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# Status of Fiber Fuel Use in Minnesota With Emphasis on Automated Systems

October 1986

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Division of Forestry  
Department of Natural Resources

Fiber Fuels Institute



MINNESOTA  
Department of Energy  
and Economic Development





## STATUS OF FIBER FUEL USE IN MINNESOTA

with emphasis on automated systems

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Prepared by:

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St. Paul, Minnesota

Fiber Fuels Institute, Minneapolis, Minnesota

OCTOBER 1986

The fiber fuels industry in Minnesota is growing. Producers, consumers and associated service industries are all feeling the effects of this growth and occasionally the frustration of not having a ready source of industry information. This summary of the status of the fiber fuels industry in Minnesota is intended to alleviate some of the latter frustrations.

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# **CHRONOLOGY OF FIBER FUEL USE IN MINNESOTA**

## **Prior to 1970**

- \* A small number of wood industries burn residue for energy and waste disposal.
- \* Ottertail Power Company uses wood energy to produce electricity at a small plant in Bemidji.
- \* Annual consumption of wood for residential heating approaches 200,000 cords.

## **1970 to 1975**

- \* The Arab oil embargo causes a dramatic increase in fossil fuel prices.
- \* Grand Marais School District converts the first Minnesota school to wood energy.
- \* Residential fuelwood consumption increases.

## **1976 to 1980**

- \* Wood pelletizing plants are established at Marcell and Stillwater. The Stillwater plant fails.
- \* Schools at Laporte, St. Joseph and McGregor convert to pelletized wood fuel.
- \* Residential fuelwood consumption increases to 1.3 million cords annually.
- \* Thirteen wood industries and three nonwood related companies convert to wood energy.
- \* Two "Minnesota Coal" conferences in Brainerd bring industry, government and community leaders together to examine the use of wood for energy.
- \* DNR initiates the Minnesota Peat Program and the Peat Inventory Project.
- \* The Grand Rapids Regional DNR Headquarters becomes the first state facility to convert to wood energy.

- \* A study by Minnesota Energy Agency and DNR shows adequate non-industrial wood resources available to support substantial wood energy development.

## **1981 to the Present**

- \* Wood fuel briquetting plants are established at Pine River, Grand Rapids, Blackduck, Rice, and Virginia. Wood fuel pellets are produced in Gilbert, Crosby and Marcell. Densified wood fuel production capacity exceeds market demand. Gilbert and Crosby later ceased production.
- \* Northwest Economic Development Corporation installs residential pellet furnaces as part of a fuel assistance program.
- \* Blandin Paper Company builds a large scale wood residue fired co-generation plant at Grand Rapids.
- \* Aitkin Ironworks installs a wood fired district heating system to provide heat for their plant and sixteen public buildings in Aitkin.
- \* DNR installs wood burning systems at eight sites.
- \* The Western Lake Superior Sanitary District began using wood chips to incinerate sludge at Duluth.
- \* The Fiber Fuels Institute is formed to promote the Minnesota bio-fuels industry.
- \* Legislation is passed to permit third party financing of state facility heating system fiber fuel conversions.
- \* Peat is harvested by private firms for DNR combustion testing. Peat fuel combustion testing is done at Virginia Public Utilities, U.S. Bureau of Mines, and U of M Duluth.
- \* Over 200 commercial and industrial scale facilities are using fiber fuel energy.

# FIBER FUEL SUPPLIERS

## DENSIFIED FUEL PELLET SUPPLIES IN MINNESOTA

(Wood, Peat, Paper, Agriculture, Residues)

Alternative Fuels, Inc.  
15831 Highway 55  
Plymouth, MN 55447  
(612)553-9560

Rapid River Companies  
P.O. Box 458  
Baudette, MN 56623  
(218)634-2041

St. Cloud Conversion Corp.  
670 N. Highway 10  
St. Cloud, MN 56302  
(612)253-3668

Aspen Fiber Corp.  
1112 First St. East  
Duluth, MN 55805  
(218)728-2582

Northern Xtrax, Inc.  
P.O. Box 185  
Gonvick, MN 56644  
(218)487-5279

Dynamic Resources, Inc.  
Norman Nelson  
Rt. 3, Box 277  
Bagley, MN 56621  
(218)657-2272 or (218)657-2501

## DENSIFIED FUEL PELLET SUPPLIERS OUTSIDE MINNESOTA

Forest Fuel Corp.  
Route 2, Box 205-B1  
Mason, WI 54856  
(715)372-4024

LaCrosse Milling Co.  
Box 86  
Cochrane, WI 54622  
(608)248-2222

Whetstone Pelleting  
Rural Route 1, Box 52  
Milbank, SD 57252  
(605)432-5020

## DENSIFIED FUEL LOG/BRIQUETTE SUPPLIERS IN MINNESOTA

Sonoco Products Division  
P.O. Box 69  
Pine River, MN 56474  
(218)587-4432

Maust Fiber Fuels, Inc.  
Preston, MN 55965  
(507)765-2188 or  
(507)765-2126

Ferche Millwork, Inc.  
P.O. Box 39  
Rice, MN 56367  
(612)393-2288

Bemidji Fiber Fuels, Inc.  
919 Carr Lake Road S.E., Box 126  
Bemidji, MN 56601  
(218)759-1450

## PEAT FUEL SUPPLIERS

Lindquist Logging  
Route 1, Box 48C  
Swatara, MN 55785  
(218)697-8296

Peat Production  
81 N. Lake Street  
Forest Lake, MN 55025  
(612)464-7996

## FIBER FUEL DISTRIBUTORS

Forest Fuels, Inc.  
1020 Washington St.  
Brainerd, MN 56401  
(218)828-0904

H & H Wood Products  
Rt. 1, Box 146  
Floodwood, MN 55736  
(218)476-2860

Nordheim Sheet Metal Co.  
First St. & Minnesota Ave.  
Bemidji, MN 56601  
(218)751-3923

Fiber Fuel Finders, Inc.  
R.R. 5, Box 372  
Brainerd, MN 56401  
(218)963-7582 Attn: Don McHale



# FIBER FUEL SUPPLIERS

## GREEN WOOD FUEL SUPPLIERS

Green wood fuel is generally available from three sources:

- \* Wood Processing Industry
- \* Tree Service Companies
- \* Full Tree Chippers

### Wood Processing Industry

There are over 700 sawmills and 1,000 secondary manufacturers statewide that can supply wood residues in the form of bark, sawdust, slabs and edgings, cut-offs, shavings, and sanderdust. Of the sawmills, over 30 have debarking and chipping machinery that produce chips which are available for fuel.

Contact DNR, Division of Forestry (612/296-6491) for a complete list of wood products manufacturers.

### Tree Service Companies

Most municipalities throughout the state are serviced by tree service companies. Most of these companies have facilities that produce chips which are available for fuel.

