



Kickapoo Valley Solid Biofuel and Wood Product Feasibility Study

SPONSORED BY:
MISSISSIPPI RIVER REGIONAL PLANNING COMMISSION
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This study was authored by Short Elliott Hendrickson Inc. and Renewable Resource Solutions, LLC through grant awards to the Mississippi River Regional Planning Commission and the Village of La Farge from the U.S. Department of Commerce – Economic Development Administration and the Wisconsin Department of Administration. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of the grantors or grantees.

"A society grows great
when old men plant trees
whose shade they know
they shall never sit in."

Greek Proverb



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Abstract

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Dedication



This study is dedicated to the memory of George 'Paul' Bader who served as a key advisor and confidante while battling the throes of cancer. His positive attitude and commitment to this study was an inspiration. He passed away on May 14, 2013. On the cover of this study is a Greek proverb that appeared in Paul's obituary. It says "*A society grows great when old men plant trees whose shade they know they will never sit in.*" This is how he lived and also points the way on how to build a more resilient economy in the Kickapoo Valley. His knowledge and love for the people and places in the Kickapoo Valley created the spark that made this study possible

Obtaining Copies of Study: Copies of this study can be downloaded from the Mississippi River Regional Planning Commission website: <http://www.mrrpc.com>

DISCLAIMER

The figures and percentages used throughout the feasibility study are subject to change depending on the conditions of future markets, supply and demand, dollar value, local, state, and national economic status, and other unforeseeable variables.

All information provided will be true to the best of the project team's knowledge and any oversight or misrepresentation is unintentional. All information is presumed to be the most up-to-date information available as of the official publication date of each individual study. Direct research should be done for the most current information when looking for specific costs/prices in months/years following the publication.

New technology and innovative practices are constantly being discovered and the most efficient systems and methods today could be outdated in the near future. This study is written to provide the most accurate information possible.

It is known and understood that a large part of the information is either common knowledge or the project team's previously compiled general data. It is also known and understood that with the completion of this feasibility study, the project team is free to utilize all non-proprietary information in any future studies or reports.

Executive Summary

The purpose of this study is to analyze the feasibility of sustainable harvesting, production, distribution, and use of solid biomass and other wood products to create a more resilient economy in the Kickapoo Valley area (Vernon, Richland, Monroe, & Crawford counties). The recommendations contained in this report are intended to identify solid biofuel and wood product opportunities that will increase quality jobs, income levels, energy savings, and energy security among households and businesses in the Kickapoo Valley.

The study is based on analysis of regional assets and needs, a survey of local households and commercial/industrial businesses, interviews with wood processors, two stakeholder meetings, discussions with area economic development officials, Wisconsin DNR staff, and local foresters.

The study should be viewed as a regional guide for future solid biofuel and wood product initiatives. It is intended to help pull the region together and encourage collaboration on wood product and solid biofuels economic development projects.

Results of the study indicate that current market conditions are not favorable for development of a large scale wood pellet plant in the region; however, a smaller less than 10,000 ton a year plant co-located with an existing wood processor that utilizes dry residues as feedstock could be economically viable and should be encouraged. Building pellet demand incrementally through increased residential and commercial biomass heating is key. A smaller pellet plant could grow to supply the region with a locally sourced and produced heating fuel that would create over one hundred hometown jobs, generate millions of dollars in annual fuel savings and reduce thousands of tons of carbon dioxide emissions per year. To create these economic and environmental benefits only 20% of the homes and businesses currently heating with higher cost fuels such as propane, heating fuel oil, and electricity would need to switch to pellets as a heating source.

To make this switch several challenges need to be overcome. These include the availability of inexpensive natural gas in some areas and the convenience of heating with conventional fossil fuels which require less maintenance, attention and fuel delivery concerns compared with today's solid biofuel heating practices in the region. The study points out the efficiencies of contemporary solid biofuel heating technologies and delivery methods used in other parts of the United States and how these can address these challenges but an organized regional effort would be needed to make them work.

The study encourages pilot projects to promote the benefits of heating with biomass. One suggested pilot project is the promotion of biomass heating through the Wisconsin Department of Administration's Low Income Heating Assistance Program. Through this program low income households are given the option to switch their heating source to wood pellets through installation of a pellet stove or furnace paid through this program. Fuel switching in many cases can result in hundreds and over a thousand dollars in annual energy savings. Other pilot projects could include installation of biomass heating at the Kickapoo Valley Reserve, Fort McCoy, courthouses, highway departments, clinics, hospitals, schools, federal, state and municipal buildings. It is the fuel switching of the larger institutions, businesses, and industries that will have the biggest impact on creating a strong solid biofuel energy economy.

In terms of economic development potential from value-added wood products the study identifies cabin logs, utility poles, cabinetry products, furniture, and products from ash trees now threatened by the Emerald Ash Borer. Suggestions for wood products from ash trees include: baseball bats, tool handles, walking sticks, snowshoe frames, skis, canoe paddles and hockey sticks. Success in the value-added wood product manufacturing sector will also create more dry wood residues which can then be utilized for wood pellets, animal bedding, mulch, wood chips and wood flour used in resin and composite products.

The study also points out the importance of keeping apprised of nanocrystalline cellulose (NCC) technology input needs. This electricity conducting wood based technology is being researched and used in other parts of the United States and around the world to replace ceramics, composites, stainless steel, computer

components, car parts, body armour and ballistic glass because of its superior strength to weight ratio and lower cost. An added plus is NCC is produced from wood pulp or wood waste, a resource in great supply in the Kickapoo Valley. In addition the nearby U.S. Forest Product Lab in Madison is at the forefront of the research and use of this “game changing” material that is less dangerous to process than inorganic composites. The US National Science Foundation predicts NCC will become a \$600 billion industry by 2020.

As far as the environmental impacts from a stronger value added wood product and solid biofuel economy the Study notes Mr. Christopher Stillion’s 2011 Master of Science Thesis. The thesis identifies “Two land use scenarios from stakeholder interviews, site visits and content analysis of (comprehensive) plan documents. An intensive rotational grazing scenario and a woody biomass scenario were analyzed in a Geographic Information System(GIS) and refined using stakeholder feedback. A Multi-Criteria Decision Making method was employed to assess the suitability of the watershed for increased adoption of rotational grazing and the local generation of power from sustainably harvested woody biomass. The GIS model outputs indicate that the Kickapoo Watershed is both highly suited to rotational grazing and capable of supporting local generation of power from woody biomass while fulfilling long-term goals for forest management and improvement.” The thesis uses an example of a combined heat power (CHP) facility locating in La Farge utilizing 100 green tons per day or 36,500 tons a year of woody biomass for heat and electric power. The thesis concludes that this amount of woody biomass can be sustainably harvested without utilizing any biomass from the grazing lands. In regards to the findings of this study – not the thesis, the 36,500 tons of woody biomass would also be enough to supply a 18,000 ton a year wood pellet plant just from the area within 25 miles from La Farge, that is less than one- fourth the geographic size of the primary procurement area analyzed in this study that proposes a smaller 10,000 ton a year pellet plant.

The study reports that in regard to forest resources available for wood product manufacturing and pellet production the region has overstocked forests with an adequate supply of woody biomass sustainably available for even a 100,000 ton a year pellet plant. A pellet plant of this size would need 200,000 green tons of raw material. This amount could be obtained by utilizing only 12% of the net annual forest growth or 21 % of the forest’s annual mortality in the primary (four county) and secondary (five county) procurement market areas.

This study was coming to completion in January 2014 – a time when propane prices (typically one of the most economically beneficial fuels to replace with wood pellets) increased so rapidly that Governor Walker approved \$8 million for 80 percent guaranteed bank loans to propane dealers to help ensure enough propane reaches customers. He also approved an additional \$8.5 million in heating assistance for low-income people’s propane bills. Coincidentally, at about the same time, three Xcel Energy natural gas pipelines were knocked out by an explosion in Canada. As a result, Xcel Energy appealed to its customers in Minnesota and Western Wisconsin to conserve natural gas so that Xcel could meet demand until the pipelines could resume operation.

The La Crosse Tribune reported that the average Wisconsin propane price on January 23, 2014 was \$2.30 per gallon, a 39% increased compared to the October 2013 price of \$1.65/gal. In addition, propane prices during this period jumped to more than \$4.00/gal at many regional outlets and were more than \$6.00/gal at some locations. The La Crosse Tribune also reported that rising exports of propane may be part of the cause of the price rise. U.S. exports of propane have risen from 56,000 barrels per day in October 2008 to 408,000 barrels per day in 2013. Governors Walker and Dayton as well as U.S. Senators Baldwin, Franken, Klobuchar and Grassley have all formally asked for federal action regarding propane export impacts on American consumers.

This supply insecurity and price instability for propane and other fossil fuels highlights the importance of taking steps towards energy independence by further developing the Kickapoo Valley’s solid biofuel resource. The Kickapoo Valley is within the Driftless Area’s more heavily wooded tri-state region with the potential to become what some call the “Saudi Arabia” of biomass. This study points the way on how, by sustainably managing the region’s overstocked forests for solid biofuel production, we can improve business opportunities, job growth, energy savings and environmental quality.

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Kickapoo Valley Solid Biofuel and Wood Product Feasibility Study

Preface

After the flood disasters of 2007 and 2008 community officials, economic development organizations, legislators, agency officials, and businessmen began meeting on a regular basis to share concerns, ideas and solutions on flood recovery projects. Road repairs, utility repairs, flood proofing and relocation activities were often discussed but building a more resilient economy over the long term was also part of the discourse. Information shared showed the Kickapoo Valley having community assets, businesses, and initiatives that were developing its agriculture and tourism sectors but the third leg of region's economic stool - forest and wood products had comparatively less in play. This led to the idea of this study by Paul Bader, Forestry Management Coordinator of the Kickapoo Woods Cooperative.

Paul was convinced that there are better market opportunities for the region's "overstocked forests" that could be harvested and developed in a sustainable manner. Additional analysis also showed that wood and forest products are a key economic driver of Western Wisconsin and a targeted industry cluster identified in the Comprehensive Economic Development Strategy of the Mississippi River Regional Planning Commission. So with these commonalities MRRPC staff began working with Paul on a study design. Upon completion of the study design we began writing grants to fund the study. The study was denied funding from U.W. Madison Foundation's Kickapoo Valley Reforestation Fund and the USDA Rural Business Opportunity Grant Program but continued grant writing eventually led to receiving full funding from the US Department of Commerce – Economic Development Administration and the State of Wisconsin Department of Administration. In December of 2012 through a Request for Proposal process the project team of Short Elliot Hendrickson and Renewable Resource Solutions was selected to conduct the study. The study is designed to create a stronger economy by integrating sustainable forest product practices with current market recommendations and wood product knowledge of the region's residents.

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1.0 Introduction

1.1 Region's History

The Kickapoo Valley sits in the scenic, Driftless Region of Wisconsin, a rugged patchwork of working farms, cold, trout filled streams, and mixed hardwood forests. The area, mostly rural, is characterized by forested hills and ridges overlooking the Kickapoo River. The study area includes several counties in the heart of the valley including Vernon, Crawford, Monroe, and Richland.



Figure 1 – Haney Valley Road Bridge

Source: Wisconsin Historical Society, Wisconsin Architecture and History Inventory,
Haney Valley Rd. Bridge, Town of Haney, Crawford County, WI, 109487

Economic development efforts in the Kickapoo Valley have focused around the region's core strengths including recreation and tourism, agriculture and food processing, and forest and wood products.¹ Significant strides have been made in terms of developing and promoting tourism in the region, including the establishment of the Kickapoo Valley Reserve and other assets such as the Wildcat Mountain State Park and the Elroy-Sparta bike trail. In terms of agriculture, the growth of Organic Valley, which is headquartered in La Farge, WI, has had a tremendous economic impact on the region. Organic Valley has not only created opportunities for farmers themselves, but they have also added significant economic activity to the region through food processing and support services.

The forest product industry is also a key contributor to the valley's economy. According to John Nielsen, regional forestry supervisor for the Wisconsin DNR, "sawmills and wood preservation businesses contribute nearly three times as much to the Driftless Area's economy as they do statewide and are the source of one in five jobs of this type across Wisconsin. This solid and well-paying employment base means that for every 10 sawmill and

¹ Kickapoo River Valley Report on Reports and Their Economic Development Recommendations, Mississippi River Regional Planning Commission, August 11th, 2008.

wood-preservation jobs in the region, an additional 13 jobs are supported in the economy as a whole.”²

Against this backdrop, forest and wood products are still seen as the most untapped form of economic activity in the region. Just as with the organic agriculture industry, additional value-added opportunities are seen as critical. For example, the Kickapoo River Valley Report pointed out that the wood product industry would contribute to and benefit from biomass fuel and bio-composite material development.

However, past studies and current public concerns also underscore the importance of growing the wood product and/or solid biofuel industries in an environmentally sustainable manner. Organizations such as the Kickapoo Woods Cooperative are in place to assist landowners in establishing and maintain forests in a sustainable manner. Standards such as Wisconsin’s Forest Management Guidelines and Woody Biomass Harvesting Guidelines can also help ensure that growth of the wood products and solid biofuel industries is done in a sustainable manner.

1.2 Traditional Forest Products Industry

The traditional forest industry in the Kickapoo Valley Region is based off of sawmills producing lumber, which is then utilized by various companies to produce a wide range of value added products as illustrated in the figure below.

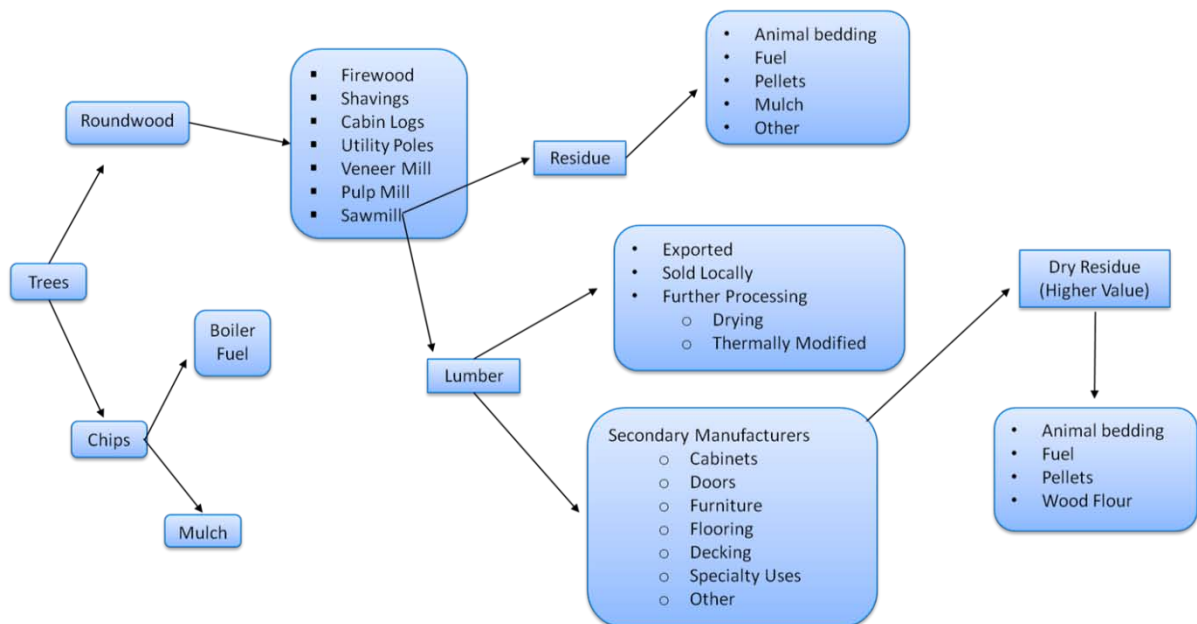


Figure 2 – Kickapoo Valley Forest Industry Product Flow

² La Crosse Tribune. August 5th, 2013. John Nielsen: Forestry key part of region’s economy.

One thing that results from these traditional forest industry companies is process residue. In the past (as recent as 15-20 years ago), these products were considered waste and were dumped on-site or brought to landfills. Today, residues have many different markets/uses. At sawmills where logs are debarked, bark is often processed into mulch and sold to urban/suburban markets or, in other instances, is utilized as fuel. Wood slabs produced at sawmills are often chipped and sold to pulp mills. Sawdust has a variety of uses; it can be dried and used as feedstock for wood pellets, to produce wood flour, utilized as animal bedding, or also utilized as fuel.

Another traditional industry is firewood, either cut and processed by homeowners for their own use or cut and processed by commercial firewood producers for sale to homeowners and other markets. In this area of the state, traditional logging has meant cutting sawlogs and not any other material for the most part; whereas the northern part of the state is dominated by cut to length operations that specialize in pulpwood harvesting. These types of harvesting operations are very limited in the Kickapoo Valley Region.

In addition to the industries themselves, the region possesses a number of educational and organizational assets to support it. A cluster-based economic development strategy to leverage these existing strengths could help companies across the region increase profitability and grow market share.

1.3 Geopolitical Profile

The study area includes the counties of Monroe, Vernon, Richland, and Crawford in southwest Wisconsin. The region is primarily rural, characterized by steep bluffs, valleys, and cold flowing streams characteristic of the Driftless Area. The figure below provides economic information showing the lower income situation that exists and the need for additional local wood product jobs and production of solid biofuels for energy savings.

Table 1
Project Area Demographics – By County and Region

County	2012 Population⁽¹⁾	2012 Housing Units⁽²⁾	2012 Median Household Income⁽³⁾	2012 Percent of Persons Below Poverty Level⁽⁴⁾	2013 Low and Moderate Income Percent⁽⁵⁾
Crawford	16,638	8,858	41,743	12.4%	46.1%
Monroe	45,056	19,473	48,768	15.0%	43.1%
Richland	18,043	8,904	44,821	11.1%	46.8%
Vernon	29,865	13,824	44,676	15.2%	48.7%
Regional Total or Avg	109,602	51,059	45,002	N/A	44.7%
Wisconsin	5,703,525	2,641,843	52,627	12.5%	40.4%
United States	313,914,040	132,452,405	53,046	14.9%	N/A

Source: (1) Wis. DOA-Demographic Services Ctr. 2012 Hsng & Pop. Est. and Census Bureau 2012 Nat'l Pop. Est.; (2) is. DOA-Demographic Services Ctr. 2012 Hsng & Pop. Est. and Census Bureau 2012 Nat'l Housing Est.; (3) American Community Survey Estimates 2008-2012; (4) U.S. Census Bureau - State and County Census Quick Facts; (5) <http://www.hud.gov/offices/cpd/systems/census/wi/index.cfm#sfl>

The figure below is a map of the four-county study area.

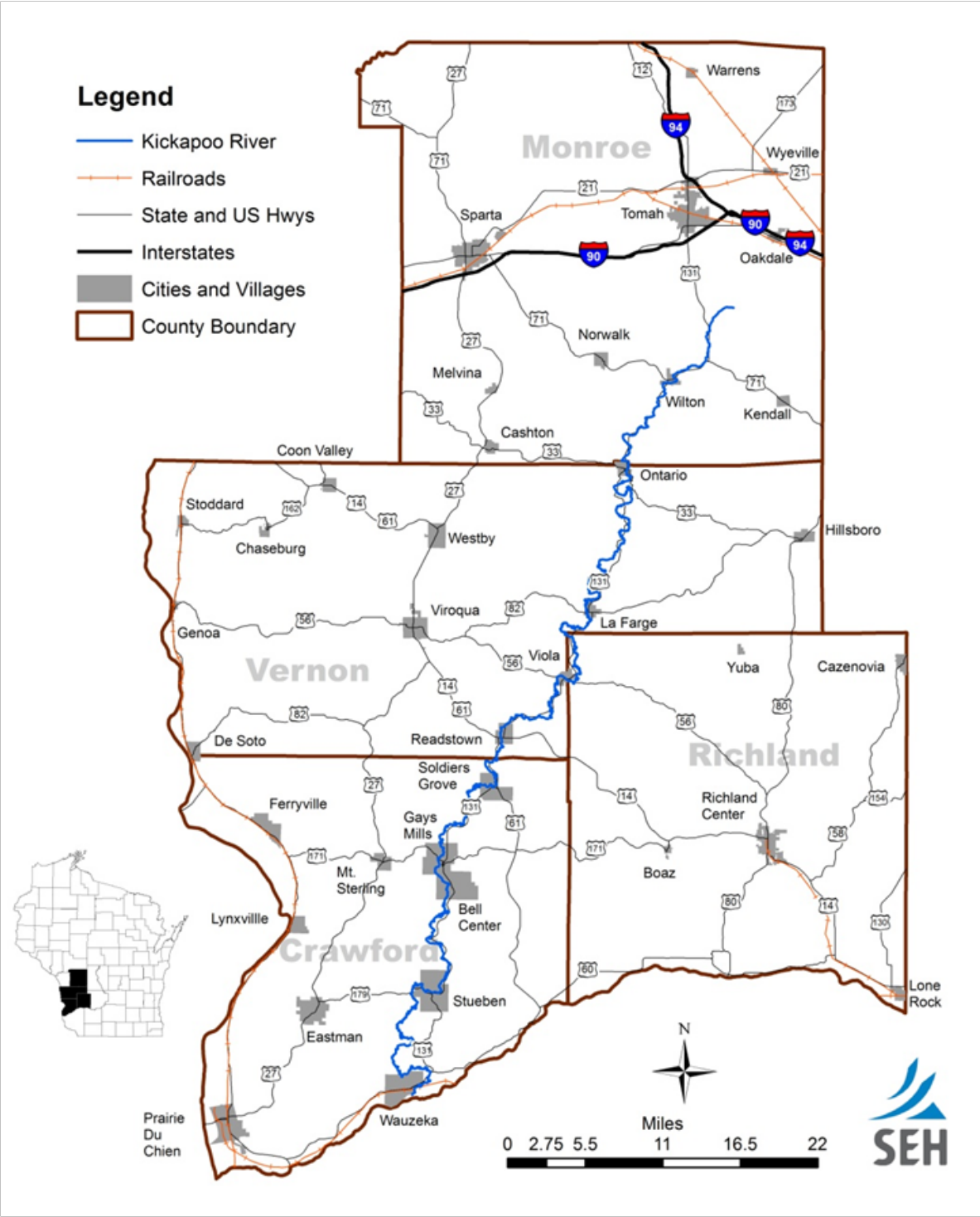


Figure 3 – Kickapoo Valley Study Area

1.4 Key Issues and Opportunities

The following issues and opportunities were identified through an analysis of economic data, demographic data, forest inventory data, a regional household and business survey, and input received during two stakeholder advisory meetings held at the Kickapoo Valley Reserve.

Forestry and Wood Products is a Key Driver of the Regional Economy

A number of strategic economic development studies focused on the Kickapoo Valley region have been conducted over the past two decades. One study found that in 2001 the wood product industry in the region directly and indirectly supported 5,700 jobs and 98 businesses in the nine county region of Western Wisconsin, including three of the counties included in this study.³ A recent economic modeling software run conducted on the four county Kickapoo Valley Region found that the demand for manufacturing wood products within the Kickapoo Valley region is approximately \$62 million annually, of which only \$13 million is satisfied by industries currently within the region. This suggests there are import substitution opportunities for wood product components and finished wood products for those currently being imported to meet local demand. This economic modeling was conducted by the Mississippi River Regional Planning Commission utilizing Economic Modeling Specialists International (EMSI) database and software.

Millions of Dollars in Energy Saving Can Occur and be Retained in the Region

In terms of solid wood biofuel, the region's forestry resource provides an opportunity to develop and expand renewable energy production and consumption. For example, it is estimated that if 20% of the homes in the Kickapoo Valley were to switch from propane, fuel oil, or electricity to wood pellet heating, it would result in annual fuel savings of \$2,626,033 while generating demand for 12,866 tons of pellets that would come from a local industry also supporting hometown jobs.

Based on Current Market Conditions A Large Pellet is Not Practical

In terms of profitability, a 100,000-ton pellet plant operating 24/7 is the most cost-effective due to lower production/operating costs. However, that is only part of the bigger picture with available raw material at a reasonable price and sustainable/profitable markets for the finished pellets. Although there are more than adequate amounts of raw material in the forests of the Kickapoo area to sustain a 100,000-ton pellet plant, the logging workforce in the area is currently not equipped to remove the volume of raw material needed at a competitive price. Secondly, there are not adequate markets for pellets in the Lake States/Midwest to warrant a large-scale pellet plant. Currently, there are five larger scale (50,000+ ton capacity) pellet plants in Wisconsin, none of which are operating at anywhere near capacity. Even though strong international pellet demand exists, the price those markets are willing to pay and the distance to them does not make that an option at this point.

Based on Current Market Conditions a Small Pellet Plant has Great Potential

A small-scale (less than 10,000 tons) pellet plant that utilizes dry residue from a wood processing plant could be economical in that the raw material requires little processing before pelletizing and growing a local market in increments sustainably lessens the risk versus establishing a large production plant. Such a plant would have to establish a process of

³ Mississippi River Regional Plan Commission. (2001). Industry Cluster and Regional Trade Report: A Guide to Building Knowledge-Based Industry Clusters that Drive the State's Economy.

creating a quality product and establishing markets, but would have strong potential with the production of a quality pellet and increasing production incrementally to meet more of the region's demand. Products could include residential heating pellets, commercial heating pellets, barbecue pellets, and animal bedding.

Wood Pellet Production and Increased Household Consumption in the Region Would Have Significant Economic Impacts

Any size wood pellet production facility will have an economic impact on the Kickapoo region, in both production facility and its corresponding employment/economic impacts and in the potential fuel cost reduction to the region's homeowners that would switch from higher priced fossil fuel to wood pellets. A smaller facility will have the ability to scale up from a few thousand tons to 10,000 tons as markets increase, which will allow for less economic risk. This sized plant can potentially have a \$4+ million impact on the region's economy. If market conditions change and a larger plant (60,000 or 100,00 tons) becomes feasible, the economic impact will be much greater.

A Regional Survey Showed a Strong Interest Exists for Solid Biofuels as an Economic Development Initiative

As part of this study, a regional on-line survey of households and business owners was conducted. Over two thirds (70%) of survey respondents agreed that encouraging/promoting the solid wood biofuel industry should be a major economic development initiative in the Kickapoo Valley.

A Regional Survey Showed There are Environmental Concerns

Over one half (53.7%) of survey respondents said they were concerned with the environmental impacts of encouraging/promoting the solid wood energy industry in the Kickapoo Valley. There is also a general misconception that wood pellets are a dirty fuel, when in fact they are very clean burning and reduce overall CO2 emissions compared with burning fossil fuels.

The Kickapoo Valley Region has Lower Incomes and Higher Energy Costs

Within the study area there is a high rate of low to moderate income (LMI) households as evidenced in the figure in Section 1.3. Vernon County has the highest percentage of low to moderate income households (48.7%), followed by Richland County (46.8%), Crawford (46.1%), and Monroe (43.1%). The average for the entire Kickapoo Valley is 44.7%.⁴ The LMI percentages are even higher for the Cities, Villages and Towns in the Kickapoo Valley that collectively were all over 50%. This was one the reasons grant funding was awarded for this study.

Households in the region also spend a large amount of their discretionary income on energy. Space heating represents over half of the total energy consumption of the average U.S. home, more in colder climates such as Wisconsin.⁵ Homeowners in the Kickapoo Valley use a higher proportion of expensive fuels such as propane, heating oil and electricity to heat their homes as compared to Western Wisconsin as well as the state of Wisconsin.

⁴ Source: <http://www.hud.gov/offices/cpd/systems/census/wi/index.cfm#sf1>

⁵ Energy Information Administration, (2009). Residential Energy Consumption Survey: Home Energy Uses and Costs.

The Region's Forests are Under Utilized

Eighty-seven percent of the forestland in the study region is privately owned. However, approximately 50% of private woodland owners do not actively manage their timber (July 16, 2013 stakeholder meeting input). The misconception that active forest management is “bad” may be partially responsible for the fact that so many landowners choose not to manage their forests. A lack of active forest management is contributing to overstocked forests that can crowd out desirable tree species and lead to forest health concerns (insect, disease, fire).

With the right incentives and education in place, this large amount of forest land could be more actively managed to support both wood product and solid wood biofuel industries. The Managed Forest Law (MFL) is a program that provides woodland owners with a management plan for sustainably managing their forests. Currently, about 30% of the private woodland acreage in these four counties are under the MFL program. In addition, the Kickapoo Woods Cooperative provides assistance to landowners in establishing and managing their forests. By facilitating sustainable woodland management and harvesting, the organization can play an important role in helping create jobs and spur economic development using privately managed woodlands.

More Awareness About the Kickapoo Valley's Solid Biofuel Product Potential is Needed

The fact that pellets are made from a nearby harvested, renewable resource with long-term sustainability achievable versus other fuels that are extracted hundreds if not thousands of miles away needs to be communicated more effectively. Outreach is also needed to educate consumers about the benign environmental impact and safety of wood pellets. Today's wood pellet stoves are vented similar to gas stoves and do not require a chimney plus their emissions are comparable in most categories to natural gas. Creating this awareness is an important step in developing a locally sourced solid biofuel economy.

Further Developing Value Added Wood Products has Great Potential

Several past studies have identified forest and wood products as having much greater economic development potential in the Kickapoo Valley. Higher level wood product refining and finishing will create new job and increased income opportunities. These valued wood products have both import substitution and export potential with higher paying jobs than many other economic sectors in the region.

A 2003 study by the Valley Stewardship Network identified an opportunity to “create and promote retail sales of locally produced goods by local branding for Kickapoo wood products.” This could apply to locally produced cabin logs, utility poles, cabinets, furniture, and products produced from Ash Trees (threatened or diseased by Emerald Ash Borer) – baseball bats, tool handles, walking sticks, snowshoe frames, skis, canoe paddles, and hockey sticks.⁶ Marketing green building materials also has potential. Interviews with local wood processors and home builders suggest there is a large untapped market for green building construction in the study area.⁷

⁶ Valley Stewardship Network. (July 2003). Kickapoo Conversation Vision 2020.

⁷ Personal Communication.

Keep Apprised of Nanocrystalline Cellulose (NCC) Technology and its Biomass Input Needs

There are many NCC products that could be commercially produced in the future, including composites, emulsion and dispersion products, medical, cosmetic, and pharmaceutical products, and most notably high strength carbon fiber products. If they all start to happen, it could have the potential to rival paper production for demand. A large scale plant operation would utilize 500,000+ tons per year per plant location. A smaller scale facility would utilize 175,000 to 225,000 tons per year.

The feed stock for NCC production would be pulpwood sized material or debarked sawmills chips as the process starts with a clean wood chip. Production economics will determine minimum plant size. The higher the value of the product being produced, the smaller the scale that becomes viable. For example, if NCC products are replacing carbon fiber in car parts, the cost of carbon fiber becomes the value that the production of the nano cellulose will have to match.

Use of Solid Biofuels Can Greatly Reduce CO₂ Emissions and New Biomass Burning Stove and Boiler Technologies Provide Very Efficient Energy Production

If 20% of households in the four county study area using propane, fuel oil, or electricity for heating were to switch to wood pellet heating, CO₂ emissions would be reduced by over 27,000 tons per year, or about 13% of baseline emissions. This reduction is equivalent to removing over 5,000 cars from the road or conserving over 2.7 million gallons of gasoline per year.¹ Proportional emission reduction increases are observed if the percentage of households switching to wood pellets increases to 50% or 100%.

Modern combustion technology is far cleaner than traditional cordwood fires or older wood stoves/boilers and can comply with today's stringent air emission standards. The U.S. EPA recently released its New Source Performance Standards proposal⁸ for new woodstoves and heaters, which go into effect in 2015, the first time that the standards have been updated since 1988. The new standards will make the next generation of stoves and heaters an estimated 80 percent cleaner than those manufactured today.

The Kickapoo Valley has the Forest Resource to Sustainably Support A Pellet Plant

A small scale pellet plant (6,000-10,000 tons/year) would get its raw material from dry mill residue available from any number of secondary manufacturers in the region. Logistically placing this small pellet plant at the same location where the residue is produced would make the most economic sense.

A larger pellet plant (100,000 tons of pellets) would need 200,000 tons of raw material. This could be realized by utilizing only 21% of the net annual growth in the four County region. The main issue is not resource availability, but having the mechanized harvesting operations to produce the pulpwood sized material needed to produce the chips to resource the plant.

⁸ <http://www2.epa.gov/sites/production/files/2014-01/documents/proposedrule.pdf>

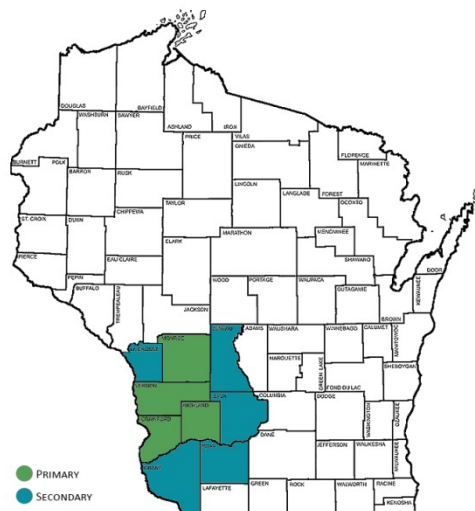
2.0 Sustainable Wood Resource Inventory and Procurement Analysis

Any analysis of wood resource availability from the forest (of any ownership) starts with the data available from the US Forest Service's Forest Inventory Analysis (FIA). This information is attained from field crews who periodically collect data from established plots located randomly throughout Wisconsin on all ownerships. This data is compiled and summarized by ownerships and forest types down to the county level. Although FIA data is very valuable in making general assessments, anybody who uses it has to realize exactly what it is, which are estimates based on samples.

2.1 Sustainable Wood Resource Inventory

A resource analysis is an important requirement for determining the feasibility of a wood pellet plant and for securing project financing.

