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 buildup of fire-prone materials in forests, and lower net carbon dioxide and greenhouse gases in the atmosphere. This fact sheet describes the types of forest biomass used to produce energy and estimates amounts of biomass resources in forests surrounding two communities in NE Minnesota – Ely and Grand Marais. It also compares biomass supplies with demands of optional biomass energy systems being considered in those communities. Other fact sheets in this series describe biomass combustion systems, environmental and life cycle impacts, Minnesota's biomass harvesting guidelines, and the economics of biomass energy. A full report of the study, titled "Supporting Community-Driven Sustainable Bioenergy Projects," will be available in December, 2012.

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

Minnesota timberlands and biomass energy fuels

Managing Minnesota's forests is a complex calculation involving forest conditions, desired land uses, timber markets, public opinion, and government policies. The state's forests are divided into 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 statewide reported that annual harvests of 4 million cords of timber could be continued indefinitely without harming key forest ecological

Forest Biomass Feedstock	Moisture % by Weight	Suitable Uses	Heat Value (mmBtu/ton)	2010 cost $ / dry ton
Cordwood	35%	Firewood in conventional fireplaces, wood-burning stoves, or boilers for home heating	9.4	$154 (+ $58 delivery)
Clean (bolewood) chips	40%	Residential and small industrial heating	8.8	$48 - $68
Field chips (hog fuel)	40%	District heating and industrial systems with mechanical feeding systems	8.8	$37 - $57
Wood pellets	10%	Residential and small industrial heating	16.8	$167 (+ $67 delivery)

Table 1. Biomass Feedstocks

Published December 2012

characteristics (soil productivity, water quality, wildlife habitat, and aesthetic values).

Since the early 2000s, declining demand for paper and construction materials and greater reliance on imported wood have resulted in current harvests approximately 30% below this base level. The current harvest rate is also well below net annual growth (5.6 million cords) and mortality (4 million cords). The notable aging of Minnesota's forests, while far below the proportion of old growth forests before European settlement, presents management concerns including increased risk of disease and insect damage, and increased fire danger from dead and downed trees. A decline in the health of trees directly impacts the health of the forest industry and can result in a loss of jobs and the management infrastructure needed to maintain healthy natural resources.

Biomass energy is a burgeoning sector of the wood products industry that, if done appropriately, could help address forest health and other energy-related concerns in Minnesota. Burning wood is a time-honored method of creating heat or electricity, and is now greatly improved through more efficient and practical technology. Biomass fuel stocks used for heat and electricity in the region include hog fuel, or the slash and waste wood from timber harvesting (tops and limbs of trees), hazardous fuels reduction (Firewise), storm clean-up, right-of-way clearings, pre-commercial thinnings and related vegetation management projects, and removal of diseased or dead trees. Whole trees can also be processed into high-quality clean chips or manufactured wood pellets. Additional sources of biomass that may be used include mill residues, brushland clearing, and dedicated energy crops. Table 1 describes principal feedstocks available within 60 miles of Ely and Grand Marais, technologies they are used in, amount of energy produced, and cost of procurement. Processed wood pellets that would be trucked in from outside the area are also included.

Biomass availability and demand for energy

The viability of biomass energy depends on availability of supply compared to the cost of demand. In the heavily-forested region of NE Minnesota, the availability of locally-sourced biomass is more than sufficient for all the options being evaluated. The current supply of just harvest residuals (tops and limbs of commercially harvested trees) within 60 miles of Grand Marais and Ely is estimated at 11,450 and 44,679 dry tons respectively. In comparison, the amount of biomass needed to produce heat only for the options under consideration range from approximately 390 dry tons/year to produce 5,200 mmBtu of annual heat load for a small resort, up to 2,450 dry tons/year to produce 30,562 mmBtu of annual heat load for a district heating system covering businesses, public buildings, and private residences. The amounts of biomass needed if multiple biomass energy systems are built in one area are estimated in the study report.

