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Final Report

EXPLORING WOOD ENERGY UTILIZATION FOR HEATING SCHOOLS IN WISCONSIN PROGRESS

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Executive Summary

The intent of this study was to explore the potential of Wisconsin public school districts as a new market for the use of woody biomass residue in Wisconsin. Based on past use of woody biomass energy in Wisconsin, other states where woody biomass plays a major role in heat energy production, and case studies on school use of woody biomass energy, this study serves to culminate current wood energy use information and to fill a knowledge-gap in the potential use of wood energy by Wisconsin public school districts. Results of the study will help inform the WDNR and other pertinent agencies about the demand and challenges of utilizing woody biomass residue to heat Wisconsin public school districts. In terms of long-term prospects, it is expected that this study will also help contribute towards increased interest and funding for further woody biomass residue utilization in Wisconsin.

Study findings focused on in this report include the characteristics and current status of Wisconsin school forests including current management practices, management issues, use and size of school forests, and estimated production of woody biomass residue. This report also includes the study's findings regarding districts' interest and familiarity of woody biomass energy and their perceived challenges and barriers to implement a wood energy heating system.

With the aid of staff associated with the Wisconsin Center for Environmental Education (i.e. LEAF (K-12 forestry education) and KEEP (K-12 energy education)), the University of Wisconsin – Stevens Point (UWSP) team developed and conducted three different online surveys. One survey was made for and sent to 431 Wisconsin public school district administrators, the second survey was made for and sent to 373 Wisconsin public school district directors of buildings operation and management (DBOMs), and the third survey was sent to 350 school forest managers. Overall, we had a 13.7% response rate for district superintendents, a 23.3% response rate for DBOMs, and a 28.6% response rate for school forest managers. Focus groups were also organized and conducted following the results of the online surveys to collect additional qualitative data. Four different focus groups were formed; one focus group consisted of 3 DBOMs, the second focus group consisted of 4 school forest managers, the third focus group consisted of 1 DBOM, and the fourth focus group consisted of 1 district administrator and 1 DBOM speaking on behalf of their administrator. Findings from this study can be used to help identify the best avenues for outreach and policy to encourage the use of wood energy by Wisconsin public school districts. However, despite the focus on school districts in Wisconsin, findings can be extended to residential and institutional facilities of similar size.

Photo 1: Wood Chip Auger Delivery System For Barron School District's Wood Boiler Heating System, Barron, WI.

Key Findings

Objective 1: Explore Forest Management Activities in Wisconsin School Forests and Their Potential to Generate Woody Biomass

- School forest sizes range from 1.2 acres to 800 acres in size. The average size of a school forest is 110.5 acres, but the most common size reported was 40 acres.
- Major forest management practices actively being implemented include invasive management, thinning and education. These three management practices tend to go hand in hand as schools use management practices as opportunities for students to learn and gain hands-on experiences.
- Woody biomass management residue from invasive management, thinning, and harvesting could be used as a fuel source from school forests for woody biomass energy. However, due to a lack of quantified information, it is difficult to predict how much woody biomass residue is produced by school forests.
- A lack of resources (i.e. manpower, machinery, time, interest, money, and storage) showed to act a as a major barrier and challenge to both actively managing school forests and using management woody biomass residue for wood energy.
- Beyond not having the resources to collect and use woody biomass debris, it was also shown that debris is typically left on the ground to be used as a free mulch source or educational tool (i.e. wildlife habitat and shelter building).

Objective 2: Assess Schools' Energy Requirements for Heating and Estimate the Demand for Forest Woody Biomass

- Districts' reported energy requirements for heating ranged from 50,000 BTUs to 20,259,000,000 BTUs with the average reported requirement being 1,160,281,010 BTUs. However, the most common energy requirements reported were 5,000,000 and 17,000,000 BTUs. These reported energy requirements were assumed to be monthly heat energy use.
- To meet the average energy requirements, about 145.0351 tons of green wood chips would need to be acquired. To meet the most commonly reported energy requirements, about 0.6250 and 2.1250 tons of green wood chips would need to be acquired, respectively.
- Based on woody biomass residue data from the National Renewable Energy Lab, districts in central and northern Wisconsin show the greatest promise to being able to have access to enough woody biomass residue to meet average and mode heat energy demands for one month to a full school year, respectively.
- The data also shows potential for districts throughout the state of Wisconsin to be able to acquire enough woody biomass residue from surrounding forestlands to meetreported mode heat energy requirements for at least two months.

Objective 3: Identify Schools' Level of Awareness and Willingness to Use Woody Biomass From Their Forests and Surrounding Areas for Heating

- Overall, districts showed a low level of awareness to using woody biomass energy, let alone acquiring woody biomass from their school forests or surrounding forestlands.
- Less than half of the districts were aware of any nearby lumber/sawmill companies or loggers where woody biomass could be obtained.
- Only a handful of districts knew of any nearby institutions using woody biomass energy whom they could potentially learn from.
- Over half of responding districts were not willing to consider using woody biomass energy to heat their school buildings. However, when offered a free feasibility assessment, responses changed to a majority selecting 'maybe'.
- Focus group discussions showed that knowledge in the areas of the technology required and the adaptability of their district's current energy system to switch to a wood energy system is needed. Discussions also showed that the best way to provide this information is through in person experiences and networking with others knowledgeable about wood energy. This increase in knowledge about wood energy could help increase districts' willingness to consider implementing a wood energy system.
- Many districts turn to the state program Focus on Energy to attain their energy information. This can act as a barrier to districts' awareness of wood energy as Focus on Energy does not highly educate or promote wood energy.
- Prioritization of information was also shown to be a barrier to increasing awareness of wood energy use but can be overcome through in-person based outreach efforts (i.e. hands-on experiences, school visits, and conferences).

Objective 4: Examine Socioeconomic, Environmental, and Policy Factors That Influence Districts' Decision to Use Forest Woody Biomass as Energy Source

- Major barriers and challenges found from the survey included cost, personnel, time, and competing cheaper fuel sources. These barriers and challenges seemed to play a role in districts' decision to use wood energy.
- Additional barriers and challenges identified through focus group discussions included: district infrastructure, maintenance, politics, utility companies, district engineers, knowledge and familiarity, interest, and access to a wood fuel supply. Through discussions, it was evident that these barriers and challenges are all factors taken into account in a district's decision to use wood energy.
- Additional factors contributing to districts' decision seemed to be political regulations (i.e. air quality) and tradition (I.e. sticking to what has worked in the past).
- A contributing environmental concern was found to be air quality.
- Knowledge or experience with the heating system was an important decision factor for district DBOMs.
- The benefits of using a renewable resource, saving money, and gaining a good educational tool were also shown to be pertinent decision factors for school districts' decision process.

Objective 5: Regional Differences Between the School Forests in Terms of the Above

- Management practices between regions showed the Northern and Central regions to commonly use harvests and thins to manage their school forests, whereas the Driftless and Non-forested regions showed invasive management to be a commonly implemented management practice.
- The Northern and Central forest regions have the largest average school forest size (acres) and thus show the greatest potential in their ability to produce a lot of woody biomass fuel.
- Terrain and accessibility to school forests showed to be a problem especially for the Northern and Driftless regions.
- Average energy requirements were shown to be the highest for the Non-forest region and lowest for the Northern forest region. In congruence to this, the Non-forest region also showed to require the largest amount of woody biomass fuel and the Northern forest region required the least amount of woody biomass fuel.
- Overall, the Northern forest region showed to have the greatest self-assessed knowledge about wood energy, the technology involved, and the required amount of woody biomass needed.
- Statistical significance was found between the Northern forest and Non-forest regions' knowledge of the required technology, and the Central forest and Non-forests regions' knowledge of the amount of wood needed.
- The Non-forest region showed to have the highest agreement to needing a cost-benefit analysis and more information and support.
- The Driftless region showed to not be aware of any pellet factories nearby and the Non-forest region reported not being aware of any industrial plantations/forests nearby.
- The Northern and Central forest regions were the only regions willing to consider using woody biomass with the offer of a free feasibility assessment and support from an expert. The Driftless region was most unlikely to consider using woody biomass.
- The Driftless and Northern forest regions showed statistical significance in selecting wood fuel supply and accessibility as a major barrier and challenge to using woody biomass energy.

- Air quality was a major concern for the Northern, Central and Non-forest regions, while increased traffic was a major concern for the Driftless region. The Central forest region also showed a noticeably higher concern for potential habitat destruction.
- While most of the regions rated the waste produced as being an important factor to consider in selecting a heating system, the Non-forest region rated this factor noticeably less important in comparison to the other regions.

Objective 6: Policy Challenges Regarding Use of Forest Biomass as Energy Source in Schools

- Energy incentives was most frequently selected by districts as their current use of energy policy and incentive tools.
- Policy and incentive programs districts reported on being most familiar with included Wisconsin's Focus on Energy Incentives program, WASBO Facilities Core Certification, Energy Star Score/Portfolio Manager, and Focus on Energy Agriculture, Schools, and Government Energy Advisors.
- Policy and incentive programs districts seem to primarily use or have applied for include Wisconsin's Focus on Energy incentives.
- Major land use policy challenges that were reported included transportation, storage, and land availability.
- Outreach to policy makers to encourage the state of Wisconsin to set a goal for percent of thermal energy being produced by wood (like Vermont) and follow-up with the development of additional funding and incentive programs (like Minnesota and Vermont) could aid in making the switch to wood energy more affordable and conducive to industries such as Wisconsin public school districts.

Objective 7: Inform WDNR and Other Related Agencies About the Demand and Challenges Regarding Forest Woody Biomass Utilization in Heating Schools

- Districts reported going to Focus on Energy to acquire their energy informational needs.
- Internet and reports were the most frequently selected methods for receiving information. But these options were not highly selected (only about 0.20 selection frequency) suggesting other methods such as social media or in-person experiences (options not included in the survey) may be more preferred.
- Identifying the barriers and challenges school districts perceive to face in implementing a wood energy system (see Objective 4) could help direct education and policy efforts to alleviate obstacles for school districts where wood energy is a feasible option.
- Potential outreach could take the form of working with or modeling after Focus on Energy and providing pertinent information through in-person experiences, the internet, and/or reports to bring this option of wood energy to the table through the facilitation of awareness to cost reduction opportunities and connections to quality, cheap fuel sources.
- It is with hopes that this increased knowledge and resources would help generate the interest and advocacy required to overcome the politics of the district, engineers, and utility companies.

Background

Wisconsin is comprised of about 16.7 million acres of forestland which produces a significant amount of currently unmerchantable woody biomass. This unmerchantable woody biomass comes in the form of forest management debris (i.e., thinning and, or harvest debris), diseased trees, small diameter trees, or even wood industry by-products. Currently this woody biomass is not adequately utilized; resulting in unhealthy forest systems, increased risk of forest fires due to debris accumulation, or payment to have by-product and debris dumped in landfills. Wisconsin shows great potential for utilizing this unmerchantable woody biomass as a source of renewable energy for thermal energy production. Using woody biomass for heating has many benefits including securing local renewable energy, potentially reducing energy costs, improving forest health, reducing fire hazards, supporting the local forest industry, and reducing dependence on foreign oil.

Of particular interest is the use of wood energy by Wisconsin public school districts (K-12) as over half of Wisconsin's public-school districts (K-12) have their own school forests which generate woody biomass that could be used as a local, sustainable source for woody biomass heating. Currently, like most of the state, a majority of Wisconsin school districts use natural gas for heating. However, a feasibility study done in 2008 identified over 200 schools that could economically benefit by switching from natural gas to wood energy heating. Natural gas prices have since dropped, resulting in the lower price of natural gas being perceived as a major barrier to using woody biomass energy. But it is possible that other barriers and challenges exist and warrant consideration in order to help provide guidance to the development of a woody biomass fuel market.

This study explored the idea of using woody biomass for heating public school districts in Wisconsin (K-12) by conducting an online survey of school district administrators, DBOMs, and school forest managers. Surveys were followed with a number of focus groups to provide additional in-depth information and clarification of survey results. Together, the surveys and focus groups provided valuable information pertaining to districts' current energy practices, knowledge of sustainable energy options (including wood energy), sources of energy information, perception of wood energy, perceived and experienced barriers and challenges to using wood energy, and school forest use and management. Through the investigation, the study addressed two of the objectives of McIntire-Stennis (M-S):

1. Protection of forest land and resources against fire, insects, disease, and other destructive agents, and
2. Utilization of wood and other forest products.

This project was completed in hopes of helping to find a solution to reducing hazardous wood fuels in Wisconsin forests through the potential development of woody biomass markets. Furthermore, in exploring heating school districts with woody biomass, it was of interest to see if the creation of an alternative market was possible while also minimizing negative health and environmental consequences. With a woody biomass market, revenue could be generated to help offset forest and wildfire management costs which could eventually encourage forest landowners including school districts with school forests to adopt fuel reduction strategies that promote forest health. It is with great optimism that the results of this study could be of use in the transition from fossil fuels to local renewable energy sources, such as woody biomass energy; thereby supporting local economies and employment. We also hope that this transition would happen not just at the school district level, but

expand to the communities at large such as hospitals, government buildings, and private residences. Looking to the future, we anticipate that our study results will contribute pertinent information to aid in the generation of increased interest and funding for additional biomass utilization in Wisconsin.

Study Objectives

The overall goal of the study was to assess and examine the interest, barriers and challenges of Wisconsin public school districts (K-12) in adopting the use of forest woody biomass for heating their school buildings.

The study aimed to achieve this overall goal by addressing the following objectives:

1. Explore forest management activities in Wisconsin school forests and their potential to generate woody biomass.
2. Assess school districts' energy requirements for heating and estimate the demand for forest woody biomass.
3. Identify school districts' level of awareness and willingness to sue woody biomass from their forests and surrounding areas for heating.
4. Examine socioeconomic, environmental and policy factors that influence school districts' decision to use forest woody biomass as an energy source.
5. Investigate the regional differences between the school districts in terms of the above-mentioned objectives.
6. Review policy challenges regarding the use of forest biomass as an energy source in school districts.
7. Inform WDNR and other related agencies about the demand and challenges regarding forest woody biomass utilization in heating school districts.

Study Accomplishments

- Three separate online surveys were created for three distinct Wisconsin public school district audiences. These three targeted audiences included: school district superintendents, school district maintenance supervisors, and school forest managers.
- Contact information was attained through the Department of Public Institute, school district websites, and UWSP Wisconsin's K-12 Forestry Education Program (LEAF).
- Collectively, the surveys provided us with data on school district's willingness to use wood energy, amount of energy required for heating, gross floor area of the schools, school forest ownership, management practices, use of school forests, known sources of local woody biomass, sustainability initiatives, and school's annual budget.
- Addition data regarding total number of students, percentage of students with reduced-priced meal programs, and other student body statistics was acquired through the DPI's website.
- Surveys were sent out on October 2019 and were closed January 2020 with four reminders evenly dispersed during the duration of the survey being open (October to January).
- Survey data was coded and organized in a manner to allow for the comparison of pertinent variables.
- A rough analysis was performed on the data to assess potential answers to our study's questions, areas that may require additional qualitative data through focus groups, and which schools to select for case studies.

- Findings from the study have been presented at the Penn State Biorenewable Workshop (Nov. 10th), multiple class presentations at UW – Stevens Point, the all UW – Extension Conference, and the International Conference on Bangladesh Environment (ICBEN).
- Held multiple focus groups at the beginning of January. One group was comprised of school district administrators, two groups were comprised of school district maintenance supervisors, and one other focus group was comprised of school forest managers.
- Conduct two case studies; one comparing the distance school districts would need to travel to meet woody biomass requirements from different Wisconsin forest regions (I.e. northern forest, central forest, non-forested, and driftless) the other investigating two industries currently using woody biomass energy.
- Investigated current and potential policies, incentives, and funding mechanisms that might impact the adoption of wood energy by school districts.
- Presented in conjunction with the Wisconsin DNR and a representative from a school district currently using woody biomass energy, at the WASBO Facilities Management Conference on March 4th.
- Writing at least one peer reviewed journal article.

Objective 1

Explore Forest Management Activities in Wisconsin School Forests and Their Potential to Generate Woody Biomass

Highlights

- School forest sizes range from 1.2 acres to 800 acres in size. The average size of a school forest is 110.5 acres, but the most common size reported was 40 acres.
- Major forest management practices actively being implemented include invasive management, thinning and education. These three management practices tend to go hand in hand as schools use management practices as opportunities for students to learn and gain hands-on experiences.
- Woody biomass management residue from invasive management, thinning, and harvesting could be used as a fuel source from school forests for woody biomass energy. However, due to a lack of quantified information, it is difficult to predict how much woody biomass residue is produced by school forests.
- A lack of resources (i.e. manpower, machinery, time, interest, money, and storage) showed to act a as a major barrier and challenge to both actively managing school forests and using management woody biomass residue for wood energy.
- Beyond not having the resources to collect and use woody biomass debris, it was also shown that debris is typically left on the ground to be used as a free mulch source or educational tool (i.e. wildlife habitat and shelter building).

School Forest Management

School forest managers were asked to report their current management practices being implemented on their school forest(s). The managers were given the following options to choose from: harvest, thinning, planting, invasive management, education, prescribed burn, restoration, inventory, other, and unsure. The option 'unsure' was not selected by any school forests managers that responded. Collectively, all listed management practices were used by at least one school forest. However, the top three forest management practices reported were invasive management (see Figure 1.1), thinning, and education. This was further supported by results from our focus groups where much of the discussion revolved around their various battles to control invasive species and the use of their forests for education. Focus groups also seemed to show how these major management practices go hand in hand. For example, for certain invasive species students are taught about the invasive species and actively put their knowledge to the test by identifying and removing the invasive species in their school forests. Further, one of the school forests allow forestry students to use their school forests as a way to learn and practice management skills. This ability merge management and education presents a win-win situation where students are able to learn and gain hands-on experience while school forests benefit from free management.