### Full Tree Chipper Operations

The following is a partial list of full tree harvesting operations which could supply green chips for fuel:

Bergstom Logging Company  
516 Second Avenue  
International Falls, MN 56649  
(218)283-4477

Ratzlaff Logging & Lumber  
508 1st Street  
Princeton, MN 55371  
(612)389-3801

Larry Mannausau  
Northwoods Chipping, Inc.  
International Falls, MN 56649  
(218)276-2316

McCabe Forest Products  
119 West Lewis Street  
Duluth, MN 55803  
(218)724-8070

Larry Pelland  
Loman, MN 56654  
(218)279-3344

Stan's Wood Chips  
Box 345  
Big Falls, MN 56627  
(218)276-2490

Arthur Newgren  
RR 1  
Cromwell, MN 55726  
(218)644-3630

Korhonen Timber Products  
221 East Park Drive  
Hibbing, MN 55746  
(218)263-7420

Ziemba & Sons  
Route 2, Box 16  
Littlefork, MN 56653  
(218)278-6735

Roger Anwiler  
RR 2, Box 55A  
Bovey, MN 55709  
(218)245-1057

Dave Baumgarten  
Superior Forest Products  
2555 London Road  
Duluth, MN 55812  
(218)728-5159

Richard Demars & Sons  
Ray, MN 56669  
(218)875-3435

Alvin Lindquist  
Hill City, MN 55748  
(218)697-8296

Hasbargen Logging Inc.  
Route 3, Box 814  
Birchdale, MN 56629  
(218)634-2174

Dick Walsh Forest Products  
Itasca Star Route  
Park Rapids, MN 56470  
(218)732-5665

## PRICES

Densified Fuel Prices: \$50 - \$55/Ton Delivered  
(Prices vary with location, volume and shipping distance)

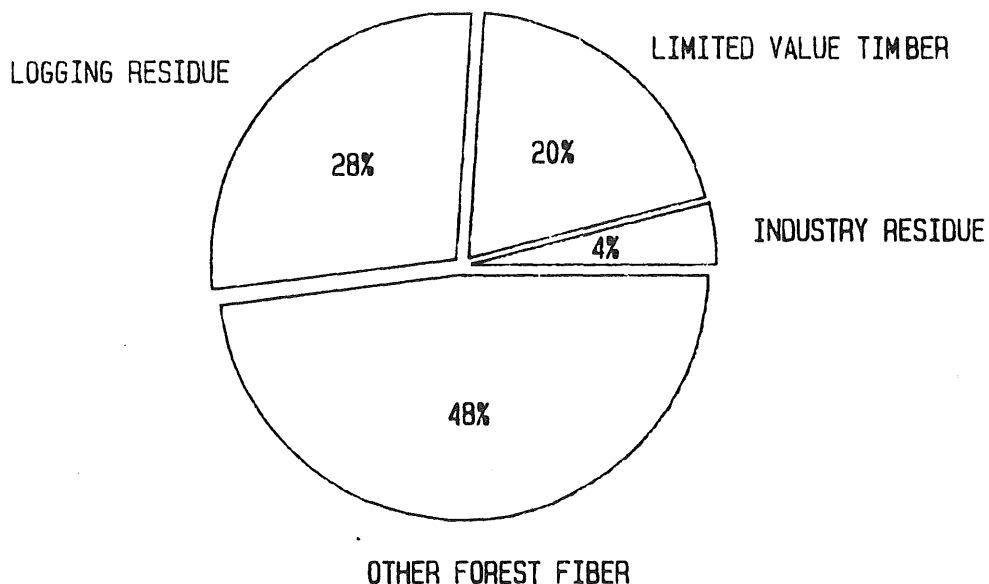
Chips: \$15 - \$24/Ton Delivered

Sawdust & Bark: \$7 - \$12/Ton Delivered

(Prices vary with location, volume and shipping distance)

## WOOD FUEL RESOURCE AVAILABILITY

### SURPLUS WOOD AVAILABLE FOR ENERGY - 1986



OF THE OVER 4 MILLION CORDS OF WOOD AVAILABLE FOR ENERGY ANNUALLY, AT LEAST 2.5 MILLION CORDS ARE NOT CURRENTLY BEING USED.

#### SOURCES OF WOOD AVAILABLE FOR ENERGY

LIMITED VALUE TIMBER = low quality standing hardwood trees not currently used by existing wood industry.

INDUSTRY RESIDUE = unused wood residue generated by the forest products industry (bark, sawdust, slabs, edgings, etc.).

LOGGING RESIDUE = limbs and unmerchantable trees left after commercial timber harvest.

OTHER FOREST FIBER = wood available from land clearing, natural tree mortality, non-commercial forest lands, etc.

NOTE: One cord (or cord equivalent) of wood equals approximately 5,000 pounds of green wood and bark or 2,500 pounds of dry fiber.

Source: Dept. of Natural Resources, Div. of Forestry



## PEAT FUEL RESOURCE AVAILABILITY

Minnesota contains between 6 and 7 million acres of peatland. Deposits are found throughout the state, except in the extreme southwest and southeast. Large, contiguous peatlands occur in the northern half of the state, while smaller, scattered peatlands occur in the southern half.

Approximately 50 percent of the state's peat resource is publicly owned, with most of the public ownership concentrated in the northern part of the state. It is estimated that approximately 10 percent of Minnesota's peatlands have energy potential. About 90 percent of these peatlands would be suited for milled peat harvesting, 10 percent would be suited for sod peat.

### Some Milestones in Minnesota Peat Energy Development

- \* 1984. A private firm mined 9,500 tons of fuel peat for use in DNR testing program.
- \* Tests using peat pellets and sod peat have led the Virginia Public Utilities Commission to contract for up to 6,000 tons of sod peat during 1985, the first large contract for fuel peat in Minnesota.
- \* Tests at U of M, Duluth have shown that peat in either pellet or sod form can be used as feedstock in a gasifier.
- \* The largest test of fuel peat ever conducted in North America (25,000 tons of peat) will commence at the Minnesota Power and Light Laskin Station in 1985.
- \* Blandin Paper Company is currently testing 1,500 tons of peat fuel in their co-generation plant.
- \* Boise Cascade has become interested in peat fuel for their International Falls paper mill.

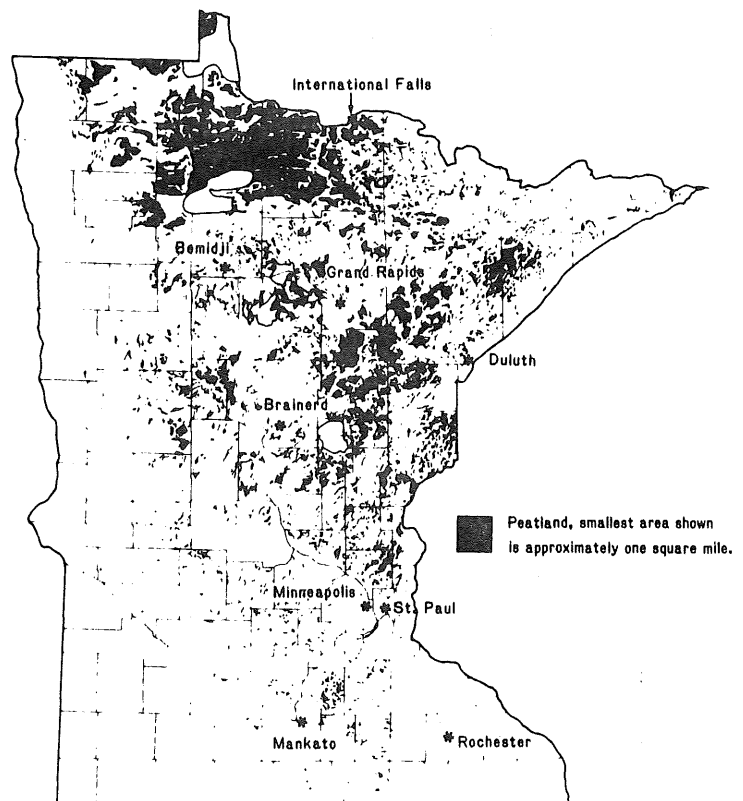
\* The Hibbing Public Utility conducted a test burn of 1,000 tons of peat fuel in March - April 1985.