Most of the biomass for a hypothetical pellet plant in the Kickapoo Valley will be coming from a specific radius of the project location once determined. For the purposes of this study, Vernon County, Wisconsin was considered the project center. County boundaries were used due to increased accuracy and availability of more in-depth data. This report summarizes Forest Inventory Analysis and other cited information for two data sets, one primary procurement radius and one secondary procurement radius* (hereinafter referred to "Primary Procurement Area" and "Secondary Procurement Area").



*NOTE: all secondary procurement radius data listed throughout is **in addition to** primary procurement radius data and does not include primary procurement radius data.*

Primary Procurement Area	Secondary Procurement Area
<ul style="list-style-type: none">▪ Crawford County▪ Monroe County▪ Richland County▪ Vernon County	<ul style="list-style-type: none">▪ Grant County▪ Iowa County▪ Juneau County▪ LaCrosse County▪ Sauk County

As shown in Table 2 below there are a combined total of 1,853,361 acres of forestland in the primary and secondary procurement area.

Table 2
Primary and Secondary Procurement Area Acres – By County and Ownership

	COUNTY	US FISH AND WILDLIFE SERVICE (USFWS)	US DEPT. OF DEFENSE OR ENERGY (US DOD OR DOE)	OTHER FEDER AL	STATE	LOCAL ^	PRIVATE	TOTAL NON- RESERVE* ACRES
PRIMARY PROCUREMENT AREA	CRAWFORD	5,274	-	-	11,218	-	151,808	168,300
	MONROE	5,021	42,590	4,701	11,414	12,341	231,397	307,464
	RICHLAND	-	-	-	5,609	-	170,424	176,033
	VERNON	2,672	-	-	15,946	1,716	222,299	242,633
	TOTAL ACRES	12,967	42,590	4,701	44,187	14,057	775,928	894,430
SECONDARY PROCUREMENT AREA	□ GRANT	9,197	-	-	11,357	1,831	173,656	196,040
	IOWA	-	-	-	11,579	-	149,854	161,433
	JUNEAU	48,574	-	-	19,745	19,161	180,998	268,478
	LA CROSSE	5,955	-	-	2,898	5,480	122,812	137,145
	SAUK	-	-	-	18,585	-	177,250	195,835
	TOTAL ACRES	63,726	-	-	64,164	26,472	804,570	958,931
AREAS COMBINED	TOTAL ACRES	76,693	42,590	4,701	108,351	40,529	1,580,498	1,853,361

^ County, Municipal, Etc.

* There were no “reserved” acres identified in any county in either procurement area. Reserved land is land that is withdrawn by law(s) prohibiting the management of the land for the production of wood products. Reserved status is either 'Not reserved' or 'Reserved'.

Tables 3 and 4 below provide a breakdown of acreages by forest type group, indicating the types of species found in both the primary and secondary procurement areas⁹.

Table 3
Primary Procurement Area Acreage – By Forest Type Group

FOREST-TYPE GROUP	TOTAL ACRES BY COUNTY				TOTAL ACRES BY OWNERSHIP			TOTAL ACRES
	CRAWFORD COUNTY	MONROE COUNTY	RICHLAND COUNTY	VERNON COUNTY	OTHER FEDERAL	STATE & LOCAL GOV.	PRIVATE	
WHITE/RED/JACK PINE	1,520	59,116	6,137	3,565	16,451	4,704	49,183	70,338
OAK/PINE	178	21,607	3,064	3,406	6,883	5,658	15,714	28,255
OAK/HICKORY	122,642	163,965	86,155	135,572	19,241	24,475	464,618	508,334
ELM/ASH/COTTON WOOD	16,144	18,896	13,056	24,967	14,784	11,538	46,741	73,063
MAPLE/BEECH/BIRCH	23,335	17,101	52,585	52,011	-	11,238	133,794	145,032
ASPEN/BIRCH	1,840	25,349	9,648	14,125	2,899	631	47,432	50,962
OTHER HARDWOODS	2,640	-	2,337	4,705	-	-	9,682	9,682
NONSTOCKED	-	1,430	2,299	753	-	-	4,482	4,482
EXOTIC HARDWOODS	-	-	753	-	-	-	753	753
EXOTIC SOFTWOODS	-	-	-	2,472	-	-	2,472	2,472
OTHER EASTERN SOFTWOODS	-	-	-	1,058	-	-	1,058	1,058
TOTAL ACRES	168,300	307,464	176,033	242,633	60,258	58,244	775,928	894,430

Table 4
Secondary Procurement Area Acreage – By Forest Type Group

FOREST TYPE GROUP	TOTAL ACRES BY COUNTY					TOTAL ACRES BY OWNERSHIP			TOTAL ACRES
	GRANT COUNTY	IOWA COUNTY	JUNEAU COUNTY	LA CROSSE COUNTY	SAUK COUNTY	OTHER FEDERAL	STATE & LOCAL GOV.	PRIVATE	
WHITE/RED/JACK PINE	3,010	6,968	42,756	3,406	8,066	9,116	10,597	41,087	60,800
OAK/PINE	-	2,472	44,462	753	3,259	17,096	9,978	23,119	50,193
OAK/HICKORY	134,357	120,650	121,964	101,683	126,322	15,277	31,678	456,338	503,293
ELM/ASH/COTTONWOOD	24,739	20,358	25,324	12,758	18,241	9,197	18,729	60,736	88,662
MAPLE/BEECH/BIRCH	32,325	4,603	17,090	2,602	26,732	-	4,079	76,671	80,750
ASPEN/BIRCH	-	6,383	15,360	14,437	7,976	7,085	6,608	16,026	29,719
NONSTOCKED	1,609	-	1,522	--	2,848	-	590	5,389	5,979
OTHER EASTERN SOFTWOODS	-	-	-	--	2,393	-	-	2,393	2,393
OTHER HARDWOODS GROUP				1,505					
TOTAL ACRES	196,040	161,434	268,478	135,640	195,837	57,771	82,259	681,759	821,789

⁹ There are 9 forest type groups in Table 3 and 11 forest type groups in Table 4. The two group difference is in regards to what is actually found in the counties being surveyed in each table. There are actually 20+ possible groups for this sort but only those groups that have acreage for that group show up. There were exotic hardwoods and softwoods in the primary counties but not the secondary counties, hence the difference.

The figure below illustrates public ownership of forestland within the study area, which represents a small percentage (approximately 15%) of the total acreage of forestland within the study area. The Kickapoo Valley Reserve land includes 8,569 acres located along the Kickapoo River Valley between La Farge and Ontario, Wisconsin. A large percentage of that acreage is forestland.

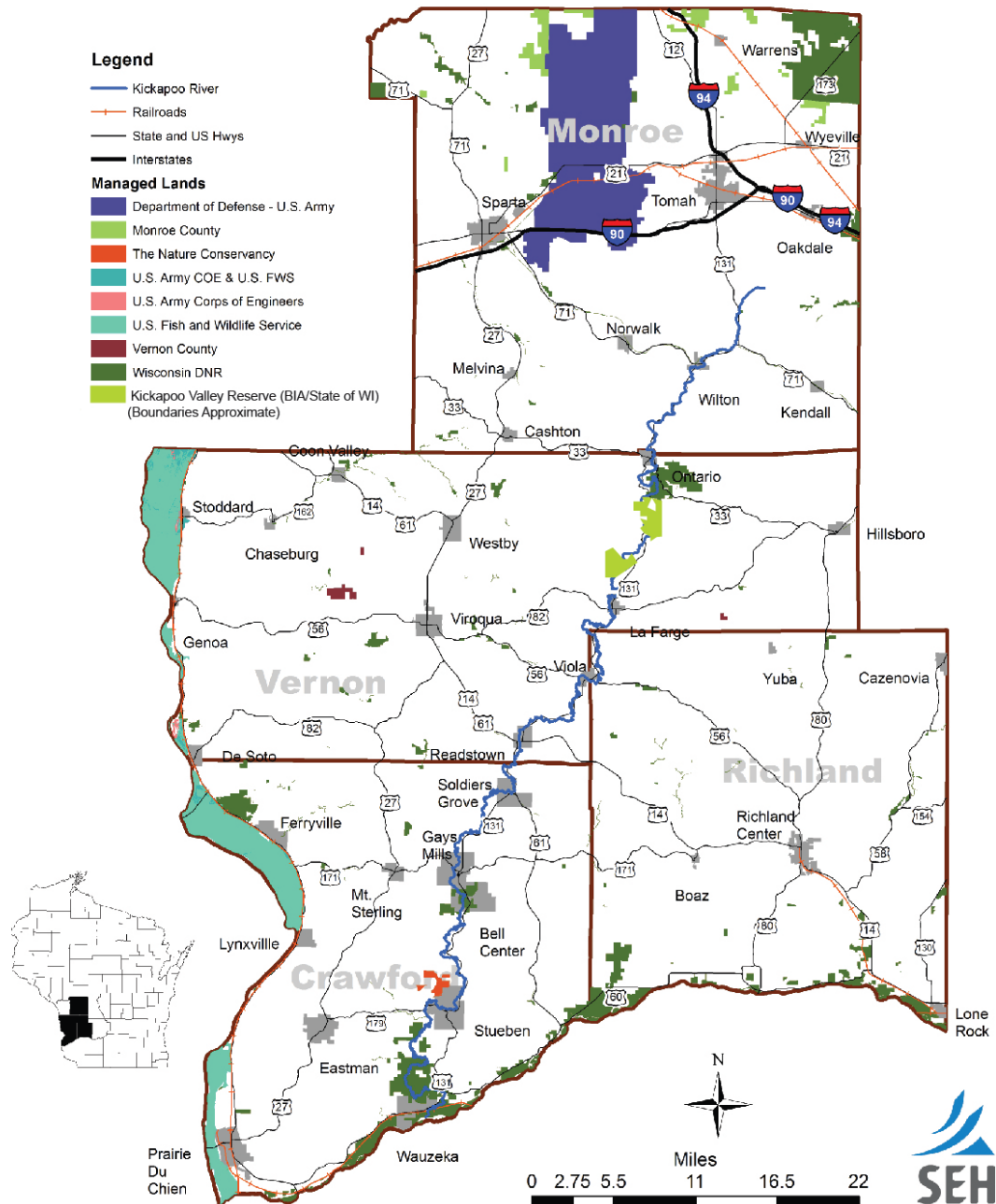


Figure 4 – Public Forestland - Kickapoo Valley

2.1.1 Growth, Mortality, and Harvest Volumes

The following tables extrapolate resource data from the US Forest Service's Forest Inventory and Analysis (FIA) National Program's 2012 forest resource analysis data. FIA data generates volume by cubic foot; conversions used in the tables below assume 79 cubic feet per cord and 2.3 green tons per cord. Green tons are defined as the weight of wood immediately after harvest with a moisture content of 45-55%, depending on the specific tree species.

Growing-stock trees are live trees of commercial species that meet minimum merchantability standards. In general, these trees have at least one solid 8-foot section, are reasonably free of form defect on the merchantable bole, and at least 34 percent or more of the volume is merchantable.

Gross annual growth refers to the sum of net annual growth, net annual mortality, and net removals. Removals are the trees harvested or killed in logging, cultural operations (such as timber stand improvement) or land clearing, and the trees neither harvested nor killed, but now growing on land that was either reclassified from forestland to nonforest or from timberland to reserved forestland or to unproductive forestland.

Annual Removals refers to what is currently being harvested on an annual basis.

Mortality is tree death by natural causes, and not the result of harvest operations or other human-caused land clearings. Finally, average annual net growth is the net change in cubic-foot volume per year of merchantable growing-stock trees (at least 5 inches diameter breast height [dbh]).

Net Annual Growth is Gross Annual Growth minus Removals and Mortality. Net annual growth is technically the amount of wood that could be utilized without depleting the forest resource.

Within the primary procurement area, there is net annual growth of 935,483 green tons of forest resource. Within the secondary procurement area there is net annual growth of 778,768 green tons of forest resource. Combined, there is an estimated 1,714,351 green tons of net annual growth within the two procurement areas annually, Tables 5 and 6.

Table 5
Procurement Areas Combined – Forest Resource Availability by Ownership Type

OWNERSHIP TYPE	Green Tons			
	GROSS ANN. GROWTH	ANNUAL REMOVALS	ANNUAL MORTALITY	NET ANN. GROWTH
FISH AND WILDLIFE	139,173	8,793	60,465	69,914
DEPT. OF DEFENSE	69,222	17,515	18,287	33,420
OTHER FEDERAL	4,736	-	241	4,495
STATE	228,322	20,200	57,187	150,935
COUNTY, MUNICIPAL, ETC.	75,148	36,243	11,248	27,658
PRIVATE	2,740,133	513,147	799,057	1,427,929
TOTAL	3,256,734	595,898	946,484	1,714,351

This study is intended to answer a fundamental question: is there an adequate amount of forest resource available to support a pellet plant in a sustainable manner? The answer is yes. A 100,000 ton a year pellet plant needs approximately 200,000 green tons of raw material to operate. As can be seen by the statistics in Table 6 this could be accomplished by utilizing only 12% of the net annual growth or 21% of the annual mortality or 55% of the net annual growth from the red and white pine timber type.

Table 6
Forest Resource Availability by Species Group on All Ownership Types – Green Tons

SPECIES GROUP	PRIMARY PROCUREMENT AREA – GREEN TONS				SECONDARY PROCUREMENT AREA – GREEN TONS			
	GROSS ANN. GROWTH	NET ANN. REMOVALS	NET ANN. MORTALITY	NET ANN. GROWTH	GROSS ANN. GROWTH	NET ANN. REMOVALS	NET ANN. MORTALITY	NET ANN. GROWTH
EAST. WHITE AND RED PINE	302,292	58,662	5,633	237,997	193,709	62,060	4,933	126,716
OTHER EAST. SOFTWOODS	3,263	1,281	-	1,982	4,499	1,500	770	2,229
SELECT WHITE OAKS	128,161	22,343	17,985	87,833	113,842	23,630	21,432	68,780
SELECT RED OAKS	158,534	11,754	23,798	122,982	269,845	86,559	66,756	116,530
OTHER RED OAKS	75,877	15,565	33,571	26,741	141,798	40,350	71,758	29,690
HICKORY	95,523	8,405	9,510	77,607	52,733	1,198	16,742	34,793
HARD MAPLE	117,170	14,559	7,909	94,701	60,628	2,669	-	57,959
SOFT MAPLE	113,419	11,946	9,216	92,257	158,416	15,883	16,761	125,772
ASH	78,619	2,381	5,277	70,961	70,040	8,126	16,669	45,246
COTTONWOOD AND ASPEN	124,846	3,162	78,297	43,388	138,036	47,996	107,151	-17,111
BASSWOOD	60,240	6,713	14,400	39,126	60,462	-	1,812	58,650
BLACK WALNUT	48,407	23,005	-	25,401	86,649	38,889	7,536	40,224
OTHER EAST. SOFT HRDWD	193,786	6,278	186,250	1,259	300,887	57,499	185,877	57,511
OTHER EAST. HARD HRDWD	5,330	-	389	4,941	20,835	0	0	20,835
JACK PINE	18,187	4,434	10,021	3,732	52,847	19,051	25,217	8,579
YELLOW BIRCH	1,018	-	-	1,018	938	-	-	938
SPRUCE AND BALSAM FIR	870	-	-	870	1,024	-	-	1,024
OTHER YELLOW PINES	3,501	-	815	2,686	503	-	-	503
TOTAL	1,529,043	190,489	403,071	935,483	1,727,690	405,409	543,413	778,868

2.1.2 Sustainable Annual Volume – Forest Resource Volume Realistically/Economically Available

Determining a sustainable biomass harvesting volume depends on several on-site and off-site variables. On site variables include:

- Soil type
- Topography
- Soil conditions (wet, dry, frozen)
- Long skid distance
- Other uses for tops (firewood, trail armoring)
- Logging company is not equipped for biomass harvesting
- Landowner goals for the property

Off-site variables that can affect biomass extraction:

- Price paid by receiving plant
- Distance to plant
- Availability/ease of use of incentive programs
- Other markets for product
- Biomass harvesting guidelines
- Buyer specifications (i.e. species, form, moisture content, etc.)
- Competition among buyers and buyer needs

2.1.2.1 Logging Residue Availability

2.1.2.1.1 *Private Forestland*

The following section of the report estimates sustainable biomass harvesting levels for a potential wood pellet or solid biofuel plant. Unlike many other parts of the state, the majority of forestland in the Kickapoo Region is privately owned.

2.1.2.1.2 *Tax Law Land*

Wisconsin's Forest Tax Laws (FTLs) offer landowners reduced property taxes in return for following a management plan that is specific to their property. The Forest Crop Law (FCL) was an early tax law program that is now phasing out and is being replaced by the Wisconsin Managed Forest Law (MFL). The MFL program is a landowner incentive program that encourages sustainable forestry on private woodlands in Wisconsin. To participate in the MFL program, landowners designate property as "Open" or "Closed" to public access for recreation and commit to a 25 - or 50 - year sustainable forest management plan. The plan sets the schedule for specific forestry practices which landowners must complete. In return, MFL participants make a payment in lieu of regular property taxes and pay a yield tax on harvested trees.

The figure below is a map of forestland enrolled in the MFL program, which illustrates the large amount of privately owned forest land in the study area.

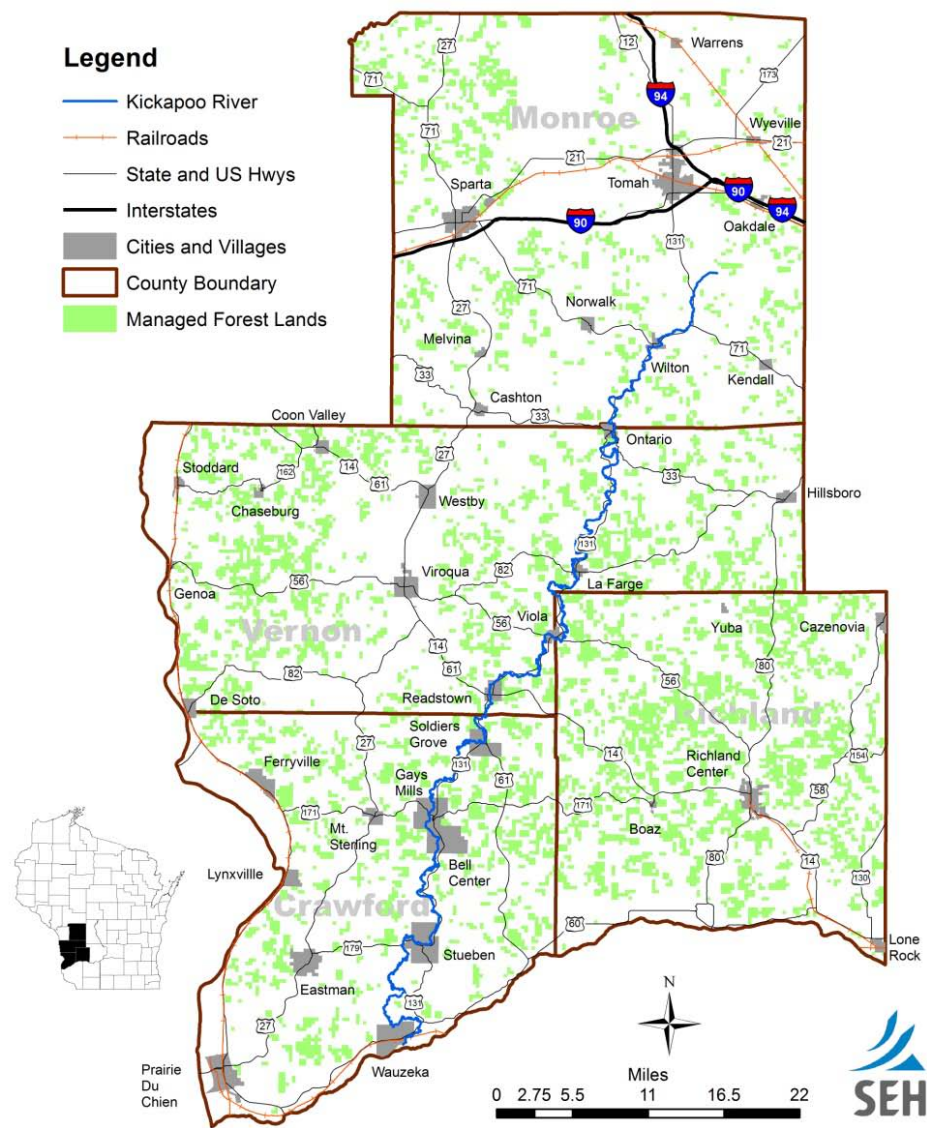


Figure 5 – MFL Acreages in Study Area

The table below summarizes the amount of lands enrolled under Wisconsin's Forest Tax Laws within the primary and secondary procurement areas. In 2013, there were 228,894 acres in the primary area and 196,936 acres enrolled in the secondary area for a total of 425,830 acres.

Table 7
FTL Forestland Acres by County and Procurement Area

	Primary Procurement Area			Secondary Procurement Area	
	County Name	Total FTL Programs Acres		County Name	Total FTL Programs Acres
				Grant	22,637
	Crawford	45,861		Iowa	48,344
	Monroe	49,233		Juneau	50,212
	Richland	63,822		La Crosse	28,649
	Vernon	69,977		Sauk	47,094
	Total	228,894		Total	196,936

The table below shows that between all tax law properties in the four Primary Procurement Area Wisconsin counties, there is an average of **17,926 cord equivalents harvested annually**. Using a ratio of .8 tons of woody biomass per cord of other products, this translates to **14,341 tons** of biomass potentially available.

Table 8
Annual Timber Harvested in the Primary Procurement Area from FTL Forestland – Cordwood Equiv.

YEAR	CRAWFORD	MONROE	RICHLAND	VERNON	TOTAL
2002	739	2,468	3,008	1,603	7,818
2003	1,109	4,209	1,840	1,514	8,672
2004	3,129	5,829	6,602	3,235	18,796
2005	2,649	11,587	8,614	3,568	26,418
2006	3,061	8,220	8,312	5,899	25,492
2007	820	7,946	7,402	3,065	19,233
2008	1,733	7,606	5,640	1,846	16,825
2009	2,530	4,226	5,291	3,379	15,427
2010	1,371	7,047	7,412	414	16,244
2011	2,574	15,410	5,513	2,230	25,728
2012	1,287	5,129	7,328	2,794	16,538
10 Yr. AVERAGE	1,909	7,243	6,087	2,686	17,926

The table below shows that between all tax law properties in the five Secondary Procurement Area Wisconsin counties, there is an average of **24,967 cord equivalents harvested annually**. Using a ratio of .8 tons of woody biomass per cord of other products, this would make **19,973** tons of biomass potentially available.

Table 9
Annual Timber Harvested in the Secondary Procurement Area from FTL Forestland – Cordwood Equiv.

YEAR	Grant	Iowa	Juneau	La Crosse	Sauk	Total
2002	93	2,817	8,852	1,076	794	13,631
2003	931	3,309	16,442	1,033	1,087	22,802
2004	1,319	1,390	23,204	2,122	4,007	32,043
2005	301	2,973	14,387	2,681	1,405	21,747
2006	506	2,263	6,362	1,917	4,792	15,839
2007	1,328	3,760	19,882	4,200	4,969	34,137
2008	947	1,938	12,281	2,488	4,890	22,544
2009	916	2,908	11,104	1,457	5,507	21,891
2010	1,162	1,718	15,805	1,433	9,590	29,708
2011	6,778	3,563	8,906	3,700	5,520	28,466
2012	5,183	3,105	14,556	2,691	6,292	31,827
10Yr. AVERAGE	1,769	2,704	13,798	2,254	4,441	24,967

2.1.2.1.3 Wisconsin Private Non-Tax Law Forest

In addition to the private ownership under a forest tax law (FTL) program in Wisconsin, there are 547,034 acres of private non-FTL forestland in the four-county Primary Procurement Area and 607,634 acres of private non-FTL forestland in the five-county Secondary Procurement Area. There is no information to suggest that FTL and non-FTL are any different in productivity or timber types; however, most of the non-FTL acres do not have management plans and they typically do not involve a forester so biomass extraction may not even be considered by the loggers who conduct these sales. Also, FTL properties require harvesting as a condition of membership whereas non-FTL forest management is at the landowner's discretion. Most non-industrial private landowners do not own forestland for timber production and are often unaware of the benefits of forest management.

Though there are nearly three times as many non-FTL as FTL acres, we will use the same volumes for both ownership types because the tax law land is more intensively managed.

The obvious variance in wood harvested from private land that is under the Managed Forest Law (MFL) makes a strong case for promoting the MFL program to private woodland owners. More forests under management means increased income for landowners and a sustainable supply of products for the forest industry and consequently the extended local economies.

Under MFL, utilization of forestland is required down to a four-inch top diameter. This smaller diameter material, which was previously not utilized, could potentially be used for wood pellets or chips.

2.1.3 Sustainable Recoverable Logging Residue from FTL and Non-FTL Private Forestlands

The figure below shows the volume of potential logging residue based on procuring 20% or 25% of the total recoverable logging residue available. These percentages allow for competition and lack of biomass removal for various reasons. The recoverable logging residue is estimated to be 80% of total removals and already factors in the recommendations of Wisconsin's Forestland Woody Biomass Harvesting Guidelines. It is estimated that the two procurement areas combined could produce between 13,725 green tons (20% recovery rate) and 17,158 green tons (25% recovery rate) to support a new solid biofuel project in the study area.

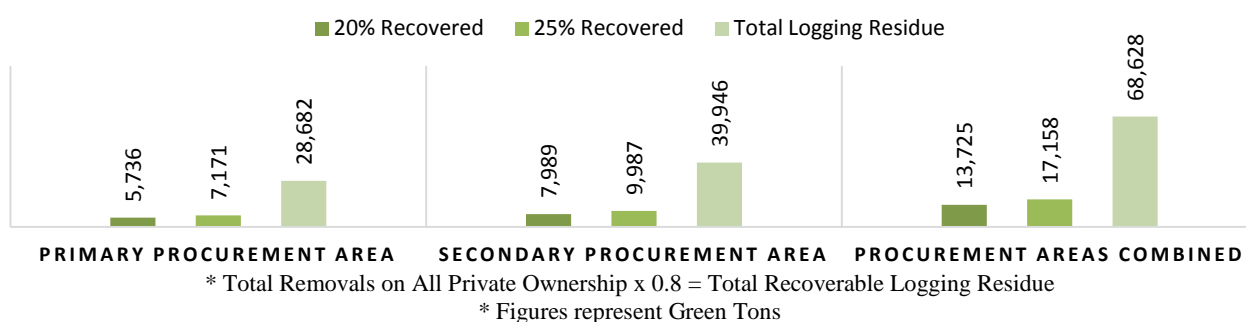


Figure 6 – Estimated Annual Green Tons of Logging Residue Available from FTL and Non-FTL Forestlands by Procurement Area (Forest Inventory Analysis Data)

2.1.3.1 All Forestlands – Excluding Private

Using a ratio of 0.24 green tons of biomass per green ton of other products removed per the 2012 USFS FIA removal volumes (see Growth, Mortality, and Harvest Volumes above), annual green tons of recoverable logging residue generated by roundwood harvesting on all ownerships (*excluding private*) was calculated.

The figure on the following page shows the volume of potential logging residue based on procuring 20% or 25% of the total recoverable logging residue available. These percentages allow for competition and lack of biomass removal for various reasons. The recoverable logging residue is estimated to be 80% of total removals and already factors in the recommendations of Wisconsin's Forestland Woody Biomass Harvesting Guidelines. It is estimated that the two procurement areas combined could produce between 3,973 green tons (20% recovery rate) and 4,965 green tons (25% recovery rate) to support a new solid biofuel project in the study area.

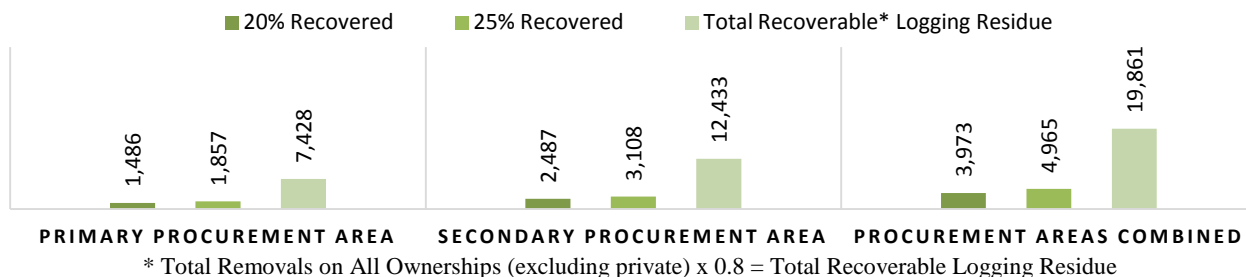


Figure 7 – Annual Green Tons of Logging Residue Generated by Roundwood Harvesting on all Ownerships, Excluding Private Ownership, by Procurement Area

2.1.4 Timber Salvage Operation

2.1.4.1 Timber Salvage Potential on All Ownership Structures

The figure below shows the volume of recoverable forest mortality through a salvage harvest across all ownership structures. Totals below assume a salvageable ratio of 20% per green ton of annual forest mortality derived using USFS FIA removal volumes from 2012 (see Growth, Mortality, and Harvest Volumes above). Feasibly recoverable volumes were then calculated based on procuring 25% or 50% of total recoverable material. These percentages allow for competition and lack of removal for various reasons.

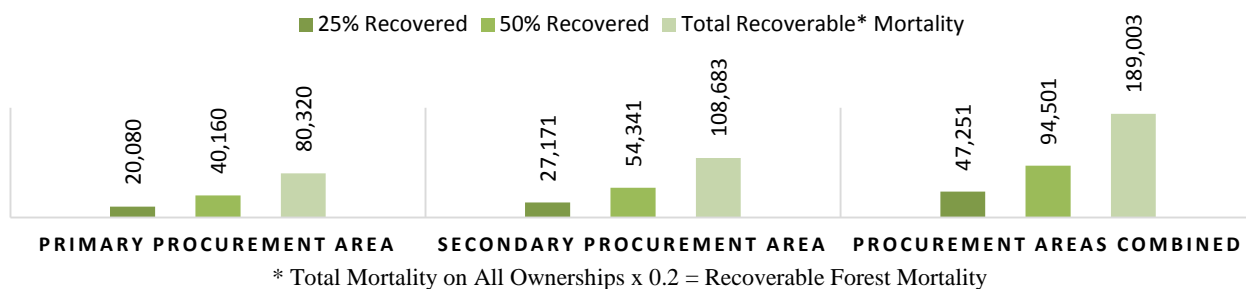


Figure 8 – Total Mortality and Potential Salvage Volume Available by Procurement Area – Green Tons

This figure does not include wood available from dead trees caused by weather events, insects, or disease as these volumes cannot be planned for or counted on in a specific year. In some years, it could account for a significant percentage of the woody biomass used at a woody biomass using facility.

2.1.5 Dedicated Biomass Harvesting – Net Growing Stock

2.1.5.1 Potential Dedicated Biomass Harvesting of Net Growing Stock on All Ownerships

The following figure shows the volume of biomass available through dedicated biomass harvesting of net growing stock (growing stock less removals and mortality). Totals were developed using a harvest ratio of 10% and 20% per green ton of net annual forest growth (see Growth, Mortality, and Harvest Volumes figures).

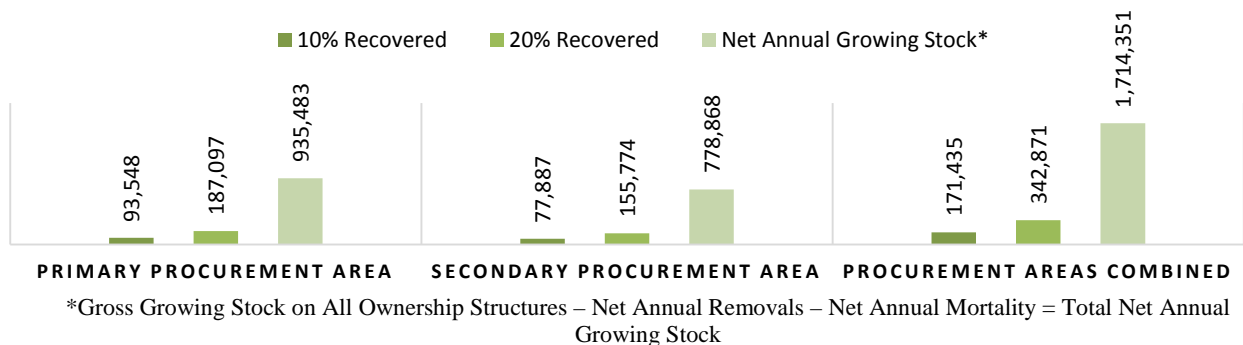


Figure 9 – Estimated Biomass Available through Dedicated Biomass Harvesting – Green Tons

2.1.6 Total Volume of Woody Biomass from all Forest Sources

The following charts review the total potential woody biomass from Logging Residue, Salvage Harvests, and Dedicated Biomass Harvesting combined at the two variable harvesting ratios presented in each section above. Under the lower recovery scenarios the total estimated biomass available for a solid biofuel project located in the study area is 236,384 green tons, including 120,850 green tons from the primary procurement area and 115,534 green tons from the secondary procurement area.

