

Supporting Community-Driven Sustainable Bioenergy Projects

April 2013



Dovetail Partners / University of Minnesota / USDA Forest Service

Sponsors

- Cook County and Cook County Local Energy Project
- City of Ely Alternative Energy Task Force
- State of Minnesota Environment and Natural Resources Trust Fund / LCCMR
- USDA Wood Education and Resource Center



Study Teams and Steering Committee

Dovetail Partners, Inc.



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Cheryl Miller, Project Manager
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Ely AETF Steering Committee

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Harold Langowski, City Engineer
Dave Olsen, Retired Engineer
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COOK COUNTY LOCAL ENERGY PROJECT

CCLEP Biomass Steering Committee

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Community-Driven Sustainable Bioenergy

Support community-led transitions to alternative energy by:

- (1) developing high-quality objective information about pertinent topics and options related to bio-energy systems; and*
- (2) building strong communication structures to gather and disseminate information among project partners, stakeholders, and the larger public*



Timeline

Fall 2011	<ul style="list-style-type: none">✓ Confirm community participation in study✓ Hire staff, recruit participants✓ Develop work plan
Winter / Spring 2012	<ul style="list-style-type: none">✓ Identify and assess energy system options✓ Assess and project local biomass supply✓ Select preferred options and investigate concerns
Summer 2012	<ul style="list-style-type: none">✓ Environmental / lifecycle impact assessment✓ Public outreach on supply chain issues
Fall 2012	<ul style="list-style-type: none">✓ Public outreach on supply chain and financing issues✓ Community meetings on findings and recommendations
Winter 2012	<ul style="list-style-type: none">o Deliver final report

Project Structure and Approach

- Phase I
 - Local steering committee and study team identify options
 - Assess financial viability and availability of fuel supply
 - Select best options for further investigation
- Phase II
 - Life cycle assessment review (focus on emissions)
 - Environmental impacts (MN Forest GEIS)
 - Biomass supply logistics (forest to customer)
 - Public education and input
 - Support next steps

Phase II Dovetail/UMN reports

- *Pre-Feasibility Financial and Wood Supply Analysis for Biomass District Heating in Ely and Cook County, MN: University of Minnesota Report to Dovetail Partners, Inc*
- *Life Cycle Impacts of Heating with Wood in Scenarios Ranging from Home and Institutional Heating to Community Scale District Heating Systems*
- *Local Environmental Considerations Associated with Potential Biomass Energy Projects in Cook County and Ely*
- *Supply Chain Logistics and Concerns*
- *Fact sheets summarize findings for public*

Major Findings

I. Financial and Wood Supply Analysis

- Recent technological innovations greatly improve bio-energy performance (efficiency, practicality)
- Optimal sizing for district heat is crucial (central core + heat density per linear foot of piping)
- Sustainable biomass supply in 60-mile radii zone
 - Estimated demand: 390 DT to 2,559 DT (*per installation*)
 - Estimated biomass supply for Ely and GM:

Resource	Ely	Grand Marais
50% timber residues	44,679 DT hogfuel	12,576 DT hogfuel
10% roundwood	34,309 DT clean chips	9,960 DT clean chips
Fuel treatment removal	Data not available	6,194 DT

- Additional engineering & business planning needed

II. Life Cycle Impacts

- Lower density of wood = higher emissions per unit of heat
- Direct emissions depend on feedstocks, boiler technology, and pollution controls
 - Clean, dry biomass feedstocks (pellets lower than chips)
 - Optimally sized, high-efficiency technology and automatic feeding
 - State of art emissions control
- Air emission estimates of the largest district heating options are below 10% of EPA/Clean Air Act thresholds, 2-14% of Minnesota Option D emission limits.
 - Air quality regulations for PM and other compounds could tighten.
- Indirect emissions (transportation & processing) can add 30 - 50% to non-local fuels (means pellets have higher emissions per unit of energy)
- Detailed information in fact sheets and reports

Total Pounds of Particulate per Year

normalized to the equivalent of the BTU from 1000 gallons of heating oil per year

