MINNESOTA FUELS FOR SCHOOLS PROGRAM

CONCEPT PAPER

A report exploring the opportunity to develop and implement a new program aimed to connect forests and communities

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OFFICE OF SCHOOL TRUST LANDS

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CONTEXT

This report was prepared for the Minnesota Office of School Trust Lands (STL) by the Biomass Energy Resource Center, a program of the Vermont Energy Investment Corporation. This report was prepared as part of an initiative led by the Minnesota Office of School Trust Lands to develop a “Fuels for Schools” type program in Minnesota for systematically targeting and converting schools and public purpose facilities to modern woodchip heating systems as a strategy to provide revenue to STL, improve forest health through good management, and enable greater financial independence for public schools in Minnesota.

BIOMASS ENERGY RESOURCE CENTER

Adam Sherman was the lead author of this report with review and support from Juliette Juillerat. The Biomass Energy Resource Center (BERC) is a program of the Vermont Energy Investment Corporation (VEIC), a mission driven non-profit organization focused on developing and implementing market solutions to expand the use of energy efficiency and renewable energy. Since 2001, BERC has specialized in the design and implementation of programs that stimulate and support wood energy conversion projects. BERC has a long-standing reputation as a source of independent and impartial information and services for modern wood heating.

More information at – www.biomasscenter.org and www.veic.org

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DISCLAIMER

The views expressed and recommendations made in this report are those of the authors, consistent with the commissioning of this work as an independent assessment. The analysis is intended to provide a level of detail necessary to make informed decisions on whether to pursue the development of a “Fuels for Schools” type program.

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EXECUTIVE SUMMARY

Minnesota's 2.5 million acres of School Trust Lands include approximately 1.4 million acres of productive, managed forestlands, and traditional timber harvesting provides vital annual revenue for the Permanent School Fund.[1] A "Fuels for Schools" type program could help develop new markets for low-grade wood essential for long-term sustainable forest management, further meet the statutory mandate of maximizing long-term revenue from these lands, and generate other benefits such as lowering and stabilizing the energy costs for public schools in Minnesota.

Nearly every school in Minnesota uses fossil fuels, such as natural gas, oil, or propane for space heating and for domestic hot water. Imported fossil fuels, while currently relatively inexpensive, have historically been expensive and their prices continue to be volatile. Proven alternatives to fossil fuels exist and are already in use. Wood fuels are a local, affordable resource for providing reliable heat. Woodchip heating has been successfully used in schools for over three decades. Today, hundreds of schools use woodchips as their primary heating fuel. Numerous states including Vermont, New Hampshire, Pennsylvania, Missouri, Montana, Idaho, North Dakota, Utah, and Nevada have already developed Fuels for Schools programs targeting and assisting public schools to make the switch to woodchip heating.

As part of the on-going active forest management of School Trust Lands, low-grade wood is harvested and sold each year to regional markets like pulpmills and biomass power plants. Yet, each year STL forests grow more wood than is harvested. There are an estimated 384,000 tons of additional low-grade wood that could be harvested annually. With this much wood, Minnesota School Trust Lands could conceptually fuel approximately 1,400 schools each year in perpetuity. There are a total of 2,051 public K-12 schools in the entire State of Minnesota and 93% are currently heated with pipeline natural gas. The remainder of the schools heat using mostly delivered fuels like fuel oil and propane.

A Minnesota Fuels for Schools program would be most effective if it focused on the northeastern portion of the state – where there is more forest and rural communities tied to the forest products economy. Many heavily forested rural areas often have limited natural gas pipeline service and rely heavily on electric, propane, and heating oil. However, several larger communities in northeastern Minnesota have natural gas pipeline service. BERC estimates there are a total of 132 schools in the five-county area (Cook, Lake, Saint Louis, Itasca, and Koochiching) and over 84% of these schools are heated with natural gas. The remainder of the schools in the target area are heated with electric, heating oil, and propane. Although there is a surprisingly high percentage of schools heating with natural gas in this five-county area, the percent of natural gas heating is less than the statewide average of 93%. Heating oil and propane are the most expensive heating fuels. While natural gas is less expensive than oil or propane, all three fossil fuels are more expensive than woodchips. Due to the high concentration of natural gas heating in schools in northeastern Minnesota, the Fuels for Schools program could initially focus on the schools heated with oil and propane, but would need to also target schools heating with natural gas.

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[1] The Permanent School Fund was established by the Minnesota Constitution for the purpose of providing long-term funding source to public education through the accumulated revenues generated by STL designated lands. https://www.revisor.mn.gov/statutes/?id=127a.31

Despite having enough surplus wood resource from School Trust forestlands to heat over half of all schools in Minnesota, a realistic target for a Fuels for Schools program focused on the 5-county region of northeastern Minnesota would be to convert 20-25 schools. A successful Minnesota Fuels for Schools Program will offer a combination of key resources needed to convince public K-12 schools in the target region to install woodchip heating systems including education and outreach, technical assistance, and project incentives and financing. A program should be designed to meet the following specific goals:

- Provide a new revenue stream to the Permanent School Fund by stimulating new, local, stable markets for underutilized low-grade wood from School Trust Lands.
- Improve composition and health of School Trust forest resources by converting low-grade species to long-lived species in order to secure long-term revenue.
- Enable greater financial independence for public K-12 schools in Minnesota by lowering and stabilizing their energy costs.

Economic analysis performed for typical school projects indicated that there are annual fuel cost savings that can drive a return on the investment of installing a new woodchip heating system, but with current low fossil fuel prices and a small amount of project cost-share funding, the payback period is long (~20 years). However, with slightly higher fossil fuel prices in the future ($3.15 per gallon for heating oil and $1.75 per one hundred cubic feet [CCF] of natural gas), these projects would be cash flow positive in the first year. Alternatively, increased levels of capital cost subsidy (55% for oil and 65% for natural gas) could also yield the same outcome – projects that are cash flow positive in the first year.

A Fuels for Schools program will have significant impacts over time. Over thirty years, 20 typical-sized schools will consume over 1/3 million tons of woodchip fuel, generate nearly $400,000 in additional stumpage revenue to the Office of School Trust Lands, displace 15 million CCF of natural gas, save schools over $18 million in heating fuel costs, lower carbon emissions by 30,000 tons, and invest over $17 million in the local economy in heating fuel expenditures alone.

A Fuels for Schools program could prove advantageous to School Trust Lands and school districts in the northeastern part of the state. Rural communities and schools in Minnesota are struggling and need innovative approaches to address the challenges they face. Lowering energy costs, retaining local wealth, and supporting local jobs in the forest products industry are vital goals, and woodchip heating is a single activity that yields measureable results for each of these. There is ample supply of wood fuel that could be sustainably sourced from STL holdings and creating new markets for low-grade wood in this region is crucial for practicing good forest management. While there would be a small amount of additional stumpage revenue generated from this program, the primary benefits would be lowering and stabilizing the energy costs for public schools. Such a program could also create an opportunity for School Trust Lands to make mission-aligned lending for school energy infrastructure that could help diversify the Permanent School Fund's investment portfolio. There are several state agencies partners with aligned interests in such a program and program partnerships could present win-win opportunities.

Even though low fossil fuel prices currently present a hurdle, prices are likely to rise in the future and improve the attractiveness of woodchip heating. Now is the time to launch a Fuels for Schools program.

SECTION 1 - INTRODUCTION

1.1 Context

The Minnesota Office of School Trust Lands (STL) is empowered to provide programmatic management advice on the state's 2.5 million acres of School Trust Lands to ensure maximum long-term economic returns through sound natural resource conservation and management principles.[2] Revenue generated from these school lands is used exclusively for the benefit of Minnesota's K-12 public schoolchildren.

Approximately 1.4 million acres of School Trust Lands are considered commercial forest lands. In addition to traditional timber harvesting, the Minnesota Office of School Trust Lands is in the early stages of designing and implementing a woody biomass utilization program. This program will be designed to develop new markets for low-grade wood from School Trust Lands which is necessary for long-term sustainable forest management and is needed to meet the statutory mandate of maximizing long-term revenue from these lands.

One goal of the School Trust Lands' effort to develop a wood energy initiative is to provide the leadership needed to forge public/private partnerships between wood suppliers, purchasers, and energy producers to encourage state and local communities to utilize local wood resources to create renewable energy.

Developing a viable market for low-grade wood requires overcoming numerous challenges. These include being able to understand the market needs and ensure consistent supply; addressing seasonality of demand and supply; achieving the critical mass of market demand for wood fuel to support the investments in supply-chain infrastructure; and ensuring that public policy is supportive. Nevertheless, finding viable approaches to use low-grade wood harvested from STL forestlands to heat schools and other public buildings will support Minnesota's burgeoning green economy, and help to mitigate carbon emissions. Removing low-grade wood from these forests in ecologically sustainable ways will also improve forest health, reduce wildfire risk, create jobs in the forest products industry, and provide a small amount of additional revenue for the Permanent School Fund.

1.2 Why Fuels for Schools?

In a region with long, cold winters, nearly every school in Minnesota uses fossil fuels, such as natural gas, oil or propane, for space heating and for domestic hot water. Imported fossil heating

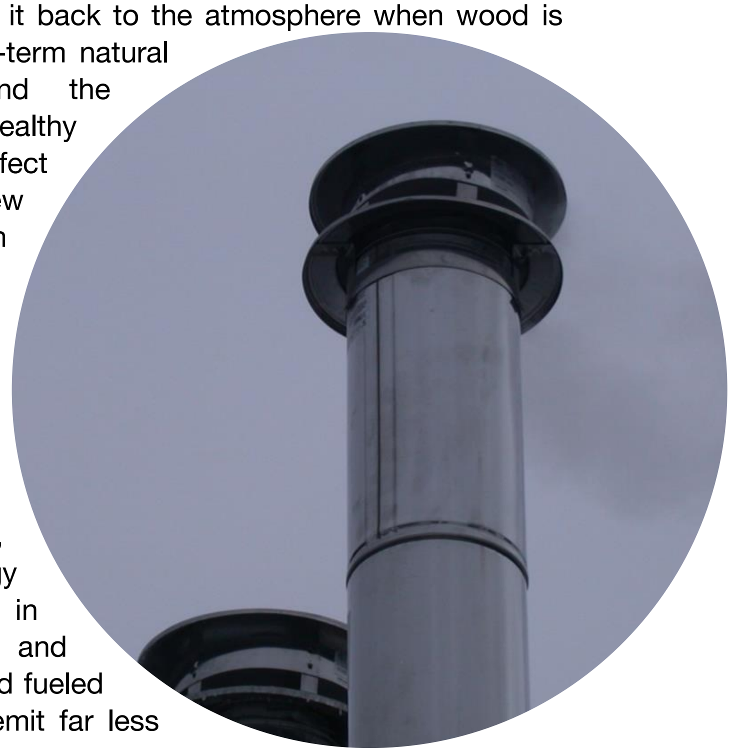
[2] Minnesota Statute - Section 127A.31 and Section 127A.353 - https://www.revisor.mn.gov/statutes/?id=127A

fuels, while currently relatively inexpensive, have historically been expensive and their prices continue to be very volatile. Additionally, burning fossil heating fuels emits large amounts of greenhouse gases that accelerate climate change. An over-dependence on imported fossil fuel also reduces the self-sufficiency of local communities. Proven alternatives to fossil fuels exist and are already in use: wood heating fuels are a local, affordable resource for providing reliable heat. Benefits of woodchip heating include:

- **Supporting the Local Economy - Heat Local.** Money spent on natural gas, oil, and propane drains local economies - sending heating dollars out of the region. Using local wood for heating can lead to increased economic opportunity in Northern Minnesota by keeping heating energy dollars in the local economy, and by creating and sustaining jobs in the forestry and forest products industries. Increased demand for wood heating fuels helps create vital markets for low-grade wood, improving the economic viability of sustainable forest management and supporting local economies with additional purchases and jobs.

- **Lowering and Stabilizing Energy Costs.** Perhaps the greatest advantage of wood fuels like woodchips is that they cost less than fossil fuels used for heating. Woodchip fuel pricing has also been much more stable over time. Over the last 30 years wood fuel prices have risen very gradually while fossil fuel prices continue to rise and fall unpredictably.

- **Reducing Carbon Footprints.** Carbon dioxide (CO_2) is a significant greenhouse gas contributing to global climate change. Fossil fuel combustion releases geologic carbon that has been locked away underground for millions of years (as crude oil and natural gas) into the atmosphere as CO_2. In contrast, carbon associated with wood is part of the ongoing forest carbon cycle where trees remove CO_2 from the atmosphere, store it as carbon in wood, and release it back to the atmosphere when wood is burned. It is therefore part of the short-term natural carbon cycle between forests and the atmosphere. As long as forests remain healthy and are sustainably harvested, the net effect of burning wood fuel is that little or no new CO_2 is added to the atmosphere. When wood fuels are sourced from sustainably managed forests and used to replace fossil fuels for space heating, it is an effective strategy for mitigating global climate change.



- **Heating with Clean, Convenient, and Efficient Systems.** Over the past decade, advanced wood combustion technology has improved dramatically – resulting in higher efficiencies, lower emissions, and overall greater ease of use. Modern wood fueled hydronic heating systems (i.e. boilers) emit far less particulate matter (PM) than older wood heating technology from just ten years ago. Additional flue gas cleaning equipment can be installed to further reduce PM emissions to those comparable to burning fossil fuels.

- **Reducing Environmental Risk.** Conventional on-site fossil fuel storage includes underground and aboveground storage tanks. Aging underground tanks can leak, contaminating the soil adjacent to buildings and posing a threat to ground and surface waters. Switching to woodchips can allow facilities to retire these tanks (replacing them with smaller aboveground tanks for back-up fossil fuel systems, if needed).

1.3 Fuels for Schools Program Concept

Public schools in northern climates have significant demands for thermal energy (heat and domestic hot water) and often burn large amounts of heating fuels like natural gas, propane, and heating oil. Public schools are often the largest facilities in rural communities and, beyond serving their primary function of a space to educate young people, schools also serve as community gathering places for events and even as emergency shelters for local residents in crisis situations.

In the early to mid-1980s, in response to the energy crisis in the 1970s, the first woodchip heating systems were installed at a handful of schools. Most of these systems were built in the upper Midwest, eastern Canada, and Vermont, where the first system was installed in 1986 at Calais Elementary School. The idea took root in Vermont, which continues today to be the national leader. There are now more than 70 public K-12 schools with wood heating systems in Vermont serving more than 1/3 of all school building space. In 2001, the US Forest Service became interested in adopting wood heating for schools in the western states, primarily motivated by a desire to create new markets for small-diameter wood thinned from fire-prone public lands. At that time, the US Forest Service hired the Biomass Energy Resource Center (BERC) to make use of the Vermont experience and manage the construction of the first school wood heating system west of the Mississippi in Darby, Montana. Based on the success of that project, the US Forest Service created a five-state program called Fuels for Schools. BERC and four cooperating state agencies formalized the Vermont approach in the Vermont Fuels for Schools partnership in 2006. Other states, such as South Dakota, New Mexico, Wisconsin, Pennsylvania, and New Hampshire are in the process of studying or creating their own Fuels for Schools programs. The US Forest Service program in the five western states (Montana, Idaho, North Dakota, Utah, and Nevada) has since been broadened to include colleges and other institutional users, under the name Fuels for Schools and Beyond.

