


Kickapoo Valley Solid Biofuel and Wood Product Feasibility Study

SPONSORED BY:
MISSISSIPPI RIVER REGIONAL PLANNING COMMISSION
VILLAGE OF LA FARGE, WISCONSIN

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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, Frankin, 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 "Saudia 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.

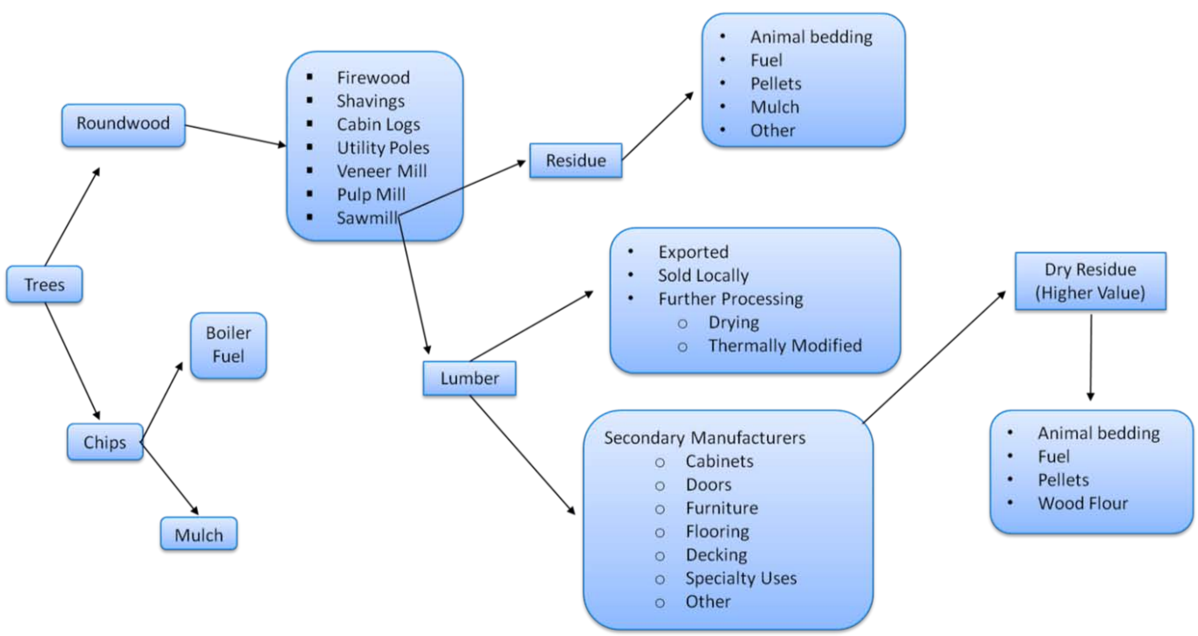


Figure 2 – Kickapoo Valley Forest Industry Product Flow

[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 bought 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.

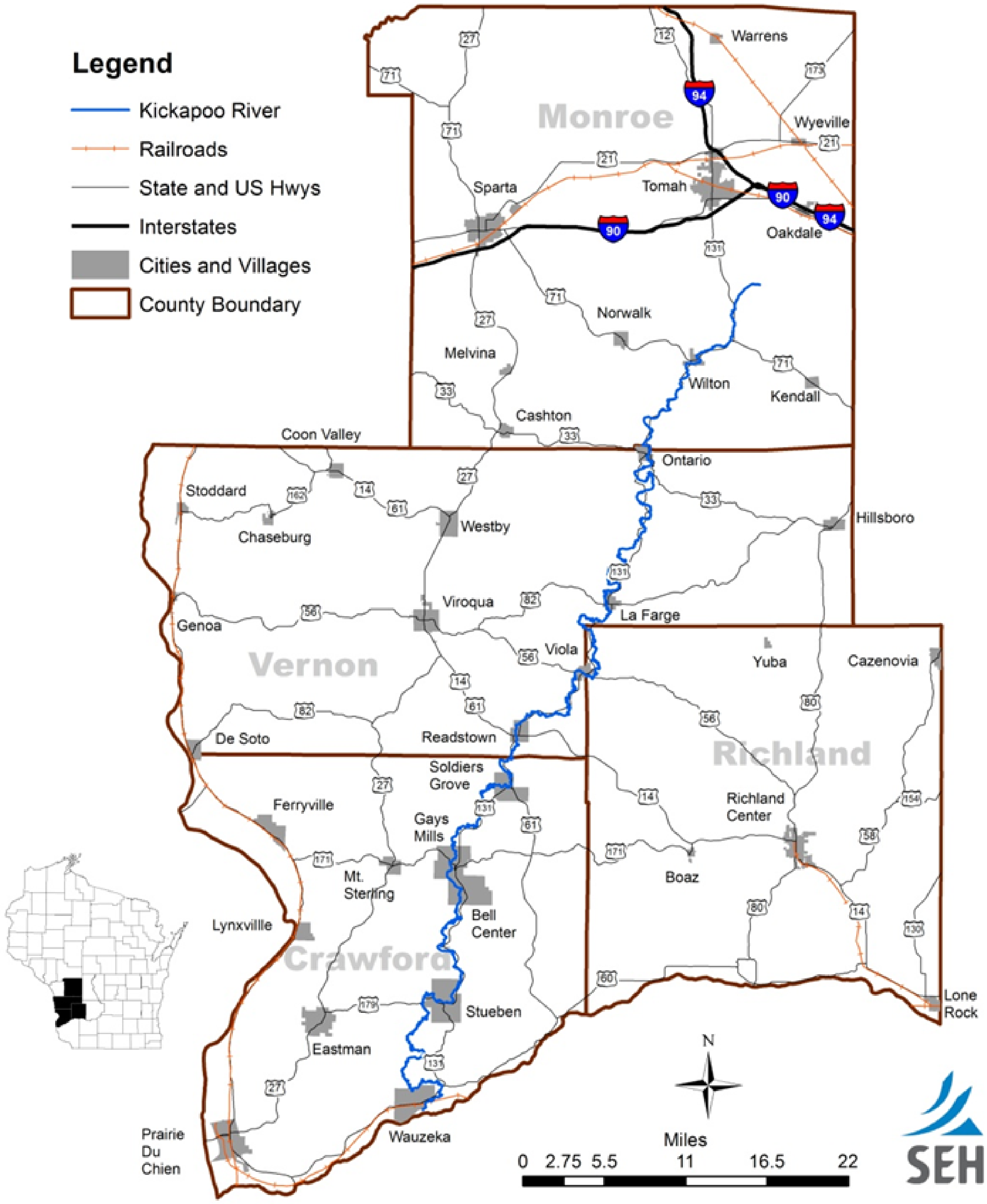


Figure 3 – Kickapoo Valley Study Area

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, barbeque pellets, and animal bedding.

<u>Wood Pellet Production and Increased Household Consumption in the Region Would Have Significant Economic Impacts</u>

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.

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

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.

<u>A Regional Survey Showed There are Environmental Concerns</u>

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 CO_2 emissions compared with burning fossil fuels.

<u>The Kickapoo Valley Region has Lower Incomes and Higher Energy Costs</u>

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, CO_2 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 proposal[8] 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.

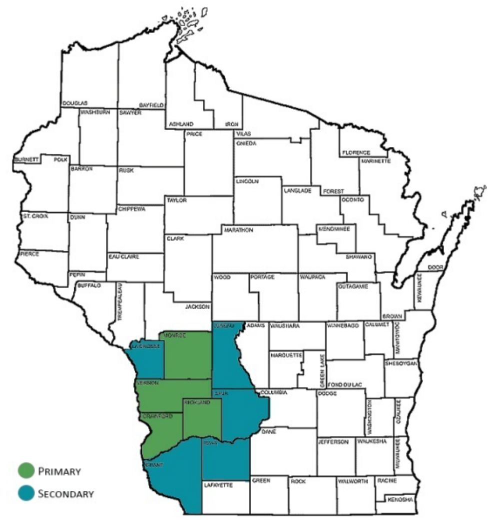
8 http://www2.epa.gov/sites/production/files/2014-01/documents/proposedrule.pdf

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
▪ Crawford County	▪ Grant County
▪ Monroe County	▪ Iowa County
▪ Richland County	▪ Juneau County
▪ Vernon 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 Federal	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 areas[9].

Table 3
Primary Procurement Area Acreage – By Forest Type Group

	Total Acres By County				Total Acres by Ownership			
Forest-Type Group	Crawford County	Monroe County	Richland County	Vernon County	Other Federal	State & Local Gov.	Private	Total Acres
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

	Total Acres By County					Total Acres by Ownership			
Forest Type Group	Grant County	Iowa County	Juneau County	LaCrosse County	Sauk County	Other Federal	State & Local Gov.	Private	Total Acres
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 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.

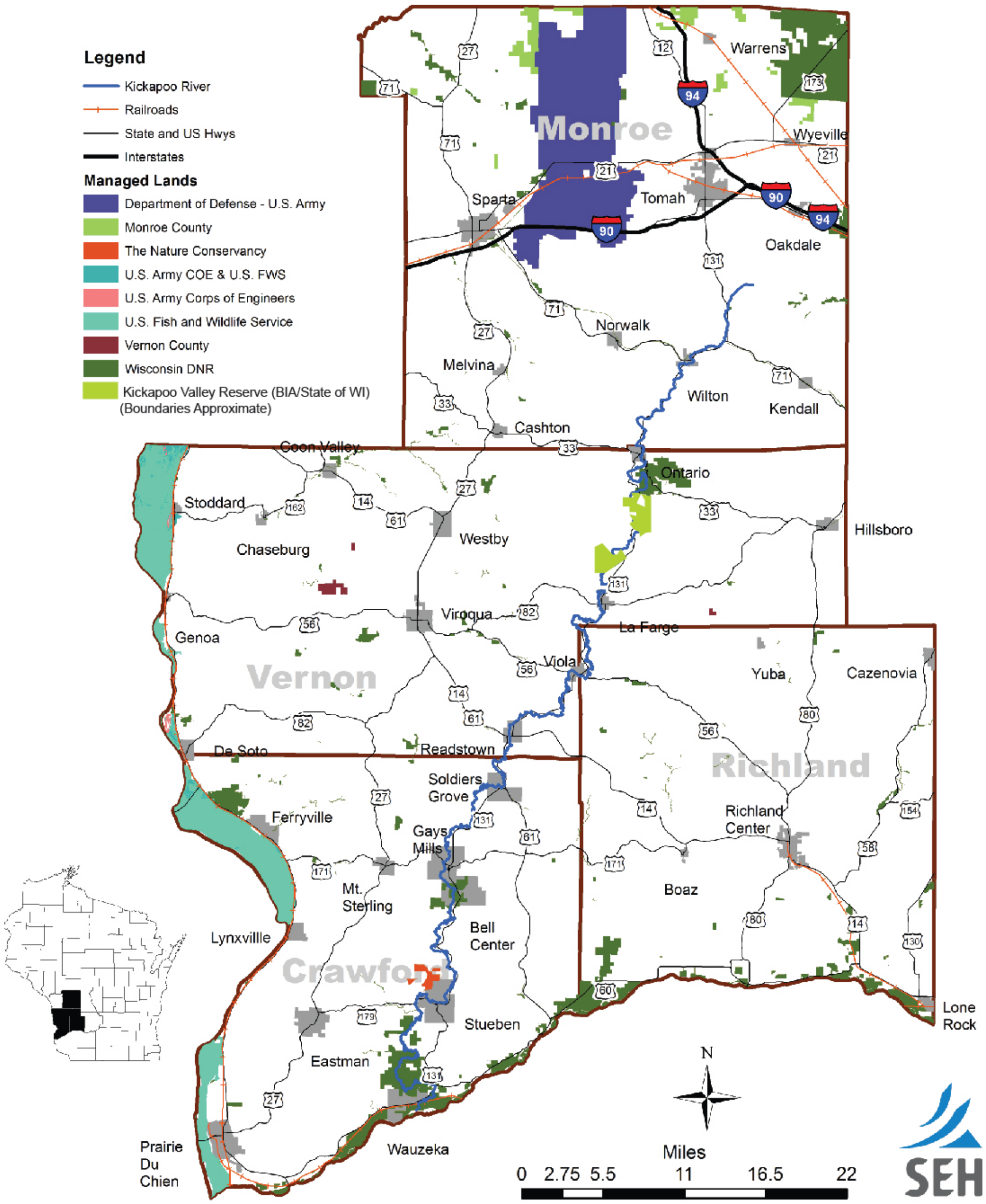


Figure 4 – Public Forestland - Kickapoo Valley

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

	Green Tons			
Ownership Type	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

	Primary Procurement Area – Green Tons				Secondary Procurement Area – Green Tons			
Species Group	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.

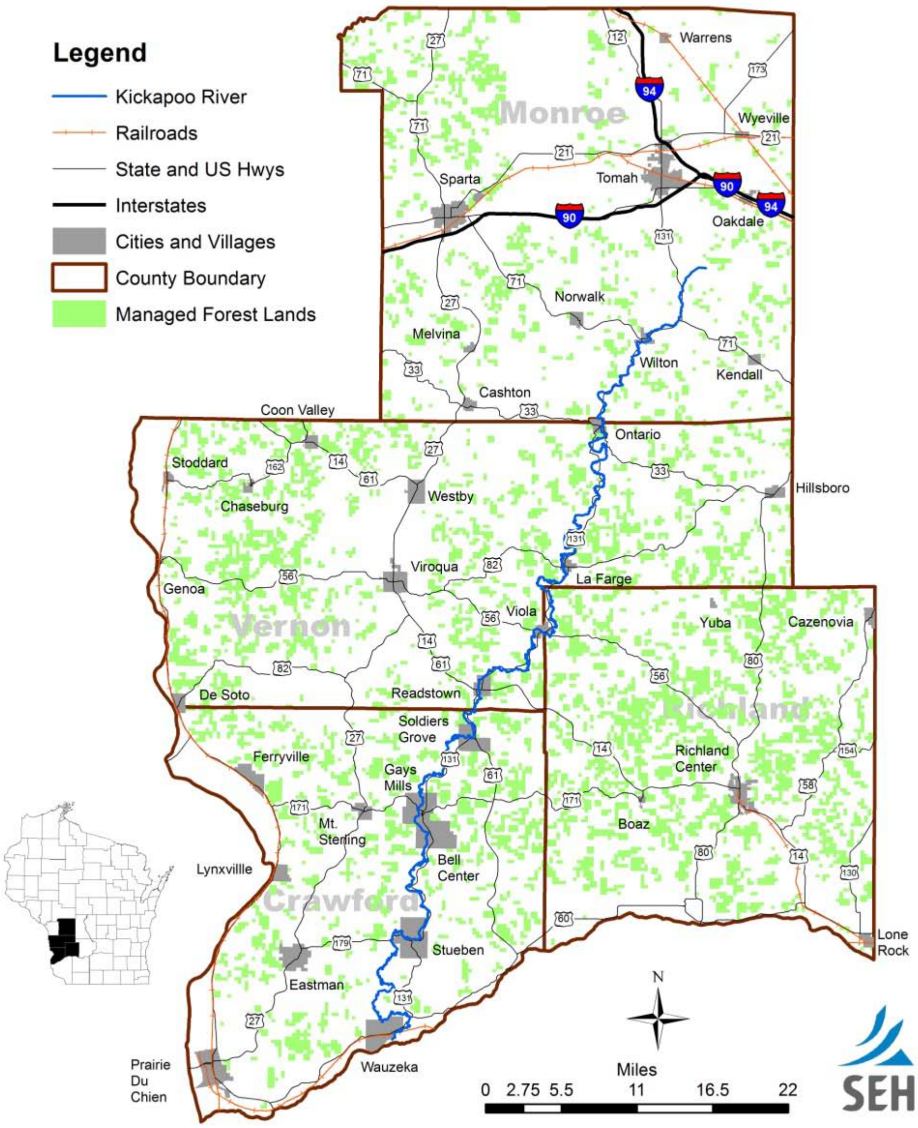


Figure 5 – MFL Acreages in Study Area

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

	County Name	Total FTL Programs Acres		County Name	Total FTL Programs Acres
Primary Procurement Area			Secondary Procurement Area	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.

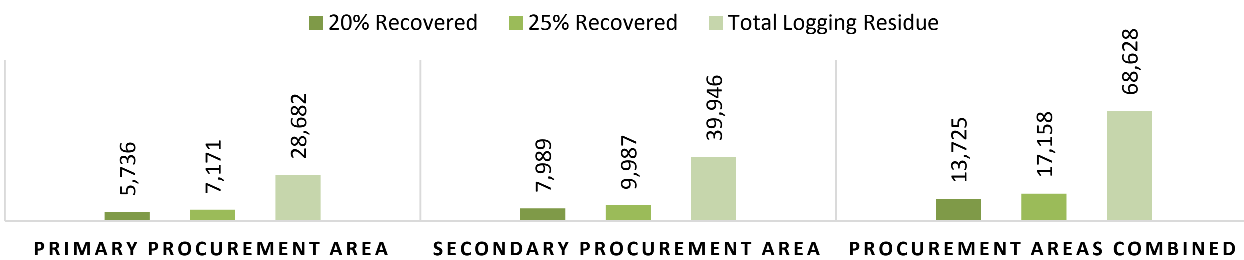
Though there are nearly three times as many non-FTL as FTL acres, we will use the same volumes for both ownership types because the tax law land is more intensively managed.

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.



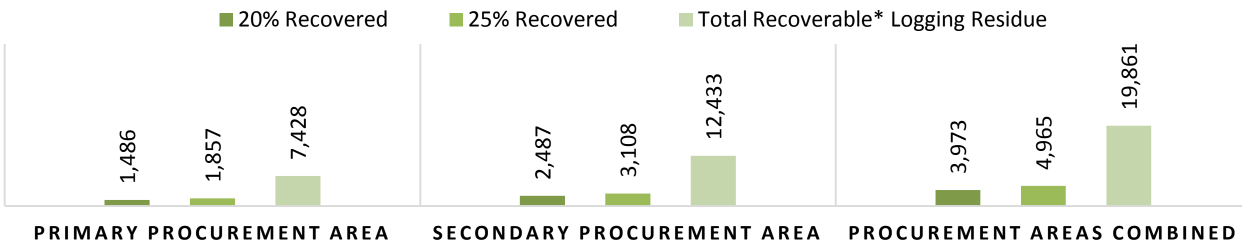
* Total Removals on All Private Ownership x 0.8 = Total Recoverable Logging Residue
* Figures represent Green Tons

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.



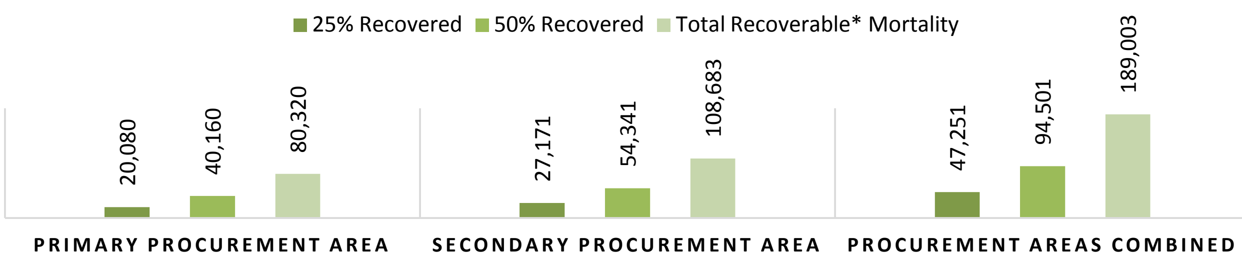
* Total Removals on All Ownerships (excluding private) x 0.8 = Total Recoverable Logging Residue

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.



* Total Mortality on All Ownerships x 0.2 = Recoverable Forest Mortality

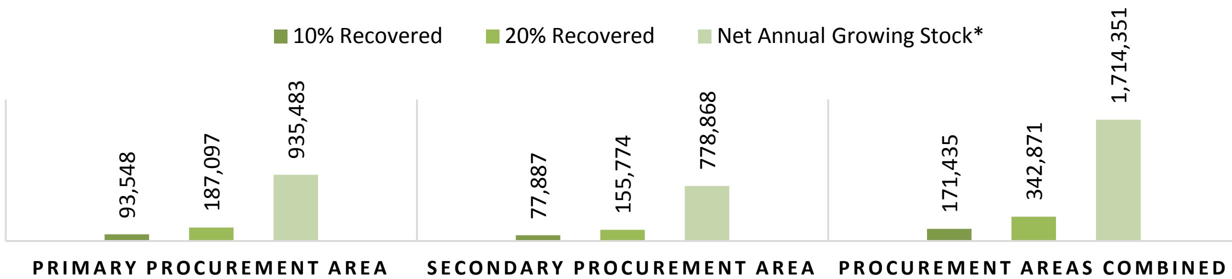
Figure 8 – Total Mortality and Potential Salvage Volume Available by Procurement Area – Green Tons

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).



*Gross Growing Stock on All Ownership Structures – Net Annual Removals – Net Annual Mortality = Total Net Annual Growing Stock

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.

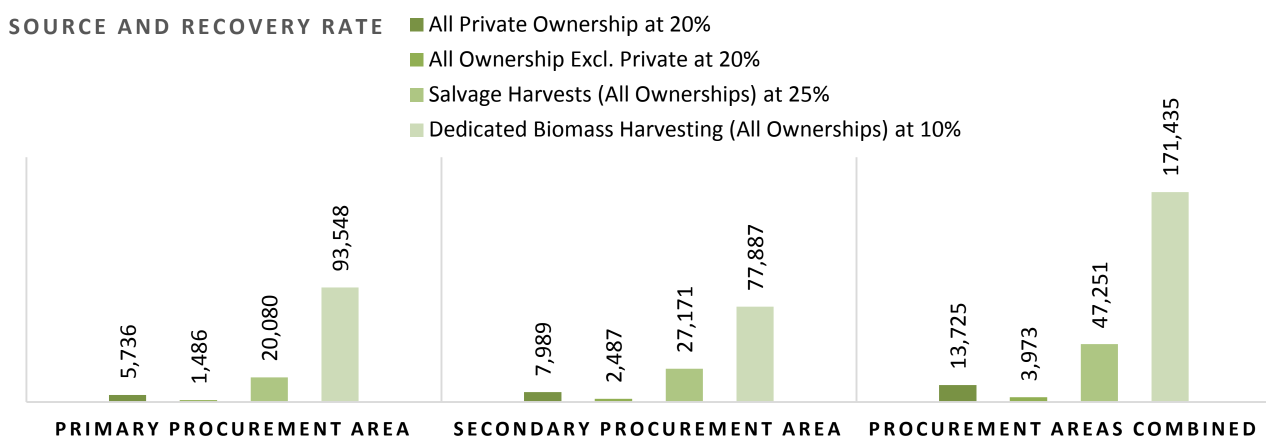


Figure 10 – Estimated Total Green Tons of Forest-Sourced Woody Biomass Minimal Recovery Rates

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.

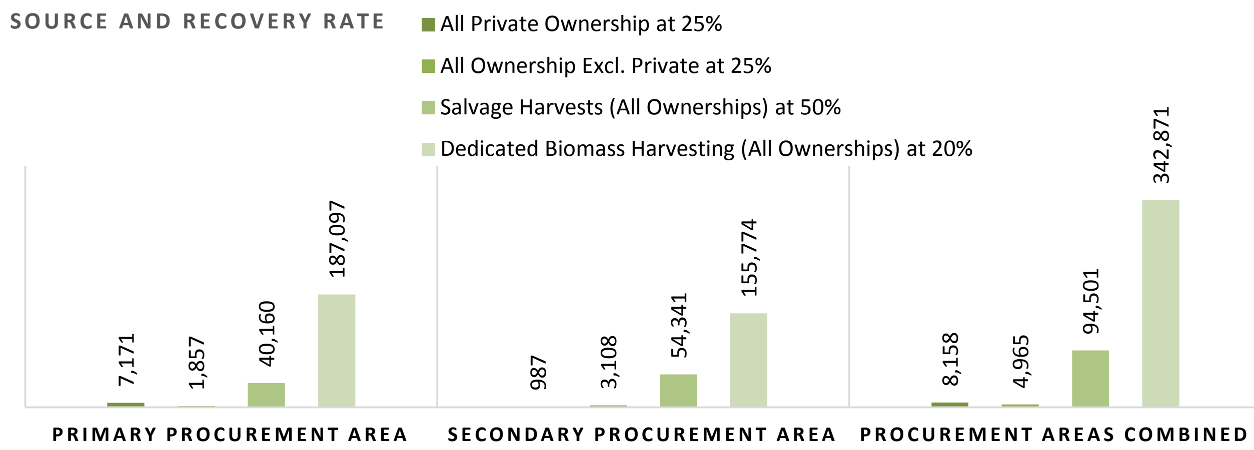


Figure 11 – Estimated Total Green Tons of Forest-Sourced Wood Biomass Medium Recovery Rates

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.

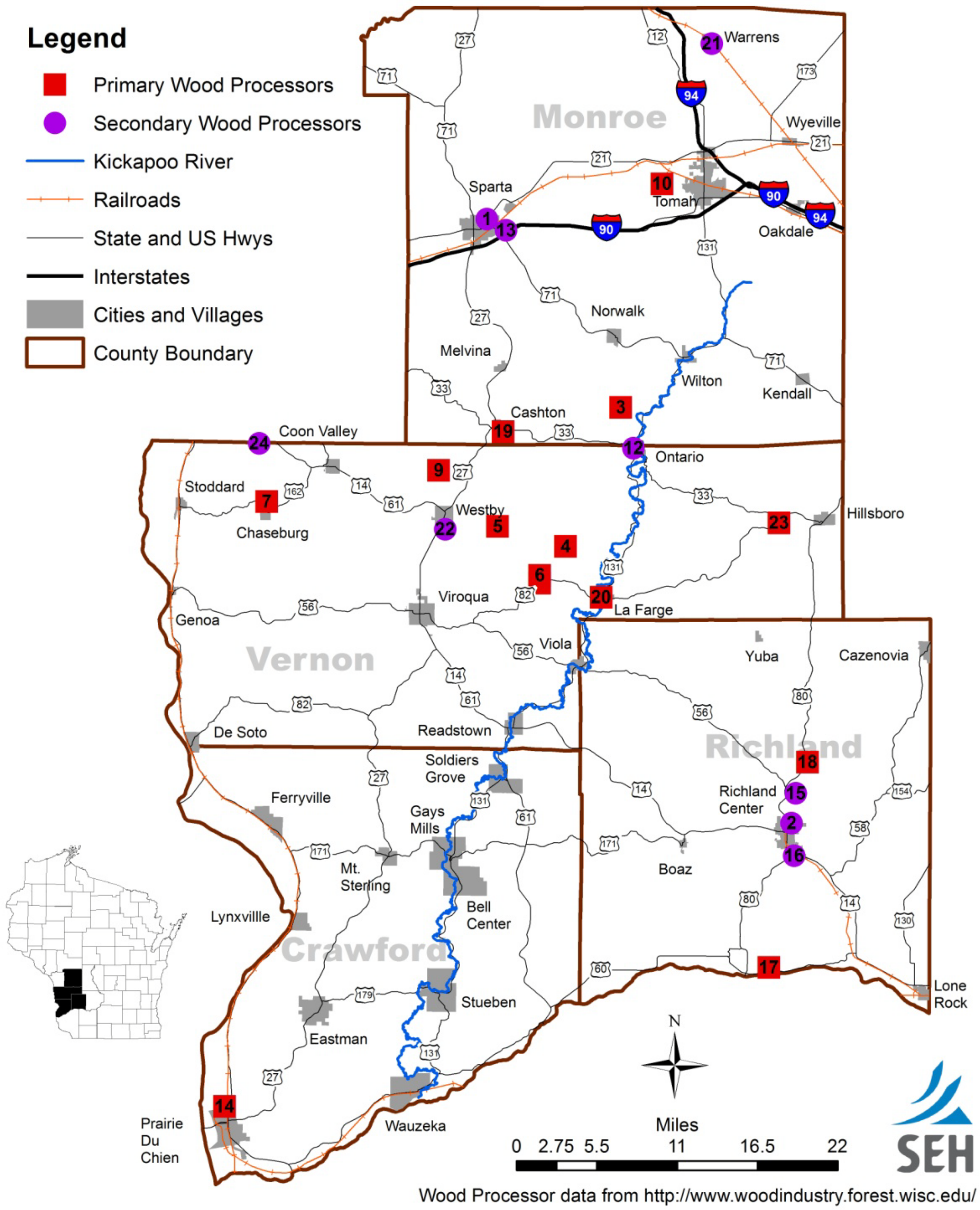


Figure 12 – Primary & Secondary Wood Processors

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

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%).

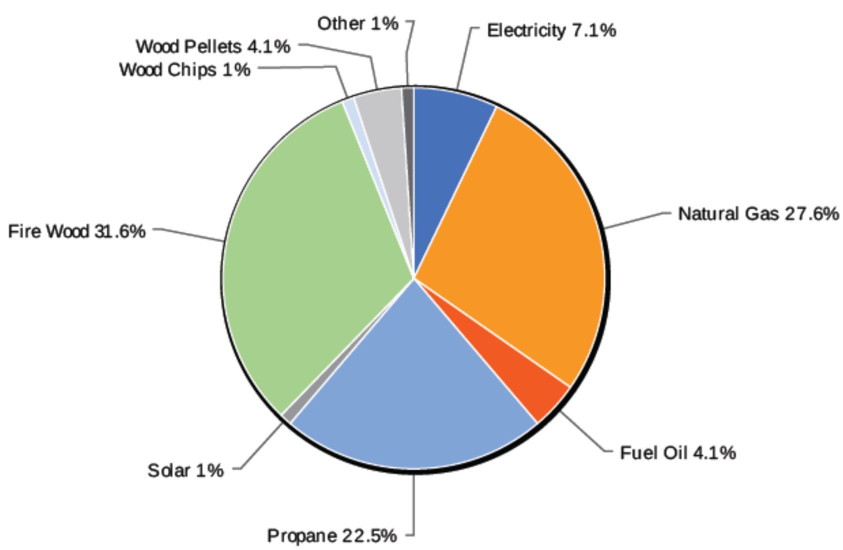


Figure 13 – Survey Respondents Primary Heat Source

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.

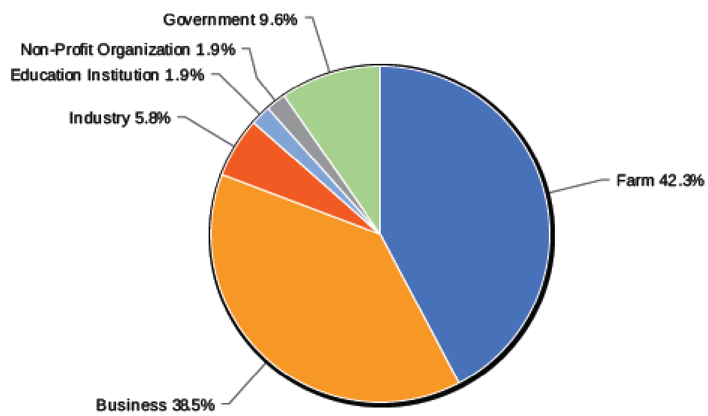


Figure 14 – Survey Respondents Type of Business

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 $^{1}/_{4}$"-$^{5}/_{16}$" 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^:
▪ 120 gallons of heating oil ▪ 170 gallons of propane ▪ 16,000 ft³ of natural gas ▪ 4,775 kilowatt hours (kWh) of electricity		▪ $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.

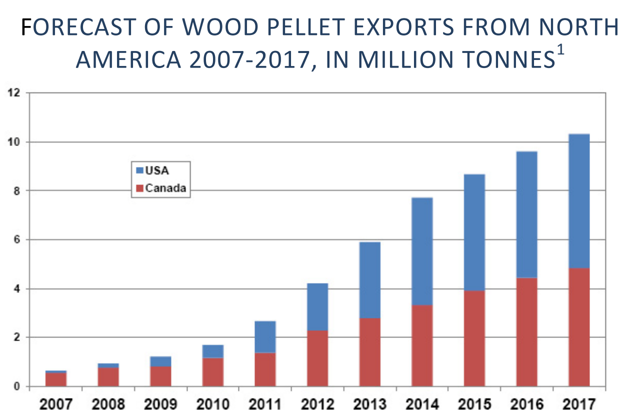


Figure 15 – Forecast of Wood Pellet Exports from North America

4.2.1 Current and Projected Domestic Demand Overview for Converted Biomass Products

US Renewable Energy (Wood^) Consumption: Consumed by Residential and Commercial Sectors[11]

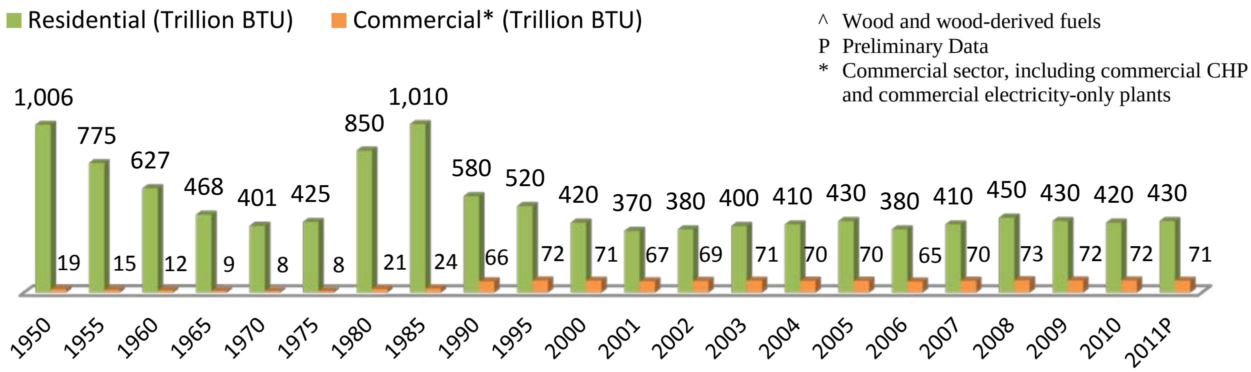


Figure 16 – Current and Projected US Wood Energy Demand

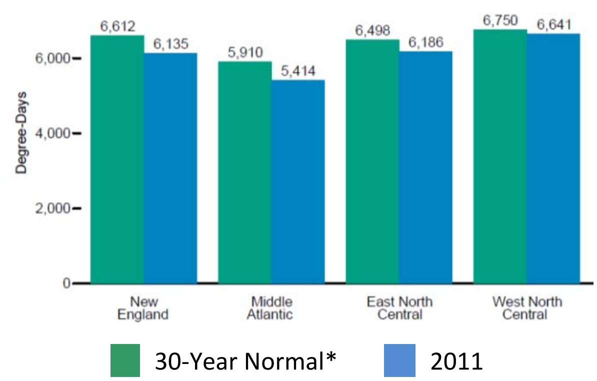
4.2.2 Residential Use ("Premium" and "Standard" Grade)

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.

Heating Degree-Days^ by Census Division, 2011[1]



^ A measure of how cold a location is over time relative to a base temperature, usually specified as 65˚F. Used in energy analysis as an indicator of space heating energy requirements or use.

*Based on calculations 1971-2000

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).

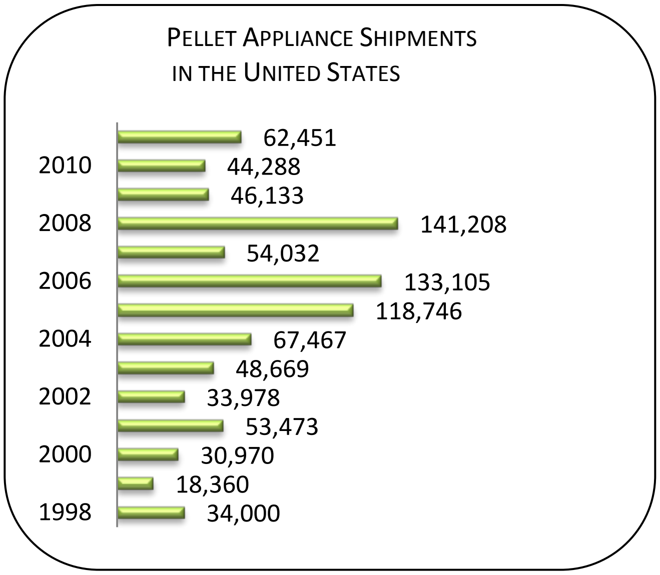
This projection is further supported by an article by Chris Nelder, "The Missing Link to a $7 Billion Market" published on July 25, 2012:

"[…] 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 year[12]. Between 2010 and 2011, pellet appliance shipments increased by 41%, from 44,288 to 62,451[13].



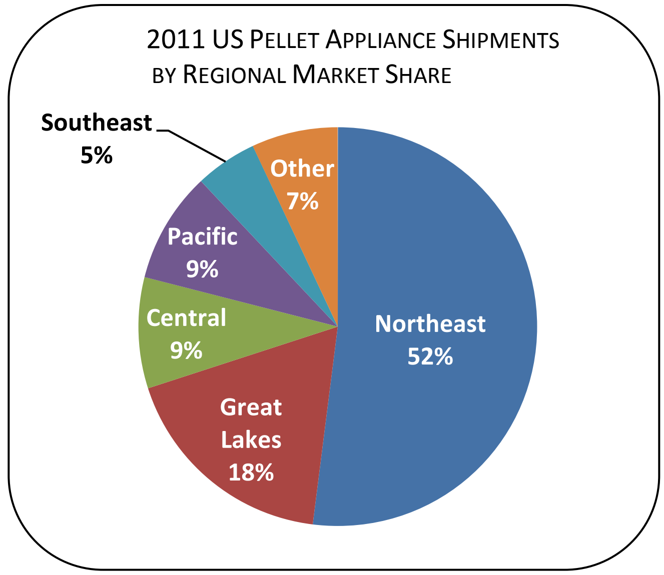


Figure 17 – Domestic Wood Pellet Stove Sales

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 Cottondale, 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.