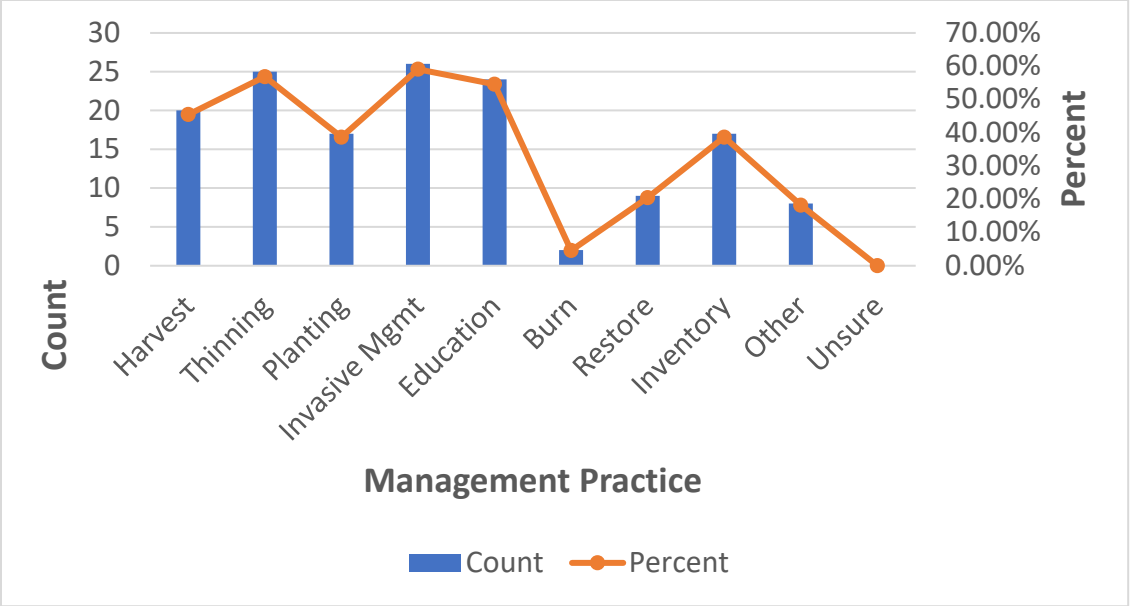

Figure 1.1: Active forest management practices of Wisconsin school forests.

The high use of invasive management and thinning by school forest managers shows promise of providing woody biomass fuel assuming some or all of the reported invasive management and thinning involves tree species. To add, harvesting was reported by less than half the school forest managers as a practice actively being implemented to manage school forests (see Figure 1.1). However, it is still possible that some additional woody biomass could come from harvest residue. But, focus groups revealed that harvests are far and few between as most school forests have a small, and sometimes non-existent budget to work from. Furthermore, due to liability issues, school forest managers must hire professionals to come in and perform the harvest. Therefore, many managers are not involved in and do not keep record of harvests; which was also reflected in our surveys as none of the forest mangers knew how much volume of wood is harvested. With this lack of information, it is hard to say for sure how much woody biomass could come from school forest harvests.

Some school managers selected the 'other' option and reported the following:

- Plant identification signs and the creation of a Plantsmap website
- Removal of trees that have fallen on the trails; otherwise, leave the trees to decompose
- Areas that need thinning but are not currently being thinned
- Deer exclosures and Snapshot Wisconsin
- Little use, no management, and some areas selectively cut about 25 years ago
- Bow hunting
- Pruning, identification, etc...
- Trail maintenance and erosion control

Forest managers were also asked to report on current forest management issues found on their district's school forest(s). Managers were provided with the following options to choose from: disease, invasive, decay, fires, wind, terrain/accessibility, other, none, and unsure. Invasive far surpassed the other options for current forest management issues (see Figure 1.2). It is unclear as to what invasive species managers are dealing with. Therefore, an important follow up question included in our focus groups would be to further define 'invasive'. If 'invasive' is referring to buckthorn, or some other tree/shrub species, then it is possible that the implementation of a woody biomass energy system could be partly fueled by these invasive species; thus, helping the district save money and promote a healthy forest system. Terrain/accessibility and disease were the next two issues of concern for district school forests (see Figure 1.2). A few school forests reported decay, wind, and other issues to be of concern, and fire was not shown to be an issue of concern.

From focus group discussions it was evident that major management issues went beyond what was listed on our surveys. Discussion revolved highly around a lack of resources. More specifically, a lack of manpower and machinery, time, interest, money, and storage. But it was apparent from our discussion that these issues just pushed forest managers to get more creative and develop pertinent partnerships. For example, one forest manager explained how he uses mowing to manage some of his invasive species. The school district he works for does not own a mower, nor does the school forest budget enable the purchase of one. So, the forest manager developed a partnership with the landscaping company that comes once a year, and borrows their lawn-mower to do an annual mow to try to control the invasives.

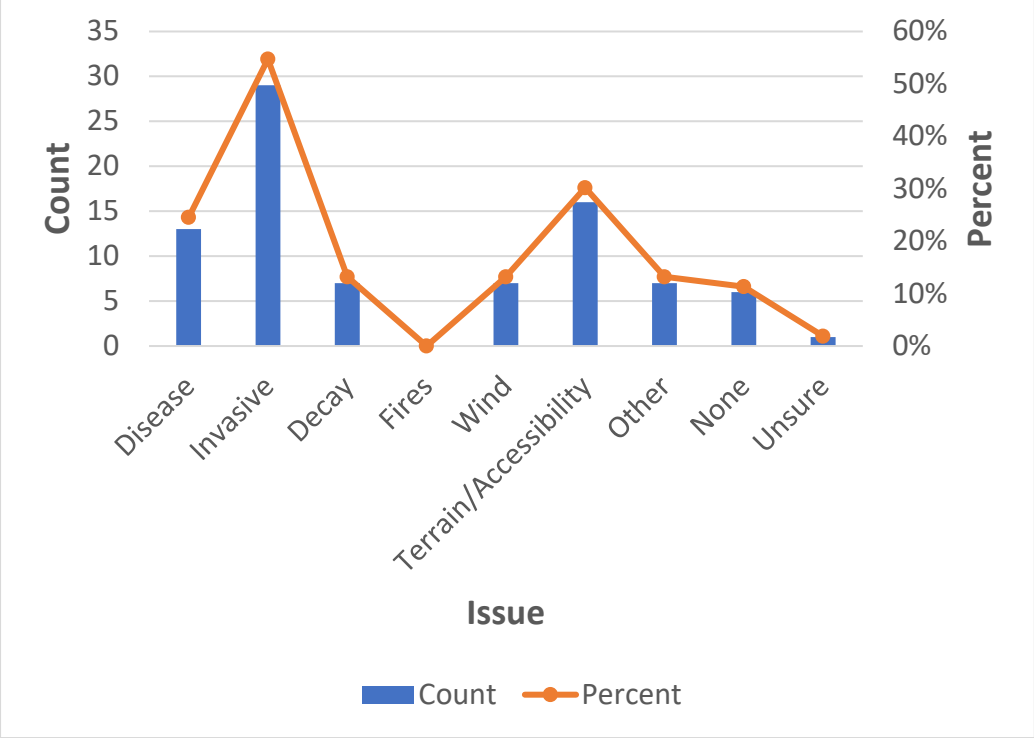

Figure 1.2: Forest management issues of Wisconsin school forests.

Potential to Generate Woody Biomass

A follow-up question for school forest managers that reported the implementation of harvesting on their school forest(s) was what they did with the leftover woody debris. The following options were provided for managers to select from: leave on the ground, heating, firewood, sell to sawmills/loggers, other, and unsure. A large majority of school forest managers reported that harvest debris is left on the forest floor (see Figure 1.3), and none of the school forest managers used the woody debris for heating. This shows that there is a potential for using the harvest debris for heating thereby extracting the full potential from the excess wood and reducing, the risk of forest wildfire and increasing the health of their school forests. Very few forest managers seem to be utilizing their harvest residue as only 26.32% reported using it for firewood or putting it to some 'other' use, 10.53% were unsure, and 5.26% sell the debris to sawmills/loggers to try and make a profit. Those that responded 'other' indicated that they use the residue for the following:

- Chipping for trails or wherever needed
- Student activities (i.e. build habitats, pile up for "rabbitats")
- Community use

Focus group discussions seemed to show that the 'other' response merely clarified the high agreement to leaving the debris. Most districts use the debris as a free mulch source or educational material to aid in students' understanding of habitat. It was also shown through the focus groups that using the debris for firewood or selling it can prove to be a challenge due to liability issues. This explained why these options were not highly selected. Discussions also explained why heating was not selected as the school forest managers involved in the focus group never considered using the debris for wood energy because there is no infrastructure, or current use of wood residue.

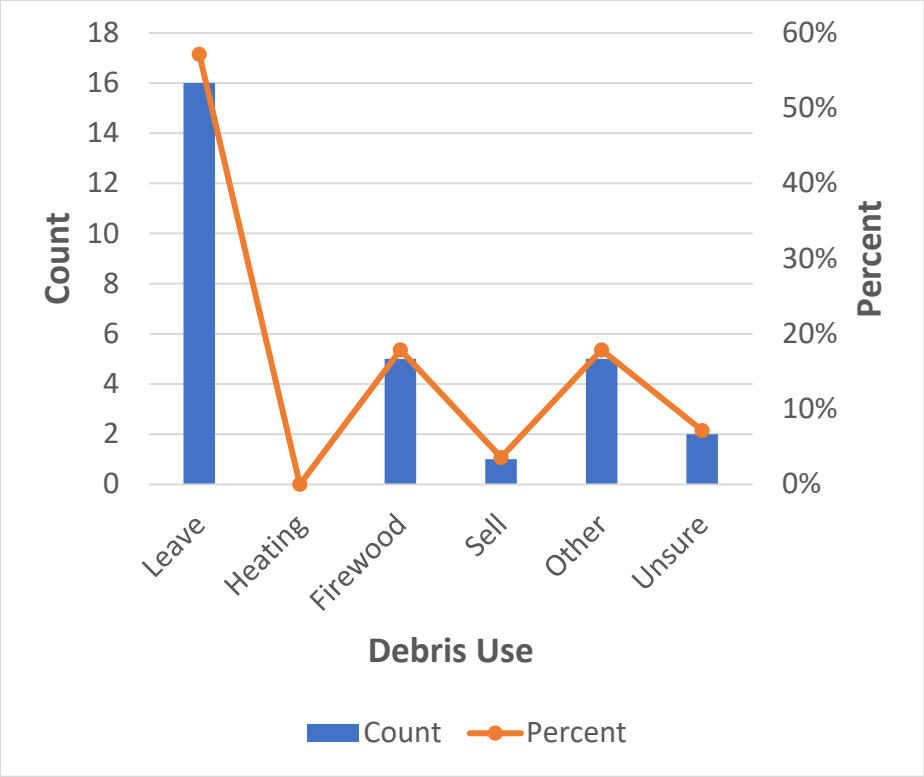

Figure 1.3: Wisconsin school forests' use of management debris (n = 28).

All forest managers were asked to provide the total acreage of their district's registered school forest(s). The largest acreage was 800 acres, and the smallest acreage was 1.2 acres (see Table 1.1). On average, school districts had 110.5 acres of school forest, but the most reported district school forest acreage was 40 acres. The district with the 800 acres shows a lot of potential for producing a substantial amount of woody biomass fuel if the forest is properly managed. However, while the numbers look promising, from the discussion groups it was apparent that without proper funding, interest, and designated use for wood debris, these school forests will remain limitedly managed and any woody biomass debris will continue to be left on the ground.

Table 1.1: Wisconsin school forest size statistics.

Statistic	Size (acres)
Minimum	1.2
Maximum	800
Average	110.5
Mode	40

Objective 2:

Assess Schools' Energy Requirements for Heating and Estimate the Demand for Forest Woody Biomass

Highlights

- Districts' energy requirements for heating ranged from 50,000 BTUs to 20,259,000,000 BTUs with the average requirement being 1,160,281,010 BTUs. However, the most common energy requirements reported were 5,000,000 and 17,000,000 BTUs per month. These reported energy requirements were assumed to be monthly heat energy use.
- To meet the average energy requirements, about 145.0351 tons of green wood chips would need to be acquired. To meet the most commonly reported energy requirements, about 0.6250 and 2.1250 tons of green wood chips would need to be acquired, respectively.
- Based on woody biomass residue data from the National Renewable Energy Lab, districts in central and northern Wisconsin show the greatest promise to being able to have access to enough woody biomass residue to meet average and mode heat energy demands for one month to a full school year, respectively.
- The data also shows potentially for districts throughout the state of Wisconsin to be able to acquire enough woody biomass residue from surrounding forestlands to meet mode heat energy requirements for at least two months.

School District Heat Energy Requirements

District maintenance supervisors were asked to report the amount of energy required to heat their school buildings. The least amount of energy required was recorded as being 120 BTUs and the most was 20,259,000,000 BTUs (see Table 2.1). The average BTUs reported was 1,160,281,010 and the most common energy requirements reported were 5,000,000 and 17,000,000 BTUs.

Table 2.1:Statistics of districts' energy and wood fuel requirements to heat their school buildings.

Statistic	Energy Required (BTUs)	Hardwood (cord)	Mixed (cord)	Wood pellets (lbs)	Green wood chips (ton)
Minimum	120	**0.0000048**	**0.0000055**	**0.015**	**0.000015**
Maximum	20,259,000,000	**810.36**	**920.8636364**	**2,532,375.00**	**2,532.38**
Average	1,160,281,010	**46.4112404**	**52.7400459**	**145,035.13**	**145.0351263**
Mode	5,000,000 17,000,000	**0.2** **0.68**	**0.2272727** **0.7727273**	**625** **2,125.00**	**0.625** **2.125**

Estimated Demand for Forest Woody Biomass

To meet the demand of the district with the lowest energy requirements (120 BTUs) only 0.0000150 tons of green wood chips would be needed (see Table 2.1). On the other hand, the district with the highest energy requirements would 2,532.3750 tons of green wood chips. Based on the average energy requirements, districts would need 145.0351 tons of green wood chips. Furthermore, according to the most commonly reported energy requirements (5,000,000 and 17,000,000 BTUs) districts would need

0.6250 and 2.1250 tons of green wood chips, respectively. The results seem to show that storage should not be an issue for most districts, however, the districts with the higher energy demands (I.e. 20,259,000,000 BTUs) may experience some difficulties with storage. However, these larger energy demands could be due to larger school sizes or larger school districts (more schools within the district). If the latter is true, storage might not be an issue as the quantity of wood would be distributed throughout the schools within the district.

From the focus group discussions, it was clear that storage can be a real issue for a lot of school districts; despite the quantity of fuel needing to be stored. This is especially true for districts located in more urban and suburban areas where every area of the schools are already accounted for. In this case, the schools would either need to devote a portion of their parking lot or invest in changing their school buildings' infrastructure. Further, through our focus group discussions with school forest managers, concerns of their efforts being worth the amount of return was often brought up (i.e. how much would they really save if they were to use if for wood heat energy, or potential financial gains in selling it to another industry that uses wood energy). They also discussed forest composition and having the proper forest composition apt to producing wood debris that burns efficiently. For example, one of the school forest managers has a school forest primarily composed of pine trees. While pine debris will burn, it is not as energy efficient, or clean, as hardwood. Pine debris also burns quicker than hardwood, so schools would need more pine, or softwood, fuel than if they were to use hardwood.

Further, a woody biomass management debris map was created by the National Renewable Energy Lab in 2014 (see Figure 2.1). This map was used to help deduct which districts could potentially meet their heat energy demands since school forest managers were unaware of how much wood is generated through management practices (i.e. harvests and thinning). Based on the map and average woody biomass required to meet heat energy demand, it seems as though districts in central and northern Wisconsin could produce enough management woody biomass residue to fulfill one month of average heat energy demands. However, based on mode energy requirements, enough woody biomass residue is available in central and northern Wisconsin to meet demand for the entire school year. Further, based on mode energy requirements, the map (see Figure 2.1.) shows that districts throughout the state should be able to acquire enough woody biomass residue from surrounding forestlands to meet heat energy demands for at least two months.

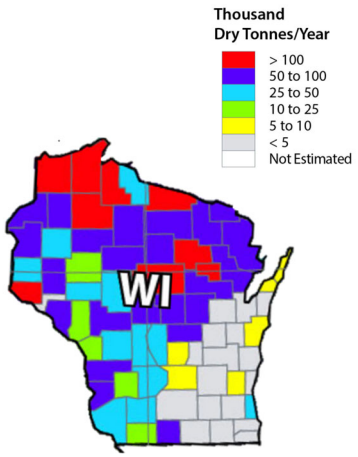

Figure 2.1: Annual supply of woody biomass residue in Wisconsin by County

Objective 3:

Identify Schools' Level of Awareness and Willingness to Use Woody Biomass from Their Forests and Surrounding Areas for Heating

Highlights

- Overall, districts showed a low level of awareness to using woody biomass energy, let alone acquiring woody biomass from their school forests or surrounding forestlands.
- Less than half of the districts were aware of any nearby lumber/sawmill companies or loggers where woody biomass could be obtained.
- Only a handful of districts knew of any nearby institutions using woody biomass energy whom they could potentially learn from.
- Over half of responding districts were not willing to consider using woody biomass energy to heat their school buildings. However, when offered a free feasibility assessment responses changed to a majority responding 'maybe'.
- Focus group discussions showed that knowledge in the areas of the technology required and the adaptability of their district's current energy system to switch to a wood energy system is needed. Discussions also showed that the best way to provide this information is through in person experiences and networking with others knowledgeable about wood energy. This increase in knowledge about wood energy could help increase districts' willingness to consider implementing a wood energy system.
- Many districts turn to the state program Focus on Energy to attain their energy information. This can act as a barrier to districts' awareness of wood energy as Focus on Energy does not highly educate or promote wood energy.
- Prioritization of information was also shown to be a barrier to increasing awareness of wood energy use but can be overcome through in-person based outreach efforts (i.e. hands-on experiences, school visits, and conferences).

