similar to ground-based yarding units; however, the cost of recovery is higher due primarily to the additional collection and handling costs.

Another option requires the loading and delivery of unprocessed material (slash) to a central location (collection site) adjacent to a road system suitable for use of conventional chip vans (48 foot to 53 foot "possum belly"). Within this operation there are a couple of alternatives: employment of roll-off type containers or modified dump trucks. In either case, material dispersed throughout the harvest unit on small landings is loaded into either the container or dump truck, hauled to the collection site and unloaded.

The material is subsequently processed, loaded into chip vans, and hauled to market. Utilizing the roll-off containers rather than the modified dump truck incurs additional cost for unloading at the collection site and in reduced payload (capacity). Each of these alternatives has been utilized by woody biomass grinding contractors working in conditions similar to those on the Quinault Reservation.

An important consideration in development of operationally and economically recoverable biomass from forest operations within the reservation is the absence of a conventional hydraulic truck tipper for unloading chip vans. The thermal energy facility fuel inventory and storage area is likely to require delivery using self-unloading trailers (also known as “live floor” or “walking floor” vans). This requirement would preclude forest biomass recovery operations employing tandem 26’ vans as described above.

These methods of developing biomass from timber harvest operations recover from 0.3 BDT per MBF to 0.7 BDT per MBF. The lower estimate represents slash recovered and transported from second growth harvest units. In the data provided by James Plampin, QIN Silviculturist, relative to slash recovery conducted by Barrier West, Inc. (fiber processing company owned by Grays Harbor Paper), one unit consisted of old growth material with substantial quantities of non-saleable material.

The recovery rate for biomass in BDT per MBF was five times greater than the average for the second growth units. Discussions with additional QIN Department of Natural Resources staff indicated that harvest units similar to this were a fairly rare occurrence. For these reasons, this unit was not included in the biomass recovery metrics developed from QIN data. The upper recovery estimate (0.7 BDT/MBF) is derived from the experience of landowners and biomass processors currently recovering biomass from similar ecosystems and operating conditions in western Washington.

An evaluation of the existing road systems for both QIN and BIA-managed lands conducted by QIN Inventory Forester Larry Wiechelman and QIN GIS Program Manager Anthony Hartrich, applied to the past five years of timber harvest activity indicated that from 15% to 30% of biomass may not be economically recoverable due to road conditions and the need to utilize live floor trailers to deliver processed biomass. The higher range reflects significant harvest activity in the North Boundary area northwest of Highway 101, which consists of a substantial number of units within the past five years requiring cable yarding with road systems presenting logistical challenges. Biomass recovery operations have occurred only within a mile of the Moclips Highway, and biomass material was removed and transported as unprocessed slash to Grays Harbor Paper. This operation was restricted relative to distance from the facility and distance from a paved road without the landowner providing financial compensation to assist recovery costs.

Employing operational filters of 75% (derived from the determination above, that from 15% to 30% of prospective biomass may not be effectively recovered based upon previous operations) of overall harvest volumes suitable for biomass recovery coupled with a recovery rate of 0.5 BDT per MBF (between the .3 and .7 BDT per MBF noted above) yields an estimate of practically available biomass. These recovery factors are applied to the 10 year annual estimated biomass volume in BDT from Table 8 above, which were developed from estimated timber harvest volumes for the next 10 year period. Table 9 shows QIN Biomass Inventory estimates of potentially and practically available biomass from both QIN and BIA managed lands.

Table 9. QIN and BIA Potentially and Practically Available Biomass Fuel Sourced from Timber Harvest Activities (Expressed in BDT per Year)

LAND MANAGER	POTENTIALLY AVAILABLE	PRACTICALLY AVAILABLE
QIN	13,100	5,460
BIA	20,650	8,600
TOTALS	33,750	14,060

Estimated Costs

Results of QIN's Biomass Inventory have assessed the full expense of collection, processing and transport of biomass fuel from QIN and BIA-managed lands to better understand the cost of biomass fuel delivered to a prospective biomass for heat facility located in Taholah. The estimated costs were generated as a result of interviews with biomass fuel processing contractors and timber harvesting contractors operating in western and northwestern Washington. The most significant variables impacting cost of processing and delivering biomass material include:

- Haul distance to market
- Timber harvest residual pile distribution
- Biomass material volume per acre
- Access/road condition
- Cost of diesel
- Cost of labor
- Road improvement and maintenance costs
- Time of year delivery
- Competing uses for the biomass material (e.g., pulpwood)

There are two alternative recovery methods with regard to delivered cost. Each method employs both 40' and 48' live floor trailers for fuel delivery. The in-forest biomass collection and processing costs range from \$22 to \$33 per BDT excluding truck transport costs. Transport costs are estimated at \$90 per operating hour, loaded or empty, for both 40' and 48' live floor trailer and tractor. These costs reflect the experience of biomass processing contractors in the western Washington region under similar operating conditions.

Alternative Recovery Method 1

Some biomass processing contractors will evaluate harvest units to determine economic suitability and the extent of unit coverage to minimize processing costs to meet current markets. This approach typically includes evaluating harvest units and determining how far into the unit to proceed with processing equipment to maintain cost effective recovery. Contractors employing this recovery method typically will not recover roadside biomass from all accessible areas within the harvest unit. Though this alternative results in lower processing costs, prospective material remains on site and must be burned or left to decompose. Also, this alternative restricts the number of harvest units for biomass recovery.

Utilizing this model (Alternative 1) for biomass recovery results in delivered costs ranging from \$33 to \$58 per BDT (depending on haul distance and chip van size). Discussions with biomass processing contractors and fiber procurement managers in the region indicate biomass fuel moisture content ranges from 35% to as much as 65%. QIN Biomass Inventory assumed 50% moisture content to reflect delivered fuel moisture for this cost analysis.

The range of costs stated above reflects transport distance and differences in van capacity. QIN Biomass Inventory estimates that 40% of practically available biomass from QIN-managed lands and 50% from BIA-managed lands can be treated employing this method. The difference between QIN and BIA recovery reflects differences in the road systems and harvest configuration employed for harvest units over the past five years. Seventy-five percent of this volume is recoverable from both QIN and BIA-managed lands using a 40' trailer and 25% is recoverable with a 48' trailer. Table 10 shows a matrix of fuel volume recoverable by each trailer size.

Table 10. Recoverable Biomass Fuel Volume – Alternative 1 (Expressed in BDT per Year)

LAND MANAGER	PRACTICALLY AVAILABLE BDT/YEAR	ALTERNATIVE 1 ECONOMICALLY RECOVERABLE	BDT RECOVERABLE BY 40' TRAILER	BDT RECOVERABLE BY 48' TRAILER
QIN	5,460	2,184	1,638	546
BIA	8,600	4,300	3,225	1,075
TOTALS	14,060	6,484	4,863	1,621

Table 11 is a matrix of delivered prices by trailer size as well as distance. The delivered prices below represent haul times of one-third hour to two hours (in one-third hour increments). The volumes for each are predicated upon harvest unit location from QIN and BIA-managed lands over the past five years for Alternative 1 as discussed above.

Table 11. Biomass Volume by Trailer Size and Delivered Price – Alternative 1

VOLUME ALLOCATION BY DELIVERED PRICE									
			DELIVERED PRICE (\$/BDT)						
LAND MANAGER	TRAILER SIZE	VOLUME	\$33.95	\$38.85	\$43.60	\$48.35	\$53.25	\$58.00	TOTALS
QIN	40'	1,638	200	119	164	48	745	362	1,638
BIA	40'	3,225	597	635	1,051	361	400	181	3,225
TOTALS		4,863	797	754	1,215	409	1,145	543	4,863
			DELIVERED PRICE (\$/BDT)						
LAND MANAGER	TRAILER SIZE	VOLUME	\$32.67	\$36.91	\$41.29	\$45.53	\$49.77	\$54.14	TOTALS
QIN	48'	546	67	40	55	16	248	121	546
BIA	48'	1,075	199	212	350	120	133	60	1,075
TOTALS		1,621	266	251	405	136	382	181	1,621

The results from Table 11 indicate an overall blended fuel price of \$44.92/BDT for 6,484 BDT per year of biomass fuel recovered, processed, and delivered to Taholah.

Alternative Recovery Method 2

Some biomass processing contractors prefer to grind or chip all available material from the entire length of the road system within the harvest unit, as opposed to only conducting operations a certain distance into the unit, or avoiding some units completely that do not meet their cost requirements for recovery. These operations typically employ similar equipment to the biomass recovery operations from Alternative 1, but incur higher processing costs to ensure each unit is cleared of recoverable biomass material and ready for replanting or additional treatment. Overall recoverable fuel volume from each harvest unit is typically higher as well.

Utilizing this model (Alternative 2) for biomass recovery results in delivered costs ranging from \$44 to \$69 per BDT. As mentioned above, moisture content of 50% was used in the cost analysis. The range of costs reflects transport distance and differences in van capacity. QIN Biomass Inventory estimates that 60% of practically available biomass from QIN-managed lands and 70% from BIA-managed lands can be treated employing this method.

The difference between QIN and BIA recovery reflects differences in the road systems and harvest configuration employed for harvest units over the past five years. Seventy-five percent of this volume is recoverable from both QIN and BIA-managed lands using a 40' trailer and 25% is recoverable with a 48' trailer. Table 12 shows a matrix of fuel volume recoverable by each trailer size.

Table 12. Recoverable Biomass Fuel Volume – Alternative 2 (Expressed in BDT per Year)

LAND MANAGER	PRACTICALLY AVAILABLE	ALTERNATIVE 2 ECONOMICALLY RECOVERABLE	BDT RECOVERABLE BY 40' TRAILER	BDT RECOVERABLE BY 48' TRAILER
QIN	5,460	3,276	2,457	819
BIA	8,600	6,020	4,515	1,505
TOTALS	14,060	9,296	6,972	2,324

Table 13 is a matrix of delivered prices by trailer size as well as distance. The delivered prices below represent haul times of one-third hour to two hours (in one-third hour increments). The volumes for each are predicated upon harvest unit location from QIN and BIA over the past five years as discussed above.

Table 13. Biomass Volume by Trailer Size and Delivered Price – Alternative 2

VOLUME ALLOCATION BY DELIVERED PRICE									
LAND MANAGER	TRAILER SIZE	VOLUME	DELIVERED PRICE (\$/BDT)						TOTALS
			\$44.95	\$49.70	\$54.60	\$59.35	\$64.10	\$69.00	
BIA	40'	4,515	835	889	1,472	506	560	253	4,515
TOTALS		6,972	1,136	1,067	1,718	578	1,677	796	6,972
DELIVERED PRICE (\$/BDT)									
LAND MANAGER	TRAILER SIZE	VOLUME	DELIVERED PRICE (\$/BDT)						TOTALS
			\$43.67	\$47.91	\$52.29	\$56.53	\$60.77	\$65.14	
QIN	48'	819	100	59	82	24	372	181	819
BIA	48'	1,505	278	296	491	169	187	84	1,505
TOTALS		2,324	379	356	573	193	559	265	2,324

The results from Table 13 indicate an overall blended fuel price of \$55.97/BDT for 9,296 BDT per year of biomass fuel recovered, processed, and delivered to Taholah.

There is sufficient feedstock to fulfill the woody biomass feedstock requirements for a biomass for heat facility for the QIN tribal buildings currently in the planning stages, as well as the existing Administration and Health Center buildings. In fact, these facilities are estimated to use only 400 BDT of woody biomass fuel per year. Forest harvest operations on the reservation, from both QIN and BIA operations, will generate, in terms of gross volume, an estimated 33,750 BDT per year. However, some of this volume would be very expensive to recover and perhaps be cost prohibitive for current biomass markets or for value-added alternatives.

Results of the QIN Biomass Inventory and analysis indicate that perhaps the most appropriate business model for recovering biomass from forest operations upon the Quinault Reservation may require chipping and screening to develop feedstock of suitable characteristics. Other alternatives are to acquire clean wood product manufacturing byproduct for the biomass for heat facility, or set aside low-grade pulp logs from QIN harvest operations and contract the chipping and delivery to the facility. The latter alternative might require the ability to store 100 BDT of chips/pellets if this operation was performed quarterly.

3. Develop a biomass energy vision statement, goals and objectives:

As previously stated ColPac in coordination with QIN, conducted strategy sessions with key representatives from the tribal community, QIN applicable departmental staff and tribal council in order to develop biomass energy vision statement, long-term goals and objectives.

The results were presented to QIN sub-committees for their approval. ColPac in coordination with QIN sub-committee then reported the vision statement, goals and objectives to the full Quinault Business Committee for council approval.