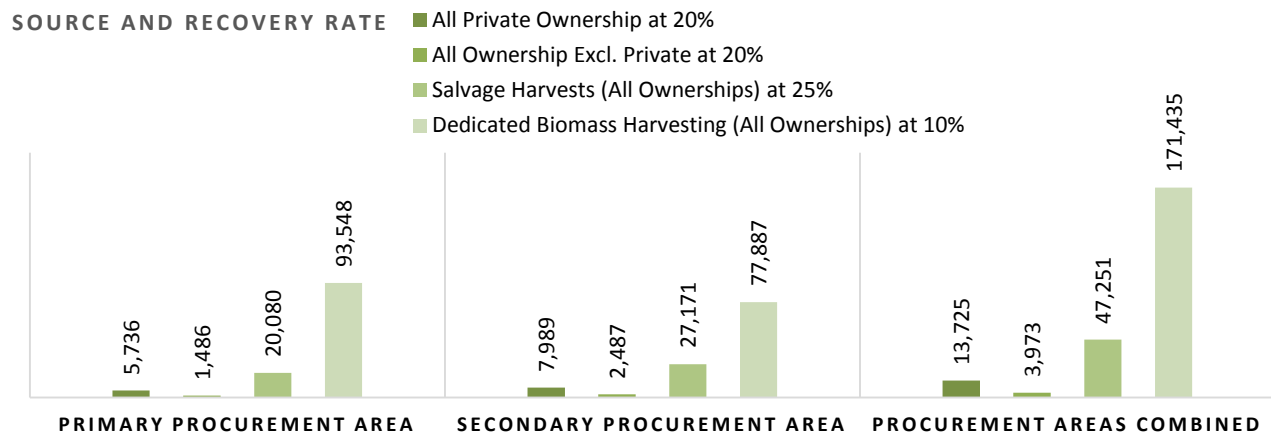
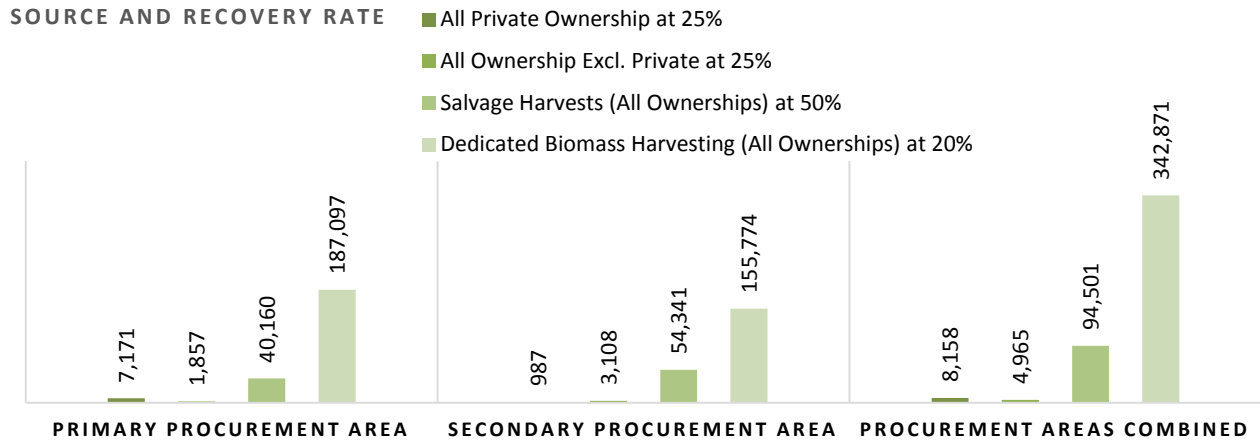


Figure 10 – Estimated Total Green Tons of Forest-Sourced Woody Biomass Minimal Recovery Rates

Under the medium recovery scenarios the total estimated biomass available for a solid biofuel project located in the study area is 450,495 green tons, including 236,285 green tons from the primary procurement area and 214,210 green tons from the secondary procurement area.



**Figure 11 – Estimated Total Green Tons of Forest-Sourced Wood Biomass
Medium Recovery Rates**

2.1.7 Industrial Wood Residue

2.1.7.1 Volume of Industrial Wood Residue from Primary and Secondary Procurement Areas Combined

In addition to the forest-sourced residue aforementioned, other sources of woody biomass may include primary and secondary forest industry companies, untreated waste (pallets), urban or R.O.W. tree removals/trimmings, and landfill brush dumps. In order to account for these additional volumes, the most recent Timber Products Output (TPO) survey was reviewed for both the primary and secondary procurement areas.

TPO surveys are conducted by the FIA and provide estimates of industrial roundwood use. To assess industrial roundwood use, all primary wood-using industries within a state are surveyed biannually. Primary wood-using industries include pulp mills, sawmills, veneer mills, composite panel mills, and other industrial products mills. These mills convert roundwood products (saw logs, veneer logs, pulpwood, etc.) into primary wood products such as lumber, veneer or sheathing, poles and posts, and wood pulp. The figure on the next page shows primary and secondary wood processors located in the study region based on the most recent publically available data. A list of processors is provided in the appendices (Available at www.mrrpc.com). Primary wood processor #20 (Shroer Lumber) no longer exists.

Legend

- Primary Wood Processors
- Secondary Wood Processors
- Kickapoo River
- Railroads
- State and US Hwys
- Interstates
- Cities and Villages
- County Boundary

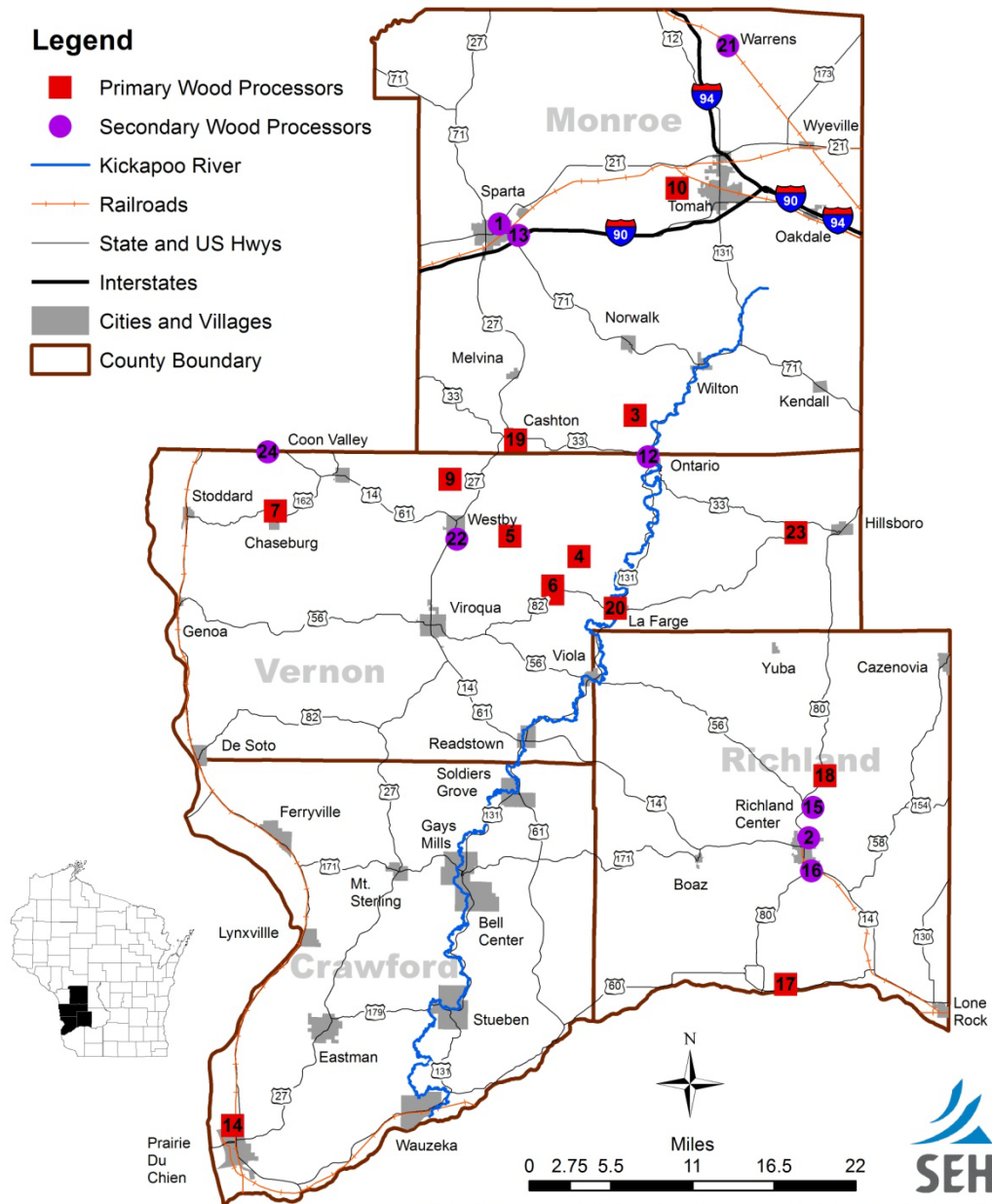


Figure 12 – Primary & Secondary Wood Processors

The table below summarizes residues potentially available from wood using mills by residue type. It is estimated that there are 29,600 dry tons of residue generated from the two procurement areas (15 lbs. of dry residue per cubic ft. was used).

Table 10
Wood Residue from Primary Wood-Using Mills by Type of Residue and Use
(1,000s of Cubic Feet) 2012

SOURCE	SPECIES GROUP	FIBER BYPRODUCT	FUEL BYPRODUCT	MISC. BYPRODUCT	NOT USED BYPRODUCT	ALL BYPRODUCTS
BARK RESIDUE	SOFTWOOD	-	3	3	-	6
	HARDWOOD	-	521	707	-	1,228
	TOTAL	-	523	710	-	1,234
WOOD RESIDUE (COARSE)	SOFTWOOD	1	4	1	-	6
	HARDWOOD	1,369	181	351	-	1,901
	TOTAL	1,370	185	352	-	1,908
WOOD RESIDUE (FINE)	SOFTWOOD	-	-	2	1	3
	HARDWOOD	270	228	298	-	797
	TOTAL	270	228	301	1	800
WOOD RESIDUE (ALL)	SOFTWOOD	1	4	3	1	9
	HARDWOOD	1,639	409	649	1	2,698
	TOTAL	1,640	414	652	1	2,707
ALL RESIDUES	SOFTWOOD	1	7	6	1	15
	HARDWOOD	1,639	930	1,356	1	3,926
	TOTAL	1,640	937	1,362	1	3,941

Numbers in rows and columns may not add to totals due to rounding.

Once fuel procurement planning begins, these additional sources would need to be contacted for potential fuel. Although many of these sources already have markets for their residue/waste, it does not mean that it would not be available because of economic or geographic factors. Therefore, it is assumed a small percentage of the fuel would come from these sources for a larger pellet operation. Logging residue, salvage harvests, and dedicated biomass harvesting will most likely be the primary fuel sources for a larger wood pellet mill. On the other hand, a smaller pellet mill, co-located with a wood processor, could source its feedstock entirely from existing mill residues.

2.2 Procurement Analysis

The information in this section is directly linked to the markets and what they will pay. The markets must be known as well as the critical “distance to market”.

2.2.1 Harvesting Systems & Technologies

There are different biomass harvesting and delivery systems, each briefly described below.

2.2.1.1 Mechanized Cut To Length (CTL)

This system typically includes a processor, which can be tracked or rubber tired. This machine is used to cut trees down and to cut them into product lengths in the woods at the stump. Once processed, the second piece of equipment, a forwarder (which can also be rubber tired or tracked) is used to take the products from the woods to a landing area where they will be put on log trucks.

A deterrent is the limitations of these systems on slopes in excess of 20%. Although many areas in this region exceed a 20% slope, a substantial portion does not. Determining these areas and setting up timber sales accordingly would be critical. A positive attribute of

utilizing the CTL system is the lack of dirt on the end-product, which is a big consideration when further processing is required.

A unique use of these systems could be tree removal in urban and suburban areas. This concept was first tried in the city of Oak Creek (suburb of Milwaukee) in November 2010 to remove ash trees that were threatened, infected, or killed by the Emerald Ash Borer (EAB). The CTL system was proven to be far more economical than removal by hand crews. With EAB affecting ash trees in the Kickapoo procurement areas, using this system could prove to be very effective in removing/utilizing this wood from cities, towns, villages, and along right-of-ways. A video entitled “Harvesting Urban Trees with Modern Logging Equipment” is available online at the following web address:

<http://dnrmedia.wi.gov/main/Play/504a7d15adae42a28a17f7f9614400541d>

2.2.1.2 Mechanized Tree Length (MTL)

This system involves a feller buncher, which is used to cut trees down and pile several trees together. The second piece of equipment is typically a grapple skidder which will pull the trees from the woods to a landing area where they are cut up by either a mechanized slasher or chainsaw.

MTL systems are more suited to clearcuts or seed tree harvests. This type of system is limited by slopes, but not nearly to the extent of CTL systems. The amount of acreage that would be best suited for this type of system would have to be determined.

2.2.1.3 Cable Logging

There are many different versions of this system but the version that was demonstrated in Wisconsin in 2011 was set up as follows: two excavators were positioned up to a ¼ mile apart either at the top and bottom of a hill or between two hill tops. There was a cable that extended between these two machines on a 40’ tower mounted to these machines. A mechanized carriage with cables to attach to trees that ran up and down the primary cable, bringing trees to either excavator to be processed and removed by trucks. Trees that were removed could be cut by either a processor, a feller buncher, or hand felled.

A system that could definitely have application in this area is the “Mobile Cable Logging” system. This type of system was demonstrated in eastern Wisconsin in 2011. It can be used on steep slopes or over sensitive soils (river bottoms or wetlands). A video entitled “Excavator-Based Cable Logging System: A Wisconsin Demonstration” is available online at: <http://dnrmedia.wi.gov/main/Play/fad4fc7dcb9b461ebbc74e1770ae19b01d>

2.2.1.4 Harvesting Costs

2.2.1.4.1 *Cost Variables*

There are always many variables to consider that affect the cost for all systems. These include:

- Total acreage/volume
- Slope
- Distance to landing area (log truck loading area)
- Volume per acre
- Soil conditions
- Access (near an improved road or substantial woods road access)
- Weather

2.2.1.4.2 Production Costs by Harvesting Systems

For Mechanized Cut to Length (CTL), system cost will typically range between \$35 and \$45 per cord, for felling the tree, processing the tree and forwarding it to a landing. For Mechanized Tree Length (MTL) system cost is roughly half that of a CTL system; however, these systems are much more limited in their application due to harvesting restrictions. Cable logging cost is known only based on a pilot project. Per this pilot, the estimated cost is \$30 to \$40 per cord. This system would be a limited application, but could potentially operate where other systems could not.

2.2.2 Delivery Costs

Trucking costs will vary by distance to the market but also by in-woods versus road miles. Also built into this is the time and cost of loading and unloading. The average cost is approximately \$2.50 per mile. Others will charge by the hour, with \$100 per hour being an average price. Figuring a ten cord load of wood being transported 50 miles to the market, the cost would be \$200 per round trip or \$20 per cord.

The total cost to deliver cordwood harvested by a CTL system, to a market 50 miles away would be:

	Cost/Cord	
Stumpage	\$8.00	(other hardwood, DNR Tables)
In-Woods	\$40.00	
Trucking	\$25.00	
Total	\$73.00	/cord that would have to be realized for cordwood products

Fluctuating fuel costs can be absorbed by the end market in some areas, depending on market demand; however, that does not always occur. In most cases, the logger is forced to bid conservatively enough on timber sales to allow for fuel price increases. If the property will be logged in a short period of time it is somewhat easier to adapt for price increases. If the logger is purchasing timber sales a year or more in advance, it is considerably more difficult to adapt for such increases. A sliding scale was developed to address the issue and is shown in the tables below.

Table 11
Sliding Scale of Fuel Costs for MCL in Woods Operations

Fuel Price per Gallon	Fuel as Percentage of Operating Costs*	Cumulative Increase in Cost per Cord Produced**
\$3.50	20.00%	N/A
\$3.60	20.12%	\$0.23
\$3.70	20.23%	\$0.46
\$3.80	20.35%	\$0.68
\$3.90	20.46%	\$0.91
\$4.00	20.58%	\$1.14
* every \$0.10 increase or decrease in the price of fuel causes an increase or decrease of 0.575% of the total operational costs		
** every increase of \$0.10 to the price of fuel adds \$0.228 to the price of a cord of wood, assuming 33 cords produced per day		

Table 12
Sliding Scale of Fuel Costs for 50 Mile Round Trip

Fuel Price per Gallon	Fuel as Percentage of Operating Costs*	Cumulative Increase in Cost per Cord Transported**
\$3.50	20.00%	N/A
\$3.60	20.11%	\$0.17
\$3.70	20.22%	\$0.33
\$3.80	20.33%	\$0.50
\$3.90	20.45%	\$0.66
\$4.00	20.56%	\$0.83
* every \$0.10 increase or decrease in the price of fuel causes an increase or decrease of 0.555% of the total operational costs		
** every increase of \$0.10 to the price of fuel adds \$0.166 to the price of a cord of wood, assuming 10 cords transported per load		

There are a number of proven harvesting technologies involving mechanized felling and processing equipment explained in the previous section that currently are in limited use in this project area that have the potential for expanded use.

The key to increased utilization is implementing technologies, such as the CTL systems aforementioned, and/or expanding the Mechanized Tree Length (MTL) systems (i.e. feller bunchers or hot saws with grapple skidders). In the case of CTL, utilizing bole wood (a.k.a. pulpwood) down to 4 inches should be the first step before the biomass (tops and branches) is even considered. Removing this material is much more cost effective than removing biomass. Pulpwood is an uncommon product in most parts of the Kickapoo procurement areas, therefore markets would have to be secured for either traditional pulpwood, firewood, or chips (mulch or fuel). Before this type of harvesting was undertaken, the economics would have to be justified.

Another product not currently utilized in this area is boltwood. This product does not meet sawlog standards primarily due to diameter, which for boltwood is typically in the range of 8-11 inches in diameter on the small end of a log. In many parts of the state, boltwood is used for producing pallet parts and lower grade lumber. There would seem to be an opportunity for existing sawmills to put in a boltwood mill or to have a standalone boltwood mill separate from existing operations.

2.3 Stumpage Rate Estimate

2.3.1 Logs

The five species listed on the next page are considerably lower in value than oak, maple, and walnut. Sourcing lumber for value-added products utilizing these species, if possible, would be more economical than the three previously mentioned species.

Table 13
Stumpage Value per Thousand Board Feet

Species	2009	2010	2011	2012	2013	2014
Aspen	65.00	56.00	52.00	30.00	37.00	50.00
Ash	141.00	142.00	100.00	112.00	114.00	128.00
Basswood	128.00	100.00	83.00	79.00	116.00	127.00
Elm	51.00	56.00	37.00	52.00	44.00	102.00
Hickory	NA	NA	NA	100.00	111.00	136.00

2.3.2 Cord Products

If material was utilized from the forest producing pellet or chip fuel, pulpwood sized material (cordwood) would be the first product class that should be utilized. The table below gives prices that are typically paid by species or species group.

Table 14
Cordwood Stumpage Rates by Species Group

Species	2009	2010	2011	2012	2013	2014
Aspen	15.00	14.00	14.00	12.00	17.00	15.00
Basswood	5.00	3.00	3.00	3.00	8.00	6.00
Other Hardwoods	9.00	12.00	11.00	11.00	10.00	8.00
Oak	11.00	14.00	15.00	15.00	18.00	13.00
Pine, Jack	30.00	29.00	22.00	24.00	20.00	20.00
Pine, Red	21.00	30.00	20.00	20.00	20.00	23.00
Pine, White	17.00	13.00	14.00	19.00	17.00	13.00
Fuelwood	10.00	5.00	5.00	5.00	5.00	9.00

¹ Pulpwood and larger sized products that are dead or cull material that is not merchantable as pulpwood or saw logs due to quality.

Note: Stumpage values used to calculate severance and yield taxes during any specific period are intended for the purposes of the Forest Crop Law and Managed Forest Law. They are not a guarantee of actual market prices. Actual market prices can fluctuate, both up and down, and are the product of macro- and micro-economic conditions reflecting specific factors of each individual sale.

3.0 Solid Biofuel Market Analysis

3.1 Regional survey results

An on-line survey was conducted as part of the study. With fluctuating energy prices, concerns about future supplies, and the potential to support the local economy, interest in renewable energy is growing. The on-line survey was designed to help determine current demand for biomass renewable energy (wood pellets/wood chips) and anticipated future demand among households and business owners in the Kickapoo Valley (Crawford, Monroe, Vernon, or Richland counties).

98 respondents replied to the survey, less than the number needed in order to make the results statistically valid. However, there were several interesting findings that emerged from the data. A full copy of the survey results is provided in the appendices (www.mrrpc.com). Of the respondents to the survey, 64% reside in a town and 36% in a city or village.

There were two primary parts to the survey. The first part of the survey was targeted to residents of households within the study area. The second part of the survey asked for responses from individuals that own or manage a business in the study area.

3.1.1 Household Survey Results

3.1.1.1 Respondents

In terms of households, respondents to the survey indicated a wide range of primary energy sources used to heat their homes. The largest respondents were those using fire wood (32%), natural gas (28%), and propane (23%), followed by significantly fewer using electricity (7%), wood pellets (4%), fuel oil (4%), wood chips (1%), solar (1%), or other (1%).

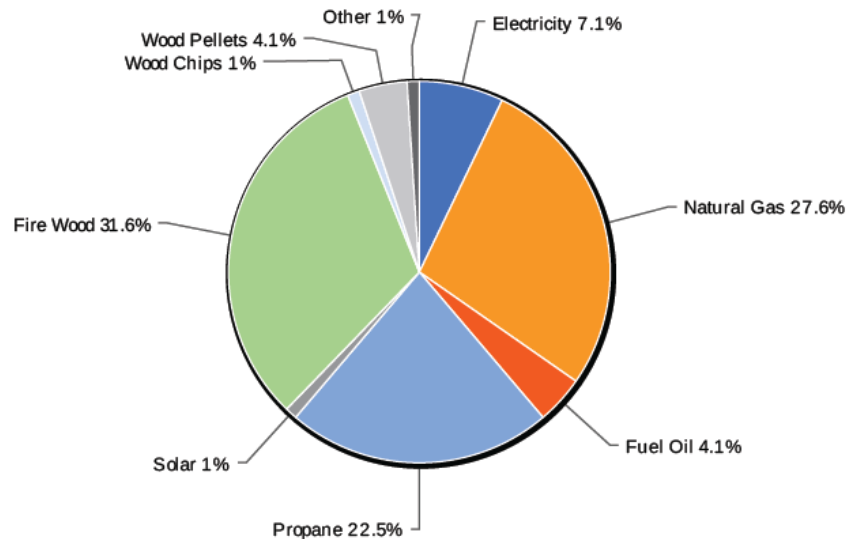


Figure 13 – Survey Respondents Primary Heat Source

The US Census provides information regarding how households heat their homes. The table below shows a breakdown of survey respondents and suggests that those taking the survey were fairly representative of the study area's overall population in terms of the percentage heating with propane. However, the percentages of survey of respondents heating with fuel oil, electricity, and natural were lower than the study area figures. Finally, the percentages of survey respondents heating with wood and other were much higher than the study area

figures in particular for wood. 37% of on-line survey respondents heat with wood, compared with 15% of actual households in the study area. Given the nature of the survey, an over sampling of households heating with wood could be expected.

Table 15
Fuel Type (%)

	Bottled, Tank, or LP Gas	Fuel Oil, Kerosene, etc.	Electricity	# Homes Heating with LP, Fuel Oil, or Electricity	Utility Natural Gas	Wood	Other
Households in study area heating with fuel type ¹⁰	25%	6%	11%	42%	40%	15%	1%
Respondents to on-line survey heating with fuel type	23%	3%	7%	33%	28%	37%	2%

The survey also asked about respondents secondary energy sources for heating their homes. When combined into one category, more respondents use fire wood or wood pellets (22%) as a secondary heat source than either electricity (21%) or propane (21%).

3.1.1.2 Key Findings

- Many survey respondents expressed concern regarding the environmental impact of wood pellet heating, in particular impacts on soil health and air quality.
- 86% of respondents indicated that even if wood pellets were close to half the price of electricity they would not switch to pellets. This response may point to a number of hurdles that any efforts to promote wood heating will likely face. For example, many consumers have sunken costs associated with their existing heating systems. Even if fuel is less costly, consumers recognize the fact that switching to wood heating requires additional up front capital costs for the equipment itself, as well as installation costs. These costs will only be recovered by consumers if they remain in their home or business for at least as long as the simple payback period for the proposed project. The simple payback period is calculated by taking the capital and installation cost of the project and dividing by the estimated annual fuel savings.
- Another hurdle for consumers switching to wood heat is convenience. Wood pellet heating requires significantly more effort than does heating with conventional fuel sources. Consumers must purchase the pellets, store the pellets, and finally load the pellets into the stove or furnace – often multiple times per day.
- 18% of natural gas users said they would switch to pellets as a fuel source even if wood pellets were slightly more expensive (7% more expensive). This response suggests natural gas users are more likely to switch to pellets than those relying on electricity as their primary source of heat. This result could reflect the fact that natural gas users are already combusting their fuel source in their home, whereas those using electricity do not (they may not have the space, for example). Another explanation is that those respondents using natural gas as their primary fuel source currently are less price sensitive than those heating primarily with electricity.

¹⁰ Source: US Census

- 67% of respondents using fuel oil as their primary energy source said they would switch to wood pellets if the cost of pellets was 44% less than fuel oil. However, only three respondents answered this question, which suggests this fuel switch opportunity is limited.
- 46% of respondents using propane as their primary energy source said they would switch to wood pellets if the cost of pellets was 53% less than propane. Twenty-two respondents replied to this question, which suggests that propane users may be a good candidate for fuel switching.
- 94% of respondents indicated they would not switch from fire wood to pellets if the cost of pellets were 11% more expensive than firewood. This result suggests that current households heating with fire wood may not be good targets for fuel switching. These households likely have access to free or inexpensive cord wood and therefore switching to pellets may not make financial sense for them.

3.1.2 Business Survey Results

3.1.2.1 Respondents

In this survey, 53% of respondents indicated they owned or managed a farm, business, or institution within the study area. Of the businesses surveyed, 64% were located in towns and 36% in cities or villages. A breakdown of type of business owned or managed by survey respondents is shown in the figure below.

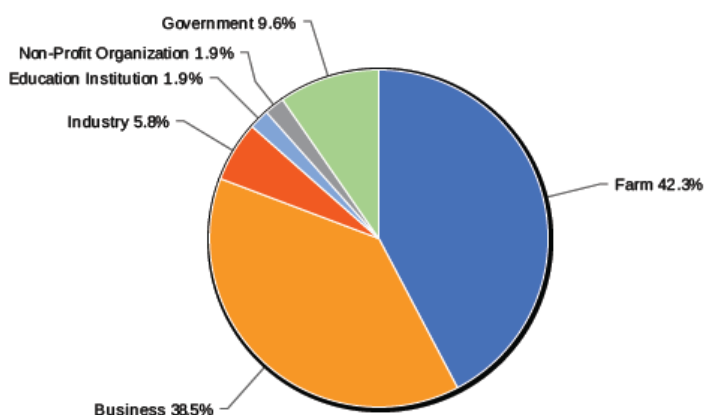


Figure 14 – Survey Respondents Type of Business

The most common energy source cited was natural gas (29%), followed by fire wood (23%), propane (15%), electricity (13%), other (10%), solar (6%), fuel oil (4%). None of the business survey respondents indicated they heat with wood chips or pellets as their primary fuel. In terms of secondary energy sources, the most common source cited was electricity (22%), followed by propane (14%), fire wood (12%), fuel oil and wood pellets (4%), other and natural gas (2%). No business respondents indicated they use wood chips as a secondary heat source.

3.1.2.2 Key Findings

- 20% of respondents indicated that if wood pellets were 47% less than the cost of electricity, they would switch to pellets as a heat source. However, only five respondents answered this question.

-
- 86% of respondents said they would not switch to wood pellets if they were 7% more expensive than natural gas. Again, this result underscores the limited potential for fuel switching from a relatively inexpensive fuel, natural gas, to wood pellets.
 - 50% of respondents said they would switch to wood pellets from fuel oil if pellets were 44% less expensive. However, only two respondents answered the question.
 - 18% of respondents indicated they would switch from propane to wood pellet heating if pellets were 53% less expensive.
 - 18% of respondents said they would switch to pellets from firewood even if pellets were 11% more expensive.

3.1.3 Combined Survey Results

- 70% of respondents indicated that encouraging/promoting the solid wood energy industry should be a major economic development initiative in the Kickapoo Valley
- 54% of respondents indicated concern about the environmental impacts of encouraging/promoting the solid wood energy industry (wood pellets/wood chips) in the Kickapoo Valley
- When asked about the type of environmental concern they have, 77% said impact on soils, 71% said air emissions, and 65% said forest impacts and water resources. 46% said other impacts and 10% said wildlife impacts.
- 58% of survey respondents indicated they would like to receive a copy of the feasibility study when completed.
- The survey results provided good information which could be used to inform future fuel switching efforts in the region and to pro-actively address environmental concerns.

4.0 Feasibility of Pellet Plant(s) and Economic Impacts

4.1 Wood Pellet Market Trends

4.1.1 Advantages of Wood Energy as a Green Biomass Fuel

4.1.1.1 Wood-General

4.1.1.1.1 *Use*

Wood and other biomass combustibles can be burned for heat, used to generate electricity, or be processed into liquid fuels. The USDA's report on the North American Pellet Sector states that modern wood stoves convert 85-95% of the energy stored in the wood to heating the intended space. Wood energy products are produced from trees, which are a locally-grown renewable resource processed using local labor in contrast with fossil fuels, which are not renewable and often come from foreign sources. Forest products are considered "renewable" when sustainably managed. Most states (including Wisconsin) have adopted Woody Biomass Harvesting Guidelines that provide sustainable harvesting guidelines for biomass extraction.

4.1.1.1.2 *Resource*

Wood in the southwestern portion of Wisconsin is abundant, with gross annual growth exceeding annual harvest rates by more than a 5 to 1 ratio. Tree species that have limited to no market(s) can always be used for wood energy. Energy markets provide a great solution for areas in need of managing low value species.

Promoting wood energy where it makes sense economically, logistically, and sustainably is highly recommended. Doing a feasibility assessment on any larger scale conversion will alleviate concerns and provide a definitive implementation plan.

4.1.1.2 Wood Pellets

The USDA defines the pelletization of wood as a process in which "raw wood is compacted into a homogeneous product with higher energy density and lower moisture content and made into uniformly sized cylindrical shapes, facilitating transportation, handling, and usage".

Using pelletized wood products is more efficient and economical than burning raw wood/biomass. In the US, the trend toward wood pellets as a heating fuel began during the 1970s energy crisis. According to the USDA, the increasing price of fossil fuels, such as propane and fuel oil, has created increased interest in the use of alternative fuels since 2000. In addition, natural disasters, such as Hurricane Katrina, also place great emphasis on the need for alternative energy production methods. Europe is years ahead of the US in developing alternative fuel production and markets, particularly in its wood pellet industry. As demand in Europe for pelletized wood increases, Europe looks to the US and Canada as a pellet source.

There are a number of advantages of using wood pellets as a source of wood fuel, including:

- Uniform size and shape (1½" long x ¼"-5/16" diameter) and storage (bagged or on-site silo)
- Uniform moisture content (4-6%)
- Relatively simple heating technology (fewer operation and maintenance requirements)
- High energy content by weight (roughly 7,750 BTU per pound at 6% moisture content)
- Inert, non toxic, low particulate emissions
- Cost effective alternative heat energy source

For heating, one ton of wood pellets equals [^] :	Paying \$200/ton for pellets is the same as paying [^] :
<ul style="list-style-type: none"> 120 gallons of heating oil 170 gallons of propane 16,000 ft³ of natural gas 4,775 kilowatt hours (kWh) of electricity 	<ul style="list-style-type: none"> \$1.67 per gallon for heating oil \$1.18 per gallon for propane \$12.50 per 1,000 ft³ for natural gas \$0.04 per kWh for electricity

[^] Source: Biomass Education Resource Center, 2007

4.2 Worldwide Wood Energy Industry Forecast of Growth

US pellet producers are poised to take advantage of the global increase in wood pellet consumption. In 2010, demand in the EU increased by 7% and approximately 1.6 million tons of wood pellets were shipped from the US and Canada to the Netherlands, the UK, and Belgium (IEA Bioenergy, 2011). The European Biomass Association predicts that the EU will increase its biomass use to 100 million tons (up from 13 million) between 2010 and 2020 as they move to achieve their goal of 20% renewable energy by 2020.

As many industrialized nations continue adopting carbon emission standards pertaining to fossil fuel-powered energy production facilities, the industrial/commercial grade fuel pellet market will continue to expand. Some facilities are converting to co-firing systems, which combine biomass with fossil fuel (typically for energy production) to lower the facility's overall carbon emission levels and stay within emissions regulations.

As co-firing with biomass is used more frequently to meet emissions regulations, the demand for commercial/industrial grade wood pellets will also grow. As a result of this increased demand, in the southern US particularly, wood pellet mills are being built to utilize tree resources directly from the forest versus the traditional sawmill residue. These are subsequently some of the largest pellet mills in the US and the world. Cottondale, Florida's Green Circle Bio Energy pellet plant, for example, boasts a 560,000 ton/year capacity (IEA Bioenergy, 2011). The target market for their finished product is primarily for export to the EU, namely the power generating industry for co-firing in coal-based power plants.