1.4 History of Institutional Wood Heating in Minnesota

Heating schools in Minnesota with woodchips is not a new concept. In fact, there are at least a half dozen public schools that have heated with woodchips since the 1980's, including:

- Goodrich School in Goodrich
- Mahnomen Public Schools in Mahnomen
- Northome School in Northome
- Backus Schools in Pine River
- Swanville Public Schools in Swanville
- Warroad schools in Warroad

In addition to these public schools, Minnesota has several other woodchip heated facilities such as Saint Gabriel's Hospital located in Little Falls.

Although woodchip heating for public schools and other facilities has a long history in Minnesota, many of the systems at these public schools are aging units that are not good examples of modern, "best in class" woodchip heating technology available today. In the last three decades, woodchip combustion technology has come a long way – today's best in class technology is highly efficient and very clean burning. Perhaps one of the best examples of modern woodchip heating for an institutional facility in Minnesota is the Itasca Community College (see sidebar for project details). It is important to note that there are also many good examples of community-scale modern wood heating in facilities throughout Minnesota that use cordwood and pellets as fuel.

For the past several years, the State of Minnesota has worked in partnership with other agencies, organizations, and businesses to develop the wood energy market with funding from the US Forest Service. The Minnesota State Wood Energy team (MN SWET) has been actively working to convert more public buildings to using wood fuels for heat and power.[3] MN SWET recent activities have yielded several projects that are currently under development (for example, the wood energy system under development at the Minnesota National Guard's Camp Riley, located outside Little Falls). The development of a "Minnesota Fuels for Schools" program would hopefully build upon the successes of these earlier initiatives and programs.

[3] http://www.dnr.state.mn.us/forestry/biomass/swet.html

CASE STUDY

Itasca community college campus heated with woodchip steam system for 3 decades and recently completed a $1.7 million project to upgrade and modernize their campus central heating plant. The project included the demolition of the old steam equipment, retrofitting a new woodchip fuel bin, installing a new biomass boiler and two new gas boilers and all the mechanical connection work.

STATS

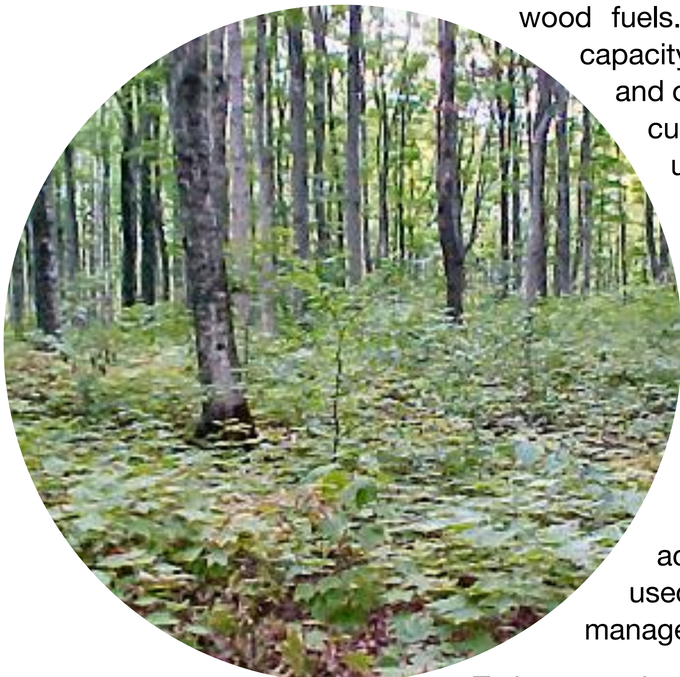
Location:	Grand Rapids, MN
Campus size:	240,000 square feet
Connections:	12 buildings
Boiler type:	Hot water
Wood fuel:	Local woodchips
Date installed:	2015-2016
System size:	2.8 MMBtu/hour
Back-up fuel:	Natural gas
Woodchip use:	600 tons annually
PM Controls:	Cyclone unit
Fuel Bunker:	50 ton capacity

SECTION 2 – PROGRAM OPPORUNITY

The first step toward designing a program is to determine the full buildout potential for such a program. The following sections explore the upper limits a program's potential based on how much wood could be sustainably supplied from STL and how many schools could be converted.

2.1 Forest Resource Capacity from School Trust Lands

Before any effort to design and implement a program, there needs to be a clear understanding of the forest resource capacity and how that resource can be used sustainably to produce local wood fuels. The following section explores the forest resource capacity of STL timberland that can be used for heating schools and other local public buildings. This rough assessment of the current supply potential is intended to help better understand the scale of the program's potential – it is not intended to serve as the definitive study quantifying the forest resources. The spreadsheet model used in this assessment was not designed with the sole purpose of providing a single, definitive number, but rather was designed to establish a probable range of how much wood fuel could be available under various scenarios.

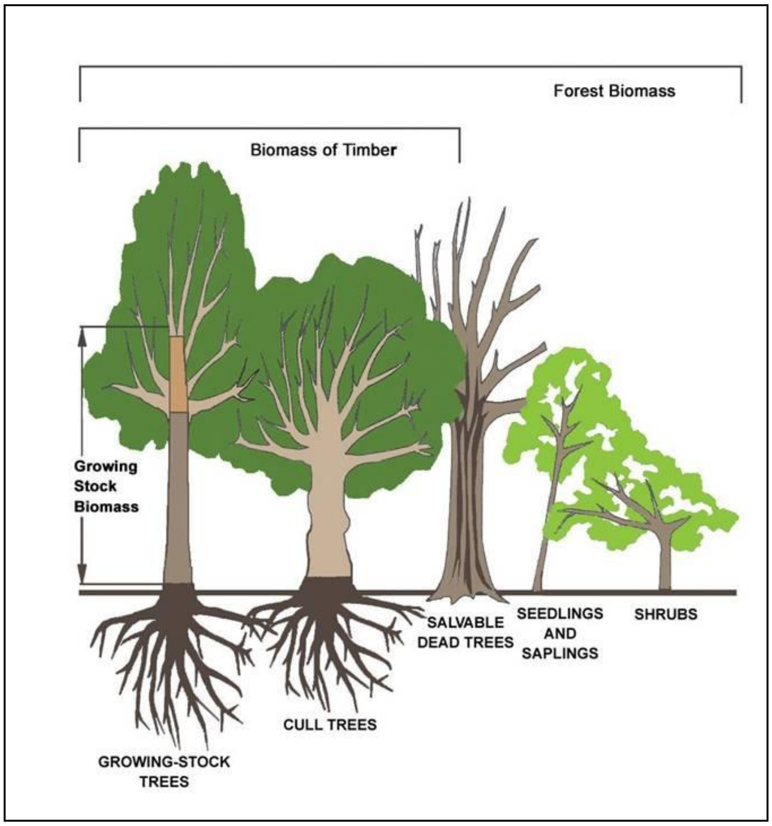


School Trust Lands encompass approximately 2.5 million acres of land, the vast majority of which is located in northeastern Minnesota. Of the total 2.5 million acres, roughly 1 million acres are swamp, brushland, or used for other purposes. The remaining 1.4 million acres are managed, productive forestlands.

To better understand the average forest stocking levels of standing wood inventory on School Trust forestlands, BERC accessed and carefully reviewed forest inventory data compiled by the USDA Forest Service's Forest Inventory and Analysis (FIA) program.

The USDA Forest Service's FIA program generates reliable estimates of the quantity, condition, and health of the forest resource and how it is changing over time. The program uses a statistically designed sampling method to select hundreds of forest plots for measurement by field crews and includes forest plots that were counted in previous inventories. Field crews also collect data on the number, size, and species of trees, and the related forest attributes. Based on the number of inventory plots measured, sample design, and statistical methods used, these forest inventory data generated by the FIA program have a relatively small margin of error.

Figure 1 - Illustration of forest inventory components (courtesy USFS FIA)



For this assessment BERC looked at the forest inventory and net annual growth data specific to State-owned lands in Minnesota.

Forest inventory data have focused almost exclusively on timber-quality trees (growing stock) and have often measured only the merchantable portion of those trees. For the purpose of this study, this traditional category is too limited. Conversely, data that quantifies all forest biomass (everything) is far too inclusive. In an effort to hone in on the portion of the forest inventory that is low-grade and suitable for use as wood fuel, this assessment utilized custom data provided by FIA personnel, detailing the 2015 inventory of all live trees five inches DBH (Diameter at Breast Height) and larger for growing stock, cull, and non-commercial species trees.[4] This custom inventory data includes only the tree bole (main stem). Standing and downed deadwood were excluded due to their value as wildlife habitat and because it does not represent inventory on which new growth occurs. Seedling and saplings were not counted either, nor were foliage, stumps or below ground forest biomass such as roots. Tree tops and limb wood were only considered as harvest residues.

When a timber harvest occurs, common practice is that the lower section of tree bole of a high-quality tree is used for veneer or sawlog and the upper section of bole is often designated as pulpwood. For lower quality, yet merchantable, trees, the lower bole section becomes pulpwood and the upper bole is used for chip or firewood.

In addition to the custom FIA inventory data used in the spreadsheet model, a series of key assumptions were applied regarding what proportion of the bole wood inventory is considered low-grade.

[4] The term “growing stock tree” refers to live trees =/>5” DBH containing traditionally merchantable wood. “Cull trees” refers to growing stock tree species that are rough or rotten or otherwise un-merchantable. “Non-commercial species” is small category of tree species that fall into neither the Growing Stock or Cull category.

Table 1 – Estimation of representative stocking for STL forestland

Parameter	Values[5]
Cubic feet of live trees on State owned timberland	2,990,321,000
Green tons	84,433,000
Acres of State timberland	3,435,000
Representative green tons per acre inventory	25
Estimated portion of inventory suitable for wood fuel production	60%
Acres of STL forestland	1,400,000
Tons of low-grade inventory on STL forestland	**20,646,000**

Once the low-grade wood inventory has been determined, net annual growth upon that inventory can be projected. FIA defines forest net annual growth as "the change, resulting from natural causes, in growing-stock volume during the period between surveys (divided by the number of growing seasons to produce average annual net growth)." The simplified FIA formula for net growth is:

In-growth (new trees) + Accretion (growth of existing trees) – Mortality (natural death) = Net growth

For the purpose of this assessment, the net annual growth of new amounts of wood was chosen as the indicator of how much wood the STL forests can provide on a sustained-yield basis. When forests are examined from a more broad perspective, wood inventory can be compared to money invested in a bank account that earns interest annually. The total annual growth of trees in a forest is analogous to the interest earned on capital invested. A wise financial investor strives to only spend the annual interest earned each year and not dip into the principal. Forest management follows the same principles -- sound forest management policy within a state or region limits harvesting to within the amount of annual growth.

Similar to the forest inventory and composition data used, this report utilized data on net annual growth from the USDA Forest Service FIA program. FIA maintains a network of semi-permanent ground plots for measuring forest inventory. After initial plot measurement, plots are periodically re-measured over time. Individual trees are re-measured until they die and new trees are measured as they grow into the plots.

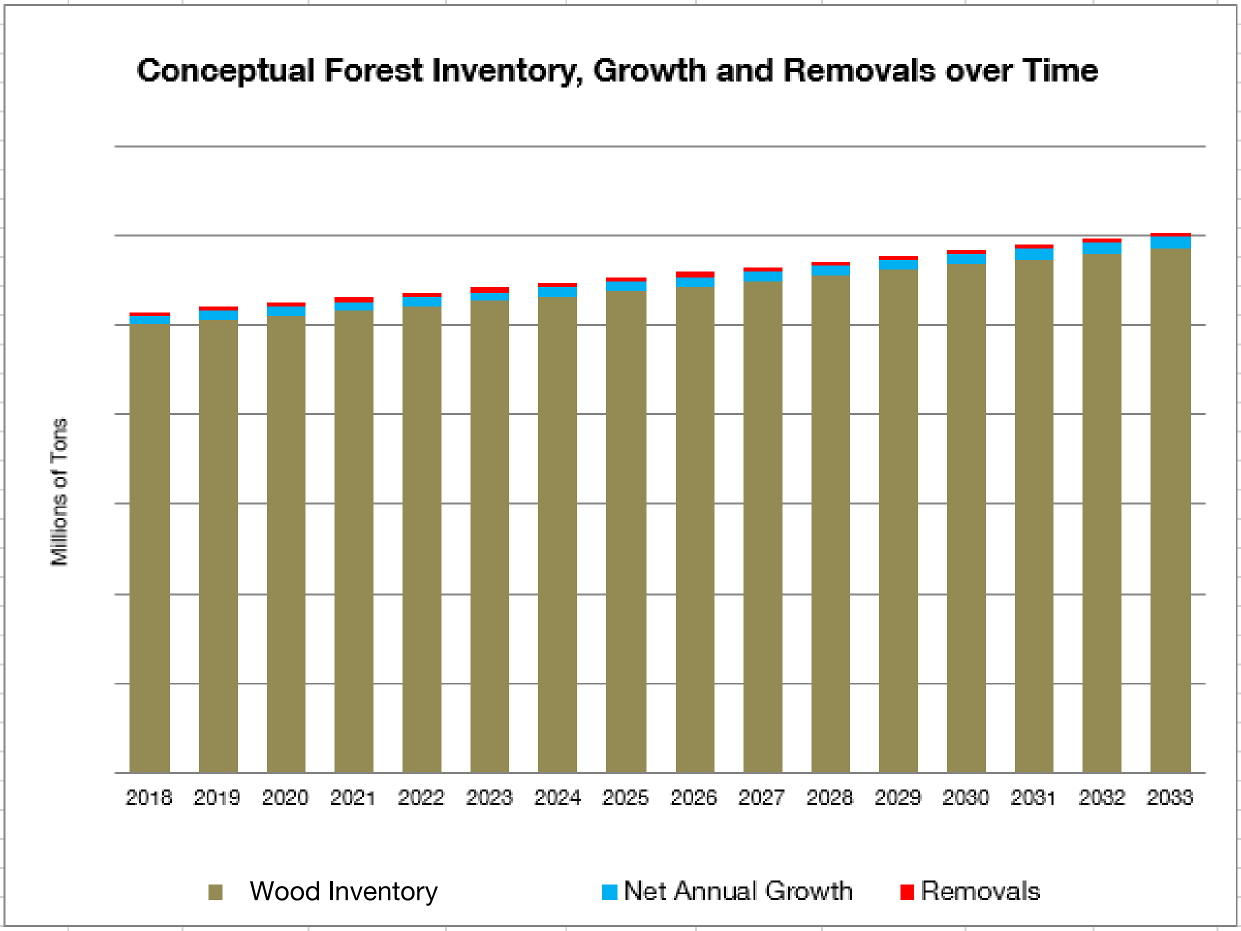
Young trees and stands of trees grow at a fast rate and older trees and stands grow more slowly. It is important to keep in mind that the rates used in this assessment are averaged rates of growth for all the various forest stands sampled and measured by FIA. It is also important to note that the net annual growth rates used in this assessment are averaged rates of ***current*** growth based on the ***current*** forest condition. Should forest conditions (species and age class composition, and stocking levels) change significantly over the landscape, the rates of growth will undoubtedly be affected. Forests are very complex and dynamic and will change significantly over time.