The QIN biomass energy vision statement to utilize readily available forest slash resources in support of sustainable renewable energy resulted from comprehensive studies of all potential sources of renewable energy throughout the Quinault Reservation. This included wind, solar, ocean wave and biomass studies and analysis. The results of these studies concluded that woody biomass in the form of forest slash was by far the most logical renewable energy producing resource. Therefore both immediate and long-term tribal energy vision statements were based on the use of woody biomass as a sustainable renewable energy resource.

The following strategies were used in support of development of QIN's biomass energy short and long-term vision:

- Ongoing information gathering, coordination, documentation in support of successful completion of biomass vision statement to be presented to QIN key tribal community stakeholders and sub-committees for additional review and comments that will be included in QIN Business Committee project presentations
- Analysis of biomass options information that was included in overall QIN energy strategic plan supporting supply/demand side of woody biomass utilization
- Analysis of small scale woody biomass combined heat and power systems such as GARN wood fired hydronic heating systems, for remote and isolated areas such as QIN Tribal Village of Queets to include Amanda Park and Neilton that are subjected to annual winter storm caused power outages
- Contact and meetings with TreeFree Biomass Solutions to investigate the adaptability of Arundo Donax (Nile Fiber) as a component of industrial grade fuel pellets when mixed with QIN forest slash in support of higher quality fuel pellet manufacturing
- Ongoing communications with QIN Tribal Community in support of identifying tribal energy needs, providing project outreach that keeps QIN tribal community informed as project moves forward, recruitment of Energy Team from volunteers identified at Community Outreach Dinners in support of incorporating them into current and future QIN Energy Projects and including their input based on Tribal Community responses to energy needs



Figure 8: QIN Chief Taholah Days Event opportunity for project outreach



Figure 9: QIN Community Biomass Project Outreach Dinner

QIN Community Events proved to be an outstanding venue for providing project details to QIN tribal members. An open information exchange environment was always promoted to ensure tribal community members were provided with opportunities to let their voices be heard. The goal was to involve the tribal community in the development of a QIN renewable energy strategic plan based on their current and future energy needs. Figure 10 is a photo taken at one of QIN's monthly Elders Dinner where the QIN energy project was presented and input was obtained.



Figure 10: QIN Tribal Elders Dinner where energy project was presented

Keeping the QIN tribal community informed about the QIN energy project was a critical component for development of a QIN biomass energy vision. Outreach strategies included brochures that were developed specifically for this project and distributed during tribal events.

The BioMass Project

Your Quinault Indian Nation is working with ColPac (Columbia Pacific Resource Conservation and Economic Development District) to develop the cost saving and job creating use of local sustainable BioMass resources to meet the energy needs of the tribe and enhance the local economy.

Just what is BioMass?



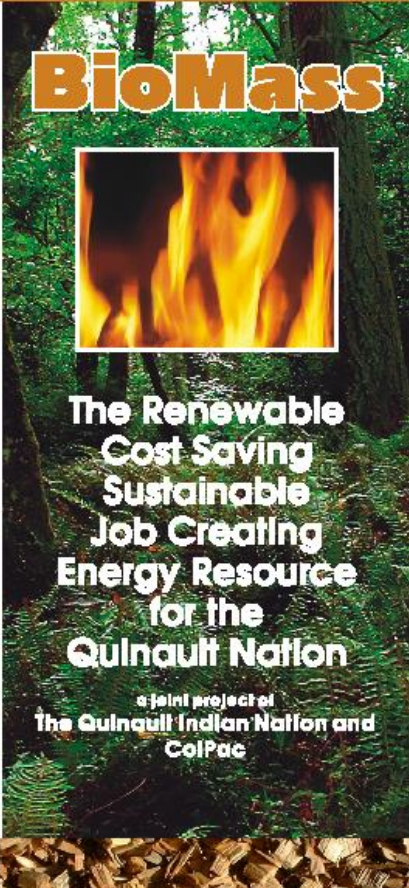
BioMass is a renewable energy source that is biological material from living, or recently living organisms such as trees. Here we're mostly talking about using wood chips as fuel for heat energy. Since we have an abundance of wood and wood byproducts in our forested area, it provides a practical way for us to reduce our dependence on fossil fuels and save on high heating costs.

We need your support

You can make a difference by supporting the BioMass Project. Talk it over with your family and your neighbors. Stay informed about the progress of the project. Participate in the discussion. **Get Involved.**

We want the Quinault Indian Nation to be the best it can be. Together we can continue to make progress. We value your opinions and comments. Call the tribal offices for more information about this important project.





BioMass

**The Renewable
Cost Saving
Sustainable
Job Creating
Energy Resource
for the
Quinault Nation**

a joint project of
**The Quinault Indian Nation and
ColPac**



Quinault Indian Nation
1214 Aulls Drive / P.O. Box 189 / Duvall, WA 98547
360-276-8215 Toll free: 1-888-816-8211 Fax: 360-276-4191



ColPac
Columbia Pacific
Resource Conservation and
Economic Development District
330 Pioneer Ave. W. / Montesano, WA 98563
360-249-2267 Fax: 360-249-4961

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Figure 11: QIN Biomass Project Brochure

Another key project strategy was to visit the QIN tribal K-12 school and provide biomass presentations geared for all grade levels. Including students in QIN's energy project outreach proved to be an excellent way to not only inform students about the QIN energy project but also have the project information taken home to parents and guardians.

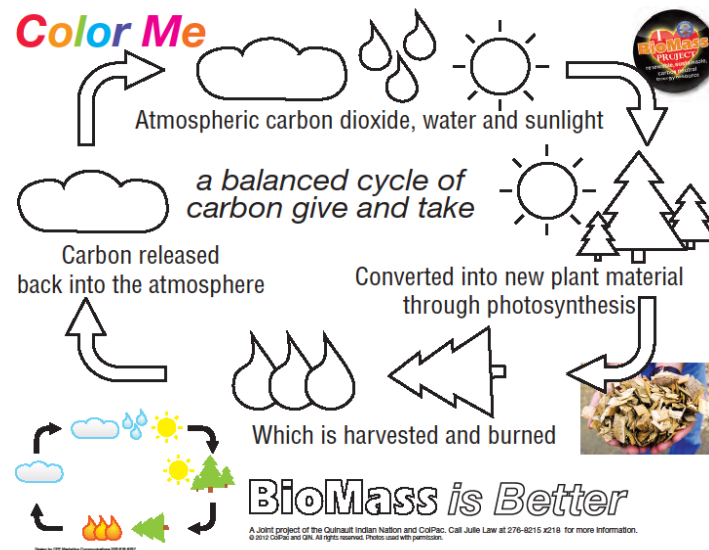


Figure 12: K-6th Grade Biomass Coloring Contest in support of project outreach

GRADE 7-12 BIOMASS ESSAY WRITING CONTEST

Sponsored by the Quinault Indian Nation and ColPac



Writing Contest Topic: How will BioMass help the Quinault Indian Nation and impact my life?

Win \$100 and other Cash Prizes!

Details: In recognition of the BioMass project sponsored by the Quinault Indian Nation and ColPac, we wanted to find out how students feel about using our local natural BioMass resources for our energy needs. Ask your teacher or Julie at the QIN Grants & Contracts Office about the details of the BioMass project.

How will using BioMass affect you, your family and your community?

We built our writing contest around this simple question: *"How will BioMass help our Quinault Indian Nation and impact my life? And in what way?"*

We want to hear how you feel BioMass can make a difference in your life and our community. You can use your own ideas, but here are some suggestions:

- What inspires you to do something positive about energy use?
- Why is it important to use BioMass instead of fossil fuels?
- How will using BioMass impact your life?
- What are the best uses for the money we save using BioMass?
- What is the message about BioMass that everyone should hear?

So tell us. Submit a 500 word (or less) essay about this topic.

Free Contest: This is a free writing contest for grade 7 – 12 students living and attending school within the Quinault Indian Nation. The sponsors, QIN and ColPac, do not require a submission fee and will select the winners at their sole discretion. All selections are final.

Contest Deadline: May 30, 2012 at Midnight Pacific Standard Time (US)

Prize Package and Winner: The Grand Prize winner, Second Prize and Third Prize winners will be selected, along with several finalists by QIN and ColPac. The Grand Prize winner will receive \$100.00, the Second Prize is \$50.00 and the Third Prize is \$25.00. All winners and finalists will receive a certificate and have their essays publicly posted. Winners and semi-finalists will be announced here after June 10th, 2012. Winners and semi-finalists will be contacted promptly.

Easy Entry Instructions:

ONE ESSAY ENTRY PER PERSON!

Write a 500 word (or less) essay typed or legibly hand written on blank or college ruled white paper. Put your name, age, grade, phone and address at the top of the first page. Hand it in to Julie Law at the QIN Grants and Contracts office by the deadline. GOOD LUCK!

Last Words:

Our hope is that your essay and thoughts will positively impact others and help with our mission of making the Quinault Indian Nation a better place. Help spread the word. Feel free to share this contest with your Language Arts/English teacher and your friends. You could win \$100.00 or other cash prizes and your story and your experience may inspire others.

Quinault Indian Nation 1214 Aasis Drive / PO Box 189 / Taholah, WA 98587 / 360-276-8215
ColPac 330 Pioneer Ave W / Montesano, WA 98563 / 360-249-2267

Figure 13: 6th – 12th Grade Biomass Essay Contest in support of project outreach

The QIN Tribal Community wanted to be involved in QIN's current and future energy solutions development. Much valuable information to support the development of QIN's biomass energy vision was provided by the tribal community during the many project outreach events. The following is an outline of the tribal community's input regarding the development of biomass for heat and energy.

- There is an ongoing need to use QIN's vast volumes of Biomass as a sustainable energy resource
- Wood heat costs less than electric heat
- Effective Weatherization Programs need to be pursued
- Biomass based Tribal Enterprises need to be developed
- Small scale combined heat & power solutions need to be considered
- Do not harm the environment – QIN Keepers of the Land

Along with Tribal Community outreach to support QIN's biomass energy strategic plan development it was also critical to involve project partners. USDA Rural Development proved to be an incredibly valuable project partner.

American Community Enrichment hosts meeting with USDA Rural Development Deputy Under Secretary Patrice Kunesch

On August 5, 2014 American Community Enrichment was contacted by USDA Rural Development Special Projects Representative Paul Johnson, and invited to host a meeting with USDA Rural Development Deputy Under Secretary Patrice Kunesch. Deputy Under Secretary Kunesch was scheduled to be in our area from August 24 through August 26th for meetings with Olympic Peninsula Native American Tribes regarding USDA Rural Development funded project presentations.

American Community Enrichment has been assisting the Quinault Indian Nation with their Biomass for Heat Projects that have been funded through the USDA Rural Business Opportunity Grant (RBOG) Program. Currently American Community Enrichment, in the role of Project Manager, is assisting the Quinault Indian Nation with their Tribal Pellet Manufacturing Feasibility Study Project funded through a USDA RBOG. Mr. Johnson felt it would be very beneficial to provide Secretary Kunesch with a program update. American Community Enrichment agreed to host this meeting on August 26, 2014 at their Elma, Washington location.

The August 26 presentation meeting consisted of a Quinault Indian Nation Biomass for Heat Project presentation by American Community Enrichment Executive Director, Jesse Cardenas and Michael Cardwell, Director of Quinault Indian Nation Community Services Division.

The Quinault Indian Nation Department of Planning represented by Department Manager Teddy Wallace and her staff, provided a Tribal Relocation Master Plan Project presentation. This project is focused on completing all planning requirements for the relocation of the Quinault Indian Nation Village of Taholah from the current flood/tsunami location to higher elevation. Julie Law, Manager Quinault Indian Nation Department of Grants and Contracts, assisted with the August 26th meeting coordination and communicated details of the meeting to Quinault Indian Nation Business Committee Executives and Tribal Council.

The meeting with USDA Rural Development Deputy Under Secretary Patrice Kunesh was a great success and provided her with details about current critical Quinault Indian Nation projects. She, along with the other USDA Rural Development representatives were very impressed with progress to date and offered continued USDA Rural Development assistance and support.

Figure 14: Project Meeting with USDA Rural Development Deputy Under Secretary Patrice Kunesh



Left to right: **Mario Villanueva** – USDA Rural Development State Director; **Tuana Jones** – USDA Rural Development, Rural Business and Cooperative Services Division, Director; **Mary Swarthout** – American Community Enrichment Vice President; **Michael Cardwell** – Director of Quinault Indian Nation Community Services Division; **Jesse Cardenas** – American Community Enrichment Executive Director; **Patrice Kunesh** - USDA Rural Development Deputy Under Secretary; **Paul Johnson** – USDA Rural Development, Special Projects Representative; **Julie Law**– Manager Quinault Indian Nation Grants & Contracts; **Philip Eggman** – USDA Rural Development Information Officer.