Woody Biomass Level of Awareness

Results showed that most districts' familiarity with woody biomass energy was rated low (84.78%), with only a few districts rating their familiarity as high (6.52%) or medium (8.70%) (see Table 3.1). Most districts also rated low to their agreement of understanding the required technology (70.45%) and amount of fuel required to heat their school buildings (77.27%). However, agreement to understanding the required technology and amount of fuel required to heat their school buildings had a higher percentage of medium and high rating than the percent of medium and high rating of familiarity with woody biomass energy. A majority of districts rated their need to set up a cost-benefit analysis and requirement of information and support as high or medium, while less than a quarter of districts selected a low rating.

Table 3.1 Description of districts' self-assessed rating of statements assessing woody biomass energy knowledge and need of more information.

Statement	Number of Responses (n)	High Rating (%)	Medium Rating (%)	Low Rating (%)
How familiar is your school district with woody biomass energy?	46	6.52	8.70	84.78
Our school district understands/knows about the technology required to convert to using wood energy.	44	13.64	15.91	70.45
Our school district understands the amount of wood required to heat our school buildings.	44	9.09	13.64	77.27
Our school district needs to set up a cost-benefit analysis.	44	43.18	34.09	22.73
Our school district would require information and support if we were to consider using woody biomass to heat any schools in our district.	44	56.82	22.73	20.45

High Rating extremely familiar or agree and very familiar or somewhat agree, Medium Rating moderately familiar or neither agree nor disagree, Low Rating slightly familiar or somewhat disagree and not familiar at all or disagree

Overall, mean and mode ratings also showed a low level of familiarity and knowledge of woody biomass energy. The average rating of familiarity with woody biomass and knowledge of technology and fuel amounts ranged from 1.65 to 1.91. The need for a cost-benefit analysis and more information resulted in an average score of 3.39 and 3.68 respectively. Mode scores closely resembled average scores except for the response to needing more information and support. The overall mode score for requiring more information and support was 5 (strongly agree) as opposed to its average score of 3.68.

Table 3.2 – Statistics of Wisconsin public school districts' rated responses to 5-point Likert scale statements self-assessing woody biomass energy knowledge and need for more information (5=extremely familiar or agree, 1=not familiar at all or disagree).

Statement	Number of Responses (n)	Mean (SD)	Mode	Standard Error
How familiar is your school district with woody biomass energy?	46	1.65 (1.04)	1	0.15
Our school district understands/knows about the technology required to convert to using wood energy.	44	1.91 (1.18)	1	0.18
Our school district understands the amount of wood required to heat our school buildings.	44	1.77 (1.20)	1	0.18
Our school district needs to set up a cost-benefit analysis.	44	3.39 (1.33)	3	0.2
Our school district would require information and support if we were to consider using woody biomass to heat any schools in our district.	44	3.68 (1.41)	5	0.21

District maintenance supervisors were asked to record any woody biomass producers within a 50-mile radius of their school district (that they are aware of). Options provided included: pellet factory, lumber

company/sawmill, loggers, industrial plantation/forest, and other. The most common response of supervisors regarding a nearby pellet factory as well as a nearby industrial plantation/forest was "unsure", with "no" closely following. The most common response to a nearby lumber company/sawmill as well as nearby loggers was "yes". Furthermore, supervisors most commonly reported "no" when reporting any other wood producers nearby. In fact, none of the supervisors reported knowledge of other wood producers in the area. This data shows an awareness of wood producers nearby, particularly lumber companies/sawmills and loggers, but less awareness of nearby pellet factories, industrial plantations/forests, and other wood producers.

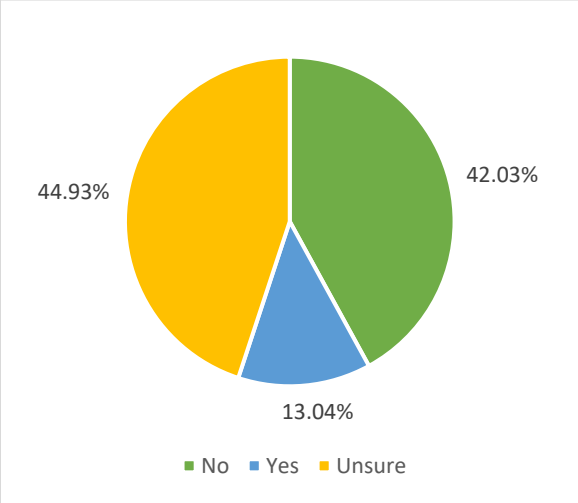

Figure 3.1: Awareness of a nearby pellet factory

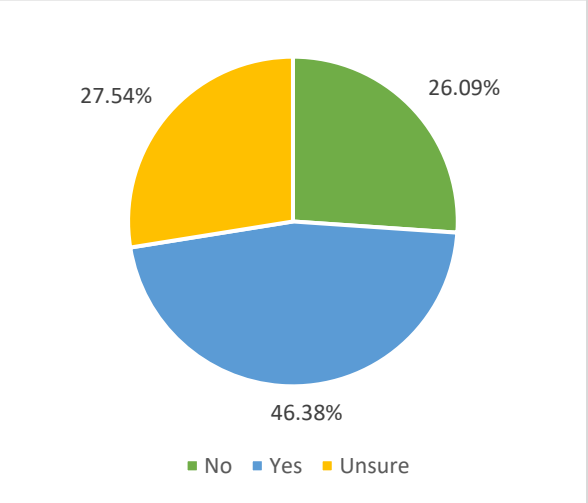

Figure 3.2: Awareness if a nearby lumber/sawmill company

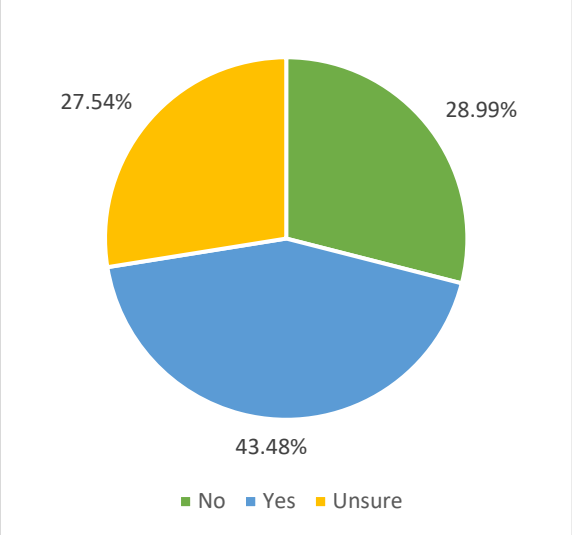

Figure 3.3: Awareness of a Nearby Logger

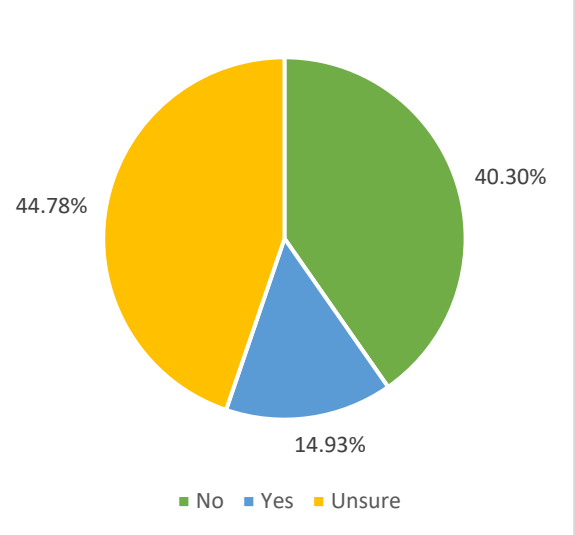

Figure 3.4: Awareness of Nearby industrial plantation/forest

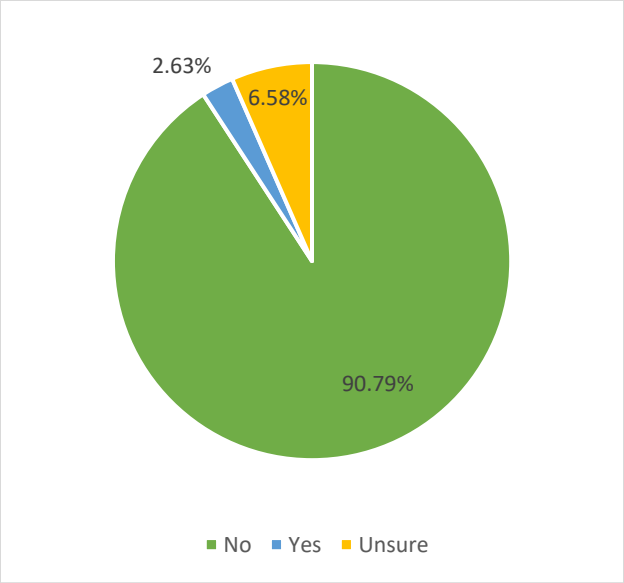

Figure 3.5: Awareness of 'Other' wood fuel source

District maintenance supervisors were asked if they were aware of any other institutions or industries within a 50-mile radius that are currently running on woody biomass energy. Most district supervisors reported being "unsure" about any other nearby institutions running on woody biomass energy.

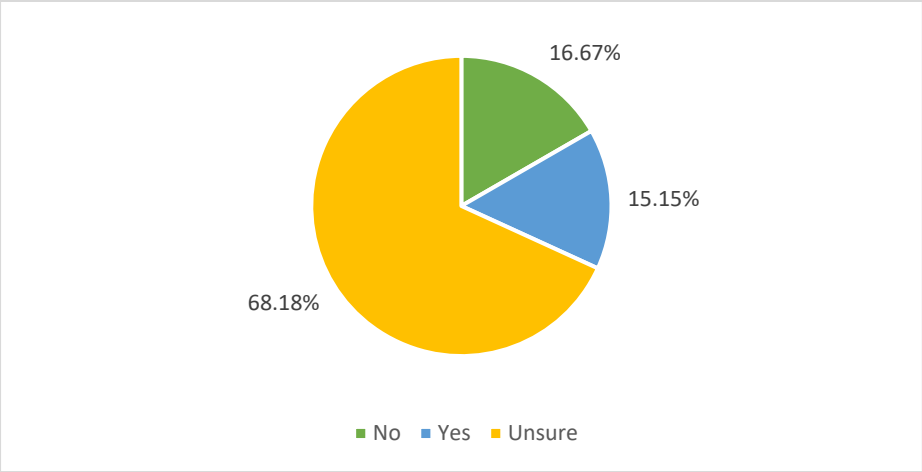

Figure 3.6: Awareness of other nearby institutions using woody biomass energy

Willingness to Use Woody Biomass

District school forest managers were asked to record the products/services they get from their school forest(s). Options included: education, firewood, wood for heating, leaves (i.e. mulching, composting), pulp (i.e. paper, tissue, board, specialty paper, etc.), maple syrup, resin (i.e. varnish, adhesive, therapeutic/incense, rosin, etc.), hunting, camping, other, none, and unsure. Education was shown to be the good/service that almost all districts receive from their school forest(s) (see Figure 3.7). None of the responding school forest managers reported using wood from their school forest(s) for heating their school buildings or for resin. However, about a quarter of the responding forest managers (24.14%) said that they used the wood from their school forest for firewood, and one of the managers reported using

their school forest to produce lumber. 'Other' respondents reported the following additional goods/services provided by their school forest(s): participation in Snapshot Wisconsin, lumber for shop class, hiking, community recreation opportunities, biking, skiing, snowshoeing, cross country, funds from programs (i.e. color run), after school programs, and disc golf.

This shows the potential for these school forests to produce some fuel wood. However, districts may be more interested in selling the firewood rather than using it to heat their schools due to the more immediate financial benefits of selling the wood versus the much longer payoff period of using it for heating their school.

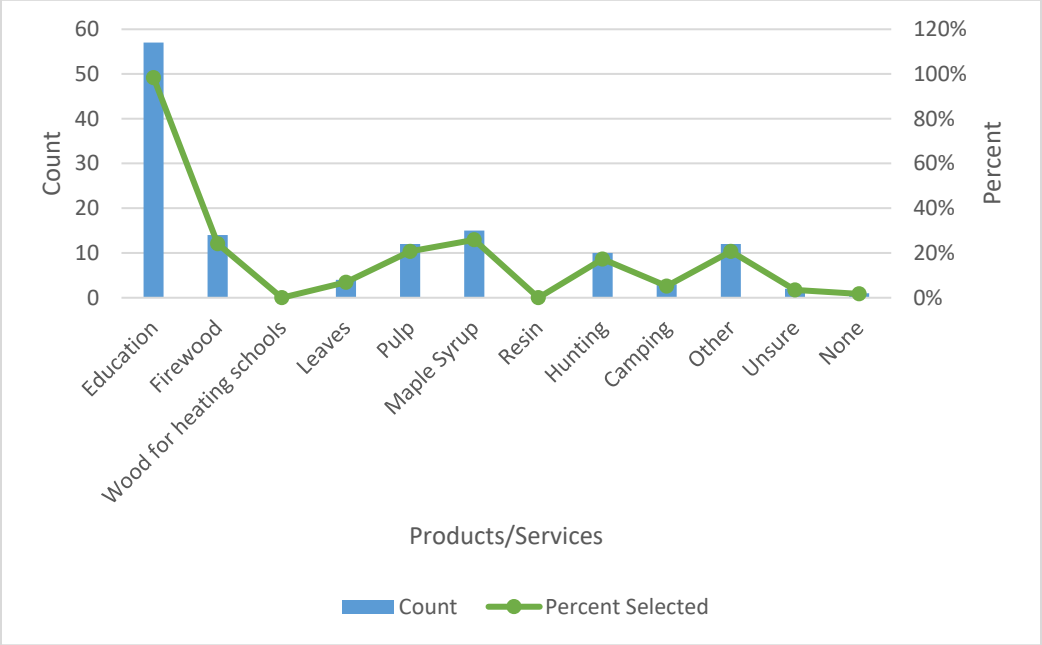

Figure 3.7: Products and services currently acquired from Wisconsin school forests

District superintendents were asked if they would consider using woody biomass to heat all or some of the schools in their districts. Most responded 'No' but about a third responded 'Yes' (see Figure 3.8). Within those that responded 'Yes', most were more open to consider using woody biomass energy to heat the buildings at some of the schools in their district. Maintenance supervisors were also asked if they were willing to consider using woody biomass energy for their school districts. The most common response to the question was "maybe" with "no" being the second most common response by about 20%. Very few maintenance supervisors responded "yes".

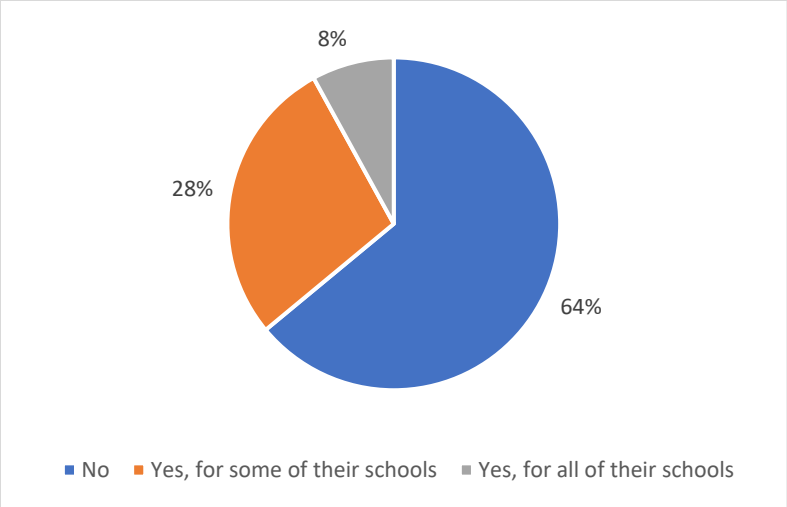

Figure 3.8: Districts' willingness to consider using woody biomass heat energy

When asked about their district's willingness to consider using woody biomass if offered a feasibility assessment and support from an expert, most superintendents answered with "Maybe" (see Figure 3.9). Very few (9%) were willing to consider using woody biomass energy and about a third (32%) were unwilling to consider using woody biomass energy despite being offered support and guidance. Perhaps it is possible districts have a lack of knowledge regarding woody biomass energy due to a lack of interest, as most were hesitant to acquire free feasibility information and guidance.

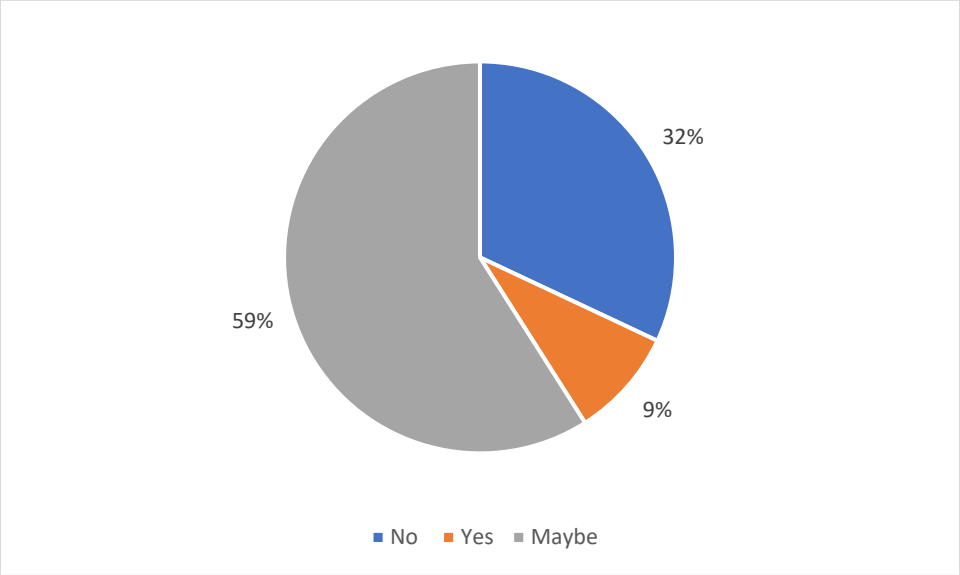

Figure 3.9: Districts' willingness to consider using woody biomass heat energy if offered support and free feasibility assessment

Focus group discussions resulted in the appearance of six main themes: *school buildings and operations, technology required, experience, networking, Focus on Energy*, and *prioritization* (Figure 3.10).