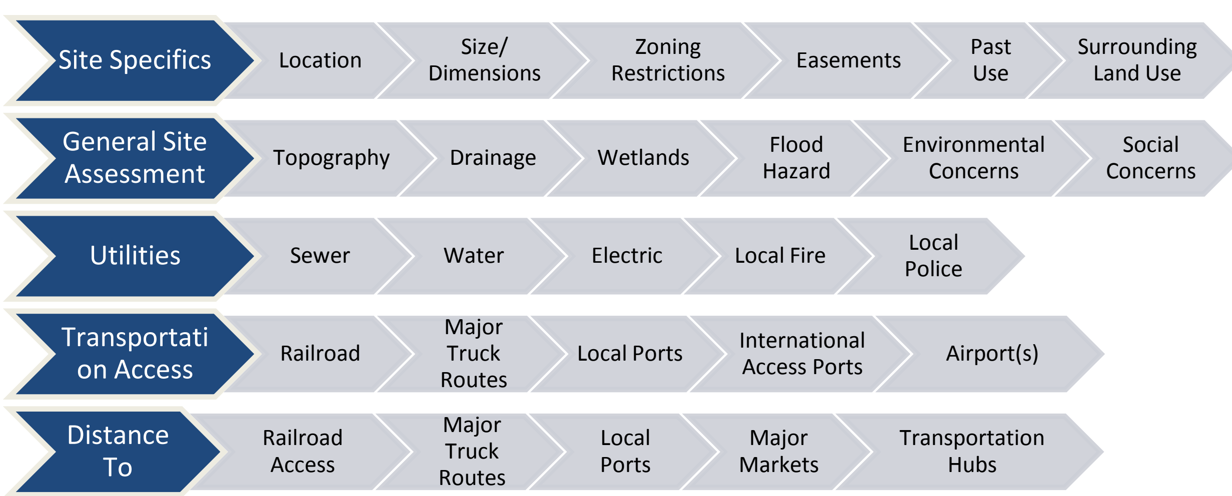


Figure 18 – Location and Site Criterion

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	The industry's common method for distribution 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. 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.

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				
Land			**$20,000**	$4,280,000
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**	$1,941,500
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)	*Industrial Production Manager*	$69,700
Office Manager (1)	*Administrative Service Manager*	$55,000
Clerical (1)	*Office Clerk (full-time)*	$25,000
Clerical (1)	*Office Clerk (part-time)*	$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	▪ 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	▪ 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	▪ 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

<table>
<tr><td>Small Business Administration (SBA) Programs (504)</td><td>
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.
</td></tr>
<tr><td>USDA Rural Development Business and Industry Guaranteed Loans (B&I)</td><td>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:
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.
Loan purposes must be consistent with the general purpose contained in the regulation. They include, but are not limited to, the following:
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
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.</td></tr>
</table>

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 ($^{1}/_{8}$") mesh screen. The pellets have a cylindrical form (approx. 1½” long x $^{1}/_{4}$” 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 Network[16] 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
- Automotive components
- Solidification
- 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 WNDR 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 then 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

		Fuel Type (%)						
County	Occupuied Housing Units (1)	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).

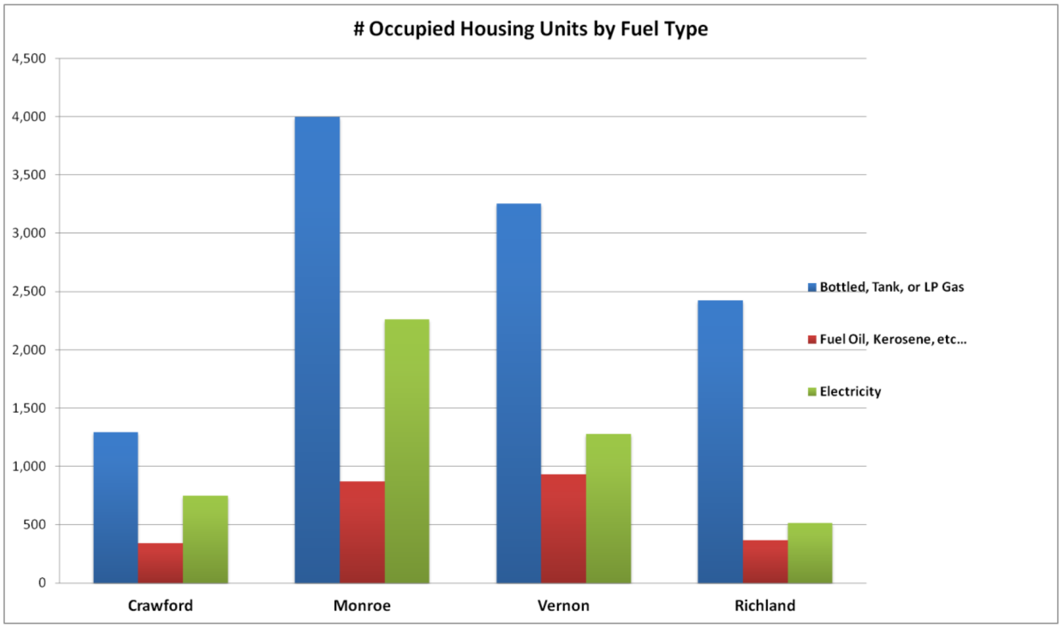


Figure 20 – Project Area Housing Units by Fuel Type

5.1.2 Current Household Fuel Costs

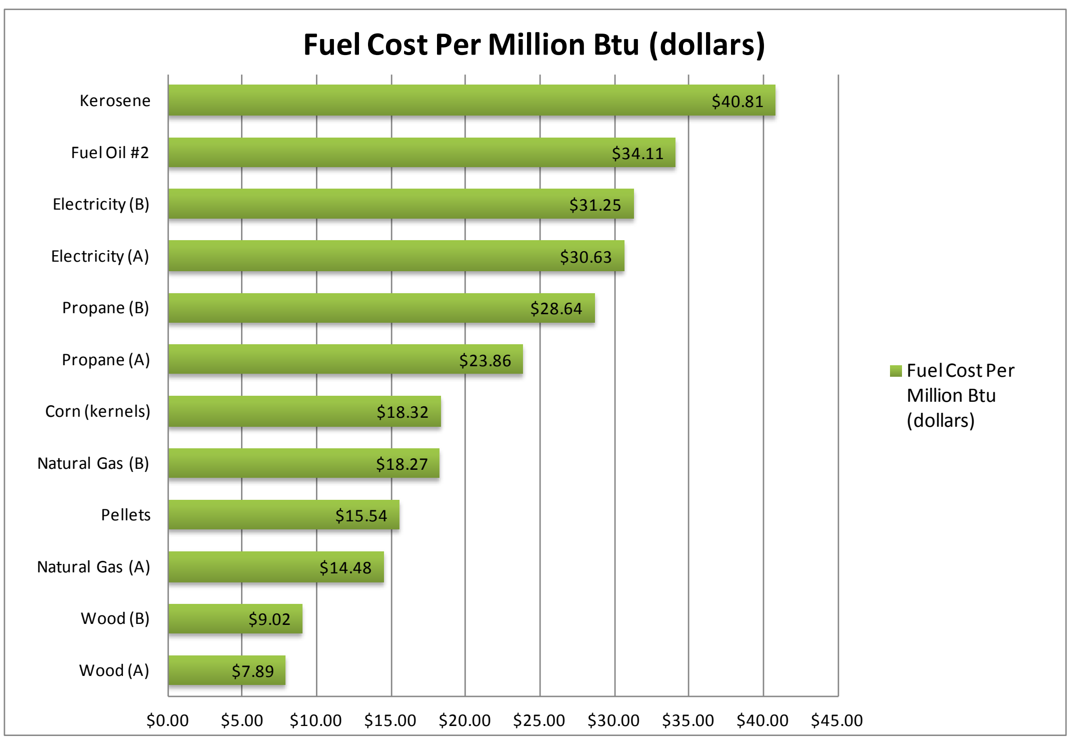


Figure 21 – Fuel Costs per MMBTU by Fuel Type

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	Craigslist, 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 yeara 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 heating[18]. 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

		Percentage of Households Switching to Wood Pellet Heating					
		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.

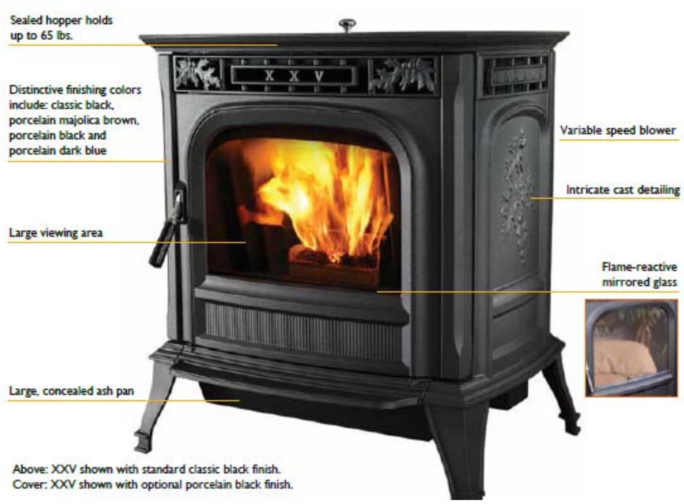


Figure 22 – Residential Wood Pellet Stove

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 Stillion [19] 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, PM_{10} 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 proposal[20] 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 (CO_2), the most prevalent and well-known GHG, is emitted primarily from fuel combustion. Using biomass for heat and/or power offsets the CO_2 emissions from carbon-intensive fossil fuels. Combustion CO_2 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 CO_2 emissions, these emissions are qualitatively different from fossil fuel CO_2 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 CO_2 emissions by about 22,500 pounds.

Table 26
CO_2 Emissions from Fuel Combustion

	Coal (electric power avg.)	Fuel Oil / Diesel	Propane	Natural Gas	Woody Biomass
CO_2 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 CO_2 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, CO_2 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 CO_2 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) CO_2 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 CO_2 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 CO_2 emissions associated with household heating would be significantly reduced. The table below estimates the CO_2 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 CO_2, the table calculations include only CO_2 emissions only from fuel combustion. In these calculations, net CO_2 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 CO_2 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 CO_2 emissions for each county include CO_2 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, CO_2 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
CO_2 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 2013[22] 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 study[23] 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 Fully Automated	 Semi Automated	Typical Wood Pellet Systems
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 <u>Wood Master</u>

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 <u>Hurst</u>

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)
- CO_2 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)
- CO_2 emissions: 8 ppm average @ 12% CO_2 (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 form 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.

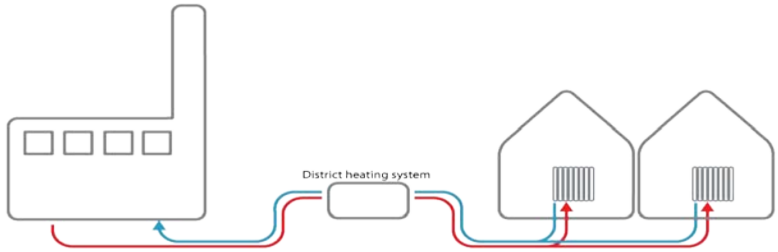


Figure 36 – Diagram of District Heating System
(Source: Swedish Energy Agency)

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 financally 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, Canada[26]

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
Buildings Included	A	A+B+C	A+C+D	A+B	A+B+C+D	A+B+D+D
Energy	Heat Only	Heat Only	CHP (only partial power)	CHP	CHP	CHP
Biomass Procurement	Purchase	Harvest w/ RW Sale	Harvest w/ RW Sale	Purchase	Harvest w/ RW Sale	Harvest w/ RW Sale
System Size (fuel input)	1.5 MMBtu/hr	4.0 MMBtu/hr	5.0 MMBtu/hr	10.0 MMBtu/hr	13.0 MMBtu/hr	13.0 MMBtu/hr
Greenhouse	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 load, 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&D[27] 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 Project[30] 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 studies[31] 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 organizations[32]. 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 products[33]. 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 or 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

Primary and Secondary Wood Processors in Region

Key #	Firm	City	County	User Types	User Types 2	User Types 3
1	3-D Entreprises	Sparta	Monroe	Specialty Products Producers		
2	Agwoods Inc	Richland Center	Richland	Specialty Products Producers		
3	Cook Creek Sawmill	Norwalk	Vernon	Sawmills		
4	David Troyer	La Farge	Vernon	Sawmills		
5	Eli Yoder	Westby	Vernon	Sawmills		
6	Emanuel P Miller	La Farge	Vernon	Sawmills		
7	Ervin Miller	Chaseburg	Vernon	Sawmills		
9	Jacob Schrock	Westby	Vernon	Sawmills		
10	John's Welding	Tomah	Monroe	Biomass/ Residue Producers		
11	Jere Hege	La Farge	Vernon	Sawmills		
12	Lamb Hardwood Lumber Inc.	Ontario	Vernon	Dimension, Flooring & Millwork Producers		
13	Macdonald & Owen Lumber Company	Sparta	Monroe	Dimension, Flooring & Millwork Producers		
14	Nelson Hardwood Lumber Co (Prairie Du Chien)	Prairie Du Chien	Crawford	Sawmills		
15	Pine River Woodcraft	Richland Center	Richland	Cabinets & Furniture Producers		
16	Richland Patterns, Inc.	Richland Center	Richland	Specialty Products Producers		
17	Riverside Sawmill, Inc.	Muscoda	Richland	Sawmills		
18	Rockbridge Sawmill Inc	Richland Ctr	Richland	Sawmills		
19	Ron Larson Sawmill	Cashton	Monroe	Sawmills		
20	Schroer Hardwood Lumber Co, Inc.	La Farge	Vernon	Sawmills		
21	Universal Forest Products, Inc. (Warrens)	Warrens	Monroe	Dimension, Flooring & Millwork Producers	Pallet & Container Producers	
22	Westby Hardwood Products	Westby	Vernon	Dimension, Flooring & Millwork Producers		
23	White City Lumber Inc	Hillsboro	Vernon	Sawmills		
24	Whole Trees Architecture & Structures	Stoddard	Vernon	Building Product Producers		

Source: Wisconsin's Wood Using Industry Database (WWUID)

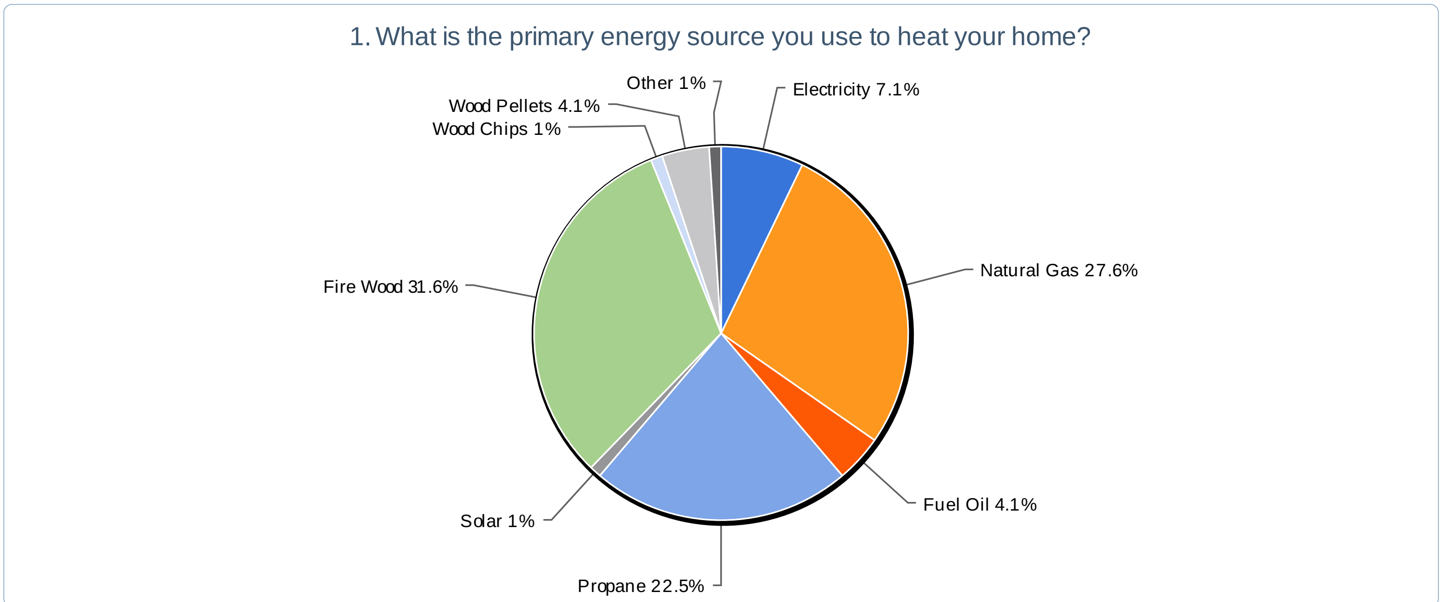
Appendix B

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

Online Surveys, Data Collection and Integration
www.SurveyGizmo.com

Summary Report - Dec 2, 2013

Survey: Kickapoo Valley Solid Biofuel and Wood Product Market Survey

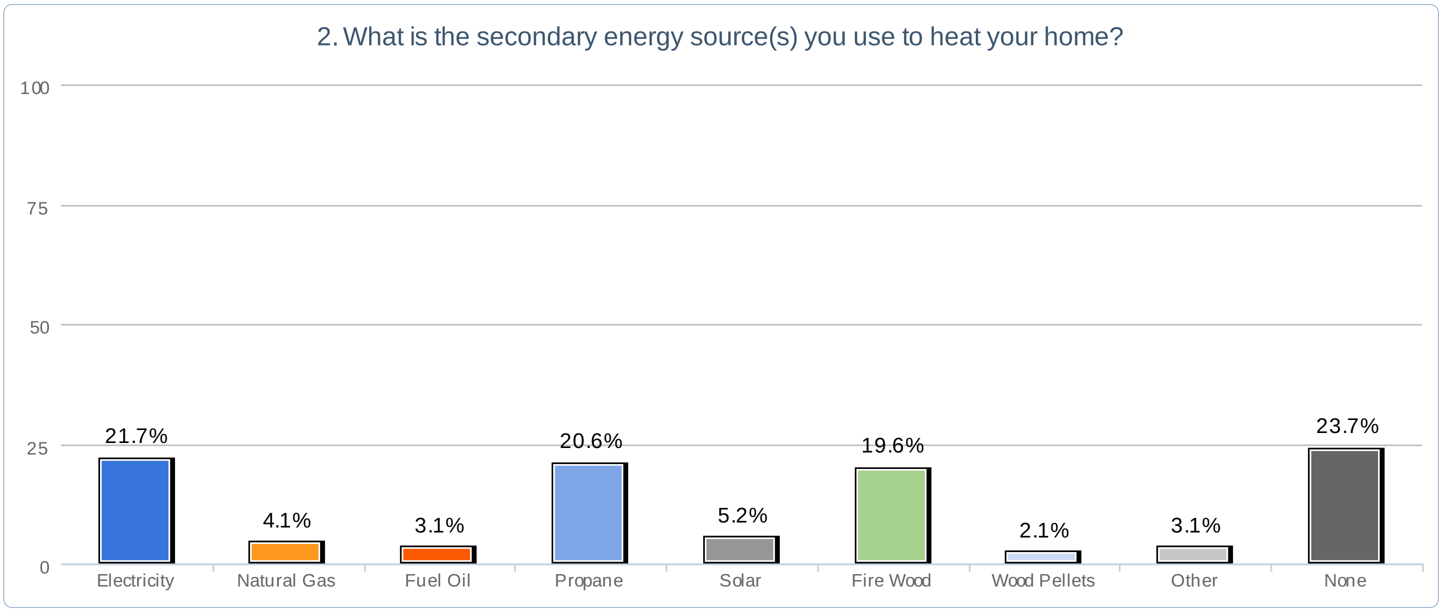


1. What is the primary energy source you use to heat your home?

Value	Count	Percent %
Electricity	7	7.1%
Natural Gas	27	27.6%
Fuel Oil	4	4.1%
Propane	22	22.5%
Solar	1	1.0%
Fire Wood	31	31.6%
Wood Chips	1	1.0%
Wood Pellets	4	4.1%
Other	1	1.0%

Statistics	
Total Responses	98

Open-Text Response Breakdown for "Other"	Count
geothermal	1



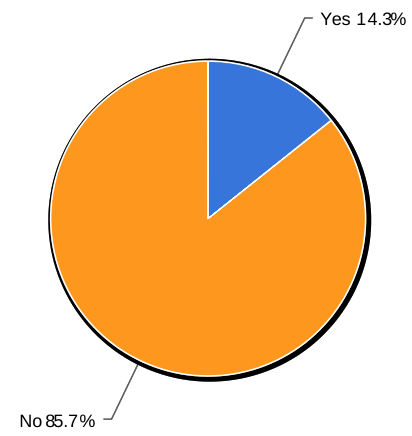
2. What is the secondary energy source(s) you use to heat your home?

Value	Count	Percent %
Electricity	21	21.7%
Natural Gas	4	4.1%
Fuel Oil	3	3.1%
Propane	20	20.6%
Solar	5	5.2%
Fire Wood	19	19.6%
Wood Chips	0	0.0%
Wood Pellets	2	2.1%
Other	3	3.1%
None	23	23.7%

Statistics	
Total Responses	97

Open-Text Response Breakdown for "Other"	Count
Left Blank	103
Geothermal	1
Passive solar	1

3. If wood pellets were 47% less in price than the cost of electricity for the equivalent amount of heat, would you switch to pellets as a heat source for your home?

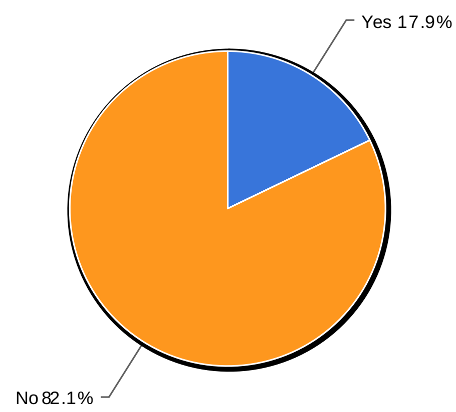


3. If wood pellets were 47% less in price than the cost of electricity for the equivalent amount of heat, would you switch to pellets as a heat source for your home?

Value	Count	Percent %
Yes	1	14.3%
No	6	85.7%

Statistics	
Total Responses	7

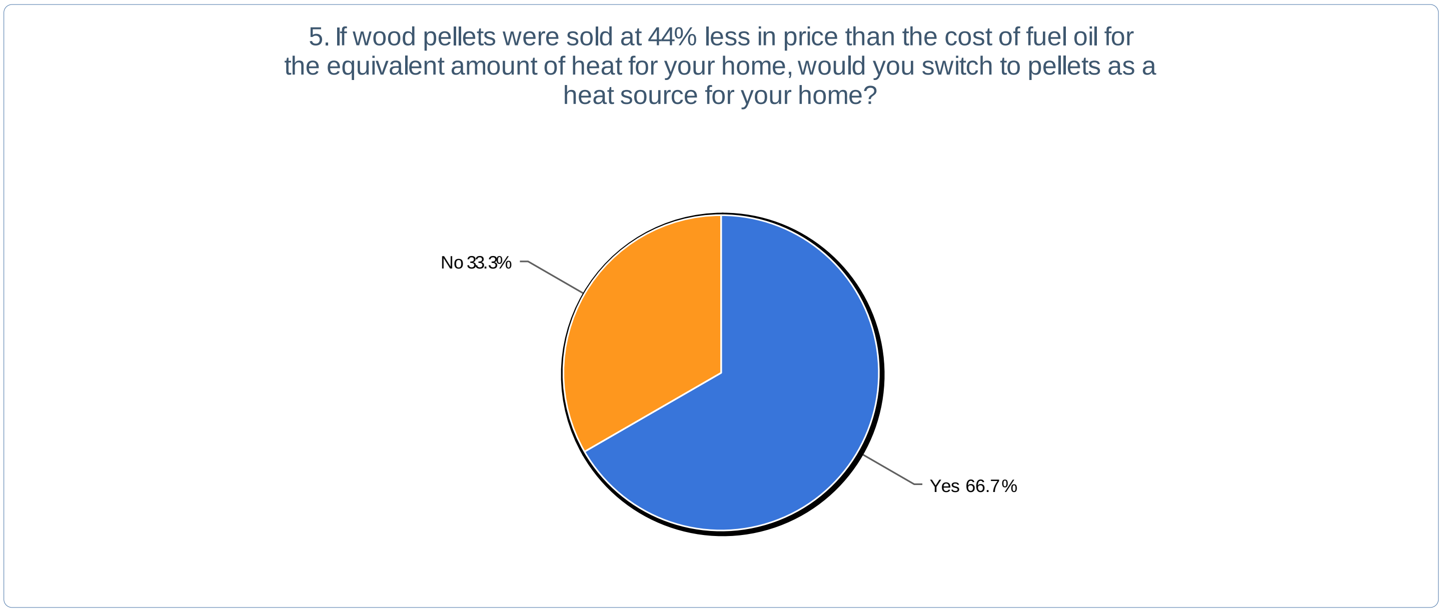
4. If wood pellets were 7% more expensive than natural gas for the equivalent amount of heat for your home, would you switch to pellets as a heat source for your home?



4. If wood pellets were 7% more expensive than natural gas for the equivalent amount of heat for your home, would you switch to pellets as a heat source for your home?

Value	Count	Percent %
Yes	5	17.9%
No	23	82.1%

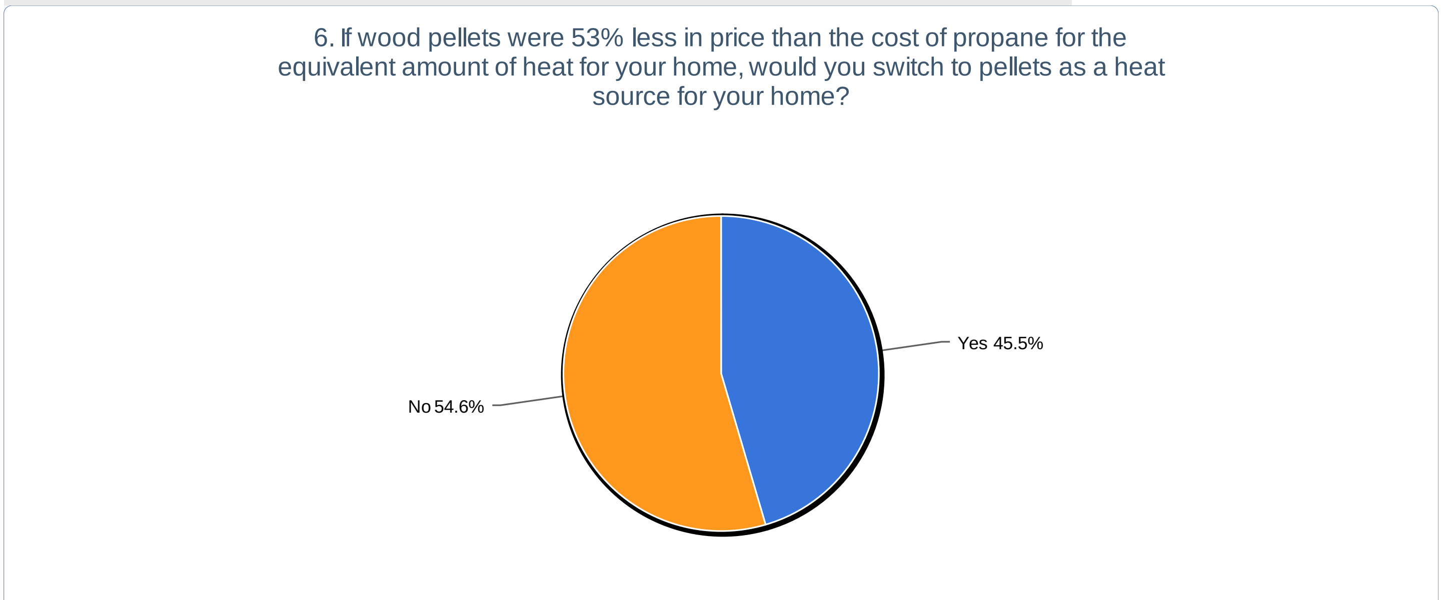
Statistics	
Total Responses	28



5. If wood pellets were sold at 44% less in price than the cost of fuel oil for the equivalent amount of heat for your home, would you switch to pellets as a heat source for your home?

Value	Count	Percent %
Yes	2	66.7%
No	1	33.3%

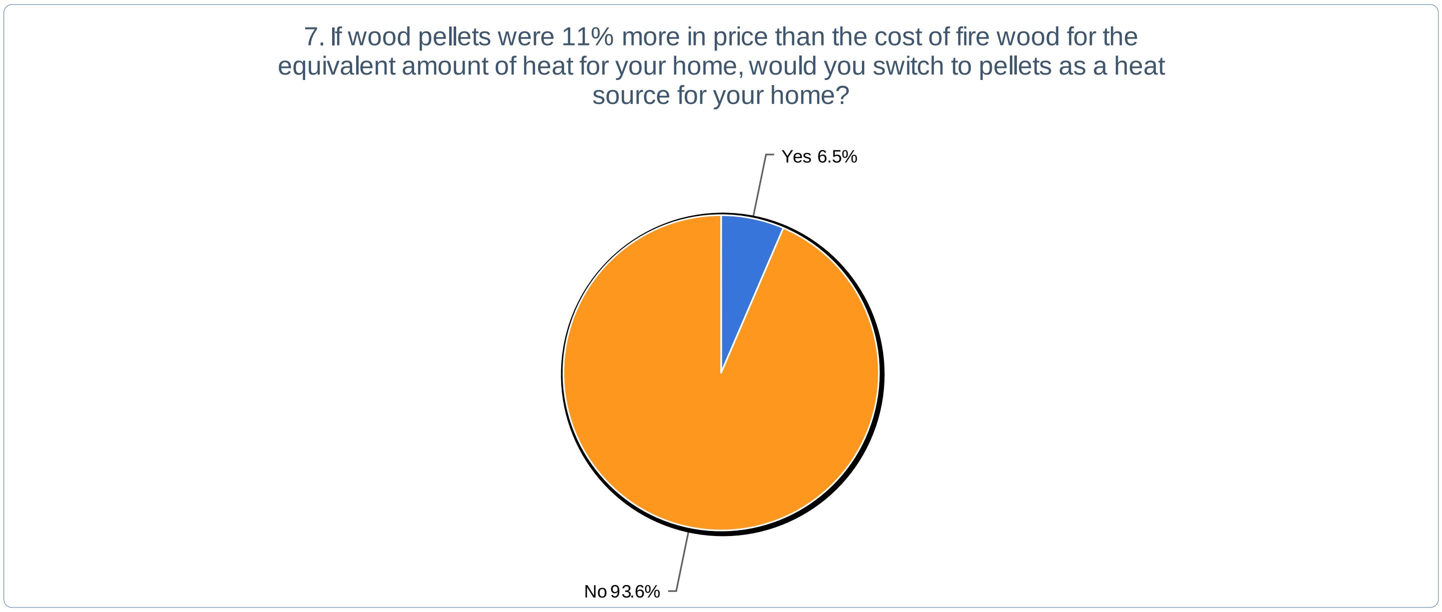
Statistics	
Total Responses	3



6. If wood pellets were 53% less in price than the cost of propane for the equivalent amount of heat for your home, would you switch to pellets as a heat source for your home?

Value	Count	Percent %
Yes	10	45.5%
No	12	54.6%

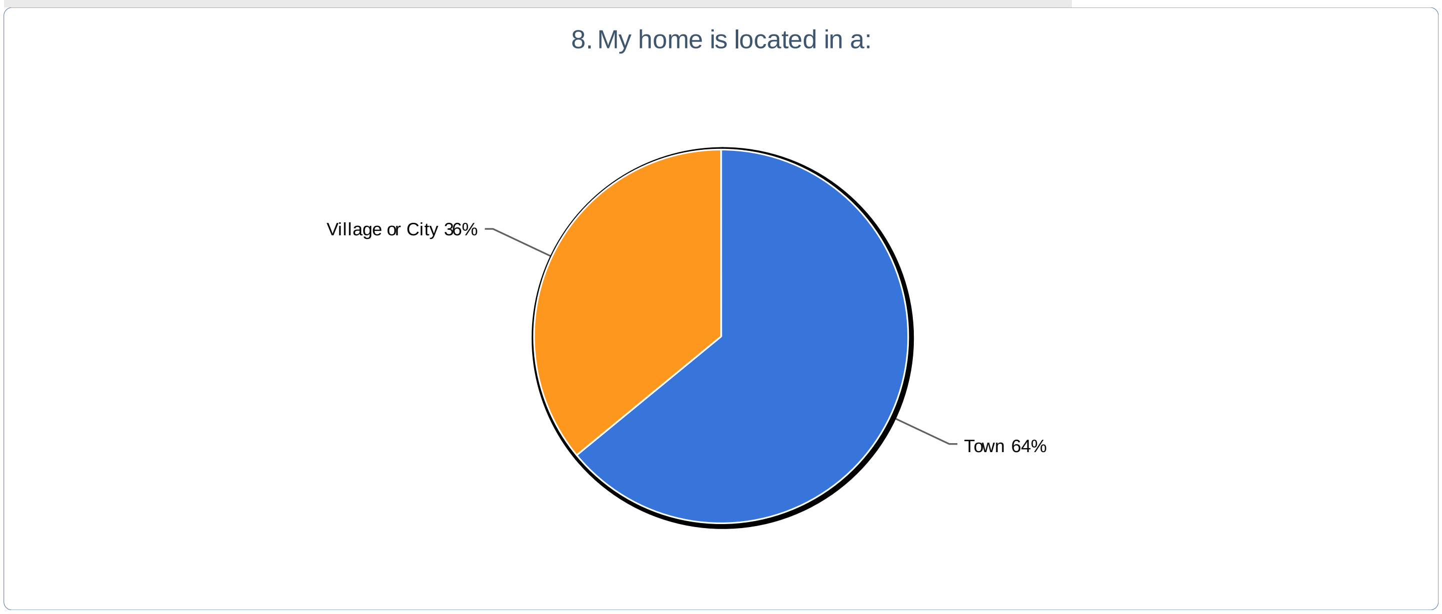
Statistics	
Total Responses	22



7. If wood pellets were 11% more in price than the cost of fire wood for the equivalent amount of heat for your home, would you switch to pellets as a heat source for your home?