FORECAST OF WOOD PELLET EXPORTS FROM NORTH AMERICA 2007-2017, IN MILLION TONNES¹

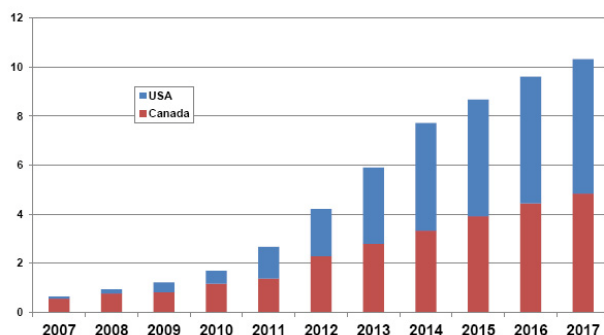


Figure 15 – Forecast of Wood Pellet Exports from North America

4.2.1 Current and Projected Domestic Demand Overview for Converted Biomass Products

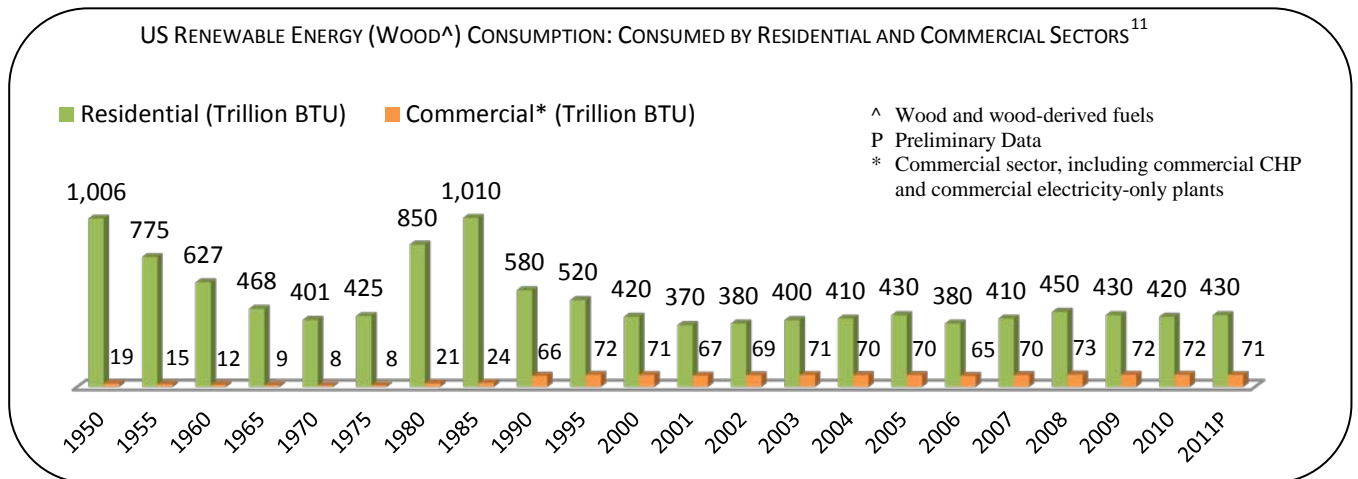


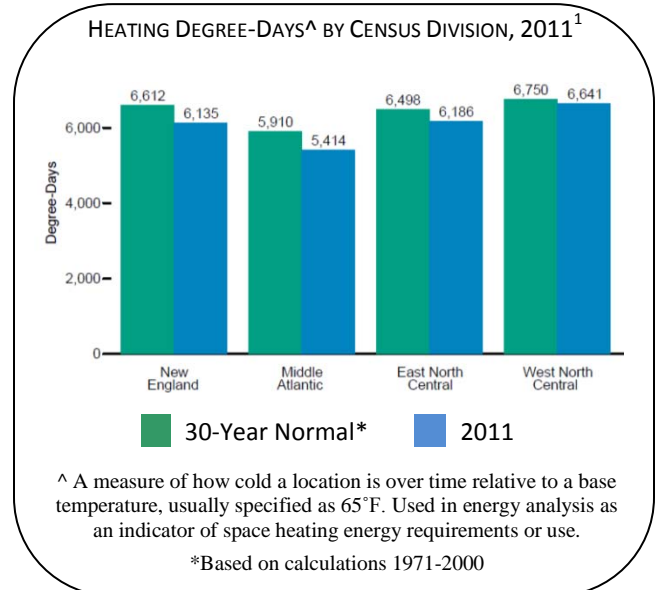
Figure 16 – Current and Projected US Wood Energy Demand

4.2.2 Residential Use (“Premium” and “Standard” Grade)

After Europe, North America has the largest pellet production capacity, which grew from 1.1 million tons in 2003 to nearly 7 million in 2011. The 2011 total production capacity in the US was 5.481 million tons and it is estimated that approximately 80% of pellets are consumed domestically for residential heating.

Domestically, winter severity and the number of wood pellet stoves in operation will determine how much available market will exist. Residential stove and boiler markets are expected to continue growing along with advances in clean technology, awareness, and consumer desire for alternatives and cost savings. According to the Pellet Fuels Institute, just over 1 million US households used pellet fuel for heat in 2010 (up from 2009 Consumer Report estimates of 800,000).

Domestically, pellets compete best against fuel oil, propane, and electricity, with natural gas prices being very similar to pellet prices in the last year.



According to Rob Davis of Forest Energy Systems and former president of the Pellet Fuels Institute (PFI), the current U.S. demand for residential pellets is about 2 million tons per year, which equates to a ratio of about 60 percent of production capacity being consumed domestically and the remaining 40 percent being exported (U.S. Endowment for Forestry, 2011). The Northern Midwest and Northeast have some of the highest demand for wood

¹¹ U.S. Energy Information Administration / Annual Energy Review 2011. www.eia.gov/totalenergy/data/annual/pdf/aer.pdf

pellets due to winter severity and current residential home heating methods. A list of regional housing information can be found in Appendix L.

4.2.3 Commercial/Industrial Use (“Utility” Grade)

Schools are a good potential market for utility grade wood pellet heating because they typically have access to long-term (10-20 year), low-interest financing.

Another potential market is outdoor pellet burners. With local zoning ordinances and the EPA potentially regulating outdoor wood burners, many manufacturers are developing outdoor pellet stoves. Information regarding numbers of regional businesses can be found in Appendix L.

With the current tightening of emissions and state-based emphasis on renewable energy production, there is a potential market to be realized with conversion of coal electric plants to a co-firing system (blend of coal and utility grade wood pellets).

4.3 Current and Projected Foreign Demand Analysis for Converted Biomass Products

4.3.1 Current Demand

According to the *North American Wood Fiber Review (3Q/2011)*, though the US did not start exporting pellets until 2008 (85,000 tons shipped to the Netherlands), US export levels have expanded tremendously, reaching almost 600,000 tons in 2010. With almost 12 million tons of wood pellets consumed in continental Europe in 2010 (about 20 percent higher than the previous year), demand in European countries such as Sweden, the Netherlands, Belgium, Italy, Denmark, and the UK continues to outpace domestic production. This imbalance in supply and demand has resulted in increased imports from neighboring countries and also from North America, with almost 50 percent of all wood pellets shipped in 2010 via Atlantic trade from North America being destined for the Netherlands and more than one-third to ports in the UK.

4.3.2 Projected Demand

Total shipments of wood pellets from the US and Canada to Europe has almost doubled in just two years. In fact, Denham Capital has projected that by 2015, the worldwide pellet market potential is 142 million tons at a value of \$2.8 billion. Projections for demand in the European Union (EU) range from 305 million tons to 500 million tons by 2020 (U.S. Endowment for Forestry, 2011).

This projection is further supported by an article by Chris Nelder, “The Missing Link to a \$7 Billion Market” published on July 25, 2012:

“[...] According to Jonathan Rager of Georgia-based Poyry Management Consulting, a 50 Mt [million ton] gap will open between global supply and demand for pellets by 2020. Western European demand will triple, from 11 Mt per year in 2010 to 35 Mt per year by 2020. For perspective, North American wood pellet production capacity was just 4.2 Mt in 2008 according to the U.S. Forest Service. North American pellet exports were just over 2 Mt in 2011, of which over half came from the southern US.

[...] The European wood pellet market alone will be roughly \$7 billion a year by 2020. The U.S. could supply a big share of that – perhaps as much as \$1 billion a year worth of exports. Globally, the opportunity is even greater, with China, Japan, and other Asian countries planning to increase their demand for pellets.”

4.3.2.1 Domestic Wood Pellet Stove Sales

According to the *National Trade Association Hearth, Patio, and Barbeque*, annual sales of wood pellet stoves in the US have increased by nearly 300 percent in the past 10 years. A 2010 study done by the PFI shows that approximately 1.6 million households had pellet stoves that year¹². Between 2010 and 2011, pellet appliance shipments increased by 41%, from 44,288 to 62,451¹³.

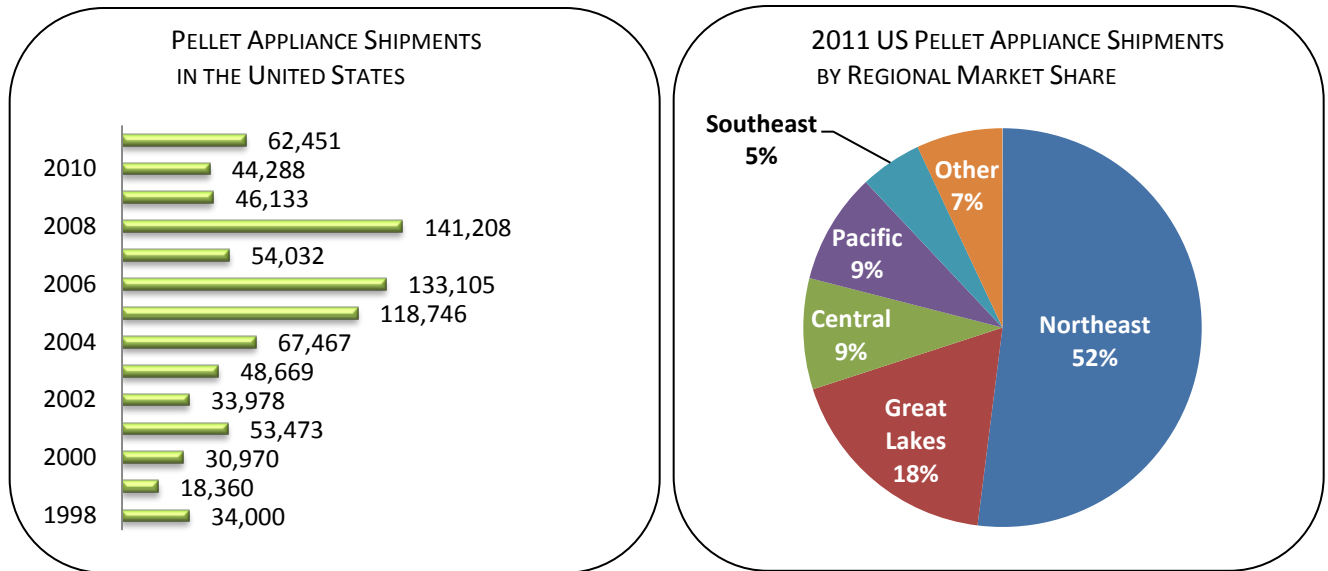


Figure 17 – Domestic Wood Pellet Stove Sales

4.3.2.2 Residential Wood Pellet Stove Market

The wood pellet market for residential heating will continue to grow if the cost of fossil fuels continues to rise and technology costs decrease. It is relatively easy for homeowners to purchase and install a new pellet stove since they have relatively low capital costs and installation is simple with direct venting through the nearest wall.

4.3.2.3 Industrial/Commercial Wood Pellet Stove Market

Use of non-residential pellet boilers in the US has been very limited. The main industrial use of pellets has been mixing them with coal to reduce emissions. This practice has been mainly experimental to date. There have been localized efforts in certain regions to utilize wood pellet boilers for public facilities such as schools and fish hatcheries and for private facilities such as restaurants, grocery stores, and greenhouses.

There is currently some speculation about a wholesale change in the poultry industry to pellet/wood heat for a variety of reasons including decreased mortality rates and an overall healthier environment from wood heat.

¹² Pellet Fuels Institute Membership Meeting pelletheat.org/wp-content/uploads/2010/01/Don-Johnson-PFI-luncheon-presentation.pdf

¹³ Pellet Fuels Institute Membership Meeting. Wednesday, February 29, 2012. Don Johnson, HPBA Director of Market Research. pelletheat.org/wp-content/uploads/2010/01/Don-Johnson-PFI-luncheon-presentation.pdf

4.3.3 Domestic Wood Pellet Boilers for Commercial Use

Continuous refinement of smaller (500,000 BTU) commercial boilers to make them as efficient and economically affordable as possible is essential to increasing commercial pellet use in the US.

Wood Master of Red Lake Falls, MN and Even Temp of Waco, NE are making serious efforts to sell their products. Concentrated marketing efforts will help grow this industry, along with assisting potential users to access grant funds to reduce capital costs. As with all commercial boilers initial capital costs is a big hurdle to overcome.

4.3.4 Benchmarking of Existing/Proposed Plants

In keeping with growth projections, the international market for wood pellets (no specific grade) increased more than 200 percent between 2002 and 2006, causing global production to increase from 8 million tons in 2007 to more than 13 million tons in 2009 (U.S. Endowment for Forestry, 2011). Canada has been the major overseas supplier of pellets to Europe, reaching about one million tons in shipments in 2010.

As demand for commercial/industrial grade wood pellets grows, so does the opportunity for exporting. As a result of this increased demand, wood pellet mills are being built to utilize roundwood versus historically utilized traditional primary sawmill residue, especially in the southern US. This has resulted in some of the largest pellet mills in the US and the world.

Green Circle Bio Energy pellet plant in Cottdale, FL has a 560,000 metric ton/year capacity (IEA Bioenergy, 2011). The target market for their finished product is primarily for export to the EU, specifically the power generating industry for co-firing in coal-based power plants.

Georgia Biomass in Waycross, GA officially opened its pellet facility in 2Q/11, paving the way for an additional consumption of 1.5 million green tons of wood fiber for pellet production. All production is expected to be exported to Europe.

New England Wood Pellets officially opened its 85,000-ton capacity pellet plant in Deposit, NY. Trebio Renewable Biomass in Quebec, Canada should complete its new 130,000-ton capacity pellet plant in the next few months

*See Appendices (www.mrrpc.com) for a List of All Existing, Under Construction, and Proposed Pellet Plants in the United States.

4.4 Plant Site Logistics, Equipment, Labor, and Costs

There are typically two different approaches to constructing wood pellet plants: using dry residue materials from wood processing operations and using green wood biomass from trees/vegetation. This analysis focuses on a residential wood pellet plant rather than an industrial wood pellet plant. The current demand for industrial wood pellets is very limited in the Upper Great Lakes Region and without adoption of policies for renewable energy similar to Europe's; it is unlikely to increase substantially.

4.4.1 Forest Industry Residue

Wood residue is one of the most abundant, cost-competitive, and environmentally friendly biomass resources. In general, less than 50 percent of the tree ends up in a final product, and the balance represents a resource to be utilized. Manufacturers generate an enormous amount of residue in the process of making products. Green residue results from primary forest

industry manufacturing (i.e. sawmills and lumber mills) and dry residue results from the secondary forest industry (i.e. furniture manufacturers, window manufacturers, etc.).

Currently, the most cost-effective residues are those resulting from crating and pallet manufacturing/wood waste. These dry residues captured from secondary forest industry may need to be further processed by a hammermill or similar equipment; however, further drying is typically not necessary unlike green residues captured from primary forest industry.

There are 42 primary forest industry manufacturing companies within the primary and secondary procurement radius and 10 located in the neighboring Minnesota counties of Fillmore, Houston, and Winona (see Appendices, www.mrrpc.com, for a list of possible sources of wood residues). Once it has been decided to move forward with the project, these facilities should be contacted to determine their available residue volumes and price points.

There are 40 secondary forest industry manufacturing companies within the primary and secondary procurement radius (www.mrrpc.com). Once it has been decided to move forward with the project, these facilities should be contacted to determine their available residue volumes and price points. Once it has been decided to move forward with the project, these facilities should be contacted to determine their available residue volumes and price points.

4.4.2 Green Biomass

Green biomass typically needs to be dried with large drying devices which require a large amount of energy. Because of high moisture content, about 2.2 tons of green biomass are required to make 1 ton of finished wood pellet product (this includes heating fuel to dry raw material).

For residential pellets, this would mean using traditional pulpwood material that would have to be debarked to meet the premium pellet specification requirements. For industrial pellets, whole tree or logging residue chips could be used since these pellets have higher ash standards.

Traditional “pulpwood” markets do not appear to have the potential to rebound to the status it reached in the early 2000s, allowing raw material typically used in those markets to be readily available for pellet production. The same would be true of whole tree chips since this material would be a combination of pulpwood and traditional logging residue. Processing and transportation of biomass chips is a major cost; therefore, it is critical to identify sources within a short radius (30-50 miles) if biomass chips are used as a raw material. The future of the wood energy industry is based on tremendous speculation at this point.

4.5 Facility and Site Size

4.5.1 Wood Pellet Production

The optimum size in the Lake States (MI, MN, and WI) for a wood pellet plant is a four-press, 24/7, 100,000-ton per year plant, if adequate markets exist for the product. This size is typically optimum for procuring raw material at a fairly consistent price within a reasonable radius.

If demand is not adequate, an oversized plant can be built with the hope of demand increasing to match plant capacity in the near future. Alternatively, a plant can be built with the capacity to meet current demand at a lower profit level, with the expectation of future expansion as demand increases.

Expansion beyond this size could lead to an increase in raw material prices. There is potential that even the raw material required for a 100,000-ton plant could drive prices up contingent upon other circumstances, such as competition from new companies or an increase in raw material use from existing companies.

A production level of 100,000 tons is considered a goal for profitability because the costs of increasing production are typically not proportionate to the increased revenue up to that level of production.

4.5.2 Capacity

A 100,000-ton plant with four pellet presses would yield the highest profit margin; however, there currently is not the demand to sustain a plant of this size in the Kickapoo Valley. If pellet demand and prices increase to the point of making a larger pellet plant economical, it is recommended that a three-pellet press operation with a plan to reach the 60,000 tons per year level in the third year be pursued. Reaching this level of production is essential to achieving long-term sustainability, keeping in mind a possible goal of expanding to a 100,000-ton operation in the future.

4.5.3 Site Size

It is recommended that a site be obtained that is large enough to allow for expansion into other production systems should they become financially viable. These systems could be related to animal bedding shavings, wood flour, a co-generation plant, chemical extraction, pallet manufacture, etc. Having multiple systems on one site will more efficiently utilize the available wood resource.

For a smaller pellet plant (less than 10,000 tons) sited at an existing facility, very little additional area would be needed, in most cases two acres or less. If sited away from an existing facility, a small plant could suffice with a five to ten acre footprint. For a 100,000 ton plant, a twenty acre site would be more than adequate unless other production facilities were associated with it (wood industry cluster).

4.5.4 Site Dependent Issues, Concerns, and Opportunities

The following are the location and site-infrastructure criterion to determine optimal site location in contrast to optimal harvest, production, distribution, and consumption.

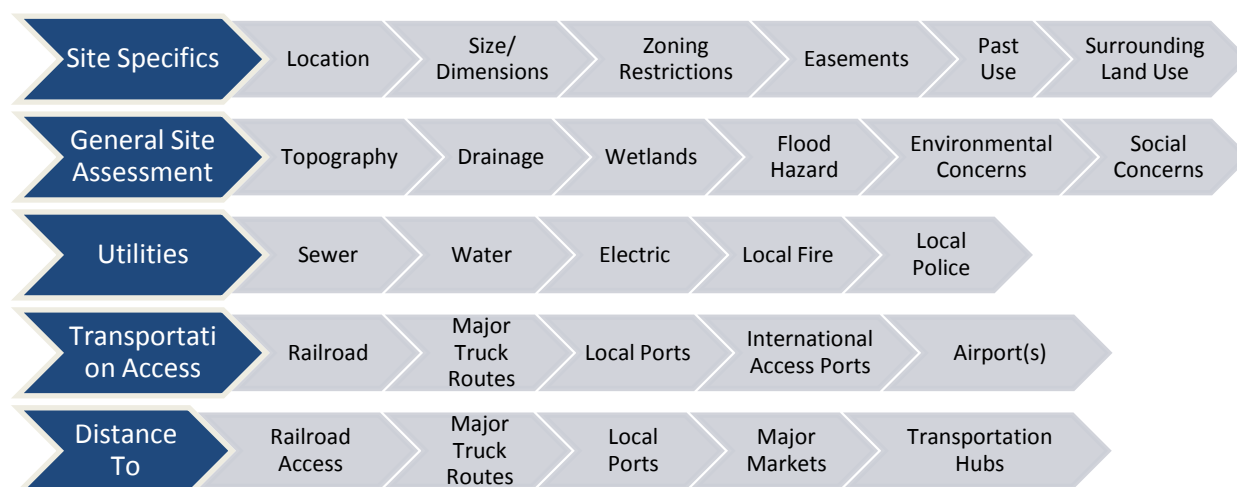


Figure 18 – Location and Site Criterion

4.5.5 Manufacturing Process, Equipment, and Technologies

The wood pellet manufacturing process involves the following steps:

Manufacturing	The production of a high-quality pellet is essential to the plant's success. Several factors influence pellet quality: pellet die specifications, roller design, raw material input consistency, and a properly trained workforce.
Raw Material	Truckloads of raw materials will be brought to the site daily. A large percentage will be eight foot long pulpwood-sized material. By processing specific raw material in the same manner, the end product will have consistent moisture content, heat value, ash content, and burn characteristics.
Debarker	All roundwood will be debarked by a contractor and piled for chipping.
Chipper	All debarked wood will be chipped by a contractor at the plant.
Trammel Screen	From a hopper, the wood chips go through a trammel screen where oversized pieces are removed and fine dust is screened out.
Initial Hammer Mill	A hammer mill will be located at the beginning of the milling process. This machine (the "hog") takes wood chips and breaks them down into a consistent smaller size, making drying quick and consistent.
Dryers	Since whole green wood (approx. 45% moisture) will be used as the predominant raw material, it will have to be dried to a consistent moisture level at approximately 300°F. A large triple pass drum dryer with a 12-ton per hour capacity will be used for drying.
Secondary Hammer Mill	After drying, the material moves through this hammer mill to reduce the wood to sawdust-sized material.
Tempering Tanks	After the hammer mill properly sizes the material, it is held in a tempering tank for approximately 30 minutes to relax the fibers. There is typically one pre-pellet tempering tank for each pellet mill.
Pellet Mill (Pelletizer)	After the tempering, the processed wood is pressed through dies at high pressure. This process causes the material to heat up and release natural lignins in the wood that binds the material together. The pelletizer also determines the density, diameter, durability, and length of the pellet.
Cooling and Storage	The pellets come out of the mill between 200°F and 250°F and in soft condition. A cooling tower is used to bring the temperature down and harden the pellets. After cooling, they are usually stored in a large silo to await bagging or bulk distribution.
Bagging and Bulk	<p>The industry's common method for distribution is to put the pellets into 40-pound plastic bags and stack them on pallets or skids. These pallets are stacked with one ton of pellets. Bagging pellets costs approximately \$26 per ton, which includes plastic bags, pallets, outer cover bags, and shrink wrap, but excludes the labor and equipment to stack and wrap them. These pallets are then loaded on trucks or rail cars arranged for by the customer.</p> <p>Bulk pellets will be loaded from the pellet mill silo directly into trucks for delivery to bulk storage containers at the customer's location. The bulk trucks are more expensive than regular flatbed trucks, but are a much more efficient system of transferring and delivering pellets.</p>

4.5.6 Labor & Required Management Expertise

4.5.6.1 Site Construction Contractor(s)

Selecting a contractor with a proven record in pellet plant construction/layout is essential. There are numerous contractors who claim expertise in pellet plant construction/design, but there are very few with proven legitimate track records. It is highly recommended to go through the bidding process with a request for references and proof of successful operating pellet plants that they have constructed.

4.5.6.2 Roundwood Procurement & Inventory Control Expertise

The most important aspect of procurement is developing raw-material quality control specifications that are adhered to while building long-term relationships with the suppliers who consistently meet specifications. Paying a fair price for a specific product will insure a steady supply of raw material. As loads are delivered, or shortly thereafter, they should be inspected to verify that they meet product specifications. A system needs to be in place to warn/penalize suppliers for bringing in non-compliant loads.

Setting up a system to purchase by the cord as opposed to by the ton would eliminate the issue of suppliers trying to deliver when the wood is at its heaviest (wettest). Paying a bonus for drier wood would offer an incentive to suppliers to deliver drier wood as well as cut drying costs for the plant.

During summer months, insects in the softwoods could be an issue. Debarking softwood as soon as possible will eliminate most insect problems.

4.5.7 Management Expertise

Having an experienced President/CEO to oversee everything from workforce hiring to raw material procurement to final product sales and shipping is essential to an efficiently operating plant. It is more beneficial to have an effective administrator/ manager than it is to have experience in the wood pellet industry. Having someone to oversee the entire operation in an efficient manner is critical.

Having an effective marketing manager is as important as having a competent plant manager. While the plant manager is responsible for producing a high-quality product, the marketing manager is responsible for making sure there is a paying consumer base to whom to distribute the product. This person is responsible for establishing a dealer network that is capable of utilizing all of the plant's pellet production. Having a person experienced in the wood pellet industry, although not a must, would be highly recommended.

4.5.8 Plant Manager Expertise

Having a plant manager with experience in producing a quality pellet from roundwood is recommended; at the very least bringing in an experienced consultant to train a plant manager is a necessity. One of the biggest problems in wood pellet manufacturing industry has been the switch from utilizing a consistent manufacturing residue (sawdust) to producing pellets using roundwood directly from the forest. Roundwood needs to be processed to a suitable consistency and moisture content. In addition, a wide range of issues from lack of a consistent species mix, excessive bark content, dirt/contaminant content, improper drying, and improper sizing of raw materials has caused numerous problems for many pellet plants

4.5.9 Other Critical Personnel

- Control Room Operator
- Front-end Loader Operator
- Pellet Mill Operator/Bagger
- Bagger
- Office Manager/Bookkeeper

4.5.10 Costs

Raw material, labor, and electricity are the main costs. If residential pellets are made, it will need to be decided if a mix of species will be purchased or if only a few specific species will

be utilized. Specific species demand may result in increased costs of raw material. Utilizing many species may increase production costs because processing may need to be adapted to the specific characteristics of each species or mix of species.

The initial capital/construction costs are estimated to be approximately \$4 million (directly dependent upon the site selected), with approximately \$8.63 million being the annual operating costs for year three.

4.5.11 Raw Material Cost

Raw materials are a major cost in the pellet process, with the average raw material cost being \$35 per ton. This wood is used as the raw material input. To manufacture 60,000 tons of pellets requires approximately 120,000 tons of wood.

Although delivered prices have fluctuated for pulpwood at various plants throughout any given year, on average over the past 50 years pulpwood prices have stayed much lower than the inflation rate. Depending on the species and raw material specification, it may be possible to purchase materials for an even lower per ton rate.

Table 16
Current and Projected Demand | Current Raw Material/Feedstock Price Structure

Type	Price/Ton (Delivered to Plant)
ROUNDWOOD (MOST SPECIES) ^A	\$30-40
BIOMASS CHIPS ^B	\$25-40
RESIDUE FROM FOREST INDUSTRY (SAWDUST, SHAVINGS, ETC.) ^C	\$10-60

^A Roundwood would come from area loggers as an alternative to traditional pulpwood markets.

This roundwood could be debarked and chipped at the plant for premium pellet raw material.

^B Biomass chips are produced by area loggers, tree services, and municipalities. These chips would be used to produce industrial pellets instead of premium pellets due to ash content.

^C Appendix II lists all of the potential wood residue producers within a 50-mile radius of the plant site. The residue from these producers would be used to produce premium pellets.

4.5.12 Facility Costs

4.5.12.1 Electricity

A 60,000-ton plant should anticipate using approximately 9,207,271 raw kWh to power the facility at full production.

4.5.12.2 Supplies (consumable)

This includes the bags (\$0.25 per bag), pallet caps (\$2.50 per pallet) and the pallets (\$7.50 per pallet), which results in a total cost of approximately \$22.50 to package a ton of pellets when labor and utility costs are factored in as well.

4.5.12.3 Insurance

Proper insurance is important as fires in the dryers are common. The site should have fire suppression equipment and sensors installed in all critical areas to detect/extinguish any fires. The annual cost of this insurance coverage (workers compensation, property, umbrella, and general liability) at full production is anticipated to be \$166,500.

4.5.13 Pellet Revenue

Though prices have fluctuated from \$150 to \$200 per ton in this region, \$170/ton has been a fairly consistent price for premium bagged pellets. One-ton tote prices have averaged \$160/ton

with bulk prices being \$150/ton. Other pellets such as animal bedding and BBQ pellets may become viable product options but initially residential pellets will be the primary product.

Prices are based on pellets sold at the plant door. Contract truckers will be used with the trucking price or rail car, with the price being the responsibility of the purchaser.

4.5.14 Wood Pellet Mill and Equipment Costs & Mill Start-up for 60,000-ton Plant (Approximate)

The initial capital/construction costs would be approximately \$4.3 million. Other start up costs would be roughly \$1.9 million. The table on the next page summarizes all cost categories.

Table 17
Summary of 60,000-ton Pellet Plant Start Up Costs

				Totals:
Building and Equipment				\$4,280,000
Land			\$20,000	
Building			\$810,000	
▪ BUILDING	▪ BUILDING IMPROVMENTS	▪ ENGINEERING/PERMITS		
Equipment*			\$3,450,000	
▪ DIGITAL TRUCK SCALE	▪ BIOMASS FUEL STORAGE	▪ PELLET BULK STORAGE		
▪ INSTRUMENTATION	▪ DRY RAW MATERIAL EQUIP	▪ BAGGING EQUIP		
▪ RAW MATERIAL HANDLING EQUIP	▪ PELLETIZINGNG EQUIP	▪ OFFICE EQUIPMENT		
▪ DRYING EQUIP	▪ COOLING, SCREENING	▪ ENGINEERING/PERMITS		
Other Expenses				
Startup Costs			\$157,000	
Wood Inventory (45 Days)			\$289,000	
Bags and Pallets (45 Days)			\$60,000	
Fuel for Equipment (30 Days)			\$500	
Working Capital (90-Day Cash Outlay)			\$1,349,000	
Capitalized Interest			\$86,000	
Total Funds Required for Startup				\$6,221,500

ANNUAL ADMINISTRATIVE SALARY & BENEFITS

Position	Title/Description	Annual Salary
President	-	\$75,000
Plant Manager (1)	<i>Industrial Production Manager</i>	\$69,700
Office Manager (1)	<i>Administrative Service Manager</i>	\$55,000
Clerical (1)	<i>Office Clerk (full-time)</i>	\$25,000
Clerical (1)	<i>Office Clerk (part-time)</i>	\$10,000
Marketing Manager	-	\$35,000
Benefits	Plant share of taxes (FICA, unemployment, etc.)	\$43,700
Total		\$313,400

ANNUAL DIRECT LABOR SALARY & BENEFITS

Position	Title/Description	Annual Salary
General Labor	6-12 Full Time Positions w/ Benefits and 10% Cost	\$171,500 - \$343,000
Shift Foreman	1-2 Full Time Positions w/ Benefits and 10% Cost	\$44,750 - \$89,500
Total		\$216,250 - \$432,500

ANNUAL INSURANCE AND OTHER PROFESSIONAL FEES

Type	Annual Cost
Workers compensation premium	\$65,000
Property insurance*	\$1,500
General liability**	\$100,000
Workers compensation premium	\$65,000
Estimated ongoing legal, accountant, network, security, bank, payroll, etc. fees	\$50,000
Total	\$216,000

4.5.15 Small Scale Pellet Plant Costs (Dry residues, less than 10,000-ton)

For a dry residue plant cost will be very dependent on what is on the site, such as if existing buildings could be used. It is therefore very difficult to estimate costs without knowing what infrastructure already exists at the current facility. A rough cost of the equipment for handling, pelletizing, cooling and bagging would range from \$465,000 to \$485,000. This is assuming production at an existing wood products company site, where equipment such as forklifts would already be in place. The estimated breakdown of costs is as follows:

- Pre-Pelletizing (Conveyance/pre-conditioning equipment, Dust Collector) \$100,000
- Pelletizing (Pellet Mill 300HP, Used, Refurbished) \$125,000
- Post-Pelletizing (Screener/Cooler, Bagger, Stretch Wrapper for Pallets) \$160,000
- Contingency \$80,000-\$100,000

This size plant, with a 3 ton per hour pelletizer operating 70 hours per week, could produce 10,000 tons of pellets annually, with gross revenues approaching \$2 million annually. This type of operation would employ 6-7 people in the plant and another 2-3 for bookkeeping and transportation of finished products. Products from this type of plant could include residential heating pellets, commercial heating pellets, barbeque pellets, and animal bedding.

The impact of a smaller pellet plant would still be very significant for the region, especially if those pellets were purchased and used by households currently heating with propane, fuel oil, or electricity. For example, if 8,500 tons of locally manufactured pellets were consumed by households currently heating with those more expensive fuel types, \$1,734,000 in *annual* cost savings would be realized. In turn, it is likely that a large percentage of those annual fuel cost savings would be spent on regional goods and services, further stimulating the Kickapoo Valley economy.

4.5.16 Organizational Structure, Financing, and Thresholds

The figure below provides an overview of organizational options for pellet ownership.

	Cooperative	Unincorporated Cooperative Association (UCA)	Corporation (C or S)	Limited Liability Company (LLC)	Partnership	Proprietorship
Owners	Members*	Members; includes patron and investor classes	1+ shareholders; S Corp limited to 100 shareholders	Members (one or more)	At least two individuals or entities	Individual
Membership requirements	Determined by bylaws. Usually one share/fee	Determined by bylaws	One share of stock	At members' discretion	At partners' discretion	At owner's discretion
Business purpose	Meet member needs for goods/services; earn return on owner investment	Meet member needs for goods/services; earn return on owner investment	Earn return on owner investment	Earn return on owner investment; provide member employment	Earn return on owner investment; provide partner employment	Earn return on owner investment; provide owner employment
Financing	Member and/or outside investor shares; retained profits	Patron and investor member shares; retained profits	Stock sales; retained profits	Members proportional to investment or by agreement	Partners in proportion to investment or by agreement	Proprietor
Profit receiver	Members in proportion to use; preferred stockholder proportional to investment, up to 8%	Patrons in proportion to use; patron and investor members proportional to investment	Stockholder proportional to investment	Members proportional to investment or by agreement	Partners proportional to investment or by agreement	Proprietor
Income tax payer	Members on qualified profit distributions; Pay on non-qualified and unallocated profits	Members pay individual rate, or can elect to be taxed as cooperative	C: pay on profits, stockholders pay capital gain rates on dividend; S: stockholders pay their rate on profit share	Members pay individual rate, or can elect to be taxed as a corporation	Partners pay individual rate	Proprietor pays individual rate
Legal liability of owner	Limited to investment	Limited to investment	Limited to investment	Limited to investment	General partners: Unlimited Limited partners: limited to investment	Unlimited

*Preferred shareholders may include nonmembers who may vote on certain issues, such as dissolution, but not for directors. Preferred stock shareholders do not set policy.