Methods for Developing Biomass Energy Vision Statement, Goals, Objectives:

- Strategy Sessions with:
 - Key QIN Tribal Community Stakeholders
 - QIN Sub-Committees
 - QIN Business Committee
 - Federal Agency Partners
- In Support of:
 - Determining QIN's current and future energy needs
 - Identifying a clear direction to fulfill energy needs
 - Set realistic goals based on readily available resources
 - Set applicable objectives to attain goals

Developing a Long-Term Biomass/Energy Strategy:

Things to keep in mind along the way:

- Focus on the resource(s) that are readily available
- Costs vs. Benefits
- Is the proposed strategy consistent with the long-term goals of the Quinault Indian Nation
- Your ongoing commitment to being "Keepers of your lands"

The development of QIN's biomass energy vision, to utilize readily available forest slash resources in support of sustainable renewable energy, for both short and long-term goals was also focused on the following:

- Tribal employment opportunities as energy programs develop and are implemented
- Tribal entrepreneurial opportunities in support of biomass hauling or harvesting , heavy equipment operators and related businesses
- Managed wood waste removal will rely less on slash pile burning resulting in less pollutants into the atmosphere
- Educational opportunities for QIN's children and community resulting in stronger interest in the field of Biomass in support of sustainable Renewable Energy
- Sustainable low cost renewable energy resources

There is sufficient and sustainable forest slash throughout the Quinault Reservation to fulfill the woody biomass feedstock requirements for a biomass for heat facility for the QIN tribal buildings currently in the planning stages, as well as the existing Administration and Health Center buildings. QIN's biomass for energy vision development has been based on this fact.

4. Identify and assess the biomass options, both demand-side (those that reduce energy consumption) and supply-side (those that generate energy), that are viable to the QIN:

Reducing energy consumption through conservation is the most cost-effective form of energy production because it meets energy needs without requiring new energy production facilities.

QIN energy conservation strategies include insulating tribal community and tribal government buildings and installing energy efficient windows and doors, encouraging day-lighting to reduce the use of electric lights and replacing incandescent light bulbs with more efficient and lower energy consuming LED lighting, encouraging the use of Energy Star rated appliances, and promoting conservative use of electric heaters through timed thermostats and other controls. The QIN continues actively supporting conservation through its residential weatherization program and its commitment to efficiency in new construction. Supporting and expanding these programs includes the planned use of woody biomass resulting from QIN forest management practices and timber sales, as feedstock for biomass heating technologies.

The QIN's Comprehensive Biomass Strategic Planning Project led to the development of other biomass projects that were conducted in parallel and in support of energy supply-side.

QIN Renewable Energy Project Getting from A to Z and Developing a Strategy along the Way:

The following is a list of the QIN biomass energy related projects that were developed and conducted in parallel to the Comprehensive Biomass Strategic Planning Project. It is important to note that all of these projects were focused on the use of woody biomass as feedstock for producing heat. This is the biomass option that QIN chose to pursue after the successful completion of the QIN Biomass Availability Inventory Project.

- QIN Renewable Energy Resource Identification and Assessment
- QIN Comprehensive Biomass Strategic Planning Project
- QIN Biomass Availability Inventory
- QIN Biomass for Heat Facility Engineering and Design
- QIN Pellet Manufacturing Feasibility Study

This section of QIN's Comprehensive Biomass Strategic Planning Project Final Report will provide specific details applicable to the QIN Biomass for Heat Facility Engineering and Design Project as well as QIN's Pellet Manufacturing Feasibility Study Project. Both of these projects were conducted by Richmond Engineering in coordination with the QIN and American Community Enrichment.

Biomass for Heat Facility Engineering and Design Overview:

Results of QIN's Biomass Availability Inventory Project concluded there is sufficient and sustainable forest slash throughout the Quinault Reservation to fulfill the woody biomass feedstock requirements for a biomass for heat facility. This biomass for heat facility was designed to provide heat for the QIN tribal buildings currently in the planning stages, as well as the existing Administration and Health Center buildings. QIN's biomass for heat option development has been based on this fact.

The QIN Biomass for Heat Facility Engineering and Design Project is outlined as follows:

- Began with project planning session meetings between QIN & ColPac regarding abundant volumes of biomass available on Quinault Reservation
- Quinault Reservation contains over 208K acres of mainly forested land
- Timber harvests and forest management create tons of bio-slash annually that has been piled and burned to dispose of
- The primary driver for the project was the need to address alternatives to disposal of forest slash as well as taking advantage of the opportunity to consider alternative, environmentally appropriate heating/energy technologies for existing buildings and new community facilities in the planning phase

Project Development: Feasibility Study Scope of Work:

- PROJECT DESCRIPTION: need, suitability, product & service, current technology
- BIOMASS FEEDSTOCK ASSESSMENT: inventory, access, processing/storage
- KEY ENVIRONMENTAL/CULTURAL ISSUES: impacts to Tribe, forest management, climate change, mitigation
- ECONOMIC FEASIBILITY: production/operations, market, budget, cash flow, risk
- ECONOMIC DEVELOPMENT: renewable energy, growth, markets, Tribal employment and apprenticeship opportunities
- RECOMMENDATIONS: strategies for success, next steps needed
- TECHNOLOGY SUPPORT & FUNDING: sources of reliable technology support, funding

Project Development: Feasibility Study Results:

This portion of QIN's Biomass Project was completed in January 2012 and resulted in the following:

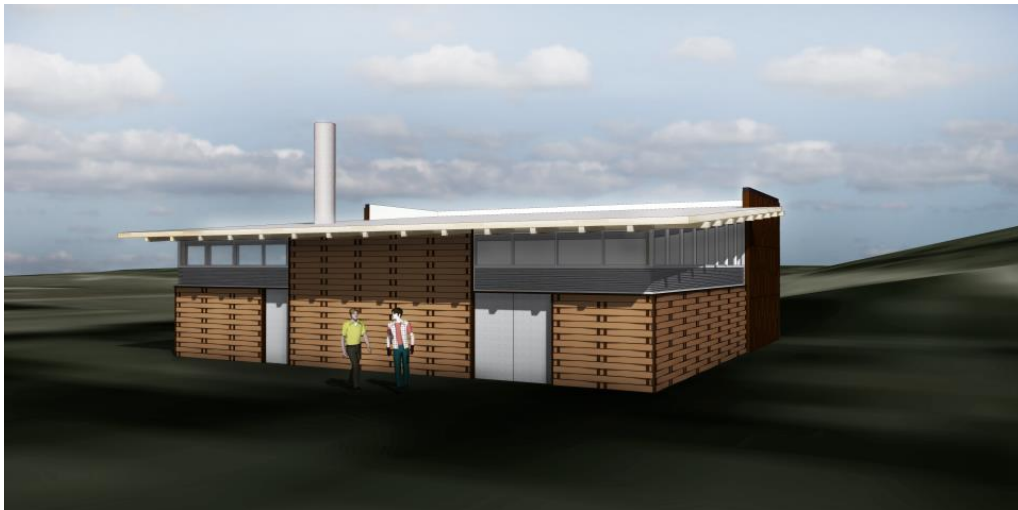
- QIN & BIA trust lands together comprise 137,050 operable forest acres
- Represents 87% of total operable area within the QIR
- Ten-Year Combined Annual Estimated Biomass Volume (BDT) 33,750

- For both QIN and the BIA-managed lands, this byproduct from timber harvest operations represents the most viable opportunity to operationally and economically recover woody biomass material suitable as fuel for a thermal energy facility

Project Development Next Step: Biomass for Heat Facility Engineering & Design:



Figure 15: QIN Biomass Heating Facility Conceptual Drawings



It is important to note that the QIN Biomass Heating Facility exterior was designed to depict a weave pattern representative of QIN's cultural basket weaving history. The QIN Biomass for Heat Facility Engineering and Design Project was made possible by a US Forest Service Woody Biomass Utilization Program Grant.

RICHMOND ENGINEERING LED DESIGN TEAM:

Biomass Heating Plant Design:

- Under the leadership of Michael Cardwell, Julie Law, and Jesse Cardenas
- **RICHMOND ENGINEERING** was selected to lead the design team to create a functional and successful operating facility

Key Design Goals:

- Reliable Operation
- Reduced Operating Costs
- Environmentally Responsible
- Compatible Appearance

Engineering and Design Status:

- Design of the QIN Biomass for Heat Facility has been completed by the **RICHMOND ENGINEERING** design team

A brief project summary:

- Single story, 2,400 square foot building
- Exterior siding has basket weave appearance
- Initial construction includes one Biomass Boiler
- Building sized for (3) Biomass Boilers and one Heating Oil Boiler
- Future build-out designed for without extensive modification

Additional Design Details:

- Investigated Biomass Combustion/Emission Systems
- Researched insulated piping options. Buried piping is PEX insulated system, both single and double types
- Invested substantial hours on accessing existing buildings for connection and heating loads

Designed for proposed buildings to be served by heating facility:

- K-12 School
- Justice Center
- Community Center Building
- Evaluated several potential construction sites, working with QIN to select a site central to existing and future facilities
- Incorporated as-built records of available utilities, water, sewer, storm, and power

- Surveyed selected site and included topographic information into site plan
- Calculated total biomass boiler heating demand for existing and proposed buildings
- Prepared biomass boiler options and sizes which led to pellet fired boiler in lieu of raw chips

Wood Pellets instead of Slash Chips:

- Researched fuel supplies and sources to run biomass facility
- Typical NW Wood Chips contain 50% PLUS in moisture content
- Dirty and difficult to burn
- Pellets arrive with less than 5% moisture content
- Easily stored and handled
- Clean burning
- Reduced Capital Equipment Costs
- Considered several pellet boiler manufacturer options and selected Viessmann-Kob's Pyrot to be the basis-of-design based on the emissions, ease of use, and efficiency of this product
- Coordinated tours to Olympus Pellet Mill in Shelton, WA and the chip fired Biomass Facility in Forks, WA
- Forks facility has taken two years (heating seasons) to achieve final operating permits from Olympic Regional Clean Air Agency (ORCAA)
- Pellet boiler will start-up without similar problems