Value	Count	Percent %
Yes	2	6.5%
No	29	93.6%

Statistics	
Total Responses	31

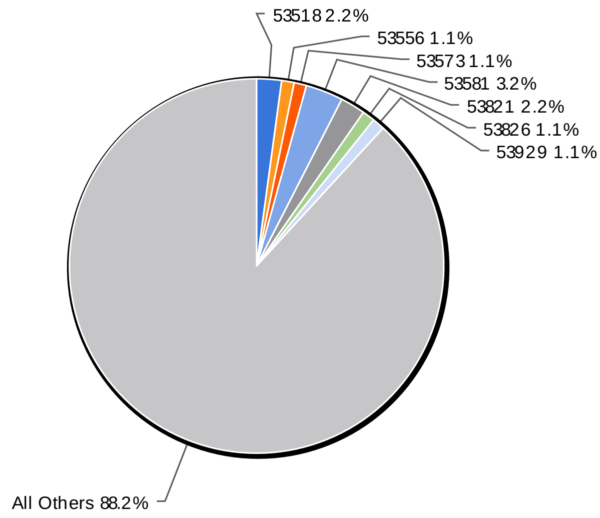


8. My home is located in a:

Value	Count	Percent %
Town	57	64.0%
Village or City	32	36.0%

Statistics	
Total Responses	89

9. Please check your Home zip code below:

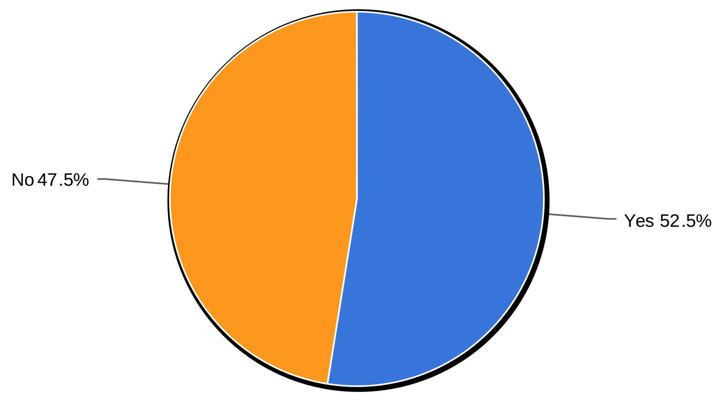


9. Please check your Home zip code below:

Value	Count	Percent %
53518	2	2.2%
53540	0	0.0%
53556	1	1.1%
53573	1	1.1%
53581	3	3.2%
53584	0	0.0%
53805	0	0.0%
53821	2	2.2%
53826	1	1.1%
53924	0	0.0%
53929	1	1.1%
53937	0	0.0%
53968	1	1.1%
54618	0	0.0%
54619	6	6.5%
54620	1	1.1%
54621	3	3.2%
54623	4	4.3%
54624	1	1.1%
54626	0	0.0%
54628	2	2.2%
54631	2	2.2%
54632	1	1.1%
54634	3	3.2%
54638	1	1.1%
54639	16	17.2%
54640	0	0.0%
54645	0	0.0%
54648	1	1.1%
54649	1	1.1%
54651	2	2.2%
54652	0	0.0%
54653	0	0.0%
54654	2	2.2%
54655	4	4.3%
54656	0	0.0%
54657	0	0.0%
54658	2	2.2%
54660	2	2.2%
54662	0	0.0%
54664	8	8.6%
54665	8	8.6%
54666	0	0.0%
54667	8	8.6%
54670	3	3.2%

Statistics	
Total Responses	93
Sum	5,070,641.0
Avg.	54,523.0
StdDev	326.5
Max	54,670.0

10. Do you own or manage a Farm, business, industry or institution?

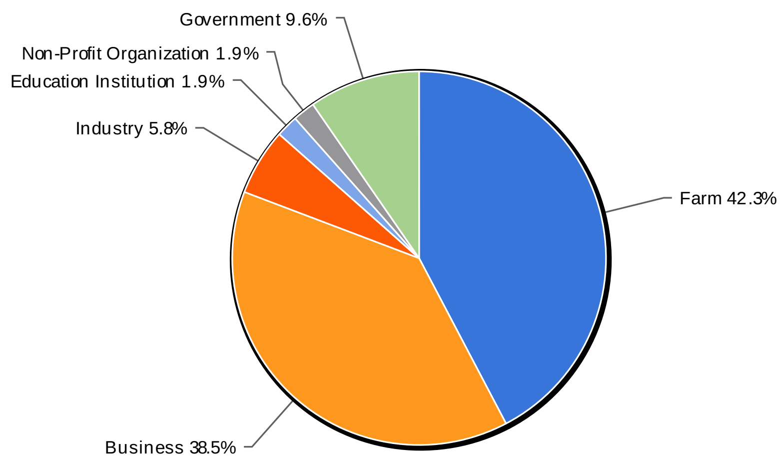


10. Do you own or manage a Farm, business, industry or institution?

Value	Count	Percent %
Yes	52	52.5%
No	47	47.5%

Statistics	
Total Responses	99

11. I own or manage a:

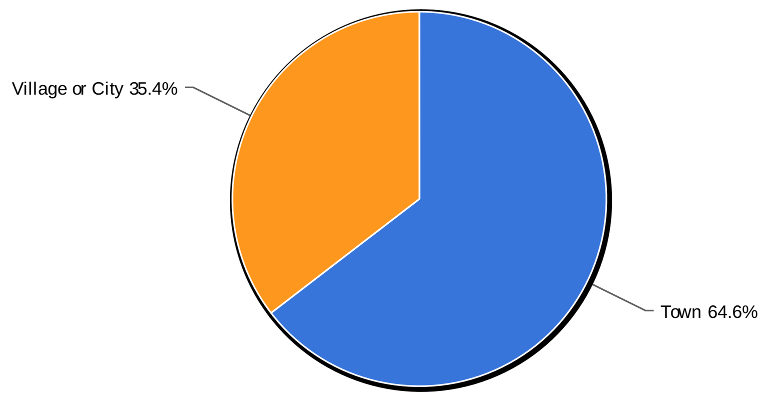


11. I own or manage a:

Value	Count	Percent %
Farm	22	42.3%
Business	20	38.5%
Industry	3	5.8%
Health Institution	0	0.0%
Education Institution	1	1.9%
Non-Profit Organization	1	1.9%
Government	5	9.6%

Statistics	
Total Responses	52

12. My Farm, Business, Industry or Institution's business is located in a:

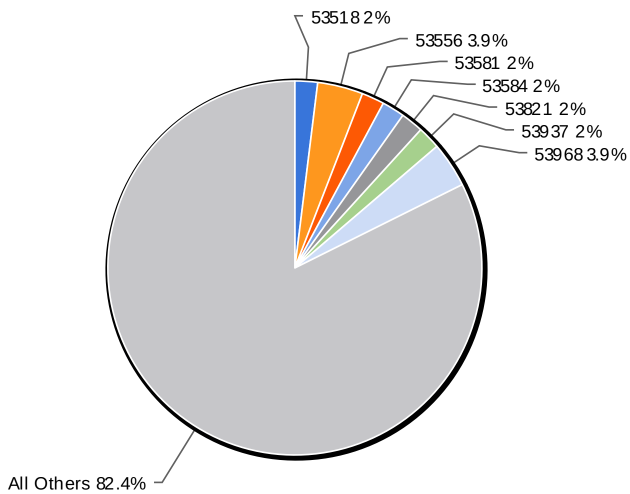


12. My Farm, Business, Industry or Institution's business is located in a:

Value	Count	Percent %
Town	31	64.6%
Village or City	17	35.4%

Statistics	
Total Responses	48

13. Please check your Farm, Business, Industry or Institution's zip code below:

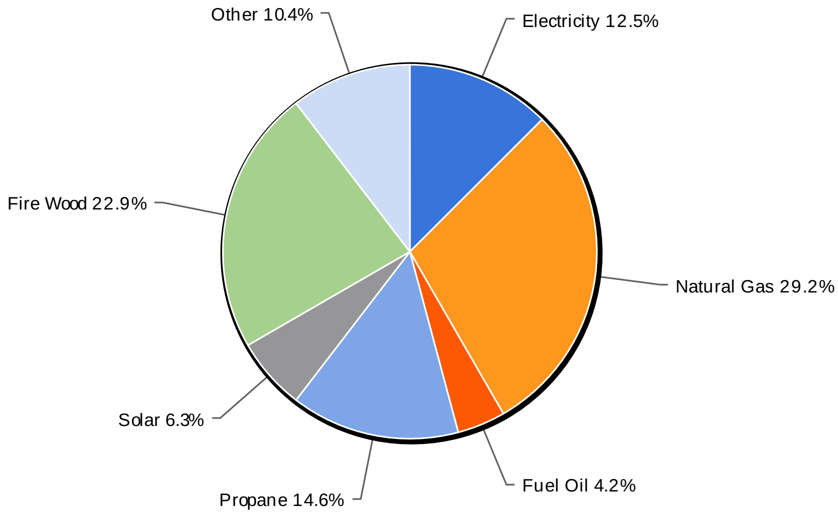


13. Please check your Farm, Business, Industry or Institution’s zip code below:

Value	Count	Percent %
53518	1	2.0%
53540	0	0.0%
53556	2	3.9%
53573	0	0.0%
53581	1	2.0%
53584	1	2.0%
53805	0	0.0%
53821	1	2.0%
53826	0	0.0%
53924	0	0.0%
53929	0	0.0%
53937	1	2.0%
53968	2	3.9%
54618	0	0.0%
54619	1	2.0%
54620	1	2.0%
54621	2	3.9%
54623	2	3.9%
54624	0	0.0%
54626	0	0.0%
54628	0	0.0%
54631	3	5.9%
54632	1	2.0%
54634	2	3.9%
54638	1	2.0%
54639	7	13.7%
54640	0	0.0%
54645	0	0.0%
54648	2	3.9%
54649	1	2.0%
54651	2	3.9%
54652	0	0.0%
54653	0	0.0%
54654	2	3.9%
54655	2	3.9%
54656	0	0.0%
54657	0	0.0%
54658	2	3.9%
54660	1	2.0%
54662	0	0.0%
54664	4	7.8%
54665	5	9.8%
54666	0	0.0%
54667	1	2.0%
54670	0	0.0%

Statistics	
Total Responses	51
Sum	2,778,609.0
Avg.	54,482.5
StdDev	361.4
Max	54,667.0

14. What is the primary energy source you use to heat your establishment?

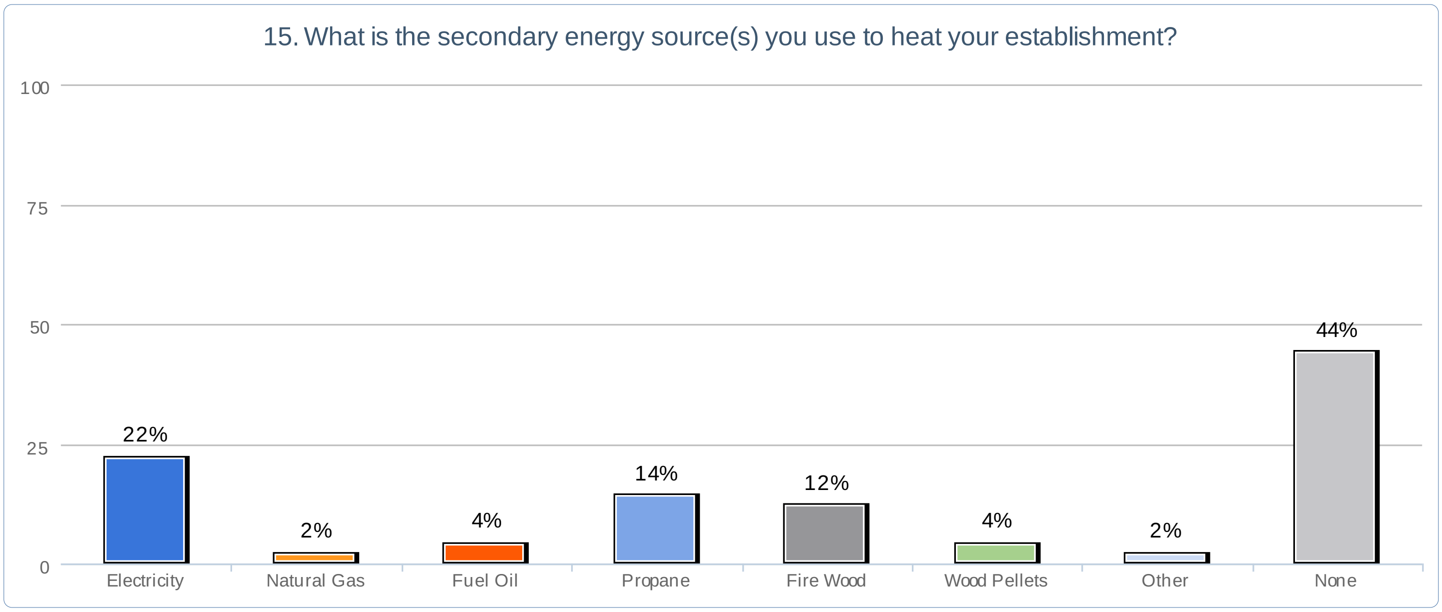


14. What is the primary energy source you use to heat your establishment?

Value	Count	Percent %
Electricity	6	12.5%
Natural Gas	14	29.2%
Fuel Oil	2	4.2%
Propane	7	14.6%
Solar	3	6.3%
Fire Wood	11	22.9%
Wood Chips	0	0.0%
Wood Pellets	0	0.0%
Other	5	10.4%

Statistics	
Total Responses	48

Open-Text Response Breakdown for "Other"	Count
Geothermal ground source heat pump	1
None (farm buildings)	1
animal heat	1
geo-thermal	1
none	1

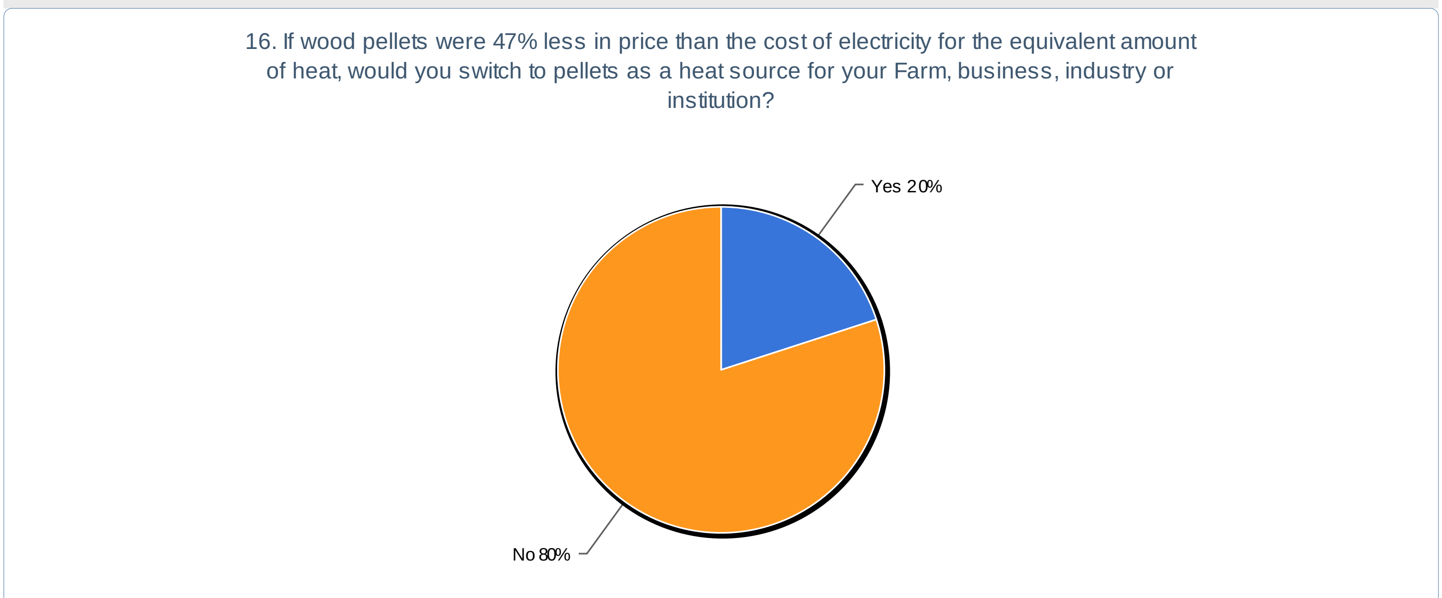


15. What is the secondary energy source(s) you use to heat your establishment?

Value	Count	Percent %
Electricity	11	22.0%
Natural Gas	1	2.0%
Fuel Oil	2	4.0%
Propane	7	14.0%
Solar	0	0.0%
Fire Wood	6	12.0%
Wood Chips	0	0.0%
Wood Pellets	2	4.0%
Other	1	2.0%
None	22	44.0%

Statistics	
Total Responses	50

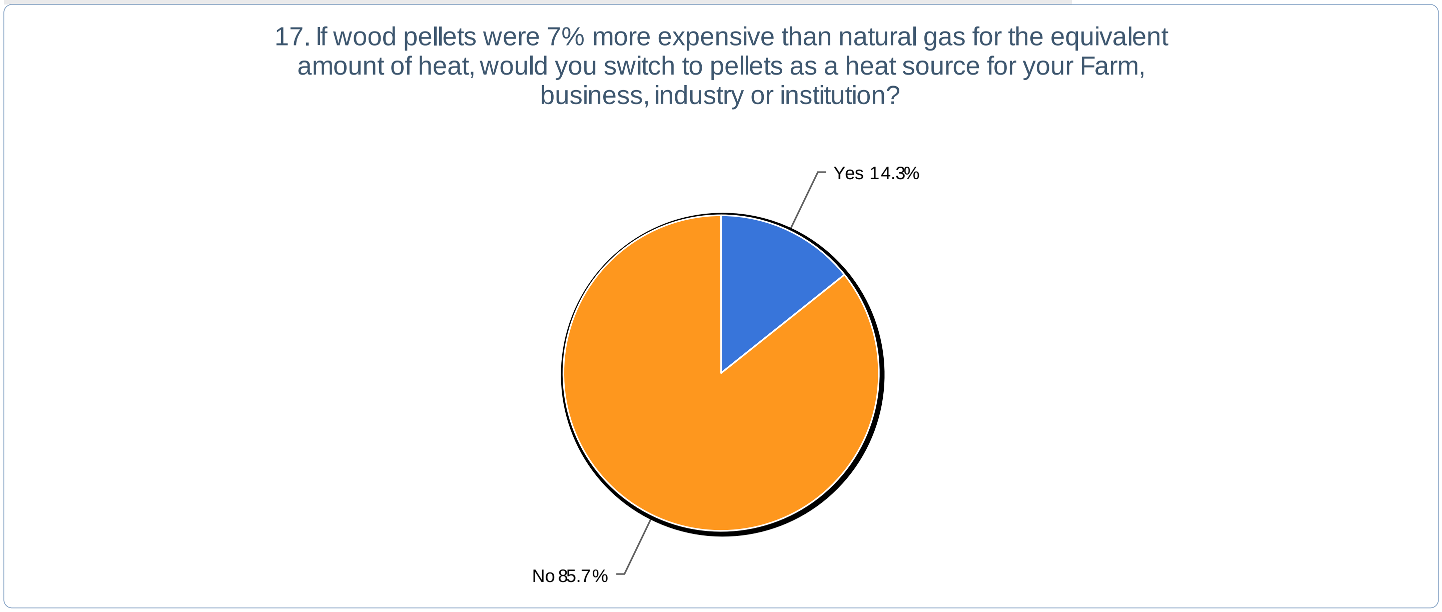
Open-Text Response Breakdown for "Other"	Count
Left Blank	104
geothermal system	1



16. If wood pellets were 47% less in price than the cost of electricity for the equivalent amount of heat, would you switch to pellets as a heat source for your Farm, business, industry or institution?

Value	Count	Percent %
Yes	1	20.0%
No	4	80.0%

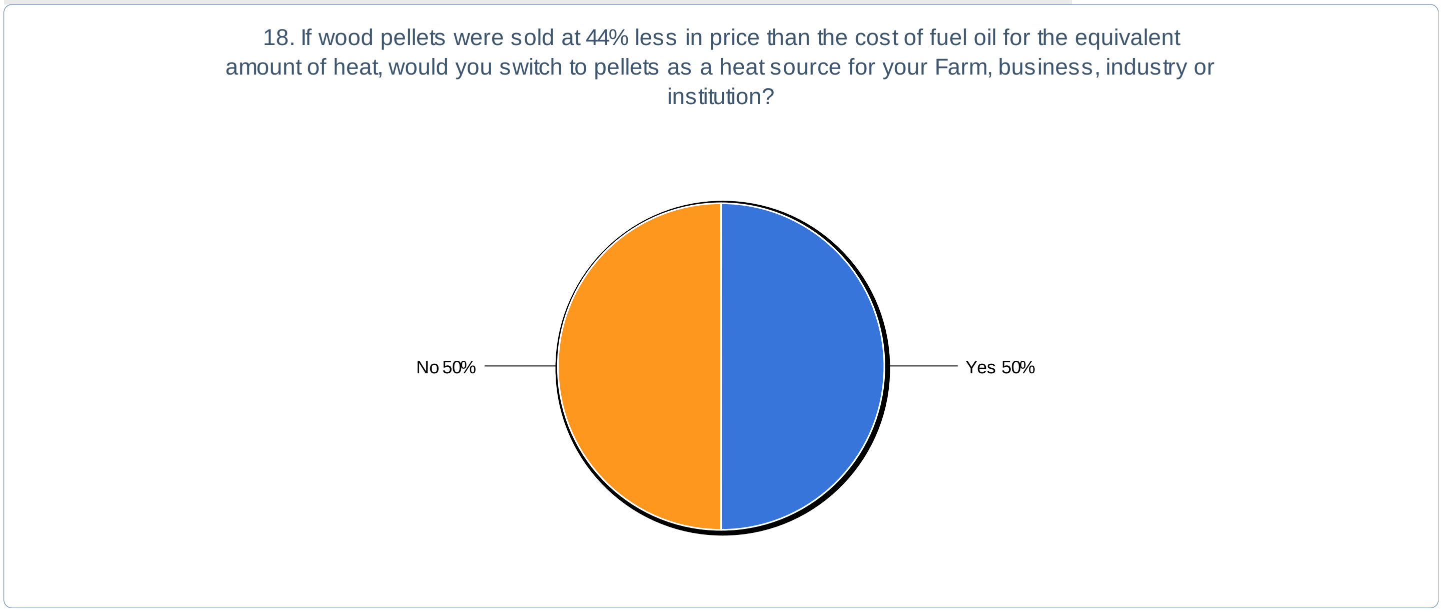
Statistics	
Total Responses	5



17. If wood pellets were 7% more expensive than natural gas for the equivalent amount of heat, would you switch to pellets as a heat source for your Farm, business, industry or institution?

Value	Count	Percent %
Yes	2	14.3%
No	12	85.7%

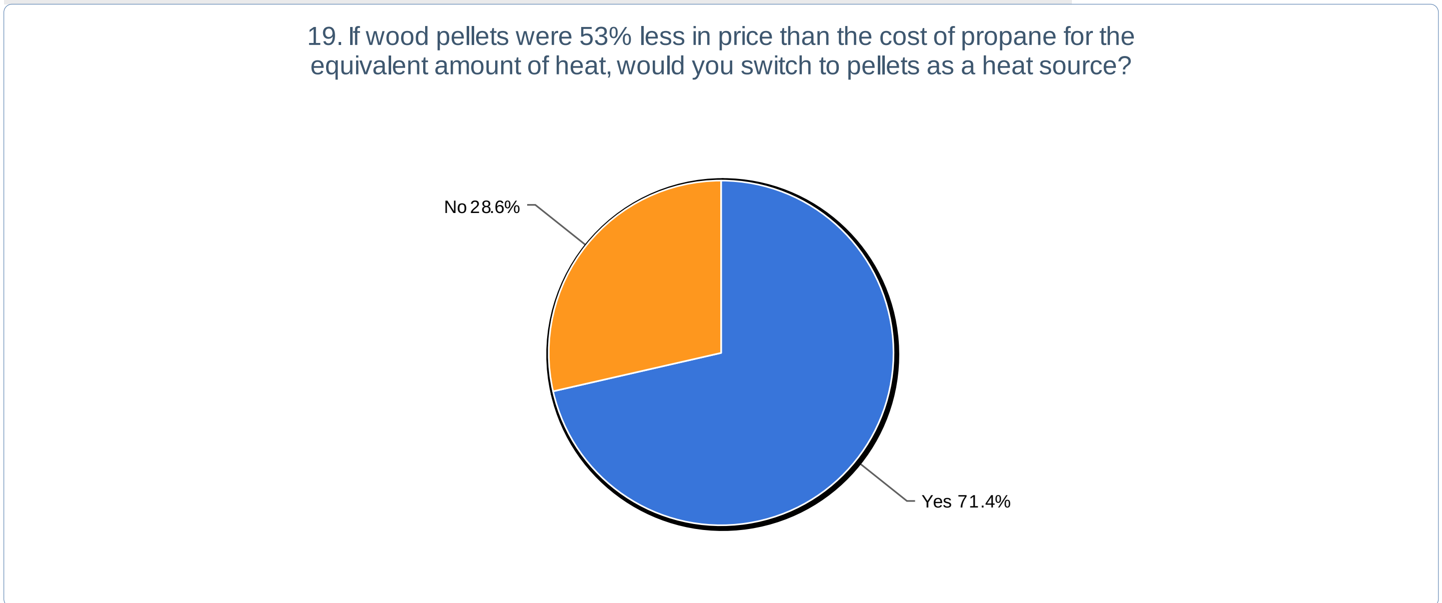
Statistics	
Total Responses	14



18. If wood pellets were sold at 44% less in price than the cost of fuel oil for the equivalent amount of heat, would you switch to pellets as a heat source for your Farm, business, industry or institution?

Value	Count	Percent %
Yes	1	50.0%
No	1	50.0%

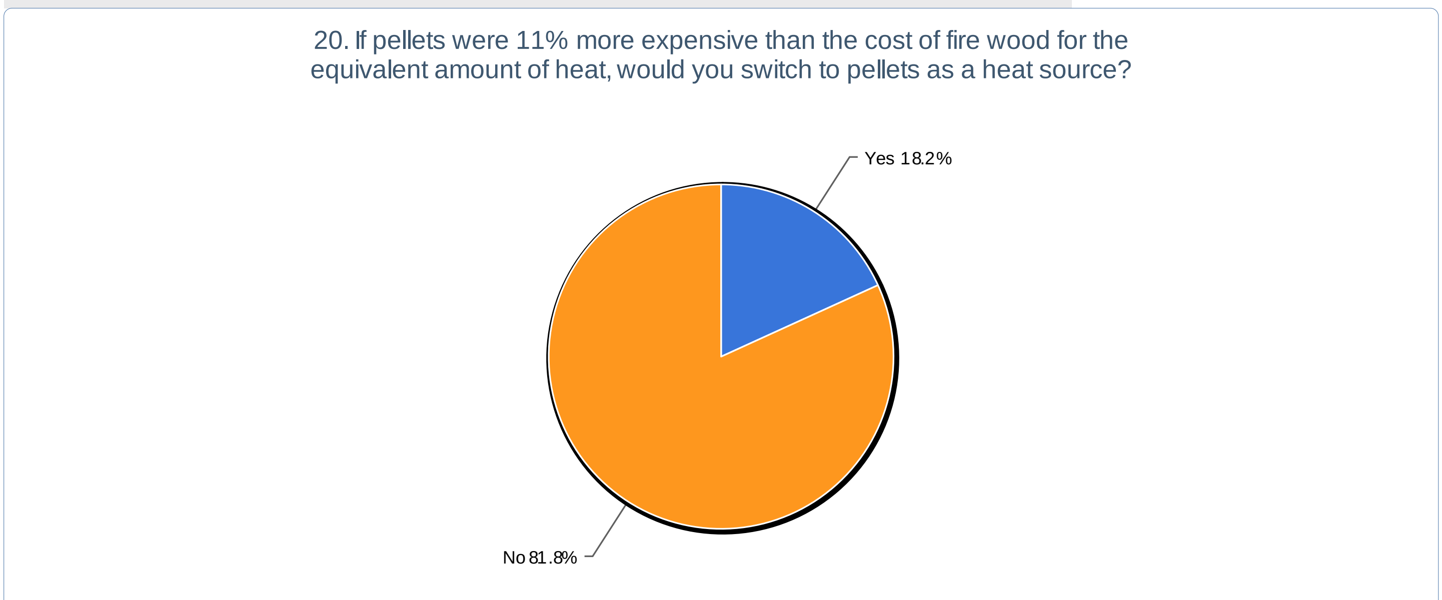
Statistics	
Total Responses	2



19. If wood pellets were 53% less in price than the cost of propane for the equivalent amount of heat, would you switch to pellets as a heat source?

Value	Count	Percent %
Yes	5	71.4%
No	2	28.6%

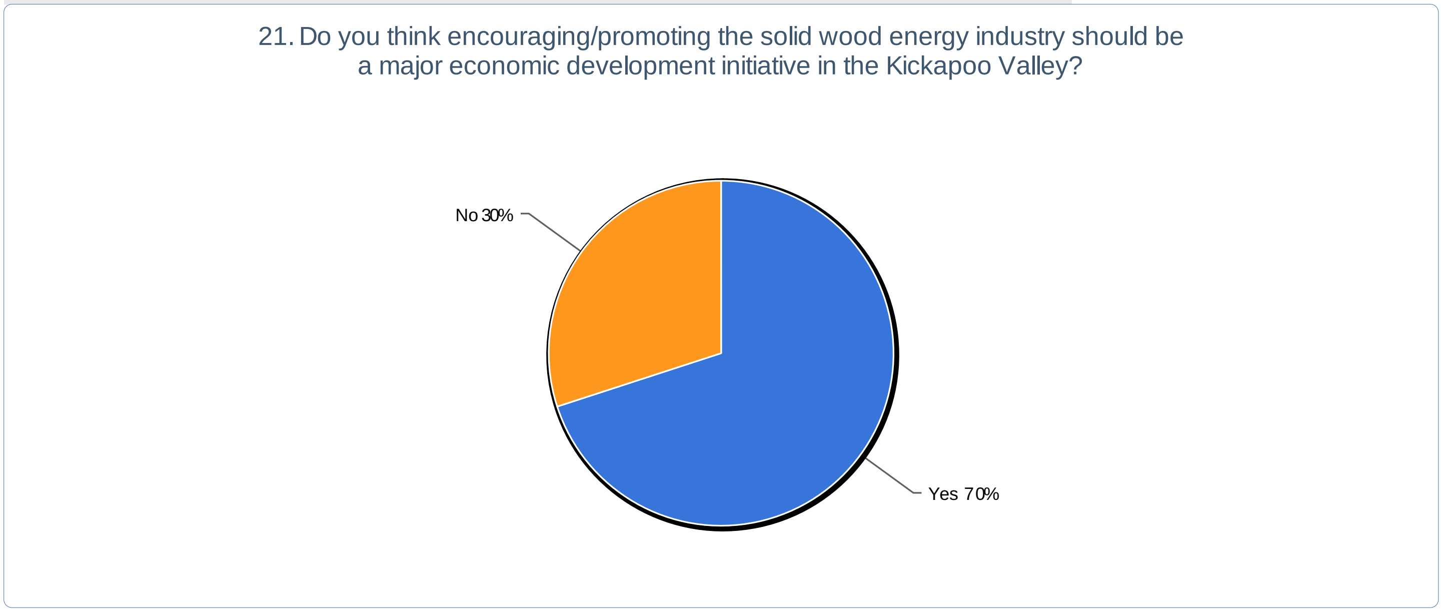
Statistics	
Total Responses	7



20. If pellets were 11% more expensive than the cost of fire wood for the equivalent amount of heat, would you switch to pellets as a heat source?

Value	Count	Percent %
Yes	2	18.2%
No	9	81.8%

Statistics	
Total Responses	11



21. Do you think encouraging/promoting the solid wood energy industry should be a major economic development initiative in the Kickapoo Valley?

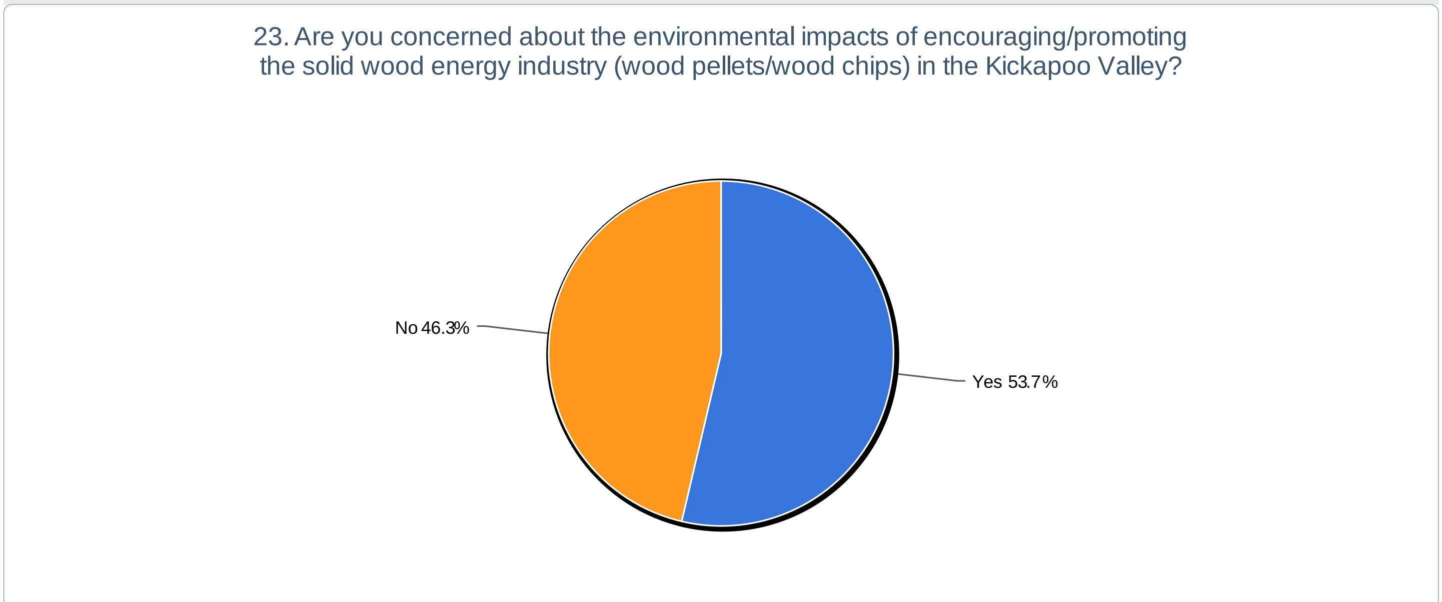
Value	Count	Percent %
Yes	63	70.0%
No	27	30.0%

Statistics	
Total Responses	90

22. Please provide any comments regarding solid wood energy industry as a major economic development initiative in the Kickapoo Valley.

Count	Response
1	Any alternative energy is something that needs to be developed, analyzed and hopefully used.
1	Can't answer the above. I don't have enough information.
1	Good way to use tops after logging. they now mainly go to waste on our farm.
1	I would rather see a focus on those trees when they are standing, as a tourism piece.
1	If there is wood let us help out the ones who have wood to sell for a income.
1	It takes energy to produce wood fuel, and the byproduct is air pollution.
1	Need more information
1	Not in favor of development.
1	What is wrong with allowing the market to dictate need and demand.
1	good idea
1	yes
1	Still unclear on the TOTAL impact of solid wood energy. Planting, growth, harvest, drying, chipping (or other prep), particulate emissions and ash disposal/use
1	I don't think it would ever be a major economic player but I believe the the logging and wood industry could make better and wider use of the wood harvested.
1	I don't know, this would take some research to see the trade-offs between development in the area and sustaining the environment.
1	I like the fact that its a rebewable energy source especially for a crises situation. However the energy loss in a wood chipper outside stove looses a consideral amount of energy before it would reach the home. A wood stove is a better option in my opinion.
1	There is probably plenty of wood waste generated by all the small sawmills, but collecting and using that material economically and responsibly is a huge challenge.
1	When my woods were harvested, there was no market for biofuel. Maybe there will be in the future.
1	There are thousands of dead trees decaying in these hills. Some are already down, some are still standing. If we could convert them to pellets, it would benefit the landscape as well as the homeowners.
1	We used to have a producer of wood pellets in Viola, however the cost to maintain the business shut it down so we only have one local option.
1	IF solid wood energy harvest is used to improve timber stand management I'm all for it. IF, however, it is used to extract biomass and degrades the resource base it's suicide... Proper forest management is of utmost importance.
1	The last time I had logging done, I had trouble getting rid of the cull logs. It would be great to see a market for timber not suitable for other purposes.
1	If we come together and build the market using quality methods and knowhow, we will all benefit from a sustainable harvest of wood.
1	Please remember that you are asking parts of the existing timber/lumber industry to handle cull material and tops. There is nothing easy or safe about trucking material that is curved (Not straight like logs). I have heard many complaints from log haulers who have tried to handle cull and top material for bio-mass.
1	This needs to be done in a sustainable manner and the local population would need to be educated as to the benefits.
1	Waste wood could be used to produce energy in clean burning centralized plants, especially in villages where there is density of commercial and institutional buildings.
1	The expansion of natural gas discoveries and the volume that has been discovered is going to make natural gas very tough to compete against economically. Wood chips will need to be cheap. This explosion is hydrocarbon discoveries is changing the whole outlook of some renewable energies and they are finding more supplies every day.
1	Wood seems to be a viable fuel source and area that has potential for economic development in our area. More people are switching to pellets and I think that the demand for them will continue into the future.
1	Worth exploring all options. Fossil fuels will continue to be more costly. Look not at cost differential today but long term.
1	It would seem that there is great potential for this because the Valley is so heavily forested. Periodic thinning and culling of these forests could provide the necessary fuel for this industry.
1	As long as the industry utilizes resources that are already here and doesn't start cutting new tree's to do it. There are

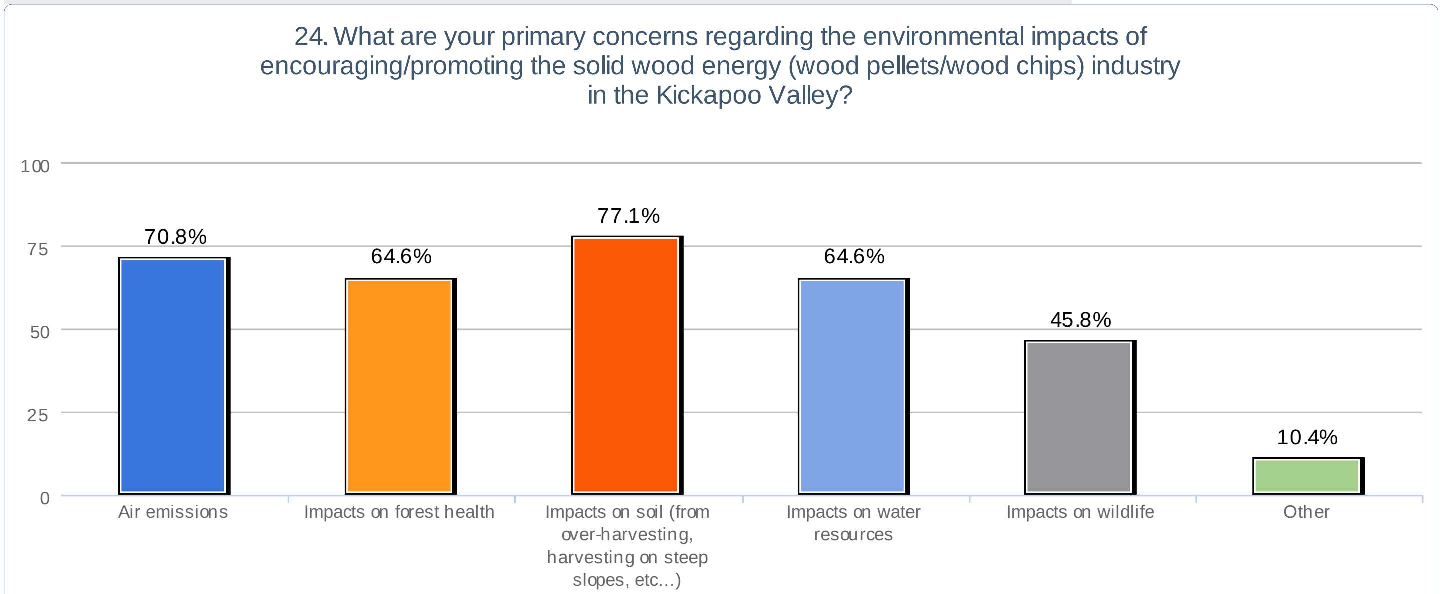
	plenty of sawmills with sawdust and woodchip resources already in place.
1	Smoke pollution is my main concern in using more pellet fuel. I do not want to see more of that in this area but would like this fuel source to be explored if it were not for the pollution problem.
1	I am wondering what species of timber would be used. It seems to me that presently there is a lot of unmarketable timber that needs to be cleared from mixed woodlands containing marketable trees. I have a small farm (120 acres) with 40 acres of woodland and pasture containing woodland. I would like to have a market for the boxelder, poplar and elms.
1	I would be concerned if wood price increase would impact ability of poor to heat their home, or use of wood was environmentally destructive.
1	wood burning is dirty and inefficient compared to commercially produced electricity; natural gas; propane
1	People heating with solid wood fuel have source of cheap fuel or they wouldn't have installed the furnace to burn it. New construction and/or new furnace in old home in not a thriving industry here.



