Developing a Business Case for Sustainable Biomass Generation: A Regional Model for Western Montana

A Biomass Energy Feasibility Study
Prepared for: NorthWestern Energy

Project Report

June 1, 2010

Co-Sponsored by NorthWestern Energy &
Montana Community Development Corporation

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Acknowledgements

NorthWestern Energy was the original client for this study. The company hired the Montana Community Development Corporation (MCDC) as the principal contractor with funding from the Montana Department of Commerce (MDOC). Mr. Tom Kaiserski of the Montana Department of Commerce administered those funds. To fill a funding shortfall, MCDC became a partner as well as a contractor and raised additional funds to complete the study.

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List of Acronyms

$/BDT	Dollars per Bone Dry Ton
$/MWh	Dollars per Megawatt hour
ARRA	American Recovery and Reinvestment Act
BA	Balancing Authority
BACT	Best Available Control Technology
BDT	Bone Dry Ton
BDT/YR	Bone Dry Tons per Year
BLM	Bureau of Land Management
BMP	Best Management Practices
BPA	Bonneville Power Administration
C/D	Construction and Demolition Waste
CH4	Methane
CHP	Combined Heat and Power
CO	Carbon Monoxide
COOP	Rural Electric Cooperative Utility
CRE	Community Renewable Energy
CROP	Coordinated Resource Offering Protocol
DBH	Diameter at Breast Height
DOE	Department of Energy
EDA	Economic Development Administration
EWG	Exempt Wholesale Generator
FEC	Flathead Electric Cooperative
FERC	Federal Energy Regulatory Commission
FOB	Free On Board
GHG	Greenhouse Gas
GPM	Gallons Per Minute
GWP	Gas Warming Potential
HCs	Hydrocarbons
I-O	Input-Output Model
IMPLAN	Impact Analysis for Planning
ITC	Investment Tax Credit
IWW	Industrial Wood Waste
kWh	Kilowatt Hour
LCA	Life Cycle Assessment
MACRS	Modified Accelerated Cost Recovery System
MCDC	Montana Community Development Corporation
MDEQ	Montana Department of Environmental Quality
MDF	Medium Density Fiberboard
MEC	Missoula Electric Cooperative
Mid-C	Mid-Columbia
MMBTu	Million British Thermal Units
MPB	Mountain Pine Beetle
MSW	Municipal Solid Waste
MW	Megawatt
MWh	Megawatt Hour
NOx	Nitrogen Oxides
NWE	NorthWestern Energy
OSB	Oriented Strand Board
PM	Particulate Matter
PPA	Power Purchase Agreement
PPH	Pounds Per Hour
PSC	Public Service Commission
PSIG	Pounds Per Square Inch, Gauge
PTC	Production Tax Credit
PURPA	Public Utilities Regulatory Policies Act
QF	Qualifying Facility
REC	Renewable Energy Credit
RFP	Request For Proposal
RPS	Renewable Portfolio Standard
RUS	Rural Utilities Service
T-G	Turbine Generator
TREC	Tradable Renewable Energy Credit
USFS	United States Forest Service
VOC	Volatile Organic Compound

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CHAPTER 1 – EXECUTIVE SUMMARY

1.1 INTRODUCTION

This report explores the feasibility of developing sustainable, woody biomass-fueled Combined Heat and Power (CHP) plants at sawmills in western Montana to supply a portion of NorthWestern Energy's (NWE) required renewable energy portfolio. Participants in the study include NWE, led by the biomass coordinator who serves on the NWE power purchasing staff; seven Montana sawmills who provided detailed information on their mills' manufacturing and forestry operations; and Montana's major forest landowners, both public and private, who submitted data on the supply of woody biomass available to CHPs from Montana forests.

With this high-quality data and cooperation, the project study team analyzed all aspects of the feasibility of developing biomass energy at Montana sawmills. This Executive Summary briefly recaps the findings in each area of analysis, as well as the high-level recommendations for the next steps to be taken in this process.

The advantage of siting CHP plants at sawmills rather than developing large, stand-alone biomass power facilities is that sawmills offer: an existing industrial site, existing air and water permits; existing interconnection to the power grid; an industrial process heat demand; experience procuring and moving biomass; experienced boiler operators; and substantial volumes of on-site fuel. Finally, and very importantly, sawmill CHP plants can increase the long-term viability of Montana's sawmills by stabilizing the value of mill residues and providing mill owners with predictable income from the sale of renewable power.

NWE and the Montana Community Development Corporation are the co-sponsors of this report. They are grateful for funding from the following sources: Montana Department of Commerce through the 2009 Legislature's House Bill 645; U.S. Economic Development Administration; U.S. Endowment for Forestry and Communities; Montana Department of Environmental Quality, and F.H. Stoltze Land and Lumber Company.

1.2 KEY REPORT FINDINGS

1.2.1 Fuel Supply

Fuel volume is not a limiting factor to developing biomass energy at Montana sawmills. By utilizing only mill residues, logging slash from existing timber harvests, and diverted urban wood waste from landfills, enough fuel is produced annually in western Montana to supply a 15 to 20 megawatt (MW) CHP plant at each of the sawmill locations.

1.2.2 CHP Design and Technology

A boiler with a moving-grate, air-swept stoker system is appropriate for combusting woody biomass, and the technology is mature and proven. In addition, neither interconnection to the existing grid nor transmission appear to be significant obstacles to the development of sawmill CHP plants in western Montana.

1.2.3 Environmental Permitting and Regulatory Requirements

The environmental permitting will require that air quality be protected by using various technologies, which are detailed in the report. Water use at a typical plant will be 230 gallons per minute (GPM) for makeup water. In addition, the prototypical CHP plant will produce about 35 to 60 GPM of wastewater. Water supply at each site appears to be adequate to meet the needs of a CHP plant.

1.2.4 Markets for Power

A number of laws affect the market price of other power with which biomass power must compete. The Public Utilities Regulatory Policies Act requires utilities to purchase power from qualifying independent facilities at the utility’s avoided cost. Avoided cost is the incremental cost an electric utility avoids incurring by purchasing an equivalent amount of power from a Qualifying Facility. A facility only qualifies if the fuel used to generate the power is renewable or is waste derived. In Montana, the Public Service Commission (PSC) does the calculation of the utility’s avoided cost.

Subsequent laws also required public utilities and power marketing agencies to “wheel” power across their systems to other buyers, if requested. The cost of wheeling is regulated.

Finally, Montana instituted a Renewable Portfolio Standard (RPS) in 2005 that requires NWE to obtain 15 percent of its power from renewable sources by 2015. In addition, the RPS requires the utilities to purchase power from Community Renewable Energy projects of 25 MW or less capacity.

On the face of it, NWE’s current avoided cost level ($50-60 per MW) is too low to support the development of biomass CHP. Nevertheless the Montana RPS requires NWE to source 15 percent of its power from renewable sources by 2015 as well as buy 75 MW of power from Community Renewable Energy Projects. The conclusion of these seemingly conflicting standards is that the Montana Public Service Commission will ultimately weigh the value biomass energy to the state, and decide the purchase price that will be allowed.

1.2.5 Renewable Energy Incentive Programs and Project Financing

At $54 million in capital investment, the typical biomass energy plant is a large financing project by Montana standards and would require substantial financial strength and strong financial packaging expertise.

Numerous state and federal programs are available. There are state investment tax credits or a property tax reduction for renewable production facilities. At the federal level, an investment tax credit/production tax credit election is available. Also potentially available are a CHP Tax Credit, accelerated depreciation, and other federal grant/loan guarantee programs.

A typical financing model uses federal tax credits to provide 30 percent of the project equity. Other programs may be layered on to support project financing, including New Markets Tax Credits, Rural Utilities Service Loan Program, Local Revenue Bonds, Indian Energy Bonds, U.S. Department of Agriculture Loan Guarantee, U.S. Department of Energy Loan Guarantee, Site Lease to a Third Party Developer, Partnership with Purchasing Utility, and Prepayment for Power, as appropriate in each individual case.

1.2.6 Prototypical Montana biomass energy plant

The study team devised a prototypical sawmill CHP to give readers a sense of the issues and design considerations each Montana sawmill might face in developing biomass plants.

The key findings are that the size of the prototypical plant would be 18 MW and have a 150,000 pound per hour (PPH) boiler. Such a plant would require about 121,000 bone dry tons (BDT) of fuel annually. The plant would have a total capital cost of $53.6 million.

Fuel supply is not an obstacle, and the prototypical plant can operate on existing mill residues, logging slash and urban wood waste. No new fuels are needed from state or national forests. However, the potential availability of fuels taken directly from the forest would add flexibility to the fuel supply picture. The fuel supply analysis revealed that the prototypical plant would have a total of 153,200 BDT of fuel available within a 40 mile radius and 279,000 BDT of fuel available within a 70 mile radius. The average delivered cost of fuel from a combination of mill residues, logging slash, and urban wood waste was estimated to be $29.05 per BDT.

The financial analysis revealed that the CHP plant would have to sell power at a rate of $88 per megawatt hour (MWh) in order to provide the owner with a 12 percent return on the investment. The available financing and grant programs in a given location may reduce the required power sales price to as low $78 per MWh and still achieve the target return. Every $1.00 per BDT change in the average delivered cost of fuel changes the required power sales price by $0.80 per MWh to continue to achieve the target rate of return.

The environmental impact of biomass energy, compared to coal, is that it is less polluting than coal except for carbon monoxide levels and emits slightly higher levels of particulates. Biomass energy also emits lower levels of greenhouse gases than coal because the combustion of biomass is viewed as a nearly carbon neutral process. The air quality benefits of replacing coal power with one prototype biomass energy plant, cumulated per year, are estimated to be between $2.0 and $11.1 million, or between

$14 and $75 per MWh. Offsetting those economic benefits would be an estimated $5.6 million in increased annual cost to NWE for purchasing power when biomass is compared to the mid-Columbia (mid-C) power rate or an increased annual cost of $2.6 million when biomass is compared to wind power.

The economic impact of building and operating a single prototype biomass CHP plant is as follows: Construction of the plant would directly create 73 jobs and $7.3 million in wages paid annually. Construction would also create 76 indirect jobs, 67 induced jobs, with an estimated $2.0 million and $2.1 million in annual wages respectively. The ongoing operation of the plant would directly create 13 jobs and $2.3 million in wages paid annually. Ongoing plant operation would also create 17 indirect jobs and 13 induced jobs, with $1.15 million and $800,000 in annual wages respectively.

1.2.7 Co-Benefits of Biomass Energy

A dispersed biomass energy network provides a forest health co-benefit that is not recognized in the market value of biomass power. Montana is facing a forest health crisis that is most visible in the form of “red trees” affected by pine beetle infestation. The lack of markets for the woody biomass harvested when these areas are treated 1) creates very high treatment costs resulting in no or reduced treatments, and 2) means that biomass from treatments that do go forward is usually burned. This is true across state, federal and private ownerships.

Providing markets for biomass and unmerchantable trees reduces the open burning of slash in forest treatments, which greatly reduces air pollution. In addition, the economic value received for the woody material allows landowners to fund more extensive fuel reduction and forest health treatments. These treatments in turn reduce the potential for high severity fires and associated negative environmental and community impacts. They also reduce fire fighting costs, can help reduce wildfire size, and can limit the spread of insect and disease outbreaks.

In sum, biomass energy can help support a viable wood products industry that in turn supports markets for biomass that result, finally, in reasonable costs for healthy forest management and in better air quality when treatment occurs.

1.3 CONCLUSIONS AND RECOMMENDATIONS

This study demonstrated that a network of biomass CHP plants in Montana would allow NWE and other Montana utilities to meet their renewable and firm replacement energy goals. In terms of biomass supply and cost, available technology, interconnection and transmission, and environmental permitting, no major obstacles appear to exist to developing biomass CHP plants in Montana. The price of biomass power is somewhat high, but is in a range that may be acceptable considering the environmental and community benefits derived. The study also shows that project financing (at $54 million in capital costs) may be a daunting task for a typical plant.

Moving forward on biomass energy in Montana will require concerted and united efforts. Some of the actions recommended include:

- NWE's leadership can articulate a clear intention with regard to development of biomass energy as part of its RPS mandate in the state of Montana. This is an important signal for mill owners, investors and public entities to continue their efforts in this sector.
- Forest landowners (USDA Forest Service, MT DNRC, and others) can continue to play strong leadership roles in Montana's biomass power development. For instance they can articulate the potential of biomass power to provide a market for small diameter trees and woody biomass from forest health treatments. They also can provide staff members and project grants to maintain Montana's biomass energy effort. The expertise and funding provided by USDA Forest Service and Montana DNRC have been, and will continue to be, critical to biomass power development in Montana.
- The Montana PSC can begin to study the costs and benefits of biomass energy in Montana. As stated within this study, a key factor in whether Montana develops biomass energy is the PSC's ultimate attitude toward the cost to ratepayers. Since this study has brought a good understanding of probable rates, it is appropriate for the PSC to move this issue forward.
- Montana sawmill owners can use the information in this report, along with the site-specific mill studies provided to each sawmill, to make business decisions about proceeding with biomass CHP.
- Montana has multiple financing and incentive programs that can meet the complex biomass financing challenge. USDA Rural Development, Montana's state agencies, the Montana Community Development Corporation and others can work together to ensure that maximum financing resources are brought to bear on CHP projects in the state.
- The State of Montana can continue to make biomass energy a priority development initiative. With a clear biomass goal, the departments of Commerce, Environmental Quality and Natural Resources, along with the Governor's Office, should maintain strong communication and a common focus on key public objectives (forest health, energy diversity, strong local economies) for this sector. Clear articulation of these public objectives is essential as a guide to the private sector which will ultimately develop Montana's biomass energy future.
- Lawmakers can consider the role of existing and new legislation in creating a biomass energy sector in Montana that recognizes biomass energy's co-benefits to Montana's citizens. The Environmental Quality Council has provided strong leadership at this level and should continue providing direction.

CHAPTER 2 – INTRODUCTION & STUDY METHODOLOGY

2.1 INTRODUCTION

CHP is the practice of using heat to simultaneously generate power and supply a manufacturing process with thermal energy (heat). This report explores the feasibility of developing sustainable, biomass-fueled CHP plants at sawmills in western Montana. The major items addressed in the feasibility study include identifying the:

- Supply and cost of biomass fuel.
- Appropriate size and technology for western Montana sawmill CHP plants.
- Economics of CHP plants at western Montana sawmills.
- Possible obstacles to sawmill CHP plants (e.g., environmental permitting, water use, interconnection and transmission, and ash disposal).
- Available renewable power incentive programs.
- The potential markets for renewable power.
- Economic and environmental benefits of sawmill CHP plants.

A biomass CHP facility produces useable heat and electrical power through the combustion of wood fiber. More specifically, various materials, including bark, sawdust, planer shavings, pulp chips, logging slash, and urban wood waste, are combusted in a furnace. The walls of the furnace are lined with water filled pipes. As the biomass is combusted, the high pressure water in the pipes boils to steam. The steam is then heated to a higher temperature before exiting the boiler and entering the T-G. The T-G is a rotating multi-stage unit that drops the steam temperature and pressure at each stage as thermal energy is converted into mechanical energy and eventually electricity in the generator. In addition, steam is extracted from the T-G at the appropriate pressure for use in heating applications (i.e., heat for drying lumber).

Through the process just described, biomass fuel is converted into electricity and useful heat. Since the technology is proven and readily available, the key premise of this study is to show that NWE can work with Montana's forest products industry to create a network of distributed CHP facilities at sawmills across western Montana. If the premise proves feasible, the facilities will allow NWE to meet Montana's RPS and provide NWE with additional firm power generation capacity.

The key advantages of siting power generation facilities at western Montana's sawmills are:

- Much of the required biomass fuel for a CHP would already be at the site in the form of mill residues (bark, sawdust, planer shavings, and pulp chips). Thus, to the extent mill residues are used as fuel, transportation costs are minimized.

- Since sawmills are generally large consumers of electricity, much of the required infrastructure for interconnecting to the power grid and transmitting power are likely to already be in place.
- Historically, the market value of mill residues has been inconsistent and often very low. This has been the case even prior to the recent closure of the Smurfit Stone paper mill in Frenchtown. Adding CHPs at sawmills would create new markets for mill residues and allow the sawmills to stabilize the market value of their mill residues.
- Most sawmills kiln dry their lumber. Since the steam produced for power generation can also be used for lumber drying, the overall efficiency of a biomass energy facility is greatly increased when the steam is used for both power generation and process heat requirements.
- Large boiler installation projects require permitting and experienced operators. Dealing with such issues is likely to be less troublesome at sawmills since most already have existing permitted boilers and experienced boiler operators.

Despite the advantages just cited, historically, the cost of producing biomass-fueled power relative to the cost of fossil fuel and hydro generated power has been a stumbling block. However, this situation is changing with the advent of renewable portfolio standards, an associated appreciation in the value of renewable power, and with the introduction and continuation of government incentives for the development of renewable power. All of these factors have combined to increase the viability of biomass energy projects. Therefore, the objective of this study is to quantify biomass CHP opportunities at the seven sawmill sites listed in Table 1.

Table 1
List of Sawmills Participating in the Study

Sawmill Facility	Location
Eagle Stud Mill, Inc.	Hall, Montana
F.H. Stoltze Land and Lumber Co.	Columbia Falls, Montana
Pyramid Mountain Lumber, Inc.	Seeley Lake, Montana
RY Timber, Inc.	Livingston, Montana
RY Timber, Inc.	Townsend, Montana
Sun Mountain Lumber Company	Deer Lodge, Montana
Tricon Timber, LLC	St. Regis, Montana

Note: A brief description of each sawmill is included in Appendix 1

Of the seven sawmills participating in the study, five currently have small wood-fired (biomass) boilers that supply medium pressure steam to the respective mill’s lumber dry kilns. The two sawmills without boilers, air dry all of their lumber and expect to continue this practice. Several of the mills with boilers and dry kilns also air dry a portion of their lumber production since their boilers or dry kilns do not have the capacity to dry all of the lumber produced. The existing boilers operating at the five sawmills run the gamut from ancient, to undersized, to adequate. However, none are less than 40 years old. Thus, aside from generating energy, the mills are interested in CHP projects as a means of acquiring new boilers.

In addition to the seven sawmills, several additional organizations participated in the study as timberland owners who have fuel to supply to the prospective CHP plants. The organizations participating in this manner include Plum Creek Timber Company, Inc.; Stimson Lumber Company, Inc.; The Nature Conservancy; and The Blackfoot Challenge, The Montana Department of Natural Resources and Conservation, The United States Forest Service, The Bureau of Land Management, and The Salish and Kootenai Tribe.

2.2 STUDY METHODOLOGY

While a great deal of data used in developing the fuel supply and cost information is publicly available, several key pieces of information (mill residue volumes and values) were supplied by each of the mills participating in the study. That information is confidential. All parties involved in the study signed non-disclosure agreements to protect proprietary information. Thus, in order to utilize the confidential data and at the same time protect its source, the project team has prepared a “prototype” CHP plant and an associated “prototype” fuel supply and fuel cost scenario.

The prototype fuel scenario fairly represents the actual situation at the participating sawmills, but is specific to no single location. Likewise, the prototypical CHP plant modeled in this report fairly represents the characteristics of a prospective CHP plant at a Montana sawmill, but is specific to no single location. Each sawmill participating in the study was provided a separate project report that details the specific estimated fuel supply and cost at their location, as well as a specific CHP plant.

2.2.1 Fuel Supply and Cost

At each sawmill site, the potential fuel sources considered in this study included mill residues, logging slash within 40 and 70 mile radii, and urban wood waste within 40 and 70 mile radii. Accordingly, the project team collected data from each of the sawmills regarding the historic (5 year history) production of mill residues and their market value.

The team also collected data on historic and projected timber harvest levels, how those harvest volumes translate into logging slash volumes, and the current extent to which logging slash is utilized among various forest landowner groups. The team also collected data and made projections about the cost of collecting, processing, and transporting fuel directly from forest management treatments to the mills. The team used published sources to estimate the annual production of urban wood waste per capita. Finally, since the long-term viability of the sawmills is critical to insuring fuel supply and, ultimately, the survival of the CHP plants, the team also assessed the risk associated with the long-term viability of western Montana sawmills.

2.2.2 Power Plant Sizing

At each sawmill, the project team identified an appropriately sized boiler and turbine generator based on the amount and cost of fuel identified for that particular mill. Up to a certain point, larger plants provide greater economies of scale. However, building a plant so large that it requires the facility to transport fuel from great distances increases the fuel cost and destroys the efficiency gain from economy of scale. Given these dynamics, the sizing of the CHP plant is still somewhat subjective depending on the mill owner's risk tolerance to the amount of fuel not directly under their control (i.e., open market fuel).

The working assumption used for this study in the sizing of the plants was to model a boiler large enough to combust all of the mill residues should that be necessary (i.e., a situation where no markets are available, or markets exist, but with very low mill residue values).

While the CHPs would be large enough to burn all mill residues, that is not be the expected mode of operation. The mills expect to continue selling shavings, sawdust, bark and possibly pulp chips to traditional, higher value markets. It is anticipated that the CHPs would use hogged fuel, mill yard cleanup, urban wood waste, other low value mill residues, and logging slash as primary fuel sources. Through the addition of CHP plants, the overall objective at each sawmill is to create a floor under the value of mill residues without simultaneously creating a ceiling on those same values.

The project team also sought to avoid sizing the CHPs such that each mill would be reaching into overlapping supply areas. Thus, the CHPs were sized based on the amount of fuel associated with each mill's own annual supply of saw logs. Sizing the plants in this way, coupled with a flexible PPA explained in the section on power marketing, makes the facilities relatively low risk from a fueling standpoint – a must in today's world of project financing.

In addition to the plant sizing, the team also investigated state and federal regulatory issues and the required air, water, and wastewater permitting requirements associated with the development of CHPs.

2.2.3 Financial Analysis

Given the economically available fuel supply and the selection of an appropriately sized boiler and turbine-generator for each facility, the project team completed a financial analysis of a CHP at each facility. Accounted for in each financial analysis was:

- The capital cost for buying and constructing the required equipment, buildings, site preparation, etc.
- The operating costs associated with each CHP (i.e., fuel, labor, maintenance, utilities, ash handling/disposal, insurance, property taxes, supplies, depreciation, and administrative costs).
- The impact of state and federal renewable power incentive programs.

- The market value of power sold that would be required for the CHP to achieve a 12 percent after tax rate of return on the project (assuming 100 percent developer equity).

2.2.4 Regional Economic Impacts

An IMPLAN (IMpact analysis for PLANning) model was used to evaluate the regional economic impacts associated with construction and operation of a prototypical plant in Montana. The IMPLAN model is an Input-Output (I-O) Model, which includes data on the linkages between different industries and facilitates the estimation of total economic effects. Total economic effects include direct effects attributed to the activity being analyzed, as well as the additional indirect and induced effects resulting from money circulating throughout the economy. This is commonly referred to as the ‘ripple effect’. Because businesses within a local economy are linked together through the purchase and sales patterns of goods and services produced in the local area, an action that has a direct impact on one or more local industries is likely to have an indirect impact on many other businesses in the region.

To understand how an economy is affected by a new business such as the prototypical plant, it is necessary to understand how different sectors or industries in the economy are linked to each other. For example, the increase in construction activity will lead to increased spending for materials used in construction. Contractors will in turn purchase more materials from suppliers, which will in turn purchase more products from the manufacturers. Firms providing production inputs and support services to the construction industry would see a rise in their industry outputs as the demand for their products increases. These additional effects are known as the indirect economic impacts. As household income is affected by the changes in regional economic activity, additional impacts occur. The additional effects generated by changes in household spending are known as induced economic impacts.

Direct impacts were derived from the financial model of the prototypical plant, as well as construction cost estimates from Wellons Inc. and other specific operating assumptions developed by The Beck Group. These direct impacts were entered into the IMPLAN model to determine the estimate of indirect and induced impacts associated with construction and operation of a prototypical plant in Montana. Other impacts qualified in this section involve impacts to existing sawmill profitability, jobs and compensation; as well as impacts to the end rate payer of electricity.

2.2.5 Environmental Impacts

The environmental impacts associated with utilizing biomass as a feedstock for power generation were evaluated using a benefit-transfer methodology. The benefit-transfer method of economic valuation calculates the values of ecosystem services at a site based on results from existing economic valuation studies conducted elsewhere. In this analysis, the environmental benefits associated with utilizing biomass energy in Montana were estimated based on the results of the previous studies conducted across the U.S. The benefit-transfer method is efficient for obtaining values for environmental benefits, but is limited in the sense that values are not necessarily specific to Western Montana.

Several studies have been published in the last ten years that have contributed to the understanding of the overall environmental implications of using biomass as an energy source. Many of these studies have examined the environmental impacts using an LCA approach. An LCA takes into account the upstream processes involved in energy production. The studies used in the benefit-transfer methodology and referenced in this report include the following:

- Mann, Margaret and Pamela Spath, “Biomass Power and Conventional Fossil Systems with and without CO2 Sequestration – Comparing the Energy Balance, Greenhouse Gas Emissions and Economics,” National Renewable Energy Laboratory (NREL), Technical Report – 510-32575, January 2004.
- USDA Forest Service, Pacific Southwest Research Station, prepared for California Energy Commission – Public Interest Energy Research (PIER) Program, “Biomass to Energy: Forest Management for Wildfire Reduction, Energy Production, and Other Benefits,” CEC-500-2009-080, January 2010.
- Morris, Gregory, “The Value of the Benefits of U.S. Biomass Power,” Green Power Institute, NREL SR-570-27541, November 1999.
- Morris, Gregory, “Bioenergy and Greenhouse Gases,” Green Power Institute, May 2008.
- Spitzley, David and Gregory Keoleian, “Life Cycle Environmental and Economic Assessment of Willow Biomass Electricity: A Comparison with Other Renewable and Non-Renewable Sources,” Center for Sustainable Systems – University of Michigan, Report No. CSS04-05R, February 10, 2005.

CHAPTER 3 – FUEL SUPPLY

3.1 CHAPTER SUMMARY

The following fuel supply section describes the sources of biomass fuel considered in the study, the volume of fuel estimated to be available from those sources, and the estimated cost of delivering fuel from each source to a CHP plant.

The project team's key findings are that an estimated 826,000 BDT[1] of fuel are produced each year in western Montana from a combination of mill residues (423,700 BDT); logging slash (332,900 BDT); and urban wood waste (69,400 BDT). There is an additional estimated 253 million tons of standing small diameter and dead timber that could be used as fuel. Depending on the source, the cost of the fuel delivered to a CHP plant ranges from roughly $23 per BDT for urban wood waste to $28 per BDT for mill residues to $44 per BDT for nearby logging slash.

The conclusions that can be drawn from the fuel supply analysis findings are that:

- Fuel volume is not a limiting factor. By utilizing only mill residues, logging slash from existing timber harvests, and diverting urban wood waste from landfills, there is enough fuel produced annually in western Montana to supply a 15 to 20 MW CHP plant at each of the sawmill locations.
- To be able to secure project financing, the plants considered in this study were sized to be supplied with fuel from reliable, existing sources (mill residues, logging slash, and urban wood waste). However, fuel supply could be augmented by utilizing biomass sourced directly from the forest, including the salvage of fire and beetle killed timber or from thinning operations aimed at reducing fire hazard and improving forest health. If one million BDTs of biomass fuel were used each year, which is more than enough fuel for seven 18 MW prototype CHP plants, there is over a 250 year supply of standing small diameter and dead timber in western Montana. Utilizing "direct from the forest" fuel sources would have environmental and economic benefits that are described in Chapter 8.
- The sizing of the CHP plants was based on each plant utilizing about two-thirds mill residues and one-third logging slash and urban wood. To the extent that higher value markets are available for mill residues (e.g., feedstock for MDF, pellets, wood shavings, beauty bark etc.), sawmill managers are likely to substitute logging slash, urban wood waste, and fuel direct from the forest for mill residues.

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[1] A bone dry ton (BDT) is an amount of wood fiber weighing exactly one short ton (2,000 pounds) and containing zero moisture. In practice, biomass always contains some moisture. Biomass facilities take samples from incoming truckloads, measure the moisture content in the sample, and convert the truckload volume to bone dry tons. Measuring fuel this way eliminates weight variation caused by moisture content.

The following sections provide detailed information about the fuel supply.

3.2 BIOMASS FUEL SUPPLY AND COST

Since the size of a CHP plant is dictated by the amount of fuel available, the most fundamental aspect of any biomass fueled CHP project is assessing how much fuel is available and how much it will cost. Accordingly, the project team collected data about the amount of fuel available and the current market values of various fuel sources and then made projections about how much it would cost to deliver fuel to the prospective CHP sites.

As described in the methodology section of this report, the fuel supply and fuel cost information specific to each sawmill is confidential. The project team has chosen to deal with the confidentiality issue by modeling a prototypical CHP plant. In addition to the prototypical CHP plant, the team has developed an associated prototypical fuel supply and fuel cost estimate. Thus, the fuel volumes and fuel costs (except where noted) are not actual data from any specific location, but rather averages based on all locations.

Biomass fuel for use at CHP plants can come from a number of different sources including sawmill residues, logging residues, urban wood waste, and forest management treatments. The project team also briefly considered sourcing fuel from NWE right-of-way clearing projects. However, after discussions with NWE staff revealed the limited volume of material generated each year and the logistical challenges associated with the accumulation and transport of the material, that potential fuel source was not considered as part of the study.

The following sections describe the amount and cost of fuel that is estimated to be available from each of these sources.

3.2.1 Sawmill Residues

Sawmills are in the business of converting logs into lumber. As part of the lumber manufacturing process, a number of additional products are produced. The additional products are often lumped into a group called sawmill residues, which include the following specific materials:

> **Bark –** as a log is converted to lumber, the first step in the process is sending the log through a debarker (a machine that removes the bark from the log). All of the bark resulting from this process is collected.
>
> **Planer Shavings –** after lumber has been dried, it is planed to its final dimension in a planing mill. As a result of this process, shavings are produced and collected. Unlike bark, pulp chips, and sawdust, which tend to have high moisture content, planer shavings are relatively dry because they are typically produced after the lumber has been kiln dried.