School buildings and operations, and *technology required* (see Figure 3.10), were the two themes that appeared the most when talking about familiarity and knowledge. The themes helped to identify where knowledge is lacking and outreach is most needed. The apparent theme of *technology required*

especially seemed to confirm an area of woody biomass energy where information is lacking and highly important as the survey also showed a knowledge deficit in terms of the technology required (see Table 3.2). To follow, within the theme of *technology required* was the subtheme of *possible avenues/energy options* which further clarified our survey results and defined the main theme of *technology required.* In other words, participants were not aware of the technology options and adaptability of their current system for implementing the use of woody biomass energy. Focus group participants expanded in stating their concerns of understanding the demands of their buildings and operations as well as the proper technology options to meet not only present demands but also those of the future which was well summarized by the following statement:

> *"You don't want to have to run a wood boiler at 100% all the time to get a peak and then add on and then you're short on whatever BTUs you add to your building…"*

The themes of *experience* and *networking* provided insight into how district leaders acquire knowledge of and become familiar with renewable energy systems including wood energy. In terms of *experience*, one of the participants explained about his gain of knowledge through his experience working with a wood energy system,

> "*… and I was a maintenance guy there. And that school burned wood. So, I have a lot of experience in biomass and, and the insides and outs and what it costs and the maintenance and all that involved."*

Based off this statement and many other similar statements, it became clear that experiential learning plays a major role in districts' knowledge and understanding of wood energy and all that is involved.

Like *experience* was the theme of *networking*, with its accompanying subthemes of presentations, WASBO (a WI school district focused organization that holds many professional development opportunities, such as conferences, focused on school business management), peers, and professionals (see Figure 3.10). Networking with individuals and organizations seemed to be a major avenue in which many districts acquire their information. The subthemes that developed helped identify specific networking opportunities where knowledge and information are gained. Statements exemplifying the importance of networking in increasing knowledge are as follows:

> *"State Association of School Boards Education convention ... If this was to get promoted, that's the place to do it with schools is that some somebody who's got the capacity to do a large-scale wood boiler project would set that up there that would introduce folks to it."*

> *"I think it's just the way we communicate. And I really think you'd have to be looking for it, or somebody has to actually stop into your school or your building and say, Hey, do you guys ever consider on doing whatever you know, and that doesn't really happen anymore."*

Something especially notable about the first participant's quote is their use of the word, "introduce." It is almost as if to assume that from the individual's networking and interactions they themselves have noticed a low familiarity and knowledge of woody biomass energy amongst their peers.

The last two themes identified, *Focus on Energy* and *prioritization* (see Figure 3.10), helped identify some potential barriers or challenges to acquiring knowledge about woody biomass energy. Focus on Energy, a statewide energy efficiency and renewable energy government organization partnered with Wisconsin utility companies, was shown, in both the survey and focus groups, to be where most districts go for their energy information needs:

> "*…Focus on Energy is kind of the traditional place that I think a lot of school districts kind of go to on a regular basis…".*

However, Focus on Energy does not always present all the possible avenues as stated by another focus group participant:

> "*…I knew of the Focus on Energy rebates and those kind of things, but there were other mechanisms that we were able to access that really, quite frankly, made it extremely cost effective."*

Focus on Energy primarily works with school districts to decrease energy consumption and increase their energy efficiency through actions such as installing LED lights. While they do provide some information on renewable energy options, wood energy, especially, is not something highly promoted to schools on their website.

As for the theme *prioritization* and its subthemes of *obligation* and *interest* (see Figure 3.10), it was apparent that, due to their limited amount of 'free time', school district leaders are left to prioritize information based primarily on obligation or interest. This was shown in multiple focus group participants' responses,

> "*I, you don't have unlimited time to sit and dig through everything, you know?"*
>
> *"I think we really try to do what we can to learn, you know, what we can do to stay up to date, but half the time, we're so darn busy that, you know, I think we can fall far behind fairly quick."*
>
> *"I guess the answer would be no, I am not informed. It's need based when, when a change or an investment needs to be made, then I do an investigation."*

This theme of *prioritized* helps to clarify the survey results of a higher agreement to needing more information (see Table 3.1 and 3.2). District leaders do not have time to look for the information themselves, therefore, they need others to provide the information to them in a quick, convenient, and simple manner.

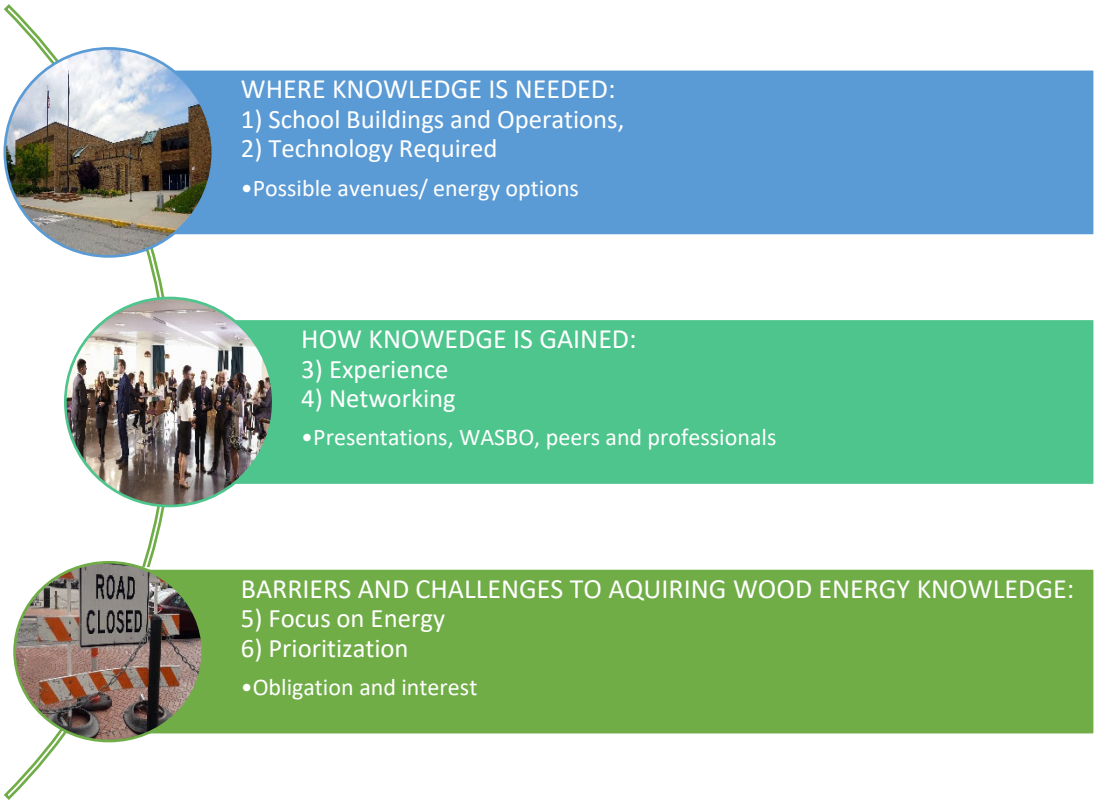

Figure 3.10: Knowledge and awareness themes and subthemes of focus groups.

Objective 4:

Examine Socioeconomic, Environmental, and Policy Factors that Influence Districts' Decision to Use Forest Woody Biomass as Energy Source

Highlights

- Major barriers and challenges found from the survey included cost, personnel, time, and competing cheaper fuel sources. These barriers and challenges seemed to play a role in districts' decision to use wood energy.
- Additional barriers and challenges identified through focus group discussions included: district infrastructure, maintenance, politics, utility companies, district engineers, knowledge and familiarity, interest, and access to a wood fuel supply. Through discussions, it was evident that these barriers and challenges are all factors taken into account in a district's decision to use wood energy.
- Additional factors contributing to districts' decision seemed to be political regulations (i.e. air quality) and tradition (I.e. sticking to what has worked in the past).
- A contributing environmental concern is air quality.
- Knowledge or experience with the heating system was an important decision factor for district Directors of Buildings Operation and Management.
- The benefits of using a renewable resource, saving money, and gaining a good educational tool were also shown to pertinent decision factors for school districts' decision process.

Factors Influencing Districts' Decision

Overall, the biggest barrier or challenge was shown to be cost, with the barriers or challenges of personnel, time and competing cheaper fuel source to be close seconds (see Table 3.1). By occupation, cost seemed to be a shared top 3 barrier or challenge, but selection frequency was different between the two occupations (see Table 3.2). In terms of frequency selected, time (0.72) was most selected by administrators followed by building infrastructure (0.70) and then costs (0.69). For DBOMs, cost (0.75) was most frequently selected, followed by competing cheaper fuel source (0.67) and personnel (0.66). However, no statistical significance was found between barrier and challenge selection frequency of district administrators versus district directors of building operations and management (DBOM).

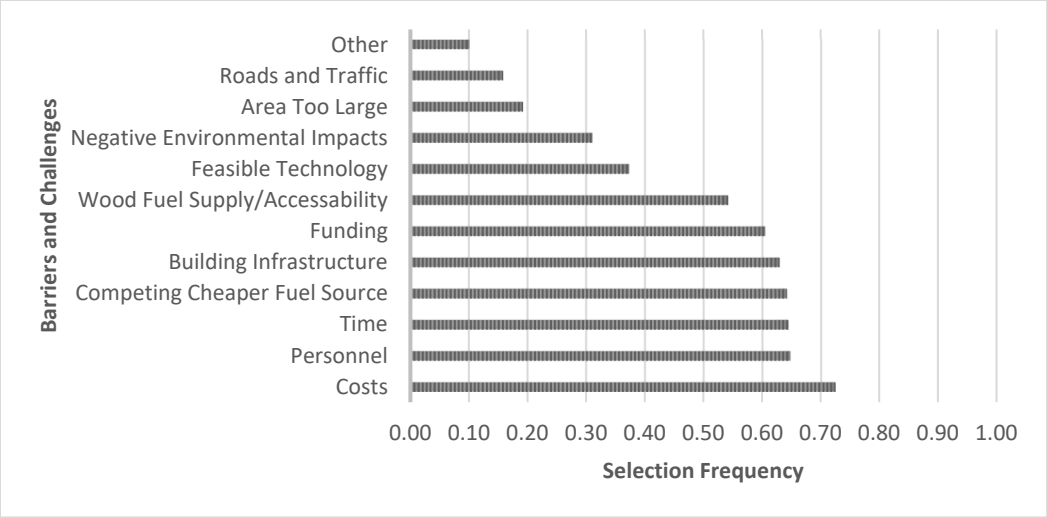

Figure 4.1: Major perceived barriers and challenges of Wisconsin public schools in implementing a wood energy system

Table 4.1: Major barriers and challenges perceived by occupation.

Barrier and Challenge	Selection Frequency	
	Administrator	DBOM
Area Too Large	0.19	0.20
Building Infrastructure	**0.70***	0.57
Costs	**0.69***	**0.75***
Competing Cheaper Fuel Source	0.60	**0.67***
Funding	0.65	0.57
Feasible Technology	0.35	0.39
Negative Environmental Impacts	0.38	0.26
Personnel	0.64	**0.66***
Roads and Traffic	0.15	0.16
Time	**0.72***	0.59
Wood Fuel Supply/Accessibility	0.41	0.64
Other	0.04	0.15

*Major perceived barriers and challenges for each occupation

Additional factors contributing to districts' decision to implement a wood energy system include perceiving their current system to be sufficiently meeting their needs, the price of natural gas to be cheaper than wood, the air quality of their area to be of concern, and the investment to convert to wood energy to be a challenge (see Table 4.2). Further, districts do not believe that they have the time or resources to properly train staff on how to operate a wood energy system. These concerns and factors can be summed by financial and time constraints as well as an adherence to city regulations and school district tradition (i.e. sticking to what has worked in the past rather).

In terms of wood energy efficiency, safety, opportunity cost, landscape challenges, and effects on forest and wildlife habitat most districts took a neutral stance (see Table 4.2). This could indicate an honest indifference, a lack of knowledge about woody biomass energy, or perhaps a combination of the two. To

add, most districts felt that their school would be easily accessible for wood fuel deliver, showing that delivery does not seem to be a factor of concern for most.

Table 4.2: Districts' perception on wood energy implementation (1 = disagree, 5 = agree).

Statement	Number of Responses (n)	Mean (SD)	Mode	SE
Investing in the conversion from our current energy source to wood would be a challenge.	45	4.49 (0.83)	5	0.12
Our school would use natural gas over wood because it is cheaper.	45	4.11 (1.04)	5	0.15
Wood can be efficiently used for heating.	45	3.64 (1.06)	3	0.16
Our current method of heating works well for us, so we have no need to change.	45	4.22 (1.01)	5	0.15
Our school district's landscape inhibits our ability to acquire woody biomass	44	2.70 (1.37)	3	0.21
Air quality is a problem/concern for our area	44	2.98 (1.36)	4	0.20
Using woody biomass for heating can help with forest management	44	3.70 (0.84)	3	0.13
Using woody biomass for heating destroys wildlife habitat	44	2.93 (0.99)	3	0.15
A semi or construction truck could easily and safely access the school in our school district.	45	4.04 (1.17)	5	0.17
Our school has the time and resources to allow staff to attend training on how to use a woody biomass heating system.	45	2.67 (1.21)	2	0.18
Using waste wood to make park benches or wood chips for landscaping would be more beneficial to our school rather than burning the wood	45	3.36 (1.01)	3	0.15
Using woody biomass for heating at our school district seems unsafe.	45	2.56 (1.13)	3	0.17

SD = standard deviation; SE = standard error

District administrators were asked to rate their school district's level of concern for certain logistical and environmental concerns with acquiring/delivering woody biomass to their school district's location. It was apparent from the resulting ratings that air quality is an important environmental factor playing a role in a districts' decision to use woody biomass energy (see Figure 4.2). This finding is also in agreement with the above finding of air quality being of concern for a majority of school districts.

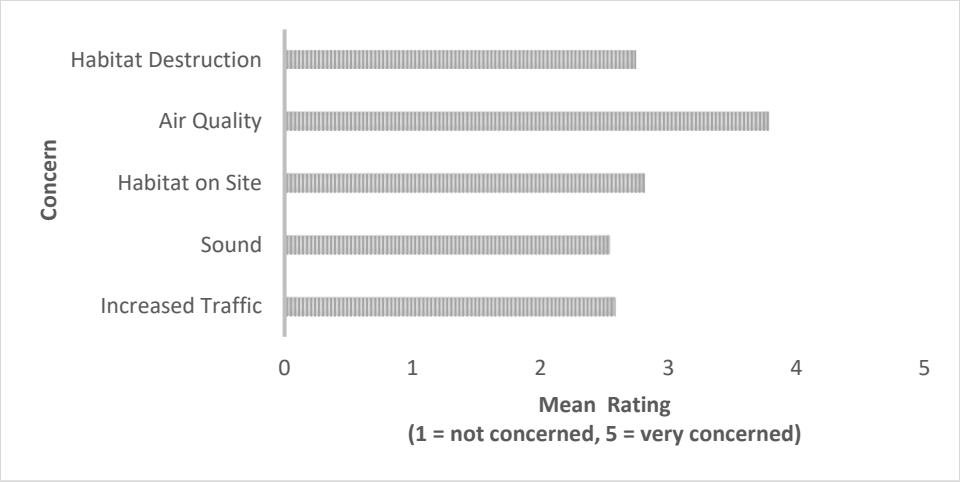

Figure 4.2: Districts' logistic and environmental concerns

DBOMs were asked to rate the importance of certain factors when choosing a heating system for their district. While all of the provided factors received a high rating of importance, the factor that received the highest rating of importance was having adequate knowledge or experience with the heating system. This finding is in congruence to the findings of objective 3 where knowledge was shown to be lacking and necessary in order for districts to consider implementing a woody biomass heating system for the schools.

Table 4.3: Districts' rated importance of certain heating system factors (1 = not at all important, 5 = extremely important).

Heat System Factor	Number of Responses (n)	Mean (SD)	Mode	SE
Time required to run the system	65	3.66 (0.89)	4	0.11
Maintenance required to run the system	65	4.20 (0.71)	4	0.09
Staffing required	64	4.00 (0.89)	4	0.11
Waste produced	64	3.47 (1.10)	4	0.14
Possible pollution/contaminants produced	64	3.66 (0.96)	4	0.12
Price of fuel source	64	4.23 (0.75)	4	0.09
Price of heating system	64	4.25 (0.64)	4	0.08
Knowledge or experience with the system	65	**4.38 (0.63)**	**5**	0.08
Fuel source availability	65	3.75 (0.85)	4	0.11
Fuel storage	65	4.23 (0.79)	4	0.10
Fuel delivery	64	3.58 (1.29)	4	0.16
Contractors	64	3.97 (0.91)	4	0.11
Pay off period	65	3.77 (0.82)	4	0.10
Supporting the local economy	65	4.12 (0.80)	4	0.10
Sustainability	65	3.58 (0.85)	4	0.10
Other	65	3.78 (0.80)	4	0.10

SD = standard deviation, SE = standard error; Highest rating in bold

Maintenance supervisors were asked to report their district's perceived benefits to using woody biomass energy. According to the results the biggest benefit to using woody biomass energy is that it is a renewable resource (see Figure 4.3)). The second most selected option was the potential to save money, and the third most selected option was the benefit of it being a good educational tool. The ability to achieve these favored benefits is another factor to add to districts' decision to use woody biomass energy.