23. Are you concerned about the environmental impacts of encouraging/promoting the solid wood energy industry (wood pellets/wood chips) in the Kickapoo Valley?

Value	Count	Percent %
Yes	51	53.7%
No	44	46.3%

Statistics	
Total Responses	95



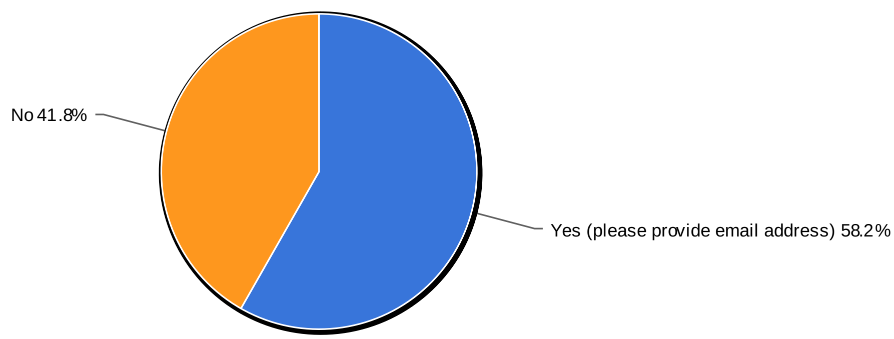
24. What are your primary concerns regarding the environmental impacts of encouraging/promoting the solid wood energy (wood pellets/wood chips) industry in the Kickapoo Valley?

Value	Count	Percent %
Air emissions	34	70.8%
Impacts on forest health	31	64.6%
Impacts on soil (from over-harvesting, harvesting on steep slopes, etc…)	37	77.1%
Impacts on water resources	31	64.6%
Impacts on wildlife	22	45.8%
Other	5	10.4%

Statistics	
Total Responses	48

Open-Text Response Breakdown for "Other"	Count
Left Blank	100
Impact on our rural home	1
Impacts of town roads	1
Trees good air conditioners - shade, wind protection give off oxygen, we need them!	1
impacts on other local energy providers	1
positive impacts compared to petroleum	1

25. Please provide your e-mail address here if you would like to be sent a web site link to view and download the results of the Survey and Feasibility Study when it is completed.



25. Please provide your e-mail address here if you would like to be sent a web site link to view and download the results of the Survey and Feasibility Study when it is completed.

Value	Count	Percent %
Yes (please provide email address)	53	58.2%
No	38	41.8%

Statistics	
Total Responses	91

Open-Text Response Breakdown for "Yes (please provide email address)"	Count

E-mail addresses are hidden to protect individual's privacy.

26. Please provide any additional comments you may have regarding the expansion of wood pellet and/or wood chip heating in the Kickapoo Valley.

Count	Response
1	Again, more information
1	Go for it!
1	I forgot to include transportation costs and impact in my concerns
1	If it is financially doable it will happen on its own.
1	If this could be expanded, maybe the cost of pellets could come down.
1	It seems a reasonable idea if it can be accomplished in a sustainable manner!
1	The more people know about this concept, the more support there will be for it.
1	We would encourage the expansion of increased use of all wood products.
1	yes
1	I think that wood fuel is preferable to oil or propane, but not preferable over solar, wind, or geothermal. We need to promote the use of all energy sources that are renewable, but also least impacting on the world environment. The cost over time and the payback on investment over time both monetarily and in labor intensity. Needs to be factored in.
1	Don't have enough information to complete the survey intelligently. Need to know if it would cause air quality problems and if it would cause too many trees to be cut down.
1	I think chips used for heating homes, schools, businesses, etc. are a great idea. Challenge may be dealing with slopes and equipment limitations.
1	If the study doesn't make the case for pellets or chips, I hope you'll be creative and look to other options for wood products - mulch, grilling coal etc.
1	There are gasification wood furnaces that operate much more efficiently than even catalytic wood burners. (Wood Gun, Essex) The gasification furnace uses an induction fan rather than a blower, inducing a down draft into a refractory. The gasses emitted from the hot wood are burned first, greatly reducing unspent combustibles. Both brands have wood pellet feeders and can be outside units.
1	I have been heating my resident with wood pellets for over 10 years and they have been a good source of heat. The only thing I would like to see is the price to be a little more economical.
1	We own a pellet stove and have yet to install it. Regarding my answer on not changing from propane if it was 53% less than pellets, we heat the downstairs of our home/business with wood and hope to supplement with pellets. But the upstairs is heated with propane primarily. The venting in the house makes this the most practical and efficient. If there were a way to switch our furnace over to pellets with little disruption, that would be something to interest us.
1	We have the resource of wood products and those that could be used will be wood that could be harvested for this use would fit TSI needs. It will be expensive to do this properly and any investment in this will face extremely stiff competition from hydrocarbon fuels. It needs to be feasible without tax payer funds to make it work. It will take some seed money to start this but your business plan needs to work without continued subsidies such as solar and wind still need to make them work.
1	I think that your questions about pellets being over 7% more than NG is misleading and unproductive. NG goes up and down so you'll never be able to pin it down.
1	If done properly, it would help the economy and there would be less waste when the woods are harvested.
1	I am in favor of development of wood heating if ALL of the products taken from our forests are used ONLY LOCALLY and never shipped away. The wood belongs HERE
1	I'm the Monroe County Economic Development Coordinator and I based this survey off of my family farm. We are having our Annual Monroe County Economic Development Conference on Feb. 24, 2014 and one of our panels is on alternative energy. I'd love to invite you to be part of the event. Please use my e-mail address that I used in this survey to contact me. Thanks!
1	Locally produced pellets could be a local source of employment, sourcing material has to be done responsibly.
1	Do we have any companies around la farge that has a lot of excess wood chips that could push or support a mass increase in demand of wood chips. Or would they be creating this company?
1	I'm not saying we all should BURN wood!! I'm saying we should manufacture wood pellets! Decaying wood produces carbon dioxide just as burning wood does so I'm not concerned about the CO2 but I'm concerned about particulates. But somebody is going to burn wood pellets and we should take advantage of the market!

Appendix C

US Pellet Plants

US PELLET PLANTS

OPERATIONAL US PLANTS BY REGION (METRIC TONS)

Northeast

Plant	State	Feedstock	Capacity
Corinth Wood Pellets LLC	ME	HRDWD and SFTWD	75,000
Geneva Wood Fuels	ME	HRDWD	90,000
Maine Woods Pellet Company	ME	HRDWD and SFTWD	105,000
Northeast Pellets LLC	ME	HRDWD and SFTWD	40,000
Jaffrey Manufacturing Facility	NH	HRDWD and SFTWD	84,000
Associated Harvest Inc.	NY	HRDWD	8,000
Dry Creek Products	NY	HRDWD	100,000
Curran Renewable Energy	NY	HRDWD and SFTWD	100,000
Essex Pallet & Pellet	NY	HRDWD and SFTWD	6,000
Hearthside Wood Pellets	NY	HRDWD	700
Deposit Manufacturing Facility	NY	HRDWD and SFTWD	84,000
Schuyler Manufacturing Facility	NY	HRDWD and SFTWD	84,000
Instantheat Wood Pellets Inc.	NY	HRDWD	50,000
Alexander Energy Inc	PA	HRDWD	8,500
Allegheny Pellet Corporation	PA	HRDWD	70,000
Barefoot Pellet Company	PA	HRDWD	45,000
Nazareth Pellets	PA	SFTWD	50,000
PA Pellets	PA	SFTWD	50,000
Energex Pellet Fuel, Inc.	PA	HRDWD	120,000
Great American Pellets	PA	HRDWD	30,000
Greene Team Pellet Fuel Company	PA	HRDWD	50,000
Log Hard Premium Pellets Inc.	PA	HRDWD	25,000
Pellheat Inc.	PA	HRDWD	5,000
Penn Wood Products, Inc.	PA	HRDWD	5,000
Tri State Biofuels	PA	SFTWD	50,000
Wood Pellets C&C Smith Lumber	PA	HRDWD	36,000
Vermont Wood Pellet Co. LLC	VT	SFTWD	15,000

Midwest

Plant	State	Feedstock	Capacity
Koetter & Smith, Inc.	IN	HRDWD	205,000
Southern Indiana Hardwoods	IN	HRDWD	10,000
American Pellet Company	MI	HRDWD and SFTWD	12,000
Wolverine Hardwood Pellets	MI	HRDWD	1,000
Equustock - Clare	MI	HRDWD and SFTWD	36,000
Fiber By-Products - White Pigeon	MI	HRDWD	60,000
Isabella Pellet	MI	HRDWD and SFTWD	40,000
Kirtland Products, LLC	MI	HRDWD and SFTWD	35,000
Maeder Brothers Quality Wood Pellets, Inc.	MI	HRDWD	18,000
Michigan Timber	MI	SFTWD	18,000
Michigan Wood Fuels	MI	HRDWD	50,000
Vulcan Wood Products	MI	HRDWD and SFTWD	9,000
Wood Pellet Coop	MN	HRDWD	Undisclosed
Ozark Hardwood Products	MO	HRDWD	85,000
Show Me Energy Cooperative	MO	Biomass Crops	15,000
Horizon Biofuels Inc.	NE	HRDWD and SFTWD	20,000
American Wood Fibers - Circleville	OH	HRDWD and SFTWD	50,000
Deadwood Biofuels LLC	SD	SFTWD	71,000
American Wood Fibers - Wisconsin	WI	HRDWD and SFTWD	25,000
Dejno's Inc.	WI	HRDWD and SFTWD	40,000
Fiber Recovery Inc.	WI	HRDWD	13,000
Great Lakes Renewable Energy, Inc.	WI	HRDWD and SFTWD	70,000
Green Friendly Pellets, LLC	WI	HRDWD	17,000
Indeck Energy Ladysmith Biofuel Center LLC	WI	HRDWD	90,000
Marth Peshtigo Pellet Company	WI	HRDWD	64,000
Marth Wood Shavings Supply	WI	HRDWD	24,000

West

Plant	State	Feedstock	Capacity
Mallard Creek Inc.	CA	SFTWD	60,000
Confluence Energy-Kremmling	CO	SFTWD	100,000
Confluence Energy-Walden	CO	SFTWD	65,000
Environmental Energy Partners	CO	SFTWD	18,000
Jensen Lumber Co.	ID	SFTWD	15,000
Lignetics of Idaho Inc	ID	SFTWD	80,000
North Idaho Energy Logs Inc.	ID	SFTWD	60,000
North Idaho Energy Logs Inc.	ID	SFTWD	45,000
Lemhi Valley Pellets	ID	HRDWD and SFTWD	2,600
Rocky Canyon Pellet Co.	ID	HRDWD and SFTWD	10,000
Bear Mountain Forest Products - Cascade Locks	OR	SFTWD	40,000
Bear Mountain Forest Products- Brownsville	OR	SFTWD	120,000
Blue Mountain Lumber Products	OR	SFTWD	20,000
Frank Pellets	OR	SFTWD	21,000
Malheur Pellet Mill	OR	SFTWD	18,000
Pacific Pellet LLC	OR	HRDWD	40,000
Dillard Composite Specialties	OR	SFTWD	40,000
West Oregon Wood Products - Banks	OR	SFTWD	30,000
West Oregon Wood Products - Columbia City	OR	SFTWD	50,000
Woodgrain Millwork Inc.	OR	SFTWD	Undisclosed
Manke Lumber Company	WA	HRDWD	38,000
Olympus Pellets - Shelton	WA	SFTWD	50,000
Arbor Pellet LLC	UT	HRDWD and SFTWD	85,000
Bearlodge Forest Products	WY	SFTWD	5,000

Southeast

Plant	State	Feedstock	Capacity
Equustock - Jasper	AL	HRDWD and SFTWD	36,000
Lee Energy Solutions	AL	HRDWD	110,000
Nature's Earth Pellets - Reform	AL	SFTWD	75,000
Westervelt Renewable Energy,	AL	SFTWD	309,000
Fiber Energy Products AR LLC	AR	HRDWD	110,000
Fiber Resources Inc.	AR	HRDWD	Undisclosed
Equustock - Montebrook	FL	SFTWD	40,000
Green Circle Bio Energy Inc	FL	HRDWD and SFTWD	560,000
Appling County Pellets LLC	GA	HRDWD and SFTWD	200,000
Georgia Biomass	GA	HRDWD and SFTWD	825,000
SEGA Biofuels LLC	GA	SFTWD	150,000
Varn Wood Products	GA	SFTWD	80,000
Somerset Pellet Fuel	KY	HRDWD	50,000
Southern Kentucky Pellet Mill	KY	HRDWD	12,000
Anderson Hardwood Pellets	KY	HRDWD	25,000
Bayou Wood Pellets	LA	HRDWD and SFTWD	60,000
New Biomass Energy	MS	HRDWD and SFTWD	250,000
Enviva Pellets Amory	MS	HRDWD and SFTWD	100,000
Enviva Pellets Wiggins	MS	HRDWD and SFTWD	150,000
Enviva Pellets Ahoskie	NC	HRDWD and SFTWD	385,000
Nature's Earth Pellets - Laurinburg	NC	HRDWD and SFTWD	100,000
Low Country Biomass	SC	HRDWD	240,000
Ace Pellet Co. LLC	TN	HRDWD	10,000
Hassell & Hughes Lumber Co.	TN	HRDWD	3,000
Henry County Hardwoods Inc.	TN	HRDWD	40,000

Southwest

Plant	State	Feedstock	Capacity
Forest Energy Corp.	AZ	SFTWD	62,000
Equustock - Raton	NM	HRDWD and SFTWD	40,000
Mt. Taylor Machine Pellet Fuel	NM	HRDWD and SFTWD	6,000
German Pellets Texas	TX	HRDWD and SFTWD	550,000
Patterson Wood Products Inc.	TX	SFTWD	40,000
Appalachian Wood Pellets	WV	HRDWD	Undisclosed
Hamer Pellet Fuel Elkins	WV	HRDWD	60,000
Lignetics of West Virginia Inc.	WV	HRDWD	125,000

Other

Plant	State	Feedstock	Capacity
Superior Pellet Fuels LLC	AK	HRDWD	12,000

US PELLET PLANTS UNDER CONSTRUCTION (METRIC TONS)

Plant	State	Feedstock	Capacity
International Biomass Energy LLC	AL	HRDWD and SFTWD	500,000
Selma Plant	AL	HRDWD and SFTWD	300,000
Dover Resources, Inc.	CA	HRDWD and SFTWD	35,000
Vulcan Renewables LLC	FL	SFTWD	120,000
Fulghum Graanul Oliver LLC	GA	HRDWD and SFTWD	200,000
German Pellets Urania	LA	SFTWD	1,000,000
F.E. Wood & Sons - Natural Energy	ME	HRDWD and SFTWD	35,000
Enviva Pellets Northampton	NC	HRDWD and SFTWD	500,000
Enviva Pellets Southampton	VA	HRDWD and SFTWD	500,000

PROPOSED US PELLET PLANTS (METRIC TONS)

Plant	State	Feedstock	Capacity
Crockett Plant	TX	Hardwood and Softwood	44,000
Beaver Wood Energy	VT	Hardwood and Softwood	110,000
Biomass Power Louisiana LLC	LA	Softwood	1,000,000
Morehouse BIoEnergy	MA	Woody Biomass	500,000
Enova Energy- Gordon	GA	Softwood	550,000
Enova Energy- Warrenton	GA	Softwood	550,000
First Georgia BioEnergy	GA	Softwood	38,000
Fram Renewable Fuels - Hazlehurst	GA	Softwood	500,000
General Biofuels - Georgia	GA	Softwood	440,000
Highland Biofuels LLC	KY	Hardwood	100,000
Mt. Taylor - WoodYouRecycle! Facility	NM	Hardwood and Softwood	6,000
Franklin Pellets	VA	Hardwood and Softwood	500,000
Nex Gen Biomass	AR	Softwood	500,000
Riverside Pellets, LLC	NC	Hardwood and Softwood	50,000
Thermogen Industries	NH	Woody Biomass	110,000

Appendix D

Possible Sources of Wood Residue

POSSIBLE SOURCES OF WOOD RESIDUE

Primary Forest Industry

Company	Type	City	State	County	Annual Prod. (MBF)
Fillmore Sawmill	Stationary	Wykoff	MN	Fillmore	0-100
Root River Hardwoods Inc.	Stationary	Preston	MN	Fillmore	3000+
Bill Johnston	Portable	Houston	MN	Houston	0-100
Crystal Valley Hardwoods	Stationary	Houston	MN	Houston	1001-3000
Staggemeyer Stave Co	Stationary	Caledonia	MN	Houston	1001-3000
Claude Patzner	Stationary	Utica	MN	Winona	0-100
Gingerich Sawmill	Stationary	St. Charles	MN	Winona	101-500
Montana Cattle and Timber	Stationary	Winona	MN	Winona	0-100
Pete Jilk	Portable	St. Charles	MN	Winona	0-100
Tom Heim	Portable	St. Charles	MN	Winona	0-100
Heitman Lumber	Sawmill	Durand	WI	Buffalo	1,500
Serum Lumber	Sawmill	Alma	WI	Buffalo	400
Bill Foley	Sawmill	Eastman	WI	Crawford	200
Hamel Forest Products (Ferryville)	Sawmill	Vesper	WI	Crawford	3,500
Nelson Hardwood Lumber	Sawmill	Pr Du Chien	WI	Crawford	7,500
Cooks Wood	Sawmill	Fennimore	WI	Grant	25
Dressler Sawmill	Sawmill	Lancaster	WI	Grant	75
F&N Mills	Sawmill	Boscobel	WI	Grant	350,
Frazier & Sons Logging and Lumber	Sawmill	Blue River	WI	Grant	2,000
Gary B Fuller	Sawmill	Pr Du Chien	WI	Grant	500,
Michael Udelhofen Sawmill	Sawmill	Cassville	WI	Grant	120
Schwabe Enterprises	Sawmill	Muscoda	WI	Grant	300
Southern Wisconsin Silo Co	Firewood	Blue River	WI	Grant	114
Wieland & Sons	Sawmill	Muscoda	WI	Grant	2,000
Nelson Hardwood Lumber Co Inc	Sawmill	Muscoda	WI	Iowa	3,000
Black River Country Log Homes Inc.	Log Home	Black River Falls	WI	Jackson	300
Levis Creek Forest Products	Sawmill	Black River Falls	WI	Jackson	2,000
Meisters Forest Products	Sawmill	Black River Falls	WI	Jackson	10,000
John's Welding	Firewood	Tomah	WI	Monroe	91
Ron Larson Sawmill	Sawmill	Cashton	WI	Monroe	300
Grell Lumber Co	Sawmill	Gotham	WI	Richland	3,000
Riverside Sawmill	Sawmill	Muscoda	WI	Richland	5,000
Rockbridge Sawmill Inc	Sawmill	Richland Center	WI	Richland	5,000
Hack-Away Forest Products Inc	Sawmill	Baraboo	WI	Sauk	1,500
Midwest Hardwoods	Sawmill	Reedsburg	WI	Sauk	15,000
Ray Zobel & Son Inc	Sawmill	Reedsburg	WI	Sauk	50
Red Beard Lumber, LLC	Sawmill	Spring Green	WI	Sauk	100
Ruhland Harland Sawmill	Sawmill	Loganville	WI	Sauk	400
Timbergreen	Sawmill	Spring Green	WI	Sauk	20
Blair Hardwoods	Sawmill	Blair	WI	Trempealeau	4,000
Hawkeye Forest Products	Sawmill	Trempealeau	WI	Trempealeau	4,500
Koxlien Bros Wood Products	Sawmill	Strum	WI	Trempealeau	5,000
Pine Creek Pallet Co	Sawmill	Dodge	WI	Trempealeau	454
S&S Wood Products Inc	Shavings	Independence	WI	Trempealeau	2,727
Cook Creek Sawmill	Sawmill	Norwalk	WI	Vernon	200
David Troyer	Sawmill	LaFarge	WI	Vernon	200
Eli Yoder	Shavings	Westby	WI	Vernon	100
Emanuel P Miller	Sawmill	LaFarge	WI	Vernon	200
Ervin Miller	Sawmill	Chaseburg	WI	Vernon	300
Jacob Schrock	Sawmill	Westby	WI	Vernon	300
White City Lumber Inc.	Sawmill	Hillsboro	WI	Vernon	2,000
Schroer Hardwood Lumber Co.	Sawmill	LaFarge	WI	Vernon	1,000

Secondary Forest Industry

Company	City	State	County	Annual Prod. (MBF)
Builders Millwork Inc	Mondovi	WI	Buffalo	0.5
Prairie Cabinet Shop	Prairie Du Chien	WI	Crawford	
Homette Corp (Div Skyline)	Lancaster	WI	Grant	
Roddy's Signs Inc	Boscobel	WI	Grant	6,000
Wisconsin Woodworks Inc	Dickeyville	WI	Grant	
Tri Star Pallets inc.	Highland	WI	Iowa	
Walnut Hollow Farm	Dodgeville	WI	Iowa	
Hart Tie & Lumber	Black River Falls	WI	Jackson	
Levis Creek Forest Products	Black River Falls	WI	Jackson	7,150
Endeavor Hardwoods	Lyndon Station	WI	Juneau	4,580
Meadow Valley Log Homes	Mather	WI	Juneau	4,010
Necedah Pallet Co Inc	Necedah	WI	Juneau	5,750
Stan's Ind Woodwork Inc	Lyndon Station	WI	Juneau	4,000
Cabinet Factory Inc	La Crosse	WI	Lacrosse	125,000,000
Coulee Region Log Homes Co	Holmen	WI	Lacrosse	1.5
Creative Laminates Inc	Lacrosse	WI	Lacrosse	2,000
Design Cabinetry Inc	Holmen	WI	Lacrosse	1,000
Heram Cust Woodworking	Onalaska	WI	Lacrosse	
Modern Woodworking Inc.	LaCrosse	WI	Lacrosse	100,000
Northern Wood Prod Inc	La Crosse	WI	Lacrosse	
Realwood Products Inc	La Crosse	WI	Lacrosse	
3-D Enterprises	Sparta	WI	Monroe	10,500
MacDonald & Owen Veneer & Lumber Co	Sparta	WI	Monroe	75,000
Northland Pallet	Sparta	WI	Monroe	30,150
Universal Forest Products Inc	Warrens	WI	Monroe	25,000
Agwoods Inc	Richland Center	WI	Richland	3,000
Pine River Woodcraft	Richland Center	WI	Richland	4,000
Richland Patterns Inc	Richland Center	WI	Richland	2
Conifer West Woodworks	Spring Green	WI	Sauk	15
Harms Cabinet & Millwork	Reedsburg	WI	Sauk	
Hillcrest	Hillpoint	WI	Sauk	15.5
Reedsburg Hardwoods	Reedsburg	WI	Sauk	
Schulter Wood Products Inc	Plain	WI	Sauk	5
Spiro Furniture	Hillpoint	WI	Sauk	
Ashley Furniture Ind	Whitehall	WI	Trempealeau	23
Ashley Furniture Industries	Arcadia	WI	Trempealeau	2,500,000
Blade Millworks Inc	Strum	WI	Trempealeau	
Hawkeye Forest Products	Trempealeau	WI	Trempealeau	3.7
Norwinn Company Inc	Galesville	WI	Trempealeau	
Speltz Sign Co	Whitehall	WI	Trempealeau	600
Starwood Rafters Inc	Independence	WI	Trempealeau	100,000

Appendix E

Wisconsin State Incentives

WISCONSIN STATE INCENTIVES

JOB CREATION DEDUCTION

Beginning with taxable years starting on or after January 1, 2011, a subtraction from federal income is allowed based on the increase in the number of full-time equivalent employees that are employed in Wisconsin during the taxable year. The subtraction from federal income is equal to $2,000 per eligible employee for businesses with gross receipts greater than $5 million or $4,000 per eligible employee for businesses with gross receipts of $5 million or less.

WHO IS ELIGIBLE TO CLAIM THE DEDUCTION

An individual, estate, trust, limited liability company (LLC), corporation or tax exempt corporation may claim the deduction.

WHO MAY NOT CLAIM THE DEDUCTION

Partnerships, LLCs treated as partnerships, and tax option (S) corporations cannot claim the deduction; however, the deduction computed by those business entities can pass through to the partners, members, or shareholders.

QUALIFICATIONS

To qualify for the Wisconsin jobs creation deduction, you must meet all of the following conditions:

- The employer must increase the number of full-time equivalent employees employed in Wisconsin during the taxable year
- The employer can be an existing business or a new business
- The business relocation credit or deduction cannot also be claimed

DEFINITIONS

"Full-time equivalent employee" means an employee who is a resident of Wisconsin, is employed in a regular, non-seasonal job, and who, as a condition of employment, is required to work at least 2080 hours per year, including paid leave and holidays. See Wis. Admin. Code Tax 3.05(2)(c).

"Employee" means any officer of a corporation or any individual who has the status of an employee or any individual who performs services for remuneration for any person. See sec. 3121(d) of the Internal Revenue Code.

CLAIMING THE DEDUCTION

Use Schedule JC to claim the job creation deduction. For further information, you may visit the department's website at revenue.wi.gov, write to the Wisconsin Department of Revenue, Mail Stop 5-144, PO Box 8906, Madison WI 53708-8906, or call the Department of Revenue at 608-266-2772.

DEDUCTION COMPUTATION

The deduction is based on the increase in the number of full-time equivalent employees employed by the taxpayer in Wisconsin during the taxable year, multiplied by $4,000 for a business with gross receipts no greater than $5 million in the taxable year or $2,000 for a business with gross receipts greater than $5 million in the taxable year.

JOBS TAX CREDIT

The Jobs Tax Credit is available for businesses for taxable years that begin on or after January 1, 2010.

CLAIMING THE CREDIT

Use Schedule JT to claim the Jobs Tax Credit and include the schedule with your Wisconsin franchise or income tax return. Also include a copy of the certificate of eligibility to claim tax benefits issued by the WI EDC when the tax return is filed. For more information regarding how to become certified, visit the WI EDC web site at www.wedc.org.

WHO IS ELIGIBLE TO COMPUTE THE CREDIT

An individual, estate, trust, partnership, limited liability company (LLC), corporation, or tax-exempt organization that is certified by the WI EDC may compute the credit.

WHO MAY NOT CLAIM THE CREDIT

Partnerships, LLCs treated as partnerships, and tax option (S) corporations cannot claim the credit; however, the credit computed by those business entities can pass through to the partners, members, or shareholders.

QUALIFICATIONS

To qualify for the Wisconsin Jobs Tax Credit, you must meet all of the following conditions:

- The WI EDC must certify that the claimant is operating or intends to operate a business in Wisconsin and that a contract has been entered into with the Wisconsin EDC.
- The claimant has received from the WI EDC a notice of eligibility to receive tax benefits that reports the amount of tax benefit for which claimant is eligible.

CREDIT COMPUTATION

The credit is based on the amount of wages paid to eligible employees in the taxable year, subject to a maximum amount of ten percent of such wages, and the costs incurred by the claimant to undertake training activities in current year.

UNUSED CREDITS

For taxable years that began in 2010 and 2011, the Jobs Tax Credit could only be used to reduce the amount of tax owed to zero. If there are unused credits remaining from those years, they may be carried forward to taxable years beginning in 2012 when the credit can be used to reduce the amount of tax to zero and any remaining credit will be refunded.

CREDIT IS INCOME

The amount of credit computed on Schedule JT is income and must be reported on your Wisconsin franchise or income tax return for the year computed.

WISCONSIN MANUFACTURING AND AGRICULTURE CREDIT

The manufacturing and agriculture credit is available to individuals and entities for taxable years that begin on or after January 1, 2013, for manufacturing and agricultural activities in Wisconsin.

CLAIMING THE CREDIT
A schedule to be used for claiming the credit will be available on the department's website by December 1, 2013.

WHO IS ELIGIBLE TO CLAIM THE CREDIT
An individual, estate, trust, partnership, limited liability company (LLC), or corporation can compute the credit if the claimant owns or rents and uses in Wisconsin real property and improvements assessed as agriculture property under s. 70.32(2)(a)4., Wis. Stats., or owns or rents and uses in Wisconsin real and personal manufacturing property assessed under s. 70.995, Wis. Stats.

Partnerships, LLCs treated as partnerships, and tax-option (S) corporations cannot claim the credit; however, the credit computed by those business entities can pass through to the partners, members, or shareholders.

Trusts and estates may pass the credit through to their beneficiaries based on the income allocable to each.

WHO MAY NOT CLAIM THE CREDIT
Insurance companies cannot claim the credit.

Note: A person who rents land to, for example a farmer, to be used in agriculture cannot claim the credit based on the rental income. Only the farmer who rented the land and used it in agriculture may use the rented land value in computing the credit.

CREDIT COMPUTATION
The credit is a percentage of "eligible qualified production activities income." The credit is calculated by multiplying eligible qualified production activities income by one of the following percentages.

- For taxable years beginning after December 31, 2012, and before January 1, 2014, 1.875 percent
- For taxable years beginning after December 31, 2013, and before January 1, 2015, 3.75 percent
- For taxable years beginning after December 31, 2014, and before January 1, 2016, 5.526 percent
  - For taxable years beginning after December 31, 2015, 7.5 percent

For a corporation, eligible qualified production activities income is the lesser of:

- eligible qualified production activities income,
- income apportioned to Wisconsin, or
- income taxable to Wisconsin as determined by combined reporting law, if the corporation is a member of a Wisconsin combined group

Income from the following activities may not be used to claim the credit

- Film production,
- Producing, transmitting or distributing electricity, natural gas, or potable water,
- Constructing real property (except that income from producing real property can qualify for the credit),
- The sale of food and beverage that you prepared at a retail establishment,
- The lease, rental, license, sale, exchange, or other disposition of land, and
- Engineering or architectural services.

CREDIT IS INCOME
The amount of credit that is claimed is income and must be reported as income on the claimant's Wisconsin franchise or income tax return for the taxable year Page 2 of 2 immediately after the taxable year in which the credit is computed.

UNUSED CREDITS

- The amount of credit not entirely offset against Wisconsin income or franchise taxes may be carried forward and credited against Wisconsin income or franchise taxes due for up to fifteen years.
- The credit can only be used to offset the Wisconsin franchise or income tax due of the corporation that generated it. It cannot be shared with other members of a combined group.
- Nothing in this fact sheet replaces or changes any provisions of Wisconsin tax law, administrative rules, or court decisions.

PROPERTY TAX EXEMPTION FOR MANUFACTURING MACHINERY AND EQUIPMENT

Under sec. 70.11(27)(b), Wis. Stats., "machinery and specific processing equipment; and repair parts, replacement machines, safety attachments and special foundations for that machinery and equipment; that are used exclusively and directly in the production process in manufacturing tangible personal property, regardless of their attachment to real property, but not including buildings" are exempt from property tax. The statute specifies that the exemption is to be strictly construed and provides definition of "building," "machinery," "manufacturing," "production process," "used directly," and "used exclusively," among other terms.

To qualify for the machinery and equipment (M&E) exemption, a business must first be classified as "manufacturing." These are activities that are classified as "manufacturing" in the Standard Industrial Classification Manual. In addition, mining, photo finishing laboratories, scrap metal processing, wastepaper processing and hazardous waste facilities are defined to be manufacturing activities. [See attached for a complete list of manufacturing activities.] A business owned by a manufacturer but not classified manufacturing does not qualify for the M&E exemption.

Once classified manufacturing, the property must be used exclusively and directly in the manufacturing production process to be exempt. The production process begins with the conveyance of raw materials to the first work point and ends with the conveyance of the finished product to the place of first storage. Thus, receipt, inspection and storage of raw materials and storage of finished products are not part of the production process.

To be used directly in the production process means that the qualifying property must cause a physical or chemical change in raw materials or cause a movement of raw materials. Equipment used only to preserve or protect raw materials is considered taxable storage equipment. The property may not be used for other purposes more than 5% of its total use.

Exempt items include the following:

- Machinery and specific processing equipment
- Repair parts
- Replacement machines
- Safety attachments
- Special foundations for qualifying machinery and equipment
- Parts of buildings that are part of the production process, e.g. kilns, malt aging silos, graving docks used as conveyers, work platforms or measuring instruments
- Equipment used for storing work in process less than three days
- Forklifts/conveyers used at least 95% of time for moving material along production line
- Quality control equipment used for testing the product manufactured
- Power wiring
- Motors, compressors and computers that exclusively power or operate exempt machines
- Process piping
- Packaging equipment, including in–house printing of labels, instructions, manuals
- Hand tools used with exempt machines
- Computers used in manufacturing process

Taxable items include the following:

- Boilers, generators, transformers
- Quality control equipment of raw materials received
- Shipping and receiving equipment
- Raw material storage equipment, e.g. racks, tanks, silos, refrigeration
- Finished product storage equipment, including refrigeration
- Storage equipment for work in process stored for more than three days
- Forklifts and shelving used in warehouses
- Equipment to maintain and repair production machines, buildings and grounds
- Communication equipment
- Research and development equipment used for new products or improving existing products
- Pilot plants involved with prototype development where sample products are not sold to customers
- Creative work by authors, artists, ad agencies, photographers, etc.
- In addition to the M&E exemption, there are separate exemptions for waste treatment facilities and computers.

Manufacturing Activities

- Metal mining
- Mining and quarrying of nonmetallic minerals, except fuels
- Food and kindred products
- Tobacco manufacturers
- Textile mill products
- Apparel and other finished products made from fabrics and similar materials
- Lumber and wood products
- Furniture and fixtures
- Paper and allied products
- Printing, publishing, and allied industries
- Chemicals and allied products
- Petroleum refining and related industries
- Rubber and miscellaneous plastic products
- Leather and leather products
- Stone, clay, glass and concrete products
- Primary metal industries
- Fabricated metal products, machinery and transportation equipment
- Machinery
- Electrical and electronic machinery, equipment and supplies
- Transportation equipment
- Measuring, analyzing and controlling instruments; photographic, medical and optical goods; watches and clocks
- Photofinishing laboratories
- Scrap processors
- Processors of waste paper, fibers or plastics
- Hazardous waste treatment facilities

Appendix F

PFI Pellet Stove Fact Sheet

Pellet Fuels Institute™

FACT SHEET

Pellet Stoves

Once you experience a pellet stove, it's easy to understand why people rave about these efficient and unique home heaters that generate an automated, economical and earth-friendly wood heat…and all without firewood! For just pennies an hour, a pellet stove can deliver a deep, penetrating warmth that provides independence from high heating bills while emitting almost no wood smoke. And, with tremendous flexibility in installation and sizing, pellet stoves are a sophisticated choice for convenient heat that helps protect the environment and doesn't break the bank.

Help Take Control of Heating Costs

Pellet stoves are the perfect choice for people that often experience high home heating bills due to fluctuating energy costs. In fact, pellet stoves are often installed in homes as secondary heat sources to help maintain control over heating expenses. The reason is the fuel. Pellet stoves burn economical pellets made from recycled sawdust. The economy of pellets is due to the low cost of the materials and the efficiency of the manufacturing processes, as well as the ability for people to lock in an entire year of fuel costs before the beginning of the heating season.

Efficient Heat and Minimal Emissions

Pellet stoves are efficient home heaters thanks to state-of-the-art technology that helps control the fuel-to-air ratio within the stove and ensures almost complete combustion of the fuel. This technology helps to generate minimal wood smoke, making pellet stoves the lowest emission solid-fuel burning hearth products available today and a popular choice in areas where winter air quality is an issue.

Automated Wood Burning

A pellet stove is an automated wood burner. Pellet stoves operate with an easy-to-use convenience while providing a rich, radiant and convection heat. To use a pellet stove, simply load a supply of pellets into the hopper and start the stove. Once the stove is operating, an automated feed system delivers the wood pellets into a burn chamber within the stove where combustion air is forced through the fire creating a mini furnace. In many pellet stoves, the ignition system is also automatic, increasing the convenience factor.

Easily Installed and Maintained

The power-venting feature of a pellet stove allows for installation almost anywhere in a home. The key to installation is placing the stove near an electrical outlet. All pellet stoves require electricity to operate, although battery packs are available for many stoves just in case the power goes out. Once installed, pellet stoves are easy to maintain. Routine tasks include filling the hopper with pellets, emptying the ash pan weekly, periodic cleaning of the burn pot, hopper, ash traps and glass, and annual professional service of the entire unit before the start of each cold season.

Selecting a Pellet Stove

Much like any other appliance, it is important to spend the time to choose the right pellet stove. Before you make your final decision, visit a specialty retailer in your area for experienced advice. A specialty retailer is a trained pellet stove expert. He or she can arrange for installation by a certified professional installer and provide a resource for where to purchase pellets in your area. Specialty retailers are also the best source of information about how to correctly operate a pellet stove and what is necessary for proper maintenance.

For a list of specialty retailers, visit www.pelletheat.org.