Pulp Chips – as debarked logs enter a sawmill, they encounter either a chipper (a machine with rotating knives that typically chips away the outer edge of two sides of the log) or a head saw, which will cut slabs from the outer portion of the log. These slabs are then sent to a chipper. In addition, pulp chips are also produced at subsequent machine centers in the sawmill from the edge and length trimmings made on pieces of lumber. All pulp chips resulting from any of these processes are collected.

Sawdust – as logs encounter the primary and secondary breakdown saws in a sawmill, sawdust is produced. All of the sawdust is collected.

3.2.1.1 Traditional Uses of Sawmill Residues in Montana

While all of the mill residues just described can be used as boiler fuel, they also have other uses, many of which provide a higher return to the mill owner when they are sold to other users. Table 2 describes the traditional use of each sawmill residue in Montana.

Table 2
Montana Mill Residues and Uses

Mill Residue Type	Traditional Use in Montana
Pulp Chips	Pulp chips are typically the highest value mill residue. They are used as a feedstock in the manufacture of paper. In Montana, the majority of the state's sawmills shipped their pulp chips to the Smurfit Stone pulp mill in Frenchtown. Some pulp chips are also shipped to paper mills in ID, WA, or Southern BC.
Planer Shavings	The majority of the shavings produced at Montana sawmills are shipped to either Missoula or Columbia Falls for use as a feedstock in the manufacture of particleboard or MDF. Additional, but less common, uses in Montana include packaging the shavings for use as animal bedding and as a feedstock in the manufacture of wood pellets.
Sawdust	Sawdust is often used in the same applications as planer shavings. In addition, sawdust is often consumed internally at sawmills as boiler fuel.
Bark	Large bark pieces are typically sorted from smaller bark pieces. The large pieces are shipped to material contractors for use as landscaping/mulch. The fine pieces are most often consumed at the sawmill as boiler fuel.

With respect to Table 2, it is important to note that the Smurfit Stone paper mill in Frenchtown was permanently shut down on December 31, 2009. It was the only paper mill in Montana and consumed (on an annual basis) about 800,000 bone dry tons of wood fiber for paper manufacturing and 200,000 bone dry tons of mill residues for use in the paper mill's boilers.

The closure of the facility has obviously had a significant impact on the market value of mill residues and local economy. The closure of Smurfit Stone has been partially offset by both Roseburg Forest Products and Plum Creek using pulp chips as a feedstock at their respective Missoula particleboard and Columbia Falls MDF facilities. However, the market value of pulp chips for use in these applications is lower than their value as a paper manufacturing feedstock. In addition to the lower value, neither the particleboard nor MDF facility has the production capacity to consume the volume of pulp chips formerly consumed at the paper mill.

3.2.1.2 Mill Residue Volume and Value

The project team visited each sawmill participating in the study to collect information about the volume and value of the mill residues produced at each operation. The information collected was entered into a database that was used for assessing the feasibility of CHP at each individual mill.

To protect the confidentiality of individual mill information, the volumes shown in Table 3 are the average volumes of mill residues produced per mill, expressed in BDTs. Also shown is the average value of mill residues per mill, expressed in dollars per bone dry ton ($/BDT). In other words, the data in Table 3 is specific to no individual mill, but is representative of all the mills.

Table 3
Prototypical CHP Plant – Average Annual Mill Residue Production Volume (BDTs) and Average Mill Residue Value ($/BDT, f.o.b. Sawmill)

Residue Type	Volume (BDT)	Value ($/BDT)
Bark	9,900	13.50
Pulp Chips	38,700	37.50
Sawdust	16,200	20.50
Shavings	13,700	22.75
Miscellaneous	1,600	10.00
Total BDT / Weighted Average $/BDT	**80,100**	**28.02**

Several important points about the information shown Table 3 are:

- With respect to the calculation of the average volumes, both RY sawmills were lumped together. This is because RY does not need a boiler at either of its sawmill locations since all lumber is air-dried rather than kiln dried. As a result, it makes more economic sense for RY to build a single large plant at one of the RY mill sites rather than building two smaller plants at each mill. In addition, the

Eagle Stud Mill was excluded from the calculation of the average because it is much smaller than the other mills included in the study.

- The project team collected annual production volumes at each mill for each mill residue type for each of the last five years. That annual mill residue production data was used to develop the volumes. Using production levels averaged over a five year time period dampens the effect of production variations due to lumber market fluctuations, log supply shortages, mill upsets, etc.
- The miscellaneous category includes a mixture of material (bark, broken logs, etc.) recovered from sawmill log yards, and miscellaneous mixtures of bark and sawdust.
- The values shown represent market values after the closure of Smurfit Stone. Depending on the location of the sawmill, the value of pulp chips after Smurfit Stone's closure dropped by $20 to $40 per bone dry ton.
- Each sawmill (except for RY Timber) burns in its existing boiler an amount of bark, sawdust, or both that is roughly equal to its annual bark production. Thus, in the prototypical mill, about 9,900 BDT of fuel is being consumed annually in the existing boiler. Since a new CHP plant would eliminate the need for the old boiler at each sawmill, the 9,900 tons of fuel would either be burned in the new CHP plant or sold to higher value markets if such markets exist.

3.2.1.3 Total Mill Residue Supply

In addition to displaying the mill residue information on an "average per mill" basis as shown in the previous section, Table 4 displays mill residue volumes as totals among the seven mills participating in the study.

Table 4
Western Montana – Total Annual Mill Residue Production Volumes by the Seven Participating Sawmills (BDT)

Residue Type	Volume (BDT)
Bark	51,800
Pulp Chips	202,900
Sawdust	86,300
Shavings	72,400
Miscellaneous	10,300
Total	**423,700**

Note that the volumes shown in Table 4 include the annual production of the Eagle Stud Mill in Hall. However, portions of the mill have not been operating since 2007.

According to mill management, the mill will resume operations if warranted by improvements in the lumber market.

3.2.2 Logging Slash

A second key source of fuel for the prospective network of sawmill CHP plants is logging slash recovered from timber harvesting operations. In recent years, this source has become an increasingly important factor in the biomass fuel supply equation as weak lumber markets have curtailed sawmill production, which, in turn, has reduced the availability of traditional hog fuel (bark and sawdust).

Figure 1

Logging Slash – during timber harvesting operations, a common practice is to fell trees and then yard them to a landing as a whole tree (i.e., with the limbs and top intact). Once at the landing, the tree is processed into logs, which means removing the limbs and cutting the logs to length. As a result of these processes, the limbs and tops accumulate on the landing (see photo to left). Much of this material is currently burned on the landing, but could also be recovered for use as fuel in CHP boilers.

3.2.2.1 <u>Logging Slash Utilization Factors</u>

A number of factors affect the available supply of logging slash. First, timberland ownership and annual timber harvest volumes directly impact the volume of logging slash. Second, the type of logging equipment used affects the amount of logging slash produced. Third, the size of log landings impacts the amount of slash that can be accumulated and the ability of grinding equipment and trucks to operate. Fourth, logging roads are generally built to accommodate more ruggedly built log trucks rather than chip vans. This is important because chip vans have proven to be the most economical method for hauling processed logging slash. The following sections describe each of these factors as they apply in western Montana.

3.2.2.2 <u>Land Ownership</u>

Perhaps the most important of the preceding factors is that different types of landowners have different management objectives for their respective properties. Therefore, it is important to understand who owns the timber in the region. The project team used USDA Forest Service, Forest Inventory and Analysis National Program data to assess timberland ownership in a 25 county region in western Montana. The area covered by the 25 counties fall within either a 40 mile or 70 mile radius of the seven sawmills locations being considered as part of this study. The counties included in the analysis are listed in Table 5 and mapped in Figure 2.

Table 5
25 Counties in Western Montana Included in the Land Ownership Analysis

Beaverhead	Broadwater	Carbon	Cascade	Deer Lodge
Flathead	Gallatin	Granite	Jefferson	Judith Basin
Lake	Lewis And Clark	Lincoln	Madison	Meagher
Mineral	Missoula	Park	Powell	Ravalli
Sanders	Silver Bow	Stillwater	Sweet Grass	Wheatland

Figure 2
Western Montana Map – 25 County Study Area

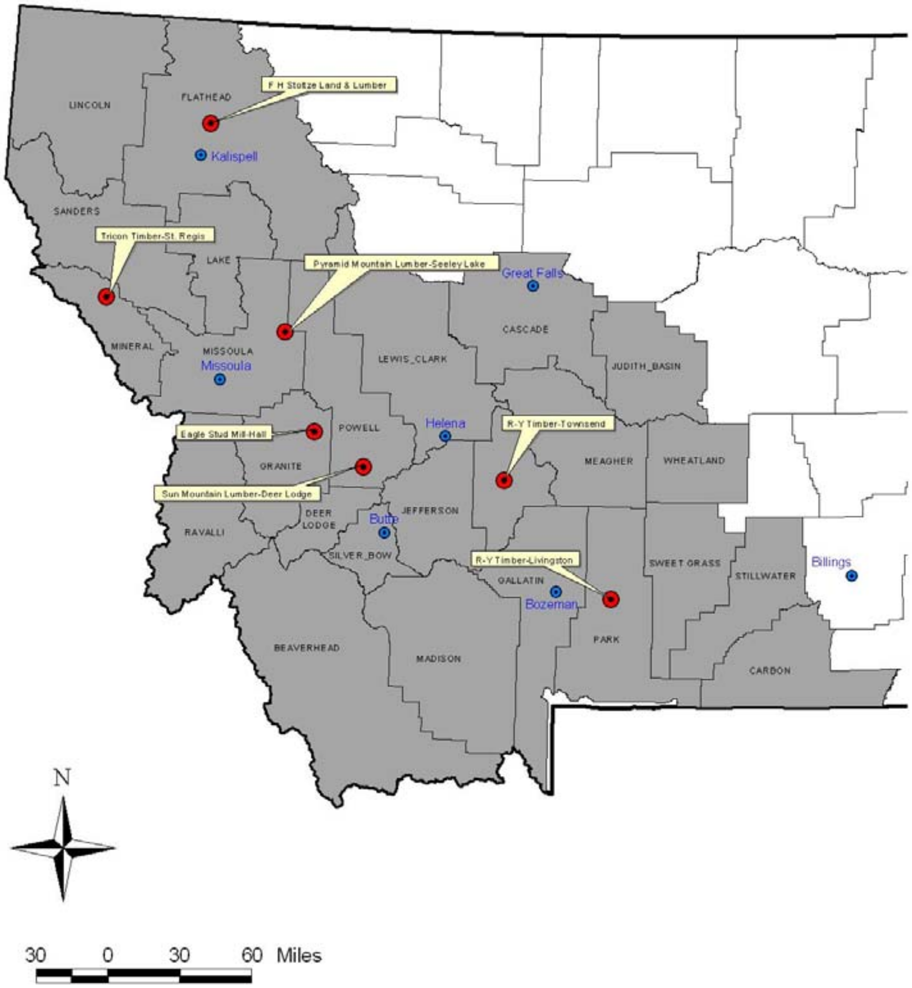


Table 6 shows the total acres of timberland found in the 25 counties in western Montana by major ownership group. In addition, Table 6 shows the volume of standing timber (millions of cubic feet) by major landowner group. Timberland is defined as forested land that is capable of producing crops of industrial wood at a rate of at least 20 cubic feet per acre per year and has not been withdrawn from timber utilization designation, and is not associated with urban or rural development.

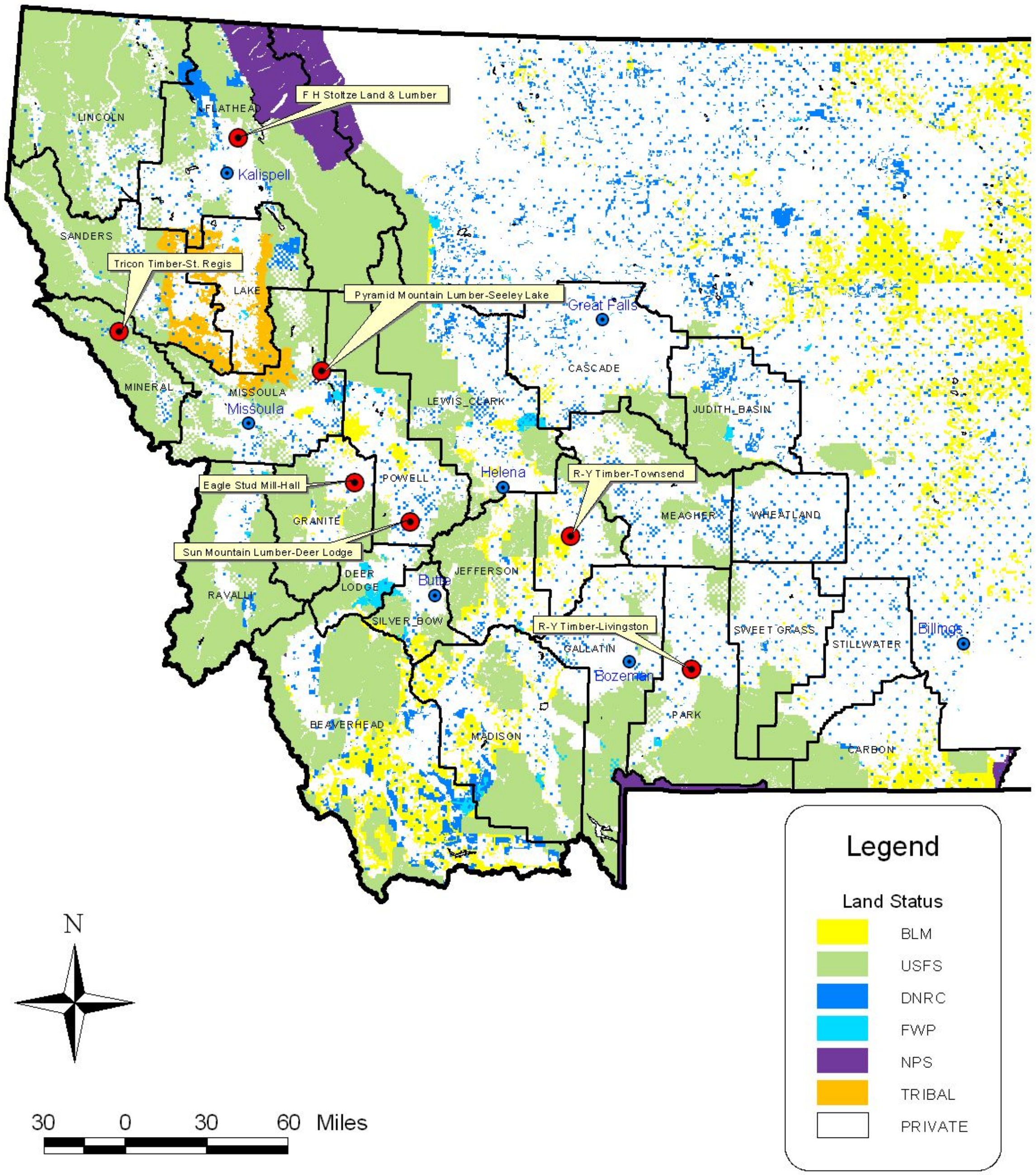
Table 6
Timberland Acres and Volume of Standing Timber by Major Landowner Group in 25 Western Montana Counties

	Acres of Timberland	Percent of Acres	Volume of Standing Timber (cubic feet, millions)	Percent of Volume
National Forest	11,417,278	68	26,918	79
Bureau of Land Management	517,997	3	1,010	3
State	692,226	4	1,273	4
Local Government	11,910	0	2	0
Private	4,215,681	25	4,735	14
Total	16,843,182	100	33,938	100

As shown in Table 6, over 70 percent of the timberland acres in western Montana are under control of the federal government (BLM and USFS). Moreover, when ownership is considered on the basis of standing timber volume, over 80 percent is under control of the federal government. This is important because over the last several decades, the level of active management in national forests has declined significantly. For example, in 1987, the annual timber harvest in Montana from federal lands was just over 600 million board feet (Scribner log scale). Since that time, harvests from federal lands have dropped steadily. In 2008, approximately 60 million board feet (Scribner log scale) of timber was harvested in Montana from federal lands, a 90 percent drop from the 1987 level. Harvest levels on State owned lands have held steady at about 50 million board feet (Scribner log scale) per year.

Over the same time period, harvest levels on privately owned timberlands have also declined, but to a lesser extent than harvests on federal lands. The annual private harvest declined from roughly 700 million board feet (Scribner log scale) in 1987 to about 325 million board feet in 2008 (Scribner log scale). It is unclear whether the declining private harvest is a function of poor market conditions or limited supply. Finally, approximately 30 percent of the privately owned timberland in the 25 counties is owned by industrial owners (e.g., Plum Creek, Stimson, and Stoltze). Figure 3 on the following page is a map sowing timberland ownership in western Montana.

Figure 3
Western Montana Timberland Ownership Map



Note: This map does not reflect the recent timberland transaction between Plum Creek and The Nature Conservancy

3.2.2.3 Other Factors

Regarding the other factors that affect the utilization of logging slash (logging equipment, landing size and road systems), the project team interviewed foresters and logging contractors currently operating in the region to better understand how these factors are managed. The interviews revealed that approximately 75 percent of the logging systems used in western Montana are such that logging slash accumulates on landings (i.e., whole-tree harvesting).

In addition, it was discovered that while there are practices that can be used to recover more logging slash (i.e., using smaller trucks to shuttle logging slash from inaccessible and inoperable areas to a centralized location that is both accessible and operable), in actual practice, few of the grinding contractors use such practices. Instead, the most easily accessible material is what is currently utilized. The project team accounted for the limited ability to recover logging slash by factoring down the “theoretically” available amount to a “practically recoverable” amount.

3.2.2.4 Logging Slash Estimated Volume and Cost

The project team contacted officials at the U.S. Forest Service, the Salish and Kootenai Tribe, the Montana DNRC, and the Bureau of Land Management to obtain information about planned timber harvests in both 40 mile and 70 mile radii around each sawmill site. The Salish and Kootenai Tribe, MT DNRC, and the BLM provided documentation showing planned timber harvests for each of the next three years within each working circle. The project team averaged the volume harvested within each circle. It was assumed that harvest levels beyond the current three year planning cycle will be consistent with the currently planned harvest levels.

The USFS directed the project team to the CROP system. CROP is a tool meant to facilitate coordination of biomass removal projects among public agencies. Through CROP, it is possible to collect data on planned timber harvests for the next five year period. The project team collected this data to project the planned harvests on USFS managed lands within each working circle.

Regarding private timber harvests, it is more difficult to project future timber harvests because there are numerous owners and, unlike some public agencies that are programmed to harvest certain levels of timber each year, private landowners are much more responsive to timber market conditions. When timber prices rise, private landowners typically harvest greater volumes of timber. Given this situation, the project team used the average annual private timber harvest over the last 5 years as an estimate of future timber harvest levels on private timberlands.

After collecting all of the projected (or historic) timber harvests from each ownership type, the project team used a factor of 1.1 bone dry tons of logging slash per thousand board feet (Scribner log scale) of timber harvested. The factor is from Morgan's[2] forest biomass assessment in Montana. It is also consistent with timber to slash ratios observed in other regions. This calculation resulted in the "theoretically available" volume of logging slash. That amount was then factored down by 57 percent to arrive at a "practically recoverable" volume. The factor applied to move from the theoretically available volume to the practically available volume was based on the experience of foresters and grinding contractors currently operating in western Montana.

Finally, the project team also evaluated the volume of logging slash using a second approach, which was using the assumption that only logging slash from the volume of logs used to supply an individual mill would be available. In this way, double counting of logging slash from places where the 40 or 70 mile working circles overlap is eliminated.

Table 7 shows the amount of logging slash (BDT) that is estimated to be available at the prototypical CHP plant under the 40 mile, 70 mile, and "own logs" scenarios. The values shown are averages calculated on the basis of the amount available to each sawmill participating in the study. Like the mill residue estimates, Eagle Stud was excluded from the calculation of the averages and the two RY Timber sawmills were considered as a single location.

Table 7
Prototypical CHP Plant – Estimated Practically Available Volumes of Logging Slash (BDT) and Estimated Averaged Delivered to the Plant Cost ($/BDT)

Logging Slash Supply Source	Estimated Volume (BDT)	Average Delivered Cost ($/BDT)
Estimated practically available slash 40 mile radius	61,600	43.47
Estimated practically available slash 70 mile radius	167,700	50.97
Estimated practically available slash from own sawlog usage	28,000	43.47

As shown in Table 7, a significant volume of logging slash is estimated to be practically available within both the 40 mile and 70 mile working circles around each sawmill. In addition, there is still a significant volume available when the supply is considered on the more conservative basis of material available from only the logs needed to supply the mill.

Regarding the delivered cost of the material, the costs shown are the average delivered to the plant costs of logging slash given the following assumptions:

- Only logging slash accumulated at log landings is processed. No attempt is made to collect logging slash scattered across timber harvest units.

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[2] An Assessment of Forest-based Woody Biomass Supply and Use in Montana. April 2009. Todd Morgan, Director, Forest Industry Research, Bureau of Business and Economic Research, University of Montana.

- Transportation costs were weighted by the volume of material likely to come from successively larger working circles (10 mile increments).
- The average moisture content of logging slash is 45 percent (i.e., 45 percent wet, 55 percent dry).

3.2.2.5 Logging Slash Cost Sensitivity

The delivered cost of logging slash is sensitive to several key factors, including the moisture content of the material and the cost of diesel fuel. Table 8 shows how the average delivered cost of logging slash is impacted by changes in these variables.

Table 8
Logging Slash Delivered to CHP Plant Cost
Sensitivity at Various Average Moisture Contents

	35 Percent MC	45 Percent MC (Base Case)	55 Percent MC
40 Mile Radius	36.94	43.47	52.91
70 Mile Radius	43.28	50.97	62.07

As shown in Table 8, the delivered cost is heavily impacted by the average moisture content of the logging slash. CHP plant managers and logging contractors can manage logging slash moisture levels through good planning. In other words, grinding operations need to be well coordinated with timber harvesting operations so that the logging slash has time to "season" on the landing before it is ground. According to grinding contractors currently operating in Montana, it is possible for logging slash to average between 35 and 40 percent moisture content (year round basis) when good planning is used.

Note from Table 9 that the impact of diesel fuel price increases are greater when the fuel is at higher moisture content.

Table 9
Price Sensitivity to Fuel Cost – Delivered to the CHP Plant Prices for Logging Slash at Various Moisture Contents, Hauling Distances, and Fuel Costs ($/BDT)

	Cost When Average MC of Logging Slash = 35 Percent		
Diesel Cost ($/gallon)	2.70	3.50	4.50
Average Delivered Cost, 40 Mile Radius ($/BDT)	36.94	37.95	39.21
Average Delivered Cost, 70 Mile Radius ($/BDT)	43.28	44.46	45.93
	Cost When Average MC of Logging Slash = 45 Percent		
Diesel Cost ($/gallon)	2.70	3.50	4.50
Average Delivered Cost, 40 Mile Radius ($/BDT)	43.47	44.66	46.15
Average Delivered Cost, 70 Mile Radius ($/BDT)	50.97	52.36	54.10
	Cost When Average MC of Logging Slash = 55 Percent		
Diesel Cost ($/gallon)	2.70	3.50	4.50
Average Delivered Cost, 40 Mile Radius ($/BDT)	52.91	54.37	56.18
Average Delivered Cost, 70 Mile Radius ($/BDT)	62.07	63.77	65.89

3.2.2.6 Region-Wide Volume of Logging Slash

In addition to estimating the logging slash volume at the prototypical plant, the region-wide volume of logging slash was also estimated. As shown in Table 10, there is an estimated 332,900 bone dry tons of logging slash produced in the 25 county western Montana region each year, given projected timber harvest levels. It is important to note that the total shown is the “practically available” volume of logging slash. Because of practical and economic constraints, not all of the logging slash produced each year can be recovered. The total amount of logging slash produced annually is roughly double the amount shown in the table.

Given the recent, poor lumber markets and decreased timber program on USFS lands, annual timber harvests are at historically low levels in western Montana. Improved lumber markets or changes in federal land management policy would likely result in increased timber harvests, which, in turn, would lead to increased volumes of logging slash. On the other hand, in recent years a number of Montana sawmills have permanently shut down. If that trend continues, it is likely that timber harvests in Montana will continue to decline because there will be fewer mills operating in the region that can use the material. Sawmill viability is discussed in greater detail in the Sawmill Viability Assessment Section.

Table 10
Practically Available Volume of Logging Slash Across a 25 County Area in Western Montana

	Practically Available Volume of Logging Slash (BDT)
Total	**332,900**

3.2.3 Urban Wood Waste

Urban wood waste was another fuel source examined. It can be divided into three categories:

1) **Municipal Solid Waste –** refers to the range of material collected by public and private trash hauling services in metropolitan areas. Yard trimmings and miscellaneous waste wood typically make up about 25 percent of MSW. While most MSW is destined for a landfill, some regions sort MSW for recycling. The wood material recovered from the sorting can be used for a number of applications including use as hog fuel, mulch, or combining the material with biosolids from wastewater plants to make compost. A study by Wiltsee[3] found that across U.S. metropolitan areas the average amount of wood waste in the MSW stream is 0.21 bone dry tons per person per year.
2) **Industrial Wood Waste –** is material such as wood scraps from pallet recycling, wood working shops and lumber yards. The Wiltsee study found that this material is produced on average at a rate of 0.05 bone dry tons per person per year.
3) **Construction and Demolition Waste –** is wood waste produced during the construction and demolition of buildings and from land clearing associated with new construction. The Wiltsee study found that this material is produced at an average rate of 0.08 bone dry tons per person per year.

According to urban foresters and MDEQ officials, very little urban wood waste is currently recycled or otherwise diverted from landfills in western Montana. Thus, the development of the prospective CHP plants represents an opportunity to begin utilizing urban wood waste. While this largely unutilized resource represents an opportunity, the required infrastructure for collecting and processing the material would likely take time to develop. For this reason, the project team first estimated the volume of urban wood waste produced in western Montana using U.S. Census population data by county and the per capita waste production rates cited on the preceding page. It was then assumed only one-third of the estimated total would actually be utilized.

Table 11 shows the total estimated volume and the discounted volume (i.e., the amount likely to be utilized) at the prototypical mill. The volume estimate is for the prototype

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[3] Urban Wood Waste Resource Assessment. G. Wiltsee. November, 1998.

CHP plant (i.e., the average amount of urban wood waste estimated to be available at each of the sawmills participating in the study). Regarding the estimated costs shown in Table 11, the project team assumed that since this material is largely unutilized at the current time the cost should be based on the cost of collecting, processing, and transporting this material as opposed to valuing the material based on market supply and demand conditions.

Table 11
Prototype CHP Plant – Estimated Volume (BDT) and Value ($/BDT) of Urban Wood Waste

40 Mile Radius			
Urban Wood Waste Type	**Total Annual Volume (BDT)**	**Estimated Utilized Volume (BDT)**	**Estimated Cost ($/BDT)**
MSW – Wood Waste	27,900	6,970	22.67
Industrial Wood Waste	7,000	1,742	22.67
Construction and Demolition	11,200	2,788	22.67
Total	**46,100**	**11,500**	**22.67**

70 Mile Radius			
Urban Wood Waste Type	**Total Annual Volume (BDT)**	**Estimated Utilized Volume (BDT)**	**Estimated Cost ($/BDT)**
MSW – Wood Waste	76,600	19,200	28.22
Industrial Wood Waste	19,200	4,800	28.22
Construction and Demolition	30,600	7,600	28.22
Total	**126,400**	**31,600**	**28.22**

3.2.3.1 Region-Wide Volume of Urban Wood Waste

The figures in Table 11 can be misleading, especially in the 70 mile radius section. This is because the supply areas overlap. Thus, there is "double counting" of the material. Therefore, the project team also estimated the total amount of urban wood waste generated on a region wide basis. Like the volume estimates shown for the prototypical plant, the project team estimated both the total amount of urban wood waste produced in the region and the volume that is likely to be utilized.

The project team cross checked the estimates shown in Table 12 with personnel at the MDEQ. According to MDEQ, the entire State of Montana disposed of 1.3 million tons of waste in landfills in 2009, which is down from a longer term average of about 1.5 million tons annually. Although strict records are not maintained about the composition of the material entering the landfills, MDEQ estimates that about 30 percent of the waste entering Montana landfills is urban wood waste. Thus, on an annual statewide basis, about 390,000 tons (1.3 million x 30 percent) of urban wood waste is generated. Since the volumes shown in Table 12 represent only 25 counties, the estimates appear reasonable.

Table 12
Western Montana – Estimated Volume of Urban Wood Waste produced Annually (BDT)

Urban Wood Waste Type	Total Annual Volume (BDT)	Estimated Utilizable Volume (BDT)
MSW – Wood Waste	127,600	42,100
Industrial Wood Waste	31,900	10,500
Construction and Demolition	51,000	16,800
Total	**210,500**	**69,400**

3.2.4 Biomass Supply from Forest Management Treatments

The ability to utilize otherwise unmerchantable small diameter, dead, and damaged timber (i.e., wildfire hazard reduction treatments and salvage of diseased and dead timber, see figure 4) is a key benefit often cited with respect to the development of a biomass fueled CHP plant.

Figure 4
Example of Beetle Killed Timber

The Montana Department of Natural Resources and Conservation, Forestry Division, in conjunction with the USDA Forest Service, State and Private Forestry Program, conducted an aerial survey of approximately 27.9 million acres in Montana between June and September 2009. As a result of the survey, it was determined that the mountain pine beetle epidemic continues to grow. It is estimated that the mountain pine beetle has now infested slightly more than 2.7 million acres, which is up from the 2008 total of 1.5 million acres.

The beetles initially attacked pure stands of lodgepole pine. However, last year it was noted that the beetles had attacked Ponderosa pine stands as well, especially around Helena. It was also observed that the beetles had moved into previously uninfested areas, including acres on the western Deer Lodge, Beaverhead, Lewis and Clark, southern Flathead, western parts of the Lolo and Gallatin National Forests. The area with the highest concentration of mountain pine beetle infestation is the west-central portion of the state.