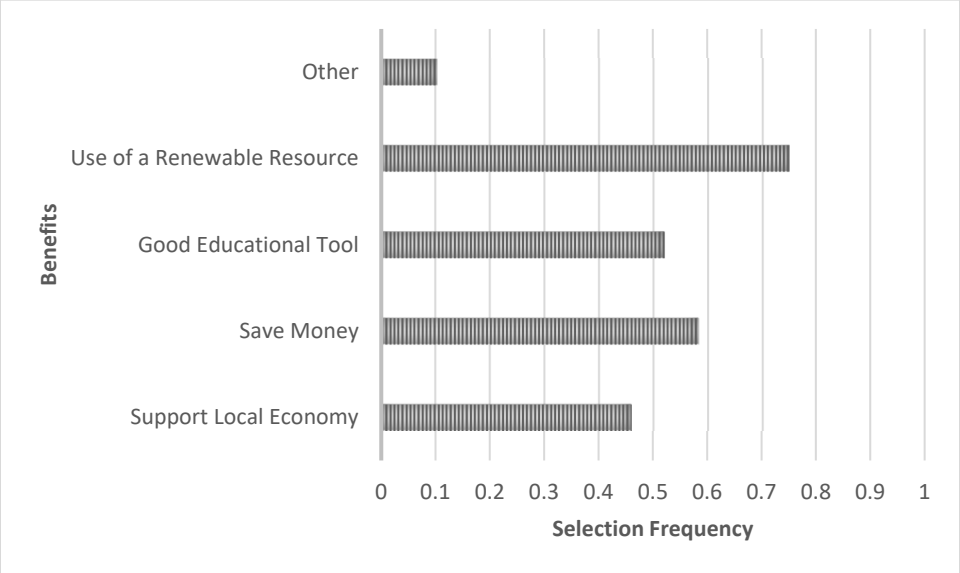

Figure 4.3: Districts' perceived benefits to using woody biomass energy

Focus group discussions resulted in the following themes under the assigned 'Barriers and Challenges' category (see Figure 4.4):

- District infrastructure and funding
- Maintenance
- Politics
- Utilities and Engineers

The themes *District infrastructure* and *Funding* proved to be of real concern as it was mentioned quite frequently across all focus groups. This theme was well summarized by one of the administrator focus group participants in saying:

> "*We're also, as I mentioned before, as an urban school system, we have very tight sites, storage, the ability to install that technology, but to be able to store the product that you would need to be able to operate that technology, just just the added investment really makes it a difficult technology to utilize.*"

The theme and reported challenge of *Maintenance* can be summarized by the following quotes. The first being from the administrator focus group and the later being from the small district DBOM focus group.

> "*and maintain the output of these boilers. woody biomass I see is the same way as mark had indicated, if there's a problem with a system, you need to have staffing, if they're not on call,*

they need to be present. And we run our systems so lean now with regard to FTP is on support staff basis that to have people at the ready that have the knowledge and the ability, be able to get in there, fix repair auger systems, everything associated with the boilers. To be able to ensure that system is operating would certainly cost more..."

"I think the biggest challenge I think of is maintenance. Like I said you had to deash the boiler, clean the fluids out in the boiler. It would actually stack up with ash in the middle of the boiler."

The theme and challenge of *Politics* was mentioned a few times but was frequently hinted at across all focus groups. *Politics* as a theme encompasses the politics of the school districts to the politics of acquiring fuel. This theme is well summarized by the following quotes, the first being from the large school district DBOM focus group and the second from the administrator focus group:

"And thus thus the issue, I think in a lot of cases, is politics. Um, if you, you know, that's been alluded to with all in all the conversation here haha You know, the politics of getting things done in schools."

" There was one point where the sawmill that we were working with-- this was a political thing—they told us they weren't going to supply us anymore."

The final themes and challenges that appeared were *Utilities* and *Engineers*. These themes are closely related to the theme of *Politics*, but due to their frequent appearance, they were developed into their own themes. The theme of *Utilities* can be summarized by the following quotes, the first from the large district DBOM focus group and the second from the administrator focus group:

"*we're we're driven by big utility, for profit utilities, for profit, you know, and and it's natural gas and electricity generated by fossil fuels. It doesn't have to be that way...you know."*

"We've researched some opportunities within the last couple years as far as PV and trying to partner with maybe some utilities-- that opportunity just isn't there anymore. The utilities have met their state requirements. So they feel very comfortable with where they're at as far as land acquisition and PV installations, so they're no longer looking to partner or offer those types of incentives."

The two sides, positive and negative, to the theme and challenge of *Engineers* can be summarized by the following quotes, the first from the large district DBOM focus group and the later from the administrator focus group:

"*When you talk to engineers or architects...um...you know, they, they got the cookie cutter heating plants and um they don't want to venture outside that box."*

"If we're doing a mechanical upgrade, you know, we're doing our due diligence and working with mechanicals, and, and engineers to make sure that we're designing it to be as efficient as it can be, regardless of the type of system that we're installing."

Together these quotes seem to show the power that engineers have to either challenge the implementation of wood energy or appropriately recommend and encourage the use of wood energy.

However, through the discussion it became apparent that the other categories proved to play their own role in acting as barriers and challenges to using woody biomass energy (see Figure 4.5). These other factors included having the time and proper connections to get the required knowledge of woody biomass energy systems, having someone who is interested, and a source that would provide the fuel wood necessary to run the system.

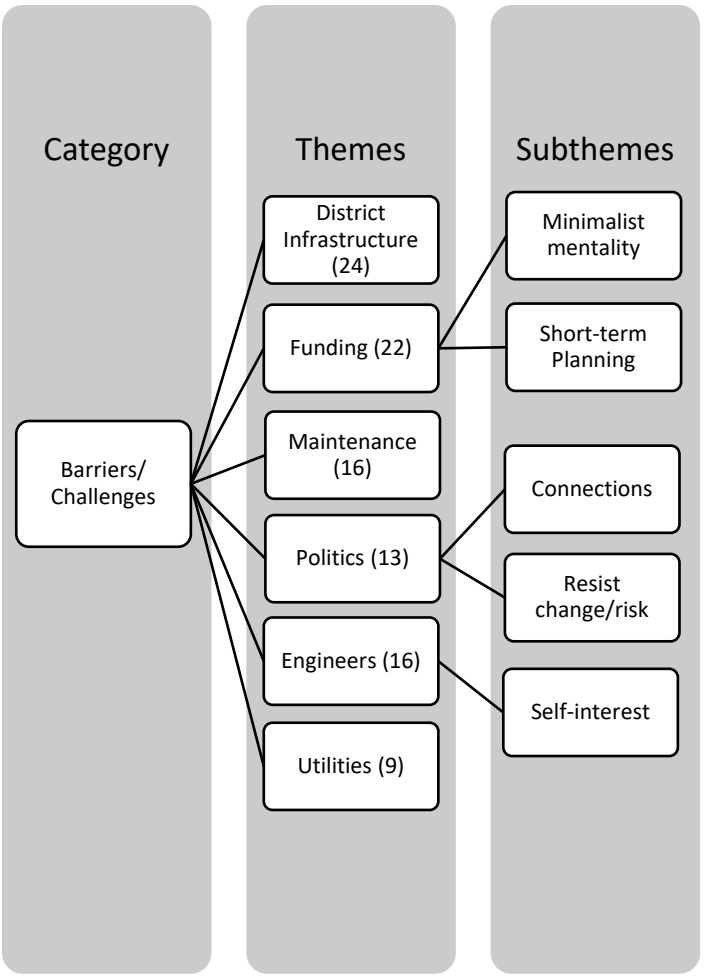

Figure 4.4: focus group resulting perceived barriers and challenges of school districts. number in parenthesis represents the number of times the main barrier and challenge appeared in focus group discussions.

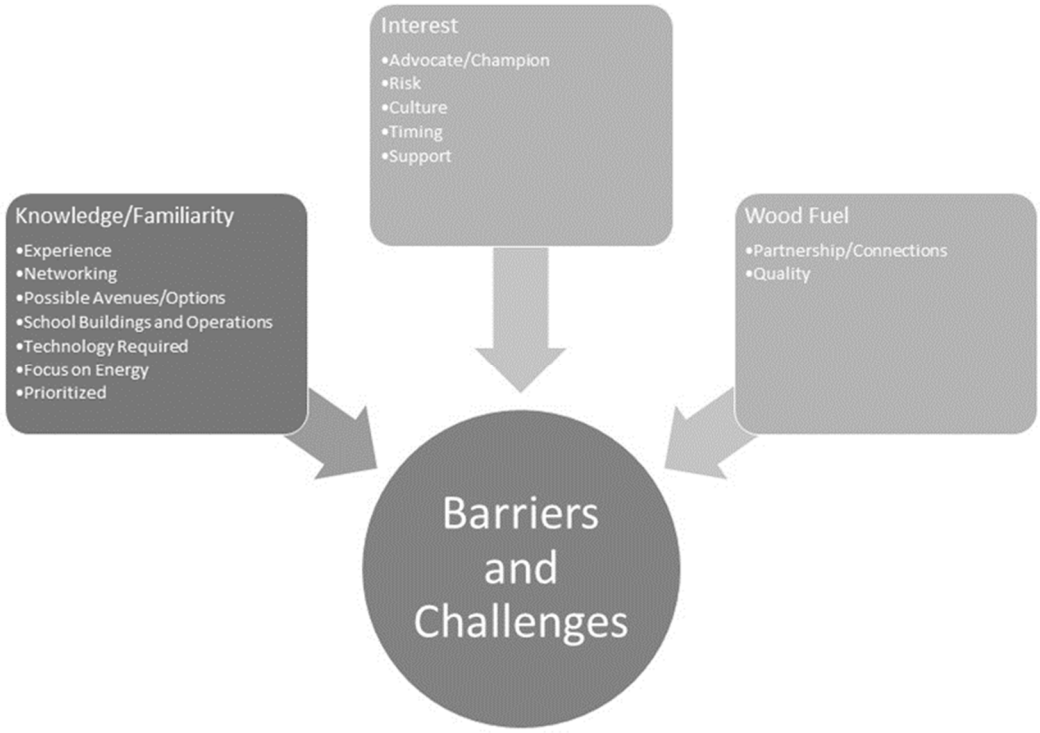

Figure 4.5: Other focus group categories and themes showing the potential to act as a barrier or challenge to using wood energy.

Objective 5:

Investigate the Regional Differences Between the Schools in Terms of the Above- Mentioned Objectives

Highlights

Forest Management Practices and Their Potential to Generate Woody Biomass

- Management practices between regions showed the Northern and Central regions to commonly use harvests and thins to be manage their school forest where as the Driftless and Non-forested regions showed invasive management to be a commonly implemented management practice.
- All of the regions reported a tendency to leave management residue on the ground. This shows potential for the regions to utilize this woody biomass residue from the regions favored management practices.
- The Northern and Central forest regions have the largest average school forest size (acres) and thus show the greatest potential in their ability to produce a lot of woody biomass fuel.
- Terrain and accessibility to school forests showed to be a problem especially for the Northern and Driftless regions.

School Districts' Heat Energy Requirements and Estimated Demand for Forest Woody Biomass

- Average energy requirements were shown to be the highest for the Non-forest region and lowest for the Northern forest region. In congruence to this, the Non-forest region also showed to require the largest amount of woody biomass fuel and the Northern forest region required the least amount of woody biomass fuel.

School Districts' Level of Awareness and Willingness to Use Woody Biomass

- Overall, the Northern forest region showed to have the greatest self-assessed knowledge about wood energy, the technology involved, and the required amount of woody biomass needed.
- Statistical significance was found between the Northern forest and Non-forest regions' knowledge of the required technology, and the Central forest and Non-forests regions' knowledge of the amount of wood needed.
- The Non-forest region showed to have the highest agreement to needing a cost-benefit analysis and more information and support.
- The Driftless region showed to not be aware of any pellet factories nearby and the Non-forest region reported not being aware of any industrial plantations/forests nearby.
- The Northern and Central forest regions were the only regions willing to consider using woody biomass with the offer of a free feasibility assessment and support from an expert. The Driftless region was most unlikely to consider using woody biomass.

School Districts' Socioeconomic, Environmental and Political Factors Influencing Decision to Use Forest Woody Biomass Energy

- The Driftless and Northern forest regions showed statistical significance in selecting wood fuel supply and accessibility as a major barrier and challenge to using woody biomass energy.
- Air quality was a major concern for the Northern, Central and Non-forest regions, while increased traffic was a major concern for the Driftless region. The Central forest region also showed a noticeably higher concern for potential habitat destruction.
- While most of the regions rated the waste produced as being an important factor to consider in selecting a heating system, the Non-forest region rated this factor noticeably less important in comparison.

Regions Defined

Responses were sorted by region (i.e. northern forest region, central forest region, driftless region, and non-forest region). Regions (see Figure 2.4) were formed based on percent forest cover, terrain, and culture (urban versus rural). As a result, the following four regions were developed: northern forest, central forest, driftless, and non-forest. The northern forest is generally more rural and is comprised of the highest percent forest cover. The central forest is primarily rural and has a decent amount of forest cover, but not as much as the northern forest region. The driftless is a mix of rural and urban, and while it does have a decent amount of forest cover, the rolling terrain and highly erosion prone soils make access to the forests difficult. The non-forest region is highly urban and has very little forest cover.

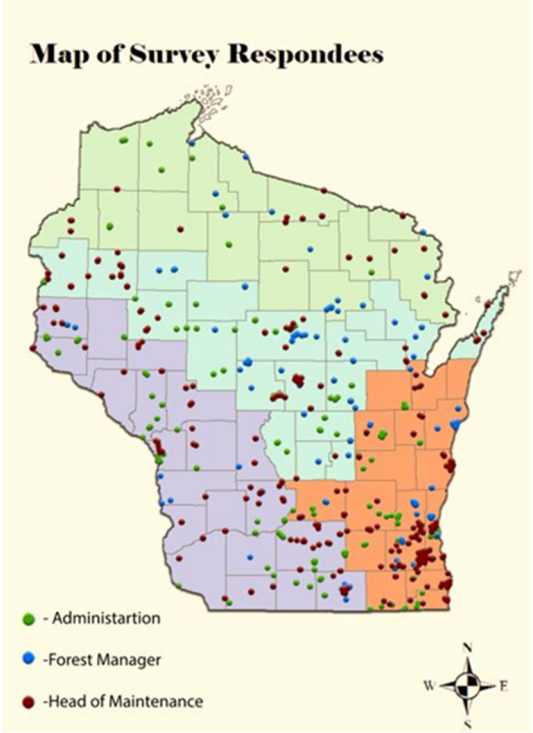

Figure 5.1: A map of the study area displaying the four different regions used for regional comparisons.

Forest management practices and their potential to generate woody biomass

Both the Northern and Central Forest reported thinning as being their most used management practice in their regions. In addition, both the Driftless and Non-Forest regions resulted in invasive management as being their top management practice selected in their regions. Burns were only performed in the

Driftless and Central Forest regions. The Northwoods and Central Forest show potential for being able to get woody biomass fuel from their school forests primarily through their harvest and thinning practices. In contrast, the Driftless region could potentially get some woody biomass fuel through invasive removal and harvest residue. Even the Non-Forest region shows some possibility of their school forests providing woody biomass fuel through invasive removal if the invasives are woody plants.

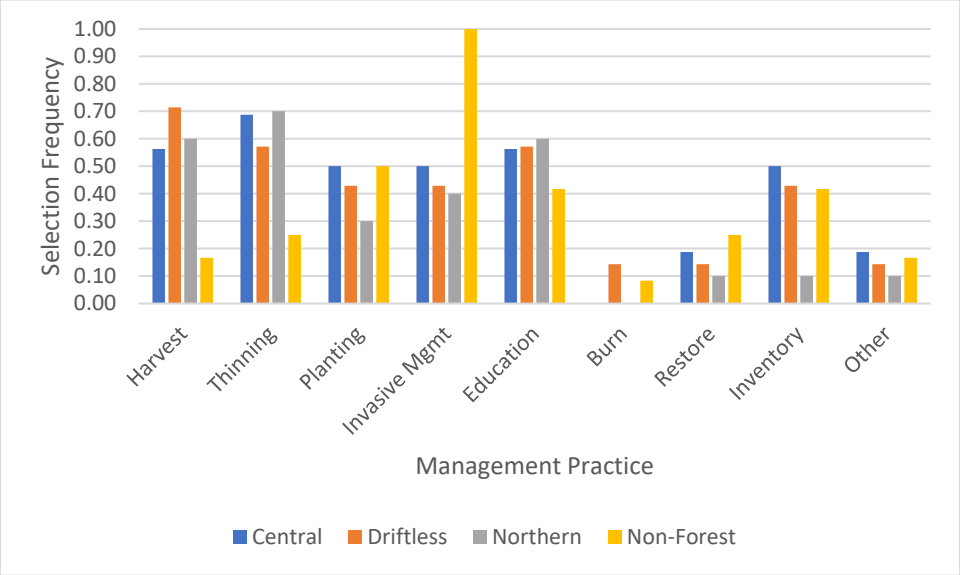

Figure 5.1: Regional school forest management practices

All of the regions showed a favoring towards leaving leftover wood on the ground after implementing their forest management. This shows potential for utilizing this wood that is left on the ground as a source of fuel for woody biomass energy. All of the regions also had some other use of the leftover wood. The Driftless and Central Forest regions were the only regions to report using some of the leftover wood as firewood. Only the Central Forest and Non-Forest regions reported being unsure of their use of leftover wood. Lastly, only the Central Forest region reported selling some of the leftover wood.