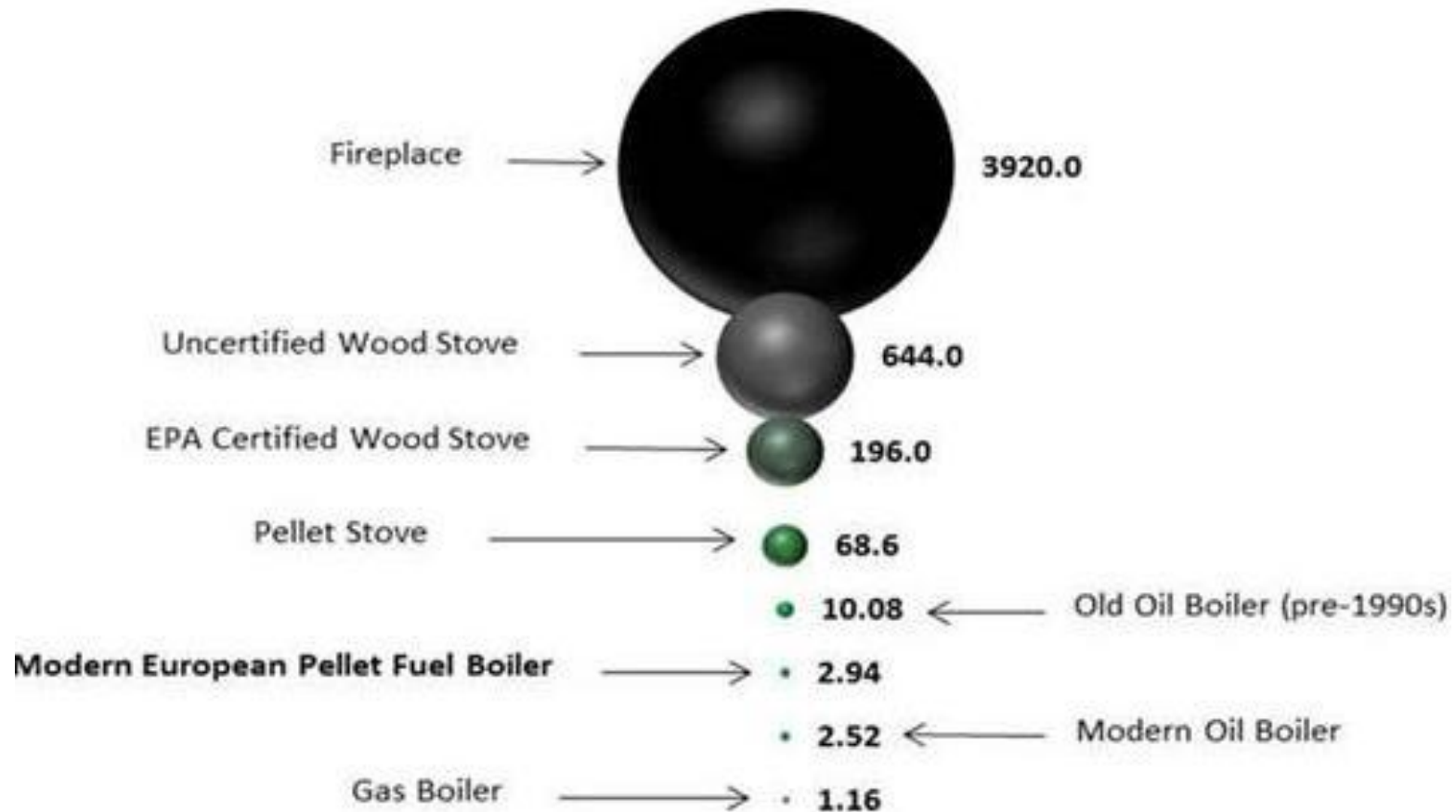
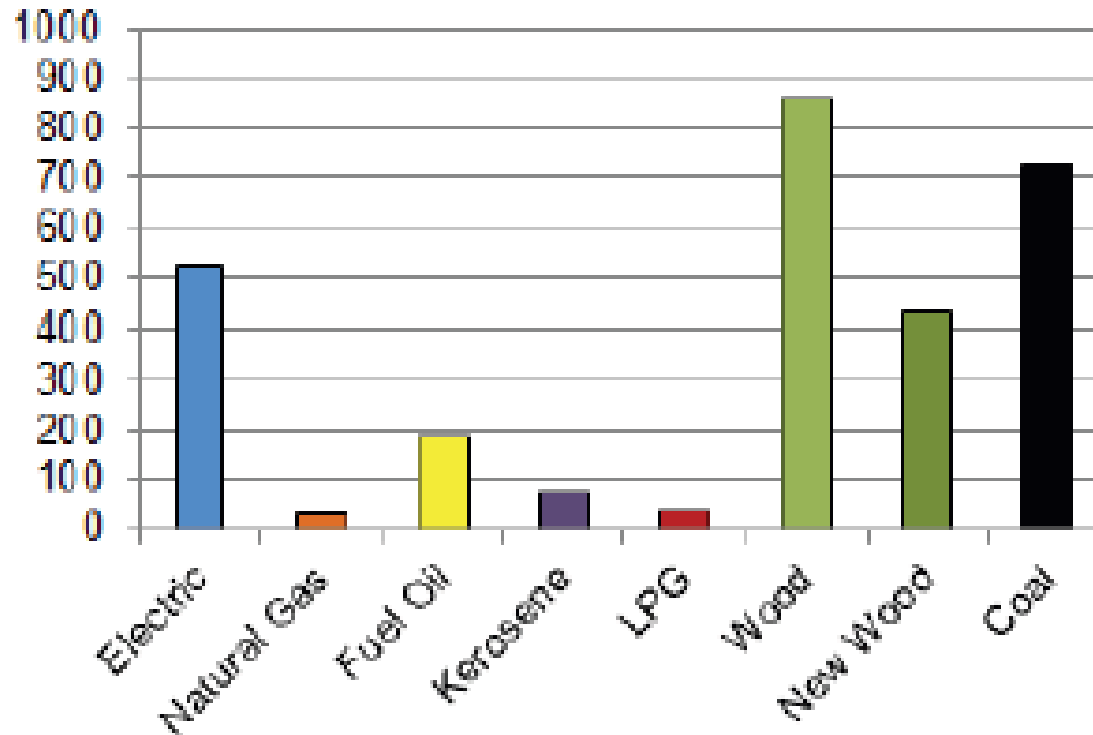