It is also important to note that this assessment is based on the underlying assumption that, over a larger landscape, removals should never exceed the amount of annual growth of new wood. The ratio of growth to removals is a fairly crude metric of sustainability, but on the whole is the best available indicator of sustained-yield capacity. However, if growth continues to exceed

[5] Not all values may add up exactly due to rounding.

removals, the result spread out over the landscape will be older, overstocked forests with greater risk of increased mortality and declining rates of net annual growth.

Figure 2 – Conceptual bar graph depicting a case where harvesting is less than the net annual growth, and inventory increases over time



It is incorrect to assume that as long as removals stay below current growth, the forests will continue to yield a constant amount of wood in perpetuity. In reality, forest inventory, composition and averaged rates of growth will continue to change over time—they do not remain constant.

Table 2 - Estimation of net annual growth of low-grade wood on School Trust Land

Parameter	Value
Tons of low-grade inventory on STL forestland	20,646,000
Rate of net annual growth[6]	4.9%
Net annual growth of low-grade wood on SLT forestland (green tons)	1,008,000

[6] Based on FIA data for State-owned timberland in Minnesota.

Initial estimates suggest there are roughly one million tons of new low-grade wood grown annually on School Trust forestlands.

As part of the on-going active management of STL forests, some low-grade wood is already cut and sold each year to regional markets like pulpmills and biomass power plants. In an effort to estimate how much wood fuel could be sourced, existing demand and harvesting must be accounted for. The last three years of harvest records for timber harvests were examined and are presented in the table below.

Table 3 – Total timber harvest amounts from School Trust Land

Year	Annual Harvest in Green Tons
FY2013 (Sawlogs, Pulpwood, and Biomass)	909,216
FY2014 (Sawlogs, Pulpwood, and Biomass)	935,040
FY2015 (Sawlogs, Pulpwood, and Biomass)	991,440
Three year Average	**945,232**

Timber harvest levels fluctuate from year to year, however over the past three years, there has been an average of 945,232 green tons of low-grade wood harvested annually from STL forestland. Of this, an estimated 624,000 tons can be considered low-grade (pulpwood quality or less). An estimate of 384,147 green tons of additional supply capacity available annually on a sustained yield basis can be reached by subtracting 624,000 from the 1,008,000 tons of annual growth.

In addition to the net annual growth on new low-grade bole wood that could be harvested for wood fuel, there is the opportunity to utilize up to 2/3 of the top and limb wood derived from existing harvesting while still meeting the Minnesota Forest Resource Council's 1/3 residue retention best practice guideline. Factoring top and limb wood portions of trees[7], BERC estimates an additional 45,598 green tons of wood fuel could be utilized annually, for a total of 429,745 green tons.

So, what could be done with 429,745 green tons of woodchips each year? In a cold climate like northeastern Minnesota a typical school of 50,000 square feet would likely burned approximately 300 green tons of woodchips each heating season to displace over 90% of their fossil heating fuel consumption. Consequently, the wood fuel resources utilized from the management of STL forestland, could conceptually heat over 1,400 schools of this size.[8]

Minnesota School Trust Lands could fuel over 1,400 schools with woodchips from surplus low-grade wood from their sustainable forest management activities.

[7] Using FIA data for tree bole to top and limb wood ratios.

[8] While there are only slightly over 2,000 public K-12 schools in Minnesota, school sizes vary widely. On a combined square footage basis, BERC estimates that the amount of wood resources that could be supplied from School Trust Land could meet the annual heat over half of the school space in Minnesota.

Table 4 below explores the potential impacts of a scenario where all 1,400 schools were heated with woodchips instead of fossil fuels.

Table 4 - Conceptual full-buildout impacts if all wood fuel from STL were used to displace natural gas.

Parameter	Result
Annual Fossil Fuel Displacement	35 million CCF of natural gas
Annual Heating Fuel Cost Savings[9]	Over $21 million
30-year Cumulative Heating Fuel Cost Savings[10]	Over $650 million

Over a thirty-year period, woodchip heating could displace over a billion cubic feet of natural gas and save an estimated $650 million in heating fuel costs incurred by public schools in Minnesota.

The positive impacts of a Fuel for Schools program are significant for both the displacement of fossil fuels and the energy cost savings over time. Over a thirty-year period, woodchip heating could displace over a billion CCF of natural gas and save an estimated $650 million in heating fuel costs incurred by public schools in Minnesota.

2.2 Public K-12 Schools

Of course, the impacts presented in Table 4 are hypothetical – a Fuels for Schools program would not be expected to achieve the full buildout levels. For this reason, we conducted further analysis to better determine the real opportunity for a Fuels for Schools program.

BERC examined several sources of information to better quantify and characterize public K-12 schools in Minnesota. BERC reviewed data accessed from the State Department of Education. However, the most detailed available data on public schools regarding the their location, size, and the type of heating fuel used came from a program called the B3 Benchmarking program, administered by the Minnesota Department of Commerce.[11]

2.2.1 Statewide School Characterization

According to the MN Department of Education there are 2,051 public K-12 schools in the State of Minnesota. Minnesota Department of Education data were combined with B3 Benchmarking data to develop state-wide estimates for the location, school building size, and heating fuels used. Table 5 below provides further details.

[9] Based on 2016 prices for natural gas and woodchips in Minnesota
[10] Simplified projection - no price escalation was factored.
[11] https://mn.b3benchmarking.com/

Table 5 - Number of public K-12 schools in Minnesota by size and heating fuel used

School Size (square feet)	Cooled Only	Electric Heat	Fuel Oil	Natural Gas	Propane	Steam/ Hot Water	Other	Grand Total
0-50,000	1	27	13	454	7	3	39	545
50,000-100,000	-	10	11	719	6	6	-	752
100,000-200,000	-	7	10	470	1	3	-	492
200,000+	1	1	1	256	1	1	-	263
Grand Total	3	46	36	1,899	16	13	39	2,051
Percent of Total	**0%**	**2%**	**2%**	**93%**	**1%**	**1%**	**2%**	**100%**

Of the 2,051 public K-12 schools in Minnesota, 93% are currently heated with pipeline natural gas and roughly 3-4% of the schools heat using delivered fuels like fuel oil and propane. School building sizes range widely across the state but the state wide average is 105,000 square feet.

SECTION 3 – PROGRAM GOALS

3.1 Goals and Objectives

Establishing the program's overall goals will help guide our further program design work. Based on our discussions with School Trust Land personnel and from the input gathered at the stakeholder meeting and the one-on-one interviews, we propose the following three simple goals that define the purpose of the Fuel for Schools program:

Goal 1 - Provide a new revenue stream to the Permanent School Fund by stimulating new, local, stable markets for underutilized low-grade wood from School Trust Lands.

- Target public schools needing new heating systems for conversion to woodchip boilers and incentivize conversions through Permanent School Fund investments.
- Promote the collaboration between public schools and Minnesota loggers for the harvest and utilization of low-grade wood offered on School Trust timber sales.

Goal 2 - Improve composition and health of School Trust forest resources by converting low-grade species to long-lived species in order to secure long-term revenue.

- Use wood fuel removals as a means to achieve forest management objectives not otherwise viable (i.e. creating more early successional cover from otherwise non-merchantable stands).
- Harvest wood fuels as a means to increase future timber value through the use of pre-commercial thinning operations.

Goal 3 - Enable greater financial independence for public K-12 schools in Minnesota by lowering and stabilizing their energy costs.

- Use carbon-friendly woodchip heating as a means to lower and stabilize local school energy costs.
- Use woodchip heating as a means to keep the flow of energy dollars in the local and regional economy.
- Enable reinvestment of energy cost savings from schools into investments such as educational supplies, teacher salaries, and designing and modeling school curricula.

PROGRAM GUIDING PRINCIPLES

1. **Use wood as locally as possible.** Sourced from within 50 miles of where it was harvested.
2. **Source all wood fuel from excellent forest management.** Meeting all best management practices.
3. **Use wood fuel in clean burning, high-efficiency heating systems.** Minimum 78% efficiency and less than 0.05 lbs./MMBtu of particulate emissions.
4. **Use wood to directly replace imported fossil fuels.** Such as oil, propane, and natural gas.

SECTION 4 – PROGRAM DESIGN

The following section lays out the conceptual framework of a Fuels for Schools program that aims to be focused, start small, build upon early successes, and keep the structure simple.

4.1 Geographic Focus

Minnesota is a large state and for a Fuels for Schools program to be successful, it needs to be focused on regions where there is the convergence of three critical factors:

- local forests and harvesting infrastructure
- longer, colder winters
- less natural gas service territory

The northern half of Minnesota is more forested than the southern half. In order to keep the use of wood fuels as local as possible and avoid trucking woodchips long distances, designing the Minnesota Fuels for Schools program to focus on the heavily forested region in the northeast portion of the state is recommended. More specifically, the program aims to link wood harvested from School Trust Lands and a very large majority of School Trust Land holdings are located within five primary counties:

1. Cook
2. Lake
3. Saint Louis
4. Itasca
5. Koochiching

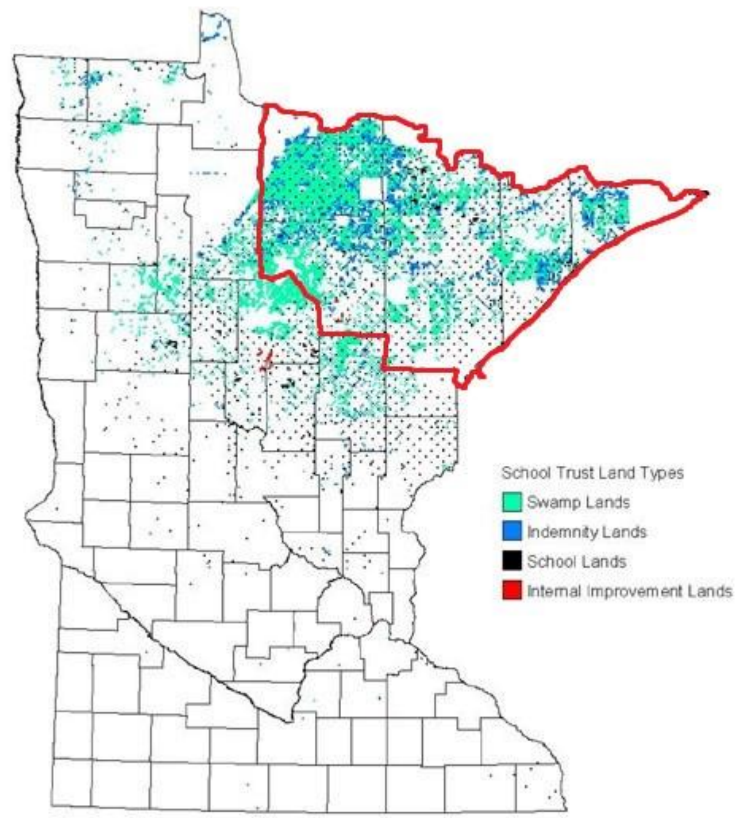


Figure 3 - Map of state lands with target 5-county boundary marked in red

4.2 Fuel Focus

There are three main categories of wood fuels that are widely used for commercial/institutional heating – cordwood, pellets, and woodchips. The Minnesota Fuels for Schools program should focus on woodchips as the primary fuel option.[12]

When the varying energy density, units of measurement, and combustion efficiencies for each heating fuel are factored and presented in an "apples to apples" framework of a cost per million British Thermal Units (Btu) for delivered thermal energy (after combustion), heating oil and

[12] Cordwood requires manual feeding. Wood pellets are not currently locally produced in Northeastern Minnesota. Woodchips can be automatically fed and can be locally produced from School Trust Land forest holdings.

propane are the most expensive heating fuels. While natural gas is less expensive than oil or propane, all three fossil fuels are more expensive than woodchips (as shown in Figure 4 below).

Figure 4 - Comparison of equivalent heating fuel prices on a $ per million Btu basis

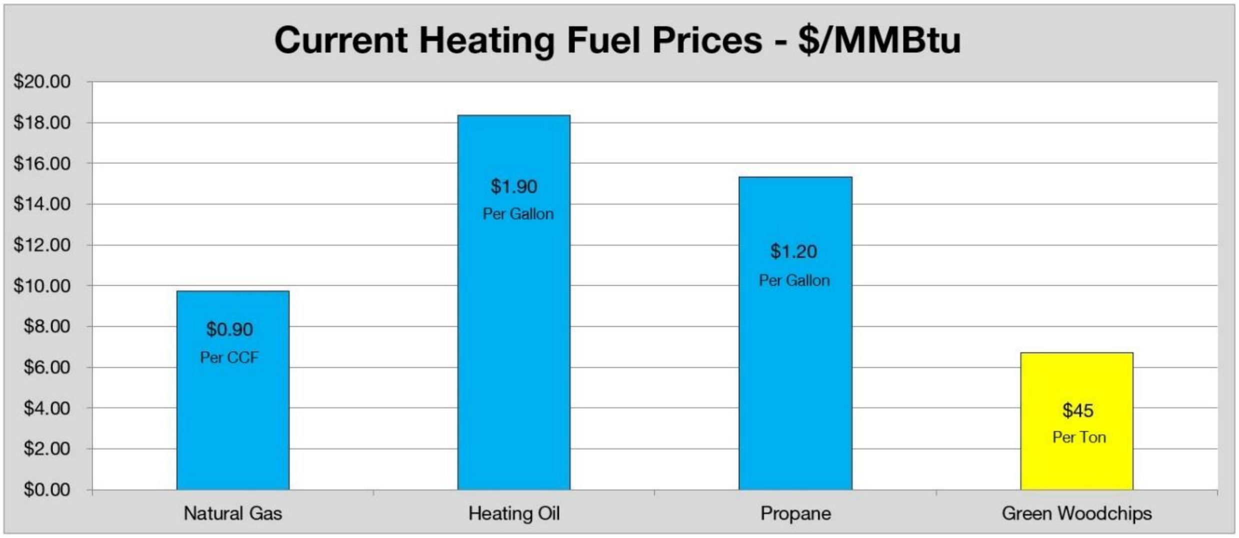


Figure 4 above illustrates the comparative heating fuel values of natural gas at $0.90 per hundred cubic foot (CCF), heating oil at $1.90 per gallon, propane at $1.20 per gallon, and woodchips at $45 per ton.[13] Woodchips provide 62% savings over heating oil, 55% savings over propane, and 29% savings over natural gas, on a per MMBtu basis.