As shown in Table 13, there is estimated to be over 6.1 billion standing live trees in the 25-county region (all landowner types). This translates into nearly 500 million bone dry tons of biomass. Nearly 30 percent of that volume (147.6 million bone dry tons) is comprised of trees less than 9.0 inches in DBH. Clearly, there is a tremendous volume of biomass present in the region. Consider, for example, that if all seven of the sawmills used a combined 500,000 bone dry tons from this fuel source annually (~71,400 BDT/mill), they would consume only 0.34 percent of the standing trees less than 9.0 inches in diameter and 0.10 percent of all standing trees. In other words, at an annual usage rate of 500,000 BDT, there is a 294 year supply of standing live trees that are less than 9.0 inches in diameter at breast height.

Table 13
Western Montana – Estimated Tree Count and Volume of Standing Live Trees

Tree DBH Class (inches)	live trees (000,000's)	Percent of Total (tree count basis)	Bone Dry Tons (000's)	Percent of Total (weight basis)	Cumulative Percent of total (weight basis)
1.0 - 2.9	2,771	45.1	13,856	2.8	2.8
3.0 - 4.9	1,236	20.1	25,949	5.2	8.0
5.0 - 6.9	793	12.9	46,001	9.2	17.2
7.0 - 8.9	543	8.8	61,861	12.4	29.6
9.0 - 10.9	332	5.4	64,992	13.0	42.6
11.0 - 12.9	195	3.2	60,004	12.0	54.6
13.0 - 14.9	116	1.9	52,151	10.4	65.0
15.0 - 16.9	64	1.0	38,881	7.8	72.8
17.0 - 18.9	40	0.7	32,387	6.5	79.3
19.0 - 20.9	23	0.4	23,664	4.7	84.1
21.0 - 28.9	31	0.5	61,283	12.3	96.3
29.0 +	6	0.1	18,336	3.7	100.0
Total	**6,150**	**100.0**	**499,365**	**100.0**	

In addition to the standing live trees, significant volumes of standing dead trees can be found in the 25-county region (all landowner types). Table 14 displays the estimated number of standing dead trees and bone dry tons grouped by diameter class. As shown in Table 14, there is an estimated 486 million standing dead trees in the region, which translates to 106 million bone dry tons.

The trees harvested during such treatments are typically either dead and therefore, may be of no use for lumber production, or too small for use as sawlogs. In addition, businesses that use small diameter trees (e.g., posts & poles and pulpwood) either do not consume large volumes or are out of business (Smurfit Stone). As a result, one of the only remaining significant potential uses for this material in western Montana is fuel.

Table 14
Western Montana – Estimated Tree Count and Volume of Standing Dead Trees

Tree DBH Class (inches)	Dead Trees	Bone Dry Tons	Percent of Total
5.0 - 6.9	184,271,078	10,687,723	10.1
7.0 - 8.9	122,137,831	13,923,713	13.1
9.0 - 10.9	73,797,165	14,464,244	13.7
11.0 - 12.9	42,853,032	13,198,734	12.5
13.0 - 14.9	25,017,681	11,207,921	10.6
15.0 - 16.9	15,153,548	9,258,818	8.7
17.0 - 18.9	8,118,294	6,535,227	6.2
19.0 - 20.9	5,755,557	5,933,979	5.6
21.0 - 28.9	7,986,843	15,813,949	14.9
29.0 +	1,495,519	4,905,302	4.6
Total	**486,586,548**	**105,929,610**	**100.0**

With respect to standing live and dead trees in the 25 county western Montana region, clearly supply is not a limiting factor. However, cost and availability are factors that must be considered.

Only the small diameter and standing dead trees are likely to be utilized for fuel. Table 15 shows the estimated volume of stand timber in the region from trees less than 9 inches in diameter at breast height and all standing dead trees.

Table 15
Estimated Volume of Standing Live and Dead Trees in 25 Counties in Western Montana (DBH = Tree Diameter at Breast Height)

	Number of Trees (Billions)	Bone Dry Tons (Millions)
Standing Live (< 9.0” DBH)	5.343	147.7
Standing Dead (all DBH size classes)	0.487	106.0
Total	**5.830**	**253.7**

As shown in Table 15, there are an estimated 253.7 million bone dry tons of standing trees that are either standing dead or are small diameter. The recent MPB epidemic is causing the standing dead portion to increase rapidly. Clearly forest management treatments aimed at utilizing even a very small fraction of this material could yield large volumes of fuel. **However, this potential fuel source was not included for the purpose of sizing the CHP plants.**

In today's financial climate, project financiers require highly stable and secure fuel supplies in order to finance a biomass CHP project. Nearly 80 percent of the standing biomass in western Montana is located on federally owned land. Given the long-term decline in active forest management on federally owned land, biomass fuel from forest management treatments is too unreliable to be used as a primary fuel source to secure project financing.

Despite the fact that this material was not considered for the purpose of sizing the prototype plant, this material, when available at an economical price, could be used as fuel at a CHP plant. This is an important factor in the context of landowners and forest managers being able to proactively address the recent mountain pine beetle epidemic in Montana. The cost of this material is highly dependent on the average size of the trees being treated. The main report contains information about the cost of this material.

3.2.5 Cost of Forest Treatment Fuel

Regarding the cost of material from forest management treatments, it depends heavily on the average diameter of the trees being harvested. The smaller the trees, the more expensive they are to harvest and process. The range of estimated costs ($/BDT, delivered to the CHP plant) are shown in Table 16.

Table 16
Range of Estimated Costs for Harvesting, Processing, and Delivering Fuel to a CHP Plant from Forest Management Treatments

Average Stand DBH (inches)	40 mile ($/BDT)	70 mile ($/BDT)
4	147	156
5	103	111
6	69	78
7	55	64
8	50	58
9	46	54
10	44	52

The costs in Table 16 were developed using the U.S. Forest Service's Fuel Reduction Cost Simulator, a spreadsheet tool for estimating the cost of treating small diameter timber. The key assumptions associated with the analysis were: use of ground based mechanical harvesting equipment (swing boom feller buncher & skidder), 800 foot average skidding distance, and partial cut (thinning).

3.3 SAWMILL VIABILITY ASSESSMENT

The mill residues produced at a sawmill are the foundation of the fuel supply for the biomass CHP plants considered in this study. While other fuel sources exist, it is important to understand the long-term viability of the sawmills as a risk factor in fueling the prospective CHP plants. Accordingly, this section analyzes the competitive factors affecting western Montana sawmills.

3.3.1 Comparison of Western Montana Sawmills with Other Regions

The western Montana forest industry is a part of the Inland West Region (for industry classification and reporting purposes), which also includes the states of Idaho, Arizona, Utah, Wyoming, Colorado, and South Dakota, as well as Eastern Washington and Eastern Oregon and parts of Northern California. This region is characterized by a multitude of tree species – many more than other timber producing regions – which complicates manufacturing and marketing since each species has particular end uses and product lines for which it is best suited. Therefore, specialized manufacturing operations and more complex marketing and distribution are required in the Inland West than in other regions. However, some of the species, such as Ponderosa Pine, are among the most valuable softwood species in North America, which provides both the timberland owners and manufacturing companies relatively high returns for these species.

In addition, the region has a shorter growing season and less precipitation than some other regions (e.g., U.S. West Coast, U.S. South) and, as a result, annual timber growth per acre (Table 17) is lower than in some other regions and harvest rotations are longer than in some other regions (Table 18).

Table 17
Timberland Productivity by Region –
Softwood Net Annual Growth* per Acre (Cubic Feet)

Region	Softwood CF/AC
Northeast	8.4
North Central	3.3
Southeast	36.5
South Central	28.6
Intermountain	27.4
Pacific Northwest	69.0
Montana	**29.7**

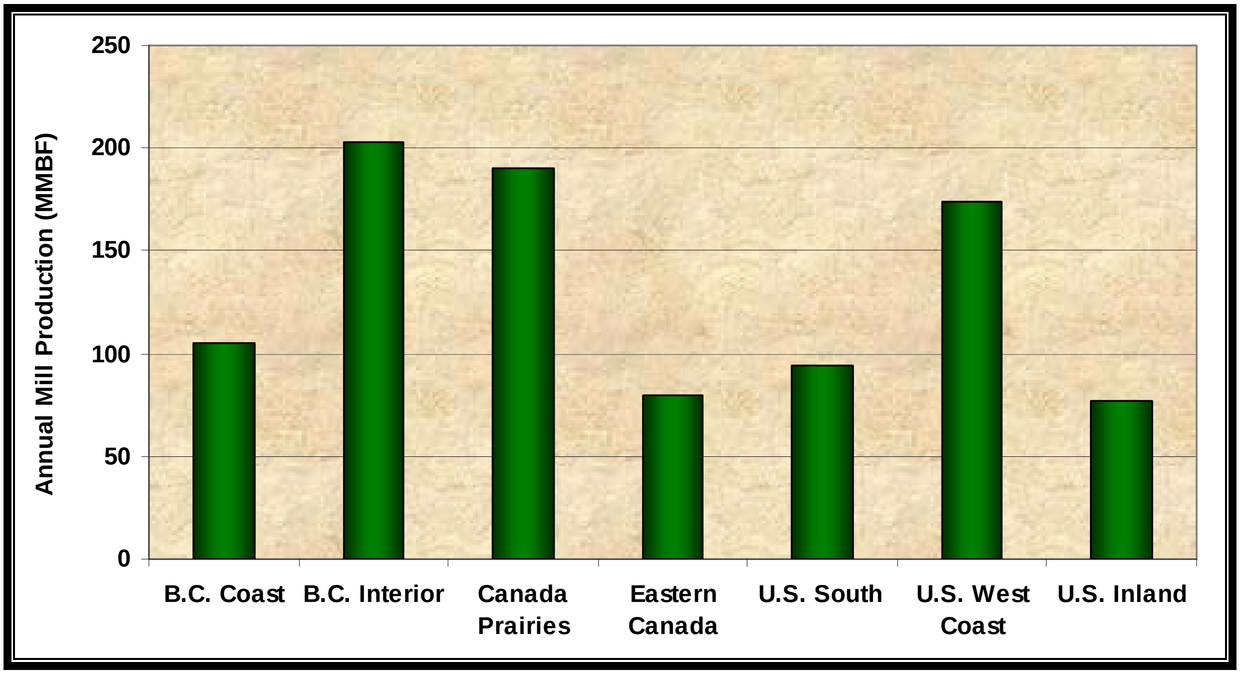
* Net Annual Growth is Annual Growth less Annual Mortality
Source: Forest Resources of the United States, 2002

Table 18
Typical Timber Rotation Length (Years) by Region

Region	Range in Tree Rotation
Northeast	50 to 90 years
North Central	40 to 100 years
Southeast	24 to 40 years
South Central	28 to 45 years
Intermountain	55 to 120 years
Pacific Northwest	40 to 80 years
Montana	**55 to 120 years**

As a result of the relatively low forest productivity and relatively long rotation age, the sustainable harvest volume per acre is generally lower in Montana than in some other regions. This contributes, as illustrated in Chart 1, to smaller scale manufacturing operations than for other timber producing regions. The chart shows the average annual sawmill production (million board feet, lumber scale) for larger (20+ MMBF/year) sawmill operations in North America. Sawmills in the U.S. Inland are smaller on average than those in other producing regions.

Chart 1
Average Annual Sawmill Production Volume in North America in 2004



Source: PricewaterhouseCoopers, International Wood Markets Research Inc. and The Beck Group, Global Lumber/Sawnwood Cost Benchmarking Report 2008 Annual Basis and Q1 2009.

Because of the relatively small scale of the operations in the Inland West, they also tend to have higher manufacturing costs as compared to larger mills in other regions. Chart 2 and Chart 3 illustrate the relative cost competitiveness of sawmills in the various regions. Although units are not shown in the charts, the magnitudes of the differences are drawn to scale. Also note that the costs are expressed on a unit cost basis (dollars per thousand board feet of lumber production). Chart 2 shows the relative manufacturing cost differences by region with log costs excluded. As Chart 2 illustrates the U.S. Inland West is among the highest manufacturing cost region. In Chart 3, log costs are included in the per unit manufacturing cost calculation and again the U.S. Inland West is among the highest cost regions.

As Chart 2 and Chart 3 illustrate, sawmills in the Inland Region, including Montana, have, on average, some of the highest total manufacturing costs (i.e., including log cost) in North America. Again, this relates to the relatively small scale of the operations and the complexity related to the number of species and products produced, as well as to a high degree of competition for the available timber supply that is derived largely from a greatly reduced federal timber supply program.

Chart 2
North American Regional Sawmill Manufacturing
Cost Comparison in 2006 (excluding log cost)

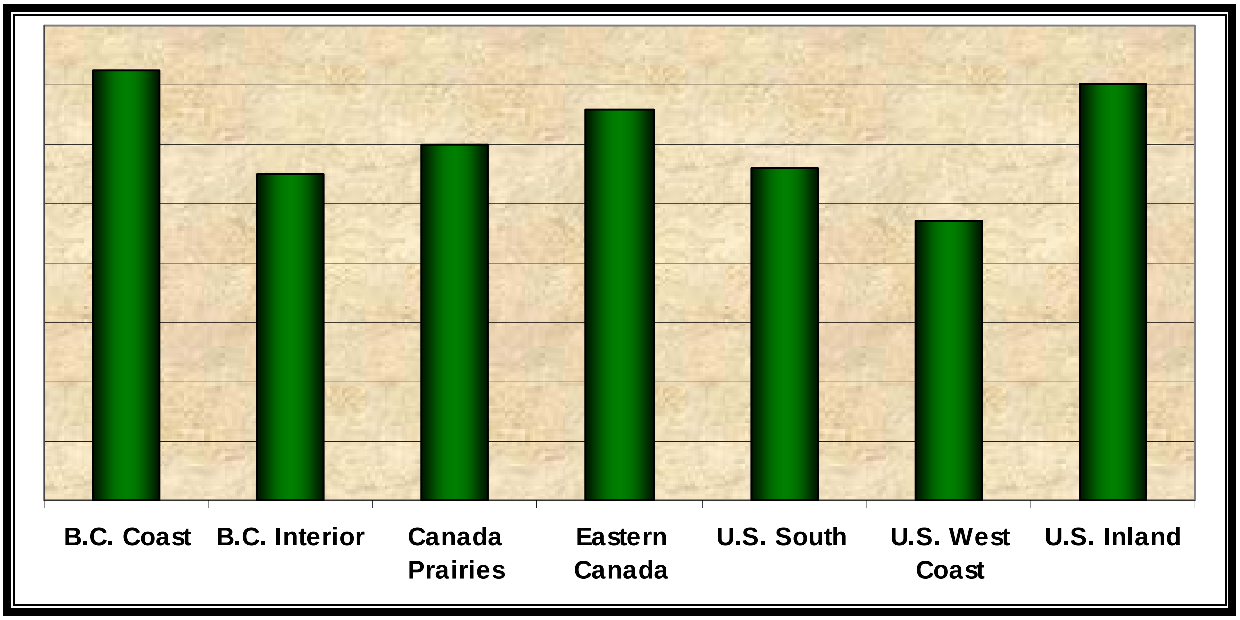
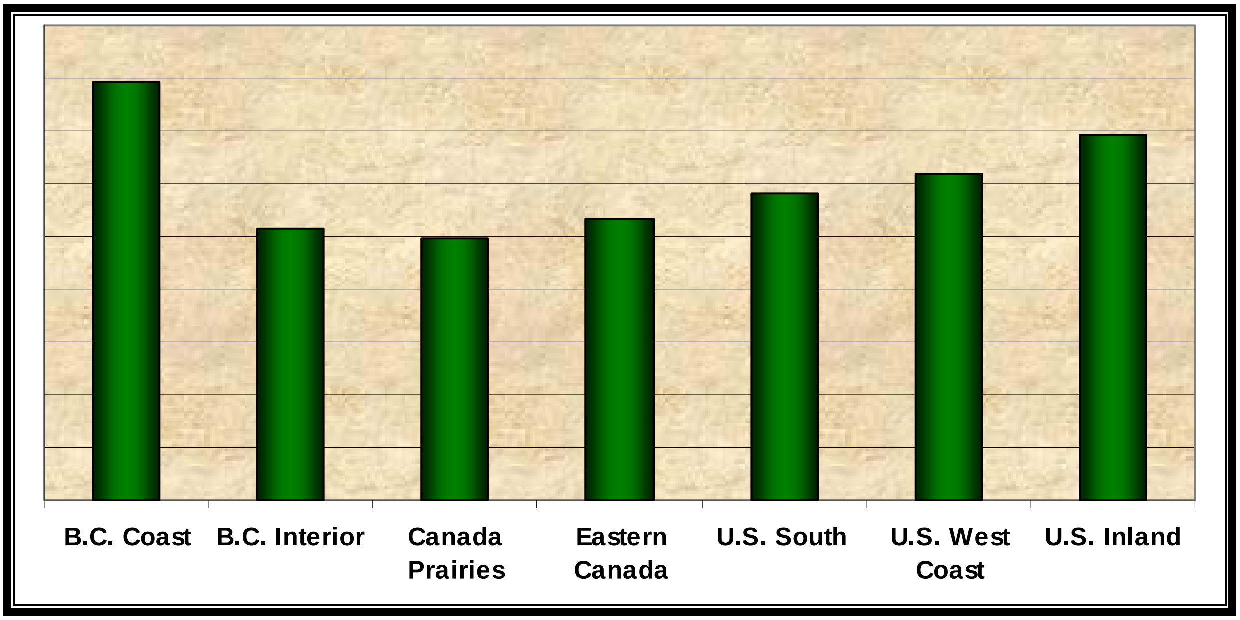


Chart 3
North American Regional Sawmill Manufacturing Cost Comparison in 2006 (including log cost)



Source: PricewaterhouseCoopers, International Wood Markets Research Inc. and The Beck Group, Global Lumber/Sawnwood Cost Benchmarking Report

The relatively high cost of manufacturing in the Inland Region is partially offset by the more valuable species and products produced, but the region has been vulnerable to loss of manufacturing capacity (e.g., mill closures) because of its high cost structure. Most of the softwood lumber products produced in North America are commodity structural lumber. While various geographic markets generally have some species preference, delivered product prices do not vary too much from one species to another, so sawmills in Montana must be competitive with other sawmills throughout North America – and globally.

3.3.2 Long-Term Mill Viability

Historically, limited timber supply has been a major factor leading to the closure of sawmills in western Montana. However, the closures have now reached a point that the remaining mills (plywood and sawmill plants) have an annual log usage of about 475 MMBF (Scribner Log Scale, assuming all mills operate at full capacity). That log usage is well aligned with the projected annual harvests, as shown Table 19. Thus, timber supply is expected to be less of a factor in the near term. Longer term, supply may again become an issue as harvests are reduced because of the impact of tree mortality (mountain pine beetle) on inventory levels.

Table 19
Projected Annual Timber Harvest (MMBF) by Source

Source	MMBF
Private	350 to 360
USFS	50 to 60
Other Public	50
Tribal	15
Total	**465 to 485**

Montana mills will continue to be high cost manufacturers because of the relatively smaller scale of sawmills in the region. However, with timber supply and demand in balance, delivered log costs are likely to be lower than the cost of logs in other regions. The lower log cost will offset higher manufacturing costs. The end result is that the total cost (manufacturing + logs) should be comparable to mills in other regions. A side effect of the less competition for logs is that landowners in the region are likely to receive lower stumpage values for their timber.

For the last several months, lumber prices have been climbing. The reason for this is believed to be that attrition throughout the industry has limited lumber production capacity and therefore tight supply is driving up lumber prices. In addition to these market related factors, the mountain pine beetle epidemic has reduced production capacity in Interior British Columbia and Alberta. The result of limited lumber production should be positive for sawmills in Montana.

The sawmills and plywood plants located in western Montana compete among themselves for timber or raw material supply, but also compete in markets for finished products with producers from within the region, from other producing regions of North America, from outside of North America, and with other products and materials that compete for the same end uses. The primary competition facing each type of operation is highlighted in the following bullet points:

- Stud mills – Sawmills specializing in the production of short length structural lumber may have the best market opportunities for the foreseeable future, relative to the other lumber producers. While new stud producing capacity is being added in Western Oregon and Washington, in addition to some increases in Interior B.C., the overall market for studs is expected to continue to be positive relative to other major lumber and plywood product lines. Tricon, Sun Mountain, and the RY Mills are in this category.
- Board producing sawmills – These mills have experienced tremendous competition in recent years, especially from European producers. However, the lower value of the U.S. dollar relative to other currencies has changed this trend. Pyramid Mountain lumber is a board mill.

- Combination “sawmills” – These mills typically produce a combination of boards, structural dimension lumber, and other industrial grades of lumber. These mills are also the most vulnerable to competitive pressures from other producing regions in terms of their manufacturing cost structure. The structural lumber industry is increasingly supplied by high volume, low cost producers (such as those located in Western Oregon and Washington and Interior B.C.) – so the relatively small scale of the Montana sawmills is a disadvantage. Stoltze is a combination sawmill.

In summary, numerous sawmills in Montana have permanently shut down. This has reduced competition for logs, which in turn has reduced log prices. While the Montana sawmills tend to have higher manufacturing costs, the reduced log cost helps offset the higher manufacturing cost, and therefore, allows the mills to be competitive in terms of total cost. The mills that are still operating in Montana at the current time have demonstrated the ability to withstand difficult operating conditions and are likely to remain viable. However, continued weak demand for lumber associated with a down housing market is a project risk. **The development of CHP plants would stabilize markets for mill residues and likely improve overall sawmill economics.**

CHAPTER 4 – CHP TECHNOLOGY AND DESIGN

4.1 CHAPTER SUMMARY

The following section describes the CHP technology considered in this assessment and how technology choices affect the design of a CHP plant.

The findings from this analysis are that a boiler with a moving-grate, air-swept stoker system is appropriate for combusting woody biomass of varying moisture contents. Interconnecting a CHP plant to the power grid and the ability (or lack thereof) of the existing power distribution system to transmit power away from the CHP plant are also important technical aspects of a CHP project. The project team found that each mill is located within a relatively short distance of a substation served by a voltage level that should be able to support transmission of the power. However, transmitting power out of the state may be problematic since the existing transmission lines lack the capacity to send power west of Montana.

The conclusions that can be drawn from these findings are that:

- The technology of combusting biomass to fire a boiler is mature. The reliability of the technology considered for the CHP plants modeled in this study has been proven many times over.
- The design of the boiler and T-G would allow the CHP plant to comply with Montana BACT and produce emissions at levels that comply with MDEQ standards.
- Based on a preliminary review, interconnection and transmission within the state do not appear to be significant obstacles to the development of sawmill CHP plants in western Montana. A comprehensive interconnection and transmission study (conducted by the utility) is part of every CHP project and will provide much greater detail and insight about interconnection and transmission.

The following sections provide detailed information about CHP technology and design.

4.2 PROJECT DESIGN AND TECHNOLOGY

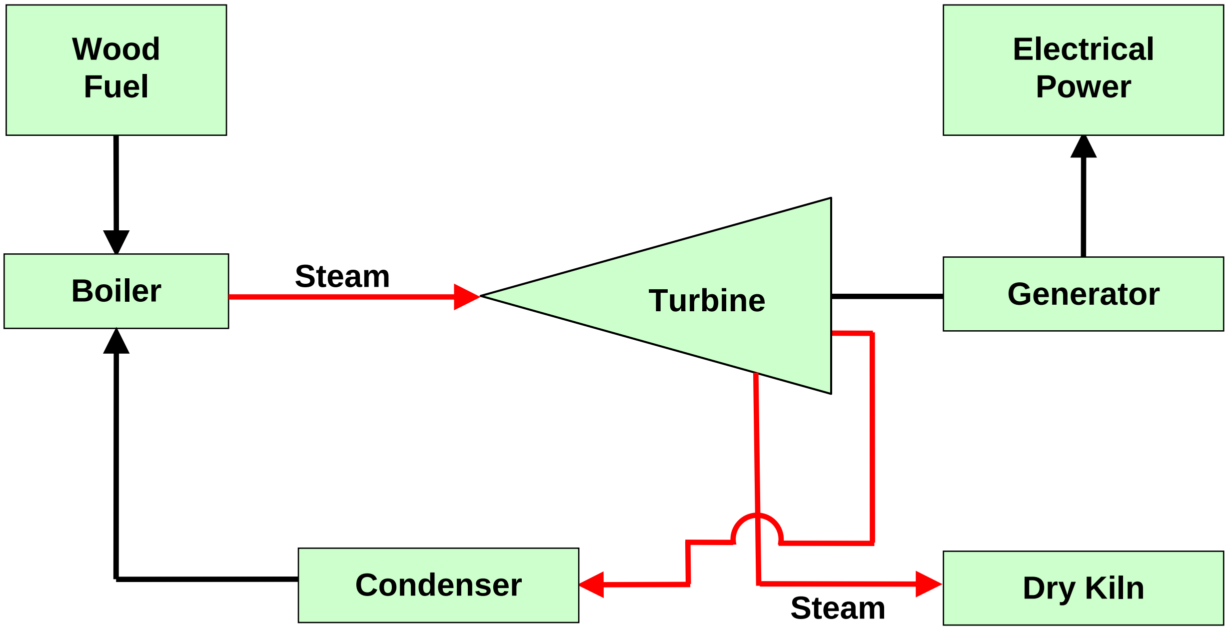
The technology underlying the CHP plants being considered as part of this study is mature. For example, biomass fuel has been successfully combusted in industrial and power generation applications for many decades. In fact, one of the sawmill boilers in Montana is over 100 years old and still in service. The following sections describe the design and technology of the CHP plants considered in this study.

As shown below in Figure 5, in the simplified diagram of a wood-fired combined heat and power system, the process begins when wood fuel is combusted in a furnace whose walls are water filled pipe. The high pressure water in the pipe boils to steam;

the steam is then heated to a higher temperature before exiting for the T-G. The T-G is a rotating multistage unit that drops steam temperature and pressure at each stage as thermal energy is converted into mechanical energy.

Partway down the T-G, a portion of the steam is extracted for use by the lumber dry kilns. The extracted amount is automatically controlled by the demand of the kilns. Further down the T-G (but not shown in the diagram), a second lower pressure extraction supplies the deaerator, a device that removes entrained oxygen from the feed water as it goes back to the boiler. The steam not needed for kilns or deaerator exits the back end of the turbine to the condenser to be turned back into water at a pressure far below atmospheric pressure in order to maximize T-G efficiency. The condenser is supplied with water from a wet mechanical draft cooling tower, which evaporates a portion of the water as it cools it for the return trip to the condenser.

Figure 5
Simplified Diagram of Wood-Fired
Combined Heat and Power System



4.2.1 Boiler Technology

The primary choice to be made in plant design is the selection of the boiler technology. The large majority of biomass boilers burn the wood on a grate containing holes so that primary combustion air can be introduced below the grate. The fuel is spread across the grate by an air swept stoker. The grate itself can be fixed, vibrating, traveling, reciprocating or rotating. The purpose of a moving grate is to automatically remove ash and to provide a space for fresh fuel. All existing biomass boilers in Montana are older fixed grate designs that require manual removal of ash.

Another boiler design is a fluidized bed, which comes in either a bubbling bed or circulating bed version. In both designs, a large bed of sand and fuel is kept "fluidized" by large volumes of air introduced below the bed. There is no grate in this design.

A third option, though much less common in boilers of this size range, is to gasify the fuel in a separate vessel. This occurs through heating the fuel in an oxygen starved condition. The gases produced as part of this process are introduced to the boiler proper where combustion is completed.

The pros and cons of various designs are debated endlessly, but some of the advantages and disadvantages of each are as follows. The grate designs are proven, efficient, rugged and reliable. The fluidized beds are newer in design; they operate at a lower temperature, which means that some pollutants (NO_x, CO) are minimized. However, they require additional auxiliary power for the fluidizing process. Gasification offers advantages when fuels with very low ash melting points are used because gasification can prevent boiler conditions that might otherwise foul boiler tube surfaces. For example, combustion of agricultural residues sometimes relies on gasification. The downside of gasification is that the systems are more complex, not proven at larger scale, and offer no thermal efficiency advantage so long as the resulting gas is simply burned in a standard boiler.

In this study, the fuel quality is known (mill, forest, and urban wood wastes) and varies only by moisture content. There will be no combustion of high moisture sludges such as might be encountered in a pulp and paper industry application and which could require fluidized bed combustion. These projects do not anticipate combusting agricultural residues that might point to a gasification process. For these reasons, the choice for costing and efficiency calculations in this study is a moving grate system fed by an air swept stoker.

The moving grate/air swept stoker system gives the widest choice of vendors and has a relatively low capital cost and auxiliary power use. Since none of the facilities will be located in air quality nonattainment areas, the stoker grate will be able to comply with a Montana BACT determination when equipped with an electrostatic precipitator for particulate control, a selective non-catalytic NO_x control system and multiple levels of heated overfire air for CO and VOC control. This design system forms the basis of the financial model used in a later section of this report.

4.3 INTERCONNECTION

To interconnect any CHP project with the electrical grid, a formal interconnection process must be followed that complies with the process and timeline put in place by the FERC. NWE has conducted numerous such interconnection studies, primarily for wind developers in eastern Montana. In the cases of two prospective CHPs located in the service areas of the COOPs, each COOP may choose to conduct its study internally or request that BPA conduct the study.

In most cases, the full range of studies associated with interconnection (feasibility, system impact, facilities) will require as much as 6 to 9 months to complete. The timeline could be even longer if the utility has a substantial queue of projects awaiting interconnection studies. The project team reviewed several previous NWE studies, and the interconnection requirements and cost, in most cases, appear reasonable.

In terms of defining the nearby electrical infrastructure to support CHP development at each of the 7 sawmills, detailed transmission maps were requested from NWE for the 5 mills within its service territory. In addition, the project team held discussions with FEC and MEC personnel to gain an understanding of their systems serving Stoltze and Pyramid, respectively. Table 20 summarizes the preliminary interconnection findings.