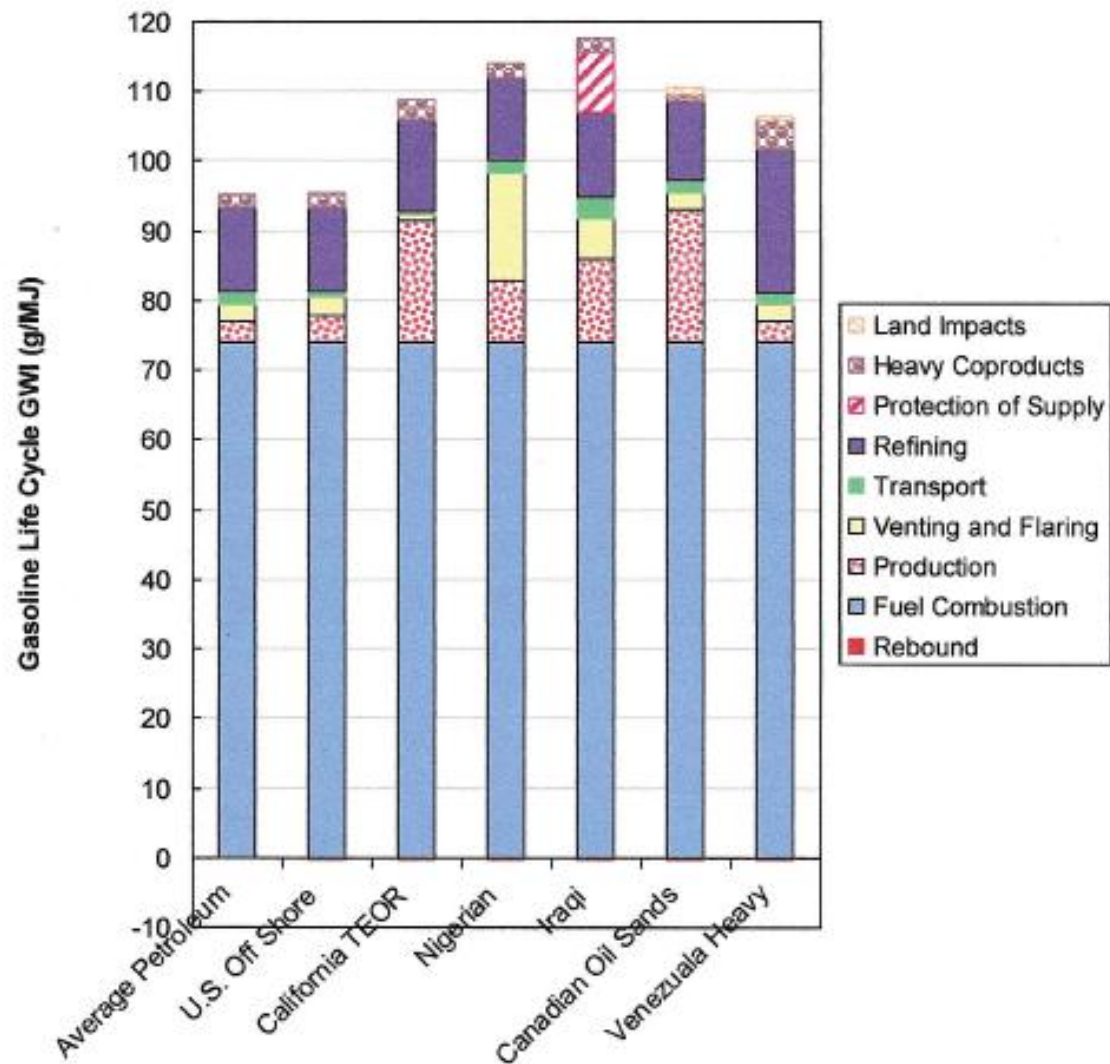
Figure 16
Fine Particle Emissions per Quad of Heat Delivered