Pellet Stove Checklist on reverse side →

Pellet Stove Checklist

Information to consider when selecting a pellet stove

☐ **TYPE:** Pellet stoves are classified by the amount of heat they generate – high versus low output.

☐ **SIZE:** The physical size of a pellet stove is less important than the heat-generating capacity of the stove and the size of the fuel hopper. A small stove can heat a large space but might not hold more than a day's worth of pellets.

☐ **LOCATION:** Pellet stoves require less installation space than other types of stoves and can be located as little as three inches from a wall, depending on the model. A pellet stove must also be installed a specific distance away from combustible surfaces and materials, such as drapes and doors, and be placed on non-combustible surface such as a hearth pad.

☐ **VENTING:** Since pellet stoves are power vented they can be installed almost anywhere in home, including through the ceiling, through a wall, or into an existing masonry chimney as long as the installation includes at least three feet of vertical chimney. Pellet stove chimneys are unique and are usually three or four inches in diameter. The chimney is also lined with stainless steel.

☐ **FEATURES:** There are three different types of ignition systems available in pellet stoves: standard (requiring the use of starter gel and a match); self-starting (where the user pushes a button to start the stove or uses a remote control); and fully automatic (where the stove is controlled by a thermostat and cycles on and off depending on the heat level selected). Other optional features include self-cleaning glass, self-cleaning burn pots, and deep pedestal ash pans. Some stove models even have battery back-up systems for when the power goes out (since pellet stoves require electricity to operate).

☐ **STYLE:** Full bay view doors and windows trimmed in gold or black are examples of the styling options available for pellet stoves. Porcelain or cast iron finishes are also available options with many models of pellet stoves.

☐ **INSTALLATION:** To ensure the safe and reliable installation of a pellet stove, the Hearth, Patio & Barbecue Association recommends that people use a specialty retailer and a certified professional installer to perform installation tasks. These professionals will obtain the necessary building permits, make sure that the necessary three feet of vertical chimney is used in the installation and ensure the stove is installed on a hearth pad.

☐ **MAINTENANCE:** Pellet stoves are simple to maintain, but routine tasks must be performed regularly to ensure proper function. These tasks include emptying the ash drawer, cleaning the burn pot, hopper, ash traps and glass, and scheduling professional service inspections each year before the start of the cold season. In addition, the HPBA recommends that chimneys and vents be inspected annually (and cleaned as necessary) by a chimney sweep certified by the Chimney Safety Institute of America.

☐ **FUEL REQUIREMENTS:** Two grades of wood pellet fuel are available for pellet stoves: premium and standard. The difference between the two is their percentage of inorganic ash content. There is significantly less stove maintenance with the use of premium pellet fuel. There are also pellet stoves that can burn pellets with corn, a growing trend in home heating.

☐ **AVERAGE COST:** The price of the appliance itself is only part of the total cost of owning a pellet stove. Other considerations are the cost of the chimney and installation, annual fuel costs and annual maintenance.

COST CHECKLIST:

☐ Pellet Stove ________________

☐ Chimney ________________

☐ Installation/Delivery ________________

☐ Hearth Pad ________________

☐ Annual Fuel Costs ________________

☐ Annual Maintenance ________________

Pellet Stove Benefits

- 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 in the home.

This information brought to you by this specialty retailer:

Appendix G

Forest Products Services Specialists Job Description

Forest Products Services Specialists

Job Announcement Code(s): 13-04466

County(ies):	*Statewide
Classification Title: / JAC: **Job Working Title:**	FORESTER-ADV 13-04466 Forest Products Services Statewide Specialist FORESTRY SPECIALIST 13-04466 Forest Products Services District Specialist
Type of Employment:	Full Time (40 hrs/week)
Salary:	Starting pay is between $22.247 and $33.000 per hour plus excellent benefits. Well qualified candidates will likely earn between $27.00 and $30.00 per hour. A six month probationary period is required. This position is in pay schedule/range 15-03.

The Department of Natural Resources is dedicated to the preservation, protection, effective management, and maintenance of Wisconsin's natural resources. The Division of Forestry is seeking four new specialists to grow the Forest Products Services (FPS) Team. This recruitment is for one Statewide Specialist and three District Specialists. Applicants that are interested in one or both of the positions can apply with this exam. If invited to future interviews, candidates will be asked to state which position(s) they are interested in applying for and their office location preference.

The FPS Team provides expert technical assistance, consultation, and technology transfer to a variety of stakeholders including businesses as well as internal and external customers to support and grow Wisconsin’s forest products industry.

The District Specialists will be located in field offices around the state. Locations will be determined based on candidate preference, matching a candidates specialized knowledge/experience with the industry needs of a district, and available office space.

The Statewide Specialist can be located in a field office based on candidate preference but the preferred location is in Madison, WI.

Job Duties:

District Specialists (three positions):

The District Specialists develop detailed knowledge of the forest resource and forest products industry within assigned counties. They provide excellent customer service and face-to-face interactions with members of Wisconsin’s forest products industry to foster job growth, job retention, and industry expansion. The District Specialists travel frequently to serve multiple counties comprising a geographic region as well as providing statewide support outside their district when needed. They conduct or coordinate manufacturing process efficiency studies or other business process improvement systems and assist forest products companies to improve their competitiveness and market positioning. They compile, interpret and provide roundwood and forest by-product supply information and identify, establish, and develop regional supply chain networks. The District Specialists provide information about wood products, prices, availability and product uses to regional partners and identify, develop, and evaluate regional marketing strategies. They also work to align existing businesses with potential partner groups and opportunities and assist communities and businesses with wood utilization and marketing plans to mitigate the impacts of invasive species. The District Specialists provide technical assistance to the forest industry including the introduction of new technology and manufacturing practices.

Statewide Specialist (one position):

The Statewide Specialist sets the pace for the division through innovation, adaptation, best practices, and transfer of knowledge. This position is a key internal and external consultant for staff, leadership, inter-divisional teams, and partner groups. This position maintains cutting-edge knowledge and expertise by staying abreast of current research and maintaining an effective professional network. The Statewide Specialist coordinates and conducts feasibility studies and reviews business plans and plant designs for new forest product business start-ups and plant expansions. They lead the Timber Product Output Survey and develop, produce, and distribute lists of Wisconsin's primary, secondary, and other forest product industries. The Statewide Specialist is the lead and point of contact for statewide forest products industry supply chains and distribution strategies. They identify prospective businesses by using business directories, following leads from existing clients, participating in organizations, and attending trade shows and conferences. The Statewide Specialist monitors, investigates, and provides expert guidance for new market developments (including export markets). They provide assistance with international trade missions for business development. They assist partners with wood utilization and marketing strategies to mitigate the impacts of invasive species. The Statewide Specialist also collaborates on the development of policy related to emerging issues such as labor availability, transportation, life cycle analysis, ecological services (e.g. carbon markets), renewable energy, woody biomass, and invasive species impacts on wood markets.

Job Knowledge, Skills and Abilities:

~ Solid understanding of the principles and practices of sustainable forest management.
~ Knowledge of forest product raw material resources required of traditional supply chain logistics, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods, including manufacturing process improvement and its application.
~ Principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, sales techniques, and sales control systems.
~ Business and management principles. Economic and accounting principles and practices with an emphasis on cost accounting, and the analysis and reporting of financial data.
~ Knowledge of ecological services, carbon markets, woody biomass and renewable energy systems and their relationship to forest industry.
~ Basic safety practices in the forest products industry.
~ General knowledge of wood drying practices.
~ Fundamental knowledge of log and lumber grades and wood measurement.
~ Data acquisition tools and survey methods.
~ Analytic tools including fundamental statistics, relevant software, and database management.

Appendix H

Heating the Midwest – A Midwest Vision for 2025

Heating the Midwest with Renewable Biomass

A Midwest Vision *for 2025*

Photo Credit: Dennis O'Hara

Key Findings and Outcomes

- Achieve **15% of all thermal** energy from renewables by 2025
- Reduce **1.01 billion gallons** of propane and **278 million gallons** of heating oil
- **Reinvest $2.2 billion** into the Midwest economy
- **Create 13,170 jobs** from the expansion of the thermal biomass industry **and up to 210,000 direct, indirect and induced jobs** from annual energy savings and the effects of no longer exporting heating fuel money from the region
- Supply **17.2 million green tons** of sustainable woody and agricultural biomass for thermal energy and combined heat and power by 2025
- **12,630,950 homes and businesses are not connected** to low-cost natural gas
- Improve air quality, **reduce greenhouse gases**, and enhance forest management
- Vitalize communities through **rural economic opportunities**, new industry and innovation

Achieve 10% of all thermal energy from biomass by 2025

The Vision

We propose that 15% of all thermal energy in the Midwest come from renewable energy sources with 10% derived from sustainably produced biomass by 2025. The remainder of this energy would come from solar thermal and geothermal sources. This shift in our sources for thermal energy will produce extraordinary economic, social and environmental benefits for the Midwest, which currently relies on fossil fuel for 97% of its thermal energy.

Strategies and Policies to Achieve the Vision

- Increase awareness and recognition of the benefits derived from biomass thermal energy
- Develop clean energy policy that includes clean and efficient biomass thermal energy
- Grow demand for biomass-based thermal fuels and heating systems/CHP in the Midwest
- Support research, technology innovation and demonstration throughout the biomass thermal supply chain
- Expand funding opportunities and programs to support the development and installation of biomass thermal/CHP projects


Photo Credit: Dennis O'Hara

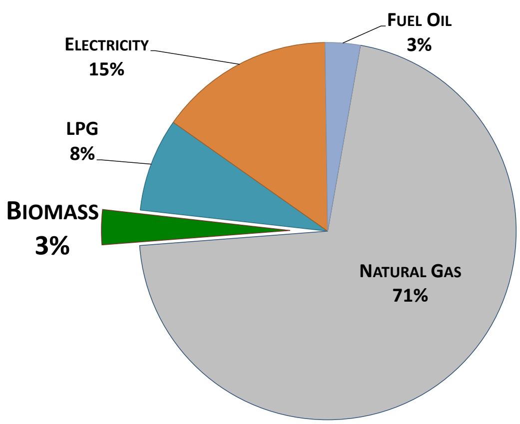
Core Objectives of Clean Energy Policy

- Efficiency and Affordability
- Sustainability
- Clean Emissions and Climate Change Mitigation
- Job Creation

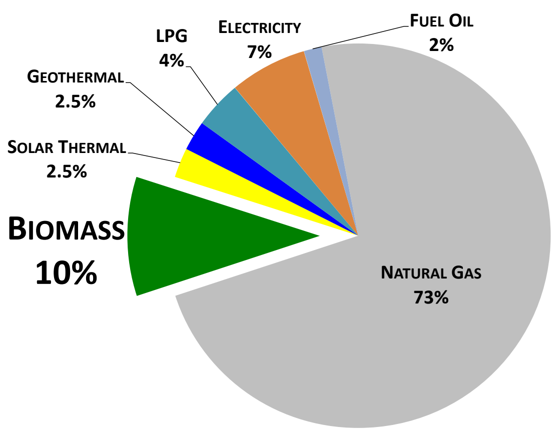
Effective Policy Frameworks

- Financing, Taxes, Grants, Loans
- Carbon Policy
- Sustainability Measures
- Emission and Regulation Enhancements

2012 Midwest Thermal Energy Sources



2025 Midwest Thermal Energy Vision



How Can You Help Achieve the Vision?

- Get Involved!
- Contact Heating the Midwest *(HeatingtheMidwest.org)* or BTEC *(BiomassThermal.org)* to offer feedback, criticism and ideas to improve this Vision
- Share the Vision document with anyone who may be interested. Invite their feedback
- Raise these issues with your governor, state and federal officials, and state legislators
- Join and support one or more of the organizations that have collaborated on this Vision

Funding for this initiative was provided by the sponsors and attendees at the 1st Annual Heating the Midwest with Renewable Biomass conference, held April 25 - 27, 2012 in Eau Claire, WI. We gratefully acknowledge this support.

This vision was developed by Heating the Midwest with Renewable Biomass supported by resource and economic analyses by FutureMetrics, LLC.

HEATING THE MIDWEST WITH RENEWABLE BIOMASS

pellets crops wood & more

Collaborative participation was provided by:

BTEC Biomass Thermal Energy Council

Appendix I

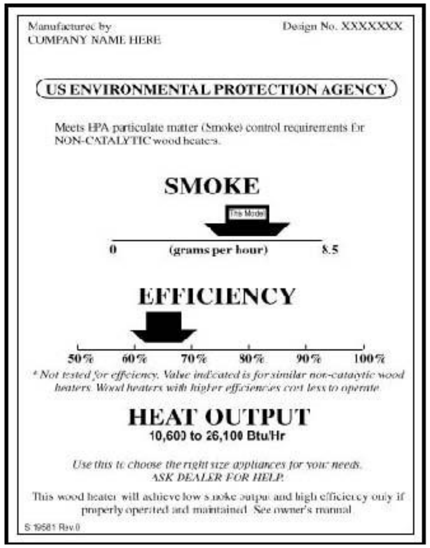
2013 EPA List of Certified Wood Stoves

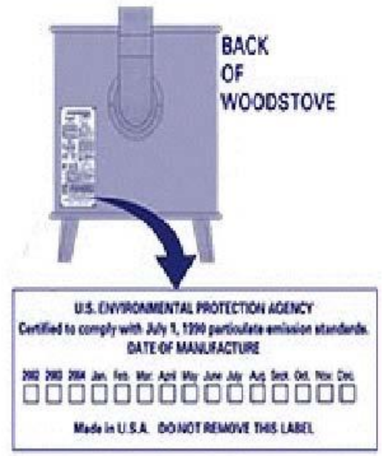
List of EPA Certified Wood Stoves
December 2013

EPA Wood Heater Program

Enclosed is the list of wood stoves certified by the United States Environmental Protection Agency (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 New Source Performance Standard (NSPS) for New Residential Wood Heaters under the Clean Air Act and are required to meet these emission limits.

An EPA certified wood heater can be identified by a temporary paper label attached to the front of the wood stove and a permanent metal label affixed to the back or side of the wood stove (see examples below). If you have questions regarding a particular model line or manufacturer, please contact Rafael Sanchez at 202-564-7028 or via e-mail at Sanchez.rafael@epa.gov.





***** *Temporary Wood Stove Label Permanent Wood Stove Label*

Wood stoves offered for sale in the state of Washington must meet a particulate emissions limit of 4.5 grams per hour for non catalytic wood stoves and 2.5 grams per hour for catalytic wood stoves.