Due to the larger price differential between woodchips and heating oil and propane, many programs intentionally target facilities heated with oil and propane. To better assess the fuel focus of the Minnesota Fuels for Schools program, BERC used the B3 Benchmarking data and filtered the database to quantify and characterize public K-12 schools located within the 5-county target area for the Minnesota Fuels for Schools program (Table 6).

Table 6 - Estimated number of public K-12 schools in the 5-county area by size and heating fuel type

	Electric	Fuel Oil	Natural Gas	Steam/Hot Water	Unconditioned	Grand Total
0-50,000	6	-	49	-	7	62
50-100,000	1	3	30	1	-	36
100,000-200,000	-	-	22	1	-	23
200,000+	-	-	10	1	-	11
Grand Total	**7**	**3**	**111**	**4**	**7**	**132**
Percent of Total	5%	2%	84%	3%	5%	100%

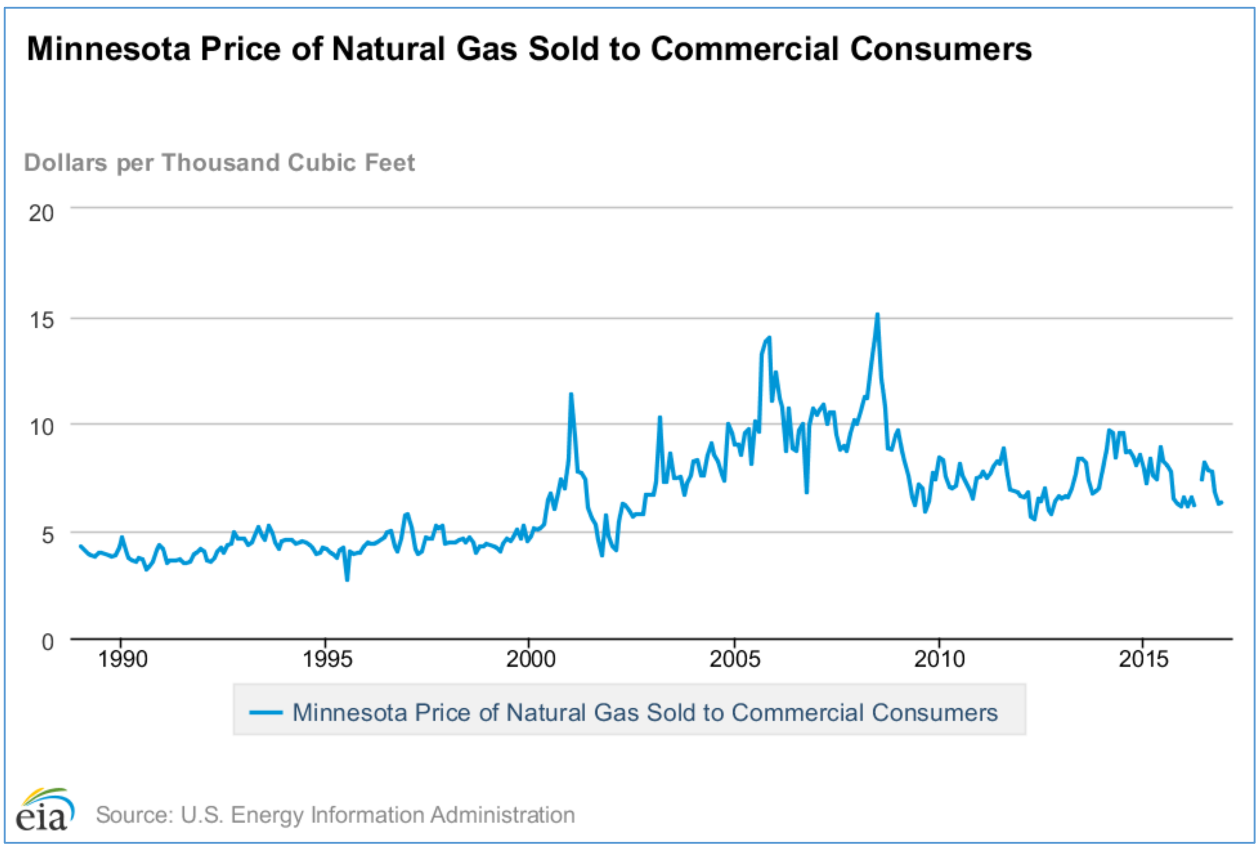
[13] Based on EIA data for natural gas, heating oil, and propane prices for commercial market in Minnesota in 2017 and telephone interviews of woodchip heated facilities in MN. Note that $45 per green ton is the price paid to the logging/chipping contractor by the facility and includes the minimal stumpage prices (approximately $1 per ton) paid by the logger to STL. The price difference between the stumpage fee paid and price of delivered woodchips reflects the costs incurred by loggers to cut, extract, process, and transport the woodchips.

In many regions of the US, heavily forested rural areas often have limited natural gas pipeline service and rely heavily on electric, propane, and heating oil. However, several larger communities in northeastern Minnesota have natural gas pipeline service. Based on B3 data for the target region, BERC estimates there are a total of 132 schools in the five-county area and over 84% of these schools are heated with natural gas. The remainder of the schools in the target area are heated with electric, heating oil, and propane. Although there is a surprisingly high percentage of schools heating with natural gas in this five-county area, the percent of natural gas heating is less than the statewide average of 93%.

Due to the high concentration of natural gas heating in schools in northeastern Minnesota, the Fuels for Schools program could initially focus on the schools heated with oil and propane but would need to also target schools heating with natural gas.

While the project economics for installing woodchip systems at natural gas heated schools take longer to achieve a return on the investment, it is important to keep in mind that natural gas prices have been historically volatile and may rise again in the near future. Figure 5 below illustrates the price volatility of natural gas in Minnesota from the late Eighties to 2016.

Figure 5 – Commercial natural gas price history in Minnesota



As illustrated in the graph above, natural gas prices spiked dramatically in 2001, 2006, and again in 2008. From 2009 to 2016 prices have fluctuated between $6 and $9 per thousand cubic feet of gas. Given the historic price trends, it is reasonable to expect natural gas prices to continue to fluctuate widely and possibly increase to a price point where there are strong enough annual heating fuel savings to drive a favorable return on investment for a woodchip heating system.

4.3 Typical Woodchip Heating Project Economics

It is helpful to understand the typical economics for a typical facility installing a woodchip heating system when considering a program aimed at supporting schools to take action. BERC reviewed the Minnesota school data and developed two representative scenarios that characterize the schools in the region.

The two scenarios to represent a typical school targeted by such a program were:

- Scenario 1 - A single 50,000 square foot school burning 20,000 gallons of heating oil[14]
- Scenario 2 - A single 100,000 square foot school burning 60,000 CCF of natural gas[15]

Many factors feed into the economic performance of a woodchip heating system and whether it would provide economic benefits for a facility to switch from fossil fuels to wood heat. Capital costs, fuel costs, operation and maintenance, as well as financing mechanisms are all important factors.

As a general rule, modern woodchip heating systems are most cost-effective when:

- Space-heating fossil fuel prices are relatively high,
- Energy consumption is relatively large,
- They are an alternative to installing another new system, rather than a replacement for a system currently in use, and
- The facility has a hydronic (hot water) heat distribution system already in place.

In a very simple analysis, the fuel cost savings over the life of the boiler can be subtracted from a rough estimate of the wood system capital costs and compared to a business-as-usual situation. A forecasted rate of escalation in fuel heating prices is factored in for each fuel. That rate can be different for different fuels to reflect historical trends. If a project is financed, the costs of debt service are included over the timeframe of the loan. If a 30-year analysis timeframe is used (i.e. the life of the boiler) and the project is financed over 15 or 20 years, there is usually a clear stepwise drop in costs when the loan is fully repaid.

Life-cycle cost (LCC) analysis accounts for future changes in fuel costs of the woodchip fuel and the competing fossil heating fuels. It also considers the cost of financing the project; looks at differences in maintenance, repair, and replacement costs of the competing options; and takes into account the present value of a future dollar amount. BERC performed 30-year LCC analysis for the two scenarios to characterize the typical project performance that could be expected.

Full details on the analysis and key assumptions used can be found in Appendix B of this report.

[14] Assumes 60,000 Btu per square foot annually
[15] Assumes 60,000 Btu per square foot annually

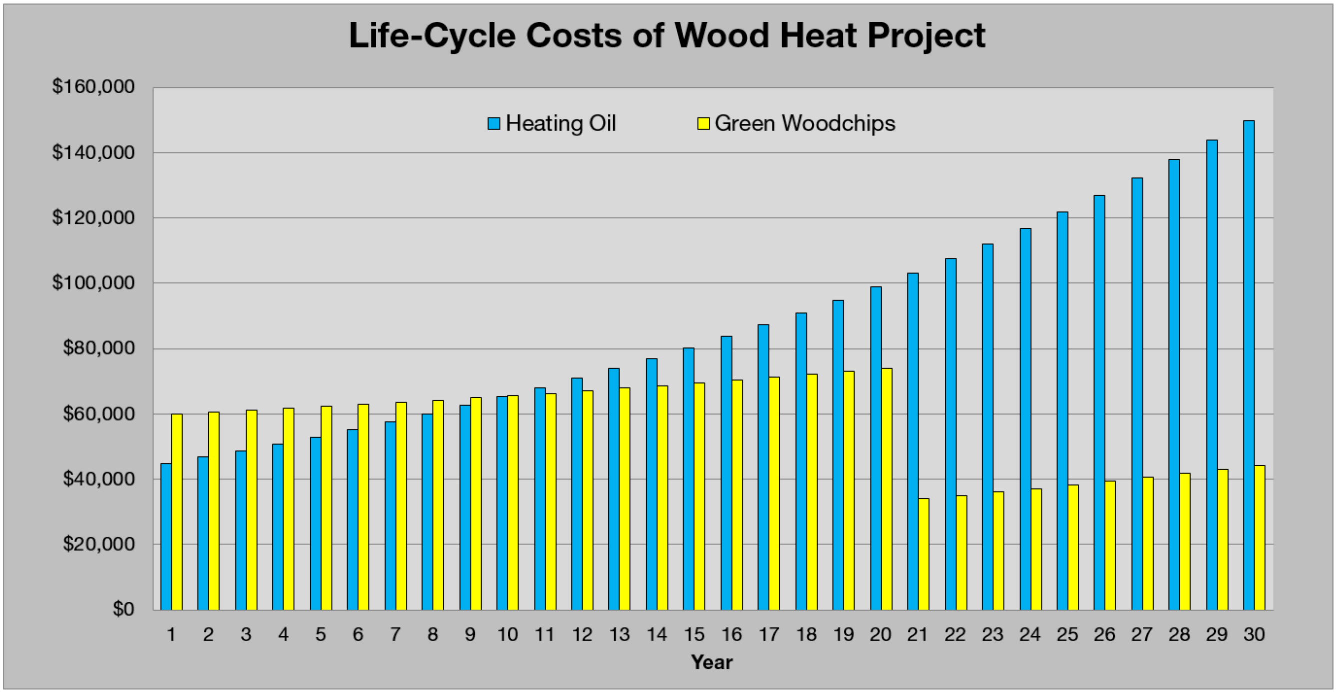
Table 7 – Typical woodchip heating project life-cycle cost analysis results

Economic Performance Indicator	Oil Scenario	Natural Gas Scenario
First year fuel savings	$29,013	$31,566
Simple payback (years)	19	23
Annual debt service	$40,934	$54,482
30YR NPV fossil fuel heating	$1,290,000	$1,875,000
30YR NPV woodchips heating	$1,002,765	$1,640,644
30YR NPV of savings	$287,235	$234,356

Both scenarios yield moderately favorable financial performance with healthy annual fuel savings but fairly lengthy simple payback periods. One important financial performance indicator that provides a more holistic view on project financial viability is the 30-year net present value (NPV) of savings between the options of continuing to heat with fossil fuels and switching to using woodchips. This metric presents the savings that would occur over the 30-year period in today's dollar value. Both the heating oil and natural gas scenarios produced positive 30-year NPV of savings.

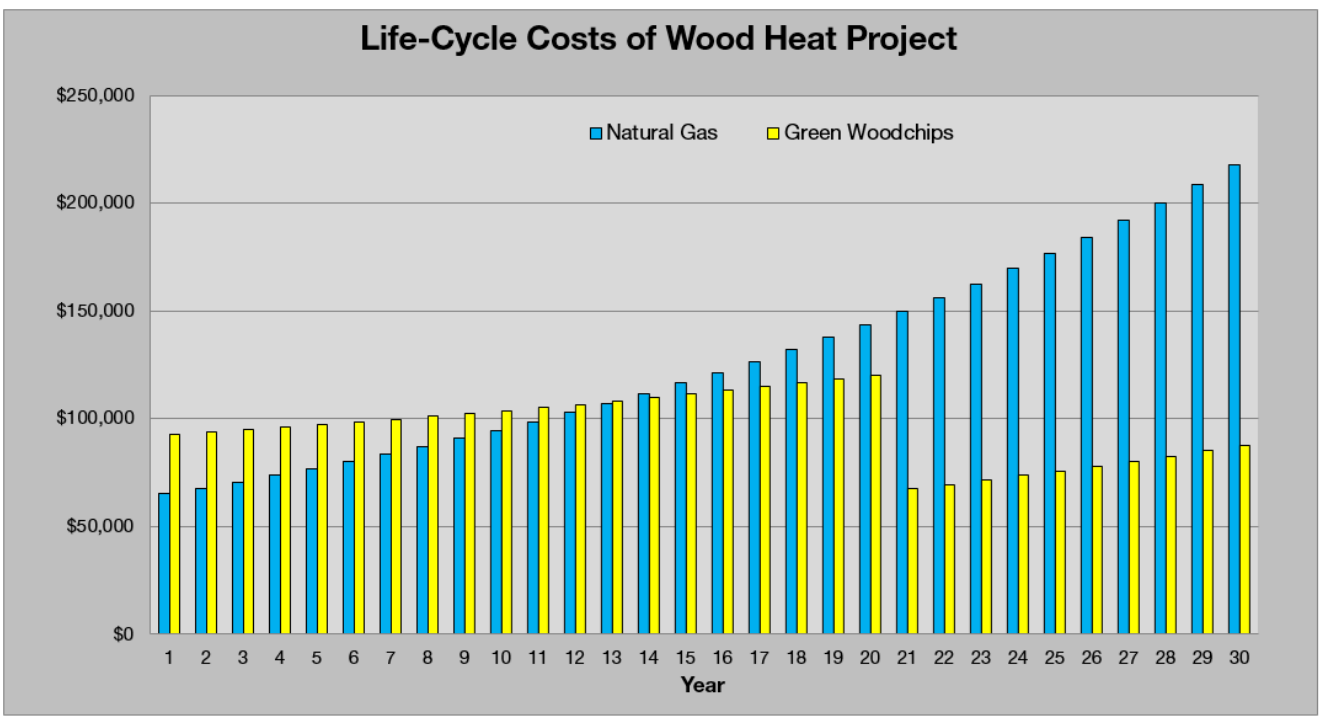
Positive NPV of savings are essential, but another important indicator is the annual cash flow comparison. Figures 6 and 7 present the annual combined costs (fuel, operation and maintenance, and debt service) of the woodchip heating project (yellow bars) against the annual costs of the business as usual option of continued heating with fossil fuels (blue bars).