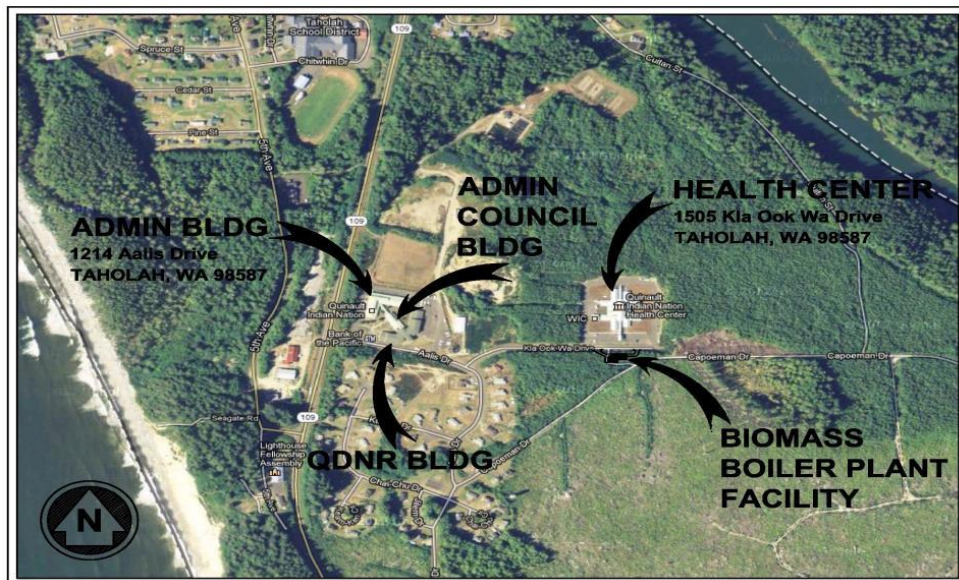
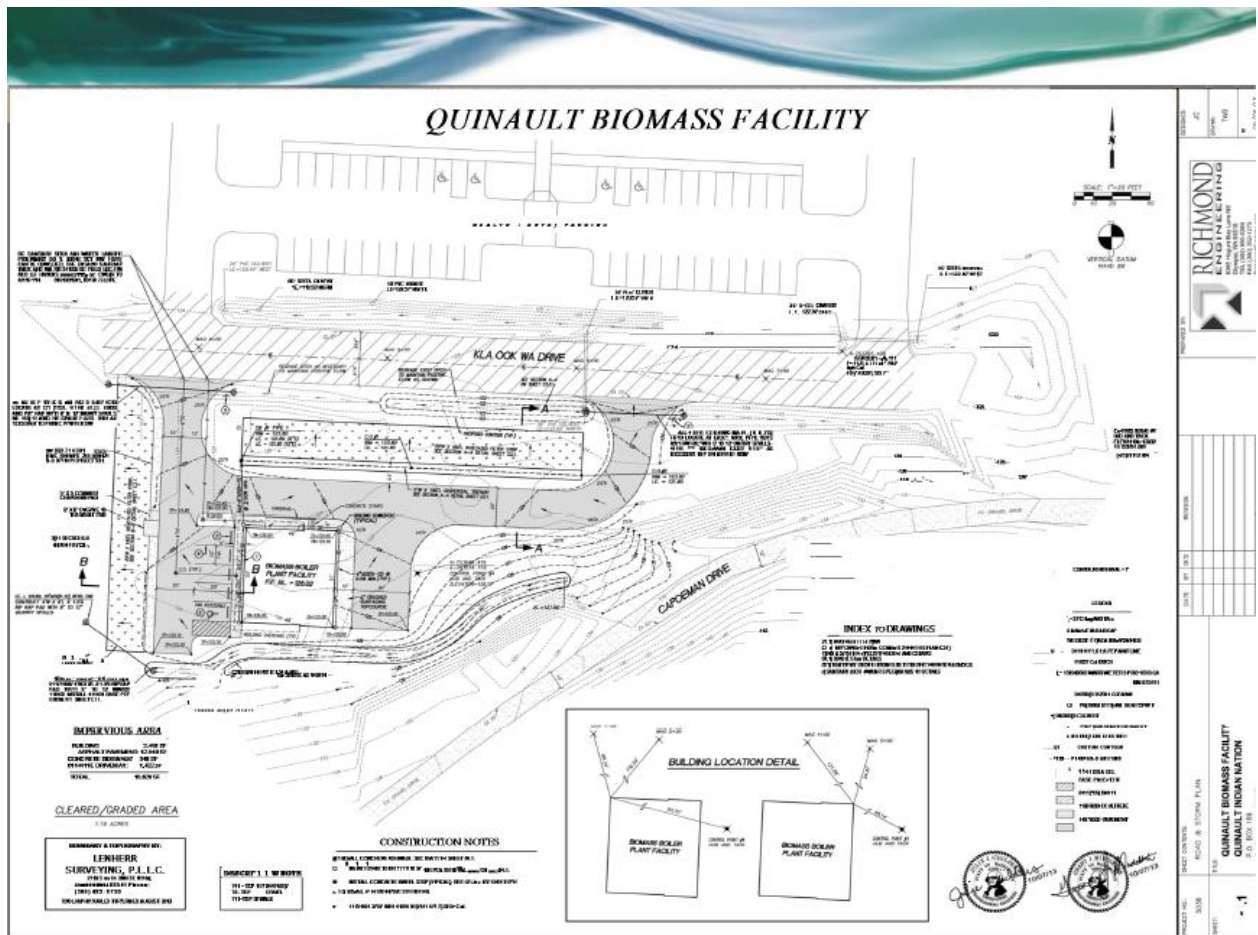


Figure 16: Site location for QIN Biomass Heating Facility



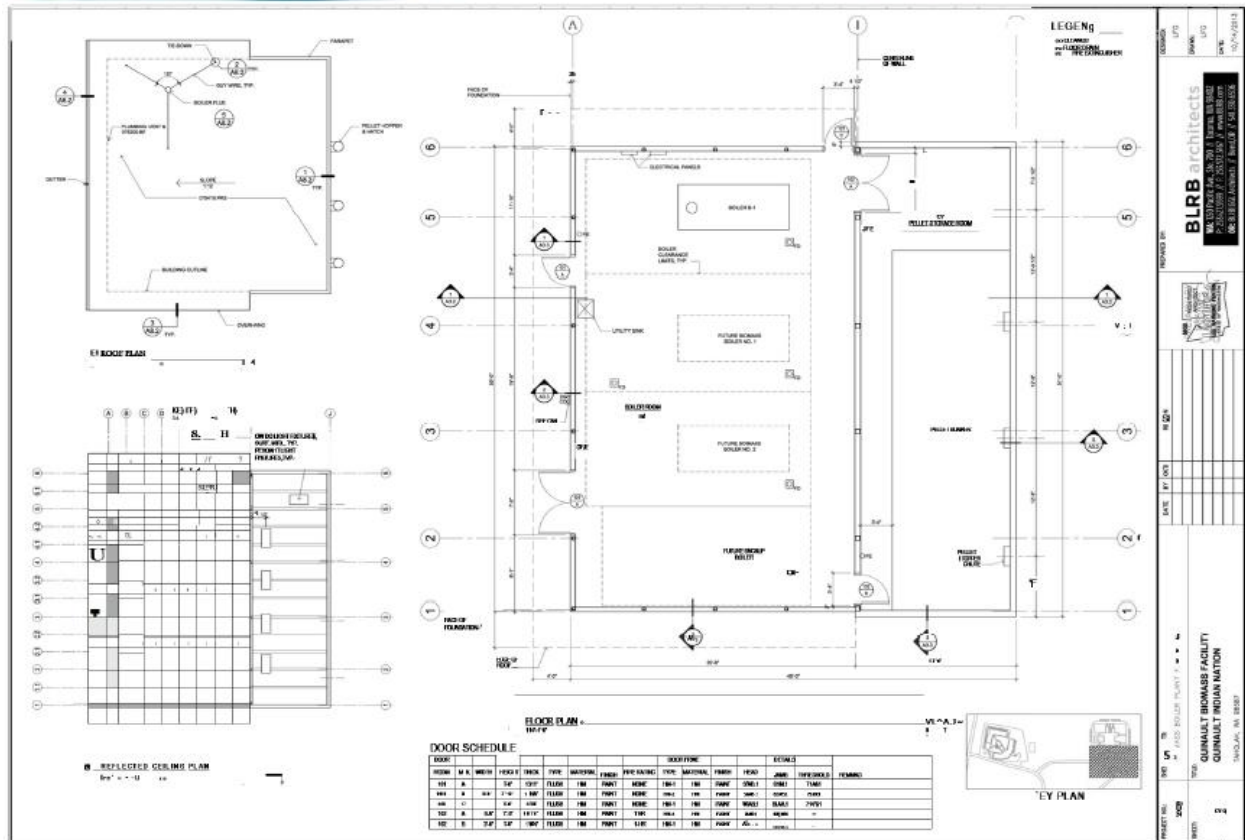


Figure 18: QIN Biomass Heating Facility Interior Layout



Figure 19: QIN Biomass Heating Facility Boiler (QIN Facility designed for up to 3 Boilers)



CONSTRUCTION COST ESTIMATE						
PROJECT NAME : QIN Biomass Facility PROJECT # : 5038				SUBMITTAL: CONSTRUCTION I DATE: 25-Nov-13 BY: BEC CK: GMR		
ITEM	ITEM	DESCRIPTION	QTY	UNIT	COST UNIT	TOTAL
1	Building		2417	SF	\$172.87	\$417,827
	Foundations			LS	\$45,713.00	
	Structure			LS	\$55,980.00	
	Siding			LS	\$229,733.00	
	Roofing			LS	\$52,704.00	
	Interior Construction			LS	\$14,449.00	
	Interior Finishes			LS	\$19,261.00	
2	Boiler System	Provide 1 of 3 pellet boilers including controls for future growth.	1	EA	\$350,000.00	\$350,000
3	Boiler Building Hydronic	Pumps, Hydronic Piping, piping accessories	1	EA	\$80,000.00	\$80,000
4	Pellet Storage Bin	75 Ton Pellet Storage Bin	1	EA	\$50,000.00	\$50,000
5	Site Improvements	Clear & Grub, Grading, Cut/Fill, base material, site access, paving, parking, landscaping	1	EA	\$95,000.00	\$95,000
6	Utility Services Hookup	Water, storm, sewer, and power	1	EA	\$25,000.00	\$25,000
7	Distribution Piping	Heated water distributed to existing facilities	2500	LF	\$120.00	\$300,000
8	Retrofit Existing Structures	Reconfigure existing heating systems to incorporate Biomass Heat supply	3	EA	\$50,000.00	\$150,000
9	Backup Gen	Backup Generator for Electrical Systems	1	EA	\$30,000.00	\$30,000
Estimated Cost of Construction:						\$1,497,826.79
CONTINGENCY (20%)						\$299,565.36
WA State Sales Tax (8.4%)						\$150,980.94
CONSTRUCTION SUBTOTAL						\$1,948,373.09

Figure 20: QIN Biomass Heating Facility Construction Cost Estimate

The timeline for the Quinault Nation's Biomass for Heat Facility Engineering and Design Project was from late 2012 through 2014. The following is a list of numerous tasks that were completed in support of the Project's Scope of Work:

- Selection of BLRB Architects to assist with building design and layout
- Biomass Combustion Systems research
- Insulated water piping options research
- Biomass for Heat Facility site research and selection
- Inspection of existing Quinault Nation buildings current HVAC system in support of identifying retrofit requirements
- Identification of available utilities including water, sewer, storm, and power

QIN Biomass for Heat Facility Engineering and Design Project Scope of Work (Con't)

- Incorporation of as-built drawings and Quinault Nation topographic information into preliminary site plan
- Reviewing heating systems of existing buildings and created action plan to incorporate biomass heating facility as primary heat source
- Estimated total biomass boiler heating demand for existing and proposed buildings
- Created preliminary conceptual drawings for review and feedback
- Researched biomass boiler options and sizes
- Researched fuel supplies and sources to initially run biomass facility
- Prepared architectural and civil exhibits for Quinault Nation Business Committee and Sub-committee project meetings
- Researched pellet manufacturer options
- Revised preliminary site layout based on smaller building footprint required for a pellet boiler facility
- Selected and sized preliminary pellet boiler system and designed equipment layout for facility
- Researched pellet mills and potential supply options
- Incorporated the basis-of-design pellet boiler into preliminary construction drawings
- Transferred draft-work of existing building layouts into construction plans and determined routes for heat transfer piping
- Researched pellet boiler manufacturer options and selected Viessmann-Kob's Pyrot to be the basis-of-design based on the emissions, ease of use, and efficiency of this product
- Coordinated tours to Olympus Pellet Mill in Shelton, WA and Biomass Facility in Forks, WA
- Developed cost estimates to include pellet productions
- Completion of site survey & 100% Construction Documents

Upon completion of the QIN Biomass for Heat Facility Engineering and Design it was time to conduct a Tribal Fuel Pellet Manufacturing Feasibility Study. Although Quinault Nation Forest Practices produce 32K – 52K tons of biomass annually in the form of forest slash, it was not yet known if this forest slash could be utilized to manufacture quality fuel pellets.

QIN in partnership with American Community Enrichment 501c3 nonprofit organization, met to plan and develop a USDA Rural Business Opportunity Grant (RBOG) Program application in support of a Tribal Fuel Pellet Manufacturing Feasibility Study. The USDA RBOG was approved for funding and the QIN Tribal Fuel Pellet Manufacturing Feasibility Study was underway.

In as much as Richmond Engineering had just completed the QIN Biomass for Heat Engineering and Design, and were fully familiar with the overall QIN Biomass Project, they were selected for conducting the QIN Tribal Fuel Pellet Manufacturing Feasibility Study Project.

QIN Tribal Fuel Pellet Manufacturing Feasibility Study Project:

Quinault Indian Nation Pellet Manufacturing Feasibility Study Project Scope of Work included:

- Assessment of currently available bio-fuel feedstock from QIN forest management practices in support of estimating load amounts
- Assessment of the availability of potential high grade bio-fuel feedstock such as Nile Fiber in support of determining biomass pellet mixture components
- Development of operational processes and economic viability in support of factors associated with biomass for bio-fuel harvesting, sorting, transporting, processing and applicable storage requirements
- Comprehensive survey of potential fuel pellet market in support of confirming economic viability

The focus of the QIN Tribal Fuel Pellet Manufacturing Feasibility Study was to confirm that woody biomass in the form of forest slash could be chipped on-site, chips loaded onto awaiting truck, chips transported to a mill where they would be processed into fuel pellets. The fuel pellets would then be used as feedstock for the QIN Biomass Heating Facility.

Among the questions to be answered as a result of this feasibility study were whether or not an additional ingredient would need to be mixed with the QIN forest slash chips in order to produce a higher quality fuel pellet. For this reason QIN chose bio-crop Arundo Donax (Nile Fiber) as the binding agent in the forest slash to pellet production process.