List of EPA Certified Wood Stoves December 2013

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	A. J. Wells and Sons LTD	Cove 2 SR	4.4	9256 - 32,557		63	Non Catalytic
x	Alladin Hearth Products	Sunburst II Model 2208	4.4	11500- 36300		63	Non Catalytic
x	American Road Equipment Company	Erik SW II Catalytic Environmentalist SSW-1000	1.2	9800-46900		72	Catalytic
	Amesti LTDA	N380	5.16	10671 - 27842		63	Non Catalytic
	Amesti LTDA	Rondo 450	4	11,842-24,288		63	Non Catalytic
	Appalachian Stove & Fabricators, Inc.	Model 32-BW	2.5	10400-24500		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Model 360-CR	2.8	10600-29100		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Model 36 BW	3.3	10600-30200		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Trailmaster Model 4N1-XL II	3.4	10100-26900		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Model 30-CD	3.7	8500-21400		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	36-BW-1988	3.9	9500-19300		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	32-BW-XL-88, Gemini-XLB 1989	4	8400-19800		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Model 52 WXL 1988	4.2	10500-15400		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Heritage Classic A, T16, Cast heat & Catskill	4.4	10,300-31,200		63	Non Catalytic
	Appalachian Stove & Fabricators, Inc.	28 CD	4.5	9500-16300		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Trailmaster 4N1-XL	4.7	9600-19600		72	Catalytic
	Appalachian Stove & Fabricators, Inc.	Heritage Classic; Model Numbers T16 & VT16	6.81	11057-31327		63	Non Catalytic
	Archgard Industries, Ltd.	Optima PS1	0.87	10,196-29,581		63	Non Catalytic
	Archgard Industries, Ltd.	Chalet 1600 and Chalet 1600 Insert	2.88	10,611-29,181		63	Non Catalytic
	Archgard Industries, Ltd.	Chalet 1800	3.62	10,700-35,500		63	Non Catalytic
	Austroflamm Industries Inc.	Integra C1121, II	2.7	9300-31100		78	Pellet
	Austroflamm Industries Inc.	Esprit Wood 119.1	6.3	11400-43600		63	Non Catalytic
	Austroflamm Industries Inc.	Irony M	6.6	11800-46800		78	Pellet
	Avalon by Travis Industries, Inc.	Spokane 1250	4.4	11600-38500		63	Non Catalytic
x	Avalon by Travis Industries, Inc	Perfect-Fit insert	4.1	11,300-33,400		63	Non Catalytic
	Avalon by Travis Industries, Inc.	Avalon Spokane 1750	1.94	9300-42200		63	Non Catalytic
	Avalon by Travis Industries, Inc.	Rainier, Rainier insert	2	11200-40000		63	Non Catalytic
	Avalon by Travis Industries, Inc.	Arbor	2.4	10,700-33,900		63	Non Catalytic
	Avalon by Travis Industries, Inc.	Olympic, Olympic insert	2.6	12000-45100		63	Non Catalytic
	Avalon by Travis Industries, Inc.	Pendleton, Pendleton insert	3	8700-44400		63	Non Catalytic
	Barbeques Galore/Pricotech	Rosewood	2.7	11600-36200		63	Non Catalytic
	Blaze King Industries, Inc.	Chinook /Sirocco/Ashford 30	0.97	11,200- 27,280	75	72	Catalytic
	Blaze King Industries, Inc.	Blaze King KEJ 1107	1.76	9100-39800	82	72	Catalytic
	Blaze King Industries, Inc.	Blaze King, King Catalytic KEJ-1101	1.9	9000-35300		72	Catalytic
	Blaze King Industries, Inc.	Princess Insert Model PI 1010A	2	7,200-29,500	80	72	Catalytic
	Blaze King Industries, Inc.	Chinook / Sirocco/Ashford 20	1.3	11,400 - 22,700	77	72	Catalytic
	Blaze King Industries, Inc.	Heat Pro C210	2.1	10700-43300		72	Catalytic
	Blaze King Industries, Inc.	Blaze King, King Catalytic Insert KEI-1300	2.2	10100-34500		72	Catalytic
	Blaze King Industries, Inc.	Princess PEJ 1006	2.4	12000-35600	81	72	Catalytic
	Blaze King Industries, Inc.	Blaze King, Auto Light PAL-4000	2.5	12200-33700		78	Pellet
	Blaze King Industries, Inc.	Blaze King, Royal Heir RHT-2200, 2250	2.5	7700-31100		72	Catalytic
	Blaze King Industries, Inc.	Blaze King Princess Insert Model PI 1010	2.8	9,300-31,200	80	72	Catalytic
	Blaze King Industries, Inc.	Heat Pro C110	2.8	9600-32400		72	Catalytic
	Blaze King Industries, Inc.	Blaze King, Royal Heir RHT-2100	3	6800-57100		72	Catalytic
	Blaze King Industries, Inc.	Blaze King PEJ 1003	2.4	10300-41600		72	Catalytic
	Blaze King Industries, Inc.	Briarwood II/90	3.5	10600-36000	71.4	63	Non Catalytic
	Blaze King Industries, Inc.	Blaze King, Princess Catalytic PEJ-1002	3.7	8400-35400		72	Catalytic
	Blaze King Industries, Inc.	Blaze King KEJ-1102	3.9	7900-42600		72	Catalytic
	Blaze King Industries, Inc.	Eagle/Pioneer E90, PZ-90, Briarwood XE-90, XEI-90	5.2	13500-38000		63	Non Catalytic
	Blaze King of Montana	Blaze King Royal Guardian, RGT-3001	5.8	9400-39800	71.1	63	Non Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Boru Stove Company	Carraig Mor BCMUS	3.9	12,878 - 28,846	73.2	63	Non Catalytic
	Bosca Chile S.A. (Ingeniera De Combustion)	Spirit 500, Classic 500	1.2	8,700-21,700		78	Pellet
	Bosca Chile S.A. (Ingeniera De Combustion)	Soul Pellet Stove Insert, Soul 700 free standing, Soul 700 Insert	2.2	6,100-30,000		78	Pellet
	Bosca Chile S.A. (Ingeniera De Combustion)	Spirit 550, Limit 450 and Classic 450, Spirit 500	3.6	11,359-26,100		63	Non Catalytic
	Bosca Chile S.A. (Ingeniera De Combustion)	Gold 400	4.4	11,800-26,800		63	Non Catalytic
	Bosca Chile S.A. (Ingeniera De Combustion)	Miner 33	4.3	11,756 - 35,388		63	Non Catalytic
	Ceramiche Savio di Elio & C. s.n.c.	Catellante di Castellante and Real Castillo di Ague Model CS1	5.1	11200-40800		63	Non Catalytic
	Ceramiche Savio di Elio & C. s.n.c.	Real Castelllo di Moncaueri/Castllo Della Venaria	5.6	10100-24200		63	Non Catalytic
	CFM Corporation	DutchWest Large 2479	1.31	11,300-26,500		63	Non Catalytic
	CFM Corporation	DutchWest Small Model	1.41	7,800-25,100		63	Non Catalytic
	CFM Corporation	DutchWest Medium 2478	1.5	10,600-25,300		63	Non Catalytic
	CFM Corporation	Model EWF 36A	2.4	11,300-75,500		72	Catalytic
	CFM Corporation	Vermont Castings Defiant 1610	2.9	10,000-30,000		63	Non Catalytic
	CFM Corporation	EWF 30	3.5	11,100-40,500		63	Non Catalytic
	CFM Corporation	Aspen 1920 & Plymouth HWS10	4.3	9100-18000		63	Non Catalytic
	CFM Corporation	CW2500X00, CW2500X02, JW2500X00,CJW2500X02, DW2500 and JW2500X10	4.7	9500-57800		63	Non Catalytic
	CFM Corporation	FW247001 to FE247004 and JW1000PF1	5	11500-18900		63	Non Catalytic
	CFM Corporation (Jacuzzi Leisure Products, Inc	Campbell/Jacuzzi CJW2000L02, JW2000L10, DW2000XXX and JW2000P10	4.4	12000-55100		63	Non Catalytic
	CFM Corporation (Jacuzzi Leisure Products, Inc	Campbell/Jacuzzi FW300005-FW300009 & FW300019-FW300027,	4.4	12000-55100		63	Non Catalytic
	CFM Corporation (Jacuzzi Leisure Products, Inc	JW1500P10, FW1500, DW1500, JW1500L10	4.4	10300-29200		63	Non Catalytic
	CFM Corporation (Jacuzzi Leisure Products, Inc	S27X/S28X & FW27 Series, CJW1500L02	4.4	10300-29200		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Defiant Encore	0.6	6200-32900		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Encore 1450 N/C	0.7	10,600-24050		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Defiant 1910 & 1945	0.8	10600-44400		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	2370	1	5700-18300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Century/Dutchmaster FW and CDW	1	11,800-32,300		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Dutchwest Small Convection Heater #2460	1.1	6600-27300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Dutchwest Extra Large Convection 2462	1.3	8300-28000		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	FA455	1.3	10400-26500		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Dutchwest Large Convection Heater (Model 2461)	1.41	10700-29500		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Lg. Fed. Convection Heater FA264CCL, FA264CCR	1.6	6600-26700		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Defiant Encore 2550 (Formerly 2190)	1.6	8700-41700		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Defiant Encore 2140	1.8	9000-41300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Intrepid II Model 1990	2.1	8300-26700		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Model 2170	2.1	9400-22800		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	WinterWarm Fireplace Insert Model 1280	2.1	10300-30000		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	WinterWarm Small Insert Model 2080	2.1	8700-31100		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	FA264	2.2	9500-31700		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Intrepid II Model 2070	2.4	9200-19300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Extra-Lg. Federal Convection Heater FA288CCL	2.6	8400-38700		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	EWF36	2.7	11,800-68,600		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Small Federal Convection Heater FA224CCL	2.8	7000-30600		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Rocky Mountain Heater FA211CL	2.9	6800-27800		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Montpelier	2.9	10,094-27,550		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	2370	3	10.094-27,550		72	Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	CFM Corporation (Vermont Castings, Inc.)	FA224	3.1	9100-34800		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	FA288	3.1	7800-29300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Intrepid II 1308	3.1	10200-22500		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Intrepid Model 1640	3.3	8200-19500		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Madison Model 1655	3.3	11,300-39,700		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Resolute Acclaim (Model Number 2490) & TLWS1	3.4	9500-33900		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Federal "A Plus" FA224ACL	3.5	7200-30000		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Sequoia FA455	3.6	8700-60300		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Adirondack Wood Heater FA267CL	3.7	8400-40000		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	WinterWarm Small Insert (model 2370)	4	9250-21500		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Large Federal Box Heater FA209CL	4.3	9000-25600		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	C.D. Small Federal Box Heater FA207CL	4.3	6200-28000		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Seville 1635 and 1600 Insert	4.5	9,900-30,800		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Resolute Acclaim 0041	5.1	8700-30900		72	Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Madison 1650	5.5	11400-31000		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Seville Insert	5.5	10200-27400		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Aspen Model 1920	6.3	10100-26400		63	Non Catalytic
	CFM Corporation (Vermont Castings, Inc.)	Seville 1630	6.3	12000-27300		63	Non Catalytic
	Consuming Fire, Inc.	Perfect Hearth	3.4	11,700-38,100		63	Non Catalytic
x	Country Flame Technologies, Inc.	R/90	1.5	10600-46800		72	Catalytic
x	Country Flame Technologies, Inc.	E-1/90	1.7	9600-37800		72	Catalytic
x	Country Flame Technologies, Inc.	B/A	2	10400-55500		72	Catalytic
x	Country Flame Technologies, Inc.	O-2	2.5	8000-30000		72	Catalytic
x	Country Flame Technologies, Inc.	OV-3000	2.9	11800-34000		63	Non Catalytic
x	Country Flame Technologies, Inc.	BBF	3	10500-51400		72	Catalytic
x	Country Flame Technologies, Inc.	BBF-6, BBF-I	3	9500-48600		72	Catalytic
x	Country Flame Technologies, Inc.	O-2/90	3	10800-34100		72	Catalytic
x	Country Flame Technologies, Inc.	E-2	3.3	13000-34400		72	Catalytic
x	Country Flame Technologies, Inc.	R-6	3.3	13800-50700		72	Catalytic
x	Country Flame Technologies, Inc.	OV-2600	3.5	11500-33600		63	Non Catalytic
x	Country Flame Technologies, Inc.	SBF/A	3.6	8700-33600		72	Catalytic
x	Country Flame Technologies, Inc.	E1-6, E1-I	3.7	12400-55300		72	Catalytic
x	Country Flame Technologies, Inc.	OV-26BF-I	3.7	11400-41300		63	Non Catalytic
x	Country Flame Technologies, Inc.	OV-2100	4.1	11700-32700		63	Non Catalytic
x	Country Flame Technologies, Inc.	OV-21	4.2	11700-42200		63	Non Catalytic
x	Country Flame Technologies, Inc.	Inglenook INGW-02	4.4	11,600-38,000		63	Non Catalytic
x	Country Flame Technologies, Inc.	B-6, B-I	4.6	9600-48200		72	Catalytic
x	Country Flame Technologies, Inc.	NC-6D	4.7	11700-54900		63	Non Catalytic
x	Country Flame Technologies, Inc.	S-6, S-I	6.5	13100-48900		72	Catalytic
x	Country Flame Technologies, Inc.	Patriot	6.9	11300-34000		63	Non Catalytic
x	Country Flame Technologies, Inc.	Combo Air OC	7	9300-46400		63	Non Catalytic
	Country Stoves, Inc.	Winslow PS40 and PI40	1.14	7,476-21,343		78	Pellet
	Country Stoves, Inc.	Striker S160 and C160	1.6	12500-41200		63	Non Catalytic
	Country Stoves, Inc.	Canyon S310	3.2	11400-34900		63	Non Catalytic
	Country Stoves, Inc.	Canyon ST310, C310, E310	3.5	11600-38800		63	Non Catalytic
	Country Stoves, Inc.	Alpine	3.53	11,455-42,445		63	Non Catalytic
	Country Stoves, Inc.	Converter C-30, C-35	4	8000-49200		72	Catalytic
	Country Stoves, Inc.	Legacy S260, C260, and E260	4.11	11800-48000		63	Non Catalytic
	Country Stoves, Inc.	Performer S210, SS210, ST210, C210 & E210	4.2	9500-36100		63	Non Catalytic
	Country Stoves, Inc.	T-TOP S 240	4.9	11300-42700		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Country Stoves, Inc.	C-240 and E-240	5.1	11500-36700		63	Non Catalytic
	Country Stoves, Inc.	STRIKER S130, C-50L, C130, CA-50, CA-50L, CA-55	5.6	9300-43600		63	Non Catalytic
	Country Stoves, Inc.	T-Top C-40, C-45, C-46	5.7	10700-40900		63	Non Catalytic
	Country Stoves, Inc.	Performer S180, C180, E180	6.6	11400-38700		63	Non Catalytic
	Country Stoves, Inc.	Starlite C-20, C-21	9.6	7700-43500		63	Non Catalytic
	Country Stoves, Inc.	Starlite C-20, C-21	9.6	7700-43500		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 2150	2.9	11800-34000		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 2100	3.2	11000-31100		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 1650	3.7	11400-41300		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 950	4.2	11700-42200		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 900	6.5	10200-30800		63	Non Catalytic
x	CRD Precision Fabricators Inc. (Chippewa)	Energy King Legacy 1600	7	11700-23100		63	Non Catalytic
x	Dansons Incorporated	Model HR-2	0.9	10500-33400		78	Pellet
x	Dansons, Incorporated	Eclipse	1	7800-33100		78	Pellet
x	Dell Point Technologies	DC 2000, Europa	0.6	10400-24100		78	Pellet
x	Derco, Inc./Grizzly Stoves	Super Achiever FPI-2-LEX	2.4	9800-34200		72	Catalytic
x	Derco, Inc./Grizzly Stoves	Little Blazer FP-20	4.7	7200-28400		72	Catalytic
x	Derco, Inc./Grizzly Stoves	Little Blazer FP-20	4.7	7200-28400		72	Catalytic
x	Deville	Deville 7794 - Comfort	6.9	11,300-35,100		63	Non Catalytic
x	Dovre, Inc.	Horizon 500 CC	2.9	10300-33800		72	Catalytic
x	Dovre, Inc.	Horizon 500 CC	3.6	8300-28000		72	Catalytic
x	Dovre, Inc.	Heirloom 300 HC	4.5	11600-45100		72	Catalytic
x	Dovre, Incorporated	Heirloom 390	2.8	9100-31800		72	Catalytic
	England's Stove Works, Inc.	25-EP, 55-TRPEP, 55SHPEP	1.43	10,700-25,100		78	Pellet
	England's Stove Works, Inc.	10-CPM, 49-TRCPM, 49-SHCPM	1.6	10,455-24,566		78	Pellet
	England's Stove Works, Inc.	30-NC, 50-TNC30L, 50-TNC30G	1.63	11,950-28,337		63	Non Catalytic
	England's Stove Works, Inc.	Model 18M-H	2	7800-26900		72	Catalytic
	England's Stove Works, Inc.	17-VL	4.3	11,875 - 19238		63	Non Catalytic
	England's Stove Works, Inc.	Summers Heat Model 50-SHW20 Englander Model 24JC	2.1	7200-28600		72	Catalytic
	England's Stove Works, Inc.	Model 18 PC	2.2	8700-26400		72	Catalytic
	England's Stove Works, Inc.	13-NCMH, 50-SNC13,	2.35	11,579-32,017		63	Non Catalytic
	England's Stove Works, Inc.	Englander Freestanding Radiant 24FC	2.4	7200-35600		72	Catalytic
	England's Stove Works, Inc.	Summers Heat Model 50-SHW25 Englander Model 24ICD	2.4	5400-17400		72	Catalytic
	England's Stove Works, Inc.	Englander Front Loading Fireplace 28IC	2.5	8200-24400		72	Catalytic
	England's Stove Works, Inc.	50-TNC Timber Ridge 13-NCI/50-TNC131 (Insert)	2.6	10,000-29,200		63	Non Catalytic
	England's Stove Works, Inc.	Englander 13-NC Summers Heat,50-snc Golden Eagle	2.6	10,000-29,200		63	Non Catalytic
	England's Stove Works, Inc.	Englander 25-PDV, Summers Heat 55SHP22, and Timber Ridge 55TRP22 Pellet	2.6	10,700-24,500		78	Pellet
	England's Stove Works, Inc.	Model 24IC	2.6	10200-27100		72	Catalytic
	England's Stove Works, Inc.	24 ACD	2.7	9000-20100		72	Catalytic
	England's Stove Works, Inc.	Englander Front Loading Space Saver 28CC	2.7	7900-25500		72	Catalytic
	England's Stove Works, Inc.	Pellet Fuel Burning Room Heater Model 25-PDCV/55-SHP10/55-TRP10	3.1	8200-22400		78	Pellet
	England's Stove Works, Inc.	Englander Econo Radiant 18PC	3.6	8500-31000		72	Catalytic
	England's Stove Works, Inc.	Summers Heat Model 50-SHW22 Englander Model 24-AC/FC	3.8	9100-25400		72	Catalytic
	England's Stove Works, Inc.	17-VL	4.3	12,791- 43,520		63	Non Catalytic
	England's Stove Works, Inc.	Englander Fireplace Insert 28JC	4.4	8400-29100		72	Catalytic
	England's Stove Works, Inc.	22 PIC	5.1	9000-30200		72	Catalytic
x	Eureka Heating PTY Limited	Emerald	4.4	11000-35500		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Evergreen Marketing, Inc.	Mohawk 60A	3.8	4700-14300		72	Catalytic
x	Evergreen Metal Products Inc.	Schrader Pelletmiser 905-P	1	11000-32700		78	Pellet
x	F. Huemer Ges. M.B.H.	Austroflamm Wega II	1.3	8500-42000		78	Pellet
	Fireplace Products International Limited	F1100S, I1100S I1200S , HI200, CS1200, CI1200, CI1250 Small Wood Stove & Insert	3	10600-34700		63	Non Catalytic
	Fireplace Products International Limited	F2400M, I2400M, S2400, HI300, CC75, CS2400 Medium Wood Stove & Insert	3.44	12000- 36800		63	Non Catalytic
	Fireplace Products International Limited	H2100M Hearth Heater	3.5	10800-46900		63	Non Catalytic
	Fireplace Products International Limited	FP90, EX90, R90 Wood Fireplace	3.78	11,700-42,300		63	Non Catalytic
	Fireplace Products International Limited	F1100S, I1100S, F1100S-1 Small Wood Stove & Insert	3.8	09400-38700		63	Non Catalytic
	Fireplace Products International Limited	F2100M, I2100M Medium Wood Stove & insert	3.8	11700-38700		63	Non Catalytic
	Fireplace Products International Limited	F2100MI	3.9	11,300-38,800		63	Non Catalytic
	Fireplace Products International Limited	H200 Cast Wood Stove	3.9	10,900 - 19,400		63	Non Catalytic
	Fireplace Products International Limited	R6,RA6,RA8 Wood Stoves	3.9	11500-59000		63	Non Catalytic
	Fireplace Products International Limited	F3100L, I3100L, S3100L, Large Wood Stove & Insert	4.19	11900-42900		63	Non Catalytic
	Fireplace Products International Limited	H300 Cast Wood Stove	4.2	10,600-28,500		63	Non Catalytic
	Fireplace Products International Limited	R3, RA3, R9 Wood Stove	4.2	11200-35500		63	Non Catalytic
	Fireplace Products International Limited	I2000M14 Wood Insert	4.5	11200-42700		63	Non Catalytic
	Fireplace Products International Limited	R14-2	5	11500-37500		63	Non Catalytic
	Fireplace Products International Limited	Z2500L Wood Fireplace	5.2	10600-39700		63	Non Catalytic
	Fireplace Products International Limited	R-16 Wood Insert	6.6	11100-32900		63	Non Catalytic
	Fireplace Products International Limited	F2000M Medium Wood Stove	7.1	11800-34200		63	Non Catalytic
	Fireplace Products International Limited	R7, RA7, R5 Small Wood Stove	8.3	5900-33500		63	Non Catalytic
	Fireplace Products International Limited	F5100	1.46	11,738 - 41,982	79.08	72	Catalytic
	Fireplace Products International Limited	GF55, GFI55 Regency Greenfire Pellet Stove & Insert	1.96	6,500-40,000		78	Pellet
	Fireplace Products International Limited	GC60, GCI60 Hampton Cast Pellet Stove & Insert	2	9,363 - 45,478		78	Pellet
	Fireplace Xtrodinair (FPX) by Travis Industries,	36 Elite	2.3	11900-47100		72	Catalytic
	Fireplace Xtrodinair (FPX) by Travis Industries,	44 Elite	2.5	11000-45300		72	Catalytic
	Fireplace Xtrodinair (FPX) by Travis Industries,	33 Elite	4.1	11,300-33,400		63	Non Catalytic
	Foundries du Lion S.A.	Efel Symphony 390.74	1.8	10700-33000		72	Catalytic
	Foundries du Lion S.A.	Harmony IIIB	2.7	11,200-57,300		63	Non Catalytic
	Foundries du Lion S.A.	Model S-33,S-83,H33,R33,X33	3.3	8,600-37,300		63	Non Catalytic
	Foundries du Lion S.A.	Efel Harmony 386.75	3.8	7100-51000		72	Catalytic
	Foundries du Lion S.A.	Harmony I	4.4	11800-55000		63	Non Catalytic
	Foundries du Lion S.A.	Efel Symphony 387.74	5.1	10600-49700		72	Catalytic
	Foyers Supreme Incorporated	Supreme Plus	7	9,600-16,300		63	Non Catalytic
	Foyers Supreme Incorporated	Volcano Plus	4.3	11,310-25,189		63	Non Catalytic
	Foyers Supreme Incorporated	Galaxy	3.5	12,833 - 27,093		63	Non Catalytic
	Foyers Supreme Incorporated	Superme 2 Face Plus, Opus	5	10,213-30,163		63	Non Catalytic
x	Frantech, Inc.	Seefire 2100 S	3.2	11000-31100		63	Non Catalytic
x	Frantech, Inc.	Seefire 900 S	6.5	10200-30800		63	Non Catalytic
x	Frantech, Inc.	Seefire 1600 S	7	11700-23100		63	Non Catalytic
	GHP Group	Pleasant Hearth HWS-224172MH-B; Pleasant Hearth HWS-224172MH-BCA	5.1	11,638 - 22,444		63	Non Catalytic
	GHP Group	Pleasant Hearth LWS-127201-B; Pleasant Hearth LWS-127201-BCA	4.3	9,238 - 16,744		63	Non Catalytic
	GHP Group	Pleasant Hearth LWS-130291-B; Pleasant Hearth LWS-130291-BCA	3.6	12,084 - 37580		63	Non Catalytic
x	Gibraltar Stoves, Inc.	LCC, MCC, SCC, CFS, CFI & DDI	2.75	8400-28700		72	Catalytic
x	GLG Australia	Pearl Bay	3.8	11,300-35,300		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Glo King/Pierce Engineered Products Inc.	GK 100 HT	3.2	10600-61400		63	Non Catalytic
	Glo King/Pierce Engineered Products Inc.	GK-500HT	6.4	10000-22400		63	Non Catalytic
	Glo King/Pierce Engineered Products Inc.	400HT	7	10000-40200		63	Non Catalytic
	Glo King/Pierce Engineered Products Inc.	GK-300HT	7	11000-31000		63	Non Catalytic
	Glow Boy	Model HR-2	0.9	10500-33400		78	Pellet
	Godin Imports, Inc.	Nouvelle Epoque 3137	3.9	10500-20700		72	Catalytic
	Gruppo Piazzetta S.P.A.	P960, P961, P962	1.98	10,000 - 38,500		78	Pellet
	Gruppo Piazzetta S.P.A.	P955, P956, and P957	2.28	9,000 - 29,700		78	Pellet
	Gruppo Piazzetta S.P.A.	Model 905	6.8	11600-30300		63	Non Catalytic
	Gruppo Piazzetta S.P.A.	Sabrina, Sveva, Samanta, Siria	2.305	9,912 - 37,169		78	Pellet
	Gruppo Piazzetta S.P.A.	Monia, Marcella, Marcella, Mia, Maira	2.15	9,912 - 37,169		78	Pellet
	Gruppo Piazzetta S.P.A.	904	7.5	6700-28300		63	Non Catalytic
	H.M.F. Forlong and Maisey Ltd.	Merlin "3", M 3000	6.1	12300-37000		63	Non Catalytic
	Hajduk	Prima MR-51	3.8	11,636-35,246		63	Non Catalytic
	Harman Stove Company	TL 2.0	2.6	9,619 - 31,825		63	
	Harman Stove Company	TL 2.6	3.7	11,281 - 32,657		63	Non Catalytic
	Harman Stove Company	TL 300	1.1	11,238-34921		63	Non Catalytic
	Harman Stove Company	Invincible RS	1.53	6200-32800		78	Pellet
	Harman Stove Company	Oakwood	2.3	10,900-30,500		63	Non Catalytic
	Harman Stove Company	Treemont TAC-340C	2.8	7400-33800		72	Catalytic
	Harman Stove Company	CW30	3.6	10000-34000		63	Non Catalytic
	Harman Stove Company	Treemont TAC-260C,TAC-260CF	3.9	8400-40700		72	Catalytic
	Harman Stove Company	Model Exception TL200	4.4	11000-42400		63	Non Catalytic
	Harman Stove Company	Treemont TAC-520C	5.2	12000-37300		72	Catalytic
	Hase Kaminofenbau	Lima 8150	3.57	11,805-31,653		63	Non Catalytic
	Hase Kaminofenbau	Bari, Lima	3.57	11,805-31,653		63	Non Catalytic
x	Hawke Manufacturing Company, Inc.	HMI 28II	2.6	6100-39600		72	Catalytic
	Hearth and Home Technologies	5100I ACC	4.2	10,491 - 27,854		63	Non Catalytic
	Hearth and Home Technologies	4100I ACC	4.3	11696 - 25,925		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 3100 ACC	1.1	11900-43200		63	Non Catalytic
	Hearth and Home Technologies	Quadra Fire 4300 ACT	1.2	11900-58500		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 3100 ACT & 3100I ACT	1.3	11400-46900		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 5100 I ACT B	2	11,900-50,600		63	Non Catalytic
	Hearth and Home Technologies	2100 ACC	2.1	12000-28000		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 3100F, 3100 I	2.1	11900-43200		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 4300	2.1	11900-39900		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 1900	2.2	11500-32200		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire Cape Cod	2.2	11500-43000		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 5100-I Fireplace Insert	2.7	11800-49900		63	Non Catalytic
	Hearth and Home Technologies	Yosemite	2.7	10900-28600		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire Isle Royale	2.9	10400-46800		63	Non Catalytic
	Hearth and Home Technologies	Arrow 55	3	9900-37500		72	Catalytic
	Hearth and Home Technologies	Quadra-Fire 7100	3.1	13,800-67,300		63	Non Catalytic
	Hearth and Home Technologies	Heat N Glo Number FT-300	3.3	10,000-41,000		63	Non Catalytic
	Hearth and Home Technologies	Northstar/Constitution	3.3	11,300-51,200		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire Cumberland Gap	3.4	11,200-44,300		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 2100, 2100 I	3.6	9300-39300		63	Non Catalytic
	Hearth and Home Technologies	Arrow S12 (Stove) & I12 (Insert)	3.7	9900-32100		63	Non Catalytic
	Hearth and Home Technologies	Heat-N-Glo FT-210	3.9	9,800-36,600		63	Non Catalytic
	Hearth and Home Technologies	Arrow 14, 20	4	14000-36100		63	Non Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Hearth and Home Technologies	Quadra-Fire 4100	4	11700-50500		63	Non Catalytic
	Hearth and Home Technologies	S-22 & S-22I	4	12000-36900		63	Non Catalytic
	Hearth and Home Technologies	5700 ACT/ Step Top	4.2	11800-45900		63	Non Catalytic
	Hearth and Home Technologies	Model 2700I	4.2	11200-35900		63	Non Catalytic
	Hearth and Home Technologies	Arrow S32 & I32	4.24	10800-47500		63	Non Catalytic
	Hearth and Home Technologies	Arrow Fireplace Insert 25	4.7	11300-55000		72	Catalytic
	Hearth and Home Technologies	Heatilator 11, 12	5.1	12400-36100		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 1800	5.1	10600-31300		63	Non Catalytic
	Hearth and Home Technologies	S10 and I10	5.9	11200-40600		63	Non Catalytic
	Hearth and Home Technologies	Heatilator 1190/Arrow 1490(S20) Heatilator 1290/Arrow 2090(I20)	6.1	10500-44500		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 2000, 2000-I	6.1	7400-43700		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 3000F, 3000 I	6.5	9000-44700		63	Non Catalytic
	Hearth and Home Technologies	Arrow 18	7.2	14500-34400		63	Non Catalytic
	Hearth and Home Technologies	4300ACC	1.1	11,842-38,305		63	Non Catalytic
	Hearth and Home Technologies	Heatilator ECO ADV WS22	2.7	11,733 - 26,957		63	Non Catalytic
	Hearth and Home Technologies	Quadra Fire 5700 ACC	2.3	11,17 - 40,359		63	Non Catalytic
	Hearth and Home Technologies	Voyageur	4.12	11,163 - 23,513		63	Non Catalytic
	Hearth and Home Technologies	Quadra Fire 2100 Millinnium & 2100 ACT	2	10900- 37200		63	Non Catalytic
	Hearth and Home Technologies	Summit Insert	3.15	10,732 - 25,578		63	Non Catalytic
	Hearth and Home Technologies	Model 400	2.9	8700-2200		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire Model 4100I and Bodega Bay	3.1	9,000-41,800		63	Non Catalytic
	Hearth and Home Technologies	Model 2590	3.8	9900-34300		72	Catalytic
	Hearth and Home Technologies	Aurora Model 700	4.3	11800-30900		63	Non Catalytic
	Hearth and Home Technologies	Quadra-Fire 1800 I	4.9	10000-33200		63	Non Catalytic
	Hearth and Home Technologies	PH35PS	0.28	9,555 - 25,081		78	Pellet
	Hearth and Home Technologies	PH50PS	0.74	9,256 - 32,396		78	Pellet
	Hearth and Home Technologies	Heatilator ECO ADV WS18	2.6	10,925 -22,563		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Homestead 8570	1.9	10500-33600		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Shelburne 1 Model 8371	2.1	11,800-32,400		63	Non Catalytic
x	Hearthstone Quality Home Heating Products In	Shelburne Model 8370	2.1	11,800-32,400		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Heritage 8090, Manchester 8330	1.3	15,320 - 31,200		78	Pellet
	Hearthstone Quality Home Heating Products In	Heritage	2.3	10700-29400		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Phoenix 8612	2.4	10500-41500		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Tula	2.55	11,455 - 29,301		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Heritage I, Model 8021	2.7	11,700-32,800		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Tribute Model 8040	3	10,600-28,300		63	Non Catalytic
x	Hearthstone Quality Home Heating Products In	Craftsbury 8390	3.08	10,973-25,563		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Craftsbury 1 8391	3.08	10,973-25,563		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Clydesdale Model 8490, 8491	3.1	11,900-33,100		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Equinox 8000	3.1	12,000-37,900		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Bennington	3.6	11900-32600		63	Non Catalytic
`	Hearthstone Quality Home Heating Products In	Starlet	3.6	9200-25400		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Mansfield 2 8012	2.9	11,370 -28, 940		63	Non Catalytic
x	Hearthstone Quality Home Heating Products In	Mansfield	2.9	11,370 -28, 940		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Morgan model 8470	4.3	10500-29300		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Castleton	2.71	11,395 - 24,569		63	Non Catalytic
	Hearthstone Quality Home Heating Products In	Manchester 8360	3.01	11,335 - 47,509		63	Non Catalytic
x	Heat Tech Industries	No. 26 GM	4	11300-35800		63	Non Catalytic
x	Heatilator, Inc.	Heatilator LE	4.46	11500-44400		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Heatilator, Inc.	1890(S30)	5.7	11200-42700		78	Pellet
x	Heating Energy Systems, Inc.	Trailblazer Genesis 1600/1800	3	11400-36400		63	Non Catalytic
x	Heating Energy Systems, Inc.	Trailblazer Genesis 2000-C	3.1	10600-37500		72	Catalytic
x	Heating Energy Systems, Inc.	Trailblazer Classic 1300/1306	3.2	11300-32400		72	Catalytic
x	Heating Energy Systems, Inc.	Trailblazer 1700/1706	4.6	11000-32400		63	Non Catalytic
x	Heating Energy Systems, Inc.	Trailblazer Classic 1500/1700	4.9	9500-36600		63	Non Catalytic
x	Heating Energy Systems, Inc.	Trailblazer Genesis 1600, Classic 1500	8.2	12100-28100		63	Non Catalytic
x	Heat-N-Glo Fireplace Products, Inc.	CBS-41	3.9	10000-30300		63	Non Catalytic
x	HeatWorx LLC	Independence	3.6	11,370 - 34,260		63	Non Catalytic
	Henan Hi-Flame	Horse Flame 737	4.9	11,200 - 37,500		63	Non Catalytic
	Henan Hi-Flame	Hi-Flame	4.9	10,500 - 30,501		63	Non Catalytic
x	Heritage Stoves Inc.	Bostonian 2500 C (Insert)	3.8	10600-22300		72	Catalytic
x	Heritage Stoves Inc.	American 2000C	5.5	13600-33800		72	Catalytic
x	Heritage Stoves Inc.	Bostonian 2500C	6.8	9600-37300		72	Catalytic
	Hestia Heating Products	Model HHP 1	2.89	7,900-30,200		78	Pellet
	Hestia Heating Products	Model HHP 2	4.1	12,084-25,496		78	Pellet
	High Energy Manufacturing, Limited	J1000 Pellet Stove	2.1	13,000 - 21,800		78	Pellet
	High Sierra Stoves, Ltd.	Evolution 8000TE	2.2	7900-40500		72	Catalytic
	High Sierra Stoves, Ltd.	Ambassador 4700TE	2.5	10100-37600		72	Catalytic
	High Sierra Stoves, Ltd.	Sweet Home Catalytic Fir AK-18	3.1	8800-29500		72	Catalytic
	High Sierra Stoves, Ltd.	Cricket MHCR 5200	3.5	6800-27600		72	Catalytic
	High Sierra Stoves, Ltd.	Evolution 7000TE,7000C	4	11200-43000		72	Catalytic
	High Sierra Stoves, Ltd.	Sweet Home Solitaire PFA 2000	4	9700-28200		78	Pellet
	High Sierra Stoves, Ltd.	Diplomat 4300 TE	5.1	10400-53400		72	Catalytic
	High Sierra Stoves, Ltd.	Sierra Classic 1500B	6.9	8600-34700		63	Non Catalytic
	High Sierra Stoves, Ltd.	Sweet Home NFX-HT	7.8	14500-33200		63	Non Catalytic
x	High Valley Construction & Maintenance Corp.	Model 1600	2.7	11800-40400		63	Non Catalytic
x	High Valley Construction & Maintenance Corp.	High Valley Bay 2500	3.1	7700-40900		72	Catalytic
x	High Valley Construction & Maintenance Corp.	High Valley Model 1500	3.4	9400-34200		72	Catalytic
x	High Valley Construction & Maintenance Corp.	High Valley 2000, Craft Stove 2000	3.3	10800-43100		72	Catalytic
	Hijos de Bartolome Fajardo S.L.	Ronda	6.6	10,978 - 29,301		63	Non Catalytic
	Hijos de Bartolome Fajardo S.L.	Antartida	5.5	11938 - 34,245		63	Non Catalytic
	Hi-Teck Stoves	Hi Teck H 2000C	3.6	12600-41400		72	Catalytic
	Hitzer, Inc.	Glo King 500SD	6.4	10000-22400		63	Non Catalytic
	Hitzer, Inc.	Glo King 300HT	7	11000-31000		63	Non Catalytic
	Hitzer, Inc.	Glo King 400HT	7	10000-40200		63	Non Catalytic
x	Horizon Research Inc.	Model HR-2	0.9	10500-33400		78	Pellet
x	Horizon Research Inc.	Eclipse	1	7800-33100		78	Pellet
x	Horizon Research Inc.	Eclipse	1	7800-33100		78	Pellet
	Horse Flame Metal USA, Inc.	517 HF	3.6	8.585-24,358		63	Non Catalytic
	Horse Flame Metal USA, Inc.	717 HF	6.6	11,400-28,857		63	Non Catalytic
	Horse Flame Metal USA, Inc.	HF577DU	6.8	10,754-43,138		63	Non Catalytic
	Horse Flame Metal USA, Inc.	917HF, HF917UA	7.2	11842-30330		63	Non Catalytic
	Hudson River Stove Works	HR1-M, Hudson River Medium	7	11,900-19,700		63	Non Catalytic
	Hussong Manufacturin Company, Inc.(Kozy Hea	Olivia, Model Number OVL-PC	2.5	8,100-21,400		63	Non Catalytic
	Hussong Manufacturing Company, Inc.	Kozy Heat Z 42	3.3	11500-35100		63	Non Catalytic
x	Hutch Manufacturing Company	DWI-42C-2 (EPA)	1.5	10700-52800		72	Catalytic
x	Hutch Manufacturing Company	DWI-42C	1.6	9800-54600		72	Catalytic
x	Hutch Manufacturing Company	HRD-27C Catalytic Freestanding	2.5	10300-56200		72	Catalytic
x	Hutch Manufacturing Company	HRS-18C Small Freestanding	2.9	10300-38400		72	Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Hutch Manufacturing Company	HRD-18C	4.5	9300-39100		72	Catalytic
	HWAM Heat Design A/S	Monet	3.4	10,996-26,221		63	Non Catalytic
	HWAM Heat Design A/S	3055	4.09	10,996-26,221		63	Non Catalytic
	J. A. Roby	Mystere	6	12,900-24,200		63	Non Catalytic
	J. A. Roby	Vulcain	6.09	9,501.-29180		63	Non Catalytic
	J. A. Roby	Atmosphere	6.9	9,043 - 28,675		63	Non Catalytic
	J. A. Roby	Evolution	6.9	9,043 - 28,675		63	Non Catalytic
	J. A. Roby	Ultimate	7.1	9,501.-29180		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Gordon Elite S18XE	3	11300-31200		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Fraser Elite I, S407E, S408E, S409E	3.4	10000-37900		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Cabot Elite S17XE	4.5	11300-34400		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Campbell Elite S14XE	5.1	11000-31100		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	JW1000L10, JW1000P10, DW1000, FW2400, S24	5.3	10600-26100		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Model Campbell II Elite S-24X & FW24 Series, CJW1000L02,	5.3	10600-26100		63	Non Catalytic
x	Jacuzzi Leisure Products, Inc.	Douglas Elite S131E, S132E; Mini Elite S111E,S112E	7.1	10400-22200		63	Non Catalytic
x	Jayline Heating Ltd.	Amzed Jayline Ukal U-12	2.9	9900-28200		63	Non Catalytic
x	Jayline Heating Ltd.	AMZED JAYLINE 1B AND FS	5.4	9500-40400		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F602 CB	3.4	11,998 - 47,713	70.7	63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Firelight 12	2.4	10500-32100		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F370	2.58	10,978-29,048		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F100 Nordic QT	3	7,700- 27,400		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Jotul Oslo F-500	3	10900-35000		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Alpha 350132	3.1	10100-33000		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Model Series 8	3.1	12600-33000		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F500	3.2	12000-34700		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F118 CB	3.5	12,000-23,500		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Model 3 TDIC-2	3.6	10900-30600		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Castine F400	3.8	11300-27800		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F3CBII	3.8	11400-43500		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Model 8 TDIC	3.8	10900-35100		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	American Fireplace Stove 3TDC	4	8800-31700		72	Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Model C350	4	11,500-34,200		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Jotul F600	4.1	11,600-32,500		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Firelight 12CB	4.4	13500-45900		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	C450, Tamarack	4.42	11,900-36,100		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	C550 CB	4.47	11,696-35933		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Jotul Petite	4.52	10500-39900		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Jotul Model 602 CB Classic	5.2	9700-42100		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	Model 3 CB	5.8	11900-58300		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	C550	7.14	12,034-36,669		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F55	3.5	11,576 - 30,399		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	F45	2.31	11,576 -26,528		63	Non Catalytic
	Jotul North America (Jotul U.S.A., Inc.)	50TL	2.84	11,696 - 32,919		63	Non Catalytic
	JR Home Heating Products	WPS 30	4.5	12,791 - 43,520		78	Pellet
	Jydepejsan A/S	Trendline, Soft Line, Fine Line, Zeus, Athene, Troja, Hera, Avanti	3.9	11300- 28100		63	Non Catalytic
	Jydepejsan A/S	H530	6.8	11,100-28,800		63	Non Catalytic
	Kalvin International and Company (HK)	KWS1-M	7	11,900-19,700		63	Non Catalytic
x	Kent Heating Limited	Rose Bay KTXRB	3.6	10300 - 37500		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Kent Heating Limited	Catalytic Tile Fire	2	5900-24500		72	Catalytic
x	Kent Heating Limited	Ultima 2000S	4.5	11000-23000		63	Non Catalytic
x	Kent Heating Limited	Log Fire LPE	5.9	8900-28200		63	Non Catalytic
x	Kent Heating Limited	Tile Fire L.E.M. TLE-1	5.9	8500-38600		63	Non Catalytic
x	Kent Heating Limited	Tile Fire 2000, Ultima 2000	6.3	12500-21700		63	Non Catalytic
x	Kent Heating Limited	Sherwood L.E.M. XLE-1	6.5	9600-33400		63	Non Catalytic
x	Kent Heating Limited	Log Fire 2000	7	11200-23700		63	Non Catalytic
x	Kent Heating Limited	Sherwood 2000	8.1	13000-26600		63	Non Catalytic
	Krog Iversen & Co. A/S	DSA 4	1.1	10,500-27,900		63	Non Catalytic
	Krog Iversen & Co. A/S	Basic 1 & 3	2.17	10032-17906		63	Non Catalytic
	Krog Iversen & Co. A/S	Basic 4	2.2	10000-22100		63	Non Catalytic
	Krog Iversen & Co. A/S	Andersen 8	2.9	11900-30100		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 24	2.9	11300-22500		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 47.2	3.1	10400 - 30900		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 4.5	3.3	9,500-31,000		63	Non Catalytic
	Krog Iversen & Co. A/S	Andersen 8.2	3.5	7,600-28,800		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 60	3.97	8,700-27,430		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 5.2	4.2	11800-26500		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 10-A	4.4	11,600-37,700		63	Non Catalytic
	Krog Iversen & Co. A/S	Model Scan 61	4.5	10,600-29,300		63	Non Catalytic
	Krog Iversen & Co. A/S	Scan 20	5.1	9900-19000		63	Non Catalytic
	Kuma Stove And Iron Works	Aspen	4.1	11,689 - 24206		63	Non Catalytic
	Kuma Stove And Iron Works	Model Kuma 100/300/400	2.2	10100-52100		72	Catalytic
	Kuma Stove And Iron Works	Kuma K-300/K-400, K-100B	2.8	12100-65200		72	Catalytic
	Kuma Stove and Iron Works	Kuma Wood Classic Model HT-2	3.2	11300-48000		63	Non Catalytic
	Kuma Stove and Iron Works	Ashwood	3.3	11300-48000		63	Non Catalytic
	Kuma Stove And Iron Works	Tamarack	3.3	11300 -48000	73.5	63	Non Catalytic
	Kuma Stove And Iron Works	KTAM	4.42	11708 -24418		63	Non Catalytic
	Kuma Stove And Iron Works	Kuma Scott HT-1	3.5	11700-29800		63	Non Catalytic
	Lennox Hearth Products	Whitfield Fireplace/Hearth Stove	1	11000-35700		78	Pellet
	Lennox Hearth Products	Whitfield WP-1, III T, II-T, II-TC, Advantage Series	1	9100-37800		78	Pellet
	Lennox Hearth Products	WP-2 III T, II-TC, Advantage Series	1	9100-37800		78	Pellet
	Lennox Hearth Products	BELLA	1.01	11,202-25,925		78	Pellet
	Lennox Hearth Products	WINSLOW PS40 and PI40	1.14	7,476-21,343		78	Pellet
	Lennox Hearth Products	Whitfield Advantage WP-2	1.3	10900-35100		78	Pellet
	Lennox Hearth Products	STRIKER S160 and C160	1.6	12500-41200		63	Non Catalytic
	Lennox Hearth Products	Bayview II, 2000C,BV4000C, BV4000C-2	1.9	6600-40900		72	Catalytic
	Lennox Hearth Products	Traditions T300HT & T3000HT The Earth Stove 1600HT, 1900HT-M	2.6	10700-37400		63	Non Catalytic
	Lennox Hearth Products	Bayview BV450C/BV400C-2	3	11000-48100		72	Catalytic
	Lennox Hearth Products	Bayview II BV4000	3.1	9200-42300		72	Catalytic
	Lennox Hearth Products	Model T200C	3.2	8500-34900		72	Catalytic
	Lennox Hearth Products	CANYON ST310, C310	3.5	11600-38800		63	Non Catalytic
	Lennox Hearth Products	1003-C	3.7	11700-36800		72	Catalytic
	Lennox Hearth Products	Traditions T-100	3.8	8300-43800		72	Catalytic
	Lennox Hearth Products	MONTAGE	4.03	6,270-29,784		78	Pellet
	Lennox Hearth Products	Traditions T150C, T100SC	4.1	6500-35300		72	Catalytic
	Lennox Hearth Products	LEGACY S260, C260, and E260	4.11	11800-48000		63	Non Catalytic
	Lennox Hearth Products	PERFORMER SS210, ST210 and C210	4.2	9500-36100		63	Non Catalytic
	Lennox Hearth Products	2800HT	4.5	11500-46700		63	Non Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Lennox Hearth Products	Brass Flame KS-805	5.3	9300-49800		63	Non Catalytic
	Lennox Hearth Products	Bayview BV400, BV450	5.5	11000-53700		72	Catalytic
	Lennox Hearth Products	Brass Flame KS-1005, KS-2000I	6	11800-44000		63	Non Catalytic
	Lennox Hearth Products	Brass Flame KS-805	6	9300-49800		63	Non Catalytic
	Lennox Hearth Products	KS-1005, SV-14; KS-2000, FI-15	6	9500-41100		63	Non Catalytic
	Lennox Hearth Products	Grandview 300	3.1	10,249-29,181		63	Non Catalytic
	Lennox Hearth Products	Grand View 230, Montake 230	3.6	11,214 - 28,216		63	Non Catalytic
	Lennox Hearth Products	Earth Stove c-1002, and Ranger 1500HT, 1400HT	6.6	11700-37000		63	Non Catalytic
	Lennox Hearth Products	1000HT, 1100HT, 2000HT, 2200HT	8.3	6600-32200		63	Non Catalytic
	Lennox Hearth Products	ES2100	3.05	10,491 -30,387		63	Non Catalytic
x	Lexington Forge	SSI 30	3.47	11,000-30,600		63	Non Catalytic
x	Lexington Forge	SSW 30FTPB, SSW30FTAL, SSW30FTAPB	3.5	11,000-30,600		63	Non Catalytic
x	Lexington Forge	SSW30STAL, SSW30STAPB Savannah	3.5	11,000-30,600		63	Non Catalytic
x	Lexington Forge	Savannah SSW 20 and Windsor WCS20	3.76	11,000-45000		63	Non Catalytic
x	Lexington Forge	SSW40	4.3	11,963-35767		63	Non Catalytic
x	Long Agribusiness	Silent Flame Model 2058A	2.3	9600-30600		72	Catalytic
x	Long Agribusiness	Silent Flame Model 2062	2.4	9900-32600		72	Catalytic
x	Long Agribusiness	2062 Catalytic freestanding/insert	3.3	10600-20700		72	Catalytic
x	Long Agribusiness	Silent Flame 2058	5.3	9000-27100		72	Catalytic
	LOPI by Travis Industries, Inc	Declaration, Walden insert	4.1	11,300-33,400		63	Non Catalytic
	LOPI by Travis Industries, Inc.	Republic 1750, Endeavor and Revere Insert	1.94	9300-42200		63	Non Catalytic
	LOPI by Travis Industries, Inc.	Leyden	2.4	10,700-33,900		63	Non Catalytic
	LOPI by Travis Industries, Inc.	Liberty, Freedom Bay insert	2.6	12000-45100		63	Non Catalytic
	LOPI by Travis Industries, Inc.	Freedom	3.6	11800-47500		63	Non Catalytic
	LOPI by Travis Industries, Inc.	ANSWER, ANSER insert, Republic1250 and Avalon Spokane	4.4	11600-38500		63	Non Catalytic
x	Luap Associates, Inc.	Eagle 2001	2.6	8400-55200		78	Pellet
	Lucky Distributing	Integra	3.6	10,024-31,268		78	Pellet
	Lucky Distributing	Esprit, Viva and Taurus	4.4	11,817-32,263		63	Non Catalytic
	M. Texeira International, Incorporated	Bef 520 H	6.4	11,721-25,859		63	Non Catalytic
x	Martin Industries, Inc.	C-92	2.4	7200-29500		72	Catalytic
x	Martin Industries, Inc.	Ashley APC2,APC2C; King KC2,KC2B; Atlanta AC2,AC2B	3	9700-27900		72	Catalytic
x	Martin Industries, Inc.	C-92	3	13900-35700		72	Catalytic
x	Martin Industries, Inc.	Ashley	3.8	5700-35300		72	Catalytic
x	Martin Industries, Inc.	Ashley APS5,APS5B; King KC5,KC5B; Atlanta AC5,AC5B	3.8	9400-35400		72	Catalytic
x	Martin Industries, Inc.	Ashley CAHF,CAHFB; King MCF,MCFB; Atlanta ACF,ACFB	4.8	9900-30000		72	Catalytic
x	Martin Industries, Inc.	C-92	5.3	5200-33200		72	Catalytic
	Max Blank GmbH	Florenz K0 2, Volterra, Padua, Atlanta BF	3.1	11,842-34,680		63	Non Catalytic
	Max Blank GmbH	Atlanta K02, Siena, Monza, Davos, Ravenna, Heidelberg	4.5	11,479-36,009		63	Non Catalytic
	Max Blank GmbH	Solero, Toulouse, Zitro, Rio, Memphis, Niagara, Fisco	4.5	11,479-36,009		63	Non Catalytic
	Max Blank GmbH	Mega K 03	5.14	10,500-33,000		63	Non Catalytic
	Max Blank GmbH	Bordeaux	5.6	10,129-34,342		63	Non Catalytic
	MCZ S.p.a.	Cubic, Cosmo	1.3	7,428 - 27,053		78	
	MCZ S.p.a.	Trendline, Soft Line, Fine Line, Zeus, Athene, Troja, Hera, Avanti	1.3	7,428 - 27,053		78	
	MCZ S.p.a.	Musa Air, Suite Air, Club Air, Sagar Air	1.3	7,428 - 27,053		78	Pellet
	MCZ S.p.a.	Star Air, Ego, Air, Toba Air, Sagar Air	1.4	8,233-24,533		78	Pellet
	MCZ S.p.a.	Nima Comfort Air, Club Comfort	1.8	9,704 - 31,758		78	
	MCZ S.p.a.	Musa Comfort Air, Suite Comfrot Air	1.8	9,704 - 31,758		78	Pellet
	Metal M.D.R. Inc.	Model HE-1400, XE-1400, & XTD-1.5	4.3	10,800-34,000		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Metal M.D.R. Inc.	XVR-III, XLT-III	7.5	11,900-35,000		63	Non Catalytic
	Monessan Hearth Systems	Century/Dutchmaster FW and CDW	1	11,800-32,300		63	Non Catalytic
	Monessan Hearth Systems	Merrimack, Essex	3.6	10,554 - 31,780		63	Non Catalytic
	Monessan Hearth Systems	CJW2500X02, DW2500 and JW2500X10	4.7	9500-57800		63	Non Catalytic
	Monessan Hearth Systems	CW2500X00, CW2500X02, JW2500X00,	4.7	9500-57800		63	Non Catalytic
	Monessan Hearth Systems	Defiant 1975	2.3	9,600 - 26,600		63	Non Catalytic
	Monessan Hearth Systems	FW247001 to FE247004 and JW1000PF1	5	11500-18900		63	Non Catalytic
	Monessan Hearth Systems	JW1000L10 and JW1000P10, DW1000, FW2400, S24	5.3	10600-26100		63	Non Catalytic
	Monessan Hearth Systems	Model Campbell II Elite S-24X & FW24 Series, CJW1000L02,	5.3	10600-26100		63	Non Catalytic
	Morso Jernstaberi A/S	2B Classic	3.9	10900 -23600		63	Non Catalytic
	Morso Jernstoberi A/S	3112 and 3142	3.1	9,300-28,500		63	Non Catalytic
	Morso Jernstoberi A/S	Model 4600	3.2	11,100-25,600		63	Non Catalytic
	Morso Jernstoberi A/S	Squirrel 1410 ,1420,1440	3.3	9600-22000		63	Non Catalytic
	Morso Jernstoberi A/S	Owl 3410/3440 & 3450	3.5	8400-23600		63	Non Catalytic
	Morso Jernstoberi A/S	7600 Series	3.6	10,000 - 21,300		63	Non Catalytic
	Morso Jernstoberi A/S	Model 4650 (Soapstone)	3.7	10,900-25,700		63	Non Catalytic
	Morso Jernstoberi A/S	Model 2040	3.8	11,100-40,100		63	Non Catalytic
	Morso Jernstoberi A/S	Model 7110	3.8	10,700-27,900		63	Non Catalytic
	Morso Jernstoberi A/S	6100	4.1	11,117-22,000		63	Non Catalytic
	Morso Jernstoberi A/S	Model 2B	4.1	9,300-30,700		63	Non Catalytic
	Morso Jernstoberi A/S	Model 5660,	4.3	8,998- 50,078		63	Non Catalytic
	Morso Jernstoberi A/S	Panther Model 2110B	4.3	8,600-42,100		63	Non Catalytic
	Morso Jernstoberi A/S	Morso 1710	4.4	12,000-39,800		63	Non Catalytic
	Morso Jernstoberi A/S	8140, 8142, 8147, 8151 and 8150	4.5	10,864-25,370		63	Non Catalytic
	Morso Jernstoberi A/S	Panther 2110	4.7	10300-60500		63	Non Catalytic
	Morso Jernstoberi A/S	Morso 7900 (7940, 7943, 7948, 7970, 7990)	4	11,600-26,705		63	Non Catalytic
	Morso Jernstoberi A/S	8180	5.1	9,300-28,500		63	Non Catalytic
	Morso Jernstoberi A/S	3600 Series	5.2	11,400-49,500		63	Non Catalytic
x	National Steelcrafters of Oregon	Breckwell W3000FS/W3000I	2.3	11600-33700		63	Non Catalytic
x	National Steelcrafters of Oregon	Craft Stove CB-4830	3.1	11600-41100		72	Catalytic
x	National Steelcrafters of Oregon	Craft Stove CB-4830, CB-300	3.1	11600-41100		72	Catalytic
x	National Steelcrafters of Oregon	Craft CB-4830 Insert	3.4	9100-22400		72	Catalytic
x	National Steelcrafters of Oregon	Craft Stove CB-4426	3.9	12100-35600		72	Catalytic
x	National Steelcrafters of Oregon	Craft Stove CB-4426, CB-26, CAT 44-1	3.9	12100-35600		72	Catalytic
x	National Steelcrafters of Oregon	Chateau NC24	5.4	14500-51000		63	Non Catalytic
x	Navigator Stove Works, Inc.	NSW-1 Sardine	3.5	11,400-19,400		63	Non Catalytic
	Navigator Stove Works, Inc.	Navigator NSW2	3.6	10500-28200		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Buck Bay Model 91	1.2	8,800-51,200		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	New Buck/Carolina Model 17	1.2	8100-27900		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	94NC	3.81	11,390 - 42,200		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Buck Master	2.1	10,800-49,800		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	50PCV, 50PBay, 50CV, 50CBay, 50CD, 50BCV, 50BBay	2.5	10100-38000		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	41BCV, BBay, CD, CS, CV, CBAY, PCV, PCBAY	2.6	6900-27800		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	MODEL XL-80	2.7	9200-40500		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 261	2.92	10271-32263		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 18	3.1	10000-22400		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 20, catalytic	3.2	10800-37500		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Bay Model 91	3.5	10400-50400		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Buck/Tharrington 74/T-74	3.6	11,600-41,400		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	New Buck Corporation (Buck Stove Corp.)	Model 71 Freestanding/Insert Catalytic	3.6	13100-40200		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Regular Buck 27000-C	3.8	14700-25100		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Little Buck 26000-C	4	6800-38700		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 81/85	4.3	11900-45400		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 21	4.4	12,000-444,000		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Big Buck 28000-C	4.7	8500-39100		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Regular Buck 27000-CR	4.8	14700-30800		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 70	5	9800-31300		72	Catalytic
	New Buck Corporation (Buck Stove Corp.)	Model 26	5.4	11900-42600		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Townsend III	6.2	11400-41200		63	Non Catalytic
	New Buck Corporation (Buck Stove Corp.)	Buck Carolina/Tharington 51/T-51	6.7	11800-40900		63	Non Catalytic
	Newmac Manufacturing Incorporated	Classic II Model NCM 120	3.04	10,700-27,000		63	Non Catalytic
	Newmac Manufacturing Incorporated	Classic 1 EPA NC 100 E	4	10,632-26,986		63	Non Catalytic
	Newmac Manufacturing Incorporated	WFA 70	2.72	11852 - 15922		63	Non Catalytic
	Newmac Manufacturing Incorporated	Status EPA Model NS220 E	4.97	11,600-27,400		63	Non Catalytic
x	NHC Inc.	Model 3-C	2	7900-15000		72	Catalytic
x	NHC Inc.	Harvest A-HII catalytic	2.5	10500-36400		72	Catalytic
x	NHC Inc.	Mansfield I	2.9	13600-45300		63	Non Catalytic
x	NHC Inc.	Mansfield	3.2	10200-27900		63	Non Catalytic
x	NHC Inc.	Phoenix (Version 2)	3.4	10400-35200		63	Non Catalytic
x	NHC Inc.	Harvest HII	3.8	8800-28900		72	Catalytic
x	NHC Inc.	Phoenix	4.94	10300-43000		63	Non Catalytic
	Nordpeis A/S	Saturn A	6	10,100-25,000		63	Non Catalytic
	NU-TEC/Upland Distributors, Inc.	Brenden BR-60	1.43	11000-29400		72	Catalytic
	NU-TEC/Upland Distributors, Inc.	Upland Amity AM-40	2.6	10600-23600		72	Catalytic
	NU-TEC/Upland Distributors, Inc.	Townsend Woodstove TN-25	2.7	10200-27500		72	Catalytic
	NYSERDA	XEOOS	2.4	11,519 - 27,432		63	Non Catalytic
x	OK Doke, Ltd.	Sweethearth Presidential 800/800XL	3.6	9900-20000		72	Catalytic
x	Olsberg Hermann Everken, Gmbh	Bristol OH-L	2.1	11,800-32,200		63	Non Catalytic
x	Olsberg Hermann Everken, Gmbh	Bristol OH-M	2.7	11,000-33,200		63	Non Catalytic
x	Oregon Woodstoves, Inc.	Model OS/1	1.4	7800-40000		72	Catalytic
x	Oregon Woodstoves, Inc.	#1, Design 01	2.7	9600-49700		72	Catalytic
x	Orley's Manufacturing Company, Inc.	Cougar G-225	2.7	9100-36200		72	Catalytic
x	Orley's Manufacturing Company, Inc.	Leopard U245,U246,UO245,UO246; Panther F245,F246	3.5	9100-39000		72	Catalytic
x	Orrville Products, Inc.	COUNTRY COMFORT CC160	2.9	11900-47800		63	Non Catalytic
x	Orrville Products, Inc.	CC250	3.5	13200-29800		72	Catalytic
x	Orrville Products, Inc.	Country Comfort CC325	3.5	18600-60600		72	Catalytic
x	Orrville Products, Inc.	CC 350	3.8	13700-68900		72	Catalytic
x	Orrville Products, Inc.	CC-185I and 165I	3.8	11500-48600		63	Non Catalytic
x	Orrville Products, Inc.	CC180	3.9	10700-57600		63	Non Catalytic
x	Orrville Products, Inc.	Country Comfort CC350	4.3	11200-29100		72	Catalytic
x	Orrville Products, Inc.	CC175 and CC155	4.4	10900-39200		63	Non Catalytic
x	Orrville Products, Inc.	Country Comfort CC160	5.25	11600-36500		63	Non Catalytic
x	Orrville Products, Inc.	CC185 and CC165	5.3	11300-46100		63	Non Catalytic
x	Orrville Products, Inc.	Country Comfort CC150, CC1000, CC150H	7.5	7200-23900		63	Non Catalytic
x	Orrville Products, Inc.	Country Comfort CC100	8.5	8700-33400		63	Non Catalytic
x	Orrville Products, Inc.	Country Comfort CC125	9.5	12300-27600		63	Non Catalytic
	Osburn Manufacturing, Inc.	Imperial 2000	4.6	9000-33000		63	Non Catalytic
	Osburn Manufacturing, Inc.	2200	5.7	10400-41500		63	Non Catalytic
	Osburn Manufacturing, Inc.	1050	6.9	10600-42900		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Osburn Manufacturing, Inc.	Imperial MKII, MKII Insert, Goldenaire	7	10700-51600		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	Neo 1.6	3.9	9161-34810	75	63	Non Catalytic
	Pacific Energy Fireplace Products Limited	Vista Series C, Vista Classic, Vista Artisan, Vista Insert, and Alderlea T4	2.92	12400-26300		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	Alderlea T5, Super 27 Design D, Spectrum, Step D1	3.4	11000-34600		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	Standard, Pacific Ins, Spectrum Classic and Fusion, ALT5INS, Super Insert	3.4	11000-34600		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	Summit Series A, Summit Insert, Summit Classic and Alderlea T6	3.6	10300-37500		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	S-27, Spectrum, Standard, Pacific	6.4	10600-36400		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	True North TN19	4.1	10,652 - 32923		63	Non Catalytic
	Pacific Energy Fireplace Products Limited	FP30	2.68	11829-38556		63	Non Catalytic
	Panda Wood Stoves	UMF-400	5	7600-38300		72	Catalytic
	Pellefier Inc.	Venturi PVI-87	0.5	9000-31800		78	Pellet
x	Polar Fireplaces	Woodchief 300 E	4.8	11600-43700		63	Non Catalytic
x	Polar Fireplaces	Woodchief 400 E	5.1	11500-59000		63	Non Catalytic
x	Precision Gas Technologies	WS-250	4	11700-50500		63	Non Catalytic
	PSG Distribution Inc.	Caddy (duct furnace)	6.6	12000-52900		63	Non Catalytic
	Quality Craft	QCPS - 28000	2.37	13,119 - 14,759		78	Pellet
	Rais A/S	Gabo Pina Vola	2.1	12,000-26,700		63	Non Catalytic
	Rais A/S	Malta, Bando and Bora	4.3	11400-32900		63	Non Catalytic
	RAIS A/S	Rondo, Mino II Steel and Mino II SST	4.3	11,431-22,561		63	Non Catalytic
	RAIS A/S	OPUS	5.7	11,479-21,630		63	Non Catalytic
	Rais A/S	Rais 60-A Insert	7.2	11600-51300		63	Non Catalytic
	Ravelli /EcoTeck	Laura / Veronica	3.87	8,500 - 44,000		78	Pellet
	Ravelli /EcoTeck	Sofia / Silvia	1.65	8,500 - 50,000		78	Pellet
	Ravelli /EcoTeck	Monica / Francesca	1.45	8,500 - 35,000		78	Pellet
	Ravelli /EcoTeck	Ilaria / Serena	4.4	8,500 - 44,000		78	Pellet
x	Renfyre Stove Co./ Maco Enterprises, Inc.	Fireview 2300	7	11700-27500		63	Non Catalytic
x	Renfyre Stove Co./Maco Enterprises Inc.	5000 Combination Range Design #50001	5.5	13600-21600		63	Non Catalytic
x	Renfyre Stove Co./Maco Enterprises, Inc	2800	3.4	11900-23700		63	Non Catalytic
x	Renfyre Stove Co./Maco Enterprises, Inc	Fireview Insert 2700	3.8	9400-27500		63	Non Catalytic
x	Reverso Manufacturing, Ltd.	Challenger MMX	2.6	11200-33800		63	Non Catalytic
x	Riteway-Dominion Manufacturing Company, Inc	Dominion 005	4.5	7000-29100		72	Catalytic
x	RJM Manufacturing, Inc	Achiever FPI-1-LEX	2	7900-26700		72	Catalytic
x	RJM Manufacturing, Inc.	FPI-2-LEX/90	1.6	10300-36500		72	Catalytic
x	RJM Manufacturing, Inc.	Energy King Bay 2000C	2.5	11400-34600		72	Catalytic
x	RJM Manufacturing, Inc.	Energy King 2500C	3	16100-39800		72	Catalytic
x	RJM Manufacturing, Inc.	Model Silhouette 2850C	3.2	8100-34700		72	Catalytic
	RSF / Industrial Chimney Company, Incorporate	Opel 2000C, OPEL AP	3.7	10600-49700		72	Catalytic
	RSF / Industrial Chimney Company, Incorporate	TOPAZ/CHAMELEON (Without Fan), TOPAZ, Chameleon	4	11100-25700		63	Non Catalytic
	RSF / Industrial Chimney Company, Incorporate	HT (Onyx), ONYX AP	4.5	11800-35600		63	Non Catalytic
	RSF / Industrial Chimney Company, Incorporate	TOPAZ/CHAEMELON (With Fan)	5.5	9500-25800		63	Non Catalytic
	RSF / Industrial Chimney Company, Incorporate	Ardent HF 40	9.9	6400-30600		63	Non Catalytic
	Russo Products, Inc.	W-25C	2.4	8400-31300		72	Catalytic
	Russo Products, Inc.	GV-30S	2.5	9500-38700		72	Catalytic
	Russo Products, Inc.	Russo Glassview GV-21	2.9	10200-29600		72	Catalytic
	Russo Products, Inc.	GV-30C	3.1	10300-39400		72	Catalytic
	Russo Products, Inc.	W-18C	6.2	7900-40900		72	Catalytic
	Salvo Machinery, Inc.	Model Citation	2.4	9600-33500		72	Catalytic