Source: Houck (1999).

Figure 6

Summary of GHG Emissions for Different Crude Oil Production Scenarios



Source: Unnasch (2009).

Table 2. Estimates of direct, on-site air emissions¹ of biomass energy options (short tons/year) based on reported emissions per MMBtu. (Note: one short ton is equal to 2000 lbs.)

Pollutant		SO ₂	NO _x	PM ₁₀	CO	CH ₄	VOC	PAH	Fossil CO ₂
Regulatory thresholds									
Standard permit (PTE) ²		50	100	25	100	---	100	---	100,000
Option D permit ³		50	50	50	50	---	50	---	100,000
Configurations									
Five hundred supplemental single-family stoves, each 35 MMBtu. ⁴	Cordwood	0.36	1.81	13.59	127.29	14.95	62.93	0.69	---
	Pellets	0.36	1.81	2.49	22.66	0.14	3.97	0.00	---
Option 1: Vermillion Community College. Annual heat load 7,227 MMBtu.	Chips ⁵	0.19	1.20	0.86	2.97	0.17	0.30	0.34	---
	Pellets	0.19	0.81	0.47	1.63	0.07	0.10	0.04	---
Option 2: District heat for E-B Community Hospital, Sibley Manor, ISD 696. Annual heat load 16,235 MMBtu.	Chips	0.43	2.71	1.93	6.67	0.38	0.67	0.75	---
	Pellets	0.43	1.82	1.06	3.67	0.16	0.22	0.10	---
Option 3A: District heat for E-BCH, SM, ISD 696 (above) plus approximately 15 businesses along Sheridan Street. Annual heat load 21,553 MMBtu	Chips	0.57	3.60	2.57	8.86	0.51	0.89	1.00	---
	Pellets	0.57	2.41	1.41	4.87	0.22	0.30	0.13	---