Figure 6 - Annual cash flow graph for heating oil scenario



The oil heat scenario is cash flow negative for 9 years before turning positive.

Figure 7- Annual cash flow graph for natural gas scenario



The natural gas scenario yields negative cash flow for the first 12 years before turning positive.

4.3.1 Sensitivity Analysis

There are many different financial performance indicators (simple payback, internal rate of return, etc.), but a key threshold is whether a project is cash flow positive in the first year. Projects that generate savings (when all the costs including debt services are factored) in the first year have a much higher likelihood of getting installed. BERC performed simple sensitivity analysis to see what it would take to get either scenarios to become cash flow positive in year one (Table).

Table 8: Conditions required for a positive cash flow in year 1

	Oil Scenario	Natural Gas Scenario
Fossil fuel price in year 1	$3.15 per gallon	$1.75 per CCF
Percent of capital cost subsidy	55%	65%

Either an increase in heating fuel prices (where level of subsidy remains the same) or an increase in the level of subsidy (where the fossil fuel price remains the same) would result in a positive cash flow in the first year.

4.3.2 Project-level Carbon Emission Reductions

In addition to the economic performance indicators discussed in detail above, it is important to consider the considerable long-term carbon emission mitigation benefits that woodchip heating can provide. By displacing fossil fuels used for heating and using locally sourced wood fuel from well-managed forests, schools can dramatically shrink their carbon footprint. Table 9 below illustrates the carbon emission reductions for the two project scenarios assessed.

Table 9: Carbon emission reduction under the oil and natural gas scenarios

Carbon reduction	Oil Scenario	Natural Gas Scenario
Annual reduction (pounds)	340,256	100,589
10 year reduction (tons)	1,701	503
20 year reduction (tons)	3,403	1,006
30 year reduction (tons)	5,104	1,509

Over thirty years, a single school can have a big impact and provide positive examples for proactive approaches to addressing climate change.

4.4 Program Offerings

A successful Minnesota Fuels for Schools Program will offer a combination of key resources needed to convince public K-12 schools in the target region to install woodchip heating systems and also overcoming the inherent challenges of establishing a reliable fuel supply chain and building market and public awareness and support for woodchip heating.

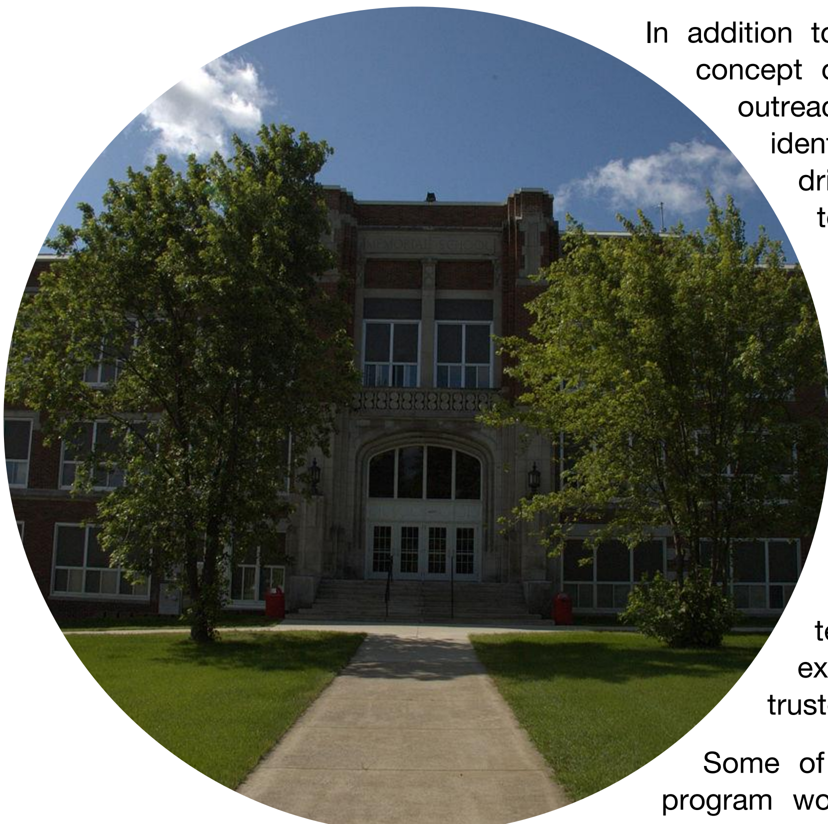
- **Education and Outreach**

Many public school administrators, school board members, and maintenance staff are completely unaware of modern woodchip heating technology and the many benefits it can provide. If people are aware of the technology, they frequently hold many misconceptions that are often influenced by their exposure to old and antiquated systems or by their impressions based on outdoor wood boilers.

For this reason the Minnesota Fuels for Schools program should develop educational activities aimed at informing key decision makers like school and school district administrators, school board members, and maintenance staff. Additional activities and engagement could help establish the participation of prospective fuel suppliers and overcome concerns they may have.

Activities could include:

- Workshops
- Tours of existing systems
- Presentations at annual meetings and webinars delivered to various school associations
- Development and distribution of user guidebooks and other written materials
- Electronic media including website, email newsletters, and social media



In addition to building awareness and support for the concept of modern wood heat, the education and outreach activities should be offered in a way that identifies and cultivates local champions to help drive these projects forward. This may be a town energy committee member, a school science teacher, a local forester, or the head of maintenance for a school district.

- **Technical Assistance**

It is critical to provide continuous support to get good projects to move forward. Most schools do not have the in-house human resources to identify good projects, figure out the details, and drive the projects forward. Many schools will have a need for technical assistance, project management experience, and good communication from a trusted advisor.

Some of the activities that the Fuels for Schools program would need to undertake to move projects forward include:

1. Develop a database of all potential candidates for wood heat
2. Filter the database to identify best candidates
3. Offer desk-top prescreening to identify most cost-effective switches
4. Offer feasibility studies
5. Provide project advisory services

- **Project Incentives and Financing**

One of the greatest challenges impeding the installation of woodchip systems is the high capital costs. There are three primary approaches to overcoming this challenge – subsidizing the capital costs in some form, providing more favorable financing instruments, and subsidizing the annual financial performance of operating systems. The following provides an overview of the existing resources that could be used to support financing woodchip heating projects developed under the Minnesota Fuels for Schools program:

1. **Possible sources of subsidies toward project capital costs:**
    - BTU Act that gives wood heating equipment federal tax incentives similar to wind and solar[16]. While public schools could not directly make use of this incentive, there are opportunities for private entities to pass along value to public institutions.
    - Competitive federal grants through USFS[17] and USDA Rural Development[18]
    - Economic development grants through the Department of Iron Range Resources and Rehabilitation.[19]
2. **Financial instruments that provide borrower lower interest, longer term fixed rate financing**:
    - General obligation bonds – require voter approval
    - Alternative facilities bonding (for qualifying school districts)
    - Energy investment loans[20]
    - Debt service equalization
    - Explore the opportunity to develop a new financing instrument for school construction/renovation projects using the Permanent School Fund. While this would require legislative action, there are good examples of other states like Wisconsin where their School Trust Land programs provides financing to school districts from their fund.[21]
3. **Possible sources of subsidy toward the annual financial performance**.
    - In 2016, the Minnesota Legislature passed the Biomass Thermal Production Incentive that provides an annual payment of $5.00 per MMBtu of thermal energy for qualifying new facilities.[22]

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16 https://www.congress.gov/bill/114th-congress/senate-bill/727
17 https://www.fs.fed.us/science-technology/energy-forest-products/wood-innovations-grants
18 https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency
19 https://mn.gov/irrrb/
20 "School districts may apply under M.S. 216C.37 for low interest loans to finance energy improvements such as roof insulation, window retrofits, lighting modifications, energy management systems, HVAC modifications, and conversions to alternative fuels. School districts are eligible for up to $1.5 million in loans, and loan payback terms must be ten years or less. Loan funds are procured from the State and/or the Petroleum Violation Escrow (Exxon) fund. Energy efficiency projects that develop energy conservation measures through contracting with qualified providers are discussed in M.S. 123B.65" - http://education.state.mn.us/MDE/dse/schfin/fac/cons/
21 http://bcpl.wisconsin.gov/section.asp?linkid=1438&locid=145
22 https://www.revisor.mn.gov/statutes/?id=41A.18&format=pdf

4.5 Program Impacts

What are the achievable benefits the Minnesota Fuels for Schools program could generate? All benefits and metrics stem from the simple and tangible act of converting a facility's heating system to woodchips. With each conversion to wood heat, things like tons of wood chips used, gallons of fossil fuel displaced, pounds of carbon dioxide emissions avoided, acres of forestland managed can all be measured as metrics of program success.

Twenty schools heating with woodchips would invest over $17 million into the local economy over 30 years in heating fuel expenditure alone.

Although there is enough surplus wood resource from STL forestland to heat over half of all schools in Minnesota, a realistic target for a Fuels for Schools program focused on the 5-county region of northeastern Minnesota could convert 20-25 schools. Table 10 presents the achievable impacts that the program could deliver at several milestones of number of schools converted.

Table 10 - Estimated impacts of a Fuels for Schools program

Number of typical sized schools	Total project capital costs (million)	Annual tons of wood fuel used	Additional annual stumpage revenue for STL[23]	Annual heating $ invested in local economy	Annual displacement of natural gas (CCF)	Annual heating cost savings to schools	Annual tons of carbon emission reductions
5 schools	$3.75	3,200	$3,200	$144,000	125,000	$157,000	250
10 schools	$7.5	6,400	$6,400	$288,000	250,000	$315,000	500
15 schools	$11.25	9,600	$9,600	$432,000	375,000	$472,500	750
20 schools	$15.0	12,800	$12,800	$576,000	500,000	$630,000	1,000

While the annual impacts may appear modest, project these annual numbers out over a 30-year period to see the more impressive long-term impacts of such a program. For example, 20 schools heating with woodchips would invest over $17 million in the local economy over thirty years in heating fuel expenditures alone.

In addition to the easy to quantify impacts estimated above, it is important to consider the many potential benefits that are more difficult to quantify. Investing in rural communities yields many benefits. Investing in schools and creating new learning opportunities for our children about renewable energy, forestry, and local energy independence is very important to the long-term economic viability and sustainability of these rural regions.

[23] Assumes $1.00 per ton paid for fuel wood stumpage.

4.6 Program Partners

Programs are only as strong and effective as the partnerships that hold them together. Having the right players is essential, but at the same time different agencies will have different priorities and levels of funding to bring to the table. Below is a short list of possible Minnesota Fuels for Schools program partners. Specifics roles and relationships would need to be determined at a later time, should a program be launched.

- Minnesota Office of School Trust Lands
- Minnesota Department of Natural Resources
- Minnesota Department of Education
- Minnesota Department of Commerce
    - Energy Office
- Minnesota Department of Health
    - Air Quality Division
- Minnesota School Boards Association
- Local partners

SECTION 5 - CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

A Fuels for Schools program could prove advantageous to School Trust Lands and school districts in the northeastern region of the state. Rural communities and schools in Minnesota are struggling and need innovative approaches to the challenges they face. Lowering energy costs, retaining local wealth, and supporting local jobs in the forest products industry are vital, and woodchip heating is a single activity that yields measureable results for each of these. There is an ample supply of wood fuel that could be sustainably sourced from STL holdings and creating new markets for low-grade wood in this region is crucial for practicing good forest management. While there would be a small amount of additional stumpage revenue generated from this program from School Trust Land, the primary benefits would be helping lower and stabilize the energy costs for schools. Such a program could also create an opportunity for School Trust Lands to make mission-aligned lending for school energy infrastructure that could help diversify the Permanent Fund's investment portfolio. There are several State agencies partners with aligned interests in such a program and program partnerships could present win-win opportunities.

Even though low fossil fuel prices currently present a hurdle, prices are likely to rise in the future and improve the attractiveness of woodchip heating. Now is the time to launch a Fuels for Schools program.

5.2 Recommendations

The following section provides basic bullet point recommendations across several topic areas that reflect both our recommendations and the input from the stakeholders engaged at the outset of this initiative. These recommendations also strive to address many of the inherent hurdles that face the successful launch of such a program first mentioned in Section 1.1.

Program Targets

- The Minnesota Fuels for Schools Program should aim to convert 20% of the public K-12 schools in Cook Lake, Saint Louis, Itasca, and Koochiching Counties by 2030. (This equates to approximately 26 schools.)

Fuel Supply

- For woodchip fuel sourcing, tree species without solid existing markets should be targeted. For example, aspen already has a strong market in northeastern Minnesota. The intent is not to complete with pulpwood market.
    - Tamarack and balsam fir are two example species without solid markets. Note that some drying may be needed of softwood woodchips to achieve desired moisture content for use as heating fuel.
    - Make sure to engage loggers and ensure this program creates realistic opportunities for them.
        - Supplying woodchips to schools needs to be a profitable endeavor.

        - Winter is already the busiest time for loggers – they don't need more work in winter. Solution is to stock-pile roundwood over summer.
- Minnesota Office of School Trust Lands also has approximately 1 million acres of "under-productive" lands. Consider strategies to also utilize these lands to make them productive and improve wildlife habitat as a win-win.
- Reports indicate that Minnesota is experiencing declines in the acres of aspen stands over past decade due to transitioning early successional forest cover to secondary forest conditions. Consider ways in which the Fuels for Schools program could be used as a strategy to reverse (or slow) this trend.
- Need to pose the question of what happens in the future if one or more pulpmills close. Pulpmills dominate the landscape until they are closed.

Program Design and Outreach

- When designing the program be sure to engage the communities (including teachers and students), forest managers and industry – several stakeholders suggested following the model of the engagement process used to develop the Minnesota harvest guidelines.
- Messaging focus should be on the reason for and benefits of such a program and directly address the "what's in it for me" issue.
- Many state agencies and economic development programs are really focused on jobs – such a program needs to also message the benefits of stopping the export flow of dollars spent on imported fossil fuels.
- Message that "communities support schools and now schools can support communities" by buying heating fuel locally.

Program Design and Delivery

- Consider developing clusters of installed woodchip systems to help achieve necessary critical mass of fuel demand to entice fuel suppliers.
- Initial focus of the program's targeting of schools should be on those that will need to replace boilers in next few years.
    - New school construction also presents a low-hanging fruit opportunity.
- Design program financial assistance offerings to get "skin in the game" from schools.
- Need to ID and cultivate local champions to advocate for projects – not state personnel or consultants. Teachers and students as part of a science curriculum?
- Adopt program requirements or dangle carrots for minimum efficiency and emissions limits for the useable heating systems and local fuel sourcing.
    - Or perhaps a tiered approach offer more assistance to the projects using the best technology, or sliding scale incentives for schools in more impoverished districts
    - Adopt program requirements for ensuring local sourcing of fuel from well-managed forests.