Biomass resource stewardship

The buildup or removal of trees and other vegetation from Minnesota forests is an important public issue. On the one hand, a lack of market demand for small dimension biomass has meant that timber residuals are disposed of by burning in the forest, raising concerns about air quality, water quality, and erosion. On the other hand, over-harvesting of biomass could reduce soil nutrients, wildlife habitat, site productivity, and cause increased water erosion. Federal and state forest plans restrict biomass removal in some forest stands, such as near river bottoms or with low-nutrient soils. In areas where residual harvest is allowed or encouraged, guidelines and best management practices developed by the Minnesota Forest Resources Council are critical components of sustainable forest management. Biomass removal is also encouraged as part of timber stand improvement programs in areas being managed for larger trees or being restored to native forest types. A fact sheet describing biomass harvest guidelines is available.

Community	GEIS base scenario (cords) [1]	2006 - 2010 Actual Bolewood harvest (cords)[2]	2006-2010 Clean chips[3] (green tons/dry tons)[4]	2006-2010 Field chips (hog fuel)[5] (green tons/dry tons)[4]
Ely	436,814	291,710	57,182 / 34,309	74,465 / 44,679
Grand Marais	219,719	79,572	15,410 / 9,246	19,083 / 11,450

Table 2. Biomass Supply under all ownerships, within 60-mile radii zones.

[1] GEIS Base Scenario of 4 million cords harvest rate statewide.
[2] 2006 – 2010 Average Annual Harvest Rate (FIA estimate)
[3] 10% of bolewood harvest available for wood chips
[4] Conversion factor: 1 green ton of wood = 0.60 dry tons of wood (40% moisture content).
[5] Field chips or hog fuel is the tops, limbs, small trees and needles as defined by the USDA Forest Service biomass attributes. A conservative estimate of 50% is retained on site to meet the MFRC Biomass Harvest Guidelines.

Biomass harvesting, transport and processing

Determining whether an adequate supply of biomass exists for energy options is only the first step. It then needs to be harvested or (in the case of logging slash) collected, transported and processed into its final form for introduction to a boiler. The nature of the raw material will dictate the end fuel type and the steps necessary to achieve the final product. Completing each of these steps involves a cost in labor, equipment, and fuel. In some locations, the necessary infrastructure may already exist. In locations where the infrastructure doesn't already exist, the limited fuel demands of a modest district heating facility could eliminate some fuels from practical consideration. This may be the case if expensive new equipment must be obtained or if costly and time-consuming materials handling and transport are required.

It is also generally true that a lower quality biomass fuel produces higher emissions and waste ash. This means that lower fuel costs may quickly be offset by the cost of additional emissions controls and ash removal. In the end, all of these factors need to be considered when weighing the benefits and costs of each biomass fuel type in a particular district heating configuration.

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Supporting Community-Driven Sustainable Bioenergy Projects is a project of Dovetail Partners, Inc. with funding provided by the *Minnesota Environment and Natural Resources Trust Fund* as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). The Trust Fund is a permanent fund constitutionally established by the citizens of Minnesota to assist in the *protection, conservation, preservation, and enhancement of the state's air, water, land, fish, wildlife, and other natural resources.*

Ely Biomass Energy Options

Configuration	Annual heat load (mmBtu)	Fuel type	Annual biomass demand	
			green tons	dry tons
Option 1 Vermillion Community College	7,227	Clean chips Hog fuel	878	523
Option 2 E-B Community Hospital, Sibley Manor, Independent School District 696	16,235	Clean chips Hog fuel	2,905	1,743
Option 3A District heat for E-B Community Hospital, ISD 696, and section of business district.	21,553	Chips/Hog fuel	4,165	2,499

Cook County/Grand Marais Biomass Energy Options

Configuration	Annual heat demand (mmBtu)	Fuel type	Annual biomass demand	
			green tons	dry tons
Typical single family dwelling, stand-alone stove	35	Cordwood Pellets	5.3 3.0	3.2 2.7
Option 1 Resort of small business cluster	5,200	Chips	650	390
Option 2 Heat for public buildings north of 5th Street N incl. courthouse and laundromat	11,796	Chips/Hog Fuel	1567	940
Option 3 District heat for business district and public buildings north of 5th Street N	30,562	Chips/Hog Fuel	4083	2450
Opton 4 "Hybrid" scenario Public buildings north of 5th St. N. and 10 principal users in downtown area	24,186	Chips/Hog Fuel	3233	1940

Graphic design and layout: Gary Atwood

Published December 2012