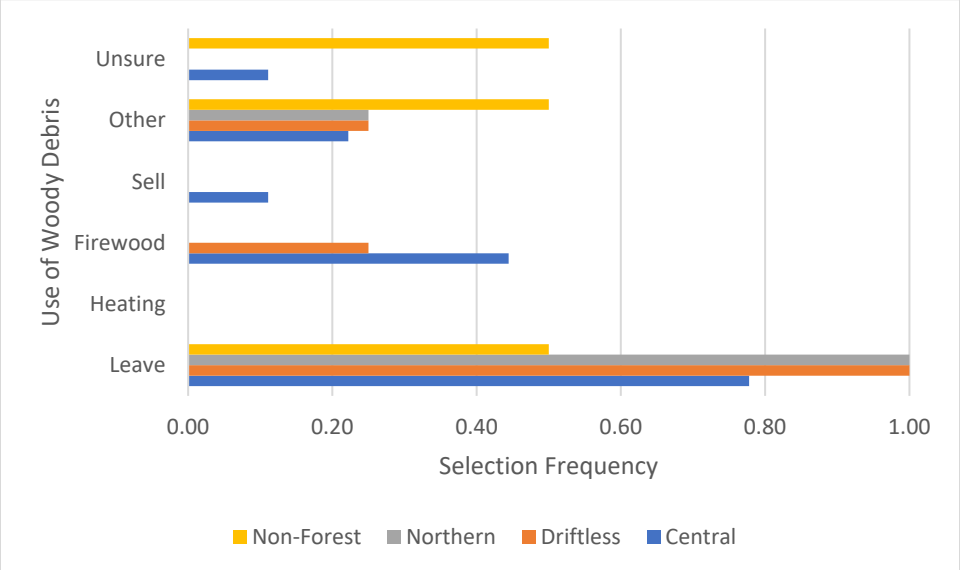

Figure 5.2: School forest use of forest management debris by region

Overall, average school forest size was greatest for the Central Northern forest regions and smallest for the Non-forest region. To add, the Non-Forest region has the smallest school forests, and the Central Forest region has the largest school forests. While the Central Forest region seems to show the most promise for providing a lot of fuel woody biomass due their seemingly large school forest. It is unclear as to what their school forests are comprised of. Factors that could bring greater meaning to these reported school forest acres include forest density, forested acres, and forest composition.

Table 5.1: School forest size statistics by region. All numbers are in units of acres.

Statistic	Region			
	Northern	Driftless	Central	Non-Forest
Minimum	6.3	7.07	7	1.2
Maximum	380	346	800	293.31
Average	136.68	108.67	147.33	42.71
Mode	40	80	320	14
	200	---	30	---
	---	---	40	---

Invasive species as a school forest management issue was reported as a common problem for all four regions. However, terrain/accessibility seemed to be an equally important management issue for the Northern and Driftless regions. This is important to keep in mind, as though the Northern and Driftless may show potential for having unused woody biomass debris, this debris may not currently be used due to inaccessibility. Therefore, perhaps the Central Forest and Non-Forest areas would be better candidates for woody biomass energy since inaccessibility was not reported as an issue nearly as much as for the Northern and Driftless regions.

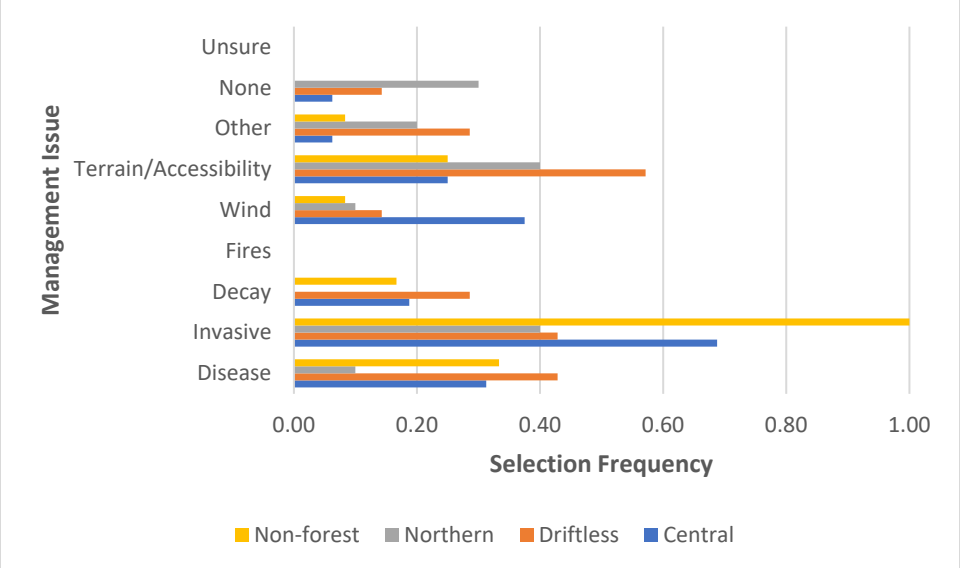

Figure 5.3: School forest management issues experienced by region.

School Districts' Heat Energy Requirements and Estimated Demand for Forest Woody Biomass

While the Central Forest contains a district with the smallest energy requirements, the Northwoods had the lowest average energy requirements. On the other hand, the Non-Forest region proved to not only have the district with the largest energy requirements, but it also has the largest average energy requirements.

Table 5.2: Districts' monthly energy requirement statistics by region.

Statistics	Regions			
	Northwoods	Driftless	Central Forest	Non-Forest
Minimum	4,000,000	76,381	50,000	60,000
Maximum	5,000,000	4,175,801,745	2,000,000,000	20,259,000,000
Mode	---	---	---	17,000,000
Average	4,500,000	528,622,266	408,865,000	2,552,020,000

To compliment the energy requirement observations, the Northwoods region, overall, requires the least amount of woody biomass, and the Non-Forest region requires the largest amount of woody biomass. The Driftless and Central Forest regions are somewhat similar, but the Central Forest region requires slightly more fuel wood to meet their slightly higher energy demands.

Table 5.3: Districts' amount of green wood chips (tons) needed by region to meet energy demands.

Statistic	Region			
	Northwoods	Driftless	Central Forest	Non-Forest
Minimum	4,000.00	50	76.381	60
Maximum	5,000.00	2,000,000.00	4,175,801.75	20,259,000.00
Average	4,500.00	408,865.00	528,622.27	2,552,020.00
Mode	---	---	---	17,000.00

School Districts' Level of Awareness and Willingness to Use Woody Biomass

According to regional mean ratings (see Table 5.4), the northern forest region showed to have the highest self-assessed familiarity with woody biomass energy (mean = 2.13), and knowledge of the technology (mean = 3.17) and amount of wood required (mean = 2.67). The driftless and non-forest regions consistently showed the lowest self-assessed familiarity of woody biomass energy and knowledge of the technology and amount of wood required. However, except for the northern forest region's knowledge of the required technology, all the regions had a relatively low familiarity and knowledge of woody biomass energy and its requirements. This exception and overall low familiarity and knowledge were also reflected in the regional mode ratings. All the regions had a mode rating of 1 (not familiar at all or disagree) with the one exception of the northern forest region's knowledge of the required technology (4= somewhat agree).

Table 5.4: Regional knowledge and information needs of school districts (1= not familiar or disagree, 5= extremely familiar or agree).

Statement	Number of Responses (n)				Mean (SD)				Mode				Standard Error			
	N	CF	D	NF	N	CF	D	NF	N	CF	D	NF	N	CF	D	NF
How familiar is your school district with woody biomass energy?	8	15	6	17	**2.13 (1.13)**	1.94 (1.39)	1.33 (0.52)	1.25 (0.45)	1	1	1	1	0.4	0.35	0.21	0.11
Our school district understands/knows about the technology required to convert to using wood energy.	6	14	6	17	***3.17 (1.47)**	2.07 (1.10)	1.33 (0.82)	*1.53 (0.94)	**4**	1	1	1	0.6	0.28	0.33	0.23
Our school district understands the amount of wood required to heat our school buildings.	6	14	6	17	**2.67 (1.97)**	*2.27 (1.22)	1.5 (0.84)	*1.12 (0.33)	1	1	1	1	0.8	0.32	0.34	0.08
Our school district needs to set up a cost-benefit analysis.	6	14	6	17	3.50 (1.05)	3.00 (1.31)	3.17 (1.33)	**3.76 (1.44)**	3	3	3	**5**	0.43	0.34	0.54	0.35
Our school district would require information and support if we were to consider using woody biomass to heat any schools in our district.	6	14	6	17	3.33 (1.37)	3.80 (1.37)	3.17 (1.33)	**3.88 (1.54)**	2	**5**	3	**5**	0.56	0.35	0.54	0.37

N: northern forest region, *CF:* central forest region, *D:* driftless region, *and NF:* non-forest region

Numbers in bold show the highest rating

SD = standard deviation

**p< 0.05; statistical significance*

In addition, a non-parametric Kruskal-Wallis test was applied to show any statistically significant differences in familiarity, knowledge, and need of additional information between regional responses. The test showed statistical significance between the mean rating of at least one pairwise comparison of regional knowledge of the required technology (p = 0.022). A Dunn's pairwise test showed a statistically significant difference (p = 0.043; Bonferroni adjusted p-value) in knowledge of the required technology between the northern forest region (mean = 3.17) and the non-forest region (μ = 1.53). The Kruskal-Wallis test also showed statistical significance between the mean rating of at least one pairwise comparison of regional knowledge of the amount of wood needed (p = 0.010). A Dunn's pairwise test showed a statistically significant difference (p = 0.010; Bonferroni adjusted p-value) in knowledge of the amount of wood needed between the central forest region (mean = 2.27) and the non-forest region (mean = 1.12). No other statistically significant differences were shown in regional responses to the other statements.

While the non-forest region showed to have one of the lowest ratings for familiarity with woody biomass and its required technology and wood supply, the region showed to have the highest agreement to needing a cost-benefit analysis and requirement of more information and support. This was reflected in both the mean and mode ratings of the non-forested region (see Table 2.3), but more

prominent in the region's mode rating (mode = 5). The central forest region also showed an agreement to needing information and support, which was slightly reflected in the region's mean rating (mean = 3.80) but more strongly displayed in the region's mode rating (mode = 5). According to its mode rating, the northern forest region was the only region to slightly disagree to requiring more information and support (mode = 2). The remaining regional mean and mode ratings for the statements regarding a cost-benefit analysis and needing more information and support, showed a neutral stance (see Table 2.3).

The Northern and Central Forest regions seemed to have a fairly even distribution between being aware of a pellet factory nearby, one not being nearby, and being unsure if there was one nearby. As for a lumber company/sawmill or logging operation being nearby, both the Northwoods and Central Forest had a high percentage of districts that were familiar of one nearby, very few were unaware or unsure of either being nearby. Both the Northwoods and Central Forest were 100% unaware of any other woody biomass producers being nearby. However, the Northwoods and Central Forest regions differed in their response trends for the presence of an industrial plantation/forest. Half of the districts in the Northwoods region were unsure of the presence of an industrial plantation/forest being nearby and about a third of the districts were aware of an industrial plantation/forest being nearby. For the Central Forest region, there was a pretty even distribution, with a slightly higher percentage towards being unsure, of responses in terms of awareness of an industrial plantation/forest being nearby. The Driftless region was unsure or unaware of a pellet factory being nearby, had about half aware of a lumber company/sawmill nearby (with about a third being unsure), equally aware of and unsure of a logging industry being nearby, over half being unsure of an industrial plantation/forest being nearby, and most not aware of any other woody biomass producers nearby. As for the Non-Forest region, districts were equally unsure and unaware of the presence of a pellet factory being nearby, and unaware of a lumber company/sawmill, logging company, industrial plantation/forest, or any other woody biomass producer.

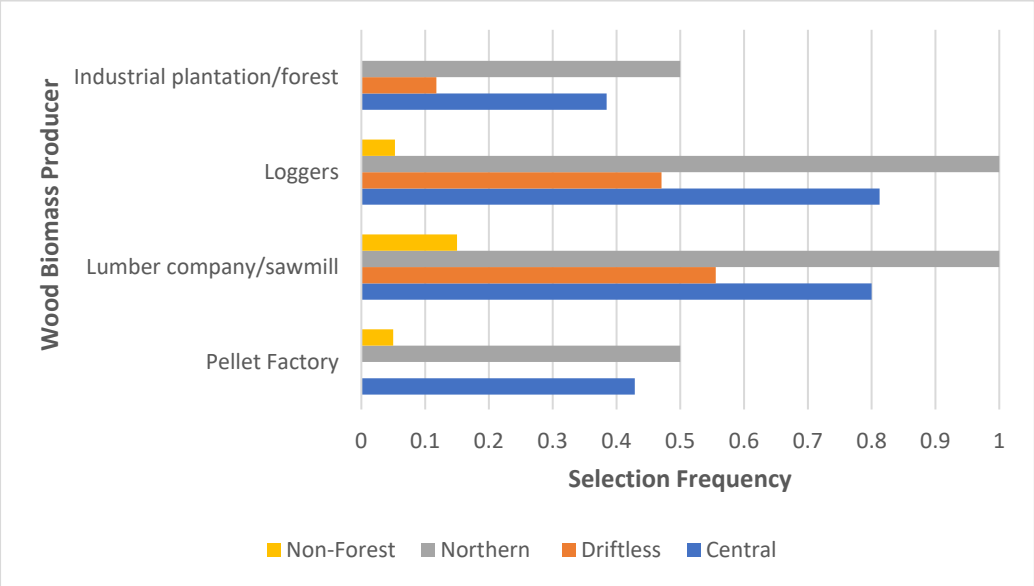

Figure 5.4: Regional knowledge and familiarity of nearby woody biomass producers

The Northern and Central Forest regions were found to be the only two regions that contained districts that were willing to consider using woody biomass energy if offered a feasibility assessment and support

from an expert. All of the regions except for the Driftless region had “maybe” as their most common response to the question. The Driftless region had “no” as their most common response to the question.

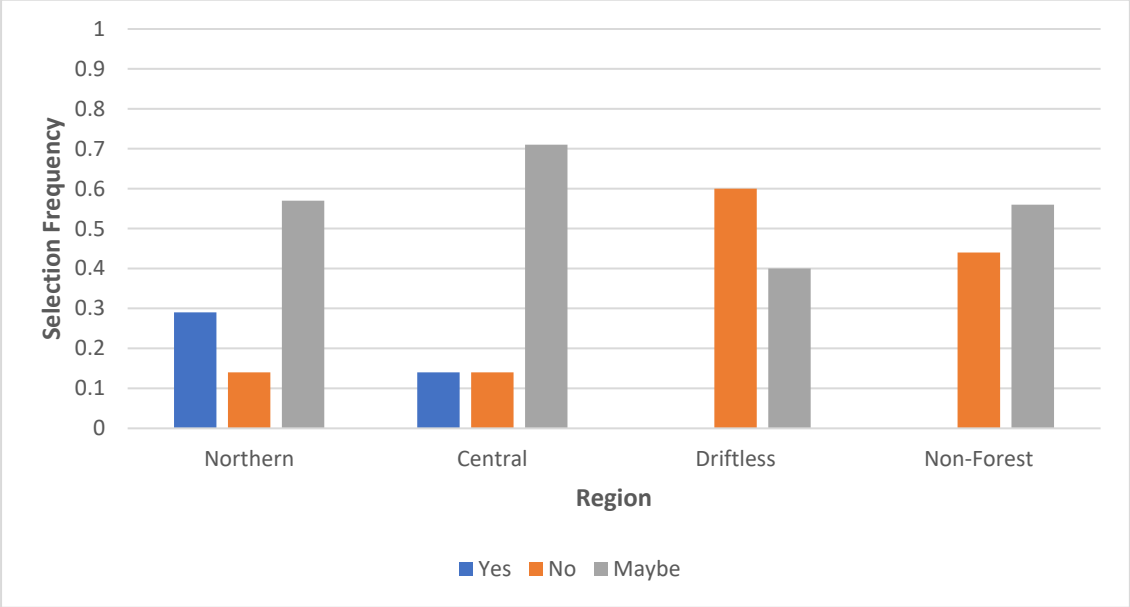

Figure 5.5: Districts’ regional willingness to consider using biomass if offered a feasibility assessment and support from an expert.

School Districts’ Socioeconomic, Environmental and Political Factors Influencing Decision to Use Forest Woody Biomass Energy

Regionally, northern forests most frequently selected cost and time (both 0.83) as a barrier or challenge with funding (0.75) closely following. Non-forested areas most frequently selected building infrastructure and personnel (both 0.64) as a barrier or challenge followed by costs, competing cheaper fuel source, time, and wood fuel supply/accessibility (all 0.62). The central forest region most frequently selected costs (0.88) as their biggest barrier or challenge with competing cheaper fuel sources (0.72) as a close second followed by building infrastructure (0.63). The driftless region most frequently selected funding, personnel, time, and wood fuel equally as their biggest barriers or challenges (all 0.71).

Table 5.5: Districts’ selection frequency of certain barriers and challenges by region.

Barrier and Challenge	Selection Frequency			
	Northern Forest	Non-Forest	Central Forest	Driftless
Area Too Large	0.08	0.28	0.13	0.21
Building Infrastructure	0.58	**0.64**	**0.63**	0.65
Costs	**0.83**	**0.62**	**0.88**	0.67
Competing Cheaper Fuel Source	0.50	**0.62**	**0.72**	0.67
Funding	**0.75**	0.51	0.59	**0.71**
Feasible Technology	0.25	0.38	0.33	0.46
Negative Environmental Impacts	0.17	0.42	0.29	0.22
Personnel	0.67	**0.64**	0.61	**0.71**
Roads and Traffic	0.08	0.15	0.10	0.29
Time	**0.83**	**0.62**	0.57	**0.71**

Wood Fuel Supply/Accessibility	0.25*	**0.62**	0.43	**0.71***
Other	0.00	0.05	0.13	0.17

Major barriers for each region are in bold.
** = p<0.05*

Results from the binary logistic regression model did show a statistically significant difference regionally in the selection of supply as a barrier or challenge to using woody biomass energy (see Table 3.4). The odds of supply being selected as a barrier or challenge was shown to be 14.16 times greater for the driftless region and 1.98 times greater for the northern region as opposed to the non-forest region.

Table 5.6: Regression analysis results for the statistically significant barrier and challenge of wood fuel supply and accessibility.