Financing

- Leverage as much from existing financial resources.

- Identify any gaps in the existing financial resources and consider strategies for how best to fill funding/financing gaps.
    - If additional financing instruments are needed evaluate the opportunity to use Permanent Fund to provide project financing (using Wisconsin School trust Lands program as possible model).
    - In addition to direct financing projects, explore further the model of Heat Supply Contracting where an entity such as School Trust Lands develops, owns, and operates the heating systems installed at the target schools and simply sells metered hot water to the local school under 15 – 20 year heat supply contracts.

APPENDICES

Appendix A – List of Stakeholders

Don Arnosti, Izaak Walton League

Kristen Bergstrand, Minnesota Department of Natural Resources (Division of Forestry)

Brian Bluhm, Minnesota Clean Energy Resource Team

Wayne Brandt, Minnesota Forest Industries/ Minnesota Timber Producers Association

Denise Dittrich, Minnesota School Boards Association

Jim Green, Duluth Energy Systems

Jeff Guillemette, Ever-Green Energy

Lisa Herschberger, Minnesota Pollution Control Agency

Calder Hibbard, Minnesota Forest Resources Council

Lisa Hughes, Minnesota Department of Employment and Economic Development

Brendan Jordan, Great Plains Institute

Bart Johnson, Itasca Community College

Dan Jordan, Minnesota Department of Iron Range Resources and Rehabilitation

Mike Kilgore, University of Minnesota Department of Forest Resources

Mark Lindquist, Minnesota Department of Natural Resources

Jim Manolis, The Nature Conservancy

Kathleen Preece, Minnesota Forest Resources Partnership

Eric Singsaas, Natural Resources Research Institute

Doug Tillma, Minnesota Department of Natural Resources (Division of Forestry)

Bob Tomlinson, Wildlife Management Institute

Appendix B – Detailed Economic Analysis of Typical Projects

It is helpful to understand the typical economics for a typical facility installing a woodchip heating system when considering a program aimed at supporting schools to take action. BERC reviewed the Minnesota school data and developed two representative scenarios that characterize the schools in the region.

The two scenarios to represent a typical school targeted by such a program were:

- Scenario 1 - A single 50,000 square foot school burning 20,000 gallons of heating oil[24]
- Scenario 2 - A single 100,000 square foot school burning 60,000 CCF of natural gas[25]

Many factors feed into the economic performance of a woodchip heating system and whether it would provide economic benefits for a facility to switch from fossil fuels to wood heat. Capital costs, fuel costs, operation and maintenance, as well as financing mechanisms are all important factors.

As a general rule, modern woodchip heating systems are most cost-effective when:

- Space-heating fossil fuel prices are relatively high,
- Energy consumption is relatively large,
- They are an alternative to installing another new system, rather than a replacement for a system currently in use, and
- The facility has a hydronic (hot water) heat distribution system already in place.

In a very simple analysis, the fuel cost savings over the life of the boiler can be subtracted from a rough estimate of the wood system capital costs and compared to a business-as-usual situation. A forecasted rate of escalation in fuel heating prices is factored in for each fuel. That rate can be different for different fuels to reflect historical trends. If a project is financed, the costs of debt service are included over the timeframe of the loan. If a 30-year analysis timeframe is used (i.e. the life of the boiler) and the project is financed over 15 or 20 years, there is usually a clear stepwise drop in costs when the loan is fully repaid.

Project Capital Costs

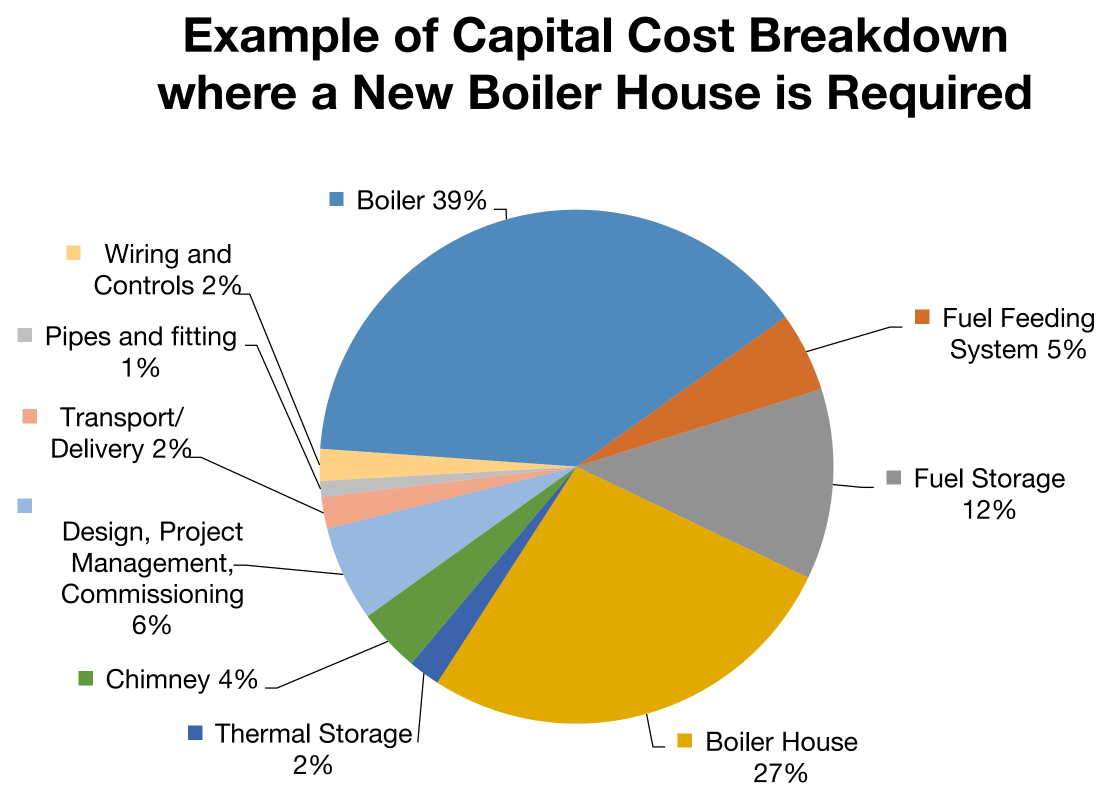
Typical capital costs for woodchip systems can often range from $80 to $450 per MBH (one thousand Btu/h) of boiler peak capacity. The smallest, simplest woodchip systems rarely cost less than $200,000 (including building construction); the total cost of an institutional-size systems is usually $250,000 to $750,000, and in the largest installations considered here, a complete wood heating system may cost several million dollars, depending on what infrastructure needs to be built. Capital costs are highly dependent on system configuration, how much additional piping is needed to connect buildings, fuel receiving and storage options, and how much heating system upgrades are needed to interface the new woodchip boiler with the existing heat distribution networks.

Capital costs can be broken down into the categories listed in Figure 6 below; however, the actual proportion of each component will be highly project-dependent. In particular, the need for

[24] Assumes 60,000 Btu per square foot annually
[25] Assumes 60,000 Btu per square foot annually

a new building housing the boiler or fuel storage, the size and design of a new boiler house, as well as how much new piping is needed are key variables in determining the total capital costs:

Figure 8 - Typical woodchip heating project capital costs



Life-cycle Cost Analysis

Life-cycle cost (LCC) analysis accounts for future changes in fuel costs of the woodchip fuel and the competing fossil heating fuels. It also considers the cost of financing the project; looks at differences in maintenance, repair, and replacement costs of the competing options; and takes into account the present value of a future dollar amount. BERC performed 30-year LCC analysis for the two scenarios to characterize the project performance that could be expected.

Key assumptions used in LCC analysis

Parameter	Oil Scenario	Natural Gas Scenario
Annual consumption of fossil heating fuel	20,000 gallons	60,000 CCF
Year 1 price of fossil heating fuel[26]	$2.15	$1.25
Annual price escalation rate for fossil heating fuels over general inflation	1.50%	1.50%
Percent of annual heat covered by woodchip system	95%	95%
Annual amount of woodchips required (green tons)	294	656
Year 1 price of woodchips (per green ton)	$45	$45
Woodchips price escalation rate (includes general inflation)	2.75%	2.75%
System capital costs	$750,000	$1,000,000
Percent of capital cost covered by grant	25%	25%
Percent of project cost financed	75%	75%
Term of financing (years)	20	20
Interest rate	4.00%	4.00%

At today's heating fuels costs and assuming 25% subsidy, the table below provides the economic performance of each project scenario.

Life-cycle cost analysis results

Economic Performance Indicator	Oil Scenario	Natural Gas Scenario
First year fuel savings	$29,013	$31,566
Simple payback (years)	19	23
Annual debt service	$40,934	$54,482
30YR NPV fossil fuel heating	$1,290,000	$1,875,000
30YR NPV woodchips heating	$1,002,765	$1,640,644
30YR NPV of savings	$287,235	$234,356

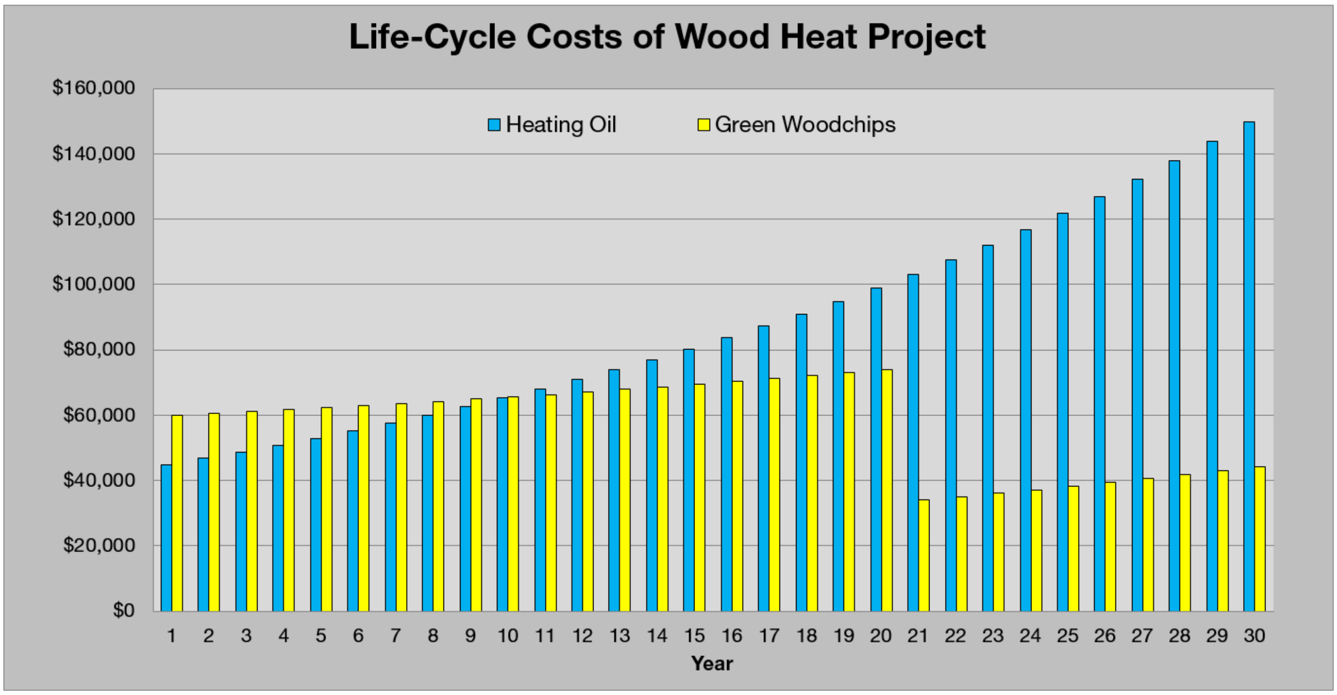
Both scenarios yield moderately favorable financial performance with healthy annual fuel savings but fairly lengthy simple payback periods. One important financial performance indicator that provides a more holistic view on project financial viability is the 30-year net present value (NPV) of savings between the options of continuing to heat with fossil fuels and switching to using woodchips. This metric presents the savings that would occur over the 30-year period in today's

[26] Reflects 3-year average prices

dollar value. Both the heating oil and natural gas scenarios produced positive 30-year NPV of savings.

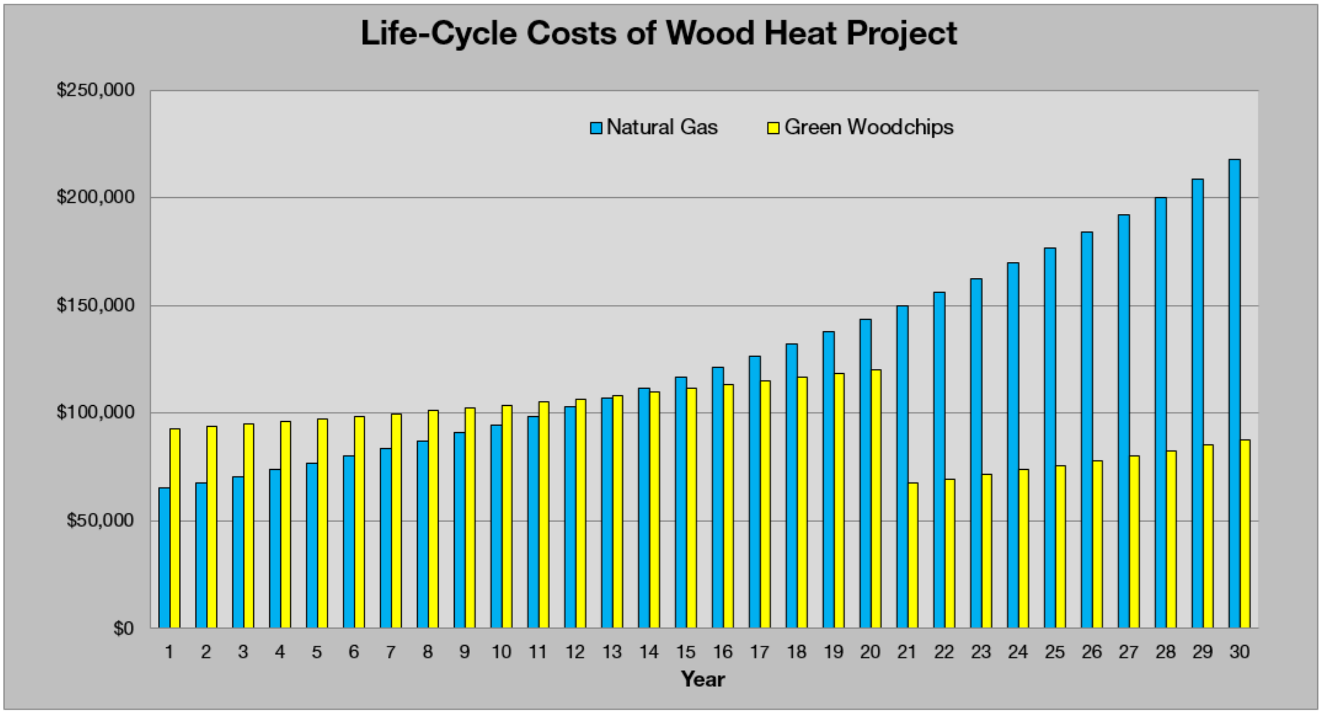
Positive NPV of savings are essential, but another important indicator is the annual cash flow comparison. Figures 5 and 6 present the annual combined costs (fuel, operation and maintenance, and debt service) of the woodchip heating project (yellow bars) against the annual costs of the business as usual option of continued heating with fossil fuels (blue bars).