III. Environmental impacts

- Increased bio-energy could alter forestry practices positively and negatively in procurement zone
 - If bi-product of timber harvest, would reduce residuals at harvest site
 - If roundwood, increase timber harvest?
- Public concern expressed about impacts to water, air, habitat, aesthetic resources
- GEIS found no significant negative impacts at timber harvest rates that would adequately supply local bio-energy needs
- Application of MN Biomass Harvest Guidelines needed to avoid negative impacts to soils, forest structure, habitat values
- Training, consistent application, and monitoring needed to improve use of guidelines & better understand impacts

Table 8. Summary of Minnesota’s Biomass Harvesting Guidelines

DO'S	DON'TS
<p><i>During Biomass Harvesting:</i></p>	<p><i>Avoid Biomass Harvesting:</i></p>
<ul style="list-style-type: none"> • Plan roads, landings and stockpiles to occupy a minimized amount of the site • Ensure that landings are in a condition to regenerate native vegetation after use, including tree regeneration • Avoid site re-entry to collect biomass after harvesting (<i>this reduces potential for soil compaction and damage to regeneration</i>) • Install erosion control devices where appropriate to reduce sedimentation of stream, lakes and wetlands • Retain and scatter at least one third of the fine woody debris on the site • Encourage native seed mixes and avoid introduction of invasive species • Retain slash piles that show evidence of use by wildlife • Leave all snags, retain stumps and limit disturbance of pre-existing coarse woody 	<ul style="list-style-type: none"> • Within 25 feet of a dry wash bank, except for tops and limbs of trees • On nutrient-poor organic soils deeper than 24 inches (<i>These sites typically have sparse (25-75%) cover that is predominantly (>90%) black spruce and stunted (<30 feet high).</i>) • On aspen or hardwood cover types on shallow soils (8 inches or less) over bedrock • On erosion-prone sites (e.g. steep slopes of 35% or more) • In areas that impact sensitive native plant communities and where rare species are present • In riparian areas or leave tree retention clumps • In a manner that removes the forest floor, litter layer or root systems; these resources

IV. Logistics / Supply Chain

- Public forest managers expressed interest in new tools (and markets) to support forestry activities
- Presence of active logging labor force is critical factor in local bio-energy expansion
- Continued dialogue is needed on viable business plans for harvest, handling, processing biofuels

IV. Logistics / Supply Chain, ii

- Numerous businesses have (1) near-term plans to replace furnaces and (2) interest in biomass DE
- Viability of downtown extensions depend on how many businesses decide to participate

Fact sheets summarize findings for public outreach



Emissions and biomass energy in Northeast Minnesota

Air quality impacts of biomass energy

Using locally grown forest biomass for energy is of growing interest in northern Minnesota because of its potential to increase energy independence, decrease carbon dioxide in the atmosphere, and reduce loading of nitrogen nutrients to forests. This fact sheet focuses on expected air emissions of low-energy projects being considered in PLS, Minnesota. It is part of a larger study on the feasibility, impacts, and social support for converting from fossil fuels to forest biomass energy. Other fact sheets in this series describe technical and economic aspects of biomass combustion systems, their wood fuel demands and local supplies, and the environmental impact of biomass harvest. A full report of the study by Dennis Hartman will be available in December, 2012.

Air emissions of energy production

All energy production – whether from fossil fuel sources (petroleum, coal, and natural gas) or non-fossil sources (hydroelectric, nuclear, geothermal, solar, wind, wood, and water) – impacts air and the larger environment. Air emissions can be categorized as direct (on-site emissions produced at the power station) or so indirect (covering all emissions generated throughout the entire life cycle of energy production and use). Sorting out the overall impact of a given energy system is challenging, involving different fuel types, equipment, pollution controls, and other factors. The exit of energy, forest biomass energy generates lower emissions than fossil fuels of some air pollutants, and higher levels of others. Locally harvested wood energy does have an advantage in avoiding emissions and environmental impacts associated with activities like offshore drilling, trading, oil-shale mining, and international transportation systems. Widespread air pollutants are produced by burning fuels are summarized in Table 1.

Direct Emissions

Combustion is the largest source of emissions in the energy production process. Direct, on-site emissions are determined by fuel used, production equipment, and pollution controls.