Variable	**Wood Fuel Supply and Accessibility**			
	B	**Exp(B)**	**Sig.**	**SE**
Occupation	-0.849	0.428	0.058	0.448
Central Forest	1.558	4.749	0.148	1.078
Driftless	2.651	14.163	0.020	1.141
Northern Forest	0.685	1.984	0.028	0.311
Student Population	0.000	1.000	0.247	0.000
Economically Disadvantaged	0.023	1.023	0.207	0.018
White/Caucasian (%)	0.032	1.033	0.177	0.024
Constant	-5.413	0.004	0.075	3.037
Model performance				
	-2 log likelihood: 128.416 Hosmer-Lemeshow: p = 0.119 Nagelkerke R^2: 0.193 Predicted correctly: 68.6%			
Null model with no IVs:				
	Predicted correctly: 54.3%			

The Northern and Central forest regions tended to respond the same in their ratings of logistical/environmental concerns. The only exception being their response to habitat destruction, where the Northwoods region agreed that is a concern, but the Central Forest region somewhat disagreed. The Driftless region only showed concern for habitat destruction. The Non-Forest region had different ratings of their concerns from all the other regions except for air quality and habitat destruction (similar to the Driftless and Northwoods regions).

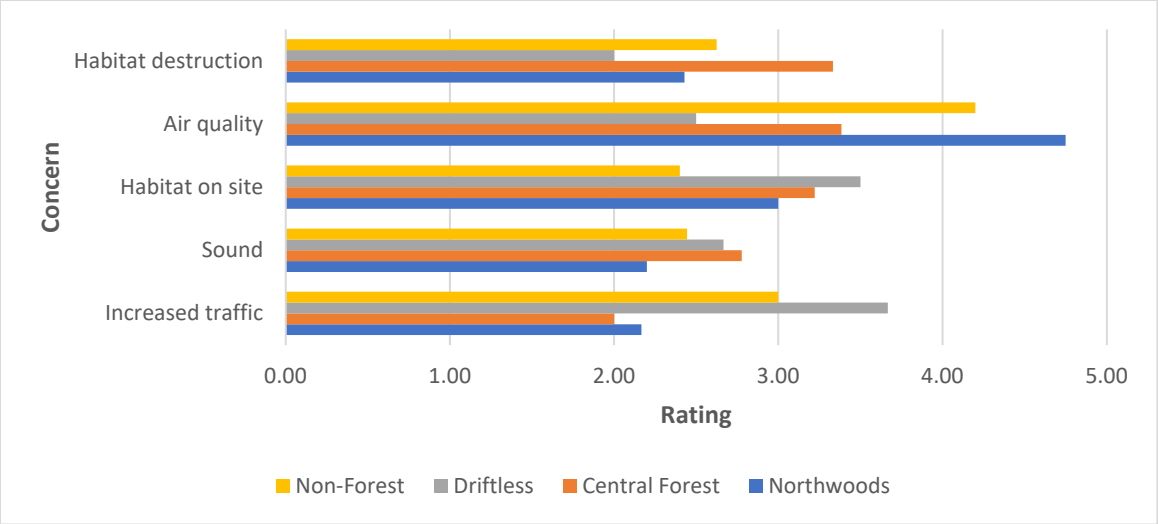

Figure 5.6: Regional rating of concern for certain logistic and environmental factors (1 = not concerned, 5 = very concerned)

Most of the regions disagreed with having their districts' landscape as an inhabitant to their ability to acquire woody biomass with the exception of the Non-Forest region which took a neutral stance. Half of the regions disagreed with the statement regarding air quality being a problem for their area. The Central Forest region took a neutral stance on air quality being a problem, and the Non-Forest region somewhat agreed to air quality being a problem. The Northwoods and Central Forest regions both somewhat agreed to using woody biomass for heating being a way to help with forest management, whereas the Driftless and Non-Forest had a neutral stance on the subject. All regions had a neutral stance towards the statement regarding the use of woody biomass destroying wildlife habitat with the exception of the Central Forest region which somewhat agreed to the statement.

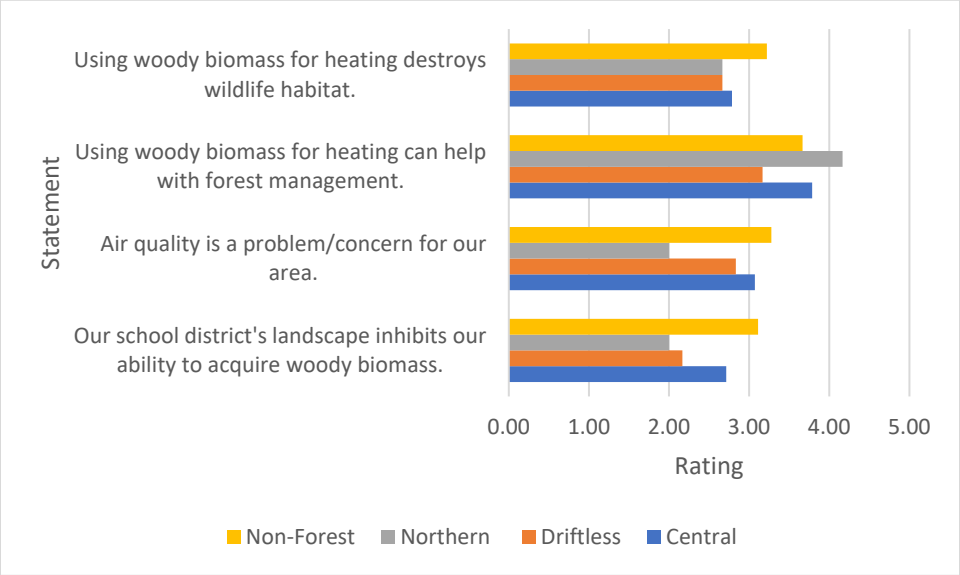

Figure 5.7: Regional views on the use of woody biomass energy (1 = disagree, 5 = agree).

Besides one factor, there was not much of a regional difference between the rating of factors to consider when choosing a heating system. One regional difference in responses occurred for the waste

produced factor. While most of the regions rated the waste produced factor as being very important, the Non-Forest region rated the waste produced factor as being moderately important.

Table 5.7: Regional rated importance of certain heating system factors (1 = not important, 5 = very important).

Heating System Factor	Region			
	Central	Driftless	Northern	Non-Forest
Time required to run the system	3.47	3.72	4.20	3.48
Maintenance required to run the system	3.94	4.33	4.80	4.14
Staffing required	3.88	4.00	4.60	3.95
Waste produced	3.94	3.50	4.20	**2.86**
Possible pollution/contaminants produced	4.06	3.72	3.60	3.29
Price of fuel source	4.29	4.06	5.00	4.14
Price of heating system	4.31	4.00	5.00	4.19
Efficiency of the heating system	4.41	4.33	5.00	4.29
Knowledge or experience with the system	3.47	3.72	4.40	3.81
Fuel source availability	4.35	4.17	4.40	4.10
Fuel storage	3.88	3.11	4.40	3.40
Fuel delivery	4.25	3.67	4.40	3.86
Contractors	3.82	3.78	4.20	3.67
Pay off period	3.94	4.17	4.80	4.10
Supporting the local economy	3.71	3.61	4.20	3.43
Sustainability	3.76	3.67	4.40	3.71

Biggest regional difference in bold.

All of the regions resulted in the option, “use of a renewable resource” as being the most selected option. Though the Northern region also had “save money” as being one of their most selected options. However, differences did start to appear in the regions’ second most selected option. The Northern had “good educational tool” as their second more selected option, the Central region had “save money” as their second most selected option, the Driftless region had “support local economy" and “good educational tool” as their second most selected options, and the Non-Forest region had “save money” as their second most selected option.

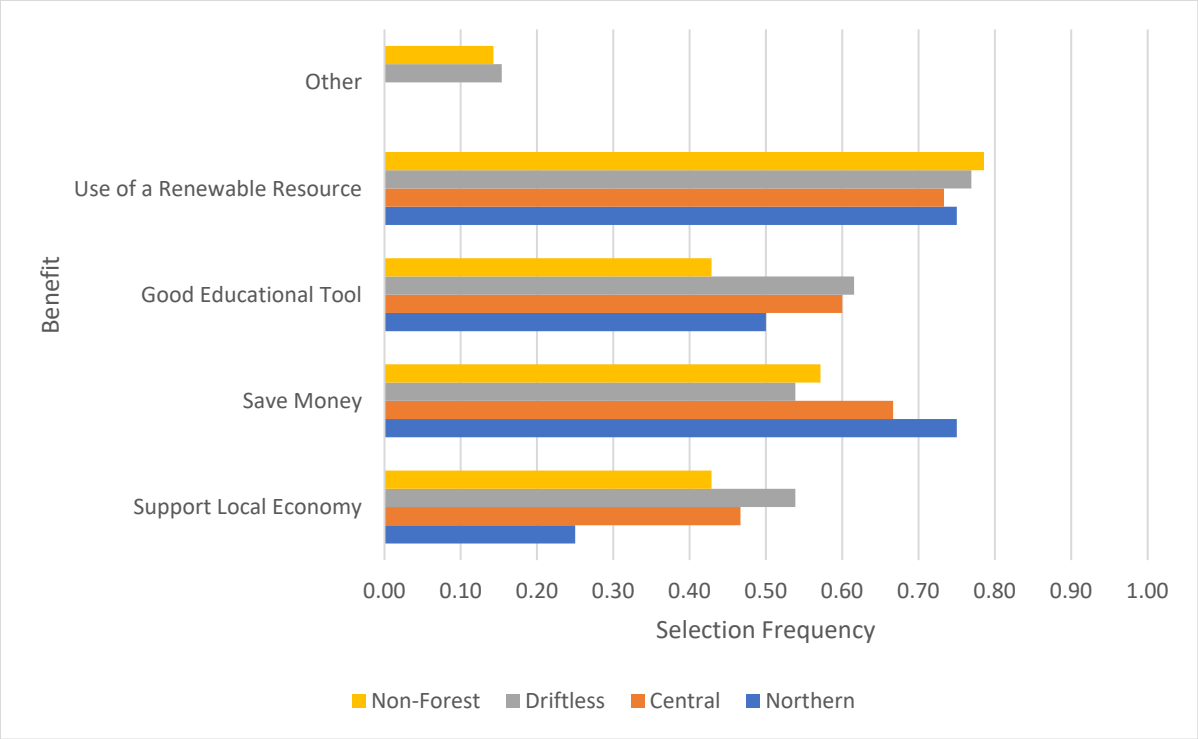

Figure 5.8: Perceived benefits to using woody biomass energy by region.

Objective 6:

Review Policy Challenges Regarding Use of Forest Biomass as Energy Source in Schools

Highlights

- Energy incentives was most frequently selected by districts as their current use of energy policies and incentives.
- Policy and incentive programs districts reported on being most familiar with included Wisconsin's Focus on Energy Incentives program, WASBO Facilities Core Certification, Energy Star Score/Portfolio Manager, and Focus on Energy Agriculture, Schools, and Government Energy Advisors.
- Policy and incentive programs districts seem to primarily being using or have applied for include Wisconsin's Focus on Energy incentives.
- Major land use policy challenges that were reported included transportation, storage, and land availability.
- Outreach to policy makers to encourage the state of Wisconsin to set a goal for percent of thermal energy being produced by wood (like Vermont) and follow-up with the development of additional funding and incentive programs (like Minnesota and Vermont) could aid in making the switch to wood energy more affordable and conducive to industries such as Wisconsin public school districts.

Policy Challenges

District superintendents were asked to report on their use of policies/incentives. According to their responses, over half (see Figure 6.1) reported the current use of energy incentives and a little under half reported the use of funding for efficiency. While the other options were selected, energy incentives and funding for efficiency proved to be the most frequently selected options. Investors were prominently reported as not currently being used by most of the districts. 'Other' options that were reported included: "Pre-buy Heating NG", "Solar panels", and "COOP Hedge".

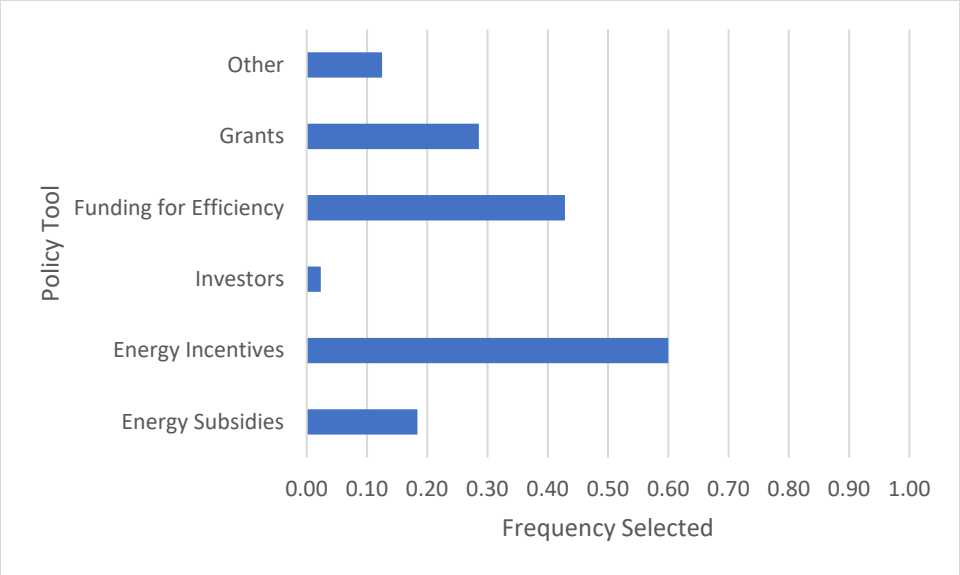

Figure 6.1: Districts' use of policy tools to fund energy initiatives.

Superintendents were asked to rate their district's familiarity with certain policy/incentive programs available in the state of Wisconsin. Data collected from this question revealed that districts are not familiar with many of the policy/incentive programs available to them. The only policy/incentive program that seemed to show some familiarity is Wisconsin's Focus on Energy Incentives Program. A few districts also seemed to report some familiarity with the WASBO Facilities Manager Core Certification, Energy Star Score/Portfolio Manager, and Focus on Energy Agriculture, Schools, and Government Energy Advisors.

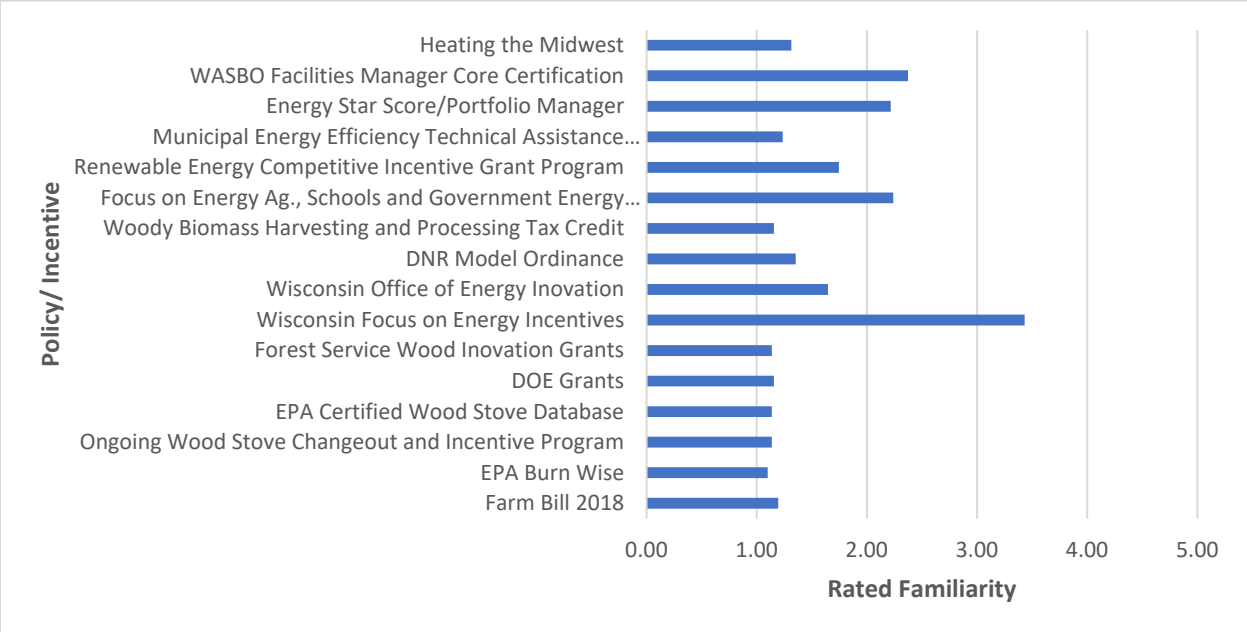

Figure 6.2: Districts' rated familiarity with certain policy and incentive programs (1 = Not familiar at all, 5 = Extremely familiar).

Superintendents were asked to report on policy/incentive programs their district is either currently using or has applied for. According to their responses, many districts have either received or applied for Wisconsin's Focus on Energy Incentives (see Figure 6.3). Only a few reported applying for or receiving funding from the Wisconsin Office of Energy Innovation organization. Most districts had applied for or received/use the Energy Star Portfolio Manager, WASBO Facilities Manager Core Certification, and Focus on Energy Agriculture, Schools, and Government Energy Advisors. Only a few districts reported applying for or receiving/using the Renewable Energy Competitive Incentive Grant Program and the Municipal Energy Efficiency Technical Assistance Program.