Table 20
Preliminary Interconnection Findings
at 7 Montana Sawmill Locations

Mill	Location	Nearby Transmission
Eagle Stud	Hall	Served off 50KV Drummond-Philipsburg line
Pyramid Mountain	Seeley Lake	MEC 50KV sub, 1/4 mile away, then to NW 230KV at Ovando
RY Timber	Livingston	Direct connection at 69KV from Livingston sub
RY Timber	Townsend	100KV line runs through Townsend with sub
Stoltze Lumber	Columbia Falls	230/115KV BPA sub in Columbia Falls
Sun Mountain Lumber	Deer Lodge	100KV Deer Lodge sub ¼ mile away
Tricon Timber	St. Regis	100KV Missoula-Taft line with St. Regis sub

Note from the preceding table, that in each case, the mill is located within a relatively short distance of a substation served by a voltage level that should be able to support transmission of the project power onward at the project sizes envisioned, provided that the line is not already overloaded. In every sawmill case, the local area is a "sink" for power, including the mill proper, with no other local generating resources. This situation makes it more likely that the system impact study will show the project can be accommodated at that location with local upgrades only. However, in at least two locations, the local step down transformer serving the community is too small to accommodate the facility and would have to be replaced.

This is, of course, only a cursory look at likely interconnection issues for the 7 locations. Detailed interconnection/transmission studies by the utility are an integral part of every generation development project, and are often on the critical path from a timing perspective. The conclusion here is that each mill location meets high level screening for successful interconnection at a reasonable expense. This situation is helped in all cases by the existence of a sawmill, which requires substantial electrical infrastructure in its own right, including the necessary rights-of-way. An amount of capital for interconnection facilities that is based on the review of several past NWE interconnection studies is included later in this study in the financial model for a typical development.

4.4 TRANSMISSION

Moving the power from CHP projects out of Montana on a bundled basis (power plus RECs) in the near term is problematic. The BPA 500KV and below system moving power west from Montana is typically fully subscribed, and discussions with BPA personnel indicate that new firm transmission rights on that portion of BPA's system are not available. Non-firm transmission is available at most times, but a project is not likely to be financed based on only having non-firm transmission rights, particularly when the resource is a firm source such as a biomass project. The potential loss of revenue during transmission curtailments is simply too great.

There are plans to expand the current modest southbound transmission assets out of Montana, which would allow power to move from Montana’s developing wind farms to southwest markets. These lines could also accommodate modest biomass CHP development in western Montana. However, the current decline in forest resource health and the loss of mill residue markets lend a sense of urgency to the prospective sawmill CHP projects that does not match transmission expansion plans. Given the current scenario, it would appear that a Montana-based electric system solution must be found to move these projects forward on a timely basis.

Proposed projects must also operate successfully within the "Balancing Authority" in which the plant resides. That BA, either NWE or BPA in these cases, is responsible for balancing system resources and loads on an instantaneous basis. Scheduling of power through the BA is an extremely important part of the operation of any generation resource, and developing "visibility" of the resource to a central dispatch center is a major portion of the interconnection costs.

Biomass CHP at a sawmill is clearly a firm base load resource, but one that has small variations in output based on changes in dry kiln loads. With the type of extraction/condensing turbine-generators proposed in this study, these variations in output are dampened considerably, and variations within an hour can typically be accommodated within the "dead band" allowed by the BA's operating rules. The projects will be "schedulable", meaning that the operator can propose a daily schedule that takes into account weather, number of kilns on line, species being dried, fuel moistures, etc. to arrive at an expected output to the grid. That schedule then sets the operation for the following day. On an annual basis, the projects should be expected to produce slightly more output in the summer, when dry kiln loads are lower and fuel moistures are down.

CHAPTER 5 – ENVIRONMENTAL PERMITTING & REGULATORY REQUIREMENTS

5.1 CHAPTER SUMMARY

The following section describes the environmental permitting and regulatory issues that affect development of CHP plants.

The environmental permitting findings are that air quality issues can be addressed through a variety of equipment technologies, including:

- multiclone collectors for large particulate removal
- an electrostatic precipitator for fine particulate removal
- multiple levels of overfire and underfire air
- an incoming combustion air heater for CO and VOC control
- a urea injection system for selective non-catalytic NO_x removal
- the installation of a continuous emissions monitoring system

Such a system complies with Montana BACT. A boiler manufacturer would be able to guarantee emission levels that are within accepted standards from such a system.

Water usage at the prototypical plant (described in the detail in the Prototypical Montana Sawmill CHP Facility section) will be 230 GPM for makeup water. In addition, the prototypical CHP plant will produce about 35 to 60 GPM of wastewater. Preliminary assessments of water rights at the sawmills indicate that adequate water should be available either from municipal water systems or from on-site wells. Ash production will be between 2,000 to 5,000 tons per year per site.

The regulatory findings are that since NWE is a regulated utility, it does not have the liberty to obtain electricity resources from whatever party it chooses or, necessarily, do so on terms and conditions preferred by the utility. Instead, decisions regarding electricity resources are made through a public process under the supervision of the Public Service Commission. Within that context, NWE seeks to acquire electricity that has three major characteristics: 1) can reliably supply power when required by the utility; 2) is dispatchable (i.e., a source that is capable of matching electric supply with fluctuating demand levels); and, 3) comes from a renewable source. Biomass power meets all three of these criteria.

The conclusions that can be drawn from the findings presented in this section are that:

- Environmental permitting is not expected to present any significant obstacles.

- The design of the boiler would allow the CHP plant to comply with Montana BACT and produce emissions at levels that comply with MDEQ standards.
- Water supply at each site appears to be adequate to meet the needs of a CHP plant. More detailed, site-specific follow-up studies are recommended. In the event water supply is not adequate, other less water use intensive cooling technologies are available, but are more costly and reduce the overall efficiency of the system.
- Wastewater can often be used at sawmills for cooling saws, sprinkling log decks, and stored in an on-site pond for water in the event of a fire. Any wastewater discharged from the CHP plant is typically relatively warm and may have slightly higher levels of minerals, but has no contaminants.
- It is expected that most ash produced from the CHP plants would be used as soil amendments for home and garden use.
- The characteristics of biomass power meet the present criteria NWE has established for acquiring power.
- Biomass power will have to be approved by the PSC.

The following sections provide detailed information about environmental permitting and regulatory requirements.

5.2 ENVIRONMENTAL REQUIREMENTS

In a typical biomass CHP application, the primary environmental/permitting emphasis is on the air quality permit, with lesser emphasis on water and solid waste issues. The following sections describe the permitting requirements for each.

5.2.1 Air

Mill residue, forest residue, and urban wood waste combustion results in very low emissions of sulfur and other contaminants. However, because of large variations, on a real time basis, in biomass particle size and moisture content there can be emission variations as well, primarily in CO and NO_x emissions.

The project team reviewed a recent BACT review by MDEQ for the Thompson River cogeneration combination wood/coal boiler. Based on that review, the project team elected to equip the prototype sawmill CHP boiler with the following pollution control equipment.

- A multiclone mechanical collector for large particulate removal
- A 3 field electrostatic precipitator for fine particulate removal
- Multiple levels of overfire air for CO and VOC control
- An air heater to heat incoming combustion air, which lowers CO and VOCs
- A selective non-catalytic NO_x removal system including urea injection

- A complete set of continuous emissions monitors for NO_x, CO, CO_2, O_2, and opacity, including an automatic data acquisition system

Given the pollution control equipment just described, it should be possible to obtain from the boiler manufacturer the environmental guarantees on maximum emission levels, as shown Table 21. The project team compared the levels shown in Table 21 to the final permit following the BACT determination for Thompson River cogeneration plant. The levels compare favorably for every pollutant.

Table 21
Anticipated Guaranteed Maximum
Emission Levels from Boiler Manufacturer

Emission Type	Maximum Emission Level (Pound per MMBTu)
Fine Particulate (as$PM_{2.5}$)	0.015 lb per MMBTU
CO	0.22 lb per MMBTU
NO_x	0.15 lb per MMBTU
VOC	0.005 lb per MMBTU

None of the prospective CHP plants lie within a nonattainment area for any air pollutant. However, the Pyramid Mountain Lumber site in Seeley Lake is borderline for fine particulates. This means that pollution offsets will not be required nor will extraordinary pollution control equipment likely be required. In addition, 5 of the 7 locations have existing boilers that have MDEQ permits. Since the existing boilers are all older technology and have less sophisticated pollution control devices, it is likely that pollutant emissions would actually decrease for particulate, CO and VOC, and only rise for NO_x. This would occur despite installing boilers that are several times larger. The introduction of the boiler and pollution control technology described earlier would most likely improve the borderline particulate levels at Seeley Lake due to the shutdown of Pyramid's current boiler and the use of forest slash now burned in place.

5.2.2 Water

Water is typically the second most difficult environmental/permitting issue to be addressed for biomass CHP projects. It is becoming a larger issue across the West. As background, a biomass CHP unit is often equipped with a mechanical draft cooling tower, a device that cools and condenses the steam exhausted from the turbine. Inherent to these types of systems, a substantial volume of water is lost to evaporation in the cooling tower. For example, in the prototype 150,000 PPH boiler and 18 MW T-G unit (described in detail later in the study), the total makeup water requirement is about 230 GPM. Nearly 95 percent of that amount is new water as compared to the amount used in current operations. The makeup amount required will vary somewhat depending on makeup water quality. For the prototypical plant (150,000 PPH boiler and

18 MW T-G), a range of 180 to 250 GPM would likely cover all the makeup water quality variations encountered in Montana.

Only about 5 percent of the total makeup water goes to the boiler and therefore needs to be of high quality. The other 95 percent goes directly to the cooling tower to replace water lost to evaporation and water removed to maintain water quality (blowdown). This makeup water going to the cooling tower does not need to be high quality and can come, for instance, from the effluent from a wastewater treatment facility.

Since the water usage levels are significant, the project team investigated water rights at each of the 7 locations. The research revealed that the water rights situations vary considerably from mill to mill. For example, some have sufficient water from on site wells while others would need additional water to supply a traditional mechanical draft wet cooling tower application.

In the event that sufficient water is unavailable in a given location, the choices are to replace the mechanical draft wet cooling tower with either a hybrid wet/dry cooling tower or with an air cooled condenser. In the case of the hybrid tower, water use is reduced substantially, while in the case of the air cooled condenser, total water use is reduced by 95 percent or more. In both cases, the capital cost of the project is increased and the efficiency of the power generation process is reduced.

Each case will be highly site specific and so no general conclusion can be drawn However, at no sawmill site was water a significant obstacle. In each case, the decision on water use will be a tradeoff between water rights and the increase in capital cost and decrease in power output that accompanies a switch to a lower water use solution.

5.2.3 Wastewater

Wastewater in a biomass CHP facility consists of blowdown water from both the boiler and cooling tower. The amount of water lost as blowdown depends on how the system has been designed to control the mineral content of the water in those units. Water exiting the boiler system as blowdown is of good quality and has not been contaminated, but typically has a more concentrated mineral content as compared to the makeup water.

The blowdown water quantities in the size facilities proposed for Montana sawmills are rather modest. Boiler blowdown will be 3 to 8 GPM, while cooling tower blowdown may be 30 to 50 GPM. These quantities are determined by the quality of the original makeup water, since the water evaporated in both the boiler and cooling tower is basically distilled water, leaving behind the original chemicals from the makeup water during evaporation. Those chemicals then leave the system via the blowdown streams.

In a sawmill environment, there are a number of water reuse opportunities for this water. For example, it can be utilized for fire suppression, to cool saw blades, or to cool other equipment, such as bearings. It may also be used to sprinkle unpaved roads, for log sprinkling, or for fire suppression. Within the CHP unit, the blowdown water is used to condition ash prior to hauling. Some boiler designs use blowdown water to replenish water in the submerged conveyer that removes ash from under the grate. The sawmill may also be connected to a public sewer to handle the excess wastewater, if any.

As in the previous discussion on water usage, the amount of wastewater can be controlled by the choice of cooling device selected. Both the wet/dry hybrid cooling tower and air cooled condenser designs described earlier reduce or nearly eliminate the need for wastewater disposal.

5.2.4 Ash Disposal/Reuse

Wood is a very low ash fuel, with the inside-the-bark portion of the tree having an original ash content of less than 1 percent. That ash consists of various minerals. The bark portion typically contains slightly more ash, perhaps 2 to 3 percent. Once the fuel is combusted in the boiler, the ash is captured, either on the boiler grate or in downstream pollution control devices. Some of the ash becomes airborne in the combustion process by virtue of the wide variation in particle size within the incoming fuel.

While nearly all of the carbon is burned away during combustion, the ash will contain a small percentage of carbon when collected. The "bottom ash" collected from beneath the grates or fluidized bed is basically the heavier sand and gravel that was embedded in the bark during log handling. The "fly ash" collected downstream is much finer and lighter and contains the ash inherent in the wood particles plus any carbon not burned away.

For the size facilities anticipated for Montana sawmills, these combined ash streams may total 2,000 to 5,000 tons per year per facility. The characteristics of the ash differ somewhat by stream. The bottom ash from the grate area is typically altered little from the sand and dirt particles picked up by the bark during its trip to the mill. This material will typically find a home with a local sand and gravel operator, or may be used on site as a road base material.

The finer fly ash is characterized by a high mineral content of such minerals as calcium, magnesium, aluminum and silica. It is high in pH and may have a carbon content of 5 to 20 percent. In locations with a substantial number of biomass plants, such as California, this ash is used widely in agricultural operations as a low grade fertilizer. It is used to raise the pH of soils and the carbon content gives the ash excellent moisture retention capability.

In Montana, perhaps the expected use would be for operations that make soil amendments for home and garden use. It is typically added to soil and wood fines as part of the mulch preparation process. If local markets are not available, the ash can be hauled to a landfill, where it is often used at the landfill as daily cover material.

5.3 REGULATORY REQUIREMENTS

A number of state and federal laws affect the CHP plants considered in this study. The following section describes these laws in the context of CHP at western Montana sawmills.

5.3.1 Regulatory Overview

Unlike an industrial company operating in Montana, a regulated public utility does not have the unilateral authority either to obtain electricity resources from whatever party it chooses or, necessarily, do so on terms and conditions preferred by the utility. Utility acquisitions of electricity resources, be it through the construction, purchase, or lease of a generating plant or through a PPA, are acquisitions for the resale of the power to customers.

That acquisition process is both structured and circumscribed by state law and administrative rules. Decisions regarding which electricity resources the utility may obtain and the terms and conditions of those acquisitions are made through a public process under the supervision of the PSC. Before a utility can put an electricity resource into its rate base or establish rate schedules to recover the cost of power purchased under a PPA, the Commission must ultimately approve the acquisition.

Defining the public interest is a multi-faceted process, and the PSC makes its assessment using a variety of criteria, including:

- Compliance with the company’s resource procurement plan. Every two years NWE prepares a resource plan which identifies the company’s needs for power and the types of resources available to fill those needs, and the likely cost of each resource. Resources that are not included in the plan are much less likely to be acquired.
- The proposed resource’s contribution to minimizing the long term cost of electricity service.
- The “cost” versus the “risk” of a proposed resource. The analysis seeks to find the optimum mix of resource reliability at lowest reasonable cost. This assessment is not static and evolves following public policy and economic issues affecting society. Potential factors which may be considered in this analysis include the potential costs associated with carbon dioxide emissions; the environmental effects of a proposed resource, and any associated remediation costs (e.g., mercury in coal); the current and forecast market price of power; fuel supply availability and price volatility; and other criteria.
- The reliability of the proposed resource. This criterion is primarily focused on intermittent resources such as solar and wind power and the costs of integrating such resources into the company’s electricity supply portfolio. This is important because at peak time periods, the utility needs to be assured that the power will be available to serve customer needs.

- What alternatives exist to the proposed resource, and how do the alternatives compare using the criteria identified above.

PSC approval of an electricity resource is required before the utility can either place the asset in rate base or adjust rates to collect PPA costs from customers. It is likely there will be high interest in biomass power because it has the distinction of being a firm supply of power that can fulfill Montana's RPS. However, the cost of biomass will receive close scrutiny in order to protect the interests of Montana's ratepayers.

5.3.2 NWE's Acquisition Goals

At present, NWE seeks to acquire electricity with three major characteristics. First, it is desirable that the resource be capable of supplying electricity when the utility requires the resource, not just when the resource can operate. The utility is focused on acquiring resources that produce electricity during peak periods of the day and year. These types of resources include hydroelectric, natural gas, coal, and nuclear plants. Biomass facilities can also serve this purpose.

Second, the company prefers to acquire dispatchable resources. This refers to resources which can be turned on and off and ramped up or down in response to the utility's load. Non-dispatchable resources, notably wind and solar applications, frequently produce power when it is not needed or fail to generate electricity when it is. Dispatchability adds to the flexibility of the supply resource. Biomass plants are dispatchable.

Third, the company needs to acquire additional renewable resources to comply with the Montana's RPS. Biomass is a renewable resource in Montana.

CHAPTER 6 – MARKETS FOR POWER

6.1 CHAPTER SUMMARY

The following section provides a description of NWE's process for acquiring and marketing power, the basis by which markets for renewable power were established, and various concepts for marketing the renewable power produced at sawmill CHP plants.

The findings are that about 15 percent of NWE's daily load is met through its own generating plants. The balance of the required power is purchased. By 2011, about 30 percent of NWE's daily load is expected to come from its own generation facilities. For the purchased power, NWE uses the Mid-Columbia power trading price as a basis for negotiations with prospective power providers.

The Public Utilities Regulatory Policies Act, a federal law, requires utilities to purchase power from qualifying independent facilities at the utility's avoided cost. Note that avoided cost is the incremental cost an electric utility avoids incurring by purchasing an equivalent amount of power from a QF. A facility only qualifies if the fuel used to generate the power is renewable or is waste derived. In Montana, the calculation of the utility's avoided cost is done by the PSC. Subsequent laws also required public utilities and power marketing agencies to "wheel" power across their systems to other buyers, if requested. The cost of wheeling is regulated.

Montana passed an RPS in 2005 that requires investor owned utilities and competitive electricity suppliers to obtain 5 percent of their power from renewable resources during 2008–2009, 10 percent between 2010 and 2014, and 15 percent beginning in 2015. In addition, the Montana RPS requires the utilities to purchase power from Community Renewable Energy projects of 25 MW or less capacity. Fifty MW must be purchased in 2011 through 2014 and 75 MW each year thereafter of Community Renewable Energy. Community Renewable Energy is defined as projects where local owners have a controlling interest.

The conclusions that can be drawn from these findings are that:

- If biomass power was to be sold at NWE's current avoided cost, the value of the power would be too low to support the development of biomass CHP.
- Despite the low avoided cost rate, the Montana RPS requires that NWE source 15 percent of its power from renewable sources by 2015 and that 75 MW of power come from Community Renewable Projects by 2015.

The following sections provide detailed information about markets for power.

6.2 ELECTRICITY PRICES AND MARKETS

Electricity prices are established two ways – through utility-owned rate-based generation and through power purchase agreements.

When NWE seeks to construct, purchase, or lease a generating plant, it makes a filing with the PSC detailing the operational characteristics of the plant, its expected capital and operating cost, and a rate of return on the investment. The Commission reviews the filing, determines whether the project is in the public interest, and, if so, issues an order allowing the utility to recover its costs and earn a rate of return. At present, approximately 15% of NWE's average daily load is met through company-owned generation, an amount which is expected to increase to about 30% in 2011.

The second method for acquiring electricity resources is through market purchases and PPAs. There is an electronic electricity trading location for the Northwestern United States located in the State of Washington called the Mid-Columbia, or Mid-C, hub, which is the physical reference point where electricity traders buy and sell electricity. The prices generated in those transactions constitute a basis for setting a "market price" of electricity for the region. When a generator sells power through the Mid-C, the generator pays for the cost of transmitting the energy to market and the purchaser pays transmission from the market to its place of use. Thus, transmission charges are a deduction from the market price of the power sold by the generator, and an addition to the market price paid by the purchaser.

The Mid-C price functions as the beginning price basis in negotiations for resource acquisition from non-utility generators through PPAs.

Typically, NWE issues a RFP to prospective generators every one to two years seeking offers for NWE to buy electricity. The proposals are reviewed and a small number are selected for further negotiation. Successful candidates will be offered a PPA which may be subject to the approval of the PSC.

NWE does not typically engage in bilateral negotiations with one generator unless the issue involves the renegotiation or extension of an existing contract or the generator offers the utility an "exceptional" acquisition opportunity.

In evaluating proposed power supply prices from a new electricity resource, NWE examines:

- The impact of the resource on the costs of the existing supply portfolio.
- The risk the resource may impose on the portfolio.
- The relationship of the proposed price to both the current market price and long term market price.
- The impact of the proposed price on customer rates.

- Long term regulatory implications of the proposed price on other generators and utility customers. This is an extremely important criterion. NorthWestern will not sign power supply agreements which may have the adverse effect of stimulating further escalation of power supply prices to customers.

Finally, the market price of electricity is a variable and often times highly volatile commodity dependent upon supply and demand and other factors. In the Northwestern United States, a high percentage of electricity generation is from hydroelectric plants. The amount of water available for generation in the Columbia River drainage varies at different times during the year and from one year to the next, dependent upon precipitation patterns.

During periods with abundant water, power prices decline, and they increase when water flows diminish. Electricity market prices are also affected by population change and conditions in the economy. Population growth, economic growth, or both, cause increased electricity demand. The opposite is also true. Economic recession causes power supply prices to drop as consumer demand decreases, particularly in the industrial sector. For the past two years, electricity prices on the Mid-C have been decreasing and are relatively low, largely because of the current national recession and the concurrent surplus of electricity generation and the low cost of natural gas. Electricity and natural gas price forecasts for the region, coupled with pessimistic assessments for economic recovery, suggest that energy prices will remain stable in the short term and increase slowly thereafter.

6.2.1 Price Risk Associated with Biomass

The most important risk factors for biomass generation are the security of the fuel supply and fuel supply price. It will be difficult if not impossible to finance a biomass plant without an identified long-term supply of fuel within a range of tolerable prices that result in energy prices comparable to alternative renewable generation facilities. It also will be necessary for a biomass plant to source fuel from several vendors to insure that if one vendor ceases operations or cannot otherwise meet its fuel supply obligations, the plant can continue operations.

The potential market for forest and mill residues is well diversified, but prices can be highly variable, including times when potential sales of wood residues to parties other than a biomass plant may be more remunerative. Accordingly, while there are advantages to a wood residue producer supplying fuel to a biomass plant, there also are opportunities, which may be foregone in the future. The fuel supply plan for an individual biomass plant should recognize and plan for this contingency.

6.3 RENEWABLE POWER BACKGROUND

The governing principle for selling power from small renewable power facilities to utilities was established nationally by PURPA. That act required regulated utilities to purchase power from independent facilities meeting certain criteria. The facilities meeting the criteria are called QFs. By law, utilities must purchase power from independent producers at the utility's "avoided cost". A facility could only be a QF if it used renewable or waste fuel, or was a highly efficient CHP facility. Avoided cost is the incremental cost an electric utility avoids incurring by purchasing an equivalent amount of power from a QF. The calculation of avoided cost and inclusion of that rate in a contract was left to each state to implement. In Montana, the law is implemented by the PSC.

Subsequent laws and regulations required the regulated utilities and power marketing agencies to "wheel" this power across their systems to other buyers, if requested. In addition later laws established mechanisms to value the “wheeling” service. This "open access" transmission principle often allows renewable producers to move their power from regions with low valued markets to higher valued markets in other states. Projects using this wheeling service, as opposed to selling to the local utility at avoided costs, register with the FERC as an EWG as opposed to a QF.

The value of renewable power in a given state is governed by a combination of the utility's inherent avoided cost, by regulatory policies adopted by the PSC, and by the existence of a RPS within a given state. The RPS is a statute that requires utilities within the state to acquire a certain percentage of their total power requirements from renewable sources by certain dates. Montana has such a statute, passed in 2005, that requires investor owned utilities and competitive electricity suppliers to obtain 5 percent of their power from renewable resources during 2008–2009, 10 percent during the period 2010–2014 and 15 percent for every year thereafter, beginning in 2015. The state did not require publicly owned utilities to meet such a program, but urged them to adopt similar goals.

Montana's law allows the utilities, primarily NorthWestern Energy, to meet the standard by the purchase or production of renewable energy directly, by the purchase of RECs separately from the underlying energy, or by a combination of the two. The RECs can be purchased from other renewable energy producers throughout the west to meet this standard. There is a limit on what the utility must pay above existing costs to meet the standard, and may instead pay a penalty of $10 per Megawatt hour (MWh) for any shortfall in the program.

The Montana RPS law includes requirements for the utilities to purchase power from Community Renewable Energy projects of 25 MW or less (originally 5 MW) in amounts of 50 MW per year for 2011–2014 and 75 MW thereafter. Community Renewable Energy is defined as projects where local owners have a controlling interest, and would therefore include sawmills that are part of this study. Again, most of this compliance burden falls on NorthWestern Energy.

As in most western states, Montana's electric service is provided by a mix of investor owned utilities and publicly owned cooperative utilities. In the western portion of the state, where the participating sawmills are located, the only sizeable investor owned utility is NWE. NWE primarily serves the more densely populated portions of the state.

The more rural portions of western Montana are served by a series of locally owned COOPs. The COOPs receive the majority of their power supply from Bonneville Power Administration, sometimes with final delivery by NWE. In the case of the 7 participating sawmills, 5 lie within the service territory of NWE. Pyramid Mountain Lumber lies within Missoula Electric Cooperative's territory and F.H. Stoltze Land and Lumber Company is located within the Flathead Electric Cooperative service territory.

Several potential complications in meeting NWE’s RPS objectives with sawmill CHP projects are that the RPS requirements do not apply directly to MEC or FEC, nor are these publicly owned utilities required to wheel power across their lines to other utilities.

6.3.1 Avoided Cost Rates in Montana

Montana's calculation of avoided cost at the PSC has always yielded relatively low values because of NWE's available base of coal and hydro generation. Therefore, when increases in natural gas prices across the west in recent years temporarily raised avoided cost calculations in some states to $80 per MWh and higher, Montana's calculation has stayed near $50–$60 per MWh. This rate cannot support the construction of a biomass CHP facility. NWE has also been able, to date, to fill its RPS requirement with relatively low cost, but intermittent, wind power from east of the Rockies.

Notwithstanding the current avoidable cost level in Montana, 2010 brings a doubling of NWE's RPS requirement to 10 percent, and the following year (2011) starts the requirement for the first 50 MW of Community Renewable Energy. Also, federal legislation is being debated that could create a national RPS of 20 percent. This would raise the Montana standard over time. Potential federal carbon legislation would also increase the cost of fossil fuel power, adding upward pressure on Montana's calculation of avoided cost.

As it stands today, Montana's current avoided cost is insufficient to create development of biomass CHP within Montana. NWE has, in the past, held RFP's for renewable power in Montana, and has received proposals from Montana sawmills, but these proposals have not advanced. One concept that may change this dynamic is to recognize, in avoided cost pricing, the legitimate value to the Montana electric system of having a network of dispersed, firm renewable power in western Montana at sawmill locations. Firmness is a measure of the reliability of the resource, particularly during peak periods, and is typically compensated in the form of an earned capacity payment in addition to standard energy payments. NWE has a rate schedule (Number QFLT1) that includes this concept, though it uses an annual earning period and only boosts total revenue above avoided costs by about $8 per MWh.

6.3.2 Other Renewable Power Market Opportunity Concepts

Identifying a power/REC sales combination that will support a minimum level of return for a project’s owner is absolutely critical to moving forward with any biomass CHP development in Montana. The following section explores a number of renewable power market opportunities that may provide independent power producers with greater value for the power they produce.

6.3.2.1 Location Price Adder

One concept that could be explored with NWE and the PSC would be to grant a location-based price adder (an additional price allowance) based on the value to grid operations of certain sawmill CHP locations that enhance local reliability and voltage support. At utilities in some western states, this takes the form of waiving the system transmission loss factor (typically 3 to 7 percent) that is embedded in avoided cost rates. Also, because the project will be located at sawmills, which will have a constant dry kiln load that reduces power production capacity; the sawmill owners might be willing to shut down the sawmills and dry kilns for a limited number of peak hours per year (e.g., 40 peak hours) during certain grid conditions. With the dry kilns not operating, the extra steam flowing to the T-G would give a sizeable bump in net power output from the sawmill CHP site precisely when it is needed to meet peak demand.

6.3.2.2 Shortened Capacity Payment Earning Period

Another very effective tool for enhancing the economics of biomass CHP projects is shortening the capacity payment earning period to just those times when capacity is truly valuable to NWE – for example, during hot summer weekday afternoons. In addition, the energy payment rate could be varied based on “on” and “off” peak times during the course of the day and “on” and “off peak times during seasonal changes in power demand. The advantage of such arrangements to NWE is that from the utility's perspective, the CHP plant looks and reacts as if it were one of NWE’s own assets. Thus, the CHP plant would match the utility's outside purchase options. Finally, such an arrangement would require the CHP plant to be reliable in order to capture these benefits.

This arrangement allows the biomass CHP owner to match periods of high dry kiln steam load with low value power periods. The arrangement does the same with required maintenance outages. Most importantly, this contract structure creates seasonal off peak periods during which the operating margin between the lowest value electricity and the highest priced fuel cost is very low, and so if fuel supply is tight due to inclement weather or market conditions, the CHP owner can curtail output with a less significant loss of margin. This flexibility ultimately makes it easier for the facility to be financed. In this case, what is good for the utility (NWE) is also good for the biomass CHP owner. This contract structure has been used successfully by biomass projects in other jurisdictions to create the proper alignment with the interests of the purchasing utility and to also lower risk of both price and volume of fuel to allow easier financing. This structure should certainly be a point of discussion between NWE and the Montana sawmills.

6.3.2.3 Bonneville Power Administration Tier II Power

As mentioned previously, two of the potential CHP plants lie within COOP service territory: Pyramid within MEC at Seeley Lake and Stoltze within FEC at Columbia Falls. The power needs of these two utilities have historically been supplied by BPA at rates reflecting the availability of power from the Columbia River hydro system. The hydro system output is fixed, or slowly declining, while loads of its preference customers continue to go up (last 2 years excepted).