Annual cash flow graph for heating oil scenario



The oil heat scenario is cash flow negative for 9 years before turning positive.

Annual cash flow graph for natural gas scenario



The natural gas scenario yields negative cash flow for the first 12 years before turning positive.

Sensitivity Analysis

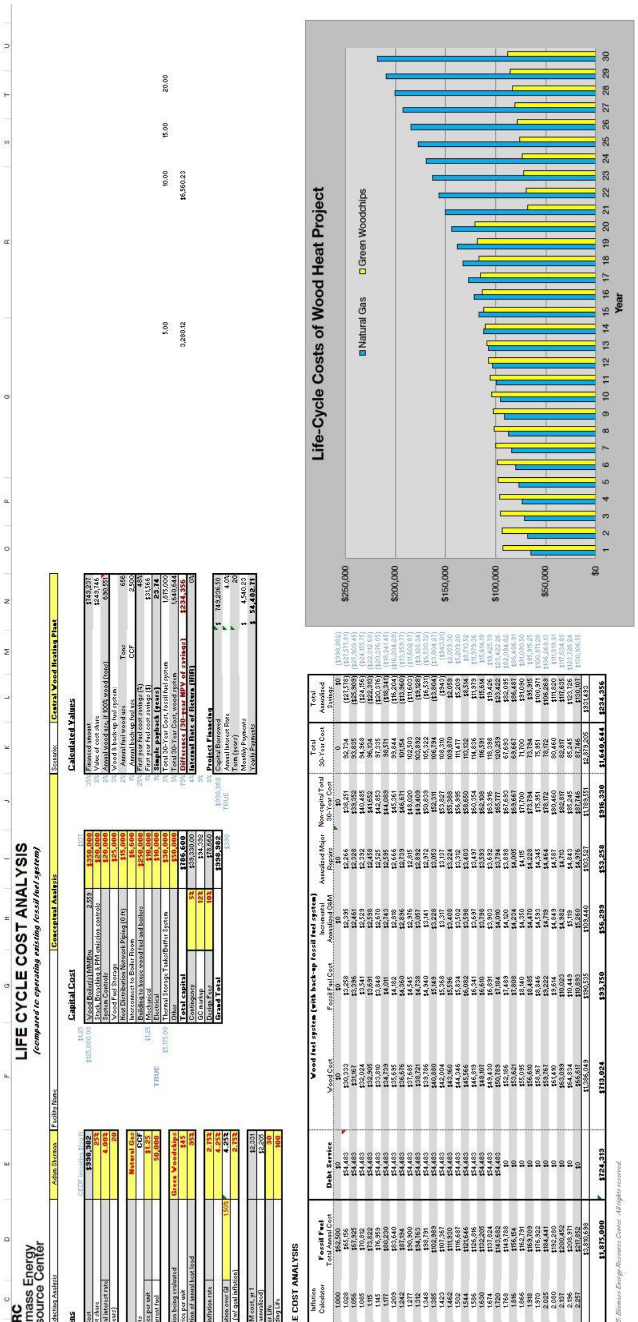
There are many different financial performance indicators (simple payback, internal rate of return, etc.), but a key threshold is whether a project is cash flow positive in the first year. Projects that generate savings (when all the costs including debt services are factored) in the first year have a much higher likelihood of getting installed. BERC performed simple sensitivity analysis to see what it would take to get either scenarios to become cash flow positive in year one (Table below).

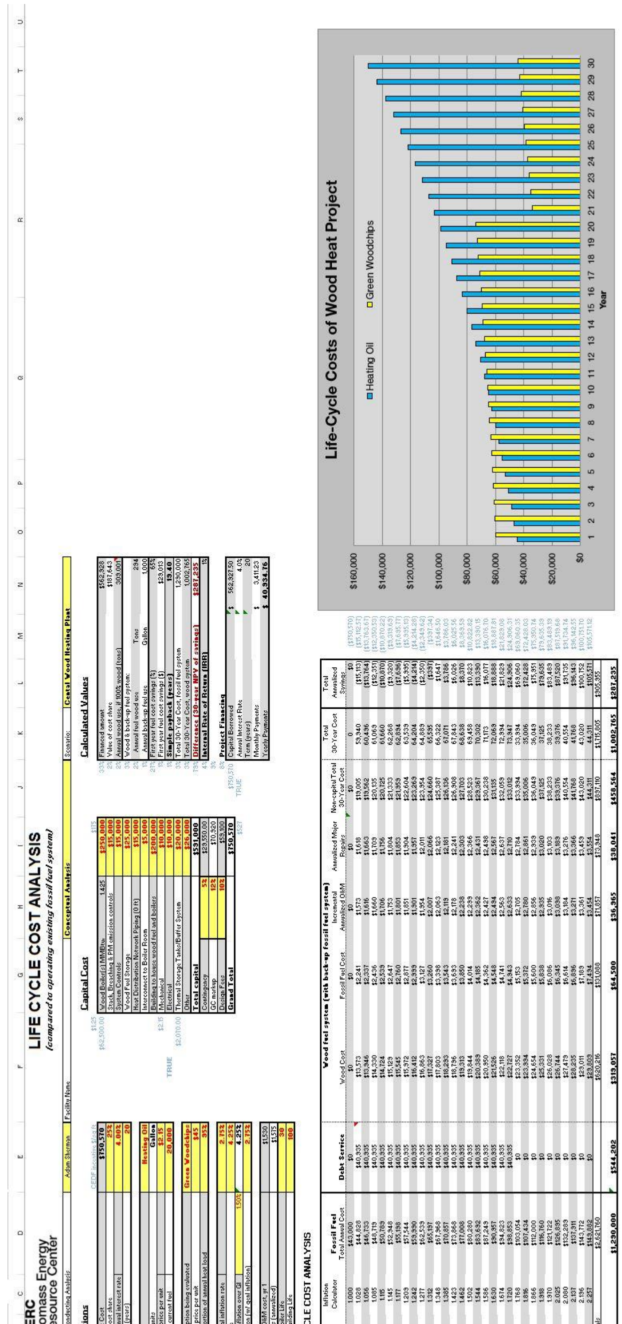
Conditions required for a positive cash flow in year 1

	Oil Scenario	Natural Gas Scenario
Fossil Heating Fuel Price in Year 1	$3.15 per gallon	$1.75 per CCF
Percent of Capital Cost Subsidy	55%	65%

Either an increase in heating fuel prices (where level of subsidy remains the same) or an increase in the level of subsidy (where the fossil fuel price remains the same) would result in a positive cash flow in the first year.

Tool used to perform the Life-cycle cost analysis





Appendix C – Woodchip Fuel Overview

Woodchip heating systems will function and perform better with a high quality fuel. Using consistent, uniform sized woodchips results in fewer mechanical jams of the fuel feeding equipment. Feeding lower moisture content woodchips to the system typically requires less fuel to produce the same amount of heat. Cleaner woodchips (free of excess bark, needle, dirt, and debris) produce less ash and can burn longer without maintenance and removal of ash. Not all woodchip heating systems will require the same quality of fuel, so matching the right fuel source and quality to the right system and application is extremely important. If possible, larger woodchip systems should be designed for a range of fuel quality. Larger woodchip systems can be equipped with fuel feeding systems designed to remove oversized materials.

Quality woodchips are consistent in shape and size. Typical high-quality chips vary in size from 1" x 1" x 1/8" thick to 2 ¼" x 2 ¼" x ¼" thick. Conveying and feeding chips that are relatively square and flat into the system is easier and goes more smoothly. While the majority of woodchip heating systems can handle some oversized material, long "stringers" (i.e. small branches and long fibers) can present a risk for jamming feed augers and shutting the system down. Long stringy wood can also often "bridge" in hoppers and bins, meaning it can form hollow cavities as the material below is removed. Material bridging can cause some systems to shut down due to the perception that the bin is out of fuel when it is not. Similarly, while most woodchip heating systems are designed to handle some amount of wood "fines" (i.e. sawdust), a high fines content can present issues when moisture content is either too low or too high. The table below (Table)[27] presents the typical quality characteristic of several different grades of woodchips commonly used as heating fuel.

Table A: Characteristics of different woodchip grades

	Sawmill	Screened Bole	Standard Bole	Whole-tree
Target chip dimensions	1.5" x 1.5" x 0.25"	2"x 2" x 0.25"	2"x 2" x 0.25"	2" x 2" x 0.25"
Target percent over sized	1%	3%	5%	8%
Target percent fines	2%	4%	5%	8%
Target moisture content	40-45%	40-45%	40-45%	40-45%
Target ash content	0.5%	1.0%	1.5%	2.0%
Target "as is" energy value (Btu/lb.)	5,160	4,988	4,902	4,816

[27] Woodchip Heating Fuel specification in the Northeastern United States, BERC, 2011, http://www.biomasscenter.org/images/stories/Woodchip_Heating_Fuel_Specs_electronic.pdf

Historically, **sawmill grade woodchips** have been supplied to wood heat users by sawmills looking to sell their by-product chips. However, sawmill activity in the US has declined in recent years and as a result, by-product material is increasingly limited in supply. Today, many woodchip heated facilities source their fuel either directly from local timber harvesting and chipping contractors or via woodchip brokers. Woodchips used for heating fuel can be made from many different tree species, components of trees, and can be produced by a variety of harvesting methods. **"Bole" chips** are the most commonly used type of heating fuel woodchips and are produced by chipping just the stem (or bole) of low-quality hardwood trees. They can be produced in the woods, but are most commonly produced at chip yards where roundwood is stored until it is chipped and delivered in tractor trailer loads to the various local heating plants as needed. Chip yards aggregate and store harvested roundwood throughout the year. The wood in these piles may come from a number of harvest jobs and suppliers, each with different forest management goals.

Bole chips are less regular in size and shape than chips produced as by-product in sawmills ("sawmill chips") but still make a very good fuel for heating. Additionally, some suppliers have invested in screening equipment to further refine their product by removing oversize chips, branches dirt, debris, and sawdust. These are typically referred to as "**screened bole chips**".

Conventional harvesting systems remove the main stem (or bole) of the tree and leaves the severed tree tops and branches scattered in the woods. By contrast, whole-tree harvesting removes the main stem with attached tops to a central landing where the wood is processed and sorted. In many harvest operations, loggers return a portion of these tops and limbs to the forest and use them on skid trails to reduce rutting and soil compaction. The resulting pile of top wood can be chipped into a wood fuel commonly known as **whole-tree chips.** It is common practice for that wood to be chipped at the log landing into box trailers, which are transported directly to large users such as power plants.

The mineral (or ash) content of the fuel is a very important factor in the overall chip quality for several reasons. Minerals bound in wood contribute to the formation of ash once the rest of the wood is combusted. In general, the lower the mineral or ash content, the better. Ideally, the ash content of chips for heating should be below 1.5 percent. Ash can come from two main sources: the naturally occurring minerals contained in the tree and bark, and the dirt and debris picked up from the soil in the process of harvesting and other poor materials handling practices (discussed further in the section below on dirt and debris).

Energy values for woodchips can also vary widely—from a higher heating value (HHV)[28] of 8,000 to 9,000 British thermal units[29] (Btu) per dry pound. Woodchip fuel users will likely be buying woodchips on a green weight basis and not a volume basis. Woodchip species composition is only important because moisture content can vary by species. The species of tree that the wood came from also affects the amount of energy present in a given *volume* of woodchips, because the density of wood varies by species, but the density of wood is only important when buying wood by volume, such as for cordwood, and not for woodchips. From when a tree is cut to when it is eventually burned, moisture content typically decreases due to some air drying. During combustion, the remaining moisture content of wood fuel vaporizes and absorbs energy in the process. In general, this moisture escapes out the stack as heated water vapor.

If the moisture content is too high, green woodchips will be difficult to handle, risk freezing in winter, and have lower fuel value resulting in the need to burn significantly more fuel to extract the same amount of energy as from a drier fuel. If the fuel is too dry there can be problems from dust. The optimal moisture content for green woodchips is 30 to 40 percent, but most woodchip combustion systems can handle wood fuel that ranges from 15 to 50 percent. Consistency in moisture content is almost as important as the fuel being within the acceptable moisture content range.

Woodchips are readily available as a heating fuel in forested regions primarily through sawmills, trucking companies and woodchip contractors who chip low-grade hardwood logs at aggregation/processing yards around the State. Forty-eight foot, live-bottom trailers typically deliver 22-28 tons of woodchips per load.

[28] Higher heating value (HHV) measures the energy content of perfectly dry wood (zero percent moisture content). Energy content can also be expressed as the lower heating value (LHV) or the net energy content after accounting for the wood's moisture content and further energy losses due to vaporization of water during combustion. LHV is determined by subtracting the heat of vaporization of the water vapor from the HHV.

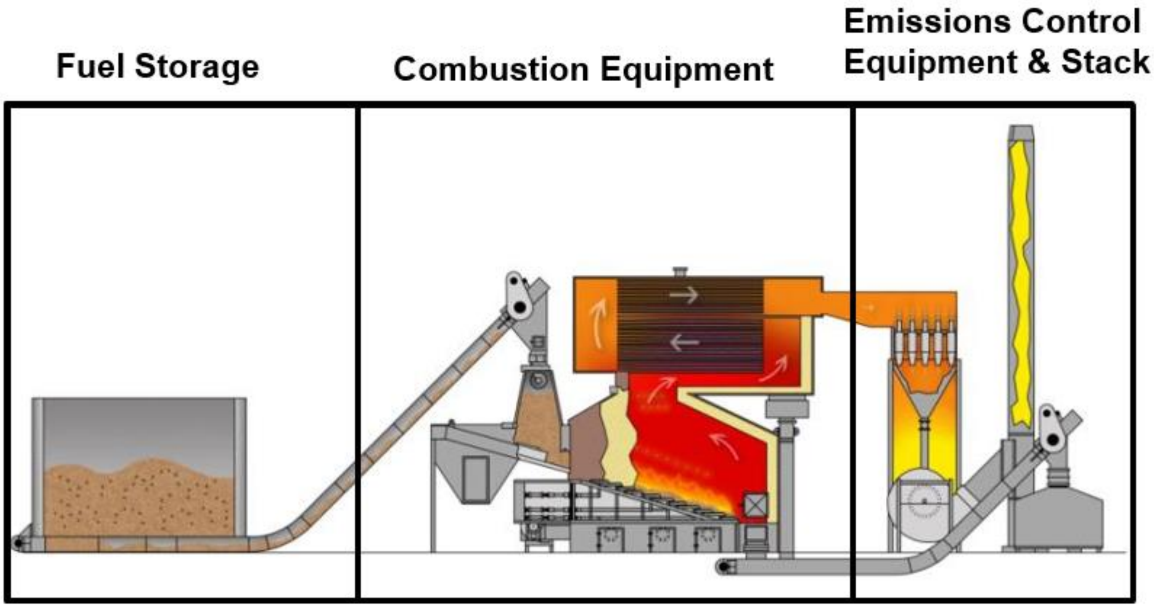
[29] British thermal unit (Btu) is a unit of heat equal to the amount of heat required to raise one pound of water one degree Fahrenheit.