\* Cambridge State Hospital has successfully tested pelletized peat fuel.

### FOR FURTHER INFORMATION CONTACT:

Minnesota Dept. of Natural Resources  
Division of Minerals  
Box 45, DNR Building  
500 Lafayette Road  
St. Paul, Minnesota 55146  
(Telephone: 612-296-4807)

### MINNESOTA PEAT RESOURCES



Source: Minnesota Department of Natural Resources, Peat Project, 1975.

## AGRICULTURAL RESIDUE FUEL AVAILABILITY

Agricultural residue is the fiber remaining after the harvest of crops. It is estimated that Minnesota produces over ten million dry tons of crop residues every year. In addition to the residues remaining in the field there are large quantities of material produced as a result of agricultural processing operations.

The accompanying map indicates the relative distribution of residues throughout southern and western Minnesota. The figures show the average available tonnages which can be removed from the field and the percentage of total residue production which this tonnage represents. These residues constitute a large, as yet, unused, fiber fuel resource.

Plans for the removal of crop residues from the field should be tempered by the following quote from "Crop Residue Removal and Tillage" by M.J. Lindstrom, et al.

"Optimum use of crop residues will require careful consideration of alternate uses - soil and environment protection, feed for livestock, or energy and industrial purposes. We think that the need to maintain soil productivity should be the first consideration. If residues are needed for erosion control or maintenance of soil structure, and economically feasible alternatives are not available, then residues should remain on the land. However, if the soil's needs can be met with partial or total removal of the crop residues, then there should be no objection to their removal. We caution, however, that any removal of residue from the field should be done only with a full understanding of the possible consequences."

Agricultural processors produce large quantities of waste products which have potential value as an energy resource. Material characteristics and availability vary by region; for example, there is about 70,000 tons of oat hulls available annually in the Twin Cities area.

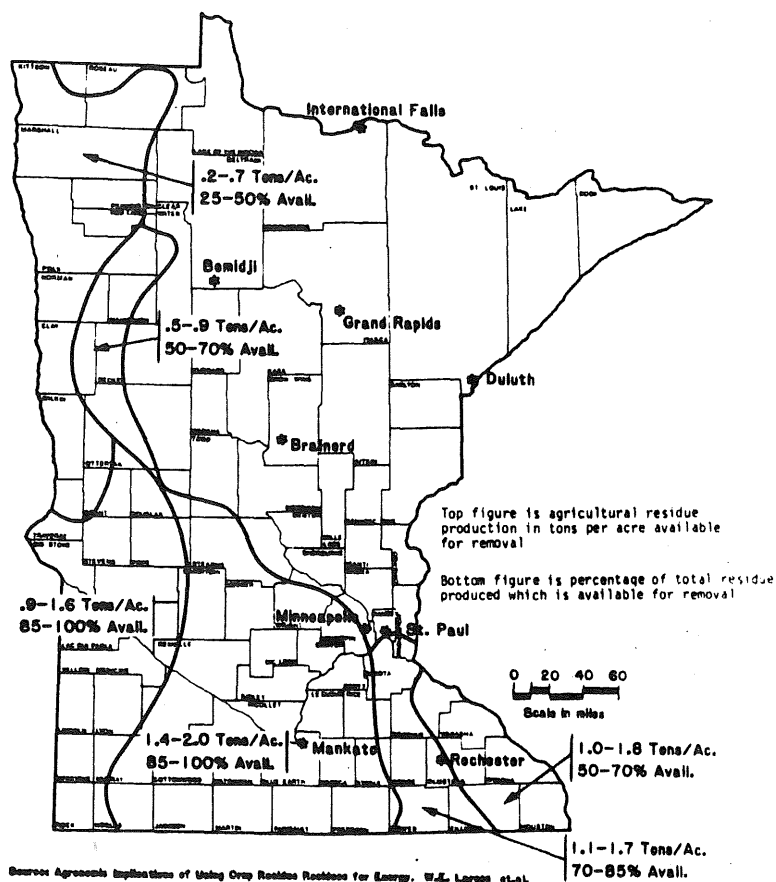
Minnesota farms also have the potential for producing energy crops as an alternative to traditional crops. Examples of such crops include sweet sorghum, sunflowers and hybrid poplars.

Various agricultural residues have different combustion characteristics and must be considered individually.

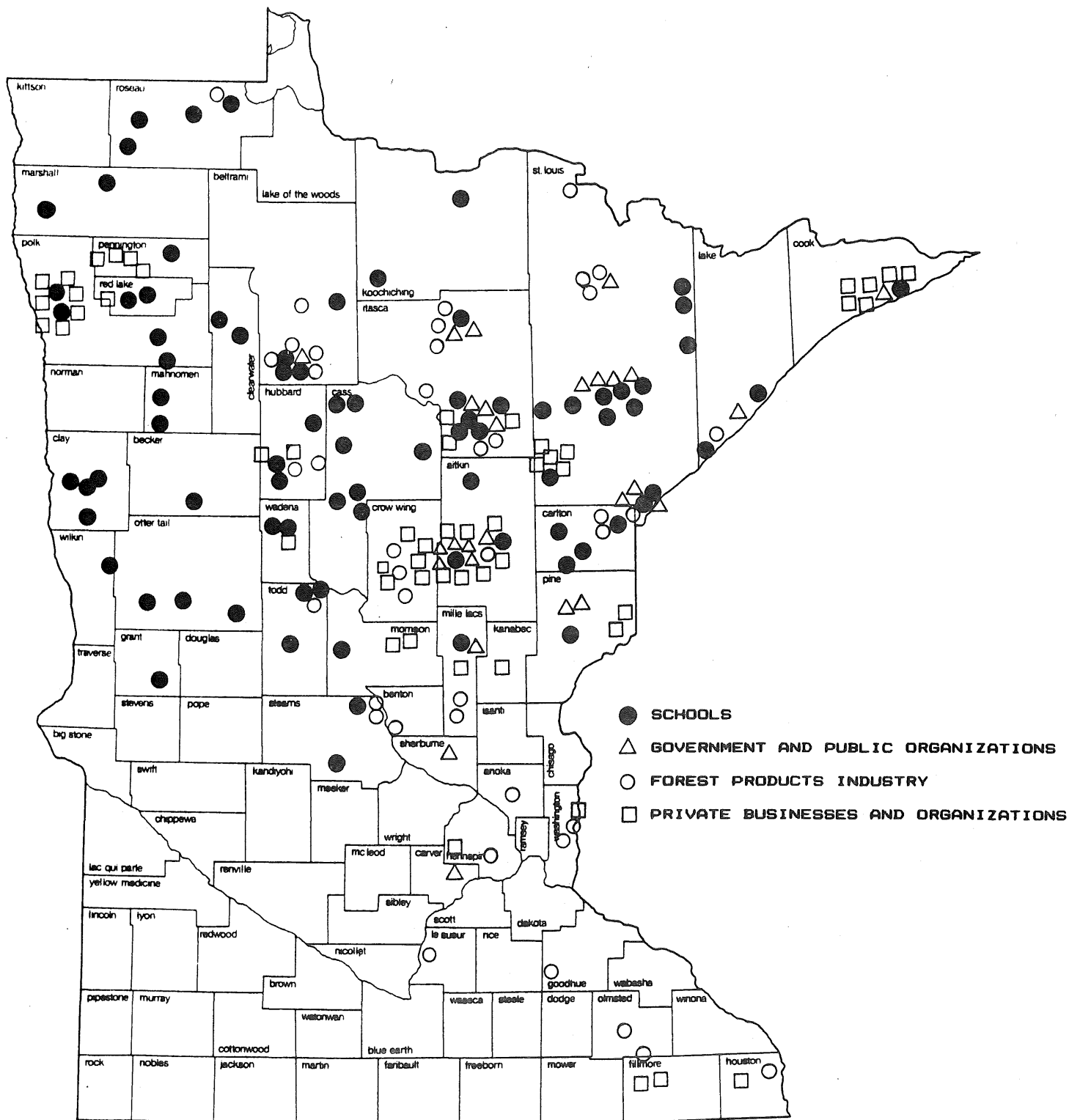
### FOR FURTHER INFORMATION CONTACT:

Minnesota Department of Energy  
and Economic Development  
900 American Center Building  
150 East Kellogg Boulevard  
St. Paul, Minnesota 55101  
(Telephone: 612/297-1291)

### CROP RESIDUE PRODUCTION AND AVAILABILITY



# CURRENT FIBER FUEL USERS IN MINNESOTA



# CURRENT FIBER FUEL USERS IN MINNESOTA

The following list of fiber fuel users is surely not complete but gives an indication of the scope of fiber fuel use in Minnesota. Information sources include Dept. of Natural Resources surveys, Dept. of Energy and Economic Development surveys and the Great Lakes Region Biomass Energy Facilities 1985 Directory. Missing data in any of the lists only indicates that the surveys did not generate those specific data.

## SCHOOLS USING FIBER FUEL

SCHOOL	LOCATION	FUEL TYPE	TONS USED	TONS USED	SYSTEM TYPE
			83/84 SEASON	84/85 SEASON	
Aitkin Jr-Sr High School	Aitkin	Dist. Heating from ASHCON			District Heating
Argyle Public School	Argyle	Pellets		61	Stoker
Aurora-Hoyt Lakes High Sc	Aurora	Pellets	735	341	Suspension
John F. Kennedy High Schl	Babbitt	Green Chips	0	312	Gasifier
Backus Public School	Backus	Pellets	221		Stoker
Badger School	Badger	Pellets	117	259	Stoker
Barnesville High School	Barnesville	Pellets(sugar beet seeds)	391	474	Sidewinder
Barnesville Elem. School	Barnesville	Pellets(sugar beet seeds)		253	Sidewinder
Barnum High School	Barnum	Green Chips	230	321	Pneu. Injector
Battle Lake Public School	Battle Lake	Pellets			Sidewinder
Bemidji High School	Bemidji	Green Wood Residue		136	Pneu. Injector
Bemidji Middle School	Bemidji	Green Chips		964	Pneu. Injector
Bemidji State University	Bemidji	Green Wood Residue			
Bigfork Public School	Bigfork	Pellets	165	226	Stoker
Biwabik School Complex	Biwabik	Pellets		324	Stoker
Blackduck Public School	Blackduck	Pellets	324	450	Sidewinder
Conner-Jasper Middle Schl	Bovey	Pellets	480	543	Stoker
Martin Hughes School	Buhl	Green Chips			Gasifier
Carlton High School	Carlton	Green Chips		570	Sidewinder
Cass Lake Elem. School	Cass Lake	Pellets	128	199	Stoker
Cass Lake High School	Cass Lake	Pellets	167	219	Stoker
Chisholm Jr-Sr High Schl	Chisholm	Green Chips	128	744	Pneu. Injector
Clarissa Public School	Clarissa	Pellets	348	369	Stoker
Clearbrook Public School	Clearbrook	Pellets	347	292	Stoker
Cohasset School	Cohasset	Pellets	250	265	Stoker
Greenway High School	Coleraine	Pellets	481	814	stoker
Cromwell	Cromwell	Pellets			Stoker
Central High School	Crookston	Pellets	720	405	Sidewinder
Washington Elem. School	Crookston			121	
Dilworth Public School	Dilworth	Pellets(sugar beet seeds)	37	219	Sidewinder
Central Administration	Duluth	Pellets		380	Suspension
St. Scholastica College	Duluth	Pellets	2500		Suspension
Watkins Secondary School	Eden Valley	Briquettes		121	Gravity Feed
Memorial High School	Ely	Green Chips			Gasifier
Vermillion Community Col.	Ely	Green Chips	784		
Ersikine School	Ersikine	Pellets			Stoker
Fergus Falls	Fergus Falls	Briquettes			Gravity Feed
Lincoln School	Floodwood	Pellets	456	468	Stoker
Gilbert Public School	Gilbert	Pellets		126	Suspension
Glyndon	Glyndon	Pellets			Sidewinder
Gonvick-Trail School	Gonvick	Pellets (wood & marigold)		146	Stoker
Goodridge Public School	Goodridge	Pellets	217	187	Stoker
Grand Marais High School	Grand Marais	Green Chips			Pneu. Injector
Forest Lake School	Grand Rapids	Pellets			Stoker
Grand Rapids Sr High Schl	Grand Rapids	Pellets			Sidewinder
Grand Rapids Middle Schl	Grand Rapids	Pellets	1138	1286	Sidewinder
Edna I. Murphy School	Grand Rapids	Pellets			Stoker
Greenbush Community Schl	Greenbush	Pellets	277	284	Stoker
Hill City School	Hill City	Green Chips	544	388	Stoker
Holdingford	Holdingford	Briquettes			Gravity Feed
Keewatin Jr Hgh/Elem Schl	Keewatin	Pellets	16	245	Stoker
Laporte School	Laporte	Pellets	172	142	Stoker
Littlefork-Bigfalls High	Littlefork	Pellets	331	269	Stoker
Mahnomen	Mahnomen	Green Chips			Sidewinder
McGregor Public School	McGregor	Pellets	534	552	Stoker
McIntosh Public School	McIntosh	Pellets	357	305	Stoker
Menahga Public School	Menahga	Briquettes	454	357	Gravity Feed
Moose Lake Public School	Moose Lake	Green Chips			Gravity Feed
Motley Public School	Motley	Sawdust			Suspension

# CURRENT FIBER FUEL USERS IN MINNESOTA

## SCHOOLS USING FIBER FUEL

SCHOOL	LOCATION	FUEL TYPE	TONS USED		SYSTEM TYPE
			83/84 SEASON	84/85 SEASON	
Merritt Elem. School	Mountain Iron	Pellets			Stoker
Mt. Iron-Buhl High School	Mountain Iron	Pellets			Suspension
Northome School	Northome	Pellets	216	324	Stoker
Onamia High School	Onamia	Pellets	216	146	Sidewinder
Park Rapids Middle School	Park Rapids	Pellets			Sidewinder
Park Rapids High School	Park Rapids	Pellets			Raw Stoker
Parkers Prairie High Schl	Parkers Prairie	Briquettes		14	Gravity Feed
Pequot Lakes Public Schl	Pequot Lakes	Briquettes		566	Gravity Feed
Pine River High School	Pine River	Briquettes	318	456	Gravity Feed
Pine River Elem School	Pine River	Briquettes	261	318	Gravity Feed
Lafayette High School	Red Lake Falls	Pellets	205	205	Stoker
St. Joseph Sch and Church	Red Lake Falls	Pellets			
Northland High School	Romer	Pellets			Stoker
Roseau Public School	Roseau	Pellets			Stoker
Rothsay Public School	Rothsay	Pellets		212	Sidewinder
Sandstone	Sandstone	Pellets			Stoker
Wm Kelley High School	Silver Bay	Green Chips	802	1657	Pneu. Injector
Staples High School	Staples	Green Chips			Stoker
Staples AVTI	Staples	Green Chips			Gravity Feed
Strandquist School	Strandquist	Pellets			Stoker
Swanville Public School	Swanville	Pellets	363	328	Stoker
Two Harbors High School	Two Harbors	Green Chips	875	1374	Pneu. Injector
Walker-Hackensack School	Walker	Pellets	433	449	Stoker
Warroad	Warroad	Waste Wood			Stoker
Waubun Elem-Secondary Sch	Waubun	Pellets	65	355	Stoker