BPA has notified customers that effective October 1, 2011, BPA will no longer supply the needs of its customers for growth energy unless the customer signs up for its growth from what is known as Tier II power. However, the customer does not know what the price will be for the Tier II power. BPA will purchase project output or market power to supply that load. Customers are allowed to purchase the growth increment outside of BPA, and if this is done, BPA requires that power to appear in "blocks" at the bottom of the loading order, and only then will BPA provide load following services above those blocks. This concept actually favors firm resources such as biomass CHP, which can indeed be represented as a block as opposed to more intermittent resources.

In addition to BPA purchasing Tier II power for its customers, there are various buying and aggregation groups of BPA customers, including Montana COOPs, that have formed to buy this increment themselves. One or more of these groups or the BPA may represent an opportunity for sale of power from one of the COOP based projects. Nothing would stop a sale of COOP based power to NWE either, so long as the mill owner can arrange with the COOP to wheel the power to NWE. Both MEC and FEC have direct interconnections with NWE, as does BPA. One of these options needs to develop quickly, however, as loss of stimulus bill programs (explained later) will make the power from these facilities more expensive later.

6.3.2.4 Sale to Federal Facilities

A long-shot opportunity is the sale of biomass power to a federal agency, since all federal agencies are under a mandate to purchase at least 7.5 percent of their power from renewable sources, with a preference for projects developed at federal facilities. This renewable mandate can be met through the purchase of renewable power directly, or through the purchase of RECs disassociated from the power.

6.3.2.5 Sale Outside of Montana

Within the larger Western Electricity Coordinating Council grid there are numerous states with RPS requirements, though none in the states bordering Montana. The largest market in the west is California, which has a 20 percent by 2010 mandate (which it will not reach) and a stated goal of 33 percent by 2020.

To reach these markets, transmission service must be purchased from each of the intervening transmission owners. This "pancaking" of transmission costs often eliminates all of the benefits arising from selling the power to a higher value market outside the state. In addition, since high voltage transmission is essentially a "common carrier" function, all of the transmission rights may have already been sold to others.

6.3.2.6 Sale to Local Markets without RECs

Another concept is to sell the power locally and sell the RECs into another market separately. The Montana PSC has made a ruling, similar to other western states, that the sale of power to the utility under avoided cost pricing does not also transfer the RECs since avoided cost was determined using a fossil proxy plant. This ruling would make it possible to have two separate transactions.

In looking at western RPS markets, however, one would quickly find that REC pricing is very low, typically well under $10 per MWh. This market is established primarily by the voluntary purchasers, people and businesses who agree to pay extra for "green" power. The utility then procures RECs on behalf of those customers. Since most western RPS standards do not ratchet to significant levels prior to 2015, this leaves only Montana and California as the markets that have significant requirements in 2010. NWE is currently "long" on RECs and the Montana legislation allows them to carry forward RECs for up to 2 years. As a result NWE will not be driving the REC market.

California recently voted to allow a limited program using tradable RECs (or TRECs as they are known in California) from throughout the WECC for RPS compliance, though that decision has been stayed temporarily. Power must be brought into the state "bundled" in most instances, but up to 25% of a utility’s RPS requirement can be met by these TRECs. For the last 6 years, California has been unable to increase the percentage of renewable power in the state above 12 to 13 percent, so the recent vote on allowing TRECs is expected to create some market opportunities for potential Montana projects. What is not known, however, is how quickly the market structure will develop to support bankable long term transactions. The concept of a local power sale in Montana and a long term REC sale to California is intriguing, but a long way from creating a market that would lead to development of sawmill based biomass CHP in Montana.

In summary, arriving, in advance, at a power/REC sales combination that will support a project financial model is critical to moving forward with any biomass CHP development at sawmills in Montana.

CHAPTER 7 – INCENTIVE PROGRAMS & PROJECT FINANCING

7.1 CHAPTER SUMMARY

The following section provides a description of state and federal renewable power incentive programs and project financing alternatives.

The findings are that at the state level, an alternate energy investment tax credit and a property tax reduction for renewable production facilities are available. At the federal level, an investment tax credit/production tax credit election is available. The production tax credit is currently worth 1.1 cents per KWh against federal income tax liability for the first 10 years of a project's operating life. The Stimulus Bill added an election in Section 48 to take an ITC equal to 30 percent of the capital cost instead of the production tax credit. The ITC can be taken in the first year of operation against federal income tax liability. The ITC can be traded for a grant equivalent to 30 percent of eligible project costs for those without the tax liability to use the ITC. Also available are a CHP Tax Credit, Accelerated Depreciation, and other federal grant programs.

The findings related to project financing are that in the last several years the model for financing has changed dramatically. In the past, a tax equity partner would provide the equity portion of the project development costs in exchange for the early tax benefits provided by the project. Today, such partners are hard to find; instead projects use the 30 percent federal grant as the basis of the project's equity. The programs that support project financing include New Market Tax Credits, RUS Loan Program, Local Revenue Bonds, Indian Energy Bonds, U.S. Department of Agriculture Loan Guarantee, U.S. Department of Energy Loan Guarantee, Site Lease to a Third Party Developer, Partnership with Purchasing Utility, and Prepayment for Power.

The conclusions that can be drawn from these findings are that numerous state and federal incentive and financing programs are available to promote project development.

The following sections provide detailed information about incentive programs and project financing.

7.2 INCENTIVE PROGRAMS

In the world of renewable power, state and national incentives programs often determine whether a project can produce power at a cost that is acceptable to the utility and its ratepayers. This situation clearly applies in the case of biomass CHP development in Montana. A listing of the key incentive programs that can lead to a viable CHP project are listed in the following sections. Programs that are too small to be of consequence or are not certain to be applicable are not included.

7.2.1 Montana Incentives

The following is a list of renewable/biomass power incentives offered in Montana.

7.2.1.1 Alternate Energy Investment Tax Credit

Montana offers a substantial investment tax credit of 35 percent of the value of the project investment (15-32-401 MCA). For a $40 million project investment, for example, a $14 million credit would be generated. This credit can then be taken against the Montana income tax liability of the project owner, but only against income generated by the particular investment that created the credit.

The credit can be taken for the tax year in which the investment is placed in service, with any unused portions being allowed to be carried forward for an additional 7 years, for a total of 8 years. The credit cannot be used in conjunction with any other state energy or state investment tax benefit, nor with the property tax exemption for such facilities. Thus, it becomes a choice of incentive program.

In the case of biomass CHP development in Montana, the choice will almost certainly be to opt for the property tax exemption (explained below) as opposed to the investment tax credit. In the example above, the $14 million tax credit must be taken over 8 years. In order to do so, at Montana's corporate tax rate of 6.75 percent, the project would have to generate a taxable income of $207 million over that 8 year period. In actuality, these projects will have little Montana taxable income during that period as accelerated depreciation (described later) will place the projects in a tax loss position in the early years. These types of projects do not generate the types of income that would make this credit of substantial value with the restrictions that are placed on its use.

7.2.1.2 Montana Board of Investments DOE Guaranteed Loan Program

The Montana Board of Investment (MBOI) has recently been authorized as an Approved Lender under the DOE guaranteed loan program. As an Approved Lender and using the existing Montana Board of Investment’s Infrastructure Loan Program, MBOI can now submit a loan package to the DOE requesting their guarantee of the submitted loan.

Section 1705 of Title XVII authorizes the Secretary of Energy to make loan guarantees under this section, notwithstanding Section 1703 of Title XVII, for only three categories of projects, that commence construction no later than September 30, 2011.

7.2.1.3 Property Tax Reduction for Renewable Production Facilities

There has been a flurry of recent activity in Montana related to the property taxation of renewable generation facilities. The base tax rate for such facilities has been lowered to 3 percent of assessed value annually by establishing such facilities as Class 14 property. This level of property tax is then reduced by 50 percent for the construction period and the first 15 years of operation (maximum of 19 years total) in accordance with H.B. 3 that was passed in 2007 (MCA-15-6-157). Any application for this reduction must first be approved by the Montana Department of Environmental Quality. In the case of Montana sawmill based CHP projects, this tax reduction is more valuable than the investment tax credit, and thus will be used in the financial model that follows.

7.2.2 Federal Incentives

Over the last five years, an array of federal incentives has been assembled for biomass, particularly for combined heat and power projects such as those anticipated by this study. This accelerated recently with the passage of the American Recovery and Reinvestment Act of 2009 (Stimulus Bill).

7.2.2.1 Investment Tax Credit/Production Tax Credit Election

Since 2005, biomass projects have been able to claim a Section 45 PTC of 1.1 cent per kWh against federal income tax liability for the first 10 years of a project's operating life, with the 1.1 cent amount escalating with general inflation. That credit could be used in a consolidated return and carried forward for up to 20 years. The Stimulus Bill added an election in Section 48 to take instead an Investment Tax Credit equal to 30 percent of the qualifying total capital cost. The tax credit can be taken in the first year of operation against federal income tax liability. In other words, a developer could choose either the PTC or the ITC.

The ITC can be further traded for a grant of an equivalent amount (30 percent of eligible project costs) from the U.S. Treasury at plant commissioning. In order to qualify for the ITC election, a project must be under construction by the end of 2010 and be completed by the end of 2013. Grants cannot be applied for after October 1, 2011. Grants lower the depreciable asset base of the project by one half of the grant amount, but are not taxable for federal income tax purposes. Legislation has been introduced in Congress to extend the grant feature for startup dates through the end of 2012, but that legislation has not advanced.

The grant feature of the ITC was added in response to the loss of many “tax equity partners” during the recent financial crisis. Previously, many projects would bring in a tax equity partner, an entity with a high tax liability such as a financial institution, who would invest substantial equity in the project in order to collect nearly all the early year tax advantages. Under a typical arrangement, the tax equity partner would exit the project when its target return was reached. This was a way for the original developer to receive the value of the tax credits that the project would not otherwise have the tax liability to monetize. This new ITC/PTC election/grant is a powerful incentive for projects that can be placed under construction quickly, and will be used in the following financial analysis.

7.2.2.2 CHP Tax Credit

Also in Section 48 of the tax code is a CHP ITC of up to 10 percent of project cost for projects that use steam sequentially for both power production and process heat. The

Montana mill projects would qualify for this incentive if at least 20 percent of the net heat energy is used for each of power generation and process heat, which is a likely scenario.

The CHP credit also has an efficiency test and a size test. The full 10 percent ITC can only be claimed if the project has an overall thermal efficiency of 60 percent (power plus steam). This is a difficult threshold for a biomass project to pass. A prorated amount is awarded for lower efficiencies. Also, the full credit is available only up to 15 MW of capacity, with reductions for larger projects and a full phase out at 50 MW. Any project must be in service by 2016 to qualify.

Along with the recent passage of the PTC/ITC election mentioned above, other changes were made in Section 48 that dictate that a project cannot collect both the PTC/grant and the CHP ITC. This is unfortunate in the case of the Montana projects, as they clearly would have qualified for both.

7.2.2.3 Accelerated Depreciation

The projects considered in this study qualify for the Modified Accelerated Cost Recovery System depreciation tax treatment. For the boiler and fuel handling portion of the project, which typically represents 55 percent or more of total project cost, the depreciation period is over just 5 years. The MACRS depreciation schedules are used in the following financial analysis.

Also, the Stimulus Bill extended “bonus depreciation” for projects such as these through 2009. The bonus depreciation allows 50 percent of the total project cost to be depreciated in the first year of service, in addition to the typical first year depreciation on the remainder. It appears likely that bonus depreciation will be extended again, and made retroactive to January 1, 2010, as bills have been introduced in Congress to that end. However, the benefits of that treatment are not included in the analysis.

7.2.2.4 USDA Grants

The U.S. Dept. of Agriculture has numerous small grant and loan guarantee programs for rural biomass projects such as those considered in this study. A typical grant for such a project is $250,000 to $500,000. Federal loan guarantees can also be obtained for up to $10 million, with new program changes pushing that amount to $25 million in certain circumstances.

The USDA grant programs have been supplemented by the 2009 Stimulus Bill, with billions of additional dollars having been appropriated by this bill towards expanding these programs. No grant funds from this source have been assumed in the analysis.

7.2.2.5 US Department of Commerce, EDA Grants

The U.S. Department of Commerce Economic Development Administration (EDA) has several grant programs for economic development projects. Their Public Works program funds infrastructure projects that produce private investment dollars and jobs. Eligible applicants are local governments and nonprofits. The average Public Works grant is 1.3 million and requires a 50/50 match or 60/40 match, depending on a region's distress criteria.

EDA also has Economic Adjustment grants for planning, engineering and architecture, and feasibility studies. Eligible applicants are local governments and nonprofits, with a 50/50 or 60/40 match being required, depending on the area's distress criteria.

7.3 PROJECT FINANCING

In the post-financial crisis world of renewable power, obtaining project financing, particularly construction financing, has become extremely difficult, frustrating, and time consuming. In order to move forward with a project, lenders require extreme quality in terms of fuel supply, technology choice, power purchase agreements and steam host credit. Governments (both state and federal) have responded by putting in place, or reviving, loan and loan guarantee programs that transfer some of the risk to the government entity.

For about the last 15 years, the business development model for renewable projects was to find a tax equity partner who would fund the equity portion of the project development costs in exchange for the early tax benefits that the project would produce. The partner might receive 99 percent of the benefits in the early years and then "flip" to a 1 percent ownership position when his equity interest was repaid, with the original developer becoming the 99 percent owner. However, since the onset of the financial crisis, these types of arrangements are very rare.

Today, projects seeking financing need to build equity from the 30 percent federal grant, described in the previous section, that has replaced the tax credit driven project development scenario described above. The 30 percent grant is typically pledged as equity towards a long term financing package that may include loan guarantees from a relevant federal agency. Most lenders will require additional equity beyond the federal grant to assure that the developer has an interest in the successful completion and operation of the project

Were it not for the ongoing financial crisis, the switch to a federal grant system versus a federal income tax credit would be seen as a simplification of the whole process. This is because under a grant system, a project developer simply gets a check for nearly 30 percent of the total cost of the project, which can easily be used as equity in the project, which in turn simplifies obtaining a loan, which in turn allows construction. However, a big issue with the grant program is a dual timing problem.

The dual timing problem typically occurs as follows: a developer cannot file to get preapproval of the federal grant until the project is "under construction". To get to the point of being under construction the developer needs to complete interconnection/transmission studies, begin the long-lead time permitting process, complete financial modeling and preliminary engineering, and contract for equipment.

The developer must also secure the following: property, a steam host agreement, a term sheet for sale of power. As a result of meeting all of these requirements, the developer may have well over $1 to 2 million invested before becoming eligible to even apply for qualification for the federal grant. Secondly, even a prequalified developer must complete construction and startup in order to certify expenditures and apply for the grant check. In other words, the developer has to spend a substantial amount of money prior to being qualified for the grant. In addition, the developer must commit all required capital before receiving the grant check.

Given some of the problems just outlined, the topic of project finance is highly complex and transitional at this point in time. The project financing climate has improved from the depths of the financial crisis, but is a long way from normal. Various programs are being put in place to help, but these are highly project and site specific, with applicability being determined by such things as the poverty level of the host community or what entity is purchasing the power.

The following sections list examples of current financing vehicles and assistance programs.

7.3.1.1 New Market Tax Credits

This is a federal program whereby the project debt lender can claim a federal tax credit of up to 38 percent of the value of the project loan over 7 years. This program is only applicable in communities with a high poverty level or low income relative to state averages, and requires a third party who has an existing allocation of credits to apply. At the project level, the net effect is a reduction in long term debt interest rates of 1 to 2 percent. Currently, only two of the proposed project locations (St. Regis and Townsend) qualify for this program, but the 2010 Census may produce other communities meeting the program’s criteria.

7.3.1.2 RUS Loan Program

A new federal loan program is available to generators who sell their project output to a rural electric cooperative or cooperative buying group such as Western Montana G&T Cooperative. In that case, the borrower can obtain up to 75 percent of the project cost as debt financing for up to 20 years at an interest rate of 3.5 to 4 percent. The program is most applicable to Pyramid in MEC territory and Stoltze in FEC. The debt is not available for construction and can only be put in place at startup.

7.3.1.3 Local Revenue Bonds

In Montana, cities and counties are able to issue tax exempt bonds to support development of private renewable energy facilities. The bonds are repaid by the project, with no recourse to the public entity. There is a limit on the amount of bonds that can be outstanding at any point in time within the state. The value of these bonds, beyond the low interest rate, is that they can be issued at project initiation and thus provide construction financing as well as long term debt.

7.3.1.4 Indian Energy Bonds

Indian Tribes may also issue tax exempt bonds for energy projects under authority granted to them by the American Recovery and Reinvestment Act. There is a national limit on the amount of bonds that can be issued for this purpose, and the development must be on tribal lands.

7.3.1.5 U.S. Department of Agriculture Loan Guarantee

The USDA has a longstanding loan guarantee program that can provide a federal guarantee of loans for up to 75 percent of the project cost on a long term basis. This is a competitive process, and Congress provides the USDA with the ceilings on the amount of loans that can be guaranteed. The USDA can guarantee up to $25 million in loans to an individual project, with the net effect of the guarantee being to lower interest rates in the market by 1 to 2 percent, thereby making credit more readily available to a project.

7.3.1.6 U.S. Department of Energy Loan Guarantee

This is a new loan guarantee program put in place by the ARRA. It is designed to guarantee loans for innovative technology and biomass CHP projects qualify under the program. Again, Congress provides the total loan ceiling, and the process is competitive. The program does not appear to have the same individual project ceilings as the USDA program, and the net effect on interest rates is the same.

7.3.1.7 Site Lease to Third Party Developer

Several western sawmills are pursuing a business model whereby they lease a site on sawmill property to an experienced biomass energy developer who constructs a biomass CHP project. There would be numerous contracts between the parties for fuel supply, steam/condensate sales, water/wastewater, ash disposal, operation and maintenance, etc. The biomass energy developer would develop the capital sources and market the power for its own account. This is a mechanism for the sawmill owner to avoid the capital investment while still retaining some of the benefits of the development (new steam source, more stable, or higher byproduct values).

7.3.1.8 Partnership with Purchasing Utility

Many renewable RFPs that have been issued recently in the West have included options of a partnership with the purchasing utility or sale of the project to the utility in the future. This arrangement potentially brings the utility's capital raising strength and a lower interest rate into a project. A guaranteed sale, for instance after development and 5 years of operation, will give lenders the comfort they need to fund the construction. The 5 year hold period prior to sale is the amount of time it takes to extinguish any repayment obligation under the federal Section 1603 ITC grant program described previously.

7.3.1.9 Prepayment for Power

When the power purchaser is a public entity, such as a city or a public utility district, they may be allowed by law to issue low interest bonds for the pre-purchase of power from the proposed project. This mechanism allows the developer to tap lower interest financing not otherwise available to them and to do so earlier in the project so that the funds can be used for construction. Deals such as this are often talked about, are very complex, and are not often completed.

Typically, only a portion of the above list of financing options will be available in a given location. The sawmill owner must decide the ownership structure and level of risk that is acceptable. The first point of contact should likely be with the mill owner’s bank. In order to participate, the bank would likely do so as part of a syndicate of banks, so as to lower the risk to any one bank. Equity requirements will be high during both construction and operation, almost always 30 percent or more of total project cost, and the equity portion will be expensive if acquired from independent investors or investment groups. Fortunately, the 30 percent federal grant allows equity substitution at startup, so outside equity investors may only be in place for a limited period of time.

In today's risk-averse finance world, the owner will not be able to employ unproven new technology, despite its promise, and manufacturer guarantees must be ironclad and backed with a strong balance sheet. The developer will likely have to accept all future environmental costs, with no pass through to the utility, in order to obtain an acceptable power contract. Likewise, fuel risk will be on the developer, though this risk can be mitigated by the contract structures previously described.

Though the above list is daunting, there are quality biomass CHP projects that are finding their way through this maze and entering construction today. A quality project by a quality company can be successfully financed and developed.

CHAPTER 8 – PROTOTYPICAL MONTANA SAWMILL CHP FACILITY

8.1 CHAPTER SUMMARY

The following section provides a description of a prototypical CHP facility at a western Montana sawmill in terms of its fuel supply, size, technology, relationship to the sawmill, environmental permitting, capital and operating costs, financial analysis, and environmental and economic impacts.

The key findings are that the size of the prototypical plant would be 18 MW and have a 150,000 PPH boiler. Such a plant would require about 121,000 BDT of fuel annually. The plant would have a total capital cost of $53.6 million. The fuel supply analysis revealed that the prototypical plant would have a total of 153,200 BDT of fuel available within a 40 mile radius and 279,000 BDT of fuel available within a 70 mile radius. The only fuels considered for sizing the plant were mill residues, logging slash, and urban wood waste. The average delivered cost of fuel from that combination of sources was estimated to be $29.05 per BDT. This average fuel value represents the cost of no single source of fuel, but is the weighted value of all sources of fuel available at a given site. Additional fuel from forest management treatments are likely to be available to augment fuel supply, but were not modeled as a fuel source for the prototype CHP plant.

The financial analysis revealed that the CHP plant would have to sell power at a rate of $88 per MWh in order to provide the owner with a 12 percent return on their investment. It is not conceivable that any owner would provide 100% equity to a transaction, but it is a common metric in the forest products industry to first evaluate a project on this basis before turning attention to financing possibilities. If the owner takes advantage of the available financing programs, the required power sales price may drop as low as $78 per MWh in certain unique circumstances and still achieve the target return. Every $1.00/BDT change in the average delivered cost of fuel changes the required power sales price by $0.80/MWh to achieve the target rate of return.

The environmental impact of biomass energy, compared to coal, is that it is less polluting than coal except for CO levels, and emits slightly higher levels of particulates. Biomass energy also emits lower levels of greenhouse gases than coal because the combustion of biomass is viewed as a carbon neutral process. The air quality benefits of replacing coal power with one prototype biomass energy plant, cumulated per year are estimated to be between $2.0 and $11.1 million, or $14 and $75 per MWh. Offsetting those economic benefits would be an estimated $5.6 million in increased annual cost to NWE for purchasing power when biomass is compared to the mid-C power rate, or an increased annual cost of $2.6 million when biomass is compared to wind power.

The analysis of the economic impact of biomass energy revealed that construction of a prototypical CHP plant would directly create 73 jobs and $7.3 million in wages paid annually. Construction would also create 76 indirect jobs, 67 induced jobs, and an estimated $2.0 million and $2.1 million in annual wages respectively. Finally, the ongoing operation of the plant would directly create 13 jobs and $2.3 million in wages paid annually. Ongoing operation would also create 17 indirect jobs and 13 induced jobs and $1.15 million and $800,000 in annual wages respectively.

The conclusions that can be drawn from these findings are that:

- Fuel supply is not expected to be a limiting factor.
- Biomass energy has significant environmental benefits that occur in the form of reduced emissions of greenhouse gases relative to coal fueled power plants.
- Biomass energy creates significant local and regional economic benefits.
- The required power sales price at the prototypical CHP plant is high relative to other power costs in Montana, but appears "doable" if the environmental and economic benefits of biomass energy are also considered.

The following sections provide detailed information about the prototypical CHP plant.

8.2 ESTIMATED BIOMASS VOLUME & COST AT THE "PROTOTYPICAL" CHP PLANT

As described previously, for the purpose of sizing the prototypical CHP plant the project team only considered fuel available from mill residues, logging slash, and urban wood waste. Table 22 summarizes the amount and cost of fuel available at the prototypical plant. The fuel volumes and costs shown in Table 22 are averages that represent all of the mills, but are specific to none of the mills.

Table 22
Estimated Volume and Cost of Biomass Fuel Available to a "Prototypical" CHP Plant in Western Montana

	40 Mile Radius		70 Mile Radius	
Fuel Source	**Volume (BDT)**	**Cost ($/BDT)**	**Volume (BDT)**	**Cost ($/BDT)**
Mill Residues	80,100	28.02	80,100	28.02
Logging Slash	61,600	43.47	167,700	50.97
Urban Wood Waste	11,500	22.67	31,600	28.22
Total	**153,200**		**279,400**	

It is important to note a number of items related to the information shown in Table 22.

- Both RY Timber sawmills were lumped together. This is because RY Timber does not need a boiler at either of its sawmill locations since all lumber is air-dried rather than kiln dried. As a result, it makes more economic sense for RY Timber to build a single large plant at one of the RY Timber mill sites rather than building two smaller plants at each mill. In addition, the Eagle Stud Mill was excluded from the calculation of the average because it is much smaller than the other mills included in the study.
- The mill residues cost shown in Table 22 is the weighted average market value for all mill residues (pulp chips, sawdust, bark, and shavings) f.o.b. the sawmill bins. The weighted average shown is based on the average market value of mill residues as reported by the mills over a five year period from 2005 through the third quarter of 2009. One exception is that pulp chip values were not based on the five year average, but rather on market prices reported by the sawmills after the closure of the Smurfit Stone Container Corporation pulp mill in Frenchtown, MT.
- The logging slash volume shown is based on projected (or historic in the case of privately owned timberlands) timber harvest levels, as reported by various Montana landowners. It was assumed that each thousand board feet of logs harvested would yield 1.1 bone dry tons of logging slash. That volume was then discounted by roughly one-half to account for logging systems that do not accumulate slash at landings and for logging roads that are inaccessible to chip vans.
- The logging slash cost is based on the assumption that logging slash is not collected for the specific purpose of use as fuel. Instead, only material that naturally accumulates at landings as a result of timber harvesting would be processed for use as fuel. As a result, no cost for bringing the slash to the landing is assumed.
- It was assumed that a horizontal grinder would process the slash, that the material would be transported in chip vans, and that the material would average 45 percent moisture content.
- U.S. Census data and published reports that estimate the per capita production of urban wood waste were used to estimate urban wood waste volume. Since, the material is currently largely unused, it was assumed that only one-third of the material would be utilized.

8.3 PROTOTYPE CHP PLANT SIZE

Based on the fuel volumes and costs shown Table 22, the team identified an appropriately sized prototype CHP plant with the following specifications:

- A 150,000 pound per hour steam 900 psig/900 degree Fahrenheit wood-fired stoker rotating grate boiler and an 18 MW nameplate extraction/condensing turbine-generator.
- The prototype CHP plant would operate 8,200 hours per year. On this operating schedule, and at this size, the plant will consume 121,125 BDT/yr, assuming the fuel has an aggregate annual moisture content of 40 percent.

Note that the 121,125 BDT annual fuel requirement is only about 80 percent of the fuel estimated to be available within a 40 mile radius of the prototype plant. This assures that the CHP plants at each sawmill would be less likely to compete for logging slash and urban wood waste (and thereby drive-up fuel costs), but still have enough capacity to combust all of the mill residues in the event that markets for these materials no longer exist.

It must be emphasized that consuming all mill residues as fuel certainly is not the expected fueling scenario since it is likely that higher valued mill residual materials will continue to flow to traditional markets, (e.g., particleboard, MDF, and pulp mills). Instead, it is expected that a significant percentage of the required fuel will come from fuel that was already being burned at each sawmill's existing boiler, the standing small diameter timber (as it becomes available), logging slash, and urban wood waste.

The project team has included all mill residues in the analysis because the CHP projects are stronger, both economically and in the financial markets, if they can show that they can be fueled internally from mill residues, if necessary.

8.4 CHP PLANT RELATIONSHIP TO THE SAWMILL

The financial model used for this project has been prepared so that the sawmill is neither advantaged nor disadvantaged financially by the decision to invest in a CHP facility. In other words, the model is structured so that the sawmill sells residual materials to the CHP facility at exactly the historic market value of the various mill byproducts. In addition, any services (e.g., water) provided to the CHP plant are paid for in full. There is no ground lease between the parties. The sawmill's existing boiler, if any, is shut down and steam is purchased from the CHP plant for the sawmill's current cost of production, including the value of the fuel currently burned.

By using this methodology to define the relationship between the sawmill and the CHP plant, the decision to invest in the project stands on its own, without intertwining the CHP project's economics with that of the sawmill. The result of such a relationship is that the sawmill gains a floor under the value of its residual streams because they can always be sold to the CHP plant. However, the sawmill also has the option of selling mill residues to higher value markets because they can be substituted with urban wood waste, logging slash, and forest management treatment fuels.

8.5 TECHNOLOGY AND PROJECT EXECUTION

Standard stoker grate technology was chosen for the boiler and a standard multistage steam T-G for the turbine. The required cooling was provided by a standard multi-cell wet cooling tower. As described in Chapter 4, all of these technologies are proven many times over.

Budgetary quotations were obtained from Wellons, Inc. for the supply of the required equipment for both the prototype CHP plant and the equipment specific to each sawmill participating in the study. The quotations from Wellons were for delivering the project on a turnkey basis. The turnkey approach to developing a power plant minimizes the owner’s risk of the plant not operating as designed since the vendor provides performance, completion, and environmental guarantees. Wellons is a leading supplier of such equipment to the forest products industry, on such a contractual basis, and so the cost estimates supplied are considered to have a high level of credibility.

The Wellons scope begins at the fuel storage silos ahead of the boiler and extends through to the stack on the boiler side. On the T-G side, the scope extends from the steam line to the T-G through to the high side of the main transformer connecting to the utility.

The fuel receiving, processing and storage facilities are handled outside of the Wellons scope and are integrated with what facilities already exist at the sawmills. Likewise, the costs of interconnecting to the utility beyond the onsite substation are beyond the scope of Wellons, but are included separately in the financial model. The mill is responsible for all permitting and construction management, site preparation, working capital, interest during construction, etc. Working capital consists of the cost of spare parts, initial chemical purchases, an initial 6 weeks of fuel supply and the cost of the first month Operating and Maintenance expense.

The design and method of delivery is such that the project can be completed in a timely manner, is designed to combust the available fuels successfully, can integrate successfully with the sawmill and interconnect with the utility, is shown to be financeable within the current financial environment, and can meet the requirements of Montana's DEQ.