Appendix D – Woodchip Heating System Overview

This appendix provides a brief overview of the components and modern technologies used to heat facilities with woodchips. Modern wood heating utilizes proven technology that has been used successfully for decades across the US to provide space heating and domestic hot water in a wide range of settings – from schools and multifamily housing apartment buildings to colleges and office buildings. While stoves and furnaces that produce hot air are good options for homes and small commercial buildings, this appendix is focused on modern boiler systems and designs that utilize high efficiency, clean burning/low emitting wood energy equipment and mechanical designs that produce hot water that can be circulated via a hot water ("hydronic") heat distribution system. It should be noted, however, that wood-fueled boilers can be relatively easily retrofitted to convert hot water to warm air and used in buildings internally equipped with ducts to circulate warm air.

Modern wood heating systems typically include the following key components:

Component	Description
Boiler room/plant	A room or dedicated building housing all the equipment and the fuel storage area.
Fuel Receiving and Storage Area	Area where the wood fuel is unloaded and stored to keep fuel clean and dry, often configured as: • a rectangular, below-grade concrete bin • a rectangular three-sided bunker on a flat slab • Vertical silos • Or various other creative solutions
Fuel-handling Equipment	Belt conveyors and augers used to move the wood fuel from the storage area to the boiler and inject controlled amounts of fuel into the primary combustion chamber.
Combustor/ Heat exchanger (Boiler)	Equipment where the fuel is combusted and hot water is heated for building heat and domestic hot water needs.
Chimney and Emission Controls	Conduit through which combustion gases are exhausted. Some larger systems also have additional flue-gas cleaning equipment to further control particulate emissions.
System Controls	Computer software, sensors, and fans that ensure efficient, clean combustion of the wood fuel.
Ash Collection	Receptacle allowing for the collection and disposal of ash resulting from combustion.
Thermal storage	A highly insulated water tank located between the boiler and the hydronic heat distribution system that can improve system performance.
Safety Devices	Code-mandated safety devices and controls associated with any large heating system, as well as safeguards against burn-back, or fire traveling back from the combustion area along the incoming fuel stream



Various manufacturers of biomass boilers offer different fuel feeding, fuel combustion configuration, thermal storage, and ash removal features. A more detailed discussion of woodchip boiler components can be found in Woodchip Heating Systems, A Guide for Institutional and Commercial Biomass Installations:

www.biomasscenter.org/pdfs/Wood-Chip-Heating-Guide.pdf.

Appendix E- Emissions from Wood and Fossil Fuels

First and foremost, all modern wood heating systems are required to meet applicable state and federal air quality regulations. Emissions limits and control technologies often vary with the size of the boiler in question. Modern woodchip heating systems produce virtually no visible emissions (although chip systems often produce a white plume of water vapor on cold days). However, all combustion processes, whether the fuel is oil, gas, or wood, emit a variety of invisible compounds. All heating fuels— including wood—produce emissions in varying amounts of:

- particulate matter (PM)
- carbon monoxide (CO)
- nitrogen oxides (NO_x)
- sulfur dioxide (SO_2)
- a variety of organic compounds (usually referred to as volatile organic compounds – VOCs- or total organic compounds-TOCs)
- carbon dioxide (CO_2)

Compared with heating oil, natural gas, or propane, wood is a more variable fuel with respect to heat content, moisture content, and combustion characteristics. Consequently, emission rates are variable, but also depend on the combustion technology and conditions. For example, in general, burning wood in a modern and well-maintained woodchip boiler produces slightly more particulate matter than burning oil, but less SO_2 than oil.

The table below provides typical emission rates (in pounds per million Btu), comparing a commercial-sized woodchip boiler without any PM control technology (such as an electrostatic precipitator) with comparable oil, natural gas, and propane systems.[30]

Table: Typical emission rates for woodchip boilers (without ESP) and fossil fuel boilers

	Woodchip Boiler	Distillate Oil	Natural Gas	Propane
PM 10	0.100	0.014	0.007	0.004
Total PM	0.12	0.024	0.0075	0.0077
NO_x	0.19	0.14	0.098	0.14
CO	0.18	0.036	0.082	0.082
SO_2	0.025	0.0015	0.0006	0.011
TOC	0.039	0.004	0.010	0.011
VOC	0.017	0.0024	0.0054	0.011
CO_2	30[31]	159	118	137

In terms of health impacts from wood combustion, **particulate matter (PM)** is the air pollutant of greatest concern. Particulates are solid matter, ranging in size from visible to invisible. Relatively small PM, 10 micrometers or less in diameter, is called PM_{10}. Small PM is of greater

[30] Data compiled from EPA AP42, Resource Systems Group, and emissions testing from numerous woodchip heating systems.
[31] http://www.biomasscenter.org/pdfs/veic-carbon-emission-and-modern-wood-heating-summary.pdf

concern for human health than larger PM, since small particles remain air-borne for longer distances and can be inhaled deep within the lungs. Particulate matter exacerbates asthma, lung diseases and increases risk of mortality among sensitive populations. Fine particulates, 2.5 micrometers or less in diameter ($PM_{2.5}$), are increasingly of concern, as they are known to increase health-related problems more than the larger particulates. There is no established safe level (concentration) of exposure to fine PM, so lower exposure is always better with regards to health impacts.

Over the course of a heating season, the woodchip system of a large (200,000 square foot) school produces about the same amount of particulate matter emissions (PM) as five home wood stoves. All but the very best and largest wood burning boilers, however, have significantly higher PM emissions than do corresponding gas and oil systems. Compared to home heating, larger wood heating systems at schools are big enough that makes it technically and economically feasible to install best available control technology (BACT) for further reducing particulate emissions.

Combustion of any fuel produces carbon monoxide (CO). The amount produced depends very much on how well a given boiler system is tuned. CO emissions from burning wood fuels are of relatively minor concern to air quality regulators, However, it is important to note that CO is a sign of incomplete combustion and CO levels are frequently used as indicator of other pollutants like organic compounds.

TOCs are a large family of air pollutants, some of which are produced by fuel combustion. Some are toxic and others are carcinogenic. In addition, the VOC subset of TOCs contribute to the formation of ozone and elevate smog levels in the lower atmosphere, causing respiratory problems. Good combustion practices can minimize TOC emissions.

Ensuring that the facility is fitted with the “best in class” combustion systems and, in some cases, best available controls and that the stack is tall enough to disperse any remaining emissions is typically all that is needed to address potential concerns regarding air emissions from modern wood heating systems.

The smallest institutional and commercial wood heating systems may not be required to install additional equipment to meet state emissions standards. Nonetheless, most system manufacturers routinely install devices to remove particulates from the exhaust gases, regardless of unit size (the exception being small systems below 1 MMBtu). These devices, called cyclone separators or multi-cyclones, mount between the heat exchanger and the chimney connection. Systems with particulate removal devices always have induced draft fans, which create a negative pressure in the combustion chamber and assure proper movement of flue gases up the stack.

Currently, the two most common air pollution control devices used to reduce PM emissions from wood-fired boilers are:

1. Mechanical collectors (single cyclones and multiple cyclones),
2. Electrostatic precipitators (ESPs),

These devices can reduce PM emissions by 70 to 99%. It is highly recommended to install the best available control technologies to wood heating systems in community settings because of the particular vulnerability of certain populations to health impacts from fine particulates released by wood combustion.

Stacks should be designed with sufficient height to effectively disperse any remaining emissions into the air and minimize ground-level concentrations of PM (and other pollutants) to ensure acceptable levels are maintained. For larger facilities considering installing a wood heating system, building owners should consider commissioning an emission dispersion modeling study to account for weather patterns, local topography, neighboring facilities, and wind directions to determine the appropriate dimensions and location of the stack. Dispersion modeling may also be required by air quality regulators for systems over a certain size threshold.

Appendix F – Typical Project Development Process

The following provides further information about the typical project development process.

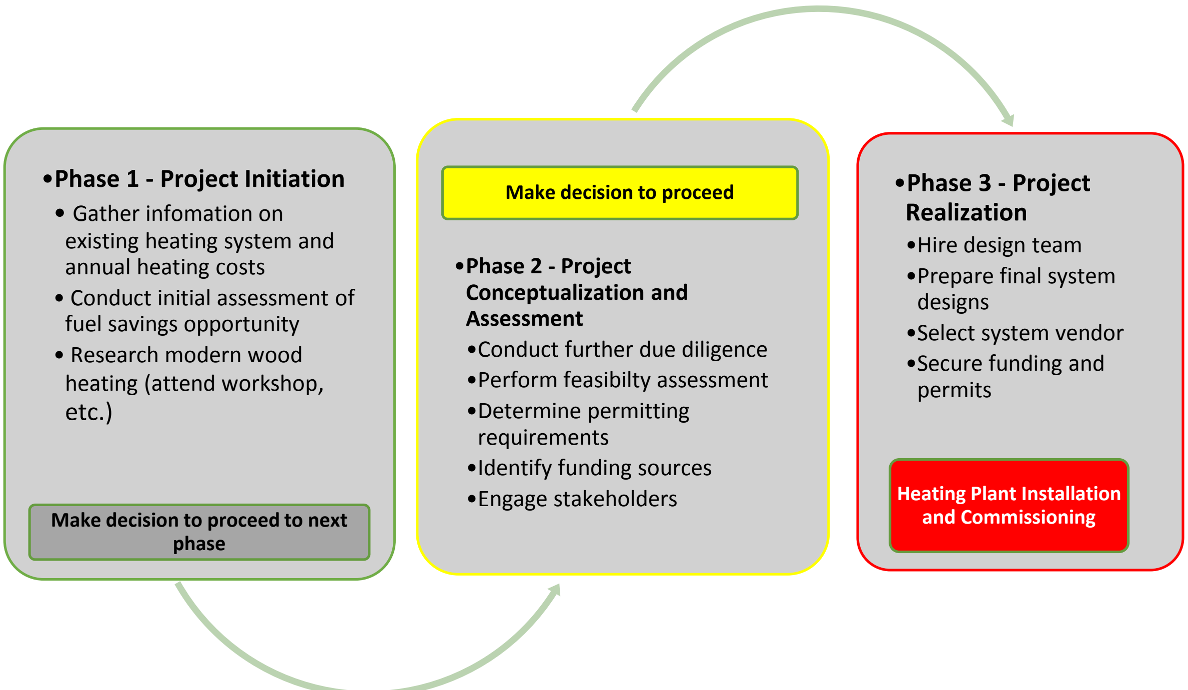


Figure 9: A simplified project development critical path

Even though the fuel cost savings from using wood can be significant, the high capital costs of installing a wood system can be a considerable hurdle; therefore, it is essential to correctly select and install the equipment. Building owners considering the installation of a wood pellet or woodchip heating system should begin by taking the following steps:

Phase 1 – Project Initiation

Once the idea of a wood heating conversion has taken root, there are number of simple steps that can be taken to better understand the costs and benefits for a given building. The goal is to understand quickly whether wood is likely to be an appropriate heating solution for the site before investing in further analysis. This phase involves gathering some basic information about your current heating systems and heating fuel usage, conducting a basic assessment of cost-effectiveness, and a review of other potential benefits. You can perform this assessment yourself following the steps outlined below or work with a modern wood heating professional to help you through these steps:

Step 1
To calculate your potential fuel cost savings, you first need to determine the type and amount of heating fuel you use per year and multiply that by your average price per unit. This gives you the total heating fuel bill for the year, to which you will compare your estimated fuel bill if you were using wood (Step 2). For example, if you typically use 11,200 gallons of propane in a year for space heating (excluding any heating fuel that is used for cooking) and your average price over the past year for propane was $1.75 per gallon, your total average annual fuel bill would be $19,600.

Step 2
The next step is to estimate how many tons of wood fuel your building requires in a year, using fuel equivalency factors (see Table 7). In the case of propane, one ton of wood pellets is equal to nearly 170 gallons of propane. Approximately 66 tons of wood pellets will be needed to heat for one year (11,200 gallons of propane divided by the equivalent 170 gallons of propane per ton of wood pellets). If the current price of wood pellets is $260 per ton, your estimated fuel bill using wood pellets would be $17,160 (66 tons of wood pellets multiplied by $260 per ton).

Table 7: Fuel equivalency factors

	Oil (gallons)	Propane (gallons)	Natural Gas (CCF)
1 Ton of Woodchips	69	98	82
1 Ton of Wood Pellets	120	169	142
1 Cord of Firewood	99	140	118

Step 3
The dollar savings from switching to wood pellets this year can be calculated by subtracting an estimated fuel bill using wood pellets from your current annual fuel bill. As you project these savings into the future, those prices would change and the gap would increase, since fossil fuel prices will escalate faster than wood fuels.

It can also be extremely valuable at this phase to take time to further research modern wood heating technology and even to tour a few facilities with existing wood heating systems. Seeing this technology and talking with current owners will help you when addressing doubts and concerns you may encounter with stakeholders or the public.

Phase 2 – Project Conceptualization and Assessment

The goal of this phase of the project is to acquire all the necessary information on which to make a firm decision on whether to pursue the conversion to a modern wood heating system. If the initial results from Phase 1 indicate favorable financial performance, a more detailed preliminary feasibility (pre-feasibility) study will then determine with greater certainty whether the wood heating project will be cost-effective and if the site is logistically viable for wood heat. A pre-feasibility study will include a preliminary analysis of site-specific data on site heat demand, required system characteristics, logistics, fuel availability, fuel storage, and will estimate potential project capital and operating costs. Facilities may also choose to hire an engineer to explore key issues specific to larger or more complicated projects.

At this point, it is also important to learn about potential state and local permitting requirements. This is also a good time to identify any potential financing and funding sources including any renewable energy incentives and/or grants available.

Almost all the critical questions raised in the early stages of public decision-making on woodchip systems become nonissues when the public is presented with factual information in a thoughtful, well-organized manner. The earlier the public is brought into the process, the better. For public institutions, this process should start while the feasibility study is being done. This way, as soon as there is a demonstrated economic case for installing a wood-chip system, the decision-makers will be ready to make a well thought-out case. This guidebook can be used as a tool to inform key stakeholders on the benefits and potential drawbacks of the projects. For schools, municipal or public projects, it is essential to inform the public about the benefits of modern wood heat prior to any vote.

Phase 3 – Project Realization

Once a firm decision is made to install a wood heating system, facility owners and managers will secure financing, apply for all necessary permits, and go to out to bid to select the team that will design, engineer, install, and commission the boiler and all associated components (buildings, storage area, etc.).