## GOVERNMENT AND PUBLIC ORGANIZATIONS USING FIBER FUEL

ORGANIZATION	LOCATION	FUEL TYPE	TONS per YR	SYSTEM TYPE
Aitkin City Offices	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Co. Courthouse	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Co. Courthouse Annex	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Co. Library	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Co. Sheriff Office	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Fire Department	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Aitkin Public Utilities	Aitkin	Dist. Heating from ASHCON		District Heating (steam)
Chisholm/Hibbing Airport	Hibbing	Pellets		
Community Center	Floodwood	Pellets		
DNR - French R. Hatchery	Duluth	pellets	650	Underfeed Stoker
DNR - Gen. Andrews Nurs'y	Willow River	Pellets	80	Underfeed Stoker
DNR - Gooseberry Falls Pk	Gooseberry Falls	Pellets	25	Underfeed Stoker
DNR - North Service Centr	Grand Rapids	Green Chips	450	Gravity Feed - Grate
DNR - Regional Gar./Shop	Grand Rapids	Pellets	40	Underfeed Stoker
DNR - Savanna State Park	McGregor	Pellets	25	Underfeed Stoker
DNR - Scenic State Park	Bigfork	Pellets	15	Underfeed Stoker
DNR - Tower Soudan Park	Tower	Pellets	65	Underfeed Stoker, 2 Units
DOT - District Office	Bemidji	Pellets		
DOT - Isle Truck Station	Isle	Pellets	30	Underfeed Stoker
DOT - Monticello Trk Sta	Monticello	Pellets	70	Underfeed Stoker
DOT - Nopeming Truck Sta.	Duluth	Pellets	60	Underfeed Stoker
Grand Marais Munic. Pool	Grand Marais	Green Chips	400	
Grand Marais Sch Bus Gar	Grand Marais	Green Chips		
Grand Marias Hospital	Grand Marias	Green Chips		
Iron Range Interp.Center	Chisholm	Green Chips, Peat		
IRRRB - Giants Ridge Ski	Biwabik	Pellets		
Itasca County Garage	Bigfork	Pellets		
Itasca Memorial Hospital	Grand Rapids	Pellets		
Northwest Exp. Sta. Barn	Crookston			
Shakopee Correctional	Shakopee	Green Chips		
St. Louis Co. Tool House	Virginia	Pellets	200	Stoker
W. Lk. Superior San. Dist	Duluth	Green Chips		
Willow River Correctional	Willow River	Chunk Wood		Garn

# CURRENT FIBER FUEL USERS IN MINNESOTA

## FOREST PRODUCTS INDUSTRIES USING FIBER FUEL

BUSINESS	LOCATION	FUEL TYPE	TONS per YR	SYSTEM TYPE
Adams, Rudy	Le Sueur		38	
Anderson Corporation	Bayport	Sawdust	24,000	Suspension Burner
Aspen Fiber Corp.	Marcell	Green Wood Residue	5,400	Pile Burner
Bagley Kiln & Component	Bagley	Dry Wood Residue		Suspension Burner
Blandin Paper Co.	Grand Rapids	Green Wood Residue	280,000	Traveling Grate; Co-Gen.
Blandin Wood Products	Grand Rapids	Green Wood Residue	40,000	Suspension Burner
Boise Cascade Corp.	International Falls	Green Residue, Chips	90,000	Vibrating Grate; Co-Gen.
Bourman-Shims-Stakes-Fuel	Spring Lake		20	
Brainerd Hardwoods	Brainerd	Dry Wood Residue		
Champion International	Sartell	Green Wood Residue	50,260	Traveling Grate; Co-Gen.
Clover Valley Sawmill	Two Harbors		52	
DeWandler, Wettles & Weav	Ponsford		47	
Diamond Brands	Cloquet	Green Wood Residue	11,400	
E & R Enterprises	Cook		87	
Ferche Millwork, Inc.	Rice	Dry Wood Residue	4,000	Suspension Burner
Foldcraft Co.	Kenyon	Dry Wood Residue		
Forbes Wood Products	Park Rapids	Green Chips		
Grunig Administration	Badger	Green Wood Residue		
Hanson Woodshed	Sherburn	Green Wood Residue		
Hedstrom Lumber Co.	Grand Marais	Green Wood Residue	8,000	Grate Burner
Hill Wood Products	Cook	Dry Wood Residue		
Indian Wood	Ogema	Chunk Wood		Garn
Lahmers Construction	Rochester			
Lake Elmo Hardwood	Lake Elmo	Dry Wood Residue	300	Pneumatic Injection
Land-O-Lakes Wood Pres.	Tenstrike	Green Wood Residue		
Marcell Mill & Lumber	Marcell	Pellets	5	Underfeed Stoker Furnace
Marvin Windows	Warroad	Dry Wood Residue	4,500	Injection Over Grate
Minn. Sawdust & Shavings	Anoka	Green & Dry Wood Residue	1,250	Suspension Burner
Northwood Panelboard	Bemidji	Green Wood Residue	60,000	Stationary Grate
Potlatch Corp.	Bemidji	Green Wood Residue	50,000	Suspension Burner
Potlatch Corp.	Cloquet	Green Wood Residue	258,700	Water Tube - Grate
Potlatch Corp.	Cook	Green Wood Residue	16,200	Stationary Grate
Rajala Mill Co.	Bigfork	Green Wood Residue	2,565	Auger Fed Stoker
Rajala Timber Co.	Deer River	Green Wood Residue		
Seeba's Shop	Fergus Falls		27	
Seven Star Lumber Co.	Milaca		40	
Sleepy Hollow Millwork	Fort Ripley	Dry Wood Residue		
SONOCO Products	Pine River	Green Wood Residue	2,000	Stoker
Steamboat Sawmill	Bemidji		58	
Superwood Corp.	Bemidji	Green Wood Residue	25,000	Stnry Grate, Dutch Oven
Superwood Corp.	Duluth	Green Wood Residue	18,000	Grate and Suspension
Thompson Hardwood Lumber	Minneapolis	Dry Wood Residue	200	Suspension Burner
Toms Wood Service	Bemidji		32	
Tri-State Forest Products	Hokah	Green Residue, Chips	200	Trvlg Bed, Underfire Stkr
Tuohy Furniture	Chatfield	Dry Wood Residue	550	
Warner Manufacturing	Akeley	Dry Wood Residue		
Warrenwood, Inc.	Rice	Dry Wood Residue		
Winkelman Bros.	Northome	Green Wood Residue	167	
Woodcraft Indust., Inc.	Foreston	Dry Wood Residue	3,000	Suspension Burner
Woodcraft Indust., Inc.	St. Cloud	Dry Wood Residue	3,000	Suspension Burner
Woodland Container, Inc.	Aitkin	Green Wood Residue	3,500	
Woodland Container, Inc.	Staples	Green Wood Residue		