- Fuel:** Clean, dry wood fuels deliver superior energy efficiency and are environmentally friendly, wet fuels. Emissions are especially dependent on moisture content and percentage of all, uniformly-sized fuels provide greater value, more uniform burning, lower emissions, a less need for boiler maintenance that wet, dirty, non-uniform fuels.
- Production equipment:** Modern, high-efficiency equipment and optimal size are crucial for controlling combustion emissions. For wood-scale systems, EPA-certified wood processing plants emit 50 percent less particulate pollution and are approximately 50 percent more efficient than wood saw manufacturing before 1990s. Larger, denser drying systems should focus on high-density areas (high energy demand and short piping distance) and use automatic rather than manual fuel handling systems. Balancing all factors, the largest scale does not necessarily translate to lowest overall impact. Instead, systems engineered to optimize energy use density and energy transport distance have been found to have the lowest overall impact.
- Pollution control:** Technologies are available that significantly reduce hazardous emissions. For example, clean water precipitation reduces particulate emissions from combustion of wood. Forest energy does have an advantage in avoiding emissions and environmental impacts associated with activities like offshore drilling, trading, oil-shale mining, and international transportation systems. Widespread air pollutants are produced by burning fuels are summarized in Table 1.

Stationary sources of air pollution are regulated by Minnesota Pollution Control Agency under the federal Clean Air Act. Major facilities with a potential to emit (PTE) more than certain threshold amounts of any regulated pollutant must obtain an individual air quality permit. Facilities with emissions below these standards through.

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Forestry and biomass energy in Northeast Minnesota

The feasibility and impacts of using locally grown forest biomass for energy is being extensively studied because of its potential to lower energy costs, reduce loading of nitrogen nutrients to forests, and lower net carbon dioxide and greenhouse gas in the atmosphere. This fact sheet describes the types of forest biomass used to produce energy and estimates amounts of biomass resources in forest communities in NE Minnesota – PLS and Grand Marais. It also compares biomass supplies with demands of regional biomass energy projects being considered in other communities. Other fact sheets in this series describe the state's productive zones, environmental policies, and the economics of biomass energy. A full report of the study titled "Integrating Community Design Feasibility Biomass Energy Project" will be available in December, 2012.

Minnesota timberlands and biomass energy fuels

Managing Minnesota's forests is a complex challenge involving forest conditions, desired land uses, timber markets, public opinion, and government policies. The state's forests are divided into



Forest workers, the timber industry and local communities have together to satisfy the multiple demands placed on Minnesota's forests. (Photo courtesy of USFS-Gilbert District)

timberland where wood is harvested, reserved land (such as designated wilderness areas) that cannot be harvested, and brush and other lands, also not commercially harvested. A comprehensive environmental assessment of timber harvest strategies reported that annual harvest of 4 million cords of timber could be considered self-sufficiently sustaining key forest ecological

Forest Biomass Feedstocks	Maximum % by Weight	Suitable Uses	Heat Value (Btu/cord)	2010 Cost (\$/dry ton)
Cardboard	35%	Powerplant in conventional dryers, wood-burning stoves, or boilers for home heating	0.4	\$114 (+ \$55 delivery)
Clean (kiln-dried) chips	40%	Residential and small industrial heating	0.8	\$45 - \$60
Field chips (log tail)	40%	Distill heating and industrial systems with mechanical sorting systems	0.8	\$57 - \$57
Wood pellets	10%	Residential and small industrial heating	15.0	\$167 (+ \$67 delivery)

Table 1. Biomass Feedstocks

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Environmental Impacts of Biomass Harvesting and Wood Energy Production in Northeastern Minnesota

Using locally grown forest biomass as community energy systems in northern Minnesota has the potential to increase energy independence, lower carbon dioxide in the atmosphere, and reduce loading of nitrogen nutrients to forests. This fact sheet focuses on potential environmental impacts of biomass harvest and forest sustainability guidelines needed to address such impacts. It summarizes a study by Dennis Hartman, Inc. that reviews relationships and lessons from forestry experts and stakeholders groups. Other fact sheets in this series describe technical and economic aspects of biomass combustion systems, wood fuel demands and local supplies, and air emissions from biomass combustion. A full report of the study will be available in December, 2012.