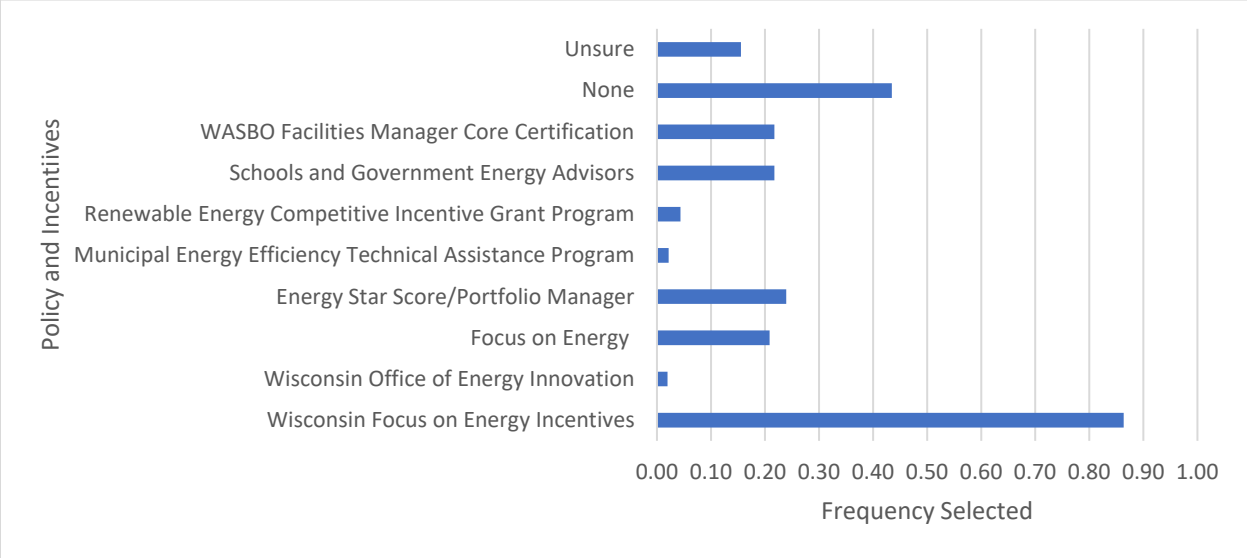

Figure 6.3: Districts' use of certain policy and incentive programs.

Superintendents were asked to record any land use policy challenges their district has, or is currently, experiencing. The three biggest land use policy challenges reported were transportation (see Figure 6.4), storage, and land availability. A few reported pollution and noise to be a challenge, and no districts selected the 'other' option. But overall, all of the land use policies were not frequently selected which seems to hint at few districts experiencing land use policy challenges.

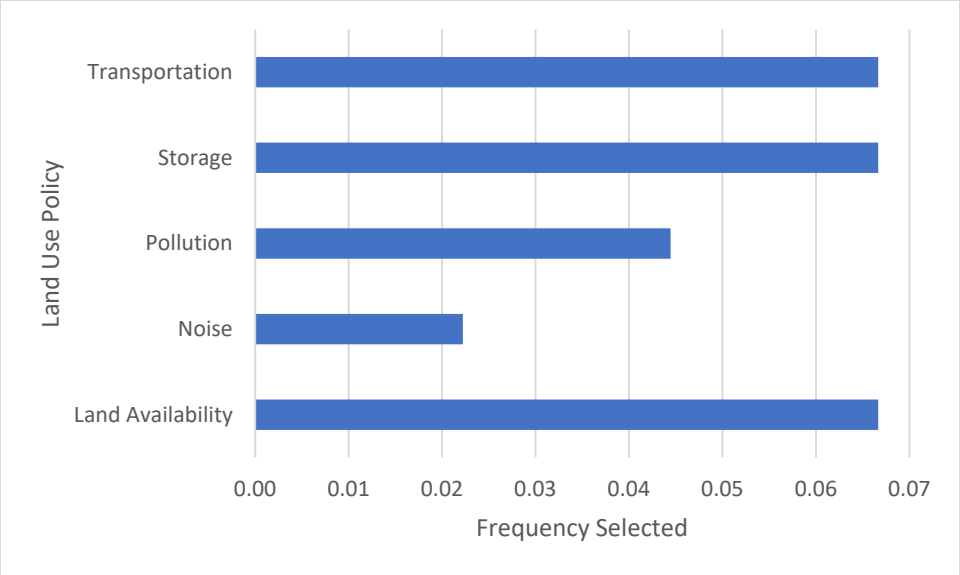

Figure 6.4: Land use policy challenges experienced by districts.

Looking at what other states have done to help encourage the use of woody biomass using policy can help provide an example for the state of Wisconsin to model after. Minnesota has an entire biomass program run by their Department of Natural Resources and supported by their state legislature. For example, they have a program called "MN Business First Stop," where a team of professionals from multiple state agencies (i.e. the departments of Commerce, Transportation, Agriculture, Natural Resources, Employment, and Economic Development, Pollution Control Agency, and Iron Range Resource's) assist large and small companies in feedstock identification, financing, environmental permitting, and site selection. In terms of financing, the state of Minnesota has a number of funding and incentives available to help reduce the costs of implementing a woody biomass energy system. Most notable policies include the AGRI Bioincentive Program, a new program developed by legislature to provide production payments and encourage commercial-scale thermal energy production from biomass, and the Legislative-Citizen Commission on Minnesota Resources, whose purpose is to make funding recommendations to legislature for special natural resources projects to help maintain and enhance Minnesota's natural environment.

Vermont is another great example to model after as they are currently pushing to have 35% of their thermal energy to come from wood by 2030. Therefore, a number of rebates and financing programs are available and actively being promoted to encourage Vermonters to make the switch to wood energy. The state offers a plethora of residential rebates (including $3000 for Modern Wood Pellet Boiler of Furnace), commercial and institutional rebates and grants (including custom incentives and assistance of up to $100,000), financing options (including a home energy loan), and sales and use tax exemptions. Recently, the state added a federal tax credit for residential customers and a coal changeout adder, showing the states active encouragement and political support from government to encourage the use of wood energy. To add, the state advertises these incentive and funding programs through the use of social media and also has an assigned wood energy coordinator to help interested industries and individuals make the right connections and get the resources they need. Looking to states like Minnesota and Vermont where the infrastructure for promoting and using wood energy is present and continually improving, it provides some guidance as to how Wisconsin can improve in adding appropriate policy to develop a wood energy infrastructure that would support the use of wood energy by Wisconsin public school districts. While outreach to these districts about the

available wood energy funding opportunities and resources Wisconsin currently provides, outreach to policy makers to encourage the state to set a goal for percent of thermal energy being produced by wood (like Vermont) and follow-up with the development of additional funding and incentive programs (like Minnesota and Vermont) to make the switch to wood energy more affordable and conducive to industries such as Wisconsin public school districts. If the proper politics infrastructure is put in place, it could help Wisconsin public school district overcome their stated barriers and challenges of school politics as well as the politics of working with utility companies and school engineers.

Objective 7:

Inform WDNR and Other Related Agencies About the Demand and Challenges Regarding Forest Woody Biomass Utilization in Heating Schools

Highlights

- Districts reported going to Focus on Energy to acquire their energy informational needs.
- Internet and reports were the most frequently selected methods for receiving information. But these options were not highly selected (only about 0.20 selection frequency) suggesting other methods such as social media or in-person experiences (options not included in the survey) may be more preferred.
- Identifying the barriers and challenges school districts perceive to face in implementing a wood energy system (see Objective 4) could help direct education and policy efforts to alleviate obstacles for school districts where wood energy is a feasible option.
- Potential outreach could take the form of working with or modeling after Focus on Energy and providing pertinent information through in-person experiences, the internet, and/or reports to bring this option of wood energy to the table through the provision of guidance to opportunities to reduce cost and make the necessary connections to quality, cheap fuel.
- It is with hopes that this increased knowledge and resources would help generate the interest and advocacy required to overcome the politics of the district, engineers, and utility companies.

Outreach

The study resulted in a clear trend in school districts relying on the state energy program (see Figure 7.1), Focus on Energy, for their energy knowledge needs. This makes sense as Focus on Energy is partnered with most Wisconsin utility companies. Therefore, school districts are bound to come across Focus on Energy at one point or another. In addition, Focus on Energy offers many energy incentives and free energy savings products which would appeal to school districts' reported desire to cut costs as much as possible. As for preferred ways of receiving energy information (see Figure 7.2), the most frequently selected options included the internet and reports. However, the selection frequency for these options were quite low (0.20), suggesting that it's possible that other preferred options exist but were not listed. This idea of other preferred options was confirmed by focus group discussions where the mention of in-person communication, including presentations, conferences, and conversations with trusted professionals, was commonly brought up when discussing energy knowledge and interest.

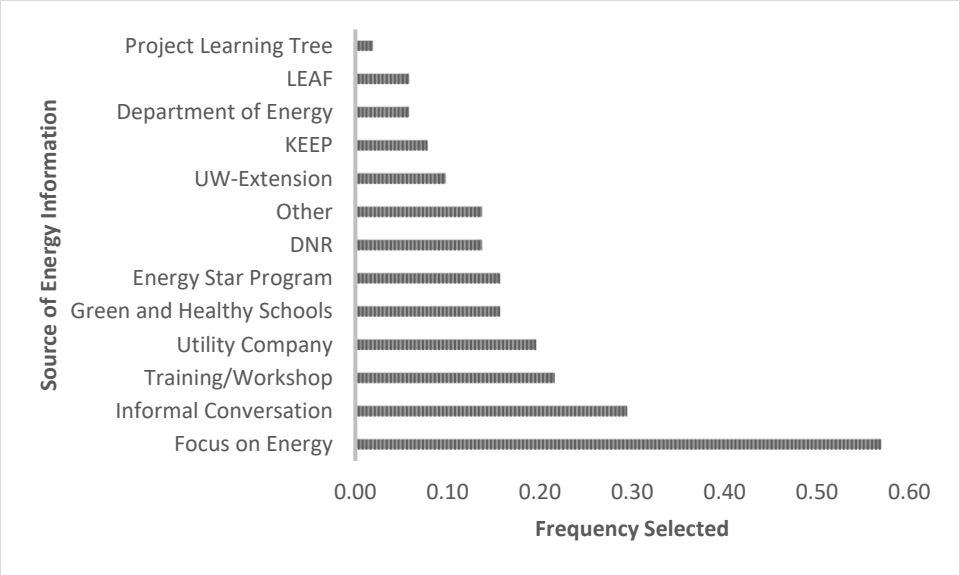

Figure 7.1: Districts' preferred sources of energy information

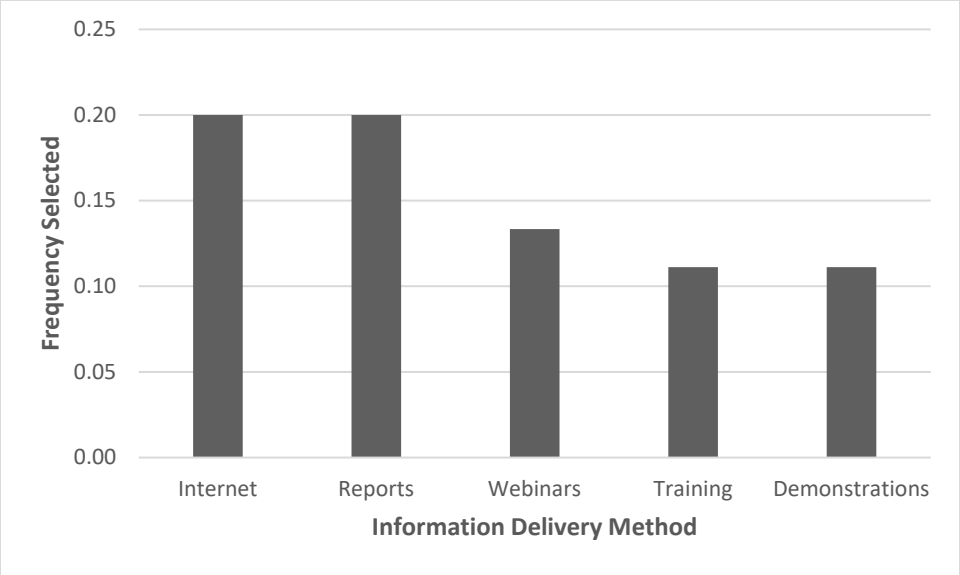

Figure 7.2: Districts' preferred methods of receiving energy information.

Results showed that major barriers or challenges included costs, personnel, time, and competing cheaper fuel sources. But other noteworthy barriers or challenges included school and fuel supply politics, working with the utilities and school building engineers, lack of time and proper connections to get the required knowledge of woody biomass energy systems, lack of a wood energy advocate or champion, and lack of a connection with a reliable and quality fuel source. Identifying the barriers and challenges school districts perceive to face in implementing a wood energy system could help direct education and policy efforts in order to alleviate obstacles for school districts where wood energy is a feasible option. But equally important to identifying barriers and challenges to direct education efforts is identifying preferred sources and forms of energy information so that these school districts are able to and more likely to access the pertinent information (see Figure 7.3). To add, while

outreach to school districts could help bring awareness to current wood energy resources offered by Wisconsin, outreach to Wisconsin policy makers may also prove to be beneficial in the development of an infrastructure to support the switch to woody biomass energy. In modeling after other states where a proper wood energy infrastructure is established and thriving (i.e. Minnesota and Vermont), it could help school districts overcome their barrier or challenge of old behavior habits (as noted in the model of pro-environmental behavior) in overcoming the politics of the district itself, utility companies, and school engineers.

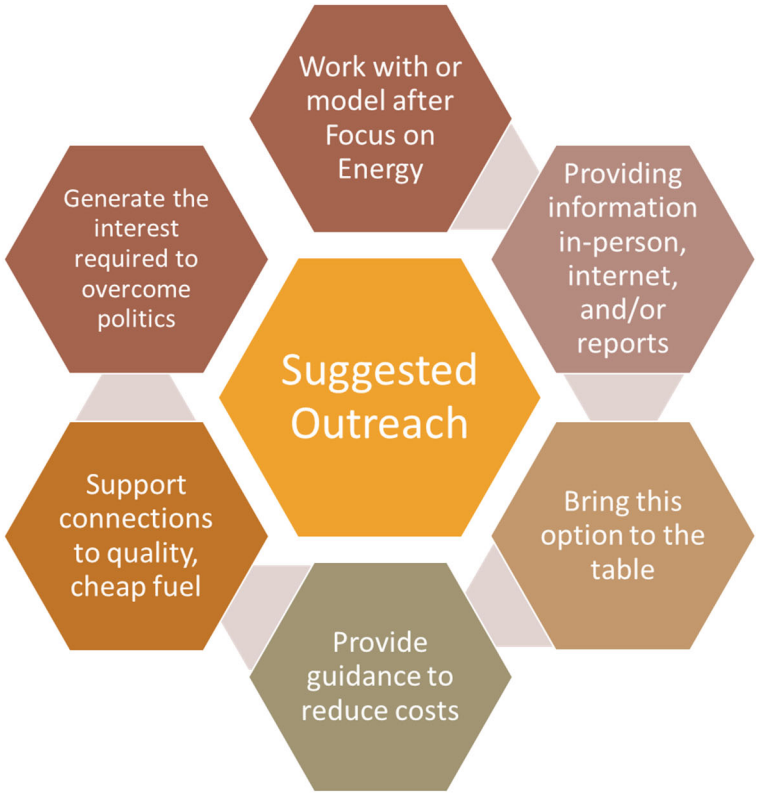

Figure 7.3: Suggested outreach to districts based on their favored sources of energy information, preferred methods of receiving energy information, and reported barriers and challenges.

Conclusion: Summary and Future Recommendations

The overall goal of this study was to assess and examine the interest, barriers, and challenges of Wisconsin public school districts (K-12) in adopting the use of forest woody biomass for heating their schools. To achieve this overall goal, the study looked specifically at school forest management activities and their potential to produce woody biomass, districts' energy and woody biomass requirements, district's level of awareness and willingness to use wood energy, districts' major barriers and challenges to using wood energy, potential regional differences, and current policy challenges to using woody biomass as an energy source in school districts. Results from the study showed an overall low familiarity

and interest in using woody biomass. However, knowledge and willingness varied regionally with the northern and central forest regions tending to display a greater knowledge and willingness to using woody biomass energy in the school districts.

A number of barriers and challenges were identified through our study's results. One potential barrier or challenge showed to be the ability to acquire enough woody biomass. While over half of Wisconsin public school districts having their own school forests, most are around 40 to 110 acres in size and struggle to gain enough support and resources for regular, proper management of their school forests. Therefore, while school forests show some potential to generate woody biomass fuel through commonly implemented management practices such as thinning, invasive species management and periodic harvests, based on the size of most school forests and the infrequency of management it is apparent that school districts would need to look beyond just their school forests in order to acquire enough woody biomass fuel to fulfill their heat energy needs.

Other barriers and challenges identified by the study included cost, personnel, time, competing cheaper fuel sources, district infrastructure, maintenance, politics, utility companies, district engineers, knowledge and familiarity, interest, and access to a wood fuel supply. Access to a wood fuel supply was shown to be especially problematic for the northern and driftless regions. However, with proper outreach and policy it is possible that many of these barriers and challenges can be overcome. Currently, in comparison to other states, particularly Minnesota and Vermont, Wisconsin has very few policies and incentives directed towards wood energy. Of those offered, school districts showed to not be aware of or able to apply for many of them. The most common political tool used was shown to be energy incentive programs offered through Wisconsin's Focus on Energy program. But looking to states like Minnesota and Vermont, where wood energy is more commonly used, it is apparent that to help encourage the use of wood energy policy makers could set a goal for a certain percent of thermal energy to be produced by wood (like Vermont) and follow with additional funding and incentive programs (as implemented in Minnesota and Vermont).

Based on our study's findings, it is recommended that outreach be implemented to address the identified barriers and challenges and increase knowledge, awareness, and use of wood energy. Results suggest reaching out to school districts by working with or modeling after Focus on Energy to provide pertinent information through in-person experiences, the internet, and/or reports so that this option of wood energy can be brought to the table through the provision of guidance to opportunities to reduce cost and make the necessary connections to quality, cheap fuel. With this increased knowledge and awareness of resources it is hopeful that it would generate the interest and advocacy required to overcome the politics of the districts, engineers, and utility companies that school districts are currently facing. But beyond school districts, it is suggested that outreach to policy makers, school district engineers, utility companies and other related agencies be conducted in order to develop the necessary infrastructure of policy and professional help to make wood energy more affordable, acceptable, and conducive to industries such as Wisconsin public school districts.