8.6 ENVIRONMENTAL PERFORMANCE

For the purposes of the study, the prototypical plant boiler was assumed to be equipped with the following air pollution control equipment:

- A three field electrostatic precipitator and a multiclone mechanical collector for particulate control.
- Multiple levels of controlled, heated overfire air for control of CO and VOCs.
- A selective non-catalytic NOx removal system consisting of a urea metering and injection system.

- A complete set of continuous emission monitoring devices for NOx, CO, CO_2, O_2 and opacity, with an automatic data acquisition system,

With these devices, the project can continuously meet the following set of environmental performance criteria typical of what might be imposed by the Montana DEQ (see Table 23).

Table 23
Montana DEQ Environmental Performance Criteria

Pollutant	Permitted Level (Pounds per MMBTu)
Carbon Monoxide	0.240
Nitrogen Oxides	0.150
Particulate	0.015
Volatile Organic Compounds	0.005

Note that despite the prospective CHP boilers being larger than the existing boilers at the sawmills, it is expected that if the CHP plants are built there will be reductions in all on site pollutants except NO_x. This is because the CHP plants will have much more modern pollution control technology.

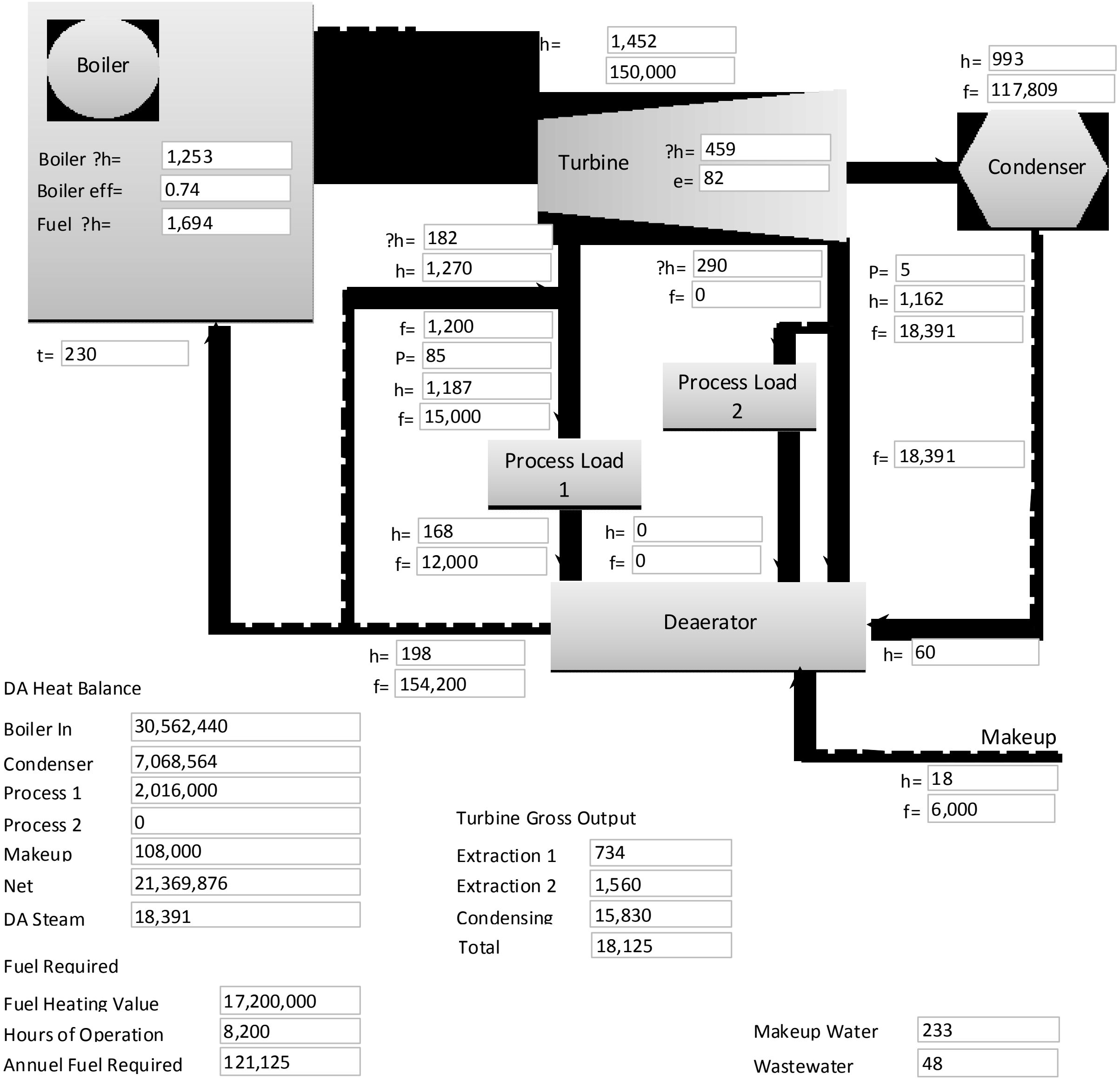
A complete heat balance for the prototype facility is included as Figure 6. In the lower right hand corner are the calculated water and wastewater requirements. The usage levels were calculated using typical incoming water quality criteria. It shows a makeup rate of 233 GPM and a blowdown rate of 48 GPM. The vast majority of this water is used to replace water evaporated in the 3 cell wet mechanical draft cooling tower. That water can be relatively low quality. For example, it could be the effluent from a modern wastewater treatment facility. Only 12 GPM (5 percent) would have to be higher quality water required for the boiler makeup.

The project team reviewed water availability at each of the sawmills and found that each has substantial well capacity or water rights in support of a project. However, depending on the appropriate size of the CHP plant at a given sawmill, more water may need to be acquired. In the event the properly sized project requires more water than is available, other cooling options could be used. However, those options would increase the capital cost and lower project efficiency. These decisions are all part of a typical permitting process.

The 48 GPM of wastewater coming from the CHP plant is high quality water, though warm. It can be used for a variety of purposes within the sawmill, including saw cooling, bearing cooling, road or log sprinkling, ash wetting. Though on site storage of this water may be necessary, it is not expected to be discharged off site.

The two ash streams: <u>bottom ash</u> from beneath the grates and <u>fly ash</u> from the pollution control devices, will be collected separately because of their different characteristics. The bottom ash will be shipped to a sand and gravel operation as aggregate material, while the fly ash will be shipped to a mulch preparation yard for incorporation into landscaping products, used on fields or pastures as a soil conditioner, or land filled. The cost of hauling and disposal is included in the financial model.

Figure 6
Complete Heat Balance of Prototypical CHP plant



8.7 BUDGETARY CAPITAL COST

As previously described, the project team obtained a quote from Wellons, Inc. for the required equipment. The quote provided by Wellons was on the basis of delivering a turnkey project. That cost, as well as any required items and costs outside of Wellons' scope (e.g., fuel handling equipment, interconnection, financing, etc.), are shown in Table 24. These additional expenditures were estimated based on a combination of the project team's experience and actual costs for similar items in recently completed or currently under construction projects. As shown in Table 24, the budgetary capital cost estimate for the prototypical CHP plant is nearly $53.6 million.

Table 24
Budgetary Capital Cost Estimate ($ 000s)

Capital Cost Item	Cost
Equipment, Engineering, and Construction Costs	41,071
Project Management/Permitting/Engineering	800
Site Prep/Roads/Fencing	500
Working Capital	1,300
Utility Interconnection	900
Fuel Receiving/Processing	3,000
Interest During Construction	3,653
Contingency	2,374
Total Capital Cost	**53,598**
Capital Cost per net MW	**3,062**

8.8 FINANCIAL ANALYSIS

The following sections describe the financial analysis completed on the prototypical plant and the associated assumptions.

8.8.1 Key Assumptions Used to Assess Financial Performance

The project team modeled the financial performance of the prototype CHP plant under the following key assumptions:

- The average fuel cost in year one is $29.05 per bone dry ton.
- Steam for lumber drying is sold from the CHP plant to the sawmill at $4.63 per thousand pounds.
- The plant will operate 8,200 hours per year. After accounting for scheduled downtime and station service (power generated and consumed by the turbine portion of the plant), the prototypical CHP facility will generate 143,423 MWh of power annually.

- All power and RECs generated at the plant (aside from the 3.5 percent station service load served internally) will be sold to the power grid.
- The prototypical plant will require 13 full time employees. Wage rates and fringe benefits typical of other Montana manufacturing businesses were used for the hourly labor. Other labor is available to the CHP facility from the adjacent sawmill, as necessary.
- The routine and major maintenance costs are based on costs experienced at similar operations. The major maintenance costs are based on an annual accrual payment into an account for a major turbine overhaul every seven years and for periodic replacement of the boiler refractory and superheater.
- Project financing assumes 100 percent owner equity (i.e., no long term debt).
- It was assumed that the project would capture the currently available 30 percent federal grant at project startup on 95 percent of the project's total capital cost.
- The MACRS depreciation schedule was used for calculating depreciation costs, but without including bonus depreciation.
- The prototypical plant takes advantage of Montana's 50 percent property tax reduction for the first 15 years of the project's operating life. The model does not attempt to utilize the Montana investment tax credit for such facilities since a choice must be made between the investment tax credit and the property tax reduction, with the property tax reduction being of greater value to the project.
- Federal taxes are included as 35 percent of income. Montana income taxes are included as 6.75 percent of income, and the Montana energy producer's tax was included.
- All expenses are assumed to rise by 3 percent annually due to inflation, with power revenue rising only 2 percent annually.
- The owner requires a 12 percent rate of return on the project.

8.8.2 Pro Forma Income Statement

As shown in the following year one (2012) pro forma income statement (Table 25), the prototypical plant generates the following revenues and expenses.

Table 25
Prototypical Plant Year One (2012)
Pro Forma Income Statement

Revenue/Expense Line Item	($ 000s)
Electric Sales	12,621
Steam Sales	569
Total Revenues:	**13,191**
O&M	4,096
Fuel	3,579
Ash Disposal	87
Total Expenses:	**7,762**
OPERATING INCOME:	**5,429**
– Interest	0
– Depreciation	4,596
PRETAX INCOME:	**833**
+ Book Depreciation	4,596
PRETAX CASH FLOW	5,429
– Net Taxes	(180)
Total Cash Flow Benefit	**5,609**

As shown in the pro forma income statement, the prototypical project generates a 2012 (full year) revenue stream of nearly $13.2 million, of which $3.6 million is used to procure fuel and $4.2 million is used to pay operation and maintenance expenses. This leaves a net operating income of $5.4 million prior to application of depreciation and taxes. The total after tax cash flow benefit is $5.6 million in 2012. After the effect of the boiler's accelerated depreciation is absorbed in the first six years, the project produces after tax cash flow benefits of about $4.2 to 4.5 million annually for the remainder of the 20 year contract from the initial $54 million investment. (Note that a 20 year pro forma is included in Appendix 2.)

Given the preceding assumptions and analysis, the project requires a power purchase price of $88 per MWh, escalating at 2 percent annually for the life of a 20 year contract, in order to provide the project owner with a 12 percent net present value after tax rate of return.

The $88 per MWh revenue requirement is high by Montana standards, but recent contracts at similar price levels exist between Pacific Northwest utilities/power wholesalers and biomass developers. Recent avoided costs filed by NWE with the PSC were well above $60 per MWh. Thus, contracts at the price level identified in this study would be new in Montana. However, having CHP plants at key locations within the power grid, their reliability and the forest health benefits of biomass energy may open options that would enhance typical Montana contract pricing levels.

8.8.3 Sensitivity to Capitalization Strategies

It is instructive to understand how changes in key variables impact financial performance.

Fuel Cost – For every $1.00 per BDT change in the delivered fuel price, there is a change of $0.80 per MWh price in the required sales price of the power to achieve the target return.

Project Financing – The following section provides analysis of the financial results under different financing arrangements. In all cases, we will back calculate the 2012 power price that would satisfy the following criteria:

- Minimum total equity, including federal grant of 30 percent (typical in market today)
- Minimum owner equity investment, exclusive of federal grant amounting to 5 percent of total capital or $2.7 million, invested at start of construction
- Minimum cumulative debt service coverage ratio of 1.75, (pre tax cash flow/debt service)
- 20 year financing, straight line
- Initial loan costs of 3 percent of loan
- Minimum pre tax cash, after debt service, of $1.5 million in every year.

The following financing cases will represent the range of currently available options:

- 8 percent annual debt interest – conventional loan for project, strong financials, no federal guarantee
- 6 percent annual debt interest – federal loan guarantee of $25 million in place or qualification for New Market Tax Credits
- 4 percent annual debt interest – borrowing from RUS based on sale to COOP or group of COOPs

The result of applying these scenarios to the prototype plant are shown in Table 26.

Table 26
Required Power Sales Price
Sensitivity to Project Financing Interest Rate

Interest Rate (Percent)	Required Power Sales Price (2012 Basis) ($/MWh)
8	88.60
6	83.50
4	78.50

These results are for only a single set of assumptions from a myriad of cases that could be prepared. The purpose is to illustrate the value, in terms of required selling price, that is gained by assembling a low interest financing package. As can be seen above, with the required loan covenants, conventional financing actually raised required selling price slightly versus an all equity evaluation.

This prototype plant represents none of the sawmill opportunities in Montana specifically. It is, however, representative of a typical project. Project financial models have been prepared for each of the participating sawmills, using their confidential data, and discussed with the mills. To give an idea of the results, the first year starting price for each mill falls in the range of $83 to $95 per MWh, and the projects range in gross output from 17 to 19 MW, with the existing Eagle Stud Mill CHP plant being refurbished and restarted at 700 KW.

8.9 PROTOTYPE PLANT ENVIRONMENTAL IMPACTS

The project team analyzed the environmental impacts associated with the development of a prototype CHP plant. The following sections describe the findings.

8.9.1 Background

Burning woody biomass fuels to create energy has both positive and negative environmental outcomes. The woody biomass source of energy is often compared to fossil fuels (e.g., coal), which are the most common fuel sources used for generating power for electricity in the U.S. This section is informed by several LCA studies that have documented the environmental impacts associated with the production, transportation and use of biomass as an energy source when compared to coal.

Biomass energy is considered to have fewer impacts in the form of emissions when compared to coal, primarily due to the fact that when burned, fossil fuels release carbon that has been sequestered (trapped under the Earth's surface) for thousands of years. The net addition of CO_2 to the atmosphere is of concern as it is the principal greenhouse gas thought to be responsible for climate change.[4] On the other hand,

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[4] Zamora, Diomy and Charlie Blinn, An Environmental Overview of Woody Biomass Utilization, Extension.org, March 24, 2010.

woody biomass is a renewable energy source as long as harvested areas are regenerated. The process of burning woody biomass is part of the present day carbon cycle. By growing or replanting to replace harvested trees, carbon is taken in by plants, therefore making the use of woody biomass "carbon neutral."

In addition, harvesting non-merchantable trees for energy can help create healthier forests and reduce the risk of wildfires and the severity of those fires. This in turn reduces not only fire suppression costs, but also associated fire costs such as forest rehabilitation costs, water quality/availability costs, lost income to recreation based businesses, and health issues from exposure to smoke.[5] Years of fire suppression in Montana have left many forest lands dangerously overstocked and at risk of intense wildfire. Removing small-diameter, low-quality woody material can help reduce hazardous fuels.

Overstocked forests may also be more susceptible to insect infestation and disease. This is a critical factor in forests affected by the pine beetle epidemic, including the forests of Western Montana. Utilizing biomass for energy production will not single handedly solve the pine beetle epidemic, but will provide another market area for trees that have been infected. In addition, the increased market for small-diameter trees will provide additional incentive to thin overstocked forest areas and indirectly assist in making the forests less susceptible to infestation and disease.

There have been several studies published in the last ten years that have contributed to the understanding of the overall environmental implications of using biomass as an energy source. Many of these studies have examined the environmental impacts using a LCA approach. An LCA takes into account the upstream processes involved in energy production. These studies include the following:

- Mann, Margaret and Pamela Spath, "Biomass Power and Conventional Fossil Systems with and without CO2 Sequestration – Comparing the Energy Balance, Greenhouse Gas Emissions and Economics," National Renewable Energy Laboratory (NREL), Technical Report – 510-32575, January 2004.
- USDA Forest Service, Pacific Southwest Research Station, prepared for California Energy Commission – Public Interest Energy Research (PIER) Program, "Biomass to Energy: Forest Management for Wildfire Reduction, Energy Production, and Other Benefits," CEC-500-2009-080, January 2010.
- Morris, Gregory, "The Value of the Benefits of U.S. Biomass Power," Green Power Institute, NREL SR-570-27541, November 1999.
- Morris, Gregory, "Bioenergy and Greenhouse Gases," Green Power Institute, May 2008.

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[5] The True Cost of Wildfire in the Western U.S. April 2010. Western Forestry Leadership Coalition. www.wflccenter.org

- Spitzley, David and Gregory Keoleian, "Life Cycle Environmental and Economic Assessment of Willow Biomass Electricity: A Comparison with Other Renewable and Non-Renewable Sources," Center for Sustainable Systems – University of Michigan, Report No. CSS04-05R, February 10, 2005.

The benefit-transfer method of economic valuation calculates the values of ecosystem services at a site based on results from existing economic valuation studies conducted elsewhere. For example, the environmental benefits associated with utilizing biomass energy in Montana could be estimated based on the results of the previous studies mentioned above. The environmental benefits of biomass energy are essentially transferred to the proposed development scenarios in this analysis.

The following section discusses the environmental impacts associated with greenhouse gas (GHG) emissions on a LCA basis. These impacts are followed by a review of air quality and pollutant impacts associated with biomass energy. Finally, environmental impacts related to forest health that are associated with biomass energy are discussed.

8.9.2 Greenhouse Gas Emissions

CO_2, methane, nitrous oxide and ozone are the main GHGs, which trap heat in the earth's atmosphere. Scientific evidence shows that the global concentrations of CO_2 and other GHGs are increasing, and may have the potential to affect regional climate and weather patterns.

8.9.2.1 Carbon

Trees and plants remove carbon from the atmosphere through photosynthesis, forming new biomass as they grow. Elemental carbon is stored in biomass, and when it is burned, carbon returns to the atmosphere in the form of CO_2. This cycle is referred to as the carbon cycle and is the reason that the net amount of CO_2 in the atmosphere does not increase with biomass energy. Essentially, the new growth of plants and trees fully replaces the greenhouse gases emitted through the process of energy creation. In contrast, the combustion of coal is from fossilized storage (carbon that was produced and stored millions of years ago). The release of emissions from fossil fuels represents a net addition into the atmosphere at a quantity more than can be sequestered by today's plants, soils, and oceans.

In 2008 and 2009, the State of Montana generated roughly 26 million MWh of power.[6] During those years, coal power accounted for between 15 and 18 million MWh or 63.4

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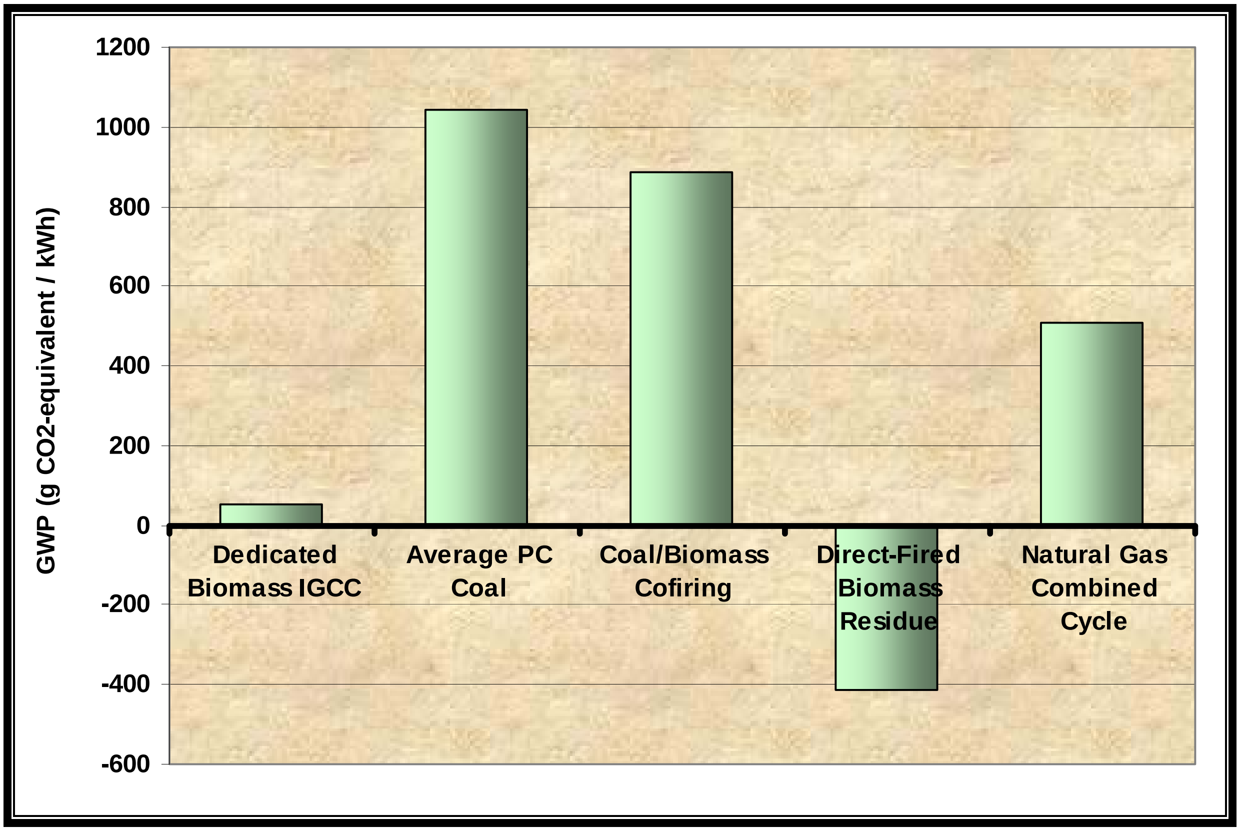
[6] Energy Information Administration, "Power Plant Operations Report," Table 1.6.B Net Generation by State by Sector, Year to Date through December 2009 and 2008, Report No: DOE/EIA-0226, accessed online at http://www.eia.doe.gov/fuelelectric.html.

percent of power generation.[7] Coal power in the State of Montana was responsible for between 18 and 19 million metric tons of carbon dioxide emissions.[8]

Woody biomass emits more CO_2 at the stack than coal power does; however, because woody biomass is part of the active carbon cycle, it is necessary to consider the emissions on a life-cycle basis. Due to this aspect of woody biomass energy production, it is considered to be "carbon neutral" in the combustion process. The combined process of growing, harvesting and using biomass for energy emits less net GHG emissions than fossil fuels. In presenting the results of a comparison of environmental consequences of power from biomass, coal and natural gas, Mann and Smith (with the National Renewable Energy Laboratory in Golden Colorado) show how greenhouse gas emissions per kWh compare for different energy sources. (See Chart 4 below)

Chart 4
Life Cycle Greenhouse Gas Emissions



Source: Mann, Margaret and Pamela Spath, "A Comparison of the Environmental Consequences of Power from Biomass, Coal and Natural Gas," National Renewable Energy Laboratory, Golden Colorado.

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[7] Energy Information Administration, "Power Plant Operations Report," Table 1.7.B Net Generation from Coal by State by Sector, Year to Date through December 2009 and 2008, Report No: DOE/EIA-0226, accessed online at http://www.eia.doe.gov/fuelelectric.html.

[8] Montana Carbon Dioxide Emissions from Fossil Fuel Consumption (1980 – 2007)

From Chart 4, it is obvious that on a LCA basis, the biomass energy options produce the least amount of emissions. The LCA (total system) takes into account the emissions from transporting, handling and burning the energy sources, as well as the upstream sequestration potential of the forest.

Morris (1999) reports similar results in “The Value of the Benefits of U.S. Biomass Power.” Morris compares different disposal techniques (i.e., composting, spreading and open burning), as well as energy production methods (coal and gas) to biomass energy production.[9] Similar results have also been reported from studies evaluating biomass from other types of woody debris. Specifically, Spitzley and Keoleian reported similar GHG emission levels in their evaluation of Willow biomass electricity with other non-renewable sources.[10]

The conclusions of the studies described above show that the comparison of biomass energy and coal power can result in a difference of carbon dioxide emissions of close to 1,000 grams per kWh, and the carbon dioxide equivalent of nearly 25 grams per kWh from reduced methane emissions. In this analysis, a total of 148.625 million kWh per plant are proposed annually. Thus, for the prototypical plant that replaces coal power, the reduced carbon emissions could be as high as 151,330 tons of CO_2 equivalent per plant on an annual basis.

There are certain marketable credits that the proposed plants could be eligible to receive which would contribute to the bottom line of the power production and to financial benefits of the plants in the future. However, the evaluation of environmental impacts focuses on the economic impacts of the project, which includes the social value of GHG emissions and not just the money that could be exchanged for certain marketable credits. The value of greenhouse gases is estimated using price forecasts of market-based trading programs; thus, in this study these market prices are used as a proxy for the social value of reduced greenhouse gases. Also, eligibility for participation in trading programs is not addressed in this analysis because economic values of environmental impacts are being explored, as compared to financial benefits.

In order to derive an estimate of the economic value of carbon reduction and sequestration, a review of potential regulations is necessary. There are several regional carbon cap and trade programs in place or being considered in the U.S., including: Regional Greenhouse Gas Initiative (RGGI), Midwest Greenhouse Gas Accord (MGGA), and Western Climate Initiative (WCI), which may involve Montana specifically. However, for purposes of this analysis, it is most appropriate to consider the national carbon cap and trade program being considered by Congress. The Waxman – Markey bill is one piece of legislation that could dramatically shift the way carbon credits are bought and sold in the United States. The draft bill allows for one billion metric tons of

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[9] Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, Table 2.

[10] Spitzley, David and Gregory Keoleian, Life Cycle Environmental and Economic Assessment of Willow Biomass Electricity: A Comparison with Other Renewable and Non-Renewable Sources, Report No. CSS04-05R, March 25, 2004 (revised February 10, 2005).

domestic offsets and another one billion metric tons from international offset projects. However, entities choosing to offset their emissions through such projects must reduce 1.25 tons of emissions outside the cap for every ton of emissions they offset under the cap. The draft allows for banking and borrowing of allowances and also directs EPA to create a strategic reserve of about 2.5 billion allowances to address unexpected allowance price fluctuations.

Allowance prices in an EPA analysis modeling the cap and trade program proposed in the Waxman – Markey bill were projected to be $13 per ton in 2015 and $17 per ton in 2020.[11] The resulting size of the offset market created from the draft bill would be roughly equivalent to $10 billion annually in domestic offsets, starting in 2012 and increasing in value thereafter. A market of equal size would also be created from international offsets. In the EPA analysis, it is anticipated that most of the domestic offsets will be generated from afforestation (establishment of new forests) and forest management projects.

Other price forecasts related to the Senate companion Lieberman-Warner compliance carbon cap and trade program, which is an older bill but similar in scope to Waxman – Markey, report calculations of between $22 to $61 per ton CO_2 in 2020, and between $48 and $257 per ton CO_2 in 2030. The variations are accounted for in a number of ways: the models each used different assumptions regarding the use of offsets, and each used different assumptions regarding the role of technology, banking, and the use of revenues from the auctioning of allowances.[12]

Using these price forecasts as the basis for the societal value of carbon dioxide reductions, the societal value of the reduction in carbon dioxide equivalents from replacing 148.625 million kWh of coal power (one prototypical plant) with biomass energy in 2020 would range from between $1.9 to over $9 million annually in real figures (2010 dollars).[13] The values projected for 2030 would range from between $7.3 million to over $38 million annually in real figures (2010 dollars). This equates to a range of societal values per kWh of approximately $0.01 in 2020 to a potential high of $0.26 in 2030.

8.9.2.2 NOx and SOx

Morris reports specific air pollutant emission levels in terms of pounds per bone dry ton from data averaged over 34 California biomass facilities, 23 grates, and 11 fluidized-bed burners (see Table 27).

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[11] EPA Analysis of the Waxman-Markey Discussion Draft: The American Clean Energy and Security Act of 2009, Executive Summary, April 20, 2009.

[12] EcoSecurities Consulting Limited, "Forecasting the Future Value of Carbon," A Literature Review of Mid- to Long- Term Carbon Price Forecasts, January 30, 2009, A report for the Northwest Power and Conservation Council (NWPCC), January 30, 2009.

[13] Carbon dioxide equivalents includes CO2 and CH4. CH4 or methane has a Global Warming Potential (GWP) of 25.

Table 27
Emissions from Biomass Energy Plants (Pounds/BDT)

NOx	2.5
SOx	0.15
CO	7.5
HCs	0.025
Particulates	0.45

Source: Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, Table 2 on pg. 9.

Morris also reports emission levels for coal. The coal emissions are reported in terms of units per MWh of energy produced. Biomass emissions factors per BDT from Table 27 above were applied to the prototypical plant to derive an emission per MWh. The differences between coal and biomass air pollutant levels are presented in Table 28.

Table 28
Comparing Emissions from Biomass and Coal (pounds/MWh)

	Biomass (Pounds/MWh)	**Coal (Pounds/MWh)**	**Difference (Pounds/MWh)**
NO_x	2.5	3.1	(1.06)
SO_x	0.15	3.5	(3.38)
CO	7.5	0.96	5.15
HC_s	0.025	0.29	(0.29)
Particulates	0.45	0.14	0.23

Source: Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, Table 2 on pg.9.

Table 28 indicates that wood-fired power plants emit more carbon monoxide than coal. Carbon monoxide in the atmosphere has a greenhouse GWP roughly equal to that of CO_2, and the ultimate fate of carbon monoxide is oxidation to CO_2. Thus, the societal value of CO emissions is considered equivalent, on a per carbon basis, to the value assumed for CO_2 emissions. Table 28 represents the emissions at the stack, and do not account for the LCA or sequestration that occurs in the forests from the growth of woody biomass. As mentioned above, by accounting for this sequestration capability in the active carbon cycle, the carbon emissions are essentially eliminated.