# CURRENT FIBER FUEL USERS IN MINNESOTA

## PRIVATE BUSINESSES AND ORGANIZATIONS USING FIBER FUEL

FIRM or ORG	LOCATION	FUEL TYPE	TONS per YR	SYSTEM TYPE
A&E Industries	Avon			
Advance Machine Company	Plymouth	Green Wood Chips	1,300	Gravity Feed
Anaco Inc.	Crosby	Pellets	20	Stoker-Forced Air Furnace
Anderson Construction	Brainerd	Pellets		
ASHCON Inc. Dist. Heating	Aitkin	Green Wood Chips	2,200	Underfeed Stoker
Assoc. Plumbing & Heating	Crookston	Pellets (wood, sunflower)	24	Hot Water Boiler
Baptist Church	Floodwood	Pellets		
Bearskin Lodge	Grand Marais	Green Wood Chips		
Bel Air Motel	Bemidji	Chunk Wood		Garn
Berger Apartments & Store	Erskine	Pellets		
Camp Shamaineau	Motley	Pellets	55	Low Pressure Boiler
Coca Cola Bottling	Crookston	Pellets	40	Auto Stoker
Combo Furnace Sales	St. Francis	Pellets		
Crest Motel & Supper Club	Caledonia	Green Wood Residue		
Crosby Carwash & Laundry	Crosby	Sawdust	500	
Crosby Theater	Crosby			
D & J Machining	Brainerd	Pellets	30	
Dan & Jerry's Greenhouse	Buffalo			
Earl Holasek Greenhouse	Chanhassen	Green Fuel		
Eichof Building	Crookston	Pellets		
Fabridyne & Custom Prod.	Litchfield	Pellets	350	Under Feed Stoker
First National Bank	Aitkin	Dist. Heating from ASHCON		
Fleet Supply	Mora	Pellets		
Floodwood Catholic Church	Floodwood	Pellets		
Floodwood Hardware	Floodwood	Pellets		
G&L Supply	Aitkin	Dist. Heating From ASHCON		
Galloway Boys Ranch	Wahkon	Chunk Wood		Garn
Garth Meschke Turkey Farm	Little Falls	Pellets		
Gehling Implemnet	Preston	Green Wood Residue		
Gessel Feed Mill	Swanville	Pellets (sunflower)	500	
GLARCO	Aitkin	Dist. Heating From ASHCON		
Glenmore Foundation	Crookston	Pellets		
GT Auto Parts	Floodwood	Pellets		
Gustafson Apartments	Warren	Pellets		
Herbies Market	Red Lake Falls	Pellets		
Humble Stove Co.	Rushford	Green Fuel		
Isle Automotive	Isle	Pellets		Under Feed Stoker
Jesus is King Church	Thief River Falls	Pellets (sunflower hulls)	12	Auger-Stoker
L&A Tool Company	Aitkin	Dist. Heating from ASHCON		
Len Busch Greenhouse	Hamel	Green Wood Residue		
LePier Tire	Crookston	Pellets		
Lutheran Church	Floodwood	Pellets		
Midway Service Station	Grand Marais	Green Wood Chips		
Mills Fur Farm	Eden Valley			
Mjolsness Shop	Felton	Pellets		
North Country Tire	Hackensack			
North Shore Building	Grand Marais	Green Wood Chips		
North Shore Dairy & Laund	Grand Marais	Green Wood Chips		
Northern Manufacturing	Staples	Pellets		



# CURRENT FIBER FUEL USERS IN MINNESOTA

## PRIVATE BUSINESSES AND ORGANIZATIONS USING FIBER FUEL

FIRM or ORG	LOCATION	FUEL TYPE	TONS per YR	SYSTEM TYPE
Northern States Power Co.	Bayport	Dry Wood Residue		Suspension/Co-generation
Northwest Hospital	Thief River Falls			
Osterberg Furniture	Mora	Pellets		
Park Rapids Floral	Park Rapids	Green Fuel		
Pine River Group Home	Pine River	Pellets	21	Forced Air Furnace
Pizza Outlet	Aitkin	Dist. Heating from ASHCON		
Poly Foam, Inc.	Lester Prairie	Green Chips	5,200	Injector
Red Pine Alfalfa	Crookston			
Rivard Quality Seeds	Argyle	Pellets (sunflower hulls)	500	Stoker
Roy Apartments	Grand Rapids	Pellets		
Sears Store	Litchfield	Pellets	15	Under Feed Stoker
Solbakken Resort		Chunk Wood		Garn
Spalding House	Crosby	Pellets	100	
Spectrum Metals	Isle	Chunk Wood		Garn
St. Francis Hospital	Little Falls	Green Wood Chips		Pneu. Injector
St. James Catholic Church	Aitkin	Dist. Heating from ASHCON		
Thompson Greenhouse	Thief River Falls	Pellets	150	Stoker-Forced Air Furnace
Tomteboda Motel	Grand Marais	Green Wood Chips		
Village Laundromat	Aitkin	Green Wood Residue		Stoker
Village of Smokey Hills	Osage	Chunk Wood		Garn
Wadena Floral	Wadena			
Wilder Boys Camp	Markville	Chunk Wood		Garn
Wilder Girls Camp	Markville	Chunk Wood		Garn

## Summary of Fiber Fuel Users

<u>User Category</u>	<u>Number of Installations</u>
Schools	84
Government and Public Organizations	33
Forest Products Industries	52
Private Businesses and Organizations	<u>72</u>
TOTAL	241

See page 18 for summary of the growth of commercial wood energy use in Minnesota since 1970.

# CONSULTANTS IN THE FIBER FUELS INDUSTRY

The following is a list of consultants providing services to fiber fuels users. This list is meant to be representative and certainly does not contain all of those firms and individuals capable of providing such services. Inclusion or omission from this list does not constitute endorsement by the publishers of this report.

<u>CONSULTANTS</u>	<u>SERVICES OFFERED</u>	<u>SYSTEM TYPES</u>	<u>SIZE</u>
1) Architectural Resources Inc. 704 East Howard St. Hibbing, MN 55746 (218/263-6868) Parnell Satre P.E.	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification	Residential Commercial Institutional Industrial
2) Blesi-Evans Co. 2533 24th Ave. So. Minneapolis, MN 55406 (612/721-6237) Mark Evans	Equipment Supplier Design Project Feasibility System Analysis	Green Fuel Densified Fuel Co-Generation Etc.	Commercial Institutional Industrial
3) Diversified Energy Consultants P.O. Box 387 Oakland, Iowa 51560 (712/482-3666) Oren Hodges/Dave Merrill	Equipment Supplier Design Project Feasibility System Analysis	Green Fuel Densified Fuel	Residential Commercial Institutional Industrial
4) Energy Research Associates 2115 West Norfolk Mequon, Wisconsin 53092 (414/242-6427) Richard C. Wright P.E.	Design Project Feasibility System Analysis Testing	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Residential Commercial Institutional Industrial
5) Energy Resource Systems Inc. 424 West County Road D Roseville, MN 55112 (612/631-1681)	Equipment Supplier Design Project Feasibility System Analysis Installation Testing	Green Fuel Densified Fuel Co-Generation Etc.	Commercial Institutional Industrial
7) Eumurian Associates 9707 Janero St. No. Mahtomedi, MN 55115 (612/631-1681)	Design Project Feasibility System Analysis	Gasification	Industrial
8) Forest Fuels Inc. 1020 Washington St. Brainerd, MN 56401 (218/828-0904) Bob Despot	Equipment Supplier Design Project Feasibility Systems Analysis Installation Testing	Green Fuel Densified Fuel	Commercial Institutional Industrial
9) Garn Inc. 384 West County Road D St. Paul, MN 55112 (612/633-1357) John Terpstra	Equipment Supplier Design Project Feasibility System Analysis	Green Fuel	Residential Commercial Institutional Industrial
10) General Heating & Engineering 1922 W. Superior St. Duluth, MN 55806 (218/727-1888) Brian Broden	Equipment Supplier Design Project Feasibility System Analysis Installation Testing	Green Fuel Densified Fuel	Commercial Institutional Industrial
11) HDR Techserv Inc. 5401 Gamble Drive Suite 300 Minneapolis, MN 55416 (612/544-7741) Don Krebs	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial

# CONSULTANTS IN THE FIBER FUELS INDUSTRY

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<u>CONSULTANTS</u>	<u>SERVICES OFFERED</u>	<u>SYSTEM TYPES</u>	<u>SIZE</u>
12) Horthy-Elving & Associates 505 East Grant St. Minneapolis, MN 55404 (612/332-4422) Jim Elving	Design Project Feasibility System Analysis	Green Fuel Densified Fuel	Commercial Institutional
13) I.E. Associates 3704 11th Ave. South Minneapolis, MN 55407 (612/823-3154) Tom Abeles	Design Project Feasibility System Analysis Project Financing	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
14) Jacobson Machine Works, Inc. 2445 Nevada Ave. No. Minneapolis, MN 55427 (612/544-8781) Bob White	Equipment Supplier System Analysis	Green Fuel Densified Fuel Gasification	Commercial Institutional Industrial
15) John E. Foss P.E. 3215 Riverside Drive Moorhead, MN 56560 (218/236-1540)	Design Project Feasibility System Analysis	Densified Fuel	Commercial Institutional
16) Joseph V. Edeskuty & Associates 15255 Minnetonka Blvd. Minnetonka, MN 55345 (612/933-5677) Robert Von Edeskuty	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
17) JRJ Inc. - Engineering Services R.R. 1, Box 90 Pengilly, MN 55775 (218/885-1525) Ray Jacobson	Design Project Feasibility System Analysis	Green Fuel Densified Fuel	Commercial Institutional Industrial
18) KMW Systems Inc. Wolf Island Road, Box 4101 Hayward, Wisconsin 54843 (715/462-9533)	Equipment Supplier Design Project Feasibility System Analysis Installation	Green Fuel Densified Fuel Co-Generation Etc.	Commercial Institutional Industrial
19) Lundquist, Wilmar, Schultz & M 821 Raymond Ave., Suite 300 St. Paul, MN 55114 (612/642-9771) Len Lundquist	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Co-Generation Etc.	Residential Commercial Institutional Industrial
20) Michaud, Cooley & Erickson 625 4th Ave So., Suite 1325 Minneapolis, MN 55415 (612/475-3419) Doug Cooley	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
21) Peat Energy Systems P.O. Box 69 Rosemount, MN 55068 612/423-5181 Ron Carlson	Equipment Supplier Design Project Feasibility System Analysis		
22) Peatalizer People P.O. Box 305 Red Lake Falls, MN 56750 (218/253-4243)	Design Project Feasibility System Analysis	Densified Fuel	Commercial Institutional Industrial
23) Posko Associates Inc. 20720 W. Watertown Rd, Suite 200 Waukesha, Wisconsin 53186 (414/786-7200) Tom Posko	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial

# CONSULTANTS IN THE FIBER FUELS INDUSTRY

CONSULTANTS	SERVICES OFFERED	SYSTEM TYPES	SIZE
24) R.W. Gorman Associates Inc. P.O. Box 548 Washburn, Wisconsin 54891 (715/373-2632) Richard Gorman	Equipment Supplier Design Project Feasibility System Analysis Installation	Green Fuel Densified Fuel Co-Generation Etc.	Residential Commercial Institutional Industrial
25) Richwood Company 310 Snelling Ave. No. St. Paul, MN 55104 (612/641-0460)	Equipment Supplier Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification	Commercial Institutional Industrial
26) Robert Massengill Inc./CPM 2524 118th Lane NW Coon Rapids, MN 55433 (612/332-1400)	Design Project Feasibility System Analysis	Densified Fuel	Residential Commercial Institutional Industrial
27) Robert O. Brown Co. 6885 Washington Ave. So. Edina, MN 55435 (612/941-8843)	Design Project Feasibility System Analysis Testing	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
28) Spaulding Engineering Ltd. 1821 University Ave. St. Paul, MN 55104 (612/644-5676) Roy Spaulding	Design Project Feasibility System Analysis Installation Testing	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
29) Sylva Energy Systems Inc. 519 Richard St. Thunder Bay, Ontario Canada P7A1R2 (807/683-6795) Terry Gunnell MN Contact: Wells Oswalt (612/251-6079)	Equipment Supplier Design Project Feasibility System Analysis Installation Testing	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Residential Commercial Institutional Industrial
30) Toltz, King, Duvall Anderson & Associates 2500 American Nat'l Bank Bldg. St. Paul, MN 55101 (612/292-4400) Jim Sebesta P.E.	Design Project Feasibility System Analysis	Green Fuel Densified Fuel Gasification Co-Generation Etc.	Commercial Institutional Industrial
31) T.S.P. 7301 Ohms Lane, Suite 480 Minneapolis, MN 55435 (612/830-0070) Rochester: (507/288-8155) Duluth : (218/722-6892)	Design Project Feasibility System Analysis Installation	Green Fuel Densified Fuel Co-Generation Etc.	Commercial Institutional Industrial
32) Sam Stewart & Associates, Inc. 3101 Old Hwy 8, Suite 201 Roseville, MN 55113 (612/636-9811) Sam Stewart	Design Project Feasibility System Analysis Testing	Green Fuel Densified Fuel Gasification Co-Generation	Commercial Institutional Industrial
33) Humble Manufacturing Hwy 43 N., Box 704 Rushford, MN 55971 (507/864-2525) Lee Humble	Equipment Supplier Design Installation Project Feasibility	Green Fuel Densified Fuel	Residential Commercial Institutional Industrial

**HOW TO CHOOSE A CONSULTANT:** Consultants vary by amount of experience, areas of major expertise, cost and location. To find the consultant to best serve your needs:

- \* Specifically identify and describe your needs.
- \* Solicit bids from several consultants.
- \* Ask each consultant for a list of similar clients served. Contact those clients to determine how their needs were met.