Actual Measured Efficiency - Per CSA B415.1
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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Salvo Machinery, Inc.	Citation Classic W45NC/WI45NC	7.1	11800-32200		63	Non Catalytic
x	Sarratt Agencies Limited	Merlin 3 FS-15, IS-15	6.1	9800-21100		63	Non Catalytic
x	Saxon Wood Heaters Pty, Ltd.	Rosewood	2.7	11600-36200		63	Non Catalytic
	Security Chimneys International Ltd.	BIS Ultima, Brentwood, BIS Tradition CE, and Montecito	3.692	10,442-27,746		63	Non Catalytic
	Security Chimneys International Ltd.	BIS Panorama, Villa Vista	4.1	10900-35,600		72	Catalytic
	Security Chimneys International Ltd.	BIS Nova, Ladera	4.8	8,700-25,700		63	Non Catalytic
	Security Chimneys International Ltd.	BIS Ultra	5.1	11033-46700		63	Non Catalytic
	Security Chimneys International Ltd.	BIS II	5.3	11300-41500		63	Non Catalytic
	Security Chimneys International Ltd.	BIS Design No. 1.2	5.5	14200-55800		63	Non Catalytic
	Security Chimneys International Ltd.	BIS Tradition and Montecito Estate	7.3	11,500-39-300		63	Non Catalytic
x	Selkirk Canada Corporation	Model: HE36	0.97	6,668-15,290		63	Non Catalytic
x	Selkirk Canada Corporation	Model HE40	5.7	11,383-45,459		63	Non Catalytic
	Seraph Industries	Genesis 106	2.1	11,100 - 45,100	83.2	78	Pellet
	Seraph Industries	Genesis 108	2.1	11,100 - 45,100	83.2	78	Pellet
	Sherwood Industries, Ltd.	CH-77, CH-84	3.1	8000-33800		72	Catalytic
	Sherwood Industries, Ltd.	Envirofire EF2, EF2i, FS and FPI, Hudson River Davenport FS/FPI	1.25	6,500-34,000		78	Pellet
	Sherwood Industries, Ltd.	Boston 1700	4.5	8000- 65000		63	
	Sherwood Industries, Ltd.	Boston 1200	3.3	6500- 74000		63	
	Sherwood Industries, Ltd.	Mini	1.6	22,585-30,113		78	Pellet
	Sherwood Industries, Ltd.	Empress FS	1.86	27,827-35,675		78	Pellet
	Sherwood Industries, Ltd.	EMPRESS FPI, Milan FPI	1.88	25,709-30,058		78	Pellet
	Sherwood Industries, Ltd.	Envirofire - EF3 FS, FPI, EF3Bi FS, Vista Flame VF100 FS	1.96	6,500-40,000		78	Pellet
	Sherwood Industries, Ltd.	Envirofire - Meridian FS & FPI	1.96	6,500-40,000		78	Pellet
	Sherwood Industries, Ltd.	Greenfire GF55, GFI55	1.96	6,500-40,000		78	Pellet
	Sherwood Industries, Ltd.	EF 3, Meridian and VF 100	2	6,500-40,000		78	Pellet
	Sherwood Industries, Ltd.	M55, M55C, V55	2	9,263-45,478		78	Pellet
	Sherwood Industries, Ltd.	Meridian	2.24	32,566-42,963		78	Pellet
	Sherwood Industries, Ltd.	Vista Flame 2100 FS, Envirofire 2100 FS	2.9	11800-34000		63	Non Catalytic
	Sherwood Industries, Ltd.	osburn	3.18	52,453-60,992		78	Pellet
	Sherwood Industries, Ltd.	Vista Flame Envirofire 2000	3.2	11000-31100		63	Non Catalytic
	Sherwood Industries, Ltd.	Enviro 1200, 1200I, Vista Flame 1200, 1200I, 1200 Venice	3.3	11,500-34,200		63	Non Catalytic
	Sherwood Industries, Ltd.	Vista Flame 1600 FS, 1600 FPI, Envirofire 1600 FS, 1600 FPI	3.5	11500-33600		63	Non Catalytic
	Sherwood Industries, Ltd.	Enviro Fire 1000FS and Vista Flame 1000FS, 1000	4.1	11700-32700		63	Non Catalytic
	Sherwood Industries, Ltd.	Enviro Model 1700I, 1700 & Vista Flame 1700I, 1700, 1700 Venice	4.5	9,400-31,800		63	Non Catalytic
	Sherwood Industries, Ltd.	Mini	1.6	8,378 - 23,488		63	Non Catalytic
	Sherwood Industries, Ltd.	Vista Flame Envirofire 1000	6.5	10200-30800		63	Non Catalytic
	Sherwood Industries, Ltd.	Vista Flame Envirofire 1500	7	11700-23100		63	Non Catalytic
x	Sierra Products, Inc.	Sierra Evolution 8000 TEC	2.5	9700-35900		72	Catalytic
x	Sierra Products, Inc.	Evolution Model 7000C	2.8	7700-29400		72	Catalytic
x	Sierra Products, Inc.	Sierra Ambassador 4700 TEC	3.2	10800-42600		72	Catalytic
x	Sierra Products, Inc.	EF-2100	5.7	11,000-42,900		63	Non Catalytic
x	Sierra Products, Inc.	Sweet Home AFX-HT, AFI-HT	6.4	11300-28200		63	Non Catalytic
x	Sierra Products, Inc.	Cricket 5300	6.6	11000-36400		63	Non Catalytic
x	Sierra Products, Inc.	Sierra Classic 1500T	7.5	6900-34600		63	Non Catalytic
	Stove Builder International Inc.	BIO-45MF, Eco-45, FP-45, Hybrid-45MF	1.2	8,569-29,784		78	Pellet
x	Stove Builder International Inc.	Emerald 2000	1.7	7500-24500		78	Pellet

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Stove Builder International Inc.	BIO-35MF, Eco-35, FP-35, Hybrid-35MF	1.77	6,668-15,290		78	Pellet
	Stove Builder International Inc.	Osburn 1100, Osburn 1100-I	2.9	11,000- 35,000		63	Non Catalytic
	Stove Builder International Inc.	Caddy, Alterna	4.2	10,142 - 71.014		78	Pellet
	Stove Builder International Inc.	FW3000	3.5	11,800-32,400		63	Non Catalytic
	Stove Builder International Inc.	HT 1600-Standard/HT 1600 Deluxe, HT-1600 Siberian, Ashley 1600	3.5	11200-26400		63	Non Catalytic
	Stove Builder International Inc.	Osburn 2400 B	3.5	11900-40900		63	Non Catalytic
	Stove Builder International Inc.	Osburn 2400-I, Osburn 2400 FS	3.5	11,900-40,900		63	Non Catalytic
	Stove Builder International Inc.	Euromax, Eco-65	2.58	6,873-34,727		78	Pellet
	Stove Builder International Inc.	HT-2000 Standard/HT-2000 Deluxe/HT-2000	3.9	11600-60300		63	Non Catalytic
	Stove Builder International Inc.	HT2000, Solution 3.4, Ashley 2000	3.9	11,600-38,700		63	Non Catalytic
	Stove Builder International Inc.	1600	4.4	11800-42400		63	Non Catalytic
x	Stove Builder International Inc.	Monaco 2008	4.4	11479-30,450		63	Non Catalytic
	Stove Builder International Inc.	Monaco, Stratford, Solution 2.5, Lafayette	4.4	11,479-30,450		63	Non Catalytic
	Stove Builder International Inc.	Osburn 1600, Osburn 1600-I, Ashley 4600, Forrester 4700	4.4	11,800-42,400		63	Non Catalytic
x	Stove Builder International Inc.	1600 B-I/Ashley 4600/Forester 4700	4.8	11900-35500		63	Non Catalytic
	Stove Builder International Inc.	S244, Pyropak, Osburn 900	5.3	10,600-26,100		63	Non Catalytic
	Stove Builder International Inc.	Gemini 1500 (With Blower), Adirondack, Savannah, Eldorado, Jurassien, Celtic, Osburn 1500	6.2	11500-43900		63	Non Catalytic
	Stove Builder International Inc.	HE-1800,Escape 1800, Solution 2.3, Solution 2.3-I, XTD1.9, XTD1.9-I, Osburn 2000, Osburn 2000-I, Dundee 1.9	6.3	11,600-38,700		63	Non Catalytic
	Stove Builder International Inc.	HT-1200 and Ashley 1200	6.5	8300-36000		63	Non Catalytic
	Stove Builder International Inc.	HT1200, Ashley 1200	6.5	8,300-36,000		63	Non Catalytic
	Stove Builder International Inc.	Gemini 1500 (Without Blower), Adirondack, Savannah, Eldorado, Jurassien, Celtic, Osburn 1500	7.5	11100-37300		63	Non Catalytic
	Stove Builder International Inc.	XTD1.5, XTD1.5-I, Solution 1.8, Solution 1.8-I, Escape 1400-I, Blackcomb, Columbia	4.3	10,800-34,000		63	Non Catalytic
	Stove Builder International Inc.	1.6 Series	4.02	0,852 - 23,272/33		63	Non Catalytic
	Stove Builder International Inc.	1.3 Series	3.99	9,887 - 21.825		63	Non Catalytic
	Stove Builder International, Inc.	Osburn 1800, Osburn 1800-I	2.7	9700-36300		63	Non Catalytic
	Stove Builder International, Inc.	Osburn 2200, Osburn 2200-I	2.7	11700-30400		63	Non Catalytic
	Stove Builder International, Inc.	Apollo, Apollo II	3.6	10600-24700		63	Non Catalytic
	Stove Builder International, Inc.	Le Chancelier, NXT-1 and Solution 2.9, Glencoe 2.1	4.4	11900-29400		63	Non Catalytic
x	Stove Builder International, Inc.	LeBachelier	4.9	11800-24500		63	Non Catalytic
	Stove Builder International, Inc.	New Generation NG 1800/Magnolia 2015	5.7	11,500-30,800		63	Non Catalytic
	Stove Builder International, Inc.	Osburn 1100	5.7	11000-35000		63	Non Catalytic
	Stove Builder International, Inc.	XVR-II, XT-1400 adn XLT-II, Eastwood 1500, Jasper, Clyde 1.6	5.9	11800-27300		63	Non Catalytic
	Stove Builder International, Inc.	XVR-I, XLT-1, Classic, Eastwood 1800	6.9	11,400-27,500		63	Non Catalytic
	Stove Builder International, Inc.	XVR-III, XLT-III, Eastwood, 1900, Millenia	7.4	11,900-34,700		63	Non Catalytic
	Stove Builder International, Inc.	Sahara, Kyle 2.0	7.5	11,000-25,700		63	Non Catalytic
	StoveBuilder International, Inc.	FP-8, Saguenay	4	10,900 -36,900		63	Non Catalytic
	StoveBuilder International, Inc.	FP-9i	4.2	11,600-38,700		63	Non Catalytic
	StoveBuilder International, Inc.	FW2700, Deco, Optima	4.4	11,000-69,500		63	Non Catalytic
	StoveBuilder International, Inc.	CW2500, Solution 2.0-I	4.7	9,600-57,800		63	Non Catalytic
	StoveBuilder International, Inc.	FW2470	5	12,000- 28,500		63	Non Catalytic
	StoveBuilder International, Inc.	Legend, Baltic, Austral, Myriad, Azimuth, Osburn 2300, Magnolia 2015	5.7	11,500-30,800		63	Non Catalytic
	StoveBuilder International, Inc.	Model HE-1800, XE-1800 & XTD-1.9	5.9	11600-38700		63	Non Catalytic
	StoveBuilder International, Inc.	Mini-Caddy	6	10,900-36,900		63	Non Catalytic

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Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	StoveBuilder International, Inc.	Eurostar, Osburn 5000	2.18	10.301 - 30,456		78	Pellet
	StoveBuilder International, Inc.	XTD1.1, XE-1000, Solution 1.6	6	9900-47300		63	Non Catalytic
	StoveBuilder International, Inc.	2.3 Series	3.89	11,600 - 32,200		63	Non Catalytic
	StoveBuilder International, Inc.	Caddy, Caddy-on, Tundra, Heatmax	6.6	12,000-52,100		63	Non Catalytic
	Stove Builder International Inc.	Olympia	4.6	9,659-26,407		72	Catalytic
	Stove Builder International Inc.	Evolution	3.5	8588 - 37,513		63	Non Catalytic
	Stove Builder International Inc.	Malibu 1700/2200	4.97	11,700-29.700		63	Non Catalytic
	Stove Builder International Inc.	Rustic 2100 and Tradition 2100	4.97	11,700-29,700		63	Non Catalytic
	Stove Builder International Inc.	Diamant, Diamante Insert	7.5	11,100-26,100		63	Non Catalytic
	Stove Builder International Inc.	Rustic/Tradition 1600	3.5	8588 - 37,513		63	Non Catalytic
	Stove Builder International Inc.	EverestEtna/Equinox/Malibu 2000	5.6	12,588 - 37,513		63	Non Catalytic
	Stove Builder International Inc.	EverestEtna/Equinox/Malibu 2500	5.9	12,588 - 37,513		63	Non Catalytic
	Stuv S.A.	30 Compact	2.79	12,129 - 16,640		63	Non Catalytic
x	Suburban Manufacturing Company	Woodchief W6-88C, Woodmaster W6-88WC	3.4	9500-42500		72	Catalytic
	TEC Enterprises	2000 pellet stove	4.7	11600-22500		78	Pellet
	Thelin Company Inc.	Little Gnome Pellet Stove	3.28	3100-8400		78	Pellet
	Thelin Company Inc.	Thelin T-4000	3.6	9,900-38400		63	Non Catalytic
	Thelin Company Inc.	Providence, Providence Signature	1.2	12,839 - 35,680		78	Pellet
x	Thermic Distribution Europe	Efel Symphony 390.74	1.8	10700-33000		72	Catalytic
x	Thermic Distribution Europe	Harmony IIIB	2.7	11,200-57,300		63	Non Catalytic
x	Thermic Distribution Europe	Model S-33,H33,R33,33	3.3	8,600-37,300		63	Non Catalytic
x	Thermic Distribution Europe	Efel Harmony 386.75	3.8	7100-51000		72	Catalytic
x	Thermic Distribution Europe	Harmony I	4.4	11800-55000		63	Non Catalytic
	Thermic Distribution Europe	S43, H43, SP43, C43	4.17	12,500-39,275		63	Non Catalytic
x	Thermic Distribution Europe	Efel Symphony 387.74	5.1	10600-49700		72	Catalytic
x	Thermic, Inc.	Crossfire FS-1	0.5	6900-39900		78	Pellet
x	Tianjin Berkeley Furniture Corporation	TR 001	4.18	9200-28300		63	Non Catalytic
	Travis Industries, Inc.	Small Flush Wood Hybrid Fyre	0.89	9,784-31,428	76.51	72	Catalytic
x	Travis Industries, Inc	Avalon Cottage/Mission	2.9	11600-36500		63	Non Catalytic
x	Travis Industries, Inc	Lopi Sheffield	3.9	10,300-34,400		63	Non Catalytic
x	Travis Industries, Inc	Flush Wood A Fireplace Insert	4.1	11,300-33,400		63	Non Catalytic
x	Travis Industries, Inc	Lopi Flawless Performance 380, 440	7	6900-48700		63	Non Catalytic
	Travis Industries, Inc.	Avalon Spokane 1750 380-NT & X-NT	1.94	9300-42200		63	Non Catalytic
x	Travis Industries, Inc.	Flush Wood	2.45	12,084 - 29,605		63	Non Catalytic
	Travis Industries, Inc.	Lopi Endeavor, Lopi Revere , Lopi Republic 1750,	1.94	9300-42200		63	Non Catalytic
	Travis Industries, Inc.	Avalon Rainier 90/Rainier 45	2	11200-40000		63	Non Catalytic
	Travis Industries, Inc.	Fireplace Xtrordinair Elite 36 Z.C. & B.I.	2.3	11900-47100		72	Catalytic
x	Travis Industries, Inc.	Model 44-A BI and Z.C.	2.3	10700-75700		72	Catalytic
	Travis Industries, Inc.	Leyden and Avalon Arbor	2.4	10,700-33,900		63	Non Catalytic
	Travis Industries, Inc.	Fireplace Xtrordinair 44 Elite	2.5	11000-45300		72	Catalytic
	Travis Industries, Inc.	Avalon Olympic,Liberty, Freedom Bay	2.6	12000-45100		63	Non Catalytic
x	Travis Industries, Inc.	Lopi Flex FS, FL, LX	2.9	10900-31000		72	Catalytic
	Travis Industries, Inc.	Avalon Pendelton 90/Pendelton 45	3	8700-44400		63	Non Catalytic
x	Travis Industries, Inc.	LOPI Answer/Patriot (Formerly Answer-NT)	3.3	12000-41000		63	Non Catalytic
x	Travis Industries, Inc.	Avalon 1000C2	3.5	7300-47100		72	Catalytic
x	Travis Industries, Inc.	Model 36 F	4	11900-55000		72	Catalytic
x	Travis Industries, Inc.	Fireplace Xtrordinair Model 36A	4.1	10300-54700		72	Catalytic
x	Travis Industries, Inc.	Flex-95 FL, LX, and FS	4.1	10900-55300		72	Catalytic
x	Travis Industries, Inc.	Lopi Elan E1, E2	4.3	11700-26300		63	Non Catalytic

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	Travis Industries, Inc.	ANSWER/LOPI PATRIOT/LOPI PARLOR, Republic1250 and Avalon Spokane, Avalon Camano	4.4	11600-38500		63	Non Catalytic
x	Travis Industries, Inc.	Avalon 901	5.2	7500-45500		63	Non Catalytic
x	Travis Industries, Inc.	LOPI 380-96	5.2	9400-52800		63	Non Catalytic
x	Travis Industries, Inc.	Avalon 996	5.5	9500-45600		63	Non Catalytic
x	Travis Industries, Inc.	Avalon 700	5.9	9200-39100		63	Non Catalytic
x	Travis Industries, Inc.	Lopi X Fireplace Insert	6	13600-29100		63	Non Catalytic
x	Travis Industries, Inc.	Lopi The Answer	6.7	10500-63100		63	Non Catalytic
x	Travis Industries, Inc.	Lopi Premiere Answer Series PA1, PA2, PA3, PA4,PA5	7	8000-31500		63	Non Catalytic
x	Travis Industries, Inc.	Lopi X/96	7.2	11600-53900		63	Non Catalytic
x	Travis Industries, Inc.	Avalon 1196, Lopi 520/96, Flush Bay-96	7.4	11300-43600		63	Non Catalytic
x	Travis Industries, Inc.	Lopi Elan-96	7.4	12000-51400		63	Non Catalytic
	Travis Industries, Inc.	LG Flushwood Insert Hybrid - Fyre	0.58	8544-35278	80.3	72	Catalytic
	Travis Industries, Inc.	Cape Cod	0.45	10,749 - 39,413	80.1	72	Catalytic
	Travis Industries, Inc.	Flushwood Plus	4.4	12000 - 29600		72	Non Catalytic
x	Tri-Fab, Inc.	SunRise P-54 & SunRise PIL-8	5	10600-26500		63	Non Catalytic
x	Tri-Fab, Inc.	SunRise P-48-H, P-48-L	5.5	11700-25800		63	Non Catalytic
x	Tri-Fab, Inc.	SunRise P56	6.2	10700-39700		63	Non Catalytic
	Tulikivi Oyj	Tulikivi Maxi XV 2	4.22	12,058-38,224		63	Non Catalytic
	Tulikivi Oyj	Tulikivi MINI XV 1	4.51	12,100-38,200		63	Non Catalytic
	United States Stove Company	Ashley CAHF-2, Atlanta ACF-2, King MCF-2	1.6	12,800 - 38.900		72	Catalytic
	United States Stove Company	Ashley AHS2, AHS2B; King KHS2	1.9	13700-34300		72	Catalytic
	United States Stove Company	2500 ST	3.1	11,576 - 36,295		63	Non Catalytic
	United States Stove Company	Country Hearth 2200I	5.4	27,136 - 69,000		63	Non Catalytic
	United States Stove Company	Ashley AFS24, King K3, cat., freestanding/insert	2.6	10300-34600		72	Catalytic
	United States Stove Company	Forester Model 5824	4.6	7,775 - 15,974		63	Non Catalytic
	United States Stove Company	Clayton Mfg Clay 60B, 70	2.7	12100-54300		72	Catalytic
	United States Stove Company	Ashley C-92	3	11000-36900		72	Catalytic
	United States Stove Company	Wonder Wood (Glass Front) 2921, Sears 143.8417	3.3	12500-54600		72	Catalytic
	United States Stove Company	Bay Insert 4500	3.7	9600-30700		72	Catalytic
	United States Stove Company	Wonder Wood 6000, 2821, Sears 143.8404	3.7	9100-18700		72	Catalytic
	United States Stove Company	ASHLEY NCA-1/KING KPS	7.16	6500-23200		63	Non Catalytic
	United States Stove Company	6039, 6039 T, 6039 HF, 6039 TP, 6041	1.5	8,528-29,921		78	Pellet
	United States Stove Company	5500M, 5500XL, 5500XLT	1.6	9,126-27,677		78	Pellet
	United States Stove Company	Model 2500, SW3100	3.06	10,100-25,000		63	Non Catalytic
	United States Stove Company	APS 1100B	5.9	10,100-25,000		63	Non Catalytic
	United States Stove Company	2000, SW2100	3.69	11,817 - 31,713		63	Non Catalytic
	United States Stove Company	2400	1.13	7,315 - 14,033		72	Non Catalytic
	United States Stove Company	3000 (AFS7500), SW4100	1.9	11,624 - 38,140		63	Non Catalytic
	United States Stove Company	3000 FT	1.9	11,624 - 38,140		63	Non Catalytic
	United States Stove Company	Breckwell W3000FS/W3000I	2.3	11,600 - 33,700		63	Non Catalytic
	United States Stove Company	Vogelzang, Ashley, King (5770, VG5770)	3.17	10,898-24,335		78	Pellet
	United States Stove Company	Breckwell (SW740)	2.47	11,057-36,681		63	Non Catalytic
	Vermont Castings	Encore 2040	1.6	9,975 – 33,963		63	Non Catalytic
	Vermont Castings	Defiant Encore	0.6	6200-32900		72	Catalytic
	Vermont Castings	Encore 1450 N/C	0.7	10,600-24050		63	Non Catalytic
	Vermont Castings	Defiant 1910 & 1945	0.8	10600-44400		72	Catalytic
	Vermont Castings	2370	1	5700-18300		72	Catalytic
	Vermont Castings	Century/Dutchmaster FW and CDW	1	11,800-32,300		63	Non Catalytic
	Vermont Castings	Dutchwest Small Convection Heater #2460	1.1	6600-27300		72	Catalytic

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	Vermont Castings	Dutchwest Extra Large Convection 2462	1.3	8300-28000		72	Catalytic
	Vermont Castings	FA455	1.3	10400-26500		72	Catalytic
	Vermont Castings	DutchWest Large 2479	1.31	11,300-26,500		63	Non Catalytic
	Vermont Castings	Dutchwest Large Convection Heater (Model 2461)	1.41	10700-29500		72	Catalytic
	Vermont Castings	DutchWest Small Model 2460	1.41	7,800-25,100		63	Non Catalytic
	Vermont Castings	DutchWest Medium 2478	1.5	10,600-25,300		63	Non Catalytic
	Vermont Castings	C.D. Lg. Fed. Convection Heater FA264CCL, FA264CCR	1.6	6600-26700		72	Catalytic
	Vermont Castings	Defiant Encore 2550 (Formerly 2190)	1.6	8700-41700		72	Catalytic
	Vermont Castings	Defiant Encore 2140	1.8	9000-41300		72	Catalytic
	Vermont Castings	Intrepid II Model 1990	2.1	8300-26700		72	Catalytic
	Vermont Castings	Model 2170	2.1	9400-22800		72	Catalytic
	Vermont Castings	WinterWarm Fireplace Insert Model 1280	2.1	10300-30000		72	Catalytic
	Vermont Castings	WinterWarm Small Insert Model 2080	2.1	8700-31100		72	Catalytic
	Vermont Castings	FA264	2.2	9500-31700		72	Catalytic
	Vermont Castings	Intrepid II Model 2070	2.4	9200-19300		72	Catalytic
	Vermont Castings	Model EWF 36A	2.4	11,300-75,500		72	Catalytic
	Vermont Castings	C.D. Extra-Lg. Federal Convection Heater FA288CCL	2.6	8400-38700		72	Catalytic
	Vermont Castings	EWF36	2.7	11,800-68,600		72	Catalytic
	Vermont Castings	C.D. Small Federal Convection Heater FA224CCL	2.8	7000-30600		72	Catalytic
	Vermont Castings	C.D. Rocky Mountain Heater FA211CL	2.9	6800-27800		72	Catalytic
	Vermont Castings	Montpelier	2.9	10,094-27,550		63	Non Catalytic
	Vermont Castings	Montelier/Stratton	2.9	10094-2727550		63	Non Catalytic
	Vermont Castings	Vermont Castings Defiant 1610	2.9	10,000-30,000		63	Non Catalytic
	Vermont Castings	2370	3	10.094-27,550		72	Catalytic
	Vermont Castings	FA224	3.1	9100-34800		72	Catalytic
	Vermont Castings	FA288	3.1	7800-29300		72	Catalytic
	Vermont Castings	Intrepid II 1308	3.1	10200-22500		72	Catalytic
	Vermont Castings	Intrepid Model 1640	3.3	8200-19500		63	Non Catalytic
	Vermont Castings	Madison Model 1655	3.3	11,300-39,700		63	Non Catalytic
	Vermont Castings	Resolute Acclaim (Model Number 2490) & TLWS1	3.4	9500-33900		63	Non Catalytic
	Vermont Castings	C.D. Federal "A Plus" FA224ACL	3.5	7200-30000		72	Catalytic
	Vermont Castings	EWF 30	3.5	11,100-40,500		63	Non Catalytic
	Vermont Castings	C.D. Sequoia FA455	3.6	8700-60300		72	Catalytic
	Vermont Castings	C.D. Adirondack Wood Heater FA267CL	3.7	8400-40000		72	Catalytic
	Vermont Castings	WinterWarm Small Insert (model 2370)	4	9250-21500		72	Catalytic
	Vermont Castings	Aspen 1920 & Plymouth HWS10	4.3	9100-18000		63	Non Catalytic
	Vermont Castings	C.D. Large Federal Box Heater FA209CL	4.3	9000-25600		72	Catalytic
	Vermont Castings	C.D. Small Federal Box Heater FA207CL	4.3	6200-28000		72	Catalytic
	Vermont Castings	Campbell/Jacuzzi FW300005-FW300008 & FW300019-FW300027	4.4	12000-55100		63	Non Catalytic
	Vermont Castings	CJW2000L02, JW2000L10, DW2000XXX and JW2000P10	4.4	12000-55100		63	Non Catalytic
	Vermont Castings	JW1500L10 and JW1500P10, FW1500, DW1500	4.4	10300-29200		63	Non Catalytic
	Vermont Castings	S27X/S28X & FW27 Series, CJW1500L02,	4.4	10300-29200		63	Non Catalytic
	Vermont Castings	S27X/S28X & FW27 Series, CJW1500L02, JW1500L10 and JW1500P10, FW1500, DW1500	4.4	10300-29200		63	Non Catalytic
	Vermont Castings	Seville 1635 and 1600 Insert	4.5	9,900-30,800		63	Non Catalytic
	Vermont Castings	CW2500X00, CW2500X02, JW2500X00,CJW2500X02, DW2500 and JW2500X10	4.7	9500-57800		63	Non Catalytic
	Vermont Castings	FW247001 to FE247004 and JW1000PF1	5	11500-18900		63	Non Catalytic
	Vermont Castings	Resolute Acclaim 0041	5.1	8700-30900		72	Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
	Vermont Castings	Madison 1650	5.5	11400-31000		63	Non Catalytic
	Vermont Castings	Seville Insert	5.5	10200-27400		63	Non Catalytic
	Vermont Castings	Aspen Model 1920	6.3	10100-26400		63	Non Catalytic
	Vermont Castings	Dutchwest 2477	1.4	7800-25100		63	Non Catalytic
	Vermont Castings	Defiant 1975	1.1	11400-34065		72	Catalytic
	Vermont Castings	Savannah SSW30FTAL	2.5	11600-30601		63	Non Catalytic
	Vermont Castings	Savannah SSW30FTAPB	2.5	11600-30602		63	Non Catalytic
	Vermont Castings	Savannah SSW30STAPB	2.5	11600-30604		63	Non Catalytic
	Vermont Castings	Savannah SSW30STAL	2.5	11600-30-603		63	Non Catalytic
	Vermont Castings	Savannah SSW30FTPB	2.5	11600-30600		63	Catalytic
	Vermont Castings	Savannah SSI30	3.47	11000-30600		63	Non Catalytic
	Vermont Castings	Savannah SSW40	4.3	11953-35767		63	Non Catalytic
	Vermont Castings	Dutchwest DW270007	4.4	10300-29201		63	Non Catalytic
	Vermont Castings	Dutchwest DW2500X02	4.7	9500-57801		63	Non Catalytic
	Vermont Castings	Dutchwest DW2000L02	2.7	11800-32301		63	Non Catalytic
	Vermont Castings	Dutchwest DW1500L02	4.4	10300-29201		63	Non Catalytic
	Vermont Castings	Dutchwest DW244	5.3	10600-26101		63	Non Catalytic
	Vermont Castings	Dutchwest DW 247001	5	11500-18901		63	Non Catalytic
	Vermont Castings	Dutchwest DW1000L02	5.3	10600-26101		63	Non Catalytic
	Vermont Castings	Dutchwest DW300007	2.7	11800-32300		63	Non Catalytic
	Vermont Castings	Merrimack	3.6	10574-31780		63	Non Catalytic
	Vermont Castings	Savannah SSW20	3.8	11000-45000		63	Non Catalytic
	Vermont Castings	Windsor WR244	5.3	10600-26100		63	Non Catalytic
	Vermont Castings	Seville 1630, Stratton	6.3	12000-27300		63	Non Catalytic
x	Vestal Manufacturing	Vestal Fireplace Insert V-200-I, V-200-P, V-200-L	2	11700-26500		72	Catalytic
x	Vestal Manufacturing	Vestal Radiant Heater V-100	2.2	9400-27700		72	Catalytic
	Vogelzang International Corporation	TR-009B Performer	3.73	11,299-36,089		63	Non Catalytic
	Vogelzang International Corporation	TR-009 Performer	3.89	11,299-36,089		63	Non Catalytic
	Vogelzang International Corporation	TR-004 Colonial	4.02	11,299-36,089		63	Non Catalytic
	Vogelzang International Corporation	Durango TR001 and Model TR002	3.6	11,299-36,089		63	Non Catalytic
	Vogelzang International Corporation	Highlander, Shiloh Insert, Model TR003	3.8	9000-26300		63	Non Catalytic
	Vogelzang International Corporation	TR007 Norwood, TR011 Norwood	3.2	11,913-34,108		63	Non Catalytic
	Vogelzang International Incorporated	Defender	4.18	9200-28300		63	Non Catalytic
	Wamsler Herd und Ofen GmbH	HOK 10	4.6	9200-16900		63	Non Catalytic
	Waterford Stanley Limited	104 MK II 31	2.9	8800-25900		63	Non Catalytic
	Waterford Stanley Limited	100B 90 32 TV	3.1	10800-32400		63	Non Catalytic
	Waterford Stanley Limited	100B 90 32 RV	3.9	10600-26500		63	Non Catalytic
	Waterford Stanley Limited	Trinity OA	3.97	11500-43800		63	Non Catalytic
	Waterford Stanley Limited	Ashling	4.1	12000-29800		63	Non Catalytic
	Waterford Stanley Limited	Erin OA	4.1	10400-30300		63	Non Catalytic
	Waterford Stanley Limited	Erin/90 TV	4.2	10500-40900		63	Non Catalytic
	Waterford Stanley Limited	Model 100B, 100B O.S.A., Leprechaun	4.3	9000-26700		63	Non Catalytic
	Waterford Stanley Limited	Erin/90 TV	5.7	10200-39900		63	Non Catalytic
	Waterford Stanley Limited	Trinity 35	7	11800-39300		63	Non Catalytic
	Waterford Stanley Limited	100B Design 29, Fionn	7.5	7200-27500		63	Non Catalytic
	Waterford Stanley Limited	Erin	7.6	11800-41500		63	Non Catalytic
x	Webco Industries	Marquis 800, 800 XL	3.6	9900-20000		72	Catalytic
x	Weitz & Co., Inc.	Briarwood XE 88	6.4	12800-34200		63	Non Catalytic
x	Weitz & Co., Inc.	Briarwood BB, BBI and BBZC	4.8	10600-25300		63	Non Catalytic
x	Weitz & Co., Inc.	Eagle 88, Pioneer ZC	6.4	12800-22800		63	Non Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Out of Production	Manufacturer Name	Model Name	Emission Rate G/Hr	Heat Output btu/hr	Actual Measured Efficiency (CSA B415.1)	EPA Estimated (Default) Efficiency	Type
x	Weitz & Co., Inc.	Briarwood II 87	7.3	9900-45900		63	Non Catalytic
x	Welenco Manufacturing, Inc.	P-1000W	0.7	9600-23900		78	Pellet
	Weso-Aurorahautte GmbH	Prestige 125, 225, 325, 425	7.3	8900-31200		63	Non Catalytic
	Weso-Aurorahautte GmbH	Renaissance 326	8	9200-32900		63	Non Catalytic
	Winrich International	Winrich Pellet Stove	1.6	8500-27900		78	Pellet
x	Winston Stove Company	Model WP-18	0.6	10000-21300		78	Pellet
x	Winston Stove Company	Model WP-24	1.5	9700-29400		78	Pellet
	Wiseway Pellet Stoves	GW1949	1.9	7481-19475		78	Pellet
	Wittus Fire By Design	XEOOS Twinfire	2.4	11,519- 27,432		63	Non Catalytic
	Wittus Fire By Design	Shaker Stove	7.3	9,667-29,242		63	Non Catalytic
	Wolf Steel Ltd.	NPS45	2.4	8,827 - 29,023		78	Pellet
	Wolf Steel Ltd.	1900 series (Napoleon 1900)	2.9	11800-34000		63	Non Catalytic
	Wolf Steel Ltd.	Napoleon 2000	3.2	11000-31100		63	Non Catalytic
	Wolf Steel Ltd.	1400 series (Napoleon 1400, 1400L, 1450,1401)	3.5	11500-33600		63	Non Catalytic
	Wolf Steel Ltd.	2200 series (Timberwolf 2200, 2201)	3.6	12,084-31436		63	Non Catalytic
	Wolf Steel Ltd.	2100 series (Timberwolf)	3.9	11,238-37580		63	Non Catalytic
	Wolf Steel Ltd.	1100 series (Napoleon 1100, 1100L, 1100C, 1150, 1101)	4.1	11700-32700		63	Non Catalytic
	Wolf Steel Ltd.	NZ25	4.46	11200-32300		63	Non Catalytic
	Wolf Steel Ltd.	EPA1600C	5.4	12,375-28,127		63	Non Catalytic
	Wolf Steel Ltd.	NZ-26	5.4	11500-27400		63	Non Catalytic
	Wolf Steel Ltd.	Napoleon 1000	6.5	10200-30800		63	Non Catalytic
	Wolf Steel Ltd.	Napoleon 1500	7	11700-23100		63	Non Catalytic
	Wolf Steel Ltd.	1600C-1	7.18	9,200-33,400		63	Non Catalytic
	Wolf Steel Ltd.	TPSI35	2.1	11,200 - 36,000		78	Pellet
	Wolf Steel Ltd.	NZ3000	7.2	11129-31436		63	Non Catalytic
	Wolf Steel Ltd.	EPI22	2.6	11129-31436		63	Non Catalytic
	Wolf Steel Ltd.	EPI3	2.6	11,281 - 28,500		63	Non Catalytic
x	Wolf's Casual Living	BV	3.8	10800-35400		72	Catalytic
x	Wolf's Stoves	BV2 Elite Bay	2.6	11700-46100		63	Non Catalytic
x	Woodkiln Inc.	Woodkiln WK-23	3.8	10700-27200		63	Non Catalytic
	Woodstock Soapstone Company, Inc.	Catalytic Fireview Soapstone Stove #205	1.35	10900-42900		72	Catalytic
	Woodstock Soapstone Company, Inc.	Paladian Model 202, Paladian Model 203 & Keystone Model 204	1.9	8500-35000		72	Catalytic
	Woodstock Soapstone Company, Inc.	Catalytic Fireview Soapstone Stove #201, Classic #200	3.5	13200-40000		72	Catalytic
	Woodstock Soapstone Company, Inc.	Progress Hybrid Soapstone Stove #209	1.33	12,538 - 73,171	81	78	Catalytic-Hybrid
x	Yunca Heating	Yunca WEGJ E/481	5	10700-30300		63	Non Catalytic
	Zephyr Stoves, Inc.	View 2.0	4.5	10,700-34,800		63	Non Catalytic