Wood fired plants produce higher levels of particulate matter than coal. However, particulate matter is the easiest emission to control and can be managed using pollution-control devices such as scrubbers, filters, and electrostatic precipitators.[14]

The emissions of NO_x and SO_x are much less in wood-fired plants as compared to coal plants. If wood-fired plants replace coal power plants, the annual net reduction in emissions would be 158,000 pounds (79 tons) of NOx and over 500,000 pounds (251 tons) of SO_x by extrapolating this data to match the size of the prototypical plant considered in this analysis. NO_x and SO_x market values are used in this analysis as a proxy for the societal values associated with these emissions. Prices for NO_x and SO_x have reached as high as $4,500 and $1,600 per ton respectively. Current prices for NO_x are closer to $1,300 and SO_x prices have fallen to less than $100 per ton. By using these current values as a proxy for the potential reduced emissions, a prototypical plant would represent approximately $123,000 in annual benefits associated with reduced NO_x and SO_x emissions, or $0.001 per kWh in 2010 dollars.

Similar emission levels were reported by Spitzley and Keoleian in their Life Cycle Environmental and Economic Assessment of Willow Biomass.[15] The Morris study, referenced above, was written in 2006, when NO_x and SO_x prices were much higher ($9,800 and $4,500 per ton). It is important to point out that price swings in emission credits could significantly impact the results of this evaluation. For example, the prices used by Morris would equate to environmental benefits from NO_x and SO_x in the amount of $0.02 per kWh alone. Therefore, a reasonable range for NO_x and SO_x emission reductions resulting from biomass energy would be $0.001 to $0.02 per kWh.

8.9.2.3 Total Greenhouse Gas Benefits

Based on the assumptions and methodology presented in the previous sections, there are obvious environmental benefits to utilizing biomass for power generation as a replacement for coal power. Quantifying these benefits by using existing and projected environmental credit markets as a proxy, results in a reasonable range of benefits per kWh of $14 to $75 per MWh. This range of results is less than an estimate ($114 per MWh) resulting from a similar study performed by Morris.[16] However, the Morris study included some benefits that may not be perfectly applicable to this evaluation. Table 29 summarizes the societal values and total benefits on a per kWh basis for the prototypical plant modeled in this analysis.

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[14] Zamora, Diomy and Charlie Blinn, Air Quality and Human Health, Extension, March 24, 2010, accessed online at www.extension.org/pages/Air_Quality_and_Human_Health

[15] Spitzley, David and Gregory Keoleian, Life Cycle Environmental and Economic Assessment of Willow Biomass Electricity: A Comparison with Other Renewable and Non-Renewable Sources, Report No. CSS04-05R, March 25, 2004 (revised February 10, 2005)

[16] Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, Table 6.

Table 29
Total Value of GHG Benefits from Replacing Coal Power with Biomass Energy

	Amount (tons)	Social Value Per Unit ($/ton)		Total GHG Benefit of Prototypical Plant (dollars)	
		Low	High **	Low	High
CO_2 Equivalent*	151,330	13	61	1,967,290	9,231,130
NO_x	79	1,300	9,800	102,700	774,200
SO_x	251	88	4,500	22,088	1,129,500
Total GHG Emission Value (Dollars)				**2,092,078**	**11,134,830**
Value ($ per MWh)				**14**	**75**

* CO_2 Equivalent includes carbon dioxide and methane.

** CO_2 prices have been projected as high as $258 per credit, but a more reasonable $61 per credit (2020 credit price projection) is applied in this analysis.

8.9.3 Air Quality

As with GHG emissions described above, the other air pollutant emissions of a biomass energy facility are compared against the traditional coal-fired facility in this section. To release the energy stored in fossil fuels (such as coal), the fuel source must be burned. During the combustion process, a variety of gaseous emissions and particulates are released, including SO_x, NO_x, VOCs, mercury, other toxic compounds, and particulate matter.

These air pollution particles can persist in the atmosphere for several weeks and be moved for many miles in air currents. Environmental effects could include acid deposition; loss of atmospheric ozone, which absorbs harmful UV-B radiation from the sun; damage to plants; and climate change. Also, because air pollution particles are small, they can reach deep within the lungs and enter the blood stream. Over a lifetime of exposure, a person’s ability to transfer oxygen and rid pollutants is impeded. Health effects range from minor irritation of eyes and the upper respiratory system to chronic respiratory disease, heart disease, and lung cancer.[17]

Conventional wood-fired biomass plants typically produce some of the same emissions as coal-fired plants, including CO_2 and CO. However, environmentally, biomass has advantages over fossil fuels such as coal. When biomass is used for electricity generation it is not likely to pollute the atmosphere as much with SO_x and NO_x, as explained above. In addition, biomass contains very little mercury and sulfur, so it does not produce pollutants that cause acid rain. Also, biomass has a lower ash content than

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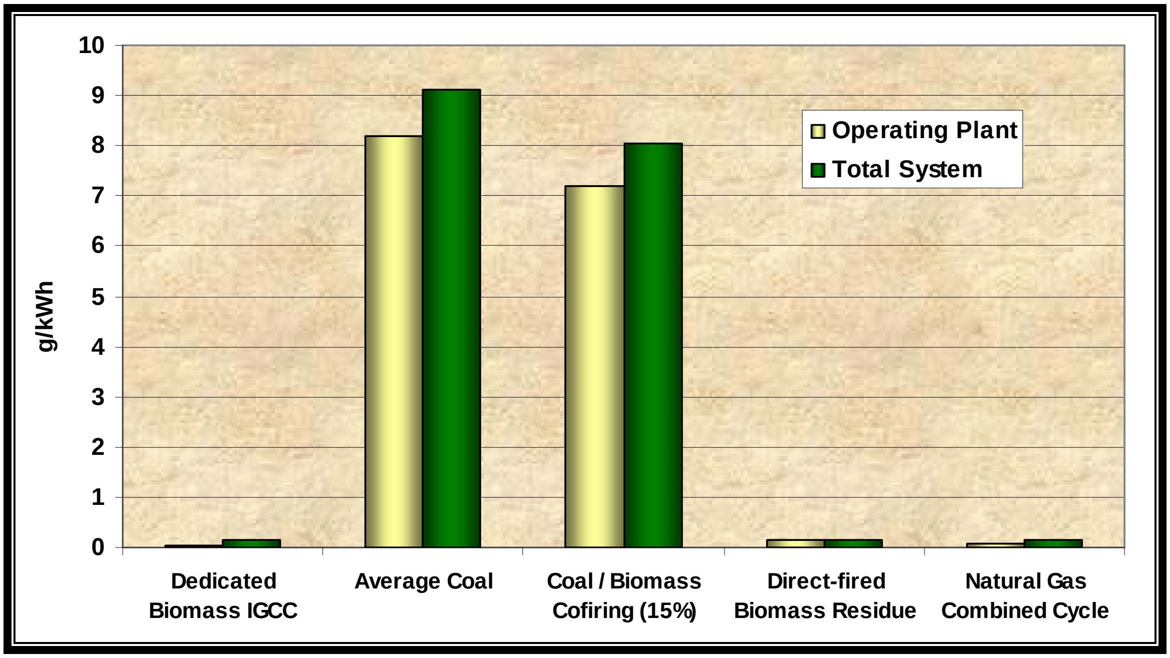
[17] Zamora, Diomy and Charlie Blinn, Air Quality and Human Health, Extension, March 24, 2010, accessed online at www.extension.org/pages/Air_Quality_and_Human_Health

coal, accounting for one to two percent of weight, as compared to coal's typical more than five percent of weight.[18]

In addition to benefits associated with air emissions related to replacing coal power, there are air quality benefits associated with utilizing forest fuel in power production as opposed to slash burning or forest fires. Smoke emissions from forest fires and slash burning adversely impact air quality. Removing biomass from forested areas where an excess of dead wood has accumulated reduces forest fire risk. Compared to the smoke emitted from wildfires and slash burning, the emissions from using wood fuel for energy are far less harmful. Industrial combustion boilers with pollution control equipment in place burn vastly more efficiently and cleanly than open fires.[19]

In addition, the particulate emissions from a LCA approach from direct–fired biomass residue are significantly less than from other energy sources. In the section above, particulate emissions are reported for coal and biomass plants, and it shows that at the stack biomass plants emit more emissions than coal plants. However, this does not take into account the extraction and hauling associated with the energy sources. Mann and Spath have documented the particulate emissions from an LCA approach for various power sources; results of their research are presented in Chart 5.

Chart 5
Comparison of Particulate Emissions



Source: Mann, Margaret and Pamela Spath, “A Comparison of the Environmental Consequences of Power from Biomass, Coal and Natural Gas,” National Renewable Energy Laboratory, Golden Colorado.

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[18] Zamora, Diomy and Charlie Blinn, Air Quality and Human Health, Extension, March 24, 2010, accessed online at www.extension.org/pages/Air_Quality_and_Human_Health

[19] Biomass Energy and the Environment, State of Oregon web-site, accessed online at http://www.oregon.gov/ENERGY/RENEW/Biomass/Environment.shtml

From the previous chart, it is obvious that on a LCA basis, using coal as a fuel source creates the highest concentration of pollutants. The LCA (total system) takes into account the particulate emissions from transporting, handling and burning the energy sources. Replacing a portion of the power produced from coal with power produced from biomass will lower the overall particulate emissions of power production.

8.9.4 Forest Health

The environmental impacts associated with forest health that relate to utilizing woody biomass for power production are summarized here in the form of reduced fire risks, utilization of pest and disease-killed wood, control of pest and disease areas, and soil and water quality impacts.

8.9.4.1 Forest Slash and Hazardous Fuels

The proposed biomass facilities would utilize sawmill residue, urban waste, and forest slash as the feedstock. In an LCA, it is important to evaluate the alternative uses of some of this material. Some of the sawmill residual material would have had other markets for it (i.e., particleboard and medium density fiberboard, linerboard, etc.) that would have sequestered the carbon in its solid form, at least temporarily. However, with the disappearance of the Smurfit Stone Container Corporation plant in Frenchtown, the regional market has a large void needing to be filled in this area.

This section does not focus on the sawmill residue piece, but rather on the forest slash that would be associated with biomass energy. The forest slash would have typically been burned in the woods (without the capability of capturing the energy) to meet the state wildfire hazard reduction requirements. Urban wood waste in Montana is typically disposed in landfills. Both processes would result in negative environmental impacts as compared to using the material for power generation. The woody biomass utilized would be excess to the amounts needed to meet wildlife, soil and other ecological values.

Putting wood processing residue into a landfill is an undesirable option because it has a slower decay rate than other biomass forms and is thus slow to stabilize in the landfill environment. It takes up to 15 to 20 percent of the space in a typical county landfill, and its decay leads to emissions of CH_4, a much more potent greenhouse gas than CO_2.[20]

Open burning of forest biomass residues is a major source of air pollution in many regions. It produces massive amounts of visible smoke and particulates, plus significant quantities of emissions of NO_x, CO, and hydrocarbons. Quantifying the emissions from open burning is difficult since conditions and burning practices are highly variable.[21]

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[20] Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, p.4.

[21] Morris, Gregory, The Value of the Benefits of U.S. Biomass Power, Green Power Institute, Berkeley, California, National Renewable Energy Laboratory, NREL/SR-570-27541, November 1999, p.7.

In addition, a biomass energy facility will indirectly influence the market for small diameter trees and forest slash. In the financial model of the prototypical plant, there is no additional forest thinning considered for the supply of the proposed biomass energy plant. However, this is because a feedstock supply for the proposed biomass plant needs to be from a guaranteed source in order to obtain financing for the project.

In reality, a biomass plant will expand the market for non-marketable trees (thinning) from the forest. By expanding the market for these products, the forest benefits associated with thinning could be expanded. The benefits of increased forest thinning include treating fuels between the ground and crowns of larger trees by removing ladder fuels to reduce the chances of a ground fire becoming a crown fire, creating space between tree crowns to reduce the chance of a running crown fire, and improving the overall health of the forest.[22] The reduced fire risk associated with increased thinning would have implications for avoided costs associated with fire fighting, fatalities, facilities losses, timber losses, and other issues.

A recent study (2007) summarized previous efforts and evaluated the non-market valuation of fire risk reduction associated with thinning and treatments in Eastern Washington.[23] The benefits from fuel removals were found to be $1,677 per acre in high risk areas and $882 per acre in moderate risk areas. See Table 30 for a summary of benefits associated with fire risk reduction.

Table 30
Value of Environmental Benefits from Fire Risk Reductions ($ Per Acre)

	High Risk ($/Acre)	Moderate Risk ($/Acre)
Fire Fighting Costs Avoided	481	231
Fatalities Avoided	8	4
Facility Losses Avoided	150	72
Timber Losses Avoided	772	371
Regeneration and Rehab Costs Avoided	120	58
Community Value of Fire Risk Reduction	63	63
Increased Water Yield	83	83
Total Benefits	**1,677**	**882**

Source: Modified from Mason, Larry et al, DP 10: Benefits / Avoided Costs of Reducing Fire Risk on Eastside, Timber Supply and Forest Structure Study, accessed online at http://www.ruraltech.org/projects/fwaf/final_report/pdfs/16_Discussion_Paper_10.pdf.

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[22] Hazardous Fuel Reduction Program Technical Specifications, State of Montana, accessed online at http://www.gallatin.mt.gov/

[23] See Mason, Larry, Bruce Lippke, and Elaine Oneil, Discussion Paper 10 (DP10): Benefits / Avoided Costs of Reducing Fire Risk on Eastside, Timber Supply and Forest Structure Study.

8.9.4.2 Pest and Disease

The current pine beetle outbreak is a concern for western Montana forest health. During pine beetle epidemics, widespread tree mortality alters the forest ecosystem. In addition, the profusion of beetle-killed trees can change wildlife species composition and distribution by altering hiding and thermal cover and by impeding movement. Moreover, the dead trees left after epidemics are a source of forest fire fuel. While supply from pine beetle-killed trees is not specifically modeled in this analysis, dead trees would likely serve as a portion of the supply source for wood-fired biomass facilities.[24]

In addition to utilizing beetle-killed trees, a nearby biomass CHP plant can aid in reducing pine beetle hazard, as it would allow for forest management treatments aimed at improving forest health before an epidemic has begun. It has been demonstrated that thinning stands of lodgepole and ponderosa pines will minimize beetle-caused mortality. In addition, patch cutting in lodgepole pine stands creates a mosaic of age and size classes, which reduces the acreage of homogeneous lodgepole pine stands that are highly susceptible to beetles.[25, 26]

8.9.4.3 Soil Quality

Harvesting biomass has the potential to decrease soil quality as organic matter is removed from the site in the form of coarse woody debris. Decreases in soil quality can impact the quantity and quality of wildlife habitat. This concern is mitigated by requirements to retain snags and woody material on site and through private forest management certification systems.

Another area of concern is the removal of essential minerals by the utilization of woody biomass, particularly on coarse textured soils and where short rotation and repeated removal of all the biomass is practiced. This concern is avoided by laws governing the public lands that prevent such short rotation harvesting practices and the requirement for site specific prescriptions to protect these kinds of sites. It also is not practical on most private forest lands in Montana due to the inherently lower productivity and the steepness of the slopes, which make such practices operationally impractical.

Yet another area of concern is the creation of intensively managed woody biomass plantations. However, this issue is not relevant in this study as biomass is modeled to be supplied from only non-plantation forest resources. Other concerns that are often cited involve the development and creation of infrastructure (roads, skid trails, and

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[24] Amman, Gene and Mark McGregor, and Robert E. Dolph, Jr., Mountain Pine Beetle, Forest Insect & Disease Leaflet 2, U.S. Department of Agriculture, Forest Service, accessed online at http://www.barkbeetles.org/mountain/fidl2.htm.

[25] Amman, Gene and Mark McGregor, and Robert E. Dolph, Jr., Mountain Pine Beetle, Forest Insect & Disease Leaflet 2, U.S. Department of Agriculture, Forest Service, accessed online at http://www.barkbeetles.org/mountain/fidl2.htm.

[26] High Elevation White Pines Management Strategies, U.S. Forest Service, accessed online at http://www.fs.fed.us/rm/highelevationwhitepines/Management/Strategy/mpb.htm.

landings) that can expose soil, leading to possible erosion and impairment of water quality; drain soil of organic matter and nutrients; and allow invasive species to spread through harvesting equipment.

While these concerns are legitimate, these are the same concerns associated with any harvesting operation. Best management practices to minimize the environmental consequences of growing and harvesting trees have been developed and implemented in the state.

A number of states in the U.S. have developed and implemented biomass harvesting guidelines to minimize impacts of biomass harvesting and utilization on the environment. These states include: Minnesota, Missouri, Michigan, Pennsylvania, and Wisconsin. While Montana is not among this list, the Department of Natural Resources & Conservation has a group of interested parties actively evaluating biomass current guidelines and practices on various ownership throughout the State.[27]

The CHP plant business model considered in this study is based on utilizing only material that is already being brought to the roadside. The prototypical plant is not based on any additional removals.

8.10 PROTOTYPE PLANT REGIONAL ECONOMIC IMPACTS

This section analyzes the economic effects of construction and operation of a prototypical biomass energy plant in Montana. Effects are analyzed in terms of employment and labor income using an IMPLAN model. The IMPLAN model is an I-O Model, which includes data on the linkages between different industries and defines how the output of one industry becomes the input of another industry.

The IMPLAN model is used to estimate total economic effects of a prototypical biomass energy plant. In addition to the direct impact of new jobs and income generated at the biomass plant, construction and operation of a new power plant will generate additional economic impacts in other, linked sectors. Known as indirect and induced effects, the impacts in linked sectors result from money being spent and re-spent in the local economy, and are commonly referred to as the ‘ripple effect’. Because businesses within a local economy are linked together through the purchase and sales patterns of goods and services produced in the local area, an action that has a direct impact on one or more local industries is likely to have an indirect impact on many other businesses in the region.

Employment and labor income are common economic indicators used to measure the value of economic activity in an economy. Labor income is the sum of employee and proprietor compensation (including all payroll costs and benefits). Employment is the average number of employees, whether full or part-time, of the businesses producing

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[27] DNRC, Biomass BMP Sub-Group Meeting Notes, December 14, 2009, accessed online at http://dnrc.mt.gov/forestry/Assistance/Biomass/Documents/WorkingGroup/Minutes121409.pdf.

output. Income and employment represent the net economic benefits that accrue to a region as a result of economic activity.

To understand how an economy is affected by a business or industry, it is necessary to understand how different sectors or industries in the economy are linked to each other. For example, an increase in construction activity will lead to increased spending for materials used in construction. Contractors will in turn purchase more materials from suppliers, which will in turn purchase more products from the manufacturers. Firms providing production inputs and support services to the construction industry would see a rise in their industry outputs as the demand for their products increases. Conversely, a decrease in construction will have the opposite effect on those industries that provide production inputs and support services to the construction sector. These additional effects are known as the indirect economic impacts. As household income is affected by the changes in regional economic activity, additional impacts occur. The additional effects generated by changes in household spending are known as induced economic impacts.

8.10.1 Methodology and Direct Expenditures

This section details the methodology and assumptions used to measure statewide impacts of construction and operation of a prototypical biomass fired energy plant in Montana. Various assumptions regarding construction and operation expenditures were necessary to ascertain the effects that this new development would have on the greater economy of the State of Montana. These assumptions are discussed in detail below.

8.10.1.1 Construction Estimates

Budgetary construction expenditures were obtained from Wellons, Inc. and also modeled in the pro forma financial statements. The total capital costs for the prototypical plant are estimated to be $53.6 million. In order to estimate spending in Montana versus other areas, ENTRIX developed spending assumptions in conjunction with Wellons data and consultation with Bill Carlson, a member of the project team and principal of Carlson Small Power Consultants. The total construction expenditures included nearly $15 million in labor costs, of which an estimated $7.3 million will be paid to 73 full-time on-site construction workers in Montana. Thus, direct construction impact of a prototypical biomass energy plant is 73 full-time equivalent jobs and $7.3 million income.

Wellons also estimated $31 million in construction materials. Based on the structure of the Montana economy and the types of construction materials required, it is estimated that this expenditure will generate additional output in Montana of approximately $8 million (in such sectors as wholesale trade, truck transportation, and manufacturing). Additionally, engineering, permitting and project management costs were estimated to be $800,000, all of which is assumed to be spent in Montana. Finally, all banking activity was modeled to be $5 million over the course of construction and was assumed to be spent outside of Montana. Estimates for total spending in Montana are provided in Table 31.

Table 31
Direct Spending in Montana
Associated with Prototypical Plant

Spending Category	Spending Amount (Dollars)
Total Labor	7,277,000
Total Construction Materials	7,970,000
Engineering	800,000
Banking Activity	0
Total Spending in Montana	16,047,000

8.10.1.2 Operating Estimates

Operating costs and input requirements for the prototypical biomass energy plant are modeled in the earlier in this chapter. These operating expenditures are modeled as new economic activity in the region, and they increase demand for such goods and services as utilities, maintenance, environmental compliance, chemical products, hauling, ash handling, and others.

It is assumed that biomass plant demands for sawmill residue would not increase sawmill production but would rather generate demand for existing by-products. Due to this assumption, the value of the sawmill residual is not expected to generate additional economic activity in the sawmill sector and is thus not included in the IMPLAN model. (To the extent that sawmill production would increase to meet the demand for CHP fuel, this assumption would result in an underestimate of economic impact). However, the chipped wood fuel source from processing forest slash would generate additional economic activity with regard to grinding and hauling the material. Operating estimates were developed by Roy Anderson with The Beck Group and were based on operating requirements for grinding and hauling.

The production capacity of one, 500 horsepower horizontal grinder is equivalent to the annual in-woods fuel requirement for the prototypical plant, or 27,421 BDT. Operating the grinder requires two employees: one excavator operator and one loader operator. Additionally, it was assumed that two hours would be required as the average round trip time needed per truckload or 1,000 average loads per year per trucker. Based on the average payload per truckload (16.5 bone dry tons), it was determined that 1.7 full time equivalent truckers would be needed for hauling the fuel requirement from the woods for the prototypical plant.

8.10.1.3 Limitations of Approach

IMPLAN analysis has some limitations which are attributable to the I-O methodology. One of the most important is that of fixed proportions: for any good or service, all inputs are combined in fixed proportions that are constant regardless of the level of output. Hence, there is no substitution among production inputs and no economies of scale are possible. Second, each production function incorporates fixed technology, so, for example, the same proportion of labor and capital are used. If an industry is undergoing rapid technological change, this rigidity may under or overestimate impact. This concern is offset in part by the slow, gradual technological changes that are typical in many sectors of the economy. Third, I-O does not model any price effects that might be important to a region. Regardless of the level of production, it is assumed that price and returns per unit of production are constant. Finally, I-O assumes that resources that become unemployed or employed due to a change in final demand have no alternative employment.

The introduction of a CHP plant will provide another market demand for the residual material produced from normal operations at a sawmill. As there are other economic uses for sawmill residual material, it is possible that increased demand for this material due to operation of a CHP plant could increase the market price of residual material. Price of residual material will depend on the demand and relative value of residual material in alternative uses and will consequently determine the demand for sawmill residual versus other fuel sources for the CHP. Other prices could potentially be affected by introduction of the CHP, but this is not expected as the demand for other commodities from the prototypical plant will be a relatively small share of the overall market.

While the approach does have these limitations, a realistic set of assumptions were developed for the operation of a prototypical mill and results from this I-O modeling effort are presented below.

8.10.2 IMPLAN Results

This section presents the estimated total regional economic impacts associated with the construction and operation of the prototypical plant modeled.

8.10.2.1 Construction Impacts

Total construction impacts are estimated at approximately 216 jobs in the State of Montana and a corresponding $12.4 million in employee compensation for the one-year construction period. Of this amount, only 73 jobs and $7.3 million are related to direct construction, as explained previously. Nearly 76 jobs and close to $3 million in income would be the result of increased economic activity in indirectly-linked sectors providing construction inputs and support services or additional output (trade, transport, manufacturing, etc.). Induced impacts, or increased household spending in primarily retail and service sectors, are valued at $2.08 million and 67 jobs. Table 32 provides a breakdown of the indirect and induced impacts association with the construction of the prototypical plant. The total economic income impacts related to construction account for $86 per MWh for the first year of power production.

Table 32
Total Impacts in Montana Related to Construction of the Prototypical Plant

	Direct	Indirect	Induced	Total
Jobs	73	76	67	216
Income (Dollars)	7,277,000	2,989,000	2,085,000	12,351,000

8.10.2.2 Operation Impacts

Based on the operating assumptions modeled for the prototypical plant, the total economic impacts related to operation of the plant are estimated to be 42 jobs and $2.3 million in employee compensation (see Table 33). Of this amount, 13 jobs and $1.15 million are for biomass plant employees. Indirect impacts of 17 jobs and $800,000 refer to the increased spending on plant inputs and support services as a result of the prototypical plant operations, including the above referenced jobs involved in the collection and hauling of the portion of feedstock supply from the woods. Induced impacts of $397,800 and nearly 13 jobs are supported by increased household spending associated with the increased economic activity related to the operation of the prototypical plant. In total, economic impacts related to operating the CHP plant are equivalent to $16 per MWh on an annual basis.

Table 33
Total Impacts in Montana Related to Operation of the Prototypical Plant

	Direct	Indirect	Induced	Total
Income (Dollars)	1,150,000	802,000	397,800	2,350,000
Jobs	13	17	13	43

8.10.2.3 Impacts Related to Increased Energy Costs

The price of biomass power modeled in this analysis ($88/MWh) will result in a net increase in price of NWE's supply portfolio and similarly to the ratepayer. In determining the net increase in these costs, it is necessary to compare the biomass power rate to a baseline. In this analysis, two comparisons are made: biomass to Mid-C power and biomass to wind power. Our findings were a $5.6 million net increase to NWE's supply portfolio cost in year 1 when compared to Mid-C power prices. This is based on a biomass price of $88 per MWh as a replacement for short-term Mid C power at $46.20 per MWh.[28]

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[28] Personal Communication with John Fitzpatrick, NorthWestern Energy, Government Affairs, May 3, 2010. It is important to note that the $5.6 million represents an increase to all rate classes, not just residential.

Mid-C power is short term supply of power and is comparable to biomass in this analysis only in that NWE does not have a vested interest in the power production. Other sources of power (wind, coal and hydro projects) are higher cost power sources than Mid-C, but NWE has long term agreements for purchases from these sources. However, Mid-C power would not be eligible to contribute toward NWE's renewable energy portfolio. Therefore, it does not provide an appropriate comparison in power production sources.

In 2009, NWE supplied more than 6.3 million MWh of power and carried a total of 10.6 million MWh to 335,000 customers in 187 communities and their surrounding areas in Montana.[29] One prototypical plant would provide roughly 2.3 percent of NWE's total power portfolio. Thus, a net increase of $5.6 million in the cost of the supply portfolio from purchasing biomass power instead of Mid-C power would equate to an increase in cost to ratepayers of 1.8 percent if costs were passed through directly. Furthermore, transmission and distribution is billed as separate line items to ratepayers, so the total bill for NWE customers would increase by less than 1 percent.

Similarly, if the comparison is made to wind power instead of Mid-C power, the total increase in energy cost to rate payers would be 0.6 percent based on the size of the prototypical plant. When transmission and distribution charges are factored in, the net increase to the total bill of a NorthWestern customer would be 0.36 percent.

Table 34 shows the induced effects from the change in household income associated with a reduction of both scenarios (biomass to Mid-C and biomass to wind).

Table 34
Total Impacts in Montana Related to
Net increases in Power Prices

	Direct	Induced	Percent Increase to Power Bill
Biomass to Mid-C			
Income (Dollars)	5,600,000	1,510,000	0.95
Jobs		50	
Biomass to Wind			
Income (Dollars)	2,600,000	701,000	0.36
Jobs		20	

While direct impacts ($5.6 and $2.6 million) were modeled to determine the impact to household spending (induced impacts), they do not represent a true direct impact. This is due to the fact that these increases in utility costs do not represent reductions in total spending within the state. Rather, these statewide cost increases are a re-distribution

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[29] NorthWestern Energy Annual Report, 2009, accessed online at http://www.northwesternenergy.com/documents/investor/AnnualReport2009.pdf, page 8.

of other expenditures. The induced impacts presented in Table 34 represent the reduction in the circulation of the net increase in costs throughout the statewide economy.

From this analysis, it is clear that biomass currently costs more than wind power in Montana. In light of this, the cost increase is handled by transferring more money into the electricity sector from other sectors associated with household spending and evaluating how the circulation of money is impacted (see induced impacts above). However, in order to accomplish a proper analysis of the tradeoffs between wind, biomass and Mid-C power, an analysis of income and jobs created from constructing and operating wind and other power projects (Mid-C power) would be required. This level of analysis is beyond the scope of this report.

In summary there are multiple methods for computing the increased costs to the supply portfolio, but both methods used result in a relatively minor (less than 1 percent) increase in costs to the ratepayer. All other economic impacts (direct and indirect) are positive.

An additional factor that requires mention, but is not quantified in this analysis, is the potential opportunities associated with the Renewable Energy Certificates (RECs). In this analysis, it is assumed that RECs are bundled with the power sales. However, if NorthWestern Energy has additional RECs, they could potentially unbundle these RECs and sell them on the open market. Current prices for voluntary RECs in the Western Electricity Coordinating Council (WECC) have ranged between $6 and $9 per REC (REC equivalent to MWh).[30] Such sales of excess REC's would lower the economic impacts described above.

8.10.2.4 <u>Other Potential Mill Impacts</u>

The utilization of sawmill residual material as an input to power production would also have other impacts on mill workers and mill profitability that are not quantified in the above IMPLAN model. These impacts include increasing the profitability of sawmills due to another source of demand for mill residues, which could potentially increase sawmill profitability and stability of existing mill jobs and associated household income.

The IMPLAN model used in this study only considers increased economic activity associated with the prototypical plant. Adding another market for residual materials will give mill managers more flexibility in determining where to use (or sell) mill residue, thereby, potentially increasing the overall value of the residual material. This is especially important currently due to the closure of the Smurfit-Stone Container plant in Missoula. Historical data shows that the Smurfit-Stone mill was using approximately 1.0 million bone dry tons of material per year. The closure of the Smurfit-Stone Container mill and the associated loss of demand for residuals will require sawmills to utilize other markets such as particle board, pellets, and biomass.