Figure 19 – Pellet Plant Business Organization

4.5.17 Financing

Funding Opportunities: Grants

USDA Value-Added Grant	To be eligible, the organization must be 51%+ controlled by producers (loggers and/or landowners).
US Forest Service Grant	Forest Product Lab Wood Energy grant RFP is recurring every year.
Renewable Energy America Program – USDA Rural Development	<ul style="list-style-type: none">▪ This agency accepts applications to purchase renewable energy systems and make energy efficiency improvements for agriculture producers and rural small businesses in eligible rural areas. The forms of funding are grants, guaranteed loans, and combined guaranteed loans and grant applications.▪ Minimum grant request for renewable energy systems is \$2,500; maximum is \$500,000.▪ Minimum grant request for energy efficiency improvements is \$1,500; maximum is \$250,000.▪ The maximum amount of a guaranteed loan made to a borrower will be \$10 million. About 50 percent of the grant funding is reserved for the grant portion of combination grant and guaranteed loan applications. The guarantee fee amount is 1 percent of the guaranteed portion of the loan. The annual renewal fee is 0.125 percent of the guaranteed portion of the loan.
Dept. of Energy Grants	<ul style="list-style-type: none">▪ Announced on a perpetual basis.▪ To date, emphasis has been on liquid bio-fuels (i.e. ethanol, bio-diesel, and bio-oil) rather than solid-state fuels (i.e. wood pellets).
USDA 9006 Grant/Loan Program	<ul style="list-style-type: none">▪ Provides grants and loans to rural small businesses and agricultural producers for the purchase and installation of renewable power projects.▪ Energy Trust will provide eligible approved participants with cost-shared financial assistance for hiring a grant-writing consultant to help them apply for 9006 grants for certain new renewable energy projects.

4.5.18 Funding Opportunities: Loans

Small Business Administration (SBA) Programs (504)	<ul style="list-style-type: none">▪ The primary loan program is the 7(a) Loan Guaranty, in which the money from the loan can be used to expand and renovate a business' machinery. This loan guarantees major portions of loans made to small businesses.▪ The SBAExpress loan is available for loans up to a maximum of \$350,000 and guarantees up to 50% of the loan. Loans under \$25,000 will not need collateral. Maturities are about five to seven years for working capital and up to 25 years for real estate and equipment.▪ CAPLines is a revolving line of credit with five loan programs. These five programs are financing seasonal working capital needs; financing direct costs for construction, service and supply contracts; financing purchase orders by retrieving advances against existing inventory and accounts receivable; and consolidate short-term debt.▪ Export Working Capital Program (EWCP) gives working capital financing for export activities. This loan cannot be used to refinance fixed assets, marketing, or setting up operations abroad.
USDA Rural Development Business and Industry Guaranteed Loans (B&I)	<p>A borrower may be a cooperative organization, corporation, partnership, or other legal entity organized and operated on a profit or nonprofit basis; an Indian tribe on a Federal or State reservation or other Federally recognized tribal group; a public body; or an individual. A borrower must be engaged in or proposing to engage in a business that will:</p> <ul style="list-style-type: none">▪ Provide employment;▪ Improve the economic or environmental climate;▪ Promote the conservation, development, and use of water for aquaculture; or▪ Reduce reliance on nonrenewable energy resources by encouraging the development and construction of solar energy systems and other renewable energy systems. <p>Loan purposes must be consistent with the general purpose contained in the regulation. They include, but are not limited to, the following:</p> <ul style="list-style-type: none">▪ Business and industrial acquisitions when the loan will keep the business from closing, prevent the loss of employment opportunities, or provide expanded job opportunities▪ Business conversion, enlargement, repair, modernization, or development▪ Purchase and development of land, easements, right-of-ways, buildings, or facilities▪ Purchase of equipment, leasehold improvements, machinery, supplies, or inventory <p>The total amount of Agency loans to one borrower must not exceed \$10 million. The Administrator may, at the Administrator's discretion, grant an exception to the \$10 million limit for loans of \$25 million under certain circumstances. The Secretary may approve guaranteed loans in excess of \$25 million, up to \$40 million, for rural cooperative organizations that process value-added agricultural commodities.</p>

In addition to the funding sources identified above, the Wisconsin Economic Development Corporation provides a variety of programs which may be applicable to a pellet plant.

4.5.19 Funding Opportunities: Incentives

The following are a list of possible Wisconsin incentives that the prospective plant could potentially take advantage of:

- Job creation deduction
- Jobs tax credit
- Wisconsin manufacturing and agriculture credit
- Property tax exemption for manufacturing machinery and equipment
- Exemption for fuel and electricity consumed in manufacturing
- Tax Incremental Finance

*See Appendices (www.mrrpc.com) for details about several of these incentives.

4.5.20 Input and Output Thresholds

A three-pellet press operation with a plan to reach the 60,000-ton per production would be the minimum threshold for a 'green' raw material plant and would require approximately 120,000 tons of raw 'green' material. Reaching this level of production would be essential to achieving long-term sustainability, with a possible goal of expanding to a 100,000-ton operation in the future.

A dry residue pellet plant would be a much simpler operation with a screen pelletizer, cooling rack, and bagger. Operated on-site where the residue is produced will reduce overhead and allow the operation to scale up to meet demand. This operation could be from 1,000 to 10,000 tons, depending on both raw material supply and pellet demand.

4.6 Regional Supply and Demand Analysis

Within the four-county study area, it is estimated that less than one percent (0.68%) of all households currently use wood pellets for heating. This figure translates into 2,934 households. If each household uses an average of 3 tons of pellets per year for heating, the regional pellet demand would be 8,803 tons.

Based on existing household heating fuel mix, if 10% of existing households heating with propane, electricity, and fuel oil switched to wood pellet heating, that fuel switch would induce an additional demand for 6,433 tons of pellets annually.

4.6.1 Fuel Cost and Conversion to Wood Pellets

Like any market-driven product, demand for this product will be largely driven by economics and payback period. Work done by the Biomass Energy Resource Center (BERC)¹⁴ has shown that homeowners were most likely to install a wood pellet heating system if the payback period was within three years versus five years, and least likely to install if the payback was five to seven years. For a three-year payback period for the typical home installation, average oil prices need to be \$3.00+ per gallon.

¹⁴ Feasibility Study of Pellet Manufacturing in Chittenden County, Vermont. August 2011. Biomass Energy Resource Center. www.sustainableheatingvt.org/files/docs/VSHIreport-FINAL_hi-res%20for%20print.pdf

4.6.2 Competition Overview

4.6.2.1 Regional Competition

Pellet production has increased as demand for wood pellets has increased. Production of a quality wood pellet with a marketing campaign to promote wood pellet heat will help create a balance between demand and supply of wood pellets. Additionally, wood pellet heating will be more attractive with innovations in pellet heating systems and bulk storage and as prices for fossil fuels increase.

The table below provides a list of operational wood pellet plants in the upper Midwest region.

Table 18
Operational Wood Pellet Plants in WI, MN, and MI (Metric Tons) ¹⁵

PLANT		ST	FEEDSTOCK	CAPACITY	PRODUCT
AMERICAN PELLET COMPANY	CORUNNA	MI	HRDWD/SFTWD	12,000	RESIDENTIAL
AMERICAN WOOD FIBERS	SCHOFIELD	WI	HRDWD/SFTWD	25,000	RESIDENTIAL, BEDDING, WOOD FLOUR, BBQ
DEJNO'S INC.	KENOSHA	WI	HRDWD/SFTWD	40,000	RESIDENTIAL
EQUUSTOCK	CLARE	MI	HRDWD/SFTWD	36,000	RESIDENTIAL, BEDDING
FIBER BY-PRODUCTS	WHITE PIGEON	MI	HRDWD	60,000	RESIDENTIAL, BEDDING, WOOD FLOUR, WOOD SHAVINGS, MULCH
FIBER RECOVERY INC.	RINGLE	WI	HRDWD	13,000	-
GREAT LAKES RENEWABLE ENERGY	HAYWARD	WI	HRDWD/SFTWD	70,000	RESIDENTIAL, BEDDING, BBQ
GREEN FRIENDLY PELLETS	BALSAM LAKE	WI	HRDWD	17,000	RESIDENTIAL
INDECK ENERGY - BIOFUEL CENTER	LADYSMITH	WI	HRDWD	90,000	RESIDENTIAL, BEDDING
ISABELLA PELLET	LAKE ISABELLA	MI	HRDWD/SFTWD	40,000	RESIDENTIAL, BEDDING
KIRTLAND PRODUCTS	BOYNE CITY	MI	HRDWD/SFTWD	35,000	RESIDENTIAL
MAEDER BROTHERS WOOD PELLETS	WEIDMAN	MI	HRDWD	18,000	RESIDENTIAL
MARTH PESHTIGO PELLET COMPANY	PESHTIGO	WI	HRDWD	64,000	RESIDENTIAL, BEDDING, BBQ
MARTH WOOD SHAVINGS SUPPLY	MARATHON	WI	HRDWD	24,000	RESIDENTIAL, BEDDING, BBQ
MICHIGAN TIMBER & TRUSS	FLINT	MI	SFTWD	18,000	RESIDENTIAL, BEDDING
MICHIGAN WOOD FUELS	HOLLAND	MI	HRDWD	50,000	RESIDENTIAL
VULCAN WOOD PRODUCTS	VULCAN	MI	HRDWD/SFTWD	9,000	RESIDENTIAL, BEDDING
WOLVERINE HARDWOOD PELLETS	AU GRES	MI	HRDWD	1,000	-
WOOD PELLET COOP	PIERZ	MN	HRDWD	UNDISCLOSED	RESIDENTIAL, BBQ

¹⁵ <http://biomassmagazine.com/plants/listplants/pellet/US/Operational/>. Last modified November 18, 2013

4.6.3 Pellet Composition

4.6.3.1 Potential Products

The following reviews the potential products that could be produced, as well as potential byproducts and vertical integration opportunities.

Developing a high quality residential pellet will be essential to being a successful operation. A softwood pellet or a mixed (softwood/hardwood combination) residential pellet is currently in high demand, but the ability to adapt to changing demands and being able to produce other products should always be an option. These other products may include:

- Hardwood residential pellets
- Commercial/industrial pellets
- BBQ pellets
- Animal bedding pellets

4.6.4 Wood Pellets

4.6.4.1 Residential Pellets Definition

Premium | In accordance with the Pellet Fuels Institute (PFI), the “Premium Grade” wood pellet standard specifies that premium pellets will have inorganic ash content that shall be less than 1% and moisture content less than 8%. See Appendix F for a table of PFI’s pellet regulations. The standard further specifies that the pellet bulk density shall not be less than 40 lbs/cubic foot and the pellet fines shall not be more than 0.5% by weight. Fines are defined as particles that will pass through a 3mm ($\frac{1}{8}$ ”) mesh screen. The pellets have a cylindrical form (approx. 1½” long x $\frac{1}{4}$ ” diameter).

Standard | The “Standard Grade” wood pellet includes the same criteria as “Premium Grade” regarding dimensions, but has a less stringent inorganic ash specification of less than 3% and a less stringent fines percentage of less than 1% per weight. The moisture content must be less than 10% and a bulk density of no less than 38 lbs/cubic foot.

According to the EPA, pellet stoves have extremely low particulate emissions due to their high burn efficiency and the density of the fuel (<1 gm/hr).

4.6.4.2 Commercial/Industrial Pellets Definition

The “Utility Grade” (a.k.a. Commercial or Industrial Grade) wood pellet includes the same criteria as “Standard Grade” described above regarding bulk density, percentage of fines, and dimensions, but has a much less stringent inorganic ash specification than any wood pellet classified by PFI: more than 3%, but less than 6%. The moisture content must be less than 10%.

4.6.5 Wood Pellet Animal Bedding

Using wood pellets for animal bedding has become increasingly popular among stable and farm owners. The low moisture content of wood pellets allows for the bedding to be highly absorbent, up to four times their own weight. Additionally, the intensive production process of wood pellets removes many of the natural oils and eliminates the mold, bacteria, and aromatic hydrocarbons found in unprocessed wood bedding materials. Because wood pellets are screened to reduce fines, very little dust is created by the product. Disposal volume, in any given time period, compared to traditional bedding products, can be reduced by up to 50%. In addition, a mix of wood pellets and manure can be used as compost and fertilizer.

This could be a substantial market, with the opportunity to have a significant portion of production go to this market if sustainable contracts could be secured. To date, aspen and pine are the preferred species for animal bedding. It is suggested that the plant design its capability to utilize both the heating wood pellet production along with animal bedding wood pellets.

These markets, which would be year-round, can balance out the typically low demand periods in the summer months for heating pellets. The necessary species for bedding products are prevalent within the primary and secondary procurement areas.

4.6.6 Specialty Wood Pellets

4.6.6.1 Barbeque/Smoker Pellets

Similar to residential heating, pellet grills are becoming increasingly popular for barbequing. Wood pellets in a variety of “flavors,” such as hickory, mesquite, apple, cherry, sugar maple, and oak, provide the energy source and infuse the food with flavor. According to an article published in the Forest Business Network¹⁶ in December 2012, the use of flavor-infused wood pellets for grilling is one of the most popular cooking trends in the country.

Pellet grills are fueled by wood pellets loaded into a hopper affixed to the grill. This hopper auto-feeds the grill as needed through the connected thermostat, allowing the grill to maintain a specific internal temperature. According to the *Hearth, Patio, and Barbeque Association*, some pellet grills are now available in a dual-fuel unit that can switch over from pellet heat to gas when higher temperatures are needed. An attribute unique to a pellet grill is the ability to also use the grill to smoke meats.

4.6.7 Other Products

4.6.7.1 Wood Flour

As with pellets, wood flour has typically been produced from wood residue created from various wood manufacturing processes. As demand increases, the potential for creating wood flour from roundwood becomes more viable. Wood flour is pulverized and screened dry (8-10% moisture content), the finest grinds look like wheat flour. Most of the industry demands a product that is light in color and weight, highly absorptive, and resin-free. Having no bark and dirt is a requirement for this product (light colored wood species, such as white pine are preferred). The following products use wood flour:

- Composite decking, siding and railing
- Solidification
- Automotive components
- Fillers for feed and plastic applications

4.6.7.2 Wood Shavings

Some of the raw material used for wood pellets could also be used for wood shavings. It would also be a good fit with a wood boiler operation since waste from the shavings operation could be used for fuel. Wood shavings are used as bedding material for horses, sheep, and other farm animals

4.6.7.3 Wood Chips

Having a wood chip plant for the primary purpose of creating fuel chips for wood boilers is not economical. For any fuel chip markets, it is much more economical to chip the products

¹⁶ <http://www.forestbusinessnetwork.com/24206/adirondack-manufacturer-diversifies-with-apple-infused-grilling-pellets>

in the woods thereby limiting the amount of handling necessary. A portable wood chipper that blows the chips directly to a chip van is the most economical way of producing this type of product.

4.6.7.4 Combined Heat and Power (CHP)

A biomass energy plant could be an excellent fit with a wood pellet production facility; however, there are a number of factors that this co-dependent relationship may be contingent upon:

- The production cost of electricity versus the price to purchase it from an outside source.
- The internal use of the thermal energy byproduct created from the biomass plant in other on-site production processes including drying the wood chips for pelletizing.
- The potential of residue created from the wood pellet or other on-site operations being used to fuel the biomass plant.
- A premium for “green” energy, the company may be eligible for a Renewable Energy Credit (REC) from the state/federal government.

CHP is definitely an option since electricity is typically the second highest cost of pellet production after raw material costs. A CHP plant could provide electricity for operating the plant and heat for drying the raw material.

4.6.8 Recommended Product Markets

In order to build a wood pellet plant in the interior US at this time, it is imperative to produce a consistent, high-quality premium pellet. Procuring raw material at a reasonable price (less than \$40/green ton) and having established long-term sustainable markets is critical to the establishment of a larger scale pellet plant (20,000+ tons).

Industrial/commercial pellets should always be an option, especially if export prices to Europe and Asia make exporting profitable. There is also the potential to build a local/regional market for commercial pellets, such as what exists in northern Minnesota where a fish hatchery, casino, and school currently utilize wood pellets. There is also the possibility of the poultry industry utilizing pellet boilers due to several advantages over gas heat. With Minnesota being the top poultry-producing state in the country and currently not having any operating pellet plants, there is the potential to provide product by rail from the region.

Animal bedding is a market that can provide year-round demand and help offset the peaks and valleys of heating pellet demand. This market is driven by customer preference. Some customers prefer pine, while others prefer aspen. Identifying a specific product for a specific market is critical. There can also be size preferences in the bedding/litter market with 11/64” pellets being a preference in some of these markets.

Barbeque pellets is another good diversification product with a peak season opposite of the heating season, but it is a rather limited, though high-end, market. Utilizing local species, such as cherry, hickory and sugar maple, which are known for their “smokey” flavors, could help establish a foothold in this market.

4.7 Pallet Manufacturing

If a residential pellet plant is built, a major spin-off could be the manufacture of pallets. Typically, one ton of pellets is put on one pallet, so if 30,000, 60,000, or 100,000 tons of residential bagged pellets are produced, the same number of pallets would be needed. This could be done in one of three ways:

1. An on-site sawmill cuts logs into lumber and then dries and manufactures the lumber into pallet parts.
2. Rough lumber is purchased and manufactured into pallet parts.
3. Pallet parts are purchased.

With any of these three options, a pallet manufacturing process would be the final step. If either of the first two options is taken, a residue that could be used for raw material to make pellets or fuel for the drying process would be produced. The economics of producing pallets on site should be studied to determine the level of bagged residential pellet production that it would make sense to produce pallets for.

4.8 Economic Impacts

Economic impacts were estimated using input/output analysis as well as actual jobs and earnings data from the pellet industry. Section 4.8.1 estimates economic impacts using input/output analysis. Section 4.8.2 estimates economic impacts using actual figures from the industry. Section 4.8.2 also incorporates fuel savings impacts that would result from households in the region switching from fossil fuels to wood pellet heating.

It should be noted that the regional earnings and job impact figures generated from the input/output analysis do not directly match the regional earnings and job impact figures from the pellet industry. Specifically, the input/output figures capture economic impacts not shown in Table 19, including *additional* induced demand, or tertiary impacts. Therefore, it would not be appropriate to add the two estimates together as this would result in some double counting.

4.8.1 Economic Impacts using Input/Output Analysis

Economic impact modeling for various pellet plant sizes was performed using Economic Modeling Specialists International (EMSI) Analyst software. The analysis is based on regional economic modeling using the NAICS code 32199, "All Other Wood Product Manufacturing." Impacts are based on an assumed pellet price of \$200 per ton.

- A 10,000-ton/year pellet plant would generate an estimated \$2 million in annual sales, resulting in an increase in regional earnings of \$669,533 (1.24 multiplier) while creating 19 jobs (1.32 multiplier).
- A 60,000-ton/year pellet plant would generate an estimated \$12 million in annual sales, resulting in an increase in regional earnings of \$4,017,200 (1.24 multiplier) while creating 111 jobs (1.32 multiplier).
- A 100,000-ton/year pellet plant would generate an estimated \$20 million in annual sales, resulting in an increase in regional earnings of \$6,695,334 (1.24 multiplier), creating 185 jobs (1.32 multiplier).

4.8.2 Economic Impacts Using Industry Figures

The table below shows an estimation of the overall economic impact of various pellet mill sizes on the region using industry figures. Economic impacts include cost savings associated with households in the region switching to wood pellet heating.

- A 10,000 TPY pellet plant would generate 18 jobs and more than \$2.3M of total economic impact to the region. This figure includes household fuel costs savings from pellet use (\$1.7M, based on 35% of the plant's pellets used in regional households switching from expensive heating fuels).
- A 60,000 TPY pellet plant would generate 90 jobs and more than \$7.0M of total economic impact to the region. This figure includes household fuel costs savings from pellet use (\$4.3M, based on 35% of the plant's pellets used in regional households switching from expensive heating fuels).
- A 100,000 TPY pellet plant would generate over 136 jobs and more than \$9.3M of total economic impact to the region. This figure includes household fuel costs savings from pellet use (\$5.1M, based on 35% of the plant's pellets used in regional households switching from expensive heating fuels).

Table 19
Overall Economic Impacts for Multiple Wood Pellet Plant System Sizes

	Pellet Plant ¹		Biomass Harvest/ Transport ²		Product Transport ³		Service Support Industry ⁴		Households Switch to Pellets ⁵		Total Economic Impact to Region	
Pellet Plant Size	Jobs	Earnings*	Jobs	Earnings*	Jobs	Earnings*	Jobs	Earnings*	% of Production	Cost Savings*	Jobs	Impact (\$)*
10,000 TPY	7	\$252,000	1	\$37,440	1	\$33,280	9	\$225,000	85%	\$1,734,000	18	\$2,281,720
60,000 TPY	15	\$540,000	24	\$898,560	6	\$199,680	45	\$1,125,000	35%	\$4,284,000	90	\$7,047,240
100,000 TPY	18	\$648,000	40	\$1,497,600	10	\$332,800	68	\$1,700,000	25%	\$5,100,000	136	\$9,278,400

* All dollar amounts are annual (i.e. \$/yr). All job number calculations rounded to the nearest whole job.

¹ Average wage for plant jobs is \$36,000/yr. See Section 4.5.14 for wage rates.

² Average wage rate for harvest/transport jobs of \$18/hr (\$37,440/yr).

³ Average wage rate for finished pellet transport jobs of \$16/hr (\$33,280/yr).

⁴ Assuming 1 support service industry job per pellet-related job; assumed wage of \$25,000/yr per support service job.

⁵ Assuming the given % of pellets produced by plant are used by HHs in region. Cost savings (\$/ton pellets) calculated in Section 5.1.5.

4.9 Site Location and Infrastructure Assessment Criteria

A large pellet plant should be located in an area within a 25-50 mile radius of where active biomass harvesting is occurring or could occur at an extraction cost that would be economical for pellet plant operation. Rail access would also be important if markets developed for exports.

For a small scale plant, an ideal place would be on-site where dry residue is produced to reduce transportation cost. If an adequate supply of dry residue is not available a location within a 25-50 mile radius of harvesting operations would also be important to lower transportation costs. There are many other variables to consider in site location, such as Class A Roads, Utility Availability three phase electric power, Existing Buildings, Permitting/Zoning restrictions/requirements, proximity to residential areas, etc.

4.10 Environmental Impact

4.10.1 Harvesting

There are many types of biomass fuel that could be used as feedstock for a pellet plant including forest sources (cordwood, harvest residuals, urban forest management, etc.), industrial sources (waste wood, sawdust, etc.), and energy crops (hybrid poplar, field crops or crop residue, etc.). Forest health and harvest sustainability are considerations for all forest biomass sources. Harvesting biomass from public or private forests, while utilizing a homegrown resource, has the potential to negatively impact forest health. If done irresponsibly, forest harvesting can result in reduced biodiversity, degraded wildlife habitat, soil erosion, the loss of soil nutrients, soil compaction, and degraded water quality. However, if sustainable harvesting practices are utilized, these negative impacts can be minimized or avoided altogether and even improve forest health.

The impacts of woody biomass harvesting would have to be assessed on a case by case basis in comparison to what the landowner goals are for the property. In some cases, woody biomass harvesting would not be done (i.e. where tops are needed to protect regeneration from deer browsing), where there are nutrient poor soils, where the amount of biomass available makes biomass extraction unfeasible. Harvesting methods should follow industry best practices in order to mitigate any negative environmental impacts. Best practices include following Wisconsin's Woody Biomass Harvesting Guidelines.

4.10.2 Air Quality

A larger pellet plant would likely be required to meet certain air quality regulations enforced by the U.S. Environmental Protection Agency (EPA) and the Wisconsin Department of Natural Resources (WDNR). The plant might utilize biomass energy itself for process heating and drying, and therefore may be subject to EPA emission standards such as the New Source Performance Standards (NSPS) for Small Steam-Generating Units and the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Industrial, Commercial, and Institutional Boilers. These rules require biomass energy systems to meet emission limits for PM and other pollutants. In addition, air pollution control permits issued by WDNR would likely be required for a larger size facility.

4.10.3 Waste Streams

Waste streams (other than air emissions) are generally not major concerns for pellet plants. The main solid waste that would be generated is ash from the biomass combustion process (if biomass is used as a fuel source at the facility). Bottom ash is the small portion of the biomass that does not combust and therefore remains behind in the boiler system. If the biomass used for a project is "clean" (i.e. not mixed with any other waste streams or contaminated from industrial processes), then the resulting bottom ash would contain very low concentrations of heavy metals or other potential harmful compounds. In these cases, the ash can be beneficially used as a soil amendment, either in agricultural fields or forested land, if spread thinly. Other materials managed by the plant such as waste lubricants, oils, or solvents needed for operation and maintenance would require disposal. If a pellet plant is designed and managed properly, no significant wastewater or storm water discharges would be expected.

4.10.4 Summary

Before any size pellet plant is built, all environmental permits as well as any local and state building permits would have to be obtained. The standards and limits outlined in those permits would have to be adhered to during construction and operation of the plant. Unless

the project is located on federal land or involves harvesting on federal lands, it is unlikely an environmental assessment (EA) or environmental impact statement (EIS) would be required. Obviously in any plant siting, any wetlands or waterways would want to be avoided. Several pellet plants have been permitted within the state within the last five years so the criteria/standards for environmental controls of these plants have been established.

4.11 Kickapoo Valley Location

4.11.1 Advantages

The primary advantage of a large plant in the Kickapoo area is an availability of wood resource that is not currently being utilized. The advantage of a small plant using dry residue would be substantially lower costs than using forest-sourced raw material. Depending on the facility where dry residue is produced, a pellet press may be able to be installed in an existing facility with very little capital cost other than the pellet press itself. With the small plant, marketing smaller production volumes (less than 10,000 tons) is considerably easier than finding markets for large volumes of pellets. Two to three personnel per shift could run a small pellet plant, which would result in a substantially lower labor cost/ton than in a large plant.

4.11.2 Disadvantages

Disadvantages for a large plant: currently very little utilization of any woody material below sawlog-sized material, which means the infrastructure necessary to produce that material is not currently utilized/available. The production costs involved with transforming forest-sourced material into the dry sawdust-sized material necessary to create pellets are much higher than using dry residue to produce pellets. A considerable amount of marketing/sales would have to be done to find markets for all of the volume production of a larger plant.

Disadvantages of a small plant: The only disadvantages to a small-scale plant using dry residue is if there were a total lack of markets for pellets or if there was substantial competition for the dry residue for other uses, making pellet production prohibitive.

4.12 Concerns

The following list summarizes key operational concerns for pellet plants.

- Species – pellets need to be consistent, either a single species or a consistent mix of species. This requires sorting of residues by species.
- Contaminants – handling of the residue to eliminate dirt or other contaminants. Big concern for the scenario where residue is obtained from other sources. Need a quality control system.
- Bark – residue needs to be free of bark for a premium pellet. Also, if logs were skidded on the ground, there will be dirt which will wear machinery faster and will produce a lower quality pellet.
- Markets – before production begins, markets need to be identified. Pre-production contracts are nearly impossible due to pellet quality issues.
- Quality Control – producing consistent, high quality pellets is the biggest issue affecting all pellet plants. Once the market has experienced poor quality pellets from a source, that source is at a tremendous disadvantage. Establishing an intensive quality control process is essential to survivability.

-
- Seasonality – with the heating season being approximately six months, pellet plants are also roughly six months. To adjust for this, pellet plants need to do one of three things:
 1. Have inventory volumes for heating season
 2. Do off-season sales or have a pre-buy program
 3. Produce alternative products (barbeque pellets, animal bedding pellets, etc.)
 - Weather – a warm winter can affect the demand and lead to a surplus of pellets. Conversely, an abnormally cold winter can cause a demand that cannot be met.
 - Risk – any wood processing facility is prone to fire. It is critical to have a system in place to monitor all aspects of processing and to also have an adequate fire suppression system to control/limit any ignitions.
 - Permits – determine which permits are required based on equipment used and location.

4.12.1 Critical Success Factors

The three critical factors to operating a pellet plant are:

1. Raw material supply and cost
 - a. Type of raw material
 - What further processing will be required
 - Long-term contract or sporadic supply
 - b. Other competition for raw material
2. Processing
 - a. Identify raw materials will determine equipment needed
 - b. New or used equipment
 - c. Expertise to set up processing system
 - d. Identify markets to determine equipment needed for pelletizing process
 - e. Determine the number of employees based on raw material processing
3. End markets
 - a. Ramp up the processing to match demand in order to control both raw material and end product inventories, as well as minimize processing costs
 - b. Identify product trends in demand to raw determine material purchase and processing
 - c. Diversify markets to insulate the company from market demand fluctuations for one product
 - d. Provide immediate feedback to processing on any quality or supply issues

4.13 Overall Recommendation

Given current market conditions it is much more likely that a smaller pellet plant in the 6,000-ton/year size utilizing wood processor residues would be more feasible than construction of a large 60,000- or 100,000-ton/year pellet plant.

Developing a relationship where a small production pellet plant is tied into the local communities by supplying product for local demand could provide critical stability to a small plant. Working with local entities that have established a network, such as the Kickapoo Woods Cooperative or Organic Valley Farms would be essential. If residential pellets are the primary product, having a consistent, high quality product will be the most critical marketing/sales tool. Providing as much service as possible will assist in marketing pellets. This could include a hot line, workshops, webinars, stove sales, servicing, bulk delivery, all tied together through a web site and social media marketing tools.

5.0 Regional Energy Savings from Pellets

This section of the report estimates the theoretical supply and demand for wood pellets under three different fuel switching scenarios. Household and regional cost savings are also estimated.

5.1 Summary of fuel usage and prices in the four-county area

This section of the report summarizes fuel usage and prices in the four-county area by fuel type. The analysis is intended to demonstrate the potential market for wood pellets in the study region if households were to convert to pellet heating. The data also shows the potential economic impact of residential fuel switching on the region.

The analysis follows the format provided from a January 2011 Popular Mechanics article titled “How to Heat a House”.

5.1.1 Current Household Heating Fuel Types

The table below shows the percentage of households in the study area that currently heat their homes by fuel type. Of particular interest are those homes which currently heat with propane, fuel oil, or electricity (expensive fuel types). These homes are most prone to conversion to wood heating because those fuel types are typically more expensive than wood heating.

Vernon County (48%) has the highest percent of homes using expensive fuel types, followed by Richland (45%), Monroe (41%), and Crawford (35%).

Table 20
Household Heating Percentages by Fuel Type

County	Occupied Housing Units (1)	Fuel Type (%)						
		Bottled, Tank, or LP Gas	Fuel Oil, Kerosene, etc...	Electricity	Sub-Total	Utility Natural Gas	Wood	Other
Crawford	6,812	19	5	11	35	47	17	1
Monroe	17,376	23	5	13	41	45	12	1
Vernon	11,616	28	8	11	48	32	18	1
Richland	7,349	33	5	7	45	35	18	1
Wisconsin		11	4	13	28			

(1) US Census 2010

A breakdown of the actual number of occupied housing units by “expensive” fuel type is presented in the figure below. Monroe County (7,124) has the highest number of households currently using “expensive” fuels, followed by Vernon County (5,460), Richland County (3,307), and Crawford County (2,384).