Actual Measured Efficiency - Per CSA B415.1
Default - Category rating assigned by EPA (The estimated efficiency is a follows: 72% (catalyst-equipped), 63% (non-catalyst equipped), and 78% (wood pellets)). § 60.536(i)(3).

Appendix J

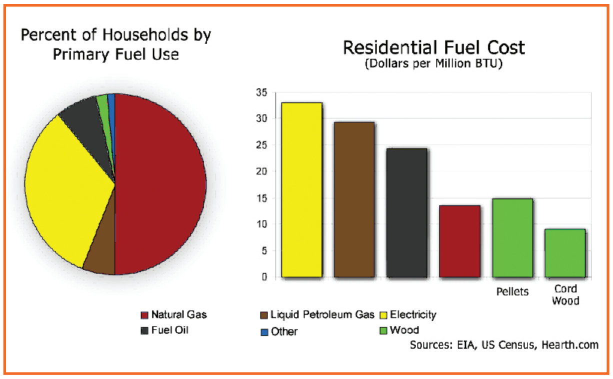
BTEC Residential Heating Fact Sheet

Residential Heating

BTEC Biomass Thermal Energy Council

There are numerous benefits to using biomass instead of fossil fuels like oil, coal, and gas for providing heat for homes, commercial users, and industrial processes.

Space heating represents about 40% of the total energy consumption of the average American home[1]. In colder regions such as New England, this number can climb as high as 60% or more. Meaning that the heating choice the homeowners make can have a significant impact on the environment and their heating bills. One often overlooked option that has the capacity to address both of these issues, is heating with biomass.



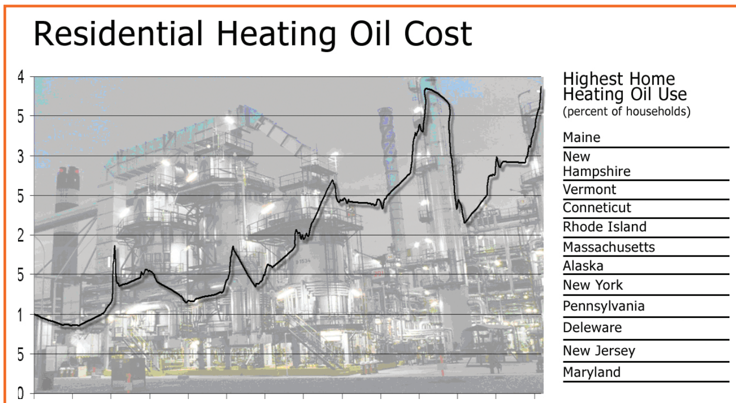
Heating Fuels

As with most energy consumptive sectors, the majority of residential heating is currently being met with non-renewable sources, such as natural gas and fuel oil. These fuels are typically combusted in a furnace or boiler, and are the primary source of heat for the whole house. Depending on the appliance, biomass can provide heat to an entire home in much the same way as a conventional furnace; or it can be used as a secondary heating source. Wood burning stoves can provide primary heating for small homes and are an excellent back-up heat source. Currently, there are about 12 million wood stoves being used in American homes for either primary or secondary heating purposes[2]. Regardless of the size of a biomass appliance, the bottom line is that when in use, it can replace or supplement the consumption of fossil fuels.

Heating Oil

Homeowners use biomass to heat their homes for a variety of reasons, but often cost savings is of the greatest priority. From this standpoint biomass is particularly well suited to displace heating oil. Heating oil is a non-renewable fuel which is derived significantly from foreign markets. As a consequence, not only does the price tend to increase in the long term, but it can also fluctuate dramatically in the short term; a phenomenon which is becoming more pronounced today than ever before. Using a wood or pellet stove as a secondary source of heat can mitigate the costs associated with these fluctuations. Heating a home solely with biomass can rid a homeowner of these pricing fluctuations altogether.

There are many other reasons that people choose to heat their homes with biomass as well: becoming energy independent, supporting local economies, or reducing their carbon footprint. Many homeowners, however, are simply enamored with the ambiance that wood and pellet stoves provide. Whatever the reason, there are a range of heating appliances on the market which can fulfill the needs of any particular homeowner.



Source: Hearth, Pation, and Barbeque Association (HPBA). Hearth Industry Unit Shipments. 2010.

Appliances[3,4]

Many people associate wood heating with billowing chimneys and smoky emissions, when in fact visible smoke is merely symptomatic of an inefficient combustion process. Not only have technological advances led to cleaner burning conventional wood stoves, but they have also spawned a new generation of extremely efficient, automated biomass heating appliances.

Fireplaces

Conventional fireplaces represent the lowest efficiency wood burning technology, and are not generally considered a heating appliance at all. Often, it feels warmest directly in front of the fireplace, however the majority of the hot air is being sucked up the chimney. There are, however, a number of models in production which meet EPA's voluntary standard for fireplaces, and are 70% cleaner than older models. A much better option, that lends itself well to older fireplaces, is a fireplace insert; which is essentially a woodstove that fits into the existing space and greatly increases the efficiency of its use by offering more complete combustion and redirecting more heat into the living space.

Wood Stoves

Fireplaces and woodstoves typically burn cordwood, or small logs, an attribute that offers a high degree of fuel cost flexibility, since cordwood can often be purchased locally or self harvested. Modern woodstoves, freestanding units usually made from cast iron or steel, are much more efficient than fireplaces. This is due in part to EPA regulations that went into effect in the early 1990's aimed at significantly reducing emissions from new wood stoves. Stoves belonging to this new generation are intrinsically more efficient because in reducing their emissions, they combust more of the materials that would otherwise escape the flue as particulate pollution. Currently, the EPA maintains a list of over 900 models of certified wood stoves from manufactures. These models are offered in a range of sizes, styles and applications, and can provide either primary or secondary heating within the home.

Example of a free-standing wood stove. Source: harmanstoves.com

[1] Energy Information Administration, (2009). Residential Energy Consumption Survey: Home Energy Uses and Costs.
[2] US Census, (2011). American Housing Survey for the United States: 2009.
[3] The Alliance for Green Heat, (2009). Available at http://www.forgreenheat.org/technology
[4] Environmental Protection Agency Burnwise Program, (2011). Available at http://www.epa.gov/burnwise/appliances.html
[5] Environmental Protection Agency, (2011). List of EPA Certified Wood Stoves.

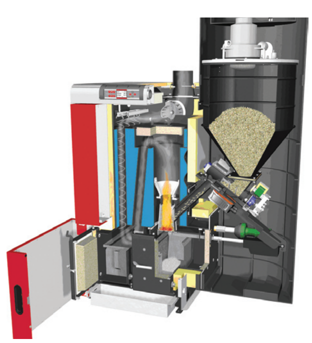
Pellet Stoves
Pellet stoves represent the nexus of convenience, automation, and efficiency. As the name implies, these stoves typically burn wood pellets (uniformly sized condensed biomass) but they can also burn corn kernels. Some units can operate on either type of fuel. The high degree of automation, coupled with the uniform, low-moisture fuel allows for an unprecedented emission profile, high efficiency, and user friendliness. Demand from the user is typically limited to reloading the pellet hopper and intermittently removing ash from the collection bin. Wood and corn pellets can be ordered by the ton and delivered directly to the home, or they can be purchased by the bag (typically 40 lbs) from a variety of vendors including: stove dealers, hardware, home and garden, and feed supply stores.

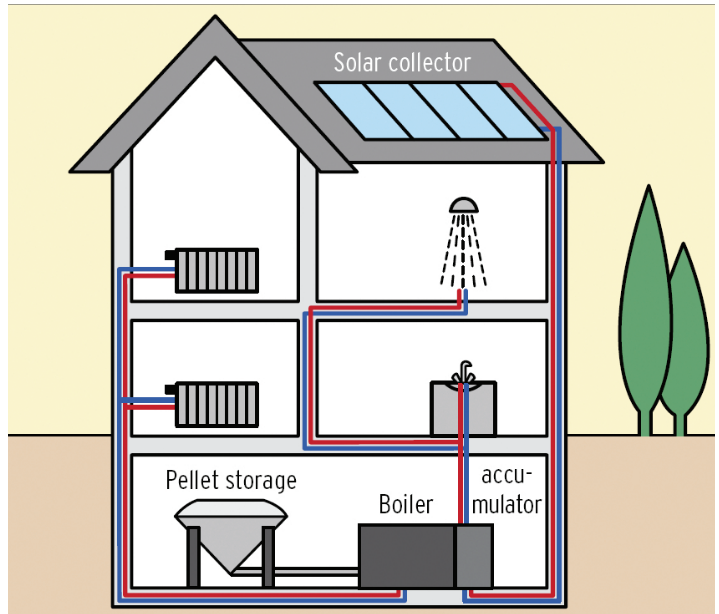
Zone Heating

Wood and pellet stoves are often categorized as zone heaters, meaning that heat is sourced directly from the appliance into the room and adjacent areas. Installing a stove in the highest used 'zone' of the house allows for the thermostat be turned down for the entire home without compromising comfort. This strategy can significantly shrink heating bills and fossil fuel usage alike.

Wood Furnaces and Boilers

Wood furnaces and boilers are centralized heating systems and can provide both space and water heating. They are used to heat the entire home in much the same fashion as conventional oil and gas systems, and can even take advantage of existing ductwork and radiators. Much like pellet stoves, they also can enjoy a high degree of automation which allows for extremely high conversion efficiencies and low emissions. However, many low efficiency and high emission boilers are also available, particularly traditional outdoor wood boilers, and should be avoided. Since pellets have a high energy density and uniformity, their utilization in a central heater is very similar to an oil furnace. The fuel being stored in a bin which is automatically fed into the combustor at the rate required to maintain the temperature dictated by the thermostat. The only additional user input that these systems could require is ash removal and refilling the fuel bin as necessary.


Example of a fully automated wood pellet boiler. Source: woodboilers.com



Schematic of a biomass central heating system. Source: Biomass heating in Upper Austria

The Future of Biomass Heating

Many European countries represent the future potential of residential biomass heating in the United States. Upper Austria, for example, was highly dependent upon heating oil until the emergence of state policies, technological innovation, and forward-thinking forest owners initiated the growth of the its biomass heating market. Today, upper Austria enjoys a strong pellet distribution network, which fuels tens of thousands of fully automated residential pellet heating systems[6]. Furthermore, biomass now accounts for 1/3 of the thermal energy use in that region. Meanwhile, pellet production capacity is rapidly expanding in the United States, but so is exportation to European markets. With greater domestic residential heating adoption, the United States can also realize the energy independence, environmental mitigation, and financial saving that biomass offers.

Conclusion

Using biomass for residential heating is a simple way to reduce fossil fuel consumption while securing a more energy independent home. The variety of choices concerning both appliances and fuel allows for nearly any homeowner to take advantage of the benefits that heating with biomass can provide.

WERC
Wood Education and Resource Center

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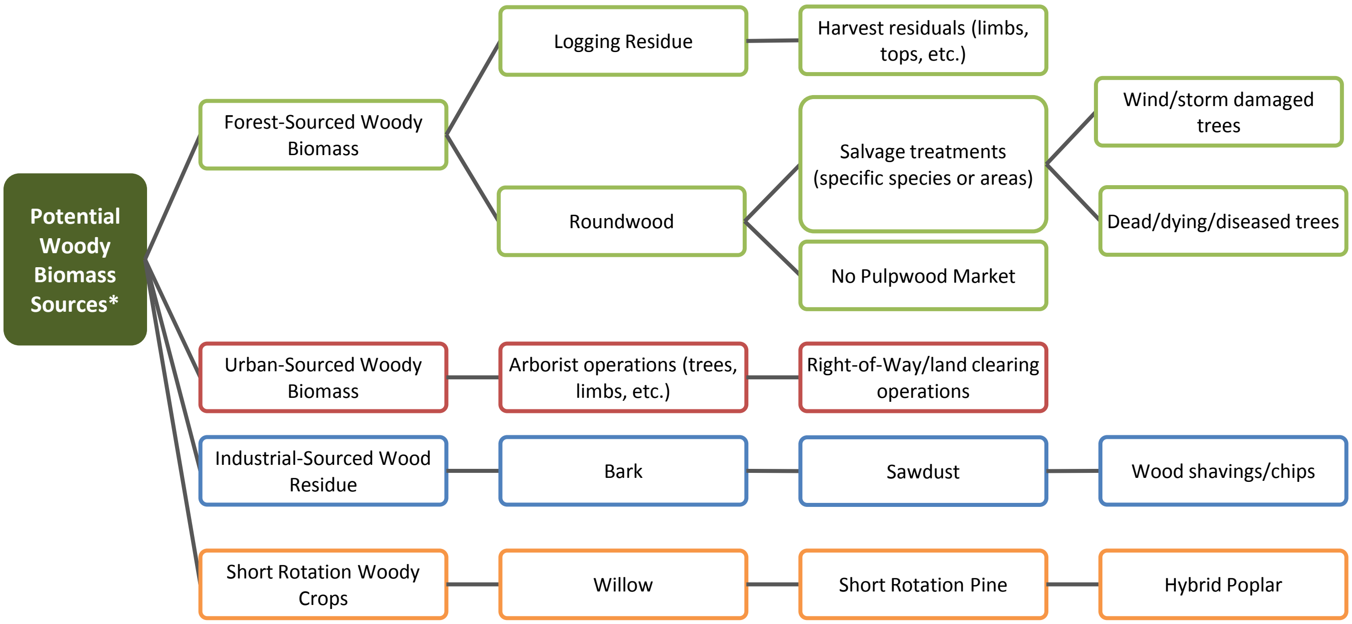
This fact sheet is available online at www.biomassthermal.org.

[6] Egger, C. et. al. (2010). Biomass Heating in Upper Austria. O.O Energiesparverband.

Appendix K

Potential Woody Biomass Sources

Potential Woody Biomass Sources



*Adapted from Kittler et al., 2010[2]

Appendix L

Preliminary List of Public and Private Facilities for Biomass Heating

List of facilities that should be considered for conversion to biomass heating.

COUNTY FACILITIES	
Crawford County Courthouse	Prairie du Chien
Crawford County Admin Bldg	Prairie du Chien
Crawford County Highway Department	Seneca
Crawford County Sheriff's Office	Prairie du Chien
Monroe County Courthouse	Sparta
Monroe County Administrative Center	Sparta
Monroe County Community Services Center	Sparta
Monroe County Highway Office	Sparta
Monroe County Highway Office	Sparta
Monroe County Highway Office	Tomah
Monroe County Highway Office	Wilton
Monroe County Highway Office	Cashton
Monroe County Sheriff's Department	Sparta
Vernon Cnty-Erlandson Office Building	Viroqua
Vernon Memorial Hospital	Viroqua
Courthouse Annex	Viroqua
Vernon Cnty-Land & Water Conservation Bldg	Viroqua
Vernon County Sheriff's Office	Viroqua
Health & Human Services Community Services Building	Richland Center
Richland County Courthouse	Richland Center
Symons Recreation Complex	Richland Center
Richland County Highway Shop	Richland Center
Pine Valley Healthcare and Rehabilitation	Richland Center
Land Conservation Department	Richland Center
LIBRARIES	
Gays Mills Public Library	Gays Mills
Joseph W & Emma L Wachute Memorial Library	Prairie du Chien
Soliders Grove Public Library	Soldiers Grove
Cashton Memorial Library	Cashton
Kendall Public Library	Kendall
Norwalk Public Library	Norwalk
Sparta Free Library	Sparta
Tomah Public Library	Tomah
Wilton Public Library	Wilton
Knutson Memorial Library	Coon Valley
La Farge New Library	LaFarge
DeSoto Public Library	DeSoto
Hillsboro Public Library	Hillsboro
Lawton Memorial Library	La Farge
Ontario Public Library	Ontario
Readstown Public Library	Readstown
McIntosh Memorial Library	Viroqua
Bekkum Memorial Public Library	Westby
Viola Public Library	Viola
Brewer Public Library	Richland Center
Lone Rock Community Library	Lone Rock

SCHOOLS (Public & Private)	
BA Kennedy School	Prairie du Chien
Bluff View Elementary and Intermediate	Prairie du Chien
Mighty River Acad--Virtual Edu	Prairie du Chien
Bible Baptist Academy	Prairie du Chien
Prairie Catholic Schools	Prairie du Chien
Prairie du Chien High School	Prairie du Chien
Wyalusing Academy	Prairie du Chien
Seneca Elementary	Seneca
Seneca Jr High School	Seneca
Seneca High School	Seneca
North Crawford Elementary	Soldiers Grove
North Crawford High School	Soldiers Grove
Wauzeka Elementary	Wauzeka
Wauzeka Middle	Wauzeka
Wauzeka High School	Wauzeka
Warrens Walk-In Clinic	Warrens
Gundersen Lutheran Medical Ctr-Sparta	Sparta
Cashton Public Schools - High School	Cashton
Cashton Public Schools - Elementary	Cashton
Cataract Elementary School	Sparta
Sacred Heart School	Cashton
Norwalk-Ontario-Wilton Elementary School	Ontario
Norwalk-Ontario-Wilton High School	Ontario
Sparta Meadowview Schools	Sparta
Cartaract Elementary	Sparta
Lakeview Montessori School	Sparta
Lawrence Lawson Elementary School	Sparta
Maplewood Elementary School	Sparta
Southside Elementary School	Sparta
Sparta High School	Sparta
Administrative and Educational Center	Sparta
Timber PUPS Learning Center	Tomah
LaGrange Elementary	Tomah
Lemonweir Elementary	Tomah
Miller Elementary	Tomah
Oakdale Elementary	Tomah
Warrens Elementary	Warrens
Wyeville Elementary	Wyeville
SAILS Sparta Alt Indep Lrn Sch	Sparta
Sparta Mennonite School	Sparta
St. Mary Grade School	Tomah
St. Patrick's Grade School	Sparta
St. Paul Lutheran School	Tomah
Tomah Baptist Academy	Tomah
Tomah Middle School	Tomah
Tomah High School	Tomah
Robert Kupper Learning Center	Tomah
Coon Valley Elementary	Coon Valley
De Soto Middle School	De Soto
De Soto High School	De Soto
Prairie View Elementary School	De Soto
English Lutheran School	Viroqua
Hillsboro Elementary and Middle School	Hillsboro
Hillsboro High School	Hillsboro
La Farge Elementary School	La Farge
La Farge Middle School	La Farge
La Farge High School	La Farge
St. Charles Elementary School	Genoa
St. Matthews Lutheran School	Stoddard
Stoddard Elementary	Stoddard
Kickapoo ElementarySchool	Viola
Kickapoo High School	Viola
Pleasant Ridge Waldorf School	Viroqua
Viroqua Elementary School	Viroqua
Viroqua Middle School	Viroqua
Viroqua High School	Viroqua
Youth Initiative High School	Viroqua
Cornerstone Christian Academy	Viroqua
Westby Elementary School	Westby
Westby Middle School	Westby
Westby High School	Westby
Doudna Elementary	Richland Center
Ithaca Elementary, Middle and High School	Richland Center
Ithaca High School	Richland Center
Lincoln Elementary	Richland Center
Richland Middle School	Richland Center
Richland Center High School	Richland Center

MEDICAL FACILITIES & NURSING HOMES/RESIDENTIAL CARE FACILITIES	
Franciscan Skemp Health Care Prairie du Chien Clinic	Prairie du Chien
Gundersen Lutheran Prairie du Chien Clinic	Prairie du Chien
Prairie du Chien Memorial Hospital	Prairie du Chien
Prairie Health Care Center	Prairie du Chien
Scenic Bluffs CommunityHealth	Cashton
Franciscan Skemp Health Care - Lake Tomah Clinic	Tomah
Gundersen Lutheran-Tomah Clinic	Tomah
Scenic Bluffs Community Center-Norwalk	Norwalk
Mayo Clinic Health System - Franciscan Health Care in Sparta	Sparta
Tomah Memorial Hospital	Tomah
Rolling Hills Rehabilitation Center	Sparta
Tomah Nursing and Rehabilitation Center	Tomah
Morrow Memorial Home	Sparta
Sannes Skogdalen	Soldiers Grove
Gundersen Lutheran Hillsboro Clinic	Hillsboro
Gundersen Lutheran Viroqua Clinic	Viroqua
LaFarge Medical Clinic	La Farge
Hirsch Clinic	Viroqua
Bland Clinic	Westby
Viola Health Services	Viola
Gundersen St. Joseph's Hospital and Clinics Hillsboro	Hillsboro
Kickapoo Valley Medical Clinic	Soldiers Grove
St. Joseph's Nursing Home	Hillsboro
Bethel Home and Services, Inc.	Viroqua
Vernon Manor	Viroqua
Norseland Nursing Home	Westby
Bethany Parkside Elderly Group Home	La Farge
Davis Duehr Dean - Richland Center	Richland Center
The Richland Hospital, Inc.	Richland Center
Schmitt Woodland Hills, Inc.	Richland
Richland Medical Center LTD	Richland Center

HIGHER LEARNING CENTERS	
Upper Iowa University- PDC Campus	Prairie du Chien
Western Technical College - Tomah Campus	Tomah
Western Wis Technical College - Viroqua Campus	Viroqua
University of Wisconsin-Richland	Richland Center

STATE/FEDERAL FACILTIES	LOCATION
National Guard Armory - PDC	Prairie du Chien
Tomah VA Medical Center	Tomah
Fort McCoy Fire Department	Fort McCoy
Veterans Administration	Tomah
Fort McCoy	Fort McCoy
Prairie du Chien Correctional Institute	Prairie du Chien
National Guard Armory-Viroqua	Viroqua
Kickapoo Reserve Visitors Center	La Farge

INDUSTRY	
Organic Valley	Vernon
Gile Cheese-Carr Cheese Factory	Grant
Mt. Sterling Cheese Co-op	Crawford
K&K Cheese	Monroe
Old Country Cheese	Monroe
Morning Glory Farms	Vernon
Westby Co-op Creamery	Vernon
Three Bears Resort	Monroe

Biomass Thermal Utilization (BTU) Act of 2013 (S. 1007, H.R. 2715)

Co-sponsors: Senators King (I-ME), Collins, (R-ME), Shaheen (D-NH), Franken (D-MN), Merkley (D-OR), and Sanders (I-VT), and Representatives Michaud (D-ME2), Welch (D-VT), Gibson (NY-19), Kuster (NH-2), Nolan (MN-8), and Owens (NY-21)

What is thermal biomass?

A thermal biomass system is a stove, furnace or boiler that runs on biomass fuels such as wood pellets and chips, solid wood or agricultural residues. The system produces thermal energy for heating residential, commercial and industrial buildings, as well as process heat for industrial applications.

Wood pellets, chips and solid wood are the most common fuels for biomass heating systems, although agricultural wastes will see growth in the future.

Wood pellets are generally made from wood waste, condensed under heat and pressure, with no additives. They have high energy density, low moisture content, and are as easy to transport and use as traditional fossil fuels. Wood chips offer a slightly less refined form of biomass fuel, but also allow for easy transport and storage.

A biomass thermal system can provide hot air, water, and process heat

Advanced combustion technologies allow the use of biomass fuels with very high efficiencies and low emissions. Leading technologies have been developed in Europe, but are now entering the U.S. market. Domestic U.S. manufacturers are also developing advanced technologies.

What are the economic and environmental benefits of renewable thermal biomass?

These technologies utilize fuels and feedstocks that support forest- and agricultural-based economic development in rural regions. Many rural regions are dependent on imported fossil heating fuels such as oil and propane, and do not have access to natural gas. Locally produced biomass fuels can displace dependence on these expensive imported fuels, thereby keeping fuel dollars local and greatly reducing heating costs.

Wood pellet and chip manufacturing, as well as dedicated production of agricultural feedstocks for thermal applications can help revitalize economies in regions that have been impacted by decline in forest industry or agriculture. Biomass thermal creates and helps retain JOBS.

Biomass fuels are low carbon and result in net reduction of greenhouse gas emissions when displacing high carbon intensity fuels such as heating oil. In addition, the use of wood fuels reduces sulfur emissions that contribute to acid rain.

The use of biomass fuels produced in America helps strengthen American energy independence and security.

Why is the BTU Act important?

The BTU Act adds high efficiency biomass thermal technologies to the list of renewable energy technologies that current 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.

Biomass fuels can be conveniently delivered in bulk

Who supports the BTU Act?

Alliance for Green Heat
American Boiler Manufacturers Association
American Forest Foundation
Aroostook Partnership for Progress
Biomass Energy Resource Center
Biomass Thermal Energy Council
Central Oregon Intergovernmental Council Development Council
Forest Guild
Hardwood Federation
Heating the Midwest with Renewable Biomass
International District Energy Association
Maine Pellet Fuels Association
Mt. Adams Resource Stewards
National Association of Forest Service Retirees
National Association of State Foresters
National Network of Forest Practitioners
New York Biomass Energy Alliance
North Country Resource Conservation and Development Council
Northeast Biomass Thermal Working Group
Northern Forest Center
Oregon Department of State Forestry
Pellet Fuels Institute
Pennsylvania Biomass Energy Association
Society of American Foresters
Sustainable Northwest
Vermont Energy Investment Corporation
Watershed Research & Training Center

Biomass Thermal Utilization (BTU) Act of 2013

Senator Angus King

Summary

The BTU Act of 2013 seeks to recognize and promote the many economic and environmental benefits that biomass thermal energy provides by opening the door to two sections of the Internal Revenue Code that already incentivize renewable energy. Currently, a host of renewable energy technologies qualify for investment tax credits for capital costs incurred in residential and commercial installations. Simply, this legislation seeks to achieve parity between thermal biomass and other renewable systems.

Section 1: The title underscores that heat from biomass is an underutilized energy source in this country. Converting biomass—in the form of agricultural crop waste, wood chips, pellets or sawmill residuals—into thermal energy is one of the most efficient uses of this resource. Biomass heating systems now entering the marketplace operate at efficiency levels of 80 percent or higher.

Section 2, Residential Tax Credit: This provision adds biomass fuel property to the list of existing technologies that qualify for the residential renewable energy investment tax credit in Section 25d of the Internal Revenue Code. To qualify, the biomass fuel property must operate at a thermal efficiency rate of at least 75 percent and be used to either heat space within the dwelling or heat water.

Included in this section is a broad definition of "biomass fuel." The term applies both to agricultural and woody biomass, wood processing residues and wastes and grasses. Essentially, any plant derived fuel that is available on a recurring and renewable basis is eligible, including densified biomass fuel.

This provision would apply to expenses incurred in years following 2013. The existing 25d tax credit expires at the end of 2016.

Section 3, Industrial Investment Tax Credit: This provision adds open-loop biomass heating property to the list of existing technologies that qualify for the commercial renewable energy investment tax credit in Section 48 of the Internal Revenue Code. Qualifying biomass heating property must operate at thermal output efficiencies of at least 65 percent (higher heating value) and be used to generate heat, hot water, steam or industrial process heat.

The credit specified in this section is two tiered. For those technologies that operate at thermal output efficiencies between 65 percent and 80 percent, the investment tax credit is limited to 15 percent of installed capital cost. Technologies operating at thermal output efficiencies greater than 80 percent would be eligible for the full 30 percent investment tax credit under Section 48.

The existing section 48 investment tax credit expires at the end of 2016.

113TH CONGRESS
1ST SESSION

S. ______

To amend the Internal Revenue Code of 1986 to include biomass heating appliances for tax credits available for energy-efficient building property and energy property.

IN THE SENATE OF THE UNITED STATES

Mr. KING introduced the following bill; which was read twice and referred to the Committee on ______________________

A BILL

To amend the Internal Revenue Code of 1986 to include biomass heating appliances for tax credits available for energy-efficient building property and energy property.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the ''Biomass Thermal Utilization Act of 2013'' or the ''BTU Act of 2013''.

SEC. 2. RESIDENTIAL ENERGY-EFFICIENT PROPERTY CREDIT FOR BIOMASS FUEL PROPERTY EXPENDITURES.

(a) ALLOWANCE OF CREDIT.—Subsection (a) of section 25D of the Internal Revenue Code of 1986 is amended—

(1) by striking ‘‘and’’ at the end of paragraph (4),

(2) by striking the period at the end of paragraph (5) and inserting ‘‘, and’’, and

(3) by adding at the end the following new paragraph:

‘‘(6) 30 percent of the qualified biomass fuel property expenditures made by the taxpayer during such year.’’.

(b) QUALIFIED BIOMASS FUEL PROPERTY EXPENDITURES.—Subsection (d) of section 25D of the Internal Revenue Code of 1986 is amended by adding at the end the following new paragraph:

‘‘(6) QUALIFIED BIOMASS FUEL PROPERTY EXPENDITURE.—

‘‘(A) IN GENERAL.—The term ‘qualified biomass fuel property expenditure’ means an expenditure for property—

‘‘(i) which uses the burning of biomass fuel to heat a dwelling unit located in the United States and used as a residence by the taxpayer, or to heat water for use in such a dwelling unit, and

"(ii) which has a thermal efficiency rating of at least 75 percent (measured by the higher heating value of the fuel).

"(B) BIOMASS FUEL.—For purposes of this section, the term 'biomass fuel' means any plant-derived fuel available on a renewable or recurring basis, including agricultural crops and trees, wood and wood waste and residues, plants (including aquatic plants), grasses, residues, and fibers. Such term includes densified biomass fuels such as wood pellets.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to expenditures paid or incurred in taxable years beginning after December 31, 2013.

SEC. 3. INVESTMENT TAX CREDIT FOR BIOMASS HEATING PROPERTY.

(a) IN GENERAL.—Subparagraph (A) of section 48(a)(3) is amended by striking "or" at the end of clause (vi), by inserting "or" at the end of clause (vii), and by inserting after clause (vii) the following new clause:

"(viii) open-loop biomass (within the meaning of section 45(c)(3)) heating property, including boilers or furnaces which operate at thermal output efficiencies of not less than 65 percent (measured by the higher heating value of the fuel) and which provide thermal energy in the form of heat, hot water, or steam for space heating, air conditioning, domestic hot water, or industrial process heat, but only with respect to periods ending before January 1, 2017,''.

(b) 30 PERCENT AND 15 PERCENT CREDITS.—

(1) IN GENERAL.—Subparagraph (A) of section 48(a)(2) is amended—

(A) by redesignating clause (ii) as clause (iii),

(B) by inserting after clause (i) the following new clause:

''(ii) except as provided in clause (i)(V), 15 percent in the case of energy property described in paragraph (3)(A)(viii), and'', and

(C) by inserting ''or (ii)'' after ''clause (i)'' in clause (iii), as so redesignated.

(2) INCREASED CREDIT FOR GREATER EFFICIENCY.—Clause (i) of section 48(a)(2)(A) is amended by striking ''and'' at the end of subclause

(III) and by inserting after subclause (IV) the following new subclause:

"(V) energy property described in paragraph (3)(A)(viii) which operates at a thermal output efficiency of not less than 80 percent (measured by the higher heating value of the fuel),".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to periods after the date of the enactment of this Act, in taxable years ending after such date, under rules similar to the rules of section 48(m) of the Internal Revenue Code of 1986 (as in effect on the day before the date of the enactment of the Revenue Reconciliation Act of 1990).

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