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[30] REC Markets Monthly Update – February 2010, Monthly Market Update, Evolution Markets, accessed online at http://new.evomarkets.com/pdf_documents/February%20REC%20Market%20Update.pdf.

In the prototypical biomass plant modeled, just over 121,000 BDT of biomass fuel is required annually to operate the plant. Approximately 80,000 BDT of that material could be supplied by mill residues, based on the “average sawmill” considered in the fuel supply section of this report. Based on historic market conditions in western Montana, the average value of those mill residues is about $28.00 per BDT. Thus, the total value of the mill residues to the sawmill is a little more than $2.2 million per year. As mentioned above, this value was not included in the IMPLAN model due to the fact that there is no additional economic activity associated with the creation of this material. However, the prototypical plant would provide another revenue stream for the residual material and would be an important component in the bottom line of the sawmill.

Related to the mill profitability is the issue of securing existing jobs and household incomes for current sawmill workers. The prototypical plant is modeled to be a part of an existing sawmill’s operation. The jobs and income associated with the existing mill workers will be secured by increasing the profitability of the plant. While these jobs and income are not representative of increased economic activity, these jobs and household incomes are an important component of the regional economies surrounding the mills.

For the seven western Montana mills participating in this study, mill census data shows that in 2004 there were a total of 527 employees as compared to 464 in 2009.[31] These are actual production employees, not full-time equivalence (FTE). The number of FTEs is actually higher than the number of people employed because mill workers tend to work more than 40 hours per week and/or more than 240 days per year (which defines an FTE). These jobs would be provided some security if the corresponding mills were to be able to increase their profitability through implementing a biomass energy plant.

8.10.2.5 Other Economic Impacts

The following section provides a brief case study example from Southwestern Colorado about the economic impact of lost forest products processing infrastructure.

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[31] Personal Communication with Todd Morgan, University of Montana Bureau of Business and Economic Research, May 10, 2010.

Southwestern Colorado: Loss of Forest Products Processing Infrastructure

The Government Accountability Office (GAO) estimates that upwards of 200 million acres of western forests are in poor condition. Forest restoration treatments involve the removal of large quantities of non-merchantable biomass (stems, branches, and logging slash). Such rehabilitation leads to the development of vigorous, hazard resistant forests.

The capacity to use wood removed from forest management treatments has a tremendous influence on a region's ability to rehabilitate forests. A recent industry profile from Colorado compares costs and revenues for forest restoration treatments in southwestern Colorado. Where adequate product and marketing infrastructure exists, revenues can be generated from treatments with scientifically developed forest restoration prescriptions. These revenues help offset treatment costs and can potentially lead to net profits for specific projects. On the other hand, in regions that lack this infrastructure, forest treatment projects can incur large financial costs.

For example, the presence of a wafer board facility within 100 miles of the Mancos-Dolores treatment site was a critical component in marketing the products from the treatment prescriptions. The facility recently closed, and thus, similar prescription treatments today would result in a large financial cost instead of net profits.

Without the ability of forests to reduce hazardous fuels on their lands, and without a harvesting and manufacturing infrastructure to mitigate treatment expense, southwestern Colorado is experiencing the societal impacts of rising expenditures related to fire suppression and rehabilitation, and potential loss of personal property. In addition, the enjoyment that residents experience from private and public lands will be compromised, as will their quality of life.

The 2002 fire season may be an appropriate proxy for impacts associated with the region's inability to reduce hazardous fuels. It is estimated that during the 2002 fire season, Colorado experienced a loss of $1.7 billion in tourism revenue. In addition, there were impacts to community infrastructure, including individual homes, subdivisions, utility distribution facilities and municipal watersheds. Losses in the millions of dollars were incurred in resource values such as timber and water. One Hayman Fire report concluded that much of the burned areas would not recover to pre-fire condition during the lifetime of any who witnessed the fires.

Sources: Colorado Statewide Forest Resource Assessment, Appendix F – Forest Industry Profile, accessed online at http://csfs.colostate.edu/pdfs/SFRA09_App-F-Forest-Industry-Profile.pdf

Arno, Steve and Roy Anderson, The Forest Products Industry: A Tree Farm Partner in Trouble, Tree Farmer Magazine, April 2006.

CHAPTER 9 – DISCUSSION AND RECOMMENDATIONS

9.1 DISCUSSION

The following sections provide a discussion of CHP from the perspective of various stakeholders and provides recommendations based on the key findings.

9.1.1 A Sawmill and Forest Landowner Perspective

Western Montana's sawmills are attractive sites for biomass CHP plants, and hold a number of advantages over development of large, stand-along biomass facilities. The practical advantages of siting CHP plants at sawmills include:

- The mills are already industrial sites with existing air and water permits.
- Existing interconnections to the electrical grid are available to each mill.
- Timber manufacturing processes at the mills use co-generated heat for lumber drying.
- The mills have existing staff , machinery and experience to procure and move biomass.
- Experienced boiler operators are on staff.
- Substantial, existing volumes of on-site fuel are available in the form of mill residues.
- CHP plants can increase the long-term viability of Montana's sawmills by stabilizing the value of mill residues and providing predictable income from the sale of renewable power.

Montana's forest landowners and managers have a great interest in the continued operation of these remaining sawmills. Montana's wood products processing capacity has been declining for several decades; 27 facilities have closed since 1990. The experience of other western states (e.g., AZ, CO, NM) has demonstrated that once the wood products industry is lost, forest management and restoration becomes 2-4 times more expensive because there are no opportunities to make something of value to help offset the cost of needed forest management services.

This is especially important in Montana, with over 70 percent of Montana's forests are in federal ownership, and an increasing proportion of federal lands treatments focusing on removing smaller tree size classes as part of hazardous fuels, forest health, and forest restoration treatments. If such treatments were needed in an area with no underlying forest products industry, the treatments would occur at great cost to taxpayers.

A specific example is the recent closure of the Smurfit-Stone plant, which offered an essential link in the forest products value chain by providing substantial markets for the lowest value wood (pulpwood). Roughly 800,000 BDT of clean mill waste and debarked small logs were utilized annually for pulp production, while another 200,000 BDT of slash and other waste were used for CHP. The loss of this outlet has had a dramatic impact on western Montana landowners, mills, and loggers.

The continued need for an outlet similar in to that of Smurfit for low-value wood is part of the motive for this investigation of establishing a distributed network of CHP plants. A distributed network would allow each facility to draw material from a very local area while creating a number of possible outlets for each fiber producer. This model is expected to be more resilient, efficient and sustainable than building one large, stand-alone plant, and should provide a variety of important values to the citizens of Montana.

Finally, it must be noted that maintaining a healthy forest products industry is also very important to Montana's economy: the forest products industry employed an estimated 9,927 people in Montana in 2009.

9.1.2 A Social and Environmental Benefits Perspective

Biomass power is typically more costly than power generated using fossil fuels, but it has several unique social and environmental benefits that can help rationalize its higher cost. Carbon is one important consideration. Burning biomass is considered carbon neutral since the carbon emitted during combustion is offset by the carbon taken up by growing trees. Thus, biomass energy has strong carbon benefits when it replaces fossil fuels and reduces the buildup of greenhouse gases.

The beneficial improvement of air quality is documented within this study. Old boilers would be replaced with newer and more modern air quality equipment that will improve air quality at each site. In recent months, very large biomass energy projects in other states have attracted opposition from environmental groups. The study team did not specifically assess this recent development, but believes that the small CHPs proposed here pose markedly smaller air quality challenges than the large facilities being challenged in other states.

Unhealthy forests are another major environmental issue in Montana. A recent mountain pine beetle epidemic has killed trees on an estimated 2.7 million acres[32]. In addition, decades of fire suppression have resulted in an estimated 7.2 million acres of forests that are rated as moderate/high for fire hazard[33]. Utilizing the overstocked and dead trees for biomass CHP can help pay for forest health treatments that mitigate wildfire hazard and tree mortality issues.

Finally, biomass energy contributes to the growth and stability of the regional economy. The construction and ongoing operation of even a single plant can create direct jobs, and support indirect logging and transportation jobs. In addition, biomass energy

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[32] Montana Forest Insect and Disease Conditions and Program Highlights, 2009. USDA Forest Service Northern Region Report 10-1.

[33] Wildfire in Montana: Potential Hazard Reduction and Economic Effects of a Strategic Treatment Program. Keegan, Charles, Fiedler Carl, and Morgan, Todd, Forest Products Journal, July/August 2004. Vol. 54 No. 7/8.

activities can diversify the sources of revenue and the options for use of forest resources at Montana sawmills. The study team believes biomass energy provides a strategically strong position for Montana sawmills in an era in which forest health treatments increasingly dominate the supply of raw material for their operations.

9.1.3 CHP from a NorthWestern Energy Perspective

NorthWestern Energy is a public utility that provides power to customers in western and central Montana. NWE must comply with Montana's RPS, which requires NWE to acquire 15 percent of its retail electricity sales from eligible renewable power sources by 2015. As a result, NWE must acquire about 900,000 MWh of renewable power annually.

In addition, the Montana RPS specifies that NWE must meet a CRE requirement, which mandates that NWE source nearly 50 MW of power per year in 2011 through 2014 and 75 MW thereafter from locally controlled power producers. No single source of community renewable energy can be larger than 25 MW.

NWE has already met a significant portion of its RPS obligations from wind power projects. However, given the intermittent nature of wind power, NWE does not consider it a base load supply resource. Instead, NWE relies on a contract with PPL Montana as its principal base load supply resource. The PPL Montana contract expires in 2014. Given the intermittent nature of wind generated power and the pending PPL Montana contract expiration, a key NWE business goal is to source additional renewable resources, including biomass, which can serve the company's base load power needs as part of its overall energy portfolio.

9.1.4 Forest Health Co-benefit of Biomass Energy

The previous three sections allude to the capacity of a dispersed biomass energy industry to improve forest health, a co-benefit that is not recognized in the market value of biomass power. Montana is facing a forest health crisis that is most visible in the form of “red trees” affected by pine beetle infestation. The lack of markets for the woody biomass harvested when these areas are treated 1) creates very high treatment costs resulting in no or reduced treatments, and 2) means that biomass from treatments that do go forward is usually burned. This is true across state, federal and private ownerships.

Providing markets for biomass and unmerchantable trees reduces the open burning of slash in forest treatments, which greatly reduces air pollution. In addition, the economic value received for the woody material allows landowners to fund more extensive fuel reduction and forest health treatments. These treatments in turn reduce the potential for high severity fires and associated negative environmental and community impacts. They also reduce fire fighting costs, can help reduce wildfire size, and can limit the spread of insect and disease outbreaks.

In sum, biomass energy can help support a viable wood products industry that in turn supports markets for biomass that result, finally, in reasonable costs for healthy forest management and in better air quality when treatment occurs.

9.2 RECOMMENDATIONS

This study demonstrated that a network of biomass CHP plants in Montana would allow NWE and other Montana utilities to meet their renewable and firm replacement energy goals. In terms of biomass supply and cost, available technology, interconnection and transmission, and environmental permitting there are no major obstacles to developing biomass fueled CHP plants in Montana. However, the study also shows that a typical plant is a $54 million project and that project financing may be a daunting task.

It is estimated that biomass CHP plants in Montana can produce power at a cost of $88 per MWh, which is higher than the cost of other available sources of power. However, the development of a network of CHP plants at sawmills can provide a number of unique social, environmental, and electric system benefits that may justify the higher cost. These benefits are documented in the impact section of this study.

It is important for Montanans to continue a dialogue to determine if the value received from a network of biomass CHP plants is worth the cost to establish and maintain them. Many of the necessary stakeholders were part of the preparation of this study, and the study team sees significant potential for these groups to continue to pursue development of biomass energy at Montana sawmills.

Important actions for various stakeholders include:

- NWE’s leadership can articulate a clear intention with regard to development of biomass energy as part of its RPS mandate in the state of Montana. A solid NWE biomass development goal would provide sawmills, investors and public agencies with a signal to continue to invest time and energy in this endeavor.
- Forest landowners can continue to cooperate by assessing and addressing biomass supply issues. In addition, they can continue to provide expertise and resources to the overall biomass energy effort. It is also crucial for landowners, to act as the voice for forest health. They can articulate the importance of developing biomass energy to provide markets for small diameter trees and woody biomass from forest health treatments. All of Montana’s large forest landowners took part in this report, including both public agencies and private organizations. Those landowners should continue their high level of participation in development of biomass energy, including The Blackfoot Challenge, The Bureau of Land Management, Montana DNRC, The Nature Conservancy, Plum Creek Timber Company, Inc., The Salish & Kootenai Tribe, Stimson Lumber Company, and the U.S. Forest Service.
- The Montana PSC can study the costs and benefits of biomass energy in Montana. As stated within this study, a key factor in whether Montana develops biomass energy is the PSC’s ultimate attitude toward the cost to ratepayers.

This study has brought a good understanding of probable rates, allowing the PSC to move this issue forward by beginning to examine biomass costs and benefits.

- Montana sawmill owners can use the information in this report, along with the site-specific mill studies provided to each sawmill, to make business decisions about continuing to pursue biomass CHP.
- Montana has multiple financing and incentive programs that can meet the complex biomass financing challenge. USDA Rural Development, the State of Montana, Montana Community Development Corporation and others can work together to ensure that maximum financing resources are brought to bear on CHP projects in the state.
- The State of Montana can continue to make biomass energy a priority development initiative. With a clear biomass goal, the departments of Commerce, Environmental Quality and Natural Resources, along with the Governor's Office, should maintain strong communication and a common focus on key public objectives (forest health, energy diversity, strong local economies) for this sector. Clear articulation of these public objectives is essential as a guide to the private sector which will ultimately develop Montana's biomass energy future.
- Lawmakers can consider the role of existing and new legislation in creating a biomass energy sector in Montana. The Environmental Quality Council has provided strong leadership at this level and should continue providing direction.

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APPENDIX

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APPENDIX 1

Eagle Stud Mill, Inc.

Eagle Stud Mill is located in Hall, Montana. The company was formed in 1962 and operated continuously through 2007, when a fire forced closure of the sawmill. The sawmill has not operated since. However, the company is currently operating a post and pole plant at the facility. When the sawmill was running, it employed about 30 people and produced about 20 million board feet of stud grade lumber annually. In addition to the sawmill and post and pole plant, the facility has a boiler and 0.7 MW turbine generator on site. The turbine generator is not currently operating.

F.H. Stoltze Land and Lumber Company

F.H. Stoltze Land and Lumber is located between the towns of Whitefish and Columbia Falls, Montana. The company began operations in the early 1900s, when F.H. Stoltze contracted with the Great Northern Railway to provide supplies for the railroad's expansion activities. Today, Stoltze employs 120 people at an 80 acre facility that includes administrative offices, a log yard, a random length sawmill, dry kilns, and a planing mill. The company recently installed an optimized board edger and curve-sawing gang saw, and an optimized trimmer system. Green lumber is kiln dried before planing. The mill has the ability to produce machine stress rated lumber. The company also owns and manages about 35,000 acres of timberland near Whitefish, Montana.

Pyramid Mountain Lumber, Inc.

Pyramid Mountain Lumber in Seeley Lake, Montana has been family owned and operated since 1949. Today the sawmill employees nearly 150 people and is known as "The Stewardship Company" because of their commitment to healthy forest management. The primary tree species processed at Pyramid are ponderosa and lodgepole pine and spruce. Those species are processed into custom paneling and decking, 5/4 inch shop lumber for window treatments, and 4/4 inch boards. To a lesser extent, the sawmill also produces dimension lumber and large timbers that range in size from 4" x 4" to 16" x 16".

RY Timber, Inc.

RY Timber operates two softwood sawmills in Montana – one in Livingston and another in Townsend. RY came into existence over 20 years ago when Ron Yanke purchased Sequoia Forest Industries in Townsend from the Wickes Company. In 1996, RY also acquired the Livingston operation. Today, the company employs over 200 people in Montana, and between the two sawmills, produces an average of 162 million board feet of 2" x 4" and 2" x 6" stud grade lumber each year.

Sun Mountain Lumber Company

Sun Mountain Lumber Company is a privately owned sawmill located in Deer Lodge, Montana. The company was formed in 2004 when the current owners, Sherm and Bonnie Anderson, acquired the facility from Louisiana Pacific Corporation. The company currently employs about 130 people. The main products produced at the mill are stud grade lumber and finger jointed studs.

Tricon Timber, LLC

Tricon Timber is a softwood lumber manufacturer located in St. Regis, Montana. They have been in business since 1989, manufacturing primarily 2” x 4” and 2” x 6” stud lumber up to 9 feet in length. Other products manufactured at the sawmill include interior finish products such as western larch flooring and various moldings and wainscoting. The sawmill employs 125 to 130 people when operating at full capacity. In 2006, Tricon began manufacturing wooden posts and poles at a separate facility in Superior, Montana (about 15 miles from the sawmill).

APPENDIX 2

NWE ANALYSIS OF BIOMASS POWER'S ECONOMIC IMPACT

NWE provided their analysis of biomass energy's economic impact on supply costs and customer power rates. A key difference in their analysis and that of the project team is that the rate impact of the biomass energy's cost is compared to the average price of power purchased by NWE in 2009. The project team, in contrast, compared the cost of biomass energy to that of wind, another renewable source of power. The reason for the project team's comparison to another renewable power source is that NWE is obligated to acquire a certain percentage of renewable power by Montana's RPS, and that is the logical context in which to consider purchase of sawmill CHP.

The following sections contain NWE's analysis.

IMPACT OF BIOMASS GENERATION ON NWE SUPPLY COSTS AND CUSTOMER RATES

Table 35 presents a price comparison between the prototypical biomass plant and other electricity supply resources, including two acquisitions completed during the past two years. Table 35 illustrates the relatively high cost of biomass energy compared with other energy supply alternatives. Over a 20-year period, the biomass price ranges between \$88.00 and \$128.20 per MWh, with a levelized price during the period of \$101.50/MWh. During that same time period, the Mid-Columbia forecast ranges between \$46.20 and \$81.51 per MWh, with a levelized price of \$59.14 per MWh. Thus, biomass is \$42.36 per MWh higher than market on a levelized basis over the next 20 years. What does this mean for customers? For a 25 MW project, customers would have to pay substantially more for the biomass power compared to the market alternative.

Table 35
Price Comparison of Prototypical Biomass Plant Versus Other Electricity Supply Resources

Type of Plant	20-Year Power Supply Cost (Nominal Dollars/MWh)	20-Year Power Supply Cost Levelized[1] ($/MWh)
19 MW Prototypical Biomass Plant	88.00 - 128.80	101.50
Mid-C Price Forecast (Average Price)[2]	46.20 - 81.51	59.14
15 MW Hydro Unit[3]	65.25 - 73.75	69.51
222 MW Share of Colstrip Unit 4[4]	56.61 - 64.72	61.24

[1] Levelized price using 8.46% discount rate.

[2] Average Mid-C price obtained by developing a weighted average of heavy load (56.1% of year) and light load (43.9% of year) prices. Based on October 6, 2009 price update.

[3] Contract signed in 2009. Unit to start production in 2011. Includes the Renewable Energy Credit (REC).

[4] Entered NWE's rate base on January 1, 2009.

NWE also observes that, in general, PPAs invariably escalate in price over time. In contrast, with rate-based resources, the depreciation offsets increased operating expenses (e.g., labor, taxes, maintenance, etc.) is captured for the benefit of the customer. That phenomenon is illustrated in Table 35 which shows the narrow price horizon for the company-owned share of Colstrip Unit 4.

To compute the impact of a biomass plant in NWE’s supply portfolio, a matrix was developed that shows the amount of power which would be produced given various levels of biomass generation, multiplied by the price of power from a prototypical plant starting at $88.00 per MWh. A biomass acquisition would relieve the company of purchasing a comparable amount of power on the market. Those acquisitions averaged $42.22 per MWh in 2009.

Table 36 shows the total amount of energy expected to be produced from one or more biomass plants, total payments to biomass producers given an $88.00/MWH electricity price, and the estimated net increase in cost to NWE’s electricity supply portfolio for <u>one</u> year.

Table 36
First Year Cost Impact of Biomass Generation on NorthWestern Energy

Number of Biomass Plants	Net Total MW of Capacity[1]	MWhs Produced[2]	Total Payments to Biomass Producers ($/Million MWh)[3]	Net Increase in Cost to NWE Supply Portfolio ($/Million MWh)[4]
1	17.5	143,500	12.6	6.5
2	35.0	287,000	25.3	13.2
3	52.5	430,500	37.9	19.7
4	70.0	574,000	50.5	26.2
5	87.5	717,500	63.1	32.7
6	105.0	861,000	75.8	39.3

[1] Assumes a 19 MW plant with a 1.5 MW production derate due to steam sales and internal electricity use.

[2] Assumes 8,200 hours per year of production.

[3] Assumes $88.00 MWh sale price.

[4] Assumes the utility will reduce existing market purchases of power, which averaged $42.22 MWh in 2009 by an amount equal to biomass purchases.

A second way of looking at the cost impact on NWE's supply portfolio is to compare the levelized cost of biomass versus the levelized Mid-C index price over a 20-year period (see Table 37). Over 20 years, one biomass plant would increase the supply portfolio cost above market by an estimated $121.58 million. For six biomass plants, the above market expense would be $729.44 million.

Table 37
Cost Comparison of 20-Year Levelized Biomass Resource[1] with the Mid-C Index Price[2]

Number of Plants	Net Total MW of Capacity[3]	MWh Produced Over 20 Years (in Millions of MWh)[4]	Total Payments to Biomass Producers ($/Million MWh)	Cost of Foregone Energy Acquisition at Mid-C Price ($/Million MWh)	Net Increase in Cost to NWE Supply Portfolio ($/Million MWh)
1	17.5	2.87	291.31	169.73	121.58
2	35	5.74	582.61	339.46	243.15
3	52.5	8.61	873.92	509.20	364.72
4	70	11.48	1,165.22	678.93	486.29
5	87.5	14.35	1,456.53	848.66	607.87
6	105	17.22	1,747.83	1,018.39	729.44

[1] Assumes a levelized price of $101.50/MWh for biomass.

[2] Assumes a levelized price of $59.14/MWh at Mid-C Index.

[3] Assumes a 19 MW plant with a 1.5 MW derate due to steam sales and internal electrical use.

[4] Assumes 8,200 hours per year of production.

IMPACT ON CUSTOMERS

Table 38 allocates the above market costs of biomass power between major customer classes on the NWE system. Residential customers will pay approximately 38 percent of the above market costs, with commercial customers paying 53.0 percent. The remaining 8.1 percent of the costs will be split between industrial, street lighting, yard lights, and irrigation accounts. Montana law allows customers with an electric load of 5 megawatts and larger to obtain electricity supply service from parties other than the local utility, and most have taken that option. Accordingly, the share of NWE's electric load made up of industrial customers is very low, and that sector pays a very small percentage of any increase in electricity supply costs, irrespective of the cause of the increase.

Table 38 shows that residential electricity costs will increase $47.3 million if a prototypical biomass plant is constructed, ranging up to $283.8 million if six plants are built over a twenty-year period. The impact on the commercial sector is somewhat larger, with an above market increase ranging between $64.4 million and $387.4 million, again, with between one and six prototypical plants being constructed.

Table 38
Total Fiscal Impact of Biomass Development by Customer Type Over 20-Year Period ($/Millions)

Number of Biomass Plants	Residential ($)	Commercial ($)	Industrial[1,2] ($)	Other[3] ($)	Total ($)
1	47.3	64.4	6.8	3.0	121.5
2	94.6	129.1	13.4	6.0	243.1
3	141.9	193.7	20.1	9.0	364.7
4	189.2	258.3	26.8	12.0	486.3
5	236.5	322.9	33.5	15.0	607.9
6	283.8	387.4	40.2	18.0	729.4

[1] Includes industrial and large commercial accounts which take substation or transmission level electricity service.

[2] Electricity customers whose loads exceed 5 MW generally purchase their electricity supply on the open market, not from NorthWestern Energy.

[3] Includes lighting and irrigation accounts.

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APPENDIX 3

Table 39
Prototypical Sawmill CHP Pro Forma Income Statement (20 years)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Total
REVENUE																						
Electric Sales		12,621	12,874	13,131	13,394	13,662	13,935	14,214	14,498	14,788	15,084	15,385	15,693	16,007	16,327	16,653	16,987	17,326	17,673	18,026	18,387	306,663
Steam Sales		569	587	604	622	641	660	680	700	721	743	765	788	812	836	861	887	914	941	970	999	15,302
Total Revenue		**13,191**	**13,460**	**13,735**	**14,016**	**14,303**	**14,595**	**14,894**	**15,198**	**15,509**	**15,827**	**16,151**	**16,481**	**16,819**	**17,163**	**17,515**	**17,874**	**18,240**	**18,614**	**18,996**	**19,385**	**321,965**
EXPENSES																						
Operating & Maintenance		4,096	4,106	4,063	4,073	4,117	4,166	4,242	4,344	4,450	4,561	4,675	4,793	4,915	5,042	5,172	5,490	5,618	5,751	5,890	6,034	95,049
Purchased Steam		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel		3,579	3,686	3,797	3,911	4,028	4,149	4,273	4,402	4,534	4,670	4,810	4,954	5,103	5,256	5,414	5,576	5,743	5,915	6,093	6,276	96,168
Ash Disposal		87	90	93	95	98	101	104	107	110	114	117	121	124	128	132	136	140	144	148	153	2,343
Total Operating Expenses		7,762	7,882	7,952	8,079	8,244	8,416	8,619	8,853	9,095	9,344	9,602	9,868	10,143	10,426	10,718	11,202	11,501	11,811	12,132	12,462	193,560
OPERATING INCOME		5,429	5,578	5,783	5,937	6,059	6,179	6,274	6,345	6,415	6,482	6,548	6,613	6,676	6,738	6,797	6,672	6,739	6,803	6,864	6,923	128,405
INTEREST		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEPRECIATION		4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	0	0	0	0	0	0	0	0	0	0	45,960
PRETAX INCOME		**833**	**982**	**1,187**	**1,341**	**1,463**	**1,583**	**1,678**	**1,749**	**1,819**	**1,886**	**6,548**	**6,613**	**6,676**	**6,738**	**6,797**	**6,672**	**6,739**	**6,803**	**6,864**	**6,923**	**81,894**
TAXES		(180)	(1,694)	(206)	674	763	1,421	2,064	2,118	2,150	2,177	2,203	2,228	2,253	2,277	2,301	2,278	2,331	2,357	2,381	2,404	32,300
NET INCOME - BOOK		**1,013**	**2,676**	**1,393**	**666**	**700**	**162**	**(386)**	**(369)**	**(331)**	**(291)**	**4,346**	**4,385**	**4,423**	**4,460**	**4,497**	**4,394**	**4,408**	**4,446**	**4,484**	**4,519**	**49,594**
TAX INCOME STATEMENT																						
PRETAX INCOME		833	982	1,187	1,341	1,463	1,583	1,678	1,749	1,819	1,886	6,548	6,613	6,676	6,738	6,797	6,672	6,739	6,803	6,864	6,923	81,894
PLUS: Book Depreciation		4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	4,596	0	0	0	0	0	0	0	0	0	0	45,960
LESS: Loan Principal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRETAX CASH FLOW		**5,429**	**5,578**	**5,783**	**5,937**	**6,059**	**6,179**	**6,274**	**6,345**	**6,415**	**6,482**	**6,548**	**6,613**	**6,676**	**6,738**	**6,797**	**6,672**	**6,739**	**6,803**	**6,864**	**6,923**	**127,854**
State Taxes		(29)	(274)	(33)	116	131	244	354	363	368	373	377	382	386	390	394	390	400	404	408	412	5,556
less: State credits		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Taxes		(151)	(1,420)	(173)	559	632	1,178	1,710	1,755	1,781	1,804	1,825	1,846	1,867	1,887	1,906	1,888	1,932	1,953	1,973	1,992	26,744
less: Federal credits		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET TAXES		(180)	(1,694)	(206)	674	763	1,421	2,064	2,118	2,150	2,177	2,203	2,228	2,253	2,277	2,301	2,278	2,331	2,357	2,381	2,404	32,300
NET CASH FLOW																						
CAPITAL INVESTMENT	(53,598)																					
AMOUNT TO FINANCE	0																					
OPERATING PRETAX CASH FLOWS		5,429	5,578	5,783	5,937	6,059	6,179	6,274	6,345	6,415	6,482	6,548	6,613	6,676	6,738	6,797	6,672	6,739	6,803	6,864	6,923	127,854
STATE CREDITS / TAXES	0	29	274	33	(116)	(131)	(244)	(354)	(363)	(368)	(373)	(377)	(382)	(386)	(390)	(394)	(390)	(400)	(404)	(408)	(412)	(5,556)
FEDERAL CREDITS / TAXES	15,275	151	1,420	173	(559)	(632)	(1,178)	(1,710)	(1,755)	(1,781)	(1,804)	(1,825)	(1,846)	(1,867)	(1,887)	(1,906)	(1,888)	(1,932)	(1,953)	(1,973)	(1,992)	(11,469)
TOTAL CASH FLOW BENEFITS	**(38,322)**	**5,609**	**7,272**	**5,989**	**5,262**	**5,296**	**4,758**	**4,210**	**4,227**	**4,265**	**4,305**	**4,346**	**4,385**	**4,423**	**4,460**	**4,497**	**4,394**	**4,408**	**4,446**	**4,484**	**4,519**	**57,232**
Cumulative Pretax Cash Flow		5,429	11,007	16,790	22,726	28,785	34,964	41,238	47,584	53,998	60,480	67,029	73,642	80,318	87,056	93,853	100,524	107,264	114,067	120,931	127,854	
Cumulative After Tax Cash Flow		5,609	12,880	18,870	24,132	29,428	34,186	38,396	42,623	46,887	51,193	55,539	59,923	64,347	68,807	73,303	77,697	82,105	86,551	91,035	95,554	