The following information provides additional details specific to the QIN Tribal Fuel Pellet Manufacturing Feasibility Study Project including detailed information regarding TreeFree Biomass Solutions, Inc. who provided Arundo Donax (Nile Fiber) in chipped form for QIN's pellet batch testing and Richmond Engineering's final report.

Quinault Indian Nation Forest Slash Chipping Operation:

August 11, 2014:

Approximately 6 tons of QIN forest slash was chipped on site in support of fuel pellet batch testing. The chipped forest slash was comprised of Hemlock that is the predominate tree species on the Quinault Reservation.

The chipped forest slash was loaded on a truck provided by Richmond Engineering and shipped to Mid Valley Milling in Prosser, Washington where pellet batch testing took place.



Figure 21: QIN on-site Forest Slash Chipping Operation



Figure 22: Selection of Forest Slash Piles for Chipping Operation



Figure 23: Current method of forest slash pile disposal



Figure 23 illustrates graphic views of forest slash piles being burned as a means of disposal. This is clearly not an environmentally friendly solution. Converting forest slash into wood chips for fuel pellet production is a much cleaner and safer solution.

Historically QIN has disposed of vast amounts of forest slash by simply piling it up and initiating controlled burns. Although these are controlled burns, the high volume of slash piles on the Quinault Reservation renders this method unsafe and unhealthy to the environment.

Diversion of forest biomass away from the traditional pile and burn fate and into a controlled combustion system with air emissions mitigation technology will likely result in a net improvement to air quality on the Quinault Reservation and surrounding communities.

It is anticipated that forest biomass recovered from the Quinault Reservation and utilized as fuel for thermal energy production will result in net air quality improvement in the region.

This has been the primary driver for the Quinault Indian Nation to pursue Biomass for Heat and/or Energy Projects focused on the use of forest slash as a renewable energy fuel feed stock.

QIN Pellet Manufacturing Feasibility Study: Ingredients for Fuel Pellet Production

In order to get the highest quality fuel pellet possible the QIN forest slash chips were mixed with equal amounts of chipped Arundo Donax (Nile Fiber). American Community Enrichment coordinated a partnership between QIN and TreeFree Biomass Solutions in support of obtaining sufficient quantities of Nile Fiber for pellet batch testing requirements. The following is information about TreeFree Biomass Solutions Inc. and their patented bio-crop Nile Fiber.



TreeFree Biomass Solutions Inc. spent the last 12 years researching Arundo Donax as a sustainable biomass feedstock. In addition to confirming Nile Fiber™ as a replacement for wood fibers in producing pulp and paper, TreeFree discovered additional applications in other major industry sectors. TreeFree owns or controls an intellectual property portfolio of Nile Fiber™ products and processes. (www.nilefiber.com)

After over a decade of research and development, TreeFree is now commercializing its product and operational methods to guarantee success moving forward.

TreeFree produces Nile Fiber™ cultivars, plants and grows Nile Fiber™ grass, harvests Nile Fiber™ crops, prepares Nile Fiber™ raw biomass feedstock in the form the end-user requires and delivers it to the end-user. TreeFree is forging relationships with government, community, University, Tribes and public and private companies to launch an aggressive effort to confirm and develop Nile Fiber's™ potential as a critical part of the solution to energy dependency, replacing fossil fuels, protecting, enhancing and sustaining the environment and provide economic development opportunities for rural communities.

Nile Fiber is a patented domesticated cultivar of Arundo Donax grown by TreeFree Biomass Solutions, Inc. Due to its high biomass productivity, Nile Fiber is the leading contender as the premier energy crop. The fiber cell structure makes it an ideal alternative for industries needing a sustainable feedstock supply. Nile Fiber is a viable alternative to wood, coal and petroleum based feedstock.

Innovative Biomass Energy Solutions from Nile Fiber:

- **Fuels:** With yields as much as 5 times more fiber per acre than corn, Nile Fiber is a strong alternative fuel. It reduces feedstock costs and provides economic benefits as a non-food source.
- **Energy:** Nile Fiber™ can be burned with coal at 8000 BTU's or it can be converted into E-Coal, which is a complete coal replacement.
- **Pellets:** Can supply a dedicated and sustainable renewable supply of pellets away from commodity pricing.



Figure 24: Nile Fiber yields 25-30 tons per acre



Nile Fiber is a member of the perennial grass family. In its first year, Nile Fiber produces up to 10 dry tons per acre and reaches full maturity in its third year, producing up to 30 dry tons per acre. Nile Fiber can be harvested annually and produces usable biomass at a rate more than fifteen times that of Douglas fir. Nile Fiber is extremely hardy, has no natural enemies, grows with as little as 24 inches of water per year and grows in poor soils without fertilizer. The plant flourishes in warm climates and is a very efficient converter of the sun's radiation into biomass.

Nile Fiber in chipped form is a premium hardwood replacement and fossil fuel alternative which can be used in a multitude of industries from energy (for combustion purposes), pulp and paper, to composite building materials. TreeFree created a patent portfolio around Nile Fiber which was developed to supply a feedstock for multiple industries.

We're confident that adding Nile Fiber chips to QIN forest slash chips for fuel pellet manufacturing will result in a high quality and high BTU fuel pellet with less ash content and less harm to our environment.



Figure 25: American Community Enrichment Executive Director Jesse Cardenas at Mid Valley Milling

**Chipped QIN Forest Slash on Left, Chipped Nile Fiber on Right
These chips were mixed together to produce fuel pellets.**

The QIN Tribal Fuel Pellet Manufacturing Feasibility Study Project was completed in December 2014. This study concluded that a pellet mill can be an economically viable business on the Quinault Reservation in the Village of Taholah area and that it should be pursued not only to provide employment but also to reduce both pollution and reliance on fossil fuel.

A pellet mill, producing 480 tons per month, would cost \$1.3-1.5 million to construct over a two year period. This sized production facility would be adequate to supply the proposed heating plant for the QIN's administrative buildings, health clinic and educational facilities with surplus product to market. It is economically viable and should be considered as a means of reducing heating fuel costs while consuming a large portion of the slash from Reservation logging operations. The economic gains for the Taholah region do not end with just the few jobs that the mill will provide, it will also benefit from spin-off businesses such as pellet stove and boiler installers as well as the jobs to produce logging or mill waste materials that are needed at the pellet mill.

Richmond Engineering Final Report: QIN Pellet Manufacturing Feasibility Study

This study will show that a pellet mill can be an economically viable business in the Taholah area and that it should be pursued not only to provide employment but also to reduce both pollution and reliance on fossil fuel. Burning wood to produce power (in the form of heat, steam, or electricity) is classified as carbon neutral. The carbon released during the combustion of wood is carbon that was sequestered from the air over the life of the tree. No new carbon is released into the atmosphere as occurs in the combustion of fossil fuels. Furthermore, because Washington's forests grow at a much faster rate than those in Europe, it is cheaper for us to manufacture pellets which should allow for the U.S. manufacturers to export them and be competitive in a world market. Japan is a consumer of wood pellets that has little or no means of supplying for their own needs and would perhaps be a customer that could be pursued once the new pellet plant is firmly established. Japan and Europe are much further ahead in switching to biomass fuels, and they utilize wood pellets as a high density renewable fuel. Wood pellets are a good solution because material handling is simplified and the fuel meets the requirements of the Kyoto Protocol, since it is carbon neutral. The potential growth of the pellet industry is promising and as the timber industry begins to recover, the market for pellets should grow.

A pellet mill, producing 480 tons per month, would cost \$1.3-1.5 million to construct over a two year period. This sized production facility would be adequate to supply the proposed heating plant for the Taholah administrative buildings and educational facilities with surplus product to market. It is economically viable and should be considered as a means of reducing heating fuel costs while consuming a large portion of the slash from Reservation logging operations. The economic gains for the Taholah region do not end with just the few jobs that the mill will provide, it will also benefit from spin-off businesses such as pellet stove and boiler installers as well as the jobs to produce logging or mill waste materials that are needed at the pellet mill.

Raw material

This report will show that while there may be adequate volumes of hog fuel, logging slash, pre-commercial thinning waste, and other wood debris to meet the local region's demand for wood pellets, these materials aren't suitable for producing the premium grade pellets needed. While fiber is available in adequate volume, the type of fiber required is going to be the problem. Clean, debarked wood fiber suitable for premium grade pellets, such as sawdust and shaving waste is already a sought after commodity in the pulp industry. The plant under consideration here is small compared to the fiber resources available.

The available materials are best used in large industrial type heating plants where robust ash handling equipment can accommodate the ash volumes and clinkers associated with burning lower quality wood fiber pellets. Residential wood stove owners will not be satisfied with anything less than premium grade pellets.

Labor costs

A modern pellet plant sized to meet the local region demand would employ approximately 5 people with family wage jobs. The pellet plant envisioned by this study would best fit an owner/operator with a small core-group of full time employees.

Although peak pellet production would take place in the summer, peak sales are in the winter heating months. The fiber gathering and pellet distribution activities can easily become a year-round operation.

Transportation costs

A plant sized to meet the local region wood pellet energy demand would limit haul distances to approximately 60 miles, inherently limiting transportation costs. Raw fiber haul costs would be \$15 and less per ton with similar expense for pellet delivery. The region is estimated to have a population base of approximately 60,000 people within a 60 mile radius.

Market demand for pellets

Residential, commercial, and public heating demand within 60 miles of Taholah has been estimated at approximately 10,000 tons of wood pellets per year. This would equate to approximately 24,000 tons of green, wet sawdust and hog fuel. These numbers assume that less than 50% of the existing heating systems would be converted to pellets.

Environmental concerns

Working with environmental regulations would be a frequent occurrence for the operator of the pellet plant, from logging regulations in fiber procurement to emission regulations controlling particulate release during combustion. In particular, air quality regulations for solid fuel combustion will present the most challenging obstacles to expanding pellet heating systems into a larger customer base spreading across residential, commercial, and public buildings. Existing air quality regulations cover large power producers and small residential stoves but there are no regulations now in place to certify the in-between sized furnaces suitable for large residential and small commercial heating systems. This leaves most potential commercial heating systems without a cost effective solution to use wood pellets as a heating fuel.

Renewable Energy – Why Pellets?

Wood biomass represents the largest volume of readily available, renewable energy on the planet. Forests cover 30% of the terrestrial (non-water covered) surface of the Earth. New crops can be produced in Pacific Northwest forests every 20 to 30 years as compared to 70 year crop rotations for the Scandinavian countries where woody biomass is being widely used. Wood pellets are a readily available, dried and compressed form of fuel that provides clean burning energy to replace fossil based heating oil, propane, natural gas, coal, and electricity.

The small amount of ash left over from burning pellets (1% or less) can be used as a fertilizer which can increase the productivity of farms or be put back into the forest to increase tree growth. Long term benefits could include National recognition for green energy use that should be achieved if most of the homes and businesses switch to pellet heating. It is also possible that pellets could eventually be used to provide clean electricity production in place of fossil fuels.

For every 1,000 board feet of timber harvested less than 1 BDT of logging slash is produced. Timber harvests and forest management create 32,000 BDT of biomass- slash annually on the Quinault Reservation. Removal of logging slash from recently logged areas was in the past done by piling and burning. Burning of slash piles will soon not be allowed due to air quality control regulations. A significant percentage of that logging slash could be used as biomass fuel.

Greenhouse Gas Emission Reduction

Burning wood for heat is defined as carbon neutral. The carbon dioxide released during the combustion of wood is carbon that came from the air over the life of the tree through photosynthesis. No new carbon is released into the atmosphere as occurs in the combustion of fossil fuels. Even the energy needed to dry the fiber in the pellet plant comes from burning fiber, reducing fossil fuel demands and reducing new carbon emissions.

Economic Development

Assuming 10,000 tons of pellets sold per year, the local pellet plant could expect gross sales of more than \$2 million per year. The plant in Taholah would generate approximately 5 direct jobs, while fiber collection, hauling, and pellet distribution would contribute another 4 or 5 seasonal jobs. In addition to employment, pellet sales would keep the money spent on heating in the local economy rather than going overseas.

An indirect benefit could be removal of waste debris from the forest which would reduce the danger of wild fires and/or removal of waste from the mills, allowing an income stream from waste products. The ash left over from burning pellets could be used as a fertilizer for farms or forest.

Safety and Availability

Oil and natural gas must be handled by professionals and require expensive equipment dedicated to the product. Gas is typically supplied by underground pipe which limits its' area of availability. Oil is delivered by truck to the point of service and it can only be delivered to areas that allow the transport of flammable, hazardous material. Wood chips and pellets can be handled safely by anyone, and in the case of wood pellets they come readily transportable in 40lb bags or bulk.