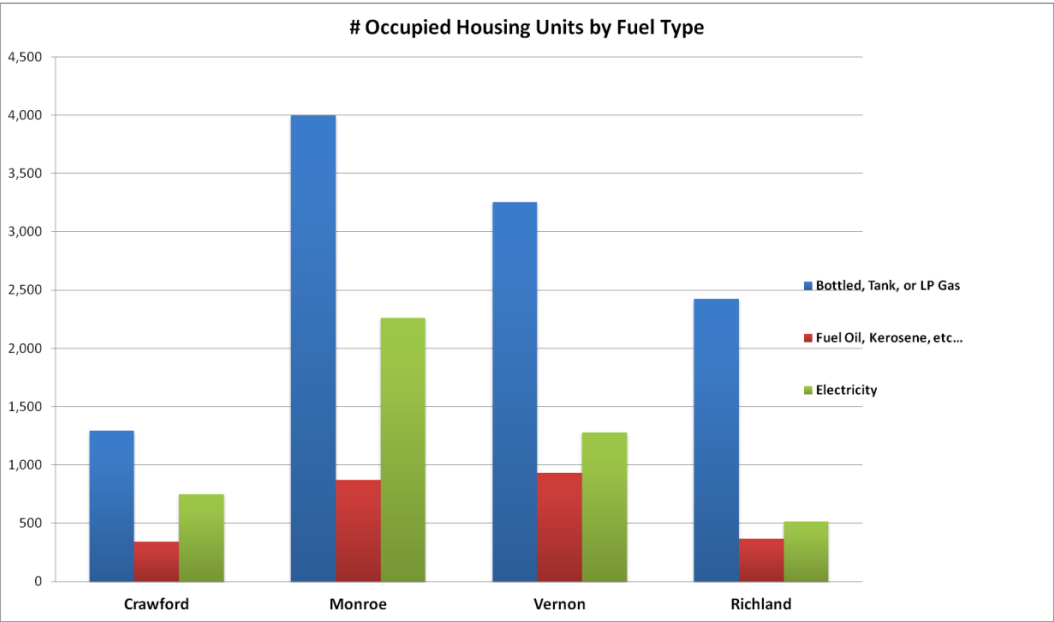


Figure 20 – Project Area Housing Units by Fuel Type

5.1.2 Current Household Fuel Costs

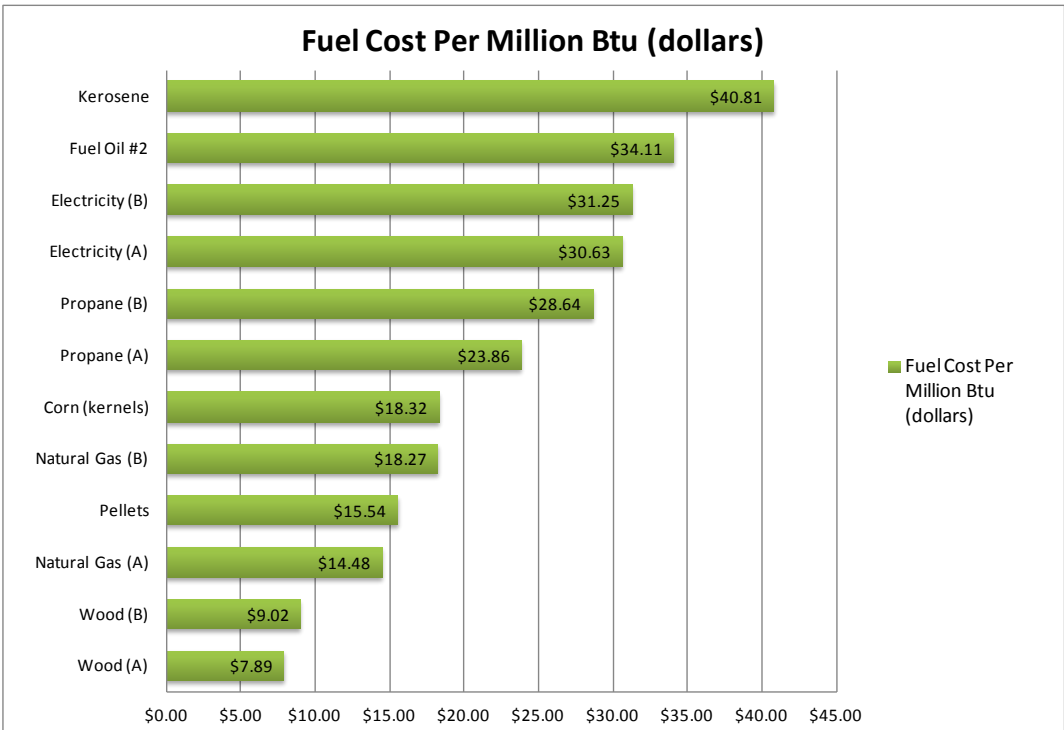


Figure 21 – Fuel Costs per MMBTU by Fuel Type

The figure on the previous page summarizes current household fuel costs estimated for the study region. As can be seen propane, fuel oil, and electricity (expensive fuel types) cost the consumer more on an energy unit/dollar basis than wood pellets. Natural Gas (B) is the fuel cost for a natural gas room heater. Natural Gas (A) is the fuel cost for a natural gas furnace. Wood (A) is the fuel cost for a catalytic wood stove using cord wood. Wood (B) is the fuel cost for a non-catalytic wood stove using cord wood.

The table below provides additional information used to calculate the unit cost per million BTU figures in the figure above. With current (December 2013) fuel costs wood pellet heating competes favorably with propane, fuel oil, and electric heating.

Table 21
Fuel Characteristics by Fuel Type

Fuel Type*	Fuel Unit	Fuel Price Per Unit (dollars)	Fuel Heat Content Per Unit (Btu)	Fuel Price Per Million Btu (dollars)	Heating Appliance Type	Type of Efficiency Rating	Approx. Efficiency (%)	Fuel Cost Per Million Btu (dollars)
Wood (A)	Cord	\$125.00	22,000,000	\$5.68	Wood Stove, Catalytic	EPA	72%	\$7.89
Wood (B)	Cord	\$125.00	22,000,000	\$5.68	Non-Catalytic, Room Heater	EPA	63%	\$9.02
Natural Gas (A)	Therm	\$1.19	100,000	\$11.88	Natural Gas Furnace or Boiler	AFUE	82%	\$14.48
Pellets	Ton	\$200.00	16,500,000	\$12.12	Wood Pellet Room Heater	EPA	78%	\$15.54
Natural Gas (B)	Therm	\$1.19	100,000	\$11.88	Natural Gas Room Heater (Vented)	AFUE	65%	\$18.27
Corn (kernels)	Ton	\$200.00	14,000,000	\$14.29	Corn Room Heater	EPA	78%	\$18.32
Propane (A)	Gallon	\$1.70	91,333	\$18.61	Propane Furnace or Boiler	AFUE	78%	\$23.86
Propane (B)	Gallon	\$1.70	91,333	\$18.61	Propane Room Heater (Vented)	AFUE	65%	\$28.64
Electricity (A)	KiloWatt-hr	\$0.105	3,412	\$30.63	Electric Baseboard/Room Heater	Estimate	100%	\$30.63
Electricity (B)	KiloWatt-hr	\$0.105	3,412	\$30.63	Electric Furnace or Boiler	Estimate	98%	\$31.25
Fuel Oil #2	Gallon	\$3.69	138,690	\$26.61	Fuel Oil Furnace or Boiler	AFUE	78%	\$34.11
Kerosene	Gallon	\$4.41	135,000	\$32.65	Kerosene Room Heater (Vented)	Estimate	80%	\$40.81

* Some fuel types are divided into types (A) and (B) based on different heating appliances

Source: Adapted from the U.S. Energy Information Administration's "Heating Fuel Comparison Calculator"

Fuel Price Assumptions

Fuel Type	Price	Source
Natural Gas	\$1.1876/therm	Midwest Natural Gas, Nov. 2013 Effective Rates
Propane	\$1.70/gallon	Midwest Propane, La Crosse, Wis. Personal Communication, October 2013
Pellets	\$200/ton	Craigslis, November 2013
Electricity	10.45¢/kWh	Avg. Vernon Electric Cooperative Residential & Small Commercial Rates (posted rates as of Dec. 1st, 2013)

5.1.3 Household Heating Demand

Space heating is the largest energy demand and utilizes 58 million BTUs of energy per household in Wisconsin annually, followed by appliances (29 million BTUs), water heating (15 million BTUs), and air conditioning (1 million BTUs)¹⁷.

¹⁷ Source: (3)Table CE3.3 Household Site End-Use Consumption in the Midwest Region, Totals and Averages, 2009. US Energy Information Administration.

5.1.4 Fuel Switch Savings

The table on the following page summarizes annual cost savings associated with switching from various fuel types to wood pellet heating. Comparative annual cost savings calculations include fuel costs and the heating application capital/installation costs. It is estimated that the greatest return on investment is switching from fuel oil to wood pellets, which would save a residential homeowner approximately \$1,021/annually. Close behind is switching from electric heating to wood pellets with approximate saving of \$1,016/year. Switching from natural gas to pellets would result in a small net increase in space heating costs.

Table 22
Comparative Fuel Savings: Wood Pellets vs. Other Fuel Types

Fuel Type	Heating Appliance ¹	Installed Cost (\$) ²	Annualized Installed Cost (\$) ³	2013 Heating Fuel Cost (\$/MMBtu) ⁴	Annual Heating Cost (\$/yr) ⁵	Total Annualized Cost (\$/yr)	Comparative Savings of Pellets (\$/yr)
Natural Gas	Furnace or Boiler	\$3,000-\$5,500	\$343	\$14.48	\$840	\$1,183	-\$21
Fuel Oil	Furnace or Boiler	\$2,300-\$3,800	\$246	\$34.11	\$1,978	\$2,225	\$1,021
Electric	Baseboard/Room Heater	\$5,500	\$444	\$30.63	\$1,776	\$2,221	\$1,016
Propane	Furnace or Boiler	\$2,750-\$5,650	\$339	\$23.86	\$1,384	\$1,723	\$519
Wood	Wood Stove, Catalytic	\$3,000-\$4,200	\$291	\$7.89	\$458	\$748	-\$456
Pellets	Wood Pellet Room Heater	\$3,500-\$4,000	\$303	\$15.54	\$901	\$1,204	\$0

¹ Annual heating costs based on lower cost/BTU unit values when multiple technologies using same fuel type are present

² How to Heat a House (Popular Mechanics July 2011)

³ Average of min/max installed cost range annualized assume 15 years and a 2.5% discount rate.

⁴ Includes appliance heating efficiency. Heating Fuel Cost Calculator, US Energy Information Agency. Last Updated 9/12/2013.

www.eia.gov/neic/experts/heatcalc.xls

⁵ Assumes an annual household heating demand of 58 MMBtu.

5.1.5 Regional Impact of Fuel Switching

Table 23 below summarizes the impact of residential households currently heating with expensive fuels switching to wood pellet heating¹⁸. If 10% of households currently utilizing expensive fuels were to switch to wood pellet heating, the total amount those households would save in annual heating costs is estimated at over \$1,300,000. This scenario would generate a demand for approximately 6,400 tons of wood pellets, enough to support a small scale pellet plant. The 20% scenario would result in annual fuel savings of \$2,600,000 and generate demand for about 12,900 tons of pellets annually. If 50% of households in the study region were to switch from expensive fuels to wood pellets it would result in annual savings of over \$6.6 million and induce a demand for over 32,100 tons/year of pellets.

¹⁸ This study was coming to completion in January 2014 a time when propane prices that are one of the most economically beneficial fuels to replace with wood pellets made a rapid rise. As a result Governor Walker approved \$8 million in 80 percent guaranteed bank loans to propane dealers and \$8.5 million in heating assistance for low income people's propane bills. On Thursday January 23, 2014 the La Crosse Tribune reported the Wisconsin average per gallon of propane was at \$2.30 compared to October's 2013 price of \$1.65 per gallon a 39 percent increase but more recently propane jumped to more than \$4.00 at many outlets and was more than \$6.00 per gallon at some locations. These recent prices show the positive economic impacts of switching from propane at \$1.70 per gallon used in Table 21 to wood pellets at \$200 a ton is greatly underestimated based on the January 2014 propane price variance of \$2.30 -\$6.00 per gallon. For price stability comparison the price of wood pellets was still selling for \$200 a ton (as reported in the above table) at a major western Wisconsin retailer in late January 2014.

Table 23
Percentage of Households Switching to Wood Pellet Heating

		<i>Percentage of Households Switching to Wood Pellet Heating</i>					
		10%		20%		50%	
Fuel Type	Current Households in Region (#)¹	Estimated Savings (\$/yr)²	Induced Pellet Demand (ton/yr)³	Estimated Savings (\$/yr)²	Induced Pellet Demand (ton/yr)³	Estimated Savings (\$/yr)²	Induced Pellet Demand (ton/yr)³
Bottled, Tank, or LP Gas	10,968	\$569,346	3,861	\$1,138,692	7,722	\$2,846,730	19,304
Fuel Oil, Kerosene,	2,506	\$255,760	882	\$511,520	1,764	\$1,278,801	4,411
Electricity	4,800	\$487,911	1,690	\$975,821	3,379	\$2,439,553	8,449
TOTALS	18,275	\$1,313,017	6,433	\$2,626,033	12,866	\$6,565,083	32,164

¹ Assumes 3.52 Tons/HH/Year Demand (based on 16.5 MMBTU/Ton pellets & 58 MMBTU/year Avg. WI Space Heating Demand)

² Based on the given % of HHs with each fuel type switching to pellets (e.g. 10% of Fuel Oil HHs, 10% of Electricity HHs, etc.)

³ Equivalent to \$204 in fuel cost savings per ton of pellet demand induced

5.1.6 Future Energy and Household Trends

The table below shows estimated energy price trends for traditional heating fuels (natural gas, fuel oil, electricity, propane) and biomass heating fuels (wood, pellets) in the Kickapoo Valley. All prices have been converted to 2013 dollars. Past prices are derived from various U.S. Energy Information Administration (EIA) data sets. Current prices are taken from the table in the “Current Household Fuel Costs” section above. Projected future prices were calculated using annual cost increase data from the EIA Annual Energy Outlook 2013 reference case (i.e. ‘business as usual’) assumptions.

Current prices for natural gas and propane are somewhat lower than historical prices, whereas the prices of these fuels are projected to slightly increase over time. On the other hand, current fuel oil and electricity prices are higher than historical values, with future prices remaining steady or slightly increasing. No historical data was available for biomass fuel sources.

Table 24
Heating Fuel Prices by Year (all prices in 2013\$)

Heating Fuel Prices by Year (all prices in 2013 \$)							
Fuel Type	Unit	2003 Price (\$/unit) ¹	2008 Price (\$/unit) ¹	2011 Price (\$/unit) ¹	2013 (current) Price (\$/unit) ²	2018 Price (\$/unit) ³	2023 Price (\$/unit) ³
Natural Gas	Therm	\$1.62	\$1.91	\$1.40	\$1.19	\$1.27	\$1.39
Fuel Oil	Gallon	\$1.74	\$3.24	\$3.60	\$3.69	\$3.54	\$3.84
Electric	kW-hr	\$0.084	\$0.095	\$0.103	\$0.105	\$0.112	\$0.113
Propane	Gallon	\$1.62	\$2.49	\$2.17	\$1.70	\$1.71	\$1.84
Wood ⁴	Cord	-	-	-	\$125.00	\$131.38	\$138.08
Pellets ⁵	Ton	-	-	-	\$200.00	\$215.46	\$232.11

¹ Historical residential heating fuel prices (various EIA sources by fuel, <http://www.eia.gov/>). EIA values for Wisconsin were scaled based on 2013 (current) price levels and then converted to 2013 dollars (<http://oregonstate.edu/cla/polisci/sahr/sahr>).

² Current fuel price assumptions (see "Current Household Fuel Costs" section above).

³ Based on residential fuel cost increase projections (fossil fuels and electricity only), US Energy Information Agency (Annual Energy Outlook 2013, Reference Case). <http://www.eia.gov/forecasts/aeo/data.cfm#enprisec>

⁴ Assumed 1% annual increase in price in future years.

⁵ Assumed 1.5% annual increase in price in future years.

The table below shows the past and projected number of households in the four-county study area. The number of households in all four counties increased steadily from 1970 to 2010. However, household numbers in Crawford and Richland Counties are projected to remain constant or slightly decrease over the next 10-20 years, whereas household numbers in Monroe and Vernon Counties are projected to slowly increase during this time period. Overall, the number of households in the four-county study area is projected to increase by over 3,800 households by 2035. Marketing wood pellets as a primary or secondary heat source for these new households could play a significant role in increasing wood pellet demand in the region.

Table 25
Housing Trends and Projections (2013-2033, 20 year projection)

Year	1970	1980	1990	2000	2010	2020	2030	2035
Crawford	5,207	6,770	7,315	8,480	8,802	8,030	8,341	8,369
Monroe	10,168	12,741	14,135	16,672	19,204	20,220	22,339	23,170
Richland	5,928	6,984	7,325	8,164	8,868	7,914	8,138	8,213
Vernon	8,448	10,141	10,830	12,416	13,720	13,109	14,157	14,692
4-Co Area	29,751	36,636	39,605	45,732	50,594	49,273	52,975	54,444
Wisconsin	1,472,332	1,863,897	2,055,676	2,321,144	2,624,358	2,639,494	2,831,682	2,905,664

(1) U.S. Department of Commerce-Bureau of the Census, (2) Projections arrived at by dividing Population by Avg Household Size

The housing unit projections shown for 2020-2035 are based on the persons per household projections from the State of Wisconsin – Dept. of Administration Demographic Services Center.

6.0 New Pellet and Wood Burning Technologies

Biomass heating is a well-established renewable energy technology. Many of the concerns regarding emissions from older, less efficient technologies including older outdoor water jacket boiler systems, have been addressed with technologies that do a better job of fully combusting biomass materials at high temperatures.

This section of the report provides an overview of existing and new solid wood biofuel technologies with a focus on wood pellet and wood chip systems that provide thermal energy for residential and commercial applications. A short discussion of district energy and district Combined Heat and Power (CHP) is provided at the end of the chapter.

These systems can provide heat throughout an entire home or business similar to how a regular furnace or boiler functions. They can also be used as a secondary heating source or a back up source of heat. Finally, district energy systems can be used to heat and/or power multiple facilities within a close geographic area.

6.1 Residential Biomass Heating Systems

Modern wood pellet stoves can function as either forced air, or “convection” furnace type systems or hot water or “hydronic” boiler systems. Forced air systems can be installed in a living room or other room in the house and used to heat the home directly. They can also be installed in a basement and attached to the home’s duct work in order to force air throughout multiple rooms.

Boiler systems are typically installed in the basement or outside the home, where they heat water for circulation through networked pipes. Water to air heat transfer is accomplished through a series of radiators located throughout the home. Hydronic heating can offset a greater portion of a home’s existing fuel needs by providing domestic hot water heating in addition to space heating.

6.1.1 Wood Stoves and Fireplaces

The basic wood stove options for residential heating with wood include fireplaces, wood stoves, and pellet stoves. Fireplaces typically use cordwood. They typically have a lower efficiency than either wood stoves or pellet stoves, as much of the hot air generated by combustion is simply lost up the chimney. They typically have worse air emissions than either wood stoves or pellet stoves as well. For these reasons, many consumers are utilizing fireplace inserts, which fit into the existing fireplace cavity but create better conditions for full combustion and lead to greater system efficiencies resulting in more heat transfer to the home.

Wood stoves also typically burn cordwood or small logs, providing the user greater flexibility in terms of fuel type. In the Kickapoo Valley, many consumers have access to either their own free wood fuel supplies or relatively inexpensive cordwood. Wood stoves are more efficient compared with most fireplaces, and can be located inside or outside the home or business. In the 1990’s the EPA developed new regulations that have helped reduce emissions from wood stoves. Prior to this time there was little quality control occurring in the wood stove market. As a result, many poorly designed systems were installed, including a large number of outdoor water jacketed systems that are often operated under low oxygen environments resulting in poor combustion and substantial air emissions.

6.1.2 Pellet Stoves

Finally, pellet stoves provide a third primary option for wood heating. Pellet stoves operate at efficiencies on par with or greater than most wood stoves. They utilize technology to control fuel to air ratios within the stove which ensures almost complete combustion, which generates very little smoke and keeps emissions low. Unlike wood boilers and traditional fireplaces, pellet stoves are fully automated. Feed systems regulate fuel delivery from the hopper to the combustion chamber. Automatic ignition eliminates the need for manual lighting. An electric motor power vents air into the combustion chamber, either vented in from outside the home or from inside the home.

Pellet stoves typically burn wood pellets, however there are models that accept other biomass fuels as well, including corn, cherry pits, and grass pellets for example. Pellet stoves are typically more automated than fireplaces or wood stoves, which allow the user to adjust the rate of air intake and pellet supply, either manually or in some cases automatically. Several models can also be set up on a thermostat system as well, with setback temperatures for night time and/or periods of time when nobody is in the home or business. Pellets are typically purchased in 40 lb bags in the United States. Customers that use pellet stoves as their primary heat source typically purchase these bags by the ton, which come delivered on a pallet.

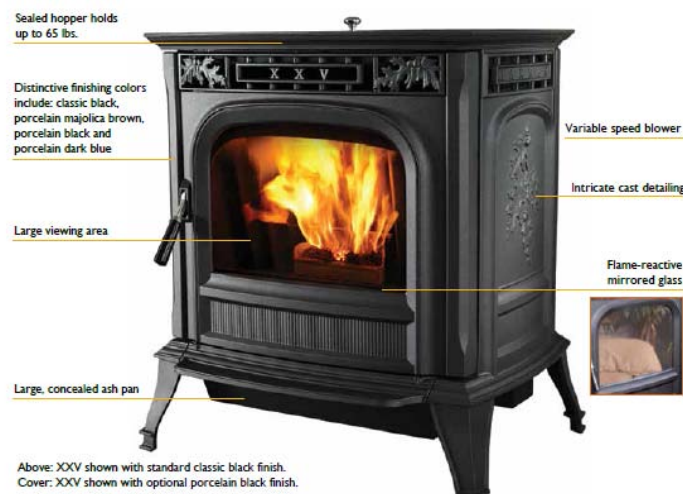


Figure 22 – Residential Wood Pellet Stove

6.1.2.1 Benefits of using wood pellet heating

There are a number of benefits of using wood pellet heating, including:

- Helps control home heating bills.
- Lock in annual fuel costs before the cold weather begins.
- Protects the environment
- Creates an automated wood fire.
- Simple to operate and maintain.
- Installation flexibility in most places of the home

6.1.2.2 Challenges with wood pellet heating

There are also challenges associated with using pellets for heating. A few of the challenges include:

- Cost – pellets prices fluctuate seasonally, but current market conditions make pellet heating more expensive than natural gas heating
- Labor – filling the hopper with pellets (typically, one to three 40lb. bags per day depending on the size of the home and weather conditions), emptying of the ash pan (typically weekly or bi-weekly depending upon the model of stove and rate of fuel consumption), cleaning of the burn pot, hopper, ash traps and glass (typically weekly or bi-weekly), thorough cleaning/maintenance including stove pipe (annually, by a professional chimney sweep or stove maintenance provider)
- Noise – pellet stoves operate using an electric fan, which depending upon the model and the home, can create levels of noise which some consumers find unpleasant.

6.1.2.3 Installation Considerations

Installation of wood pellet stoves is relatively straightforward. Many building codes simply require the owner to follow the installation guidelines provided by the manufacturer. Exhaust venting can be done either horizontally through the wall of the home or vertical piping can be added inside or outside the home to improve exhaust ventilation, especially in the case of a power outage.

6.1.3 **Factors to Consider when purchasing a pellet system**

There are several types of pellet systems on the market in the U.S. Factors to consider when purchasing a pellet stove include type of appliance, location, venting, additional features, style, installation considerations, maintenance requirements, fuel requirements, and cost. The U.S. Department of Energy also provides an excellent resource for consumers considering wood heating available on line at: <http://energy.gov/energysaver/articles/wood-and-pellet-heating>.

6.1.4 **Wood Furnaces and Boilers**

Wood furnaces and boilers provide central heating. However, unlike stoves, they can be used for both space heating and water heating. They distribute heat throughout the entire home similar to a conventional natural gas system. If space is available, they can be tied into existing ductwork and radiator systems. Similar to pellet stoves, wood furnaces and boilers are often highly automated, which contributes to high conversion efficiencies and low emissions. Unfortunately, as was noted above, low efficiency and high emission boilers are also still available, particularly traditional outdoor wood boilers. These systems should be avoided due to pollution concerns.

An advantage with furnace type pellet systems is that fuel can be stored in a larger hopper or an adjacent pellet bin. In the latter case, fuel can be automatically augured into the combustion chamber at the optimal rate to maintain the desired temperature as set on the thermostat. As with the pellet stoves described above, maintenance is primarily limited to weekly or bi-weekly ash removal, refilling the hopper or pellet bin, and monthly cleaning to remove “clinkers” and perform other light maintenance work. This work amounts to approximately 1 hour per month.

Strict emissions standards and higher density populations using biomass heating have led to the development of higher efficiency and cleaner burning biomass systems in Europe.

6.1.5 Bulk Fuel Delivery & Energy Storage

The rapid growth of biomass heating in Europe has led to the development of new technologies and approaches applicable to both residential and smaller scale commercial biomass heating in the study area. A few areas of innovation are highlighted below.

One of the key barriers to increasing market penetration of wood pellet stoves in the U.S. is the lack of fuel delivery infrastructure in place. Typically, most pellet users must purchase their fuel in 40lb. bags either individually or have them delivered by the ton on pallets (Figure 20 below). The bags must then be carried manually inside the home or to a garage, and then carried one at a time and fed into the stove directly or via a very small pellet hopper located adjacent to the unit.



Figure 23 – Typical Pellet Delivery in the U.S. by 1 ton Pallet

Source: <http://vermontrenewablefuels.com>

In Europe, and more recently in the northeast United States, bulk fuel delivery systems have been put in place that allows pellet users to purchase and receive larger quantities of pellets similar to how fuel oil is delivered to residential and commercial customers. Delivery trucks pull up to the home or business and feed the pellets directly into or adjacent the facility and automatically feed the pellets into a larger storage bin, or hopper, typically through a flexible hose (See figures above and on the next page).

With a large hopper in place, an auger can be used to automatically feed wood pellets into the furnace or boiler. This arrangement dramatically reduces the amount of manual labor required to feed a pellet appliance on a daily basis. The photos below are from a company in Vermont that currently provides bulk fuel pellet delivery and pellet storage units.



Figure 24 – Bulk Pellet Fuel Delivery



Figure 25 – Bulk Pellet Fuel Delivery & Storage Units

6.1.6 Thermal Storage

Thermal storage is another innovation which is very common in Europe. These systems can be located in conjunction with a wood chip or pellet boiler. The storage system serves as a heat sink for excess heat produced by the boiler. This arrangement allows the boiler to operate more efficiently, as the boiler does not need to cycle up and down as frequently to meet varying load demands throughout the day. For example, during the shoulder heating season, the boiler may not need to be running all day at a low output. Instead, the boiler can be run at a higher output thereby increasing its efficiency. The storage unit serves as a buffer

in the system, holding surplus heat and releasing it to the heat distribution system when required without having to restart the boiler.

The figure below shows a thermal storage tank which could be coupled with a wood boiler system.



Figure 26 – Thermal Storage Tank

Source: <http://www.woodboilers.com/products/heat-storage-systems/energy-tank.html>

6.2 Recommendations

The above section of this report summarized recommendations on new technologies, uses and efficiencies of pellet stoves, furnaces, and biomass burners for heat and electricity to promote the merits of wood pellets as a fuel source. The focus is on residential applications. See chapter 8 of the report for a discussion of large business (commercial) and district heating/CHP applications.

6.2.1 Promote the use of high efficiency stoves, furnaces and boilers

In terms of promoting biomass heating it is important to recognize that consumers turn to wood heating for a variety of factors, including:

- A desire to save money
- A desire to be energy independent
- A desire to support local businesses and jobs
- A desire to reduce one's environmental impact by switching away from fossil fuels
- A love for wood heat and the ambiance it provides in the home or business.
- Compliance with local, state, or federal mandates

Any efforts to promote increased biomass heating in the Kickapoo Valley should recognize the various factors that influence consumer decision making. Efforts should also be coupled with efforts to promote energy conservation, which is typically the most cost effective energy improvement a consumer can invest in.

In some parts of the state boiler residential swap out programs have been implemented to encourage existing wood heating households to replace their older, inefficient units with newer, high efficiency clean burning units. A swap out program targeted at low income households currently utilizing expensive heating fuels is another model which could be explored.

7.0 Sustainability

7.1.1 Harvesting & Land Use

Depending on the type of ownership, there are many different policies/guidelines in place to protect forest from unsustainable harvests, including woody biomass. All state and county lands as well as Managed Forest Law lands are covered by guidelines found in the Wisconsin Silvicultural Guidelines and in Wisconsin's Forest Management Guidelines for traditional harvesting and Wisconsin's Woody Biomass Harvesting Guidelines for biomass harvesting.

On private lands not under the Managed Forest Law, management practices are at the discretion of the individual landowner; however, most commercial users of biomass have adopted the policy of only purchasing biomass from producers who follow Wisconsin's Woody Biomass Harvesting Guidelines. Woody biomass harvesting should comply with Wisconsin's Woody Biomass Harvesting Guidelines, which can be found at: www.council.wisconsinforestry.org/biomass.

Because of the region's topography and existing agricultural practices, sustained biomass harvesting in the region would need to be approached very carefully. However, previous research suggests that balancing agricultural and environmental goals may be possible. Christopher Stillion¹⁹ found that the "Kickapoo Watershed is both highly suited to rotational grazing, and capable of supporting local generation of power from woody biomass while fulfilling long-term goals for forest resources management and improvement."

7.2 Air Quality

One of the primary potential concerns with biomass energy systems and fossil fuel energy systems is air pollutant emissions. Because fuel combustion is a fundamental aspect of any biomass energy system, any biomass energy project will emit air pollutants to the atmosphere. Air pollutants are chemicals or compounds that can cause human health impacts and ecological damage at high concentrations. The ambient concentration of air pollutants in the air is often referred to as "air quality." While the majority of air emissions from a biomass energy project will originate from the combustion of the biomass fuel, procurement and transportation of biomass can also produce air pollutant emissions depending on the methods utilized.

The primary two air pollutants of concern from biomass fuel combustion are particulate matter (PM) and nitrogen oxides (NO_x). Particulate matter is a mixture of solid particles suspended in air. These particles can be large enough to be clearly visible (e.g. smoke) or can be so small that they cannot be seen with the naked eye. PM is typically divided into multiple categories based on particle size: PM_{2.5} has a diameter less than 2.5 micrometers, PM₁₀ has a diameter less than 10 micrometers, and total PM has a diameter less than 100 micrometers. From a regulatory and human health perspective, PM_{2.5} is the most important size category. Nitrogen oxides, on the other hand, are highly reactive gases that can cause ground-level ozone pollution and other impacts. Emissions of other gaseous air pollutants as well as hazardous air pollutants (HAPs) such as heavy metals are also possible from biomass energy systems.

Larger biomass energy systems would likely be required to meet certain air quality regulations enforced by the U.S. Environmental Protection Agency (EPA) and the Wisconsin Department of Natural Resources (WDNR). Many new biomass combustion systems (larger

¹⁹ See "Around the Bend: Comprehensive Planning and Land Use in the Kickapoo Watershed", Master's Thesis, UW-Madison, Christopher Stillion (2011).

than household size) are subject to EPA emission standards such as the New Source Performance Standards (NSPS) for Small Steam-Generating Units and the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Industrial, Commercial, and Institutional Boilers. These rules require biomass energy systems to meet emission limits for PM and other pollutants. In addition, air pollution control permits issued by WNDR would likely be required for larger biomass energy projects.

The mass of air pollutants emitted by a biomass energy system is typically proportional to the system size. Emissions from small household systems are typically small, whereas emissions from larger industrial-scale projects can be significant. System design, combustion efficiency, and biomass fuel type and quality will all affect emission rates. However, modern combustion technology is far cleaner than traditional cordwood fires or older wood stoves/boilers and can comply with today's stringent air emission standards. Post-combustion control devices to reduce PM emissions are employed for most system sizes. These PM emission control devices can include multi-cyclone collectors, fabric filters, baghouses, and electrostatic precipitators (ESP). Using modern combustion and control technologies, air pollutant emissions from biomass combustion, while higher compared to natural gas combustion, are typically similar to fuel oil combustion and much lower than coal combustion.

Provided in the appendices (www.mrrpc.com) is the list of wood stoves certified by the EPA. The EPA Certified Wood Stoves list contains information about wood stoves or wood heating appliances that have been certified by the EPA along with its manufacturer name, model name, emission rate (g/hr), heat output (btu/hr), efficiency (actual measured and estimated), and type of appliance. It also indicates whether the appliance is still being manufactured.

An EPA-certified wood stove or wood heating appliance has been independently tested by an accredited laboratory to determine whether it meets the particulate emissions limit of 7.5* grams per hour for non-catalytic wood stoves and 4.1* grams per hour for catalytic wood stoves. All wood heating appliances that are offered or advertised for sale in the United States are subject to the NSPS for New Residential Wood Heaters under the Clean Air Act and are required to meet these emission limits.

The U.S. EPA recently released its New Source Performance Standards proposal²⁰ for new woodstoves and heaters, which go into effect in 2015, the first time that the standards have been updated since 1988. The new standards will make the next generation of stoves and heaters an estimated 80 percent cleaner than those manufactured today, affecting certain wood heaters manufactured beginning in 2015 and not affecting heaters and stoves already in use in homes or currently for sale today.

7.3 Greenhouse Gas Emissions and Climate Change

One of the primary motivations of biomass energy systems is the use of a renewable fuel (biomass) instead of fossil fuels (coal, oil, natural gas, etc.). Emissions of greenhouse gases (GHGs) from fossil fuel combustion are driving global climate change (or global warming), which will likely have a negative impact on the environment and human livelihoods in Wisconsin and worldwide. Carbon dioxide (CO₂), the most prevalent and well-known GHG, is emitted primarily from fuel combustion. Using biomass for heat and/or power offsets the CO₂ emissions from carbon-intensive fossil fuels. Combustion CO₂ emission rates for common heating fuels are shown in the table below. While the combustion of renewable fuels

²⁰ <http://www2.epa.gov/sites/production/files/2014-01/documents/proposedrule.pdf>

like biomass does produce CO₂ emissions, these emissions are qualitatively different from fossil fuel CO₂ emissions. Fossil fuel emissions introduce new carbon (from geologic sources) into the Earth-atmosphere system, where emissions from biomass simply cycle existing carbon in the system. Therefore, biomass at times has been stated as being a ‘carbon-neutral’ fuel. For example, offsetting 1,000 gallons of fuel oil with biomass fuel would reduce net CO₂ emissions by about 22,500 pounds.

Table 26
CO₂ Emissions from Fuel Combustion

	Coal (electric power avg.)	Fuel Oil / Diesel	Propane	Natural Gas	Woody Biomass
CO₂ Emission Rate (lb / MMBtu fuel input)	208.2	163.2	135.6	116.9	~0.0*

Source: USEPA Greenhouse Gas Reporting Rule, 40 CFR 98, Table C-1

**See text below for discussion of net CO₂ emissions from woody biomass combustion.*

While biomass does represent biogenic carbon compared to geologic carbon from fossil fuels, the true carbon-neutrality of biomass fuel is somewhat controversial. First, various scientific studies have suggested that woody biomass combustion is actually carbon-positive, depending on certain assumptions regarding the biomass vegetation re-growth, combustion efficiencies, and the timeframe considered. Second, in addition to the emissions generated from biomass fuel combustion, CO₂ emissions are also potentially generated during biomass procurement (harvesting, transport, and processing). These procurement emissions, typically accounted for in a life cycle assessment (LCA) analysis, originate from fossil fuel or electricity usage. Procurement emission can vary widely depending on the type and source of biomass and the location and method of biomass use. For example, processing CO₂ emissions for wood pellets are significantly higher than processing emissions for raw harvest residuals.