Northern forests ecosystem

Two communities in northern Minnesota, PLS and Grand Marais, are considering construction of district forest systems, fueled by locally-grown woody biomass, for public buildings and business districts. These communities lie in the Northern Superior Upland, a landscape dominated by fire-dependent forests and woodlands. The red and white pine forests of the past were largely cut down by the early 1900s. Today, they have been replaced by jack pine forests on open ridges and marsh areas, and sugar maple forests (mixed with some pine, birch and cedar) in the highlands along Lake Superior. The different forest types, their uses, and relative health determine forest management decisions, including timber and biomass harvest.

The *Global Environmental Impact Notebook on Timber Harvesting and Forest Management in Minnesota* (GEIN) is an in-depth analysis of potential environmental impacts on forest ecosystems. It and subsequent guidelines and updates provide the basis for this review of potential positive and negative impacts of woody biomass harvest on these forests.



Northern Superior Upland Section

Biomass harvest operations

Woody biomass is typically removed from a forest as part of a traditional harvesting operation and can include tree tops, limbs, bark, and tree stumps (biorefinery). Biomass is rarely removed as a stand-alone product because it is generally not economically viable. Because of this, environmental impacts of biomass harvest are contained within the context of overall timber harvest and forest sustainability. Other sources of woody biomass are wildfire risk reduction treatments, wood salvaged from wind-storm events, wildfire, insect or disease outbreaks, and reforestation efforts. This material is often piled or binned because it is not economical to haul to markets. Tree stumps, or biorefinery, are currently used for firewood and pellets. As long as viable markets for roundwood (e.g., pulp) and timber products exist in the region, it is likely to be economically limiting to chip-quality roundwood for bioenergy systems.

The current rate of timber harvest in northeastern Minnesota is significantly lower than a baseline rate (8 million cords annually statewide) found to be biologically sustainable in the GEIN. Preliminary data suggest that harvest levels for 2010 and 2011 are within the 2.8 to 2.9 million cord range. Moreover, data also show that forest growth greatly exceeds wood harvest in the state. Minnesota is experiencing annual net timber growth of approximately 5.8 million cords (approximately twice to

Ecological Classification System used by MNR and USFS for managing public lands.

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Next Steps

- Reports available on community and Dovetail websites
- Lessons learned, based on feedback from community meetings and partners, distributed statewide



Questions / comments ?

Resource slides

Table 1. Modeled biomass systems and equipment specifications for Ely.

Configuration	Heat demand (non-peak) (MMBtu/yr)	Building connections	Fuel type	Annual biomass demand dry tons (wet tons)
Option 1: Vermilion Community College	7,680	0	Chips/Hog	527 (878)
Option 2: E-BCH, Sibley, ISD 696	16,235	3	Chips/Hog	1,754 (2,924)
Option 3A: Option 2 extension	21,381	18	Chips/Hog	2,559 (4,165)

¹Assumes 55-60% of heat load with peaking backup for coldest days. ²District heating portion of a CHP system; a stand-alone district heating system was not analyzed in the LHB report.

Table 2. Financial performance of proposed options for Ely.

	Option 1:	Option 2:	Option 3A:
Capital costs including hookup (\$)	\$1,934,318	\$3,783,002	\$5,459,348
Annual electricity sales (\$)	\$0	\$0	\$0
NPV project cost (\$)	\$2,601,514	\$4,856,236	TBD
NPV savings (including PPA) (\$)	\$2,666,281	\$5,996,704	TBD
Net Present Value (\$)	\$64,767	\$1,140,469	\$4,560,259
Simple payback period (years)	12	0	13.5
Biomass cost of heat (\$/mmBtu)	\$32	\$26	\$30
Current fossil fuel price (\$/mmBtu)	\$30	\$29	\$29
Maximum annual outlay (\$)	\$10,861	\$0	TBD

¹Including Power Purchase Agreement (PPA) for electricity sold.

²Cost of fossil fuel only; does not include the full cost of heating.