Efficiency

Assuming that all heat exchanger efficiencies are essentially equal, wood chips and pellets have dramatically different combustion efficiencies due to moisture content. Wood pellets are much more efficient than wood chips because the moisture content of pellets is approximately 5% while wood chips contain 50% moisture (and potentially much more).

Types and Quantities of Woody Biomass

A requirement to identify the feasibility and sustainability of a pellet plant in the vicinity of Taholah is to find the current availability and the future availability of woody biomass in the area. In the vicinity of Taholah there are many different types of biomass residue available which include logging slash, thinning slash, hog fuel, cedar shake mill waste and storm debris. Note: *Pulp chips were not included in this study since they experience a high demand from the paper industries and are consequently more costly and unavailable.*

Also a possibility for biomass supply are biomass crops such as Nile Fiber™ which could be added to logging slash to improve wood pellet quality. There is much research still needed to understand if and how well this biomass fuel will perform on tribal land in the coastal climate and soil. Nile Fiber™ is a specialized cultivar of *Arundo Donax* cultivated by Treefree Biomass Solutions Inc. in Seattle, Washington. Nile Fiber™ has a direct combustion high heating value of 8,000 BTU/lb. and can be used in most biomass heating facilities. Nile Fiber™ is a strong candidate for use as a renewable biofuel source because of its fast growth rate, ability to grow in different soil types and climatic conditions. Nile Fiber™ will produce an average of 25 tons per acre of biomass once established. Nile Fiber's™ ability to grow 20 to 25 years without replanting is also significant.

In an effort to focus on the local economy and market sustainability, a region within 50 miles of Taholah was analyzed for this biomass availability research. In this region there are large quantities of biomass available fit for the sustainability of a plant sized to meet the local community's needs.

To support the potential market in Taholah and its surroundings, as well as allowing for market growth, an estimated 24,000 GT (green tons) or 12,000 BDT (bone dry tons) per year of biomass is required. There is also a substantial amount of low valued mill waste in the vicinity. Using a three year average, the Interfor sawmill and planing mill combined with the Allen Logging sawmill produces over 100,000 BDT per year of residual biomass. There are also sources for underutilized cedar shake mill waste in the vicinity that add to the availability of wood fiber. Mill waste would be an ideal material for a pellet mill since it would not have to be ground or produce excess material to be recycled. Using mill waste would require some method of collection, likely a commercial truck with a vacuum system used to remove the waste from the site and which would also be used to blow the waste out into a storage area at the mill.

The preceding information provides sufficient means to recommend that the availability of woody biomass in the general vicinity of Taholah is stable and sustainable for a pellet plant that meets the community's needs and provides ample room for market growth.

Availability

Assuming a 60 mile radius as an economical range of supply, there are many different types of biomass residue available. These include: sawdust; shavings; logging slash, such as limbs, tree tops, and cull logs; thinning slash, consisting primarily of small trees; hog fuel; cedar shake mill waste; and storm debris. Note that pulp chips were not included as a biomass source in this study since these chips have a higher market value than practical for pellets and the pulp and paper industry is already hard pressed for survival.

Compared to our conceptual pellet plant needs, there is a large amount of quality fiber available in the vicinity. Using a three year average, the Interfor sawmill and planing mill combined with the Allen Logging sawmill produce well over 100,000 bone dry tons (BDT) per year of waste fiber.

Unfortunately for potential pellet uses, these waste streams are already highly sought after by the several large pulp and paper mills in the region.

Underutilized waste fiber includes cedar shake mill waste and logging slash. Available waste fiber from local shake mills is estimated at more than 50,000 tons per year. Shake mill waste has the advantage of being partially processed, requiring further size reduction before palletizing.

A drawback is that the material is often not stored or handled carefully allowing dirt and other debris to get into the process. Specialized equipment will be required for loading, hauling, and unloading of the raw material.

The potential available logging slash alone is on the order of 175,000 to 260,000 green tons per year. Pre-commercial thinning activities produce another 65,000 green tons per year. The actual amount that could be harvested successfully is probably less than half, meaning that total available fiber from these sources would most probably be in the range of 140,000 green tons per year.

Suitability of Biomass Options for Pellet Production

The wood pelleting process involves the drying, grinding, conditioning, pelleting or extrusion, cooling and screening of wood fiber to produce pellets. Wood fiber is pelleted to increase its bulk density, improve its material handling characteristics, and to give the biomass a shape, which is conducive to automatic burner infeed systems.

The pelleting process will increase the bulk density of the wood fiber by approximately four fold, i.e., 10 lbs. /cubic foot to about 40-42 lbs. /cubic foot. The pelleting process does not increase the BTU per pound of the wood fiber. It simply compresses more BTUs (and pounds of wood), into a particular space. There are three different grades of pellets used for fuel recognized by the Pellet Fuels Institute (PFI); Premium, Standard, and Utility grades. The percent of ash content in the pellet is what distinguishes the categories.

1. Premium pellets must contain no more than 1% ash
2. Standard grade pellets are allowed up to 3% ash content
3. Utility pellets up to 6% ash content

Premium pellets are generally produced using hardwood and softwood without inclusion of bark and can be burned in any pellet heating appliance. The highest quality pellets are made from a Douglas-fir and cedar mix. These pellets burn very hot and clean due to their high heating value and low ash content. On the other side, standard and utility pellets can include bark, needles and other low valued forest residue such as logging slash. However, these pellets, especially utility grade, can produce significant amounts of ash and clinkers (incombustible residue that has fused together - rocks, dirt, etc.) when burned. Whole tree pellets, which normally contain about 7% ash, can create in excess of 8 times more ash and clinkers than premium pellets due to the added amount of bark and needles. This can create a nuisance increase in maintenance required for normal residential boilers and stoves but may be feasible for large commercial boilers with large automatic ash removal systems such as the boilers in the Taholah heating plant.

Hemlock and Spruce are often used in pellet production as well but the quality is less than that of Douglas-fir/cedar pellets because of its higher ash content. Pure cedar pellets are not made due to their detrimental effects to the manufacturing equipment - cedar is very abrasive and can quickly wear out pellet mill dies which are costly to replace.

Research shows that standard grade pellets can consistently be made from a mixture of chipped logging slash and clean chips (no bark) or sawdust. Chipping of aged slash in the forest and hauling to the pellet mill in a chip van is the most efficient way of harvesting slash biomass from the forest. Smaller truck trailer size would be necessary for more inaccessible areas which will not support the larger chip vans.

Logging slash and thinning slash would have to be processed through a grinder or chipper and the majority of dirt and needles separated out. Two pounds of dirt in a ton of wood fiber would contribute 0.1% of ash content in the finished product.

Dirt and needles cause excessive ash formation and also ash fusion (clinkers). Rocks are a problem for every fuel delivery system and also cause problems in the fire box. Therefore, using slash as a fuel supply for heating requires careful handling of the slash material to avoid contamination with dirt and rocks. Waiting a year before chipping a slash pile allows time for the needles to naturally fall off as well as lowering the moisture content. Also chippers can be equipped with a port or opening in the discharge chute so that most of the needles can be eliminated from the product.

With a little care in the piling of the slash and the right choices in slash handling equipment the dirt and rocks can be held to an acceptable minimum producing a very viable feedstock source for the pellet mill to produce standard or utility grade pellets.

Plant Details: Why Taholah?

The Taholah region has many of the needed resources for a pellet plant. The rural location makes other sources of fuel expensive due to transportation costs, while there is an abundance of raw fiber in the form of mill waste and logging residue. Given the apparent benefits, this feasibility study was commissioned to weigh all the factors and determine whether it would be economically sound to build a pellet plant in Taholah.

The primary factors that were considered were availability and suitability of wood fiber, economic feasibility of operating a pellet plant, potential market demand for pellets, and impact of environmental regulations.

Plant Sizing

The estimated output capacity of a pellet mill to supply the Taholah Administration buildings and the proposed school is 100 tons per month, or approximately 800 tons per year. A 5 ton per hour pellet plant, which is considered small, would produce approximately 17,600 tons per year of pellets. *Note: We recommend two shifts per day with one month production lost to maintenance per year.*

A 5-ton per hour pellet mill can fit within a relatively compact location. A pelleting production line from start to finish will fit within an indoor area that is 40 feet wide by 80 feet long with a minimum ceiling height of 22 feet. Dry storage for sawdust, wood chips, and any other biomass to be used would require a building approximately 80 feet x 100 feet. Also required would be a small office space, roughly 10 feet x 24 feet.

Building Site

Approximately ten acres of land would be large enough to meet production needs. The land would need to meet or exceed any environmental restrictions and depending on the selected site location, a cultural artifact investigation may need to take place before building can occur. Any selected site need only have road access, allowable septic tank, water, and electricity. Since mill waste would likely be the most ideal raw material for pelletizing, a location near an operating wood products operation would be preferable since it would decrease transportation costs.

Raw material storage will take up the most room. A single shift (8 hours) worth of suitable wood would be 50 tons which would fit in 800 square feet of floor space. Allowing for 3 to 4 weeks of operation from inventory, a covered storage area of approximately 14,000 square feet would be required. If sawdust from the local mills is used as the primary or only source of raw material, then a silo might be utilized, requiring less floor space. An industrial lot of one to two acres should be sufficient room for this size of operation. We believe there are several good potential sites on Reservation land.

Pellet storage will be required during summer months as the highest production is in the summer months with the lowest sales volumes. The storage area required will depend primarily on relative volumes of bagged versus bulk pellets produced. A bulk pellet operation will be the lowest first cost approach but it will require coordination with customer installations and delivery systems.

Equipment Layout: 3 Examples of Pellet Mill Equipment Layouts

All three of these setups could be configured to fit in the 3,200sf space recommended for the QIN pellet production facility.



Small pellet mill only setup with a +/- 1,600sf footprint



Small pellet mill only setup with a +/- 1,600sf footprint



Large pellet mill only setup with a +/- 5,000sf footprint

Combined Heat and Power Options

One option that is available is the ability to produce electricity with the same appliance that is heating your home or workplace. Combined Heat and Power (CHP) is the name given to this technology. Pellet boilers are available now in the United States that utilize the excess heat that is produced to power an engine to make electricity. This is a technology that has been used in Europe but has primarily been used at a more industrial scale; however the technology has been adapted to work at residential and commercial levels. This technology has been used in such a way that a pellet heating system can be self-powered to allow it to still operate if the utility power goes out. Due to its' complexity, we are not recommending adding CHP to the project at this time.

Torrefaction/Gasification

Torrefaction is a pretreatment process of creating a form of biomass 'coal' by heating the biomass to temperatures between 230° and 300°C. This creates a much better fuel quality for combustion and gasification. Torrefied biomass has water repellent properties making bulk storage in open air environments possible.

Gasification is the practice of taking carbon based fuels and heating them with a controlled amount of oxygen to ensure full oxidization of the fuel occurs. This process ensures that the fuel is completely burned and if the ash is separated from the exhaust then this type of system is extremely clean burning. Gasification has been used on the commercial scale for about 50 years and has been proven to be safe and reliable. Gasification does have the disadvantage of being expensive and requires extra equipment that smaller businesses as well as individuals may find prohibitive for their scale of operation. Again, Torrefaction can be considered in a future phase.

Start-up Costs: Equipment Options

Complete pellet systems are readily available, new or used. Anyone can make a quick survey on the internet and find complete equipment packages starting as low as \$150,000. A basic pellet production system consists of the following:

1. Screw conveyors for mixing and moving chips, sawdust, shavings, etc.
2. Screens to prevent unwanted debris from entering the system
3. Hammer hog to reduce particulate size to +/- 1/4" largest dimension.
4. Material handling fans and high pressure ductwork for transferring raw materials between processing steps.
5. High efficiency dust cyclones for capturing dust and particulates from airstream.
6. Rotary or conveyor type dryer.
7. Boiler/Furnace for pellet drying and building heat.
8. Storage bins to accumulate materials at several stages of the process to handle surge and uneven flow requirements.
9. Feeders to regulate material flow rates.
10. Two pellet mills: these machines are the workhorses of the system and run at high horsepower levels with high material stresses and temperatures. They require regular maintenance to stay in operation.
11. Cooling station: Pellets come out of the pellet mills warm and soft. Cooling is required to toughen them and make them durable enough for packaging and handling.
12. Packaging systems. Pellets are usually sold in bulk or in polyethylene bags. The packaging system can easily be one of the most complicated and expensive parts of the pellet plant. One large plant visited reported spending more than \$1 million on the robotic bagging operation alone.
13. Additional major pieces of equip would include:
 - a. 200hp chipper
 - b. Chip truck
 - c. Frontend loader
 - d. Forklift



Whole Tree Chipper



Pellet Mill Machine



Small Chip Truck



Quonset style storage and silo

There are existing commercial enterprises that already collect and chip slash to sell to facilities that utilize biomass in the region. It is recommended that hauling and chipping be contracted out rather than adding the equipment, personnel, and training necessary to supply fuel to the pellet plant. Companies already in this type of business would be more efficient and have access to equipment and more power needed to keep a dependable, steady supply of fuel. These companies, such as Hermann Brothers Logging Inc., enter into contracts with the facilities to secure a fair price and a steady stream of product for both parties. Hermann Brothers recommends entering into a 5 year long contract for a facility the size of Clallam Bay.