As a result of these two considerations, biomass in most cases should not be considered a fully carbon-neutral fuel. A detailed analysis of these considerations should be conducted to better estimate the net (i.e. life cycle) CO₂ emissions of each potential biomass energy project. However, most LCA project studies confirm that biomass represents a low-carbon fuel and a significant net reduction in CO₂ emissions compared to fossil fuels.

Consequently, if households in the four county study area were to replace fossil fuel heating systems with wood pellet heating systems, the CO₂ emissions associated with household heating would be significantly reduced. The table below estimates the CO₂ emission reductions from replacing the three most expensive heating fuels (propane, fuel oil, and electricity) with wood pellets. While the extraction, transport, and/or processing of all of these fuels (including pellets) emit various amounts of CO₂, the table calculations include only CO₂ emissions only from fuel combustion. In these calculations, net CO₂ emissions from wood pellet combustion are assumed to be zero. Fuel combustion emission factors for household combustion fossil fuels (all except electricity) are taken from the USEPA Greenhouse Gas Reporting Rule (shown in table above). Because the electricity used by customers in the four county study area is a mix of electricity generated at numerous power plants throughout the region, average CO₂ emission factors for electricity heating are taken from the USEPA 2012 Emissions & Generation Resource Integrated Database (eGRID) for

Southwest Wisconsin (an average of the “MRO West” and “MRO East” regions). Baseline household heating CO₂ emissions for each county include CO₂ emissions from the three ‘expensive fuels’ and natural gas (the most common heating fuel in each county).

As shown in the table, if 20% of households in the four county study area using propane, fuel oil, or electricity for heating switch to wood pellet heating, CO₂ emissions would be reduced by over 27,000 tons per year, or about 13% of baseline emissions. This reduction is equivalent to removing over 5,000 cars from the road or conserving over 2.7 million gallons of gasoline per year.²¹ Proportional emission reduction increases are observed if the percentage of households switching to wood pellets increases to 50% or 100%.

Table 27
CO₂ Emission Reductions from Switching to Wood Pellet Heating

			Percentage of Households Switching from 'Expensive Fuels' to Wood Pellets*								
			20%			50%			100%		
County	Total Occupied Households ¹	Baseline CO ₂ Emissions (ton/yr) ²	Total HHs Switching to Pellets ³	Total CO ₂ Reductions (ton/yr)	Reduction from Baseline (%)	Total HHs Switching to Pellets ³	Total CO ₂ Reductions (ton/yr)	Reduction from Baseline (%)	Total HHs Switching to Pellets ³	Total CO ₂ Reductions (ton/yr)	Reduction from Baseline (%)
Crawford	6,812	32,081	477	3,770	11.8%	1,192	9,424	29.4%	2,384	18,849	58.8%
Monroe	17,376	88,657	1,425	11,268	12.7%	3,562	28,170	31.8%	7,124	56,340	63.5%
Vernon	11,616	54,889	1,092	7,905	14.4%	2,730	19,763	36.0%	5,460	39,526	72.0%
Richland	7,349	32,129	661	4,300	13.4%	1,654	10,749	33.5%	3,307	21,498	66.9%
4-Cnty Total	43,153	207,757	3,655	27,243	13.1%	9,137	68,107	32.8%	18,275	136,214	65.6%

* 'Expensive fuels' for heating include propane, fuel oil, and electricity.

¹ From 2010 Census.

² Baseline CO₂ emissions from household heating are calculated using 1) the household heating fuel data presented in Section 5.1.1, 2) heating efficiencies for each fuel from Section 5.1.2, and 3) the CO₂ emission factors shown in the table above.

³ Percentage of households (HHs) switching to wood pellets are divided evenly between the three fuels (e.g. 20% of HHs using propane switch to wood pellets, 20% of HHs using fuel oil switch to wood pellets, etc.).

7.4 Forest Management and Greenhouse Gas Mitigation

According to a scientific article released in August 2013²² sharing the results of a review of carbon offsets and the role of forest management in greenhouse gas mitigation:

“Energy benefits typically are ignored in forest carbon offset projects, which promotes misunderstandings about overall atmospheric carbon flux. The authors [of this study] emphasize the carbon-storage benefits of using wood products in place of nonrenewable, energy-intensive materials and using wood-based energy instead of fossil fuels. They recommend sustainable production in forests where it supports primary management objectives and assert that well-managed production forests can promote the goals of reducing carbon emissions and increasing Earth’s carbon-storage capacity.

Key findings of this US Forest Service Study:

- Sustainably managed forests can provide greater greenhouse gas mitigation benefits than unmanaged forests while delivering numerous environmental and social benefits.

²¹ USEPA GHG Equivalencies Calculator - <http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results>

²² US Forest Service Science Findings Issue 155. August 2013 “The Role of Forest Management in Greenhouse Gas Mitigation”. <http://pelletheat.org/wp-content/uploads/2010/01/USFS-science-findings.pdf>

- Energy derived from burning fossil fuels releases carbon that has resided in Earth for millions of years, whereas energy produced from forest biomass results in no net release of carbon as long as overall forest inventories are stable or increasing.
- Using wood products instead of more energy-intensive materials such as steel, aluminum, plastic, and concrete provides substantial net emissions reductions. Unlike fossil fuel-intensive products that release new atmospheric carbon, wood products can store carbon for centuries.
- Modeled benefits of forest carbon offset projects depend on assumptions, including estimates of forest carbon flux that are rudimentary and based on limited data. Significant investment would be needed to develop carbon equations for the 542 U.S. tree species that account for both tree size and tree form.

7.5 Lifecycle Assessment Wood Pellets

A recent study²³ summarizes environmental impacts of “premium” wood pellet manufacturing and use through a cradle-to-grave life-cycle inventory. The system boundary began with growing and harvesting timber and ended with use of wood pellet fuel. Data were collected from Wisconsin wood pellet mills, which produce wood pellets from a variety of feedstocks.

Three groups of manufacturers were identified: those who use wet co-product, dry co-product, and harvested timber. Pellet mill data were weight averaged on a per unit basis of 1.0 short ton of “premium” wood pellets, and burdens for all substances and energy consumed were allocated among the products on a 0 percent moisture basis. Wood pellets produced from dry co-product required 60 percent less energy at the pellet mill. However, when considering all cradle-to-grave energy inputs, producing wood pellets from whole logs used the least energy. Pellets from wet co-product and dry co-product used 9 and 56 percent more energy across the life cycle, respectively. This study also compared environmental impacts of residential heating fuels with wood pellet fuel. Environmental impacts were measured on net atmospheric carbon emissions, nonrenewable energy use, and global warming potential (GWP). Assuming “better than break-even” forest carbon management, cordwood, and wood pellet fuels emitted 67.3 and 26.6 percent less atmospheric carbon emissions per megajoule of residential heat across the life cycle than natural gas, which is considered to be the best fossil fuel alternative. **Cordwood and wood pellets consumed fewer nonrenewable resources than natural gas, which consumed fewer resources than petroleum-based residual fuel oil. In addition wood pellet fuels had a smaller GWP and effect on respiratory health because they have more efficient combustion.**

7.6 Biomass Types and Sourcing

There are many types of biomass fuel that could be considered for biomass energy projects including forest sources (cordwood, harvest residuals, urban forest management, etc.), industrial sources (waste wood, sawdust, etc.), and energy crops (hybrid poplar, field crops or crop residue, etc.). In addition to economic considerations associated with each fuel type, the environmental consideration should be considered.

Forest health and harvest sustainability are considerations for all forest biomass sources. Harvesting biomass from public or private forests, while utilizing a homegrown resource, has the potential to negatively impact forest health. If done irresponsibly, forest harvesting can result in reduced biodiversity, degraded wildlife habitat, soil erosion, the loss of soil nutrients,

²³ Source: Forest Products Journal (Vol. 62, No. 4).

soil compaction, and degraded water quality. However, if sustainable harvesting practices are utilized, these negative impacts can be minimized or avoided altogether and even improve forest health.

7.7 Waste Streams

Waste streams (other than air emissions) are generally not major concerns for biomass energy projects. The main solid waste that would be generated is ash from the biomass combustion process. Bottom ash is the small portion of the biomass that does not combust and therefore remains behind in the boiler system. If the biomass used for a project is “clean” (i.e. not mixed with any other waste streams or contaminated from industrial processes), then the resulting bottom ash would contain very low concentrations of heavy metals or other potential harmful compounds. In these cases, the ash can be beneficially used as a soil amendment, either in agricultural fields or forested land, if spread thinly. Waste lubricants, oils, or solvents needed for the operation and maintenance of a biomass energy system (boiler, turbine, other moving parts, etc.) would require disposal. If a biomass energy project is designed and managed properly, no significant wastewater or storm water discharges would be expected.

8.0 Large Business and District Heating/CHP Opportunities

Any opportunities to utilize woody biomass to provide heat, hot water, process heat, and/or electricity to a large facility (public or private) or to a cluster of facilities (district heating/power) should be explored for feasibility. The rest of this chapter will describe potential opportunities and provide examples of successful woody biomass projects.

8.1 Commercial Biomass Heating Systems

Commercial wood heating systems profiled for this report include those utilizing pellets or wood chips. Full-scale combustion systems can be designed large enough to provide heat for a business or an entire community through a district energy system. Commercial scale applications are typically highly automated, which allows operators to monitor the systems remotely and receive text alerts or alarms when the systems need attention.

Commercial wood heating systems generally consist of three main components: fuel handling, boiler (a.k.a. combustion), and controls. The fuel-handling component contains the wood storage bin. If the system is automated, augers and conveyers are included to feed the wood to the boiler. The boiler contains the combustion chamber for conversion of the wood to energy for heating water in hot-water-heated buildings. Controls within the wood heating system will vary depending on the degree of automation. They can be limited to burn rate or include motors for augers and conveyors.

The table below describes the key design and operational considerations for fully automated and semi-automated wood chip systems, as well as wood pellet systems. Fully automated systems are exactly that – a delivery truck drops off the chipped or ground up waste wood with a live bottom floor, and a series of augers and conveyers move the wood fuel to the boiler. With computer controls and a laser eye that measures the amount of fuel in the metering bin, the system automatically turns the augers and conveyers on and off as needed to maintain the amount of wood fuel to sustain the boiler's pressure and thus, the temperature demand of the thermostat.

Semi-automated or "surge bin" systems require somewhat more manpower than the fully automated system. These systems often have a smaller storage bin, shorter, simpler fuel conveyance systems, and are designed to meet less than the full heat load of the facility. The rationale behind this is that wood fired boilers operate most efficiently when they are working hard, and sizing a boiler to meet the peak would necessarily compromise its efficiency for the majority of the time it is in use. Pellets are a highly processed fuel, and therefore, more expensive. The tradeoff is that the fuel is more condensed and uniform, which makes them much more efficient to transport and store. Because of their uniform nature, the conveyance system for pellets is simpler and less expensive than a surge bin system. These systems essentially use a grain-type of storage silo and move the fuel to the boiler using gravity. The condensed nature of this fuel also makes the storage requirements considerably smaller, reducing up-front construction costs. Typically they are most cost effective when space for fuel storage and conveyance is limited, and pellets are manufactured relatively close to the end user.

Typical Wood Chip Systems		Typical Wood Pellet Systems	
Fully Automated	Semi Automated		
Primary Fuel	Green Woodchips (up to 50% moisture)		Wood Pellets (typically <6% moisture)
Energy Output	Hot Water or Steam		
Conditioned Space	>100,000 SF	50,000 to 100,000 SF	Variable
Boiler Output	2-60MMBTU/HR	.5 - 3 MMBTU/HR	100,000 - 2 MMBTU/HR
Fuel Storage	Below grade storage bin	Slab on grade building/outdoor hopper	Silo
Fuel Handling	Automated, minimal operator requirements	Front loader to move chips from storage to bin; automated from bin to combustion chamber)	Automated from silo to combustion chamber
Labor Requirements	Up to 30 minutes daily	Up to 1 hour daily	15-30 minutes daily
Combustion Controls	PLC-based panel; automated fuel feed & combustion air rate	Electronic control panel; automated tuned control of fuel and combustion air	PLC-based panel; automated control of fuel feed and combustion air rates
Stack	Height depends on system size; local conditions; air dispersion (60-75 feet for larger system sizes)		Depends on local regulations
Stack Emission Control	Depending on size of boiler cyclone and bag house; electrostatic precipitator for larger system sizes; must meet state, federal air requirements	Must meet applicable regulations	
Ash Removal	Manual or Automated		
Boiler Space Requirements	1,000 to 15,000 SF	1,500 to 4,500 SF	200 SF
Fuel Storage Space Requirements	6 SF per Ton		Outdoor storage silo, approx. 150 SF
Approximate System Cost	\$1 Million - \$20 Million		\$150,000 - \$600,000

Figure 27 – Commercial Chip & Pellet Sizing

It can be seen in the figure that fully automated systems can be orders of magnitude larger in terms of boiler output and cost when compared to semi-automated systems or wood pellet systems. In addition, these systems may also require more extensive environmental considerations in the form of stack emission control.

8.1.1 Technology Providers

8.1.1.1 Wood Master

The figure below is a photograph of an example of a new high efficiency, flex fuel biomass boiler. Wood Master is a European-designed biomass technology that is manufactured in Minnesota using parts made in Superior, Wisconsin. Wood Master utilizes oxygen sensors and advanced controls to gasify and combust either pellets or wood chips. New system designs are flex fuel, allowing the consumer to switch between pellets or chips. The systems are considered one of the most environmentally friendly in terms of low air emissions. For a video describing key design features visit: <http://www.youtube.com/watch?v=ibjvYb-Wuuc>



Figure 28 – Commercial Biomass Heating

8.1.1.2 Froling

Froling is an Austrian company which recently began exporting higher efficiency wood chip and wood pellet technologies into the United States. The figure below shows the TX 150 model. Its rated output is 500,000 Btu/hr and up to four of the units can be coupled together for an output of up to 2 million Btu/hr to meet a variety of commercial scale needs. This unit can burn either wood chips or pellets.



Figure 29 – Froling TX 150 Pellet/Chip Boiler



Figure 30 – Froling TX 150 Pellet/Chip Boiler & Storage Chamber

8.1.1.3 Messersmith Manufacturing

Messersmith Manufacturing, Inc. designs and installs boilers with outputs between 2 and 20 million BTU per hour that can produce hot water or steam. Hot water design pressures range from 30 to 100 psi. Steam design pressures range from 15 to 300 psi. As seen below, the general system components would include a fuel storage bin, automated feed system, and boiler. To view a video of a Messersmith Boiler used to heat a school in Vermont, visit: <http://www.youtube.com/watch?v=hTcQ-O90944>



Figure 31 – Messersmith Biomass System

Source: <http://www.burnchips.com/>

8.1.1.4 Chiptec

Chiptec is a Vermont-based company which offers close-coupled gasification systems, which heat solid biofuel to a high temperature creating a syngas that is combusted in a separate vessel located directly adjacent to the gasification chamber. They provide medium scale close-coupled gasifier and boiler systems with heat exchanger outputs from 1.5 to 20 MMBtu/hr. These systems have a modular design for reduced shipping and installation costs and a deep fuel bed to accommodate a quick response to changes in demand. System features include a 20:1 or better turn down capacity which can accommodate load fluctuations, an ability to burn either green and dry fuels (6-55% moisture content), easy ash removal, high combustion temperature (cleanliness and efficiency), high fuel efficiency, the ability to idle cleanly and efficiently in low load periods, minimal daily maintenance, and soot free combustion. The figure on the next page is Chiptec's P-Series close-coupled gasification system. www.chiptec.com



Figure 32 – Chiptec Close Coupled Gasification/Combustion Unit

8.1.1.5 Hurst

Hurst Boiler has been manufacturing, designing, engineering, and servicing gas, oil, coal, solid waste, wood, biomass, and hybrid fuel fired steam and hot water boilers since 1967. With installations across all industries worldwide, Hurst Boiler is recognized for the highest code standards, innovative engineering and design, Energy Star rating, and renewable, sustainable solutions for green building design and operational efficiency.



Figure 33 – Hurst Biomass System

Source: <http://www.hurstboiler.com/>

8.2 Case Studies

8.2.1 Green Mountain College, Putney, VT

Green Mountain College, located in Putney, VT, chose Chiptec to supply a biomass gasification system to replace their dependence and consumption of #6 fuel oil with wood chips. For the second year in a row, Sierra Club has ranked Green Mountain College at the top of the list of “America’s 100 Greenest Schools” – ranked No. 1 in 2010 and ranked No. 2 in 2011. The honor of being the country’s greenest college was due in part to their initiatives and efforts in attaining college energy sustainability with the biomass system. By use of Chiptec’s patented gasification technology, Green Mountain College has not only been able to diminish their carbon footprint and foster long-term sustainability, but also significantly reduce and fix annual energy operating costs.

Project Facts:

- Plant went online in spring 2010
- Boiler output: 400 hp
- Will burn an estimated 4,000 - 5,000 tons of locally sourced woodchips annually
- 85% reduction in #6 fuel oil annually (190,000 gallons)
- CO₂ reductions: 2,844 plus metric tons per year, a 40% reduction in carbon footprint
- Electricity produced: 15-20% of the campus needs, or 400,000 kilowatt-hours per year (see steam turbine discussion below)
- CO₂ emissions: 8 ppm average @ 12% CO₂ (via EPA test method 10)
- Particulate emissions: 0.009 lbs/MMBTU, average (via EPA test method 5)

8.2.2 Gundersen-Lutheran, La Crosse, WI

Gundersen-Lutheran installed a new wood chip boiler system in spring 2013 in La Crosse, WI. The system is projected to save the hospital \$500,000 per year in fuel cost, including \$350,000 in natural gas and \$150,000 in electricity. The system generates steam which is used throughout the hospital for both space heating and process heat. A steam turbine creates electricity which is used on site as well. Jeff Rich, who heads Gundersen-Lutheran's energy subsidiary GL Envision, refers to the coulee region as the "Saudi Arabia of biomass." "We can make our own home grown energy in our area and create jobs," he said in a newspaper article published in the La Crosse Tribune.²⁴ The wood chips for the project come from Lambert Forest Products in Warrens and Nelson Hardwoods in Prairie Du Chien.

**8.2.3 Memorial Medical Hospital, Ashland, WI**

The photograph below is of a 4 MMBtu/hr biomass boiler used for heating the Memorial Medical Center in Ashland, WI. The boiler system typically consumes 2,000-3,000 tons of wood chips per year and supplies about 99% of the facility's heating needs. Installed in the 1980s, the biomass boiler currently saves the facility around \$400,000 per year in heating costs.

²⁴ Gundersen's new wood chip boiler taps region's resources. May 2nd, 2012. La Crosse Tribune.



Figure 34 – Memorial Medical Center Biomass Heating, Ashland, WI

8.2.4 Meister Cheese Company, Muscoda, WI

In 2005-2006, Meister Cheese Company installed a wood boiler at their Muscoda facility. The 400 HP boiler was installed at a cost of \$1.7 million and received \$430,000 in grant/loan financing from USDA. The project is estimated to provide annual savings of 600,000 therms of natural gas with a four-year payback at the time of installation. A pallet company ¼ mile down the road provides biomass chips for the boiler system. The trims are used in the AFS boiler which provides steam to the cheese factory and whey drying facility (Meister Cheese).



Figure 35 – Meister Cheese Company, Muscoda, WI

8.3 District Heating and Combined Heat & Power (CHP)

8.3.1 Overview

District heating is a very resource-efficient and environmentally friendly source of heat. District energy provides heat to multiple facilities in close proximity. Hot water, steam, or chilled water are produced at a central plant and transported through an underground pipeline network under high pressure to multiple buildings for space heating and air conditioning. Heat exchangers in the buildings use the hot water to heat radiators and/or hot water tanks. Figure 36 on the next page provides a simple illustration of a district heating system.

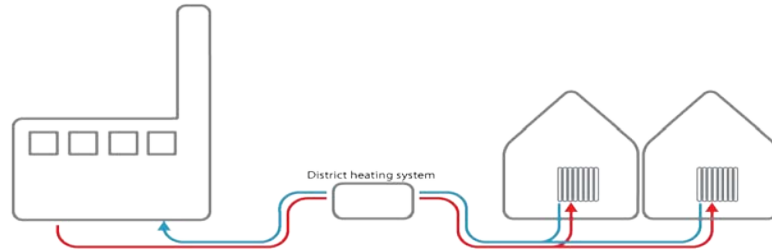


Figure 36 – Diagram of District Heating System
(Source: Swedish Energy Agency)

Another configuration for district energy system is Combined Heat and Power (CHP), which provides both heat and power to multiple facilities. Both approaches allows residential, municipal, commercial, and institutional buildings to cover their necessary heating or cooling loads without each building having its own heating or cooling equipment.

District heating systems can use a wide variety of fuel types. These systems can also take advantage of energy that would otherwise go to waste, such as waste heat from industrial processes, forestry waste and energy recovered from waste. For example, a district heating system could be fuelled by a combination of renewable energy sources, including woody biomass, solar hot water, and geothermal.

There are several district energy systems in the U.S., including a large biomass system serving most of downtown St. Paul, MN. A profile of a smaller district heating/cooling system in Barron, WI is provided below.

There are several benefits and concerns with district heating and/or CHP which are summarized below.

Benefits:

- The technology is relatively simple and very reliable
- Flexible, can be combined with district cooling, power production
- Often cost-effective compared with other renewable energy technologies
- Lower overall buildings operating and maintenance (O&M) costs

Concerns:

- Piping between buildings can be expensive
- Requires investment and on-going attention to manage air emissions
- Not financially attractive for low population densities – due to a higher investment per building

8.4 District Energy Case Studies

8.4.1 Barron, WI

The Barron Area School District installed a wood boiler system in 1980-81 to provide steam heat for the High School, Elementary School, Community Center, Hospital and Medical Center, and the Maple Crofts Senior Rest Home. More recently, an absorption chiller was added to the system which now provides cooling to the facilities as well (except the medical center). Combined, these facilities include approximately 1 million square feet. The project

supports the local community through cost savings, by supporting local businesses, by re-circulating energy dollars within the community, and through education.

The energy plant produced 23,263,508 lbs of steam for heating and cooling during the 2009-2010 season at a cost of roughly \$235,000. This cost includes biomass, gas, maintenance, salaries, and benefits. In comparison, in order to produce the same amount of steam using natural gas in 2009-2010, the cost for the gas alone would have been \$280,000. The \$280,000 figure would not have included maintenance, salary, and benefits. While it is difficult to compare the overall cost of using woody biomass versus natural gas because fuel costs vary over time, the school district administrator estimates woody biomass has saved the District between 20% and 40% in energy costs annually.

8.4.1.1 Fuel

For fuel, the District purchases chipped wood from Bell Poll lumber, a local manufacturer, and Indianhead Holsteins, a local farm and biomass supply business. In the past the District used to chip its own wood but it no longer does so for safety and logistics reasons. In general, chipped product is much better than ground product for use in the biomass boiler. Size of the ground or chipped product is most important to a good burn. Anything smaller than a quarter may cause problems

Pricing varies depending upon the source and type of product. Wood chips are currently purchased at \$20-\$47 per ton. During the height of the 2010 heating season, from January 1, 2010 through May 24, 2010, the boiler consumed 1,785 tons of wood. During the winter, up to 20-23 tons/day are consumed in the boiler, or one semi-load. Under this scenario, the boiler can achieve up to 70% efficiency; however, the efficiency of the boiler is only 50%-70%. For comparison, the newer biomass gasification unit used in Rice Lake, WI operates at 80%-90% efficiency and has lower maintenance costs with ashing required only once a week.

8.4.1.2 Storage & Conveyance.

Wood is currently stored on site in the parking lot of the High School and in two large, indoor concrete chambers. This arrangement provides flexibility for the biomass supplier to be able to drop off and/or chip piles of biomass when convenient and appropriate given school schedules and work schedules. After wood is ground, it should be used within 10 days; however, this is not always feasible.

Biomass is conveyed automatically to the boiler using two large in-ground turn screws (augers which drag the biomass horizontally) and can move up to baseball-sized chips. The system as designed is sub-optimal in that it occasionally clogs up. The long auger should be broken in two with one feeding the second. Another design improvement over the current system would be to store biomass vertically to decrease the necessary auger length. However in talking with other users vertical storage is problematic with plugging, freezing, and excessive man hours required to fill. The general consensus with operators is that the walking floor pit is the preferred method.

8.4.1.3 Boiler

Biomass conversion occurs in a 15 MMBTU Swede Stoker boiler. The boiler is a “fixed bed” system. Two natural gas fired boilers totaling 12 MMBTU provide backup. Inside the boiler there is a cast iron cone and wood is fed up underneath the cone prior to combustion. Ash is re-circulated and burned several times before exiting the system. Roughly one small dumpster of ash is generated weekly and deposited to the landfill. Dirty biomass is detrimental to the

boiler as it turns to glass (clinkers) and needs to be physically chipped out of the inside of the boiler.

8.4.1.4 Controls

A digital control system was installed in 2005. A web-based interface allows staff to monitor and adjust settings remotely. The system controls pumps, heat exchangers, valves, air handlers, etc., so that temperature can be controlled remotely on a room-by-room basis. Software integration and support is critical in terms of controls and there are different technology providers to choose from.

8.4.1.5 Operations

Five staff work at the energy plant on rotation. The new digital control system in place can alert staff at their homes if there are any issues which need attention at the plant. Staff regularly ash the boiler and check water levels (daily), perform routine maintenance checks, (daily, approx. 1 hr.), perform chemical tests (3 times/week), grease bearings and change oil (once/month). The entire system is shut down twice per year to perform maintenance.



Figure 37 – Software Controls

According to the system operator, special attention should be paid to balancing chemicals in steam systems, which are applied directly to the condensate tanks. The chemical representative should visit every month to help balance the system. In addition, the chemicals must be rated for the intended purpose of the system (humidification, etc.). Similarly, water should be tested for hardness.

8.4.2 **Finland, MN**

The Wolf Ridge Environmental Learning Center in Finland, MN provides another case study of successful district heating in the upper Midwest. The educational facility has been heating with GARN cordwood boilers since the early 1980s; however in 2012, management installed two pellet boilers with a capacity of 3.4 MMBtu/hr. One reason for the switch was to reduce

the amount of maintenance and labor costs associated with a cordwood system while maintaining a renewable energy source for heating needs.²⁵

The new system requires approximately 75% less staff time to maintain, with maintenance required once per week for 45 minutes for basic cleaning including ash removal. Another 2-3 hour maintenance routine is performed every three weeks, which includes cleaning out the air exchangers.

The Wood Master Commercial Series pellet boilers heat the entire campus of 7 buildings and 84,000 square feet using two boilers. This arrangement allows for greater handling of peak and off-peak loads. The smaller boiler has a capacity of 1.2 MMBtu/hr and the larger about 2.2 MMBtu/hr. The boilers provide both space heating and domestic hot water to the facility. Estimated annual consumption is approximately 175 tons of pellets. A 34-ton pellet silo storage bin is located on site along with a 2,500 thermal storage, or buffering tank, which allows the boilers to operate more efficiently.

Pipes with a total length of 1,200 feet were installed at a depth of 2 to 3 feet in order to connect five buildings together in three separate heating zones. The total cost of the project was about \$465,000, funded in part by a \$300,000 grant from the U.S. Department of Energy. The grant requires Wolf Ridge to use the biomass system in its educational programs, which reach over 18,000 children, teachers, chaperones, family members, college students and senior citizens each year.



Figure 38 – Wolf Ridge Bulk Pellet Storage

²⁵ Peter Smerud, Executive Director Wolf Ridge Environmental Learning Center. Personal Communication. 2013 Heating the Midwest Conference.



Figure 39 – Wolf Ridge District Heating Piping



Figure 40 – Wood Master Boilers

8.4.3 Providence University College, Winnipeg, Canada²⁶

8.4.3.1 Overview

This district heating system utilizes both straw and wood residues as feedstock. In 2010, Providence College installed a district biomass system used for heating and hot water in order to reduce their carbon footprint, establish a new biomass market for the farming economy, create a model for other institutions to follow and use local resources to substitute for non-renewable energy sources. The existing natural gas boiler heating system at the campus is now used as a backup system as well as providing extra heat on the colder winter days.

The system uses a hopper bin to feed the combustor with densified biomass. This fuel is available in Manitoba in a variety of forms from both agricultural and forestry residues from \$40 to \$100 per ton. The stoker/boiler primary combustion biomass heating system is sized (3.4 MMBtu/hr) to provide heat for the three primary natural gas users on the campus (gas used for auxiliary winter heat, domestic hot water, and cooking).

²⁶ Source: KIP Providence AltEn Biomass DLF Consulting Report 2010 October

8.4.3.2 Cost

The cost of the biomass system is \$538,800, with an estimated annual cost of around \$30,000, which with the federal grant (\$250,000) yielded a simple payback of less than 6.2 years, and an internal rate of return (assets) of 11.8%. Without the grant, this project was still considered viable with a simple payback of around 12 years.

The project is seen as an opportunity to demonstrate leadership in reducing the carbon footprint of Providence, establish a new biomass market for the farming economy, create a model for other institutions to follow, and use local resources to substitute for non-renewable energy sources. It also reduces the smog created by the open burning of straw.

8.5 Large Business and Small District Heating/CHP Feasibility Considerations

This section of the report describes key feasibility considerations for analyzing a potential small district wood heating/CHP project. The same basic analysis is required for a standalone biomass project.

There are a number of components that comprise a biomass-to-energy project, from biomass procurement on one end to energy utilization and waste disposal on the other end. Each of these components is an important consideration in the overall economic feasibility of a proposed project. Establishing a small district wood heating/CHP facility in the Kickapoo Region may be a viable option under the right conditions; however, an economic analysis should include the following:

- Costs for biomass procurement
- Project capital costs
- System operation and maintenance costs
- Energy cost savings from energy utilization
- Other potential revenue streams
- Discussion of funding and financing options
- Payback period analysis

There are a number of different overall scenarios that typically need to be looked at when considering a biomass project. The major scenario factors include 1) method of procuring biomass, 2) size and type of biomass combustion system, 3) whether the project will produce only heat or both heat and power, 4) the number and location of buildings that will utilize the produced heat/power, and 5) other off take arrangements which may be considered as part of the overall project.

Total project costs, annual revenues, and payback periods need to be estimated for appropriate combinations of these scenario factors based on the goals expressed by the community or project developer and the economic/technical feasibility of the project.

The table on the next page illustrates the type of different scenarios modeled for a district energy feasibility study that also included a potential greenhouse on site to utilize excess heat.

Table 28
Different Scenarios Modeled for a District Energy Feasibility Study

	Scenario #1	Scenario #2	Scenario #3	Scenario #4	Scenario #5	Scenario #6
<i>Buildings Included</i>	A	A+B+C	A+C+D	A+B	A+B+C+D	A+B+D+D
<i>Energy</i>	Heat Only	Heat Only	CHP (only partial power)	CHP	CHP	CHP
<i>Biomass Procurement</i>	Purchase	Harvest w/ RW Sale	Harvest w/ RW Sale	Purchase	Harvest w/ RW Sale	Harvest w/ RW Sale
<i>System Size (fuel input)</i>	1.5 MMBtu/hr	4.0 MMBtu/hr	5.0 MMBtu/hr	10.0 MMBtu/hr	13.0 MMBtu/hr	13.0 MMBtu/hr
<i>Greenhouse</i>	None	None	None	5,000 sq. ft.	None	5,000 sq. ft.

8.5.1 Project Development/Ownership

The first stage in determining the feasibility of a standalone wood heating, small scale district heating system, or CHP system using biomass is to identify potential interested project developers. A district system will make the most sense where there is a tight clustering of facilities located within close proximity of one another. However, this situation is most likely to occur in the incorporated areas of the region, most of which have access to relatively cheap natural gas.

Another factor to consider is ownership, since a district system requires a strong degree of collaboration and trust among facility owners. Therefore, a cluster of facilities owned by the same company or community is probably a more likely candidate than a cluster of facilities with multiple owners. In addition, for a tight clustering of facilities with the same owner, a potential developer may be more prone to consider district heating or CHP as part of an expansion. An expansion project, which requires new construction, provides an opportunity to seamlessly design and install the required district heat/power system elements such as heat exchangers. In retrofit situations, district solutions often do not pencil out because they require facility owners to abandon or sub-optimize existing energy generating assets. Finally, as mentioned previously, either a public entity or a commercial business with a strong sustainability ethic is seen as most likely to adopt biomass heating. Given the low price of natural gas it is unlikely that any other business types with access to natural gas would consider district heating or CHP in the current economic environment.

8.5.2 System Size

For each different scenario, various system sizes must be modeled in order to understand design requirements, operational ranges, energy balances, and peak performance. The energy balance models need to match with the seasonal heat and electric loads at the site.

8.5.3 Plant Siting

When deciding on a location for a district system, a number of critical decision factors must be considered. These factors may include environmental factors such as proximity to water bodies and sensitive areas or typical wind directions (dispersion of air emissions). They may also include social factors such as proximity to existing businesses and residences. Locating the plant close to the buildings will be important in terms of keeping costs down. Piping

and/or electrical connections between facilities can be a large portion of the overall project budget.

8.5.4 Biomass Fuel Availability & Project Requirements

As with any biomass project, there needs to be a strong assurance that there is sufficient fuel available to meet the project's needs, both in terms of quantity and cost. A resource analysis and an in-depth look at biomass procurement costs are required.

8.5.5 Project Capital Costs

Capital costs are incurred from many project components including biomass harvesting, site development, building construction, biomass combustion technology, heat conveyance and utilization equipment, power generation and distribution equipment.

8.5.6 Project Operation and Maintenance Costs

Operation and maintenance costs include labor for system operations, fuel usage for biomass handling equipment, and expected equipment maintenance. Parasitic electric load costs (electricity used to operate system) should also be considered. Since parasitic electric loads for CHP systems are met by the power generated onsite, parasitic electric loads for CHP scenarios are often incorporated into system efficiencies and are not explicitly included in O&M costs. In many cases, the majority of the total O&M costs are labor costs associated with operation and maintenance of the combustion system and/or turbine generator.