Contracting long term with a private company such as this would allow them to invest in the proper personnel and equipment necessary for the collection of the material and provide fuel at a lower price. This would add to the economic growth of the region.

Operating Costs

There are many studies that can be found detailing operating costs for new pellet plants. The Tables below show a simple analysis that can be a starting point for further study. It is the opinion of this study that a pellet operation can be profitable based on an economic analysis.

Table 1a. Cost/Benefit Analysis at 240 tons per month of pellet production

Source	Cost per month
Building/property lease/loan	\$5,000
Labor/Management	\$17,000
Energy	\$2,000
Equipment loan payment	\$5,500
Overhead	\$2,000
Raw materials purchase	\$13,920
Miscellaneous	\$1,000
Total Expenditures	\$46,420.00
Source	Income per month
Sale of Pellets Bagged & Bulk	\$ 55,200.00
Delivery Fee	Included in Pricing
Total Income	\$ 55,200.00
Net Profit per Month	\$8,780.00

Table 1b. Cost/Benefit Analysis at 480 tons per month of pellet production

Source	Cost per month
Building/property lease/loan	\$5,000
Labor/Management	\$21,000
Energy	\$6,500
Equipment loan payment	\$10,500
Overhead	\$6,000
Raw materials purchase	\$27,840
Miscellaneous	\$2,000
Total Expenditures	\$78,840.00
Source	Income per month
Sale of Pellets Bagged & Bulk	\$ 110,400
Delivery Fee	Included in Pricing
Total Income	\$ 110,400
Net Profit per Month	\$31,560.00

Environmental Regulations: Air Pollution Control Requirements

In 2011 the Olympic Region Clean Air Agency (ORCAA) permitted a new woody biomass boiler in Forks and is reviewing proposals for several others. There is no indication that existing regulations would prohibit a project of this scale. Current combustion techniques and emission controls technology can meet existing emission standards.

The following are Washington State Administrative Code (WAC) regulations which should be considered on this project with regard to air quality:

- WAC 173-400 General regulation for air pollution sources
- WAC 173-401 Operating permit regulation

State regulations are administered through the Olympic Region Clean Air Agency (ORCAA) and the Washington Department of Ecology (WDOE). This project falls under EPA regulations.

Fire Code Compliance

The International Fire Code, International Mechanical Code, and International Building Code all have sections that would pertain to the fire safe construction and operation of a pellet mill. In some instances manufacturer guidelines are also important in following fire code and should be clearly understood. In addition to these, local code requirements would also need to be followed if present.

Emissions: On-site Combustion

Life cycle emissions associated with the disposal of woody biomass through on-site decomposition include emissions from gathering logging residuals into slash piles and combustion of slash piles. There are no new products generated under the disposal options and therefore no avoided use emissions from displaced products.

Data from gathering is based on an average of logging residual volume across PNW forest types, bulldozer operational capacity, and emissions to gather logging residuals into slash piles.

Combustion emissions for slash pile logging residuals are based on values reported in the U.S. Environmental Agency's AP-42, *Compilation of Air Pollutant Emission Factors*.

Life cycle emissions data for on-site combustion of slash piles are presented in Table 2. System, displaced, and net emissions are given. Data presented assume the chip-then- transport woody biomass preprocessing approach – 50 mile transport distance, 100 mile distribution distance, and a fixed market demand. Values that are approximately zero (<0.005 or >0.005) are indicated by ~ 0 .

Table 2. On-site combustion life cycle emissions estimates

	CO2	N2O	CH4	CO	PM2.5
	(t CO2e/bdt)			(lb/bdt)	
Method					
Gathering	0.01	~0	~0	0.14	0.01
Combustion	1.74	0.06	0.03	74.01	8.00
System Emissions	1.75	0.06	0.03	74.15	8.02
Displaced	- -	- -	- -	- -	- -
Net Emissions	1.75	0.06	0.03	74.15	8.02

This analysis assumes that slash piles are ignited by hand, on-site. Complete combustion of residues is assumed. Burning wood pellets for heat is classified as carbon neutral. The gas released during the combustion of wood pellets is carbon that was sequestered from the air over the life of the tree.

No new carbon is released into the atmosphere as occurs during the combustion of fossil fuels. The pellets and raw materials collected and produced by the mill will be the major supply of fuel for the dryer which further reduces the use of electricity, thereby reducing carbon emissions even further.

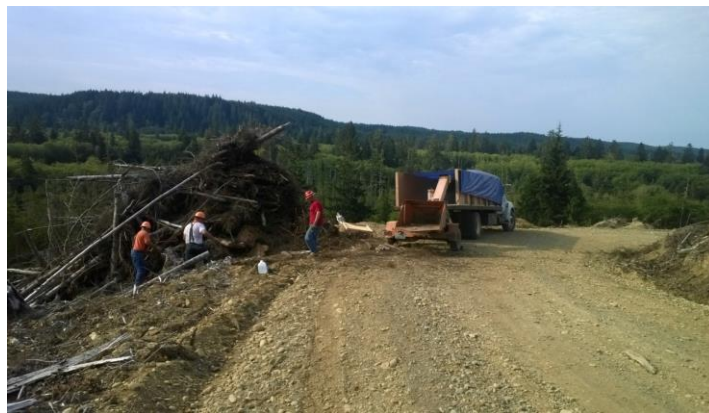
Logging Slash Testing

Logging slash from the Quinault Reservation was collected and chipped from several piles of logging residue from a site which had been logged in the first few months of 2014. The slash had already dried to very low moisture content by August when it was chipped for the test. Most of the needles had already dropped off and so the slash was in good condition to be pelleted without much drying time. The following are samples of the abundant supply of woody biomass which, with the right equipment could be chipped and made into pellets. The chipping of this slash would result in a clean environment for new stands of timber and lower fire danger on the Quinault Reservation as well as jobs for tribal members.



QIN Slash Pile after Timber Harvest

The piles of slash used for the testing contained as close as possible the average of the species, type, and size of biomass material found after logging throughout most of the Quinault Reservation. Unfortunately the chipper used to chip the test slash was limited in size of material it could chip so most of what was chipped was limbs and small poles less than 3” in diameter with bark over most of their surface area. In all 80% of the wood in the slash piles was larger than could be chipped by our test chipper. This resulted in a higher percentage of bark to wood ratio than could be obtained if all of the slash pile were used. Higher percentages of bark in pellets results in more ash and less BTU output.



Chipping QIN logging slash into truck

The chipped slash weighed approximately two and one half tons and was transported to Mid-Valley Milling in Prosser Washington to await pelleting. Nile Fiber TM was mixed with the logging slash in (2) different percentages in one of the four batch tests which were performed at Mid-Valley.

The four different batches ran at Mid-Valley for testing were:

- 1) 100% slash
- 2) 100% Nile Fiber
- 3) 50% slash/50% Nile Fiber
- 4) 60% Nile Fiber/40% slash

Pellet Testing Summary

Testing for BTU and ash content was conducted on November 3, 2014 by AmTest Laboratories in Kirkland, Washington. (Test results have been included at the end of this report).

In summary, the lab results came in very well across all the samples but we are especially pleased with the heating and pelleting results for the wood slash. The purpose of this testing was to verify or debunk previous reports that slash pelletizing could not be done successfully. We did not find that to be true at all.

A general summary of the tests indicates that the Nile Fiber has a higher BTU content but also the highest ash content and from our samples, it appears that the Nile pellets "dust" badly which is not a desirable quality in residential use pellets. The 100% woody slash pellets provide about 30% less energy per pound than 100% Nile Fiber but the output gets closer with blending. The blended pellets did not exhibit the dusting that the 100% Nile Fiber pellets did due to the natural wood resins acting as a binder for the Nile Fiber. In all cases the ash produced in our testing was greater than the 1% allowed to make Premium pellets. However, our testing did show that even using the lowest grade of slash (high bark to wood ratio) that utility grade pellets could be produced. This grade of pellets would work well for the proposed Council building heat plant.

It is the feeling of Richmond Engineering that with the available fuel supplies in the area Standard and Utility grades of pellets could be produced.

Fuel Comparison: Cost

Residential heating oil prices decreased by nearly 2 cents per gallon to reach a price of \$4.02 per gallon during the period ending January 6, 2014. This is less than 2 cents per gallon higher than last year's price at this time. Wholesale heating oil prices decreased 15 cents per gallon last week to \$3.07 per gallon but are forecast to rise as the heating season nears.

The average residential propane price increased by almost 3 cents per gallon to nearly \$2.93 per gallon, 56 cents per gallon higher than the same period last year. Wholesale propane prices decreased by less than a penny per gallon to just under \$1.69 per gallon as of January 6, 2014.

The major sources of competitive boiler based heating are oil, natural gas, wood pellets (bulk price shown), and wood chips. The statistics for each are given in the Tables below.

Table 3. Fuel Comparison

	Pellets	Natural Gas	Wood Chips	Oil	Propane
Unit price USD	0.085/LB	0.01257/ft3	0.07/LB	2.50/gal	2.93/gal
BTU / gallon				138,690	
BTU / cubic ft		1020			2,516
BTU / LB	8500		4700		
Price (USD) / million BTUs	10.00	12.32	14.89	18.03	32.11

Storage

On-site storage of fuel is an advantageous option since it allows a certain amount of freedom from price variation in the short term, and it also provides for a means of continuing to heat homes or businesses if the supply runs into a short term problem (i.e. a gas line breaking, snow stopping a fuel truck, etc.). Natural gas is not readily available to be stored residentially because of its explosive nature and the pressures required.

Oil is generally stored at the site where it will be used, but it requires a specially constructed storage tank which brings along other potential risks since it is a hazardous material. Wood chips and pellets (in water-tight bags) can be stored anywhere including outside on the ground. However, it is better to store wood chips and pellets indoors in a dry location to maintain the efficiency at which they will burn by maintaining a low moisture content.

Handling

Oil and natural gas must be handled by professionals and require expensive equipment dedicated to the purpose of moving them. Gas is supplied by pipe and is very expensive to obtain in significant volumes. Oil is delivered by truck to the location of service and it can only be delivered to areas that allow for the transport of flammable hazardous material.

Wood chips and pellets can be handled by anyone, and in the case of wood pellets they come readily transportable in a 40lb bag. Pellets can also be purchased in bulk at a cheaper price but then require a dry environment for storage.

Efficiency

High efficiency oil heaters can operate at up to 80% efficiency when new while older ones may operate at as low as 15% efficiency. New gas heaters can have efficiencies as high as 92% but older models near the end of their useful life may have efficiencies as low as 40%. Wood chip and pellet heaters can have efficiencies in the high 90s, but this is dependent on the quality of the fuel. Wood pellets are more efficient than wood chips because the moisture content of pellets is less than 10% while wood chips contain from 25% to 50% moisture.

Electricity

Electric heating is a more difficult to compare source of heating. Electric heating can operate near 100% efficiency. However, the electricity is typically produced by using fossil fuels which may be being produced at just 50% efficiency and then there is the loss of efficiency due to the long distances that the power must be transported across which may cause an additional 40% loss. Electricity costs also vary with the cost of the fossil fuel that is used to produce it.

Market Analysis: Market Strategy

Wood pellets can and should be marketed as being a green renewable energy source that is locally based and will provide employment to people within the Olympic Peninsula region. With more than forty thousand homes in Grays Harbor and Clallam County, it would be wise to market to the home owners. The average home uses approximately three tons of pellets per year for heating. If only 5% of those homes switched to pellet heating it would provide a demand for 6,000 tons of pellets per year. However, if one large facility chose to use pellet heating it could use 3,000 or more tons of pellets by itself in one year. If local uses for the pellets do not match up with the supply then it may be possible to ship the pellets to other parts of the country or to other countries and still remain profitable.

Potential Obstacles

The initial cost of starting a pellet mill is the first obstacle to overcome. There are fortunately many potential solutions including: stimulus funds, government rebates, loans, and grants.

Another potential obstacle is having enough raw materials supplied to the pellet mill and having a large enough consumer base to use the full fuel supply capacity of the mill. There are many sources of raw material in the Taholah area, most notably the saw and planer mills which would produce a more easily pelletized fiber than green wood.

The mill waste, however, could be mixed with purchased logging slash from tribal logging to add to the raw material supply. The logging slash if handled carefully could be a major supply of fiber for the pellet mill.

The consumer base is a more difficult challenge that would probably best be solved through marketing the pellets as a low cost green fuel in combination with some potential for government incentives to switch to pellet heating as a renewable fuel supply. Distributing brochures and flyers from some of the pellet stove and boiler manufacturers would probably also help, especially if the people and businesses using oil heat are targeted specifically.

Distribution of the pellets could also be a potential challenge, though much of the supply produced would be used primarily for heat on the Reservation. Excess pellets would need to be sold once produced and they could be sold in bulk, by the bag, or in some combination of the two. A combination of bag and bulk selling would likely allow for a broader consumer base, and in this case it would be most advantageous to have a few large bulk consumers and then sell the rest of the pellets by the bag to individuals for heating their homes.

To allow distribution of the bulk supply it will be necessary to have a commercial vehicle that has some means of transferring the load to a silo or warehouse. The bagged pellets could be sold from the mill directly or transported by truck to local suppliers.

During the study existing pellet plants were visited to obtain operational information as to biomass sources being used for pellet production, work flows, and equipment used both for manufacture and handling.

Pellet Plants Visited in Support of QIN Pellet Manufacturing Feasibility Study

These are a few of the pellet plants used in the study:

- Bear Mountain
- Lazy S. Lumber
- Banks Lumber
- Mid Valley Milling
- Olympus Pellets

The **Bear Mountain** plant headquarters is located in Cascade Locks Oregon and they have another plant in Brownsville Oregon in the Willamette River Valley. The company was started in 1988 by Bob Sourek using the mountains of sawdust and shavings available from the Columbia River Gorge mills and the Willamette River Valley lumber mills in Oregon as their biomass fuel source.

They produce several different kinds of pellet products to the western United States including Washington, Idaho, Oregon, California, Nevada, Montana and Utah, as well as other states across USA and other countries.

- Cozy Den Animal Bedding (cedar and pine wood shavings)
- Bear Mountain BBQ Pellets (many different 100% hardwood flavors)
- Bear Mountain Bear Bricks (fire logs and fire starters)
- Golden Fire Wood Fuel Pellets

Woody Biomass (primarily sawdust or chips) is either trucked in or brought in by railroad car to the plant. The mill has a large dry storage area where the biomass is stored to be added to whatever pellet or product they are producing at the time.

The **Lazy S Lumber Plant** is located in Beaver Creek Oregon. The mill was first started by Francis and Chris Sharron in Portland and then moved to the Beaver Creek site because of the need for expansion and increased production for their customers. The brothers did consulting designing and installing pellet equipment through a spinoff company called Natural Resource Recovery.

From 1989 to 1995 they designed and installed equipment for over 15 pellet mills. During this time period the demand for pellet products so outstripped the company's ability to meet production demands that they started construction of another large mill in 1992 in Columbia City Oregon where it eventually developed production of a premium grade fuel pellet. The old mill also continued to operate to produce premium hardwood pellets and kitty litter.

In addition a state of the art wood pellet fuel plant **Banks Lumber** has recently been added in Banks Oregon. The company produces an equivalent of 450,000 bags per month of various product lines, including commercial grade sawdust, animal bedding, and all-wood fire-logs, and fuel and barbecue pellets. The company employs 45 full-time employees and up to 5 part-timers. It is recognized nationally and locally as a model for turning waste wood into usable commodities, and for providing rural job opportunities.

They offer two different premium heating pellets as well as these other products:

- Blazer Wood Pellets (premium wood pellets)
- Hot Shot Wood Pellets (premium wood pellets)
- Wow Fire Starters
- High Energy Logs
- Noah's Choice (animal bedding)
- High Energy Quick Fire (campfire logs that start with match or lighter)
- Lil' Devils BBQ Pellets

The different mills produce most of the pellet biomass needed for the company's pellet operations. (mill waste, sawdust and chips). However some biomass product is brought in by truck or rail for the production of hardwood pellets.

The **Mid-Valley Milling** plant located in Prosser Washington is owned by Dennis Cavin. Dennis has 40 plus years of experience producing pellets of one kind or another and there is not many biomass products that he has not pelleted. He has helped in the design of several other pellet mills as well as Mid-Valley Milling.

Mid-Valley Milling was selected for testing of the logging slash chipped on the Quinault Reservation because of Dennis Cavin's willingness to help with the project and his experience with pelleting of a variety biomass products. Some of the products the mill pellets are:

- Alfalfa pellets
- Blended Feed pellets
- Fertilizer
- Wood pellets
- Wild Game Feed pellets
- Custom pellets

None of the raw materials are produced at the mill and the biomass to be pelleted is delivered by truck to the mill and stored. Mid-Valley Milling is largely dependent on nearby farms (within trucking distance) to provide biomass material to be pelleted. (hay, corn, peas, wheat, etc. and shell for fertilizer)

The **Olympus** pellet mill is located in Shelton Washington and was formerly the Atlas pellet mill started in 2008. The mill was restarted by its new owners PCFF of Spokane in August 2011. The designer of the mill remains a part owner of PCFF. Plant manager Ray McLeod, who helped start up and operate the Shelton plant originally, stayed on for the re-start and ongoing operations. And Stan Elliot, a longtime former sales executive with pioneer West Coast pellet producer Bear Mountain joined the team and is heading up the Olympus Pellets sales and marketing efforts. The plant produces 4,000 tons a month with only 9 employees.

The bag-house is 20% over-designed for plant production which creates a very safe and dust free environment. Excess dust in a pellet plant can result in fires and explosions but with the generous design used at the Olympus plant and the use of spark detectors it has created a very safe environment for its workers. Olympus Pellet uses Douglas Fir for its pellet furnish and raw material is readily available in the local area. Some of the products produced are:

- Olympus Pellets (premium pellet)
- Cascade Pellets (sold as ultra-premium lower moisture content)
- Sierra Supreme Pellets (sold as supreme)

Purchased raw material is roughly 70% sawdust and 30% planer shavings. Incoming trucks are weighed at their respective mills and when drivers enter the Olympus yard they place their weigh tickets and a load sample in a mailbox where it is picked up and tested for moisture content using a CSC machine and sent back to each mill showing moisture content for each load and total bone-dry tons delivered.

QIN Pellet Plant Strategy

Steps for establishing a Pellet Plant

The initial step would be finding a project manager who is willing and able to carry out the necessary work to build the plant. This manager should be found as soon as possible after the conclusion of the study, within one year would be best.

The next step would be for the manager to establish a relationship with the local governments and the industries that will be targeted by the pellet plant. After relationships have been established a marketing campaign would need to be designed and implemented by the project manager in conjunction with the local governments and industries.

At the same time as the marketing campaign is being designed the manager would need to start pulling together resources to build the pellet plant; this includes finding sources (both public and private) of funding, sources for materials to be pelletized and equipment to be used to pelletize. Also as the marketing campaign is being designed a suitable site for the pellet plant would need to be located.

If the marketing campaign does not appear to generate sufficient interest in Grays Harbor County then the campaign may need to be widened to include the neighboring counties. After funding has been found and marketing has generated signed agreements for the use of at least half of the planned capacity of the pellet plant then site for the pellet plant should be purchased and building and site designs should be pursued. After a building and site design has been decided on and permits have been issued then construction should begin immediately.

During construction the project manager should pursue the employees that he or she deems necessary to run the pellet plant. When construction is nearly complete then all of the employees should begin work by being trained to operate the equipment and means and time of delivery for all of the previously established customers should be finalized. As soon as construction has finished then it is time to begin operation of the pellet plant and delivery of the pellets. Some of the first pellets made would need to be tested to establish the quality of the product.

QIN Pellet Manufacturing Feasibility Study Summary

The challenges involved in operating a pellet mill in the Taholah area are many but they are surmountable. The primary concern when looking to build a new fuel supply company is establishing the current demand and determining what the demand will be in the future. Both the Quinault Indian Nation and local counties have an abundant supply of potential customers including other tribes, home owners, commercial and industrial businesses of all sizes, and government facilities. If a significant amount of advertising and marketing is put into place as the pellet mill design is started, then many people will become aware of the advantages of wood pellet fuel and will look to the new mill as their local community supplier. Sufficient raw materials exist in the Taholah area to not only support a small pellet mill but are of such scale that future expansion of the plant should also not pose a problem for the supply.

Although it may be possible to successfully start and operate a pellet mill in the current economy it would be much easier to persuade people and businesses to change from their existing heating to pellet heating if the market was in better shape. However the economy appears to be on the upswing, with new home construction starting to move again. People are becoming increasingly aware of the need to become more environmentally friendly which can only help with perception of a new pellet plant.

With the cost of pellet boilers being somewhat high in comparison to other fuel boilers enticing people to spend money up front in the current market is a challenging proposition. As with all new endeavors the proposed pellet mill will have to be helped along by the people who will be managing, marketing and earning their livelihood from the mill. However with planning at current market prices, a small local pellet plant in the Taholah area should be capable of making a profit.

5. Develop a long-term biomass strategy consistent with the long-term overall goals of the QIN:

A modern pellet plant sized to meet the local region demand would initially employ approximately 5 people with family wage jobs. The pellet plant envisioned by this study would best fit an owner/operator with a small core-group of full time employees.

Although peak pellet production would take place in the summer, peak sales are in the winter heating months. The fiber gathering and pellet distribution activities can easily become a year-round operation.

QIN's long-term biomass for heat and energy strategy was developed to ensure current and future tribal community energy needs are provided in such a manner that the environment remains undamaged. The utilization of readily available large volumes of forest slash in support of heat and energy production will more than meet this requirement.

QIN's long-term renewable energy strategies will always be focused on preserving our culture and heritage for our current tribal members and families as well as future generations.

QIN is also focused on advancing the health and wellbeing of all its tribal members and their families. The following impacts of our biomass for heat and energy strategies will continue to remain a top priority:

- Tribal employment opportunities as energy programs develop and are implemented
- Tribal entrepreneurial opportunities in support of biomass hauling or harvesting , heavy equipment operators and related businesses
- Managed wood waste removal will rely less on slash pile burning resulting in less pollutants into the atmosphere
- Educational opportunities for QIN's children and community resulting in stronger interest in the field of Renewable Energy
- Sustainable low cost renewable energy resources

Above all we are focused on always being keepers of our land in appreciation of the abundant natural resources we have been blessed with.

Thanks to the Department of Energy's First Steps Toward Developing Renewable Energy & Energy Efficiency on Tribal Lands Program Grant, the Quinault Indian Nation is now ready to realize our Biomass for Heat and Energy strategic vision. Without the Department of Energy's continued assistance and support our Biomass Projects list below would have not been possible.

- QIN Renewable Energy Resource Identification and Assessment
- QIN Comprehensive Biomass Strategic Planning Project
- QIN Biomass Availability Inventory
- QIN Biomass for Heat Facility Engineering and Design
- QIN Pellet Manufacturing Feasibility Study

It is important to note that these projects were developed in parallel with our Comprehensive Biomass Strategic Planning Project and are direct results of our renewable energy strategies.

We now have a clear direction and plans for the utilization of woody biomass as a sustainable feedstock in support of our Biomass for Heat Facility as well as a QIN Pellet Manufacturing Facility. Both of these Facilities are a top priority and a construction funding strategy is in progress.

QIN Pellet Burn Test Results.

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com



*Professional
Analytical
Services*

ANALYSIS REPORT

Richmond Systems
8365 Hogum Bay Lane NE
Olympia, WA 98516
Attention: Stephen Richmond
PO Number: 122311
All results reported on an as received basis.

Date Received: 11/03/14
Date Reported: 11/16/14

AMTEST Identification Number 14-A017376
Client Identification 100% Nile Fiber
Sampling Date

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Ash	4.6	%			SM 2540G	KF	11/14/14
BTU	10300	BTU/lb				KF	11/14/14

AMTEST Identification Number 14-A017377
Client Identification 100% Wood
Sampling Date

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Ash	4.2	%			SM 2540G	KF	11/14/14
BTU	7100	BTU/lb				KF	11/14/14

AMTEST Identification Number 14-A017378
Client Identification 50/50
Sampling Date

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Ash	3.6	%			SM 2540G	KF	11/14/14
BTU	8420	BTU/lb				KF	11/14/14