8.5.7 Energy Cost Savings

The economic evaluation should estimate the cost savings from offsetting current heating/power sources with biomass combustion (heat and/or power). Depending on project specifics, the heat and/or power generated by the project could be utilized at one or more facilities with different energy costs or billing rates. For each scenario, current (baseline) energy usage and costs for the applicable buildings are compared with usage and costs for each biomass utilization option to determine estimated cost savings.

8.5.8 Additional Revenue Streams

Other revenue streams for the project may include sale of excess electricity (for CHP) and Renewable Energy Certificates (RECs).

8.5.9 Project Funding and Financing

A variety of funding and financing opportunities are available for biomass projects. The eligibility of each opportunity depends on project type, size, and ownership. Opportunities include grants to offset capital costs, low-interest loan, or tax credits. The payback analysis should make explicit assumptions on costs and revenues. In addition, it is important to conduct a sensitivity analysis to look at project performance under different project energy pricing scenarios.

8.6 Recommendations on the Feasibility of Large Business and Small District Heating/CHP Systems

Given the low price of natural gas, and in the absence of supportive biomass heating policies, it is unlikely that large business and/or small district heating/CHP projects will be economically viable at this time. To promote large business and small district heating/CHP projects the focus should be on targeting and educating the owners and managers of those facilities prone to convert to biomass heating. An educational campaign focused on raising awareness of biomass heating coupled with access to resources to assist with project

development should be considered the top priority. As conditions change (rising energy prices, more supportive policy environment) the potential for developing large business and small district heating/CHP systems will increase. See Appendices (www.mrrpc.com) for a preliminary list of public and private facilities described below.

8.6.1 Facilities prone to convert to biomass heating

Households and businesses with the greatest potential for conversion to wood heating include those currently relying on fuel oil, electricity, and propane for their space heating needs.

A recent study conducted on behalf of the Southwest Badger RC&D²⁷ attempted to identify businesses within the region interested in converting to biomass heating. In the study, 9 of the 55 businesses contacted expressed interest in talking with someone about using renewable to provide heat/and or power to their facility.

The types of businesses most likely to consider wood heating include those built around a strong sustainability ethic, public facilities such as schools and municipal buildings, State and Federal facilities, food manufacturing, and wood processing facilities. Those businesses with boilers in need of replacement or considering expansion to their existing facilities may be more likely to consider switching primary fuel sources.

8.6.2 Businesses built around a strong ethic of sustainability

Businesses such as Organic Valley or Gundersen-Lutheran have defined their image in terms of their commitment to a more sustainable future. These businesses have built a strong brand around sustainability and are therefore inclined to consider renewable energy, including biomass for their facilities. Gundersen-Lutheran's biomass boiler system is a good example. Other hospitals in the region may be good biomass candidates as well.

8.6.3 Public facilities

Public facilities such as schools, municipal buildings, libraries, and highway shops may be good candidates for biomass heating conversion, especially if it can be shown to support the local economy and benefit taxpayers. The Barron Area School District is a good example of a public entity that utilizes wood heating and cooling and has saved taxpayer dollars.

8.6.4 State and federal facilities

State and federal facilities may also be good candidates, especially those subject to mandates requiring energy efficiency and/or renewable energy targets be met. Fort McCoy, for example, may be a good candidate for conversion at some point.

8.6.5 Food manufacturing and ag-related businesses.

Many value-added food processors and agricultural producers have installed renewable energy systems at their facilities throughout the state, including Muscoda Protein Products and Meister Cheese, located near the study area.

8.6.6 Wood Processors

Wood processors often use wood heating for process heat. Larger processors with adequate fuel supply may be good candidates for fuel conversion.

²⁷ Southwest Badger RC&D, author William A. Johnson, Biomass Consulting Services. January 18th, 2012. Southwest Wisconsin Boiler Study

9.0 Wood Product and Solid Biofuel Business Opportunities

New business opportunities for entrepreneurs to enter the wood and forest products and solid biofuels industry are summarized into long-term and short-term possibilities in this section of the report. It should be noted that several of these possibilities could be achieved in either short-term or long-term depending on market conditions.

9.1 Long-term Possibilities

9.1.1 Nanocrystalline

Nanocrystalline cellulose is being touted as a game-changer for the forest industry. Unfortunately, no one can predict when this product will be ready for commercial production. The process to make it is well understood. Some very unique and high value products can be made from it. The current state of the research does not show which product can be profitable. It will take time for companies to try making different products, such as car parts, and to develop these processes so they are profitable. When this happens, this product should take off in a dramatic way. This could happen tomorrow or in 20 years.

Using a simplified description and categorization, there are two basic types of technologies under development – “pressure cooker” and “sulfuric acid” based processes. The processes are much more complex, but for the discussion in this report the simplified description will be used.

The acid procedure requires a large capital investment and is very similar to the production of dissolving pulp which is used to produce rayon and has been in production since the 1940s. A mill in Minnesota is currently being converted to a dissolving pulp process. This is the process that the USDA FS Forest Product Laboratory is using in its small pilot plant in Madison, WI. Domtar has built a larger pilot plant in Windsor, Canada that can produce several tons per day. The Domtar plant is part of a consortium that will allow the members to have access to the material to use for the development of new products and uses for the nanocrystalline cellulose. This is also the intent of the smaller pilot plant in Madison, WI at the Forest Products Laboratory, but the production from this plant is pounds.

The pressure cooker type product has, for the most part, been limited to laboratory scale. This appears to lend itself more toward lower capital and smaller scale plants. The fiber is broken down to the nanocrystals using pressure, producing fibers that have somewhat different characteristics than the acid based crystals.

9.1.1.1.1 Potential products

- There is potential to produce car parts such as body panels, structural frame, and dash parts from a renewable resource.
- Fiberglass replacements for car parts and boats that could be lighter and stronger. Fiberglass cannot be made transparent, while nanocrystals can be transparent. This could create some interesting applications.
- One of the interesting properties of nanocrystals is the ability to conduct electricity. There is a potential for products such as sensors, active papers, flexible batteries, and electronics on wood/paper.
- The strength of the material may create opportunities for composite panels, paper and board products, airplane parts, and bullet proof glass.

9.1.1.1.2 *Time frame*

The researcher who was interviewed felt that he knew how to produce the particles. Now products from it need to be developed, along with a better awareness of the properties of nanocrystalline cellulose. The general consensus is that a significant market for this product is 10 years away. Some feel that car parts could create a market in as soon as two years. At a meeting at the Forest Products Lab in Madison, an executive from Lockheed Martin called this a game changer for the industry, with significant potential in the production of airplanes.

9.1.2 **Advanced liquid biofuels**

While beyond the scope of this study, efforts should be made to monitor the status of commercial development of liquid biofuels using woody biomass as a feedstock. While efforts to create liquid biofuels using woody biomass to date have not been commercially successful, technology advances may open new opportunities within the Kickapoo Valley.

9.2 **Short-term Possibilities**

9.2.1 **Work with new DNR Specialists to build on existing wood product markets**

This is the area with the most opportunity. Historically, this has been where increased production is easiest to promote by assisting what you have to grow. The Wisconsin DNR Division of Forestry is currently recruiting four Forest Products specialists consisting of three regional positions and one statewide position. It is anticipated that one of the regional positions will be assigned to southwest Wisconsin. These positions will identify the industry in their regions and look for opportunities to help firms grow. With this effort on the horizon, it would be advantageous for the local economic development staff to be prepared to work with these individuals, in order to take advantage of this effort and the technical expertise to be provided.

9.2.2 **Development of other solid-wood markets (Thermally modified wood, cabin logs, utility poles, etc.)**

Thermally modified wood is a product that is gaining market share in Europe and India. It can open markets for lower value wood species. European Beech has been made a higher value product in India by thermally modifying it, making it appear more like Teak. Work is being done at the Natural Resources Research Institute (NRRI) in Duluth, MN to address the high cost of the installation of thermally-wood treating chambers. This has been reviewed by several large sawmills, but they have not gone forward due to the cost of the installation.

Cabin logs and utility poles are currently being harvested in southwest Wisconsin. Companies that need these products are actively looking for them. Actions can be taken to assist the two markets by gathering the specifications of the products and putting them together with the companies that are searching for them. The information could then be provided to the foresters and landowners in the area.

9.2.3 **Consideration of Emerald Ash Borer (EAB) and other major tree mortalities**

Utilization of trees killed by noxious or invasive species/weather events depends on whether the trees are still alive or dead, and, if dead, for how long and how extensive is decay/rot. Living trees and even trees recently killed can be utilized for any of the traditional products that uninfected merchantable timber can be used for. One of the biggest concerns are quarantines that are in effect for transporting the products to market, which can be a major issue in utilization. Trees that have died that are no longer useful for traditional uses (i.e. sawlogs, pulpwood, etc.), may have the highest value as round firewood, chipped up to be utilized as fuel directly, or converted into wood pellets. Utilization of this material is also

very dependent upon the volumes available in any specific geographic area. For instance, if there were ten infected trees, utilization would in most cases be very difficult.

As proven in Lower Michigan when EAB infestations were running rampant, in many areas sawlog size trees were being utilized for both lumber and railroad ties. A key part of utilizing this material is identifying mills that have a market for that particular species. In the case of EAB, it would be ash. Developing value-added products that utilize ash lumber will help establish a stable market to utilize ash trees that are infected or threatened by EAB. Examples of value-added products that utilize ash are baseball bats, tool handles, snowshoe frames, skis and hockey sticks.

9.2.4 Growth in demand for wood chips

Additional commercial scale wood heating projects could stimulate demand for wood chips in the region.

9.2.5 Small scale pellet plant

The most practical/economic approach to wood pellet production in the Kickapoo project area is producing pellets from residue created from an existing forest industry company(ies). There are two ways to accomplish this goal.

The first approach would be to incorporate a 6,000 to 10,000 ton/year wood pellet plant with an existing residue producer. Ideally, the residue would come from a secondary manufacturer where the residue was produced from dried lumber and the residue would have less than a 10% moisture content. This would eliminate the need for a dryer and would greatly simplify the process. If the residue has a higher moisture content, a dryer will be needed and potentially other processing equipment, depending on the size of the residue (slabs versus sawdust). Regardless, if the residue is dry or green, a major advantage to this scenario is that the residue would be processed on site and would eliminate the expense of storing, loading, and transporting the residue off site.

The second approach would have a separate entity collecting residue from a number of sources to produce wood pellets. Some of the same issues arise as are found in the first approach. This entity could be structured to utilize only dry residue, or it could accept green residue which would require more processing. This scenario would require more monitoring (quality control of raw material, species, moisture content, etc.), and also would add the cost of transporting the raw material to the pellet plant.

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10.0 Strategic Recommendations

10.1 Background

Forestry is recognized as a critical segment of the Kickapoo Valley economy. Several past studies and public input also emphasize the need to promote value added wood product opportunities; promote retail sales of locally produced goods identified; and provide folk art/rural life skills school.²⁸ Interviews with stakeholders and an analysis of residential wood heating opportunities suggest biomass heating could also play a stronger role in the local economy.

Today's economy is generating more opportunities for small businesses and self-employed individuals. Creativity, innovation, and imagination are increasingly seen as critical success factors for small business. Local, authentic, and unique products and services are also being rewarded in the market place. These trends create opportunities for diversifying wood product manufacturing in the Kickapoo Valley. The Kickapoo Valley has four key assets to help grow the wood product industry and support biomass development – regional organizations and institutions, forests, established forest product industries, and creative individuals and entrepreneurs.. Leveraging these assets to support industry growth will require a coordinated and sustained effort among local, regional, and state community, economic development, and forestry specialists.

10.2 Challenges

10.2.1 Sustainability

Despite their positive attributes, biomass compares less favorably to renewable technologies such as solar and wind when it comes to direct emissions. Effective maintenance and pollution control equipment are necessary in order to meet air emission standards. Similarly, biomass feedstock must be grown and harvested in a sustainable manner in order for bioenergy to be considered renewable, and to avoid negative environmental impacts such as erosion, loss of species biodiversity, negative water quality impacts, soil compaction, negative community impacts and other impacts.²⁹ All of these aspects of sustainability must be fully addressed in order to grow a successful solid wood biofuel industry in the region.

Sustainability is also a critical challenge facing the traditional wood product industry. This is especially the case in the Kickapoo Valley, characterized by very steep slopes which make harvesting difficult.

10.3 Strategic recommendations

10.3.1 Investigate the potential of traditional pulpwood

Investigate the potential of traditional pulpwood, which would include eight-foot sticks down to four inches in diameter on the small end of the log. Due to the increased manual labor in removing pulpwood, in conjunction with the traditional chainsaw felling crews in the Kickapoo Valley and their unfamiliarity with harvesting pulpwood, almost all pulpwood removals would have to come from an increase in mechanized harvesting system use.

Since the Wisconsin DNR is requiring sustainable harvests of pulpwood from Managed Forest Lands (MFL), these properties would be the most opportune locations to initiate mechanized pulpwood removal. To accomplish this, recruiting logging contractors that

²⁸ Kickapoo Conversation Vision 2020,” Valley Stewardship Network, July 2003

²⁹ See Wisconsin’s Forestland Woody Biomass Harvesting Guidelines available at: <http://council.wisconsinforestry.org/biomass/pdf/BHG-FinalizedGuidelines12-16-08.pdf>

already utilize mechanized harvesting systems to either move crews to or establish crews within the Kickapoo Valley area would make the most sense to increase pulpwood production in this area. Both mechanized logging contractors and pulpmills need to be part of the discussion.

For products other than pulpwood (i.e. biomass fuel chips, mulch, etc.), both traditional pulpwood-size material and the tops could be used, but two things need to occur to make this feasible. First, markets would have to be identified to provide a strong enough economic return to justify these operations (new wood boilers in the Kickapoo Valley area, fuel chip/mulch markets just outside of the area). Secondly, a logger with the equipment necessary to produce these types of materials would have to be established within the area or recruited to come in.

The potential of utilizing the mobile cable logging system should be discussed with mills, foresters, and loggers in the area to determine if there is potential for year-round use of such a system.

10.3.2 Identify and educate commercial facilities with potential for wood heat conversion

The efforts should focus on those facilities that are currently using propane, oil, or electricity and have a year-round load requirement (hot water, process heat, or cooling). Development of a fuel supply should proceed as demand dictates. Utilizing existing mill residues that do not have a higher end use (such as bark) should be a priority. Identifying logging residue sources will also become critical if the demand for solid biofuel increases. Lambert Forest Products has tremendous production capacity for biomass fuel and is located within the Kickapoo project area.

10.3.3 Support wood energy opportunities at Fort McCoy

The federal government recently awarded 13 biomass Multiple Order Contracts through the U.S. Army Corps of Engineers. This award signifies the federal government's long-term commitment to renewable energy deployment including biomass. The award allows the Army or Department of Defense to purchase power from contractors who own, operate, or maintain generating assets. Up to \$7 billion in power purchase agreements will be entered into over a 30-year term, including power from biomass, solar, wind, and geothermal. Fort McCoy has already had a wood energy assessment study conducted by USFS contract engineers identifying the facilities on base that have the highest potential for utilizing wood boilers. Because of Fort McCoy's proximity to the study area and a resource of locally available biomass feedstock, efforts should be made to engage with, and monitor the status of biomass projects at Fort McCoy.

10.3.4 Support commercial biomass heating and/or CHP at Organic Valley's Cashton Facility

Organic Valley has expressed interest in potentially incorporating biomass into its future expansion plans in Cashton. Efforts should be made to support the project if it moves forward. If implemented, the project could serve as an example for other industry in the Kickapoo Valley to follow.

10.3.5 Develop an outreach program to encourage residential adoption of pellet stoves

Work with any wood pellet plants that are built in the region to develop an education program targeted at rural homeowners and farmers currently reliant on expensive fossil fuels for heating to encourage conversion to wood pellet stoves. Organic Valley's Fuel Your Farm program is designed to promote sustainable on-farm biofuel production. It could serve as a

model for development of a similar program targeted at rural residential homeowners and farmers with high potential for converting to wood pellet heating.

In New Hampshire, the Model Neighborhood Project³⁰ aims to facilitate fuel switching from fuel oil to wood pellets. A similar approach could be taken in the Kickapoo Valley in order to foster the growth of a new small scale pellet plant.

10.3.6 Support efforts to provide residential biomass heating through the State’s Department of Administration Low Income Heating Assistance Program

The State recently completed a pilot program in northwest Wisconsin to provide wood pellet heating to low income, qualified households through the Low Income Heating Assistance Program. It is anticipated the program will cut household energy costs by half. A regional partnership between agencies such as Coulee CAP and DOA could facilitate a similar program in the Kickapoo Valley because of the high concentration of low and moderate income households using higher priced fossil fuels such as propane, fuel oil and electricity. Individual counties could potentially also contribute to such a program through investment of a portion of their Wisconsin Home Energy Assistance Program (WHEAP) program funding.

10.3.7 Involve local wood boiler/stove installation contractors in future biomass planning

A local knowledgeable installer of all sizes of wood/pellet appliances would greatly assist in expanding the use of wood pellets. Wholesale and retail pellet suppliers should also be involved in future biomass expansion efforts.

10.3.8 Identify “lost” secondary wood product industries which could be ripe for a return to U.S.-based production and prone to locate in the Kickapoo Valley

With increased automation, rising labor costs overseas, quality concerns, and shipping costs, there are growing opportunities to recapture wood product industries which have been exported overseas over the past several decades. One example of such an industry is school furniture. A market study to determine the economic potential and required levels of investment should be undertaken to help identify and prioritize which of these markets could be economically viable in the Kickapoo Valley.

10.3.9 Encourage a cluster-based wood product economic development strategy

There currently exists a cluster of private companies which contribute to the wood products industry in the Kickapoo Valley. The Wisconsin DNR is in the process of hiring three district forest products specialists to support the State’s forest product industries. Upon completion of this report and the DNR’s hiring of new staff, there is an opportunity to develop a targeted, cluster-based economic development strategy focused on working with existing wood product industries in the region. Such a strategy would include bringing companies together, identifying and facilitating joint ventures when feasible, proactively addressing workforce development issues, identifying growth markets, seeking transportation efficiencies, and sharing innovative approaches.

Staff may be able to assist with networking, sharing of best practices, identification of joint marketing opportunities, funding awareness, technical assistance, and communication with DNR and other wood product stakeholders.

³⁰ <http://biomassmagazine.com/articles/9778/getting-green-heat-to-main-street>

10.3.10 Identify local, statewide, and regional markets for manufactured wood products.

Institutional furniture produced at cheaper prices overseas is also getting a reputation for low quality. Identifying potential markets for furniture, shelving, etc., such as federal contracts (Fort McCoy and Camp Douglas), schools (college to elementary), libraries, hospitals, nursing homes, public facilities and matching them up with local manufacturers could provide tremendous benefits for both the supply and demand sectors.

10.3.11 Spotlight and educate on regional commercial biomass heating opportunities

There are a number of commercial entities within the study region that may be good candidates for biomass heating. A key priority should be providing education on what types of biomass heating opportunities exist. Educational institutions, nursing homes, hospitals, government facilities, and military facilities should be targeted for education and outreach. Successful projects, such as Gunderson-Lutheran's new biomass heating project in Onalaska, WI, should be highlighted. Study tours can be an effective mechanism to increase awareness of how biomass heating is being successfully implemented around the region.

Northwest Wisconsin, where heating with wood is a common form of bioenergy, could be an excellent destination for regional study tours. Several schools, health facilities, and other community facilities use woody biomass boilers for heating across the region, including the Rice Lake School District, Barron Area School District, Glidden High School, Hayward Middle and High Schools, Lake Holcombe High School, Park Falls High School, and Shell Lake High School. In addition, businesses and community facilities including Memorial Hospital in Ashland utilize woody biomass for heating purposes.

Local educational institutions could play a role raising awareness of potential for biomass heating. For example, in prior studies³¹ it has been recommended that students of the La Farge School District could participate in creating a business plan for a biomass heating project. The area's technical colleges and University of Wisconsin Campuses (La Crosse, Richland Center) could also develop curricula or conduct applied research related to the interaction of biomass heating opportunities and other land uses with the social and environmental contexts of the region.

10.3.12 Identify a location and pursue development of a pilot commercial biomass heating project in the study region

A public facility such as a hospital, nursing home, school, library, or the Kickapoo Valley Reserve would make an excellent host for a commercial scale biomass heating project designed to showcase biomass heating potential to local residents and businesses. A first step toward realizing such a project could involve organizing a tour to visit one of the successful biomass projects profiled in this report.

10.3.13 Support local crafts persons and artisans and encourage them to utilize locally available wood products

Crafts persons and artisans enhance the region's attractiveness as a tourist destination. They help "brand" the region as creative and innovative. Yet the findings show that they are not fully involved with local development organizations³². They are often overlooked when it comes to business assistance, yet they may constitute a prime investment area for community economic development.

³¹ See "Around the Bend: Comprehensive Planning and Land Use in the Kickapoo Watershed", Master's Thesis, UW-Madison, Christopher Stillion (2011).

³² See "Craftspersons and Artists in Northwest Wisconsin: Putting a Face on a Creative Industry" (2006).

While the Kickapoo Valley has a strong tradition of wood product manufacturing, the region also likely has a large number of crafts persons and artisans. In addition, it is constantly attracting outsiders due to its scenery and quality of life. A portion of these individuals may have an interest in starting new careers related to the wood product industry. Efforts should be made to link existing crafts persons and artisans as well as new arrivals into the region with training, skills programs, and marketing assistance that can help them pursue careers and business start-ups that support local wood product manufacturing. This strategy could tie into other economic development efforts, including eco-tourism and heritage tourism, aimed at integrating and showcasing distinctive local skills and traditions.

10.3.14 Support regional studio spaces and other retail outlets for craftsmen to showcase and sell wood products

Work with local economic development staff and craftsmen to identify high profile retail opportunities, or work with existing businesses to expand the items they offer for sale.

10.3.15 Work with companies interested in developing a small-scale (less than 10,000-ton), dry residue wood pellet plant

The region's existing wood processors provide an opportunity to develop a small scale wood pellet plant. Economic development officials should facilitate successful project development by ensuring that developers have access to technical and financial resources including all available funding opportunities.

Utilizing dry residue at the source is the most cost effective way to produce pellets. One company that produces 7,000 tons per year has already shown an interest. Assisting a small local plant to establish a customer base and to educate homeowners on wood pellet usage would be a tremendous aid to the success of such a plant. Roughly 250 homes could be heated annually per 1,000 tons of pellets.

There is a thriving niche market for BBQ pellets, which could be taken advantage of by utilizing sawdust from species such as hickory and cherry that could provide further stability to a small pellet plant.

A larger scale plant (60,000+ tons) utilizing forest material is dependent on pellet demand increasing regionally and nationally. Pellet trends should be monitored to identify when this opportunity might arise.

10.3.16 Capture value-added opportunities associated with consumer preferences for locally-sourced and locally-crafted residential housing

The Kickapoo Valley is a destination location for empty-nesters and retirees. This market segment is looking for green building construction that utilizes locally sourced and locally crafted wood products³³. Additional interviews and market research should identify specific gaps in the market place for these types of materials and services. Economic development professionals and DNR forest product specialists should work with the industry to better understand how to respond to this market opportunity.

10.3.17 Develop additional joint direct marketing opportunities for wood products

Local craftsmen/woodworkers could jointly market products on a website, at events, co-op market places, etc. Joint marketing efforts could be targeted not only to small producers but to traditional industries such as furniture manufacturing, which could also benefit from

³³ Personal Communication, Emile Smith, Sebastian's Specialty Hardwoods, Inc., October 9th, 2013.

coordinated marketing. See <http://www.truenorthwoods.com/home.ashx> for an online example of joint marketing.

10.3.18 Identify companies that may be interested in expanding into Thermally Modified Wood

Thermally modifying lower value wood such as ash and basswood could potentially open up new markets for these species. The Natural Resources Research Institute in Duluth, MN has been working with this process and is interested in identifying companies that would be interested in pursuing this treatment process.

10.3.19 Primary industry expansion – Bolt Mill

This part of the state is historically known for not utilizing trees below a certain top diameter (10-14 inches depending on the specific sawmill), while other parts of the state have mills that thrive on that diameter of material and smaller for their main source of raw material. Working with local sawmills to see who might have an interest in adding this type of mill or in identifying a bolt mill from elsewhere to expand into this area could improve utilization of the trees that are harvested and have a significant economic impact.

10.3.20 Identify export market opportunities for value-added wood products

There is growing interest in markets throughout the world for hardwood lumber and value-added products from the Lake States region. There are various forms of assistance at both the state and federal levels to assist companies in getting into these markets. Bringing interested companies and these agency specialists together could be a function of local economic development staff through one-on-one meetings or by sponsoring seminars/workshops.

10.3.21 Develop partnerships to fund pilot projects and support local entrepreneurship

The Board of Commissioners of Public Lands (BCPL) operates one of the largest public lending programs in the state. The BCPL State Trust Fund Loan Program finances community and school projects, including energy projects, across Wisconsin. More than 96% of the interest paid on these loans is returned to Wisconsin communities in the form of aid to public school libraries. This program could be a good financing option for local governments and school districts to fund solid biomass conversion projects or to help fund a pellet or chip plant.

10.3.22 Support energy policies that support biomass energy

Encouraging the growth of renewable energy is often dependent on supportive state and federal policies. Unfortunately, biomass thermal energy has not benefited to the same extent as other technologies in this regard. The Biomass Thermal Utilization (BTU) Act of 2013 (S. 1007, H.R. 2715) is a piece of federal legislation sponsored by a number of organizations.

The BTU Act adds high efficiency biomass thermal technologies to the list of renewable energy technologies that currently benefit from investment tax credits under section 25D (residential) and Section 48 (commercial/industrial) of the tax code. This investment credit currently applies to solar thermal and geothermal technologies, but not to biomass thermal. The BTU Act corrects this oversight. The BTU Act only qualifies the most efficient and advanced technologies for the credit. Investment credits are needed for advanced biomass thermal technologies because of their comparatively high up front capital cost. This “capital hurdle” must be overcome to build the market and gain economies of scale that will bring system costs down. Similar policy has been very effective in reducing the cost of solar (PV and thermal) and geothermal technologies.

Another critical policy challenge for biofuels is biomass' lack of parity with the fossil fuel industry when it comes to financing structures. Biomass advocates are pushing to make biomass and other renewables eligible for Master Limited Partnership (MLP) tax status – an investment vehicle that has allowed carbon-based energy companies to raise billions of dollars of efficient, low-cost capital from a broad array of investors over the past several decades.

An MLP is a “publicly traded partnership” that holds energy or other specified assets. MLPs are traded on public stock exchanges so that small and institutional investors can buy and sell them at any time. Similar to how mutual funds allow investors to make small investments in diversified stock portfolios, MLPs allow investors to take direct stakes in energy projects. MLPs have helped build much of our modern oil and gas infrastructure, most recently fueling the shale revolution in oil and gas. In 2012 alone, MLPs raised over \$23 billion of new capital for eligible projects. Supplementing dozens of other tax incentives along various stages of the oil, gas, and coal energy supply chains, MLPs have provided a stable and efficient source of capital, but only to the energy sectors that are currently eligible.

The same approach could work for renewable energy technologies. The federal investment tax credit (ITC) and production tax credit (PTC) have been essential to spurring private sector investment, creating jobs, and driving down costs significantly, to the point where some renewable technologies are approaching cost competitiveness. Still, renewable energy markets, like other economic sectors, have been hampered by capital constraints in the aftermath of the U.S. financial crisis. All energy industries require private capital to fund projects; recent financial market volatility has illustrated the value of capital supply afforded by the MLP structure.

10.3.23 Encourage enrollment in MFL program

Work with DNR, Kickapoo Woods Cooperative, and other interested entities to conduct workshops, write articles, and engage in other information sharing regarding the Managed Forest Law program. With the goal being to encourage more participation in this program, which will in turn make more forest products available for forest industry companies.

10.3.24 Demonstrate various mechanized harvesting systems and encourage their use on appropriate landscapes

Work with the Great Lakes Timber Professionals Association, their members and equipment dealers, to demonstrate the use of mechanized logging equipment in a variety of situation. Target audience would be landowners, mills, foresters, and other interested parties.

10.3.25 Monitor pellet markets/demand - if demand and prices warrant it, pursue development of a larger scale (60,000 – 100,000-ton) pellet plant

Track trends in the wood pellet market and determine if and when it would make sense to pursue the development of a business plan for a larger scale (60,000 – 100,000 tons) pellet plant. One indicator of this would be the other pellet plants in Wisconsin operating at capacity. Another indicator would be wholesale pellet prices approaching \$200/ton.

10.3.26 Monitor and prepare for EAB

Work with DNR forestry and DATCP to monitor the spread of Emerald Ash Borer, and identify where/when substantive volumes of Ash need to be harvested to assist in the identification of buyers/markets of Ash. When these have been identified, work to bring the Ash supply together with the demand markets that can utilize it.

Table 29
Summary List of Recommendations

Objective #	Description	Type of Opportunity Wood Energy (Wood) Primary Forest Industry (Primary) Secondary Forest Industry (Secondary)	Timeframe (Short-term, Long-term)
1	Investigate the potential of traditional pulpwood	Primary	Short
2	Identify and educate commercial facilities with potential for wood heat conversion	Wood	Long
3	Support wood energy opportunities at Fort McCoy	Wood	Short, Long
4	Support commercial biomass heating and/or CHP at Organic Valley's Cashton Facility	Wood	Short
5	Develop an outreach program to encourage residential adoption of pellet stoves	Wood	Short
6	Support efforts to provide residential biomass heating through the State's Department of Administration Low Income Heating Assistance Program	Wood	Short
7	Involve local wood boiler/stove installation contractors in future biomass planning	Wood	Short
8	Identify "lost" secondary wood product industries which could be ripe for a return to U.S.-based production and prone to locate in the Kickapoo Valley	Secondary	Short, Long
9	Encourage a cluster-based wood product economic development strategy	Primary, Secondary	Short, Long
10	Identify local, statewide, and regional markets for manufactured wood products	Secondary	Short
11	Spotlight and educate on regional commercial biomass heating opportunities	Wood	Short
12	Identify a location and pursue development of a pilot commercial biomass heating project in the study region	Wood	Long
13	Support local crafts persons and artists and encourage them to utilize locally available wood products	Secondary	Short
14	Support regional studio spaces and other retail outlets for craftsmen to showcase and sell wood products	Secondary	Short, Long
15	Work with companies interested in developing a small scale, dry residue wood pellet plant	Wood	Short
16	Capture value-added opportunities associated with consumer preferences for locally-sourced and locally-crafted residential housing	Secondary	Short
17	Develop additional Joint Direct Marketing opportunities for wood products	Secondary	Short, Long

Table 29
Summary List of Recommendations

Objective #	Description	Type of Opportunity Wood Energy (Wood) Primary Forest Industry (Primary) Secondary Forest Industry (Secondary)	Timeframe (Short-term, Long-term)
18	Identify companies that may be interested in expanding into Thermally Modified Wood	Secondary	Long
19	Primary Industry Expansion – Bolt Mill	Primary	Short, Long
20	Identify Value-Added Wood Products Export Market Opportunities	Primary, Secondary	Short, Long
21	Develop partnerships to fund pilot projects and support local entrepreneurship	Wood, Primary, Secondary	Long
22	Support energy policies that support biomass energy	Wood	Short, Long
23	Encourage enrollment in MFL program	Wood, Primary, Secondary	Short, Long
24	Demonstrate various mechanized harvesting systems and encourage their use on appropriate landscapes	Wood, Primary	Short, Long
25	Monitor pellet markets/demand - if demand and prices warrant it, pursue development of a larger scale (60,000 – 100,000-ton) pellet plant	Wood	Long
26	Monitor and prepare for EAB	Wood	Short

10.4 Implementation Roles

10.4.1 Implementation Framework

The table below summarizes implementation roles by recommendation.

Table 30
Summary Matrix of Recommended Implementation Roles

Recommendation	Local/ Regional EDC	Agency Forestry Specialists (UWEX, DNR, FPL)	Regional Orgs. (MRRPC, SWWRPC SWBRCD)	Associations (GLTPA, LSLA, KWC)
1	X	X	X	X
2	X	X	X	
3		X		
4	X	X		
5			X	
6	X		X	
7	X			
8	X	X		X
9	X	X	X	X
10	X	X	X	
11	X	X	X	X
12	X	X	X	X
13	X	X		X
14	X	X	X	
15	X			
16	X	X		
17	X	X		
18	X	X		
19	X	X		X
20	X	X	X	X
21	X	X	X	X
22	X	X	X	X
23		X	X	X
24		X	X	X
25	X	X	X	X
26	X	X		

Local/Regional EDO	Municipal/County/Regional Economic Development Organizations
SWBRDC	Southwest Badger RC&D
MRRPC	Mississippi River Regional Planning Commission
SWWRPC	Southwest Wisconsin Regional Planning Commission
UWEX	UW-Extension State Specialists, County Staff/Faculty, Basin Educators
DNR	Wisconsin Department of Natural Resources
FPL	US Forest Products Lab, Madison, WI
GLTPA	Great Lakes Timber Professionals Association
LSLA	Lake States Lumber Association
KWC	Kickapoo Woods Cooperative

Appendix A

Primary and Secondary Wood Processors in Region

Appendix B

Summary Report – Kickapoo Valley Solid Biofuel and Wood Product Market Survey

Appendix C

US Pellet Plants

Appendix D

Possible Sources of Wood Residue

Appendix E

Wisconsin State Incentives

Appendix F

PFI Pellet Stove Fact Sheet

Appendix G

Forest Products Services Specialists Job Description

Appendix H

Heating the Midwest – A Midwest Vision for 2025

Appendix I

2013 EPA List of Certified Wood Stoves

Appendix J

BTEC Residential Heating Fact Sheet

Appendix K

Potential Woody Biomass Sources

Appendix L

Preliminary List of Public and Private Facilities for Biomass Heating

Appendix M

BTU Act Packet



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