## SOURCES OF FIBER FUEL INFORMATION

<u>SOURCE</u>	<u>TYPE OF INFORMATION</u>
Minnesota Dept. of Energy & Economic Development Energy Information Center 900 American Center 150 East Kellogg Boulevard St. Paul, Minnesota 55101 Telephone: Twin Cities: 612-296-5175 MN Toll Free: 800-652-9747	Agricultural Residue Resources General Information Financial Resources
Minnesota Dept. of Natural Resources Division of Forestry Box 44, DNR Building 500 Lafayette Road St. Paul, Minnesota 55146 Telephone: 612-296-6491	Wood Resources Fiber Fuel Users Fiber Fuel Producers
Natural Resources Research Institute 3151 Miller Trunk Highway Duluth, Minnesota 55811 Telephone: 218-720-4294	Fiber Fuels Research and Development, Direct Industry Assistance
Fiber Fuels Institute 3072 Ranchview Lane P.O. Box 41191 Minneapolis, Minnesota 55447 Telephone: 612-559-8164	Fiber Fuel Standards Fiber Fuel Sources, Users, And Producers General Information
Solor Energy Research Institute Technical Inquiry Service 1617 Cole Boulevard Golden, Colorado 80401 Telephone: 303-231-7303	Information On Renewable Energy Research, Including Fiber Fuels
University of Minnesota 202 Kaufert Lab 2004 Folwell Avenue St. Paul, Minnesota 55108 Telephone: 612-624-3407	General Information On The Industrial/Commercial Use Of Wood For Energy
Minnesota Dept. of Natural Resources Division of Minerals Box 45, DNR Building 500 Lafayette Road St. Paul, Minnesota 55146 Telephone: 612-296-4807	Peat Resources Peat Combustion Peat Energy Development
Iron Range Resources & Rehabilitation Board Box 411 Eveleth, Minnesota 55734 Telephone: 218-744-2993	Financial Resources

# POLLUTION CONTROL REGULATIONS

## Synopsis of State Rules That Apply to Fiber Fueled Installations and Conversions

The following is a brief synopsis of State statutes and rules that pertain to air pollution and the owners or operators of fiber fueled boilers or heating equipment.

This synopsis is not intended to represent any State statute or rule in its entirety. Please consult the appropriate reference or the Minnesota Pollution Control Agency (MPCA) for additional information.

### Permits

An owner or operator of any fiber fueled boiler or heating device that has a rated heat input of more than five (5) million BTU's per hour is required to obtain a permit from the MPCA. Such a permit is required prior to construction of new equipment or modification of existing equipment. Minn. Statute 116.081, Subd. 1, (1982); 6 MCAR § 4.4303; 6 MCAR § 4.4001.

The owner/operator of fiber fueled equipment, should be prepared to provide the following information which is routinely requested by the Agency for issuance of a permit:

1. A completed MPCA boiler data sheet for the new or modified boilers and for any remaining boilers at the site.
2. Available test data of a similar installation provided by the equipment suppliers or other sources.
3. Layout and detail drawings that are available for the boiler, the building, the wood products fueling system and the wood products storage facility.
4. A listing of the suppliers and specifications of the wood fuel.
5. The anticipated annual usage of the wood fuel.
6. Assurance from the manufacturer that the equipment will meet all applicable State and federal air emission standards.

7. Written manufacturer's operating instructions which will result in the most efficient combustion and will enable the equipment to meet emission limits. Assuming they are available, and if not, they should be created by the manufacturer at the user's request.

Permit Applications or Additional Information can be Obtained by Contacting:

George Vasilakes  
Division of Air Quality  
Minnesota Pollution Control Agency  
1935 West County Road B2  
Roseville, Minnesota 55113  
(Telephone: 612-296-7325)

### Emission Standards

The owner or operator of a fiber fueled boiler or heating device must meet two (2) criteria to be in compliance with State emission limits.

First, gases emitted to the atmosphere from the device must not exceed 20% opacity (smoke density). 6 MCAR § 4.004.

Second, particulate matter in the exhaust gases must not exceed 0.4 or 0.6 pounds of particulate matter per million BTU's of heat input, depending on the age of the device and location in the State. 6 MCAR § 4.004.

Note: Units smaller than five (5) million BTU's heat input per hour are not exempt from these standards.

### Stack Testing

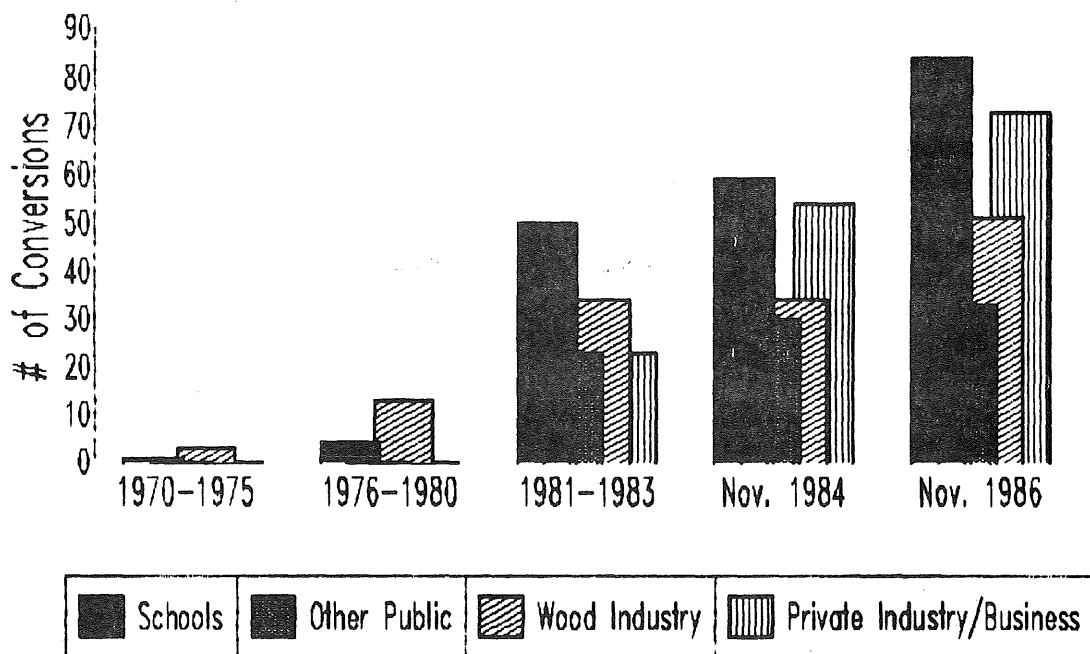
The MPCA has the authority to request the owner/operator to conduct a stack test in order to demonstrate compliance with emission standards. The cost of stack testing is the responsibility of the owner/operator. 6 MCAR § 4.4304.

### Enforcement

The MPCA has the authority to seek prosecution, civil penalties, injunction, or other legal remedies for violations of emission standards or permit requirements. Minn. Statute 115.071 (1982).

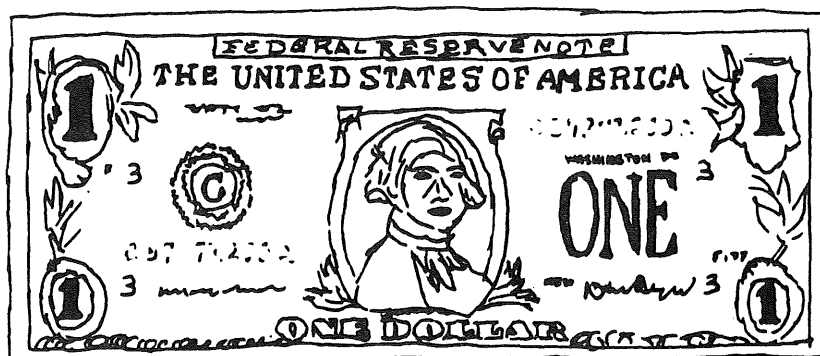
## FIBER FUEL FACTS

### GROWTH of COMMERCIAL WOOD ENERGY USE in MINNESOTA



Source: Dept. of Natural Resources, Div. of Forestry

### IMPACT OF FIBER FUEL USE ON MINNESOTA'S ECONOMY



#### WHEN \$1 IS SPENT FOR:

Petroleum Energy  
Biomass Energy

#### TOTAL ADDITIONAL ECONOMIC ACTIVITY GENERATED IN MINNESOTA IS

\$ .34  
\$1.50

Source: Dept. of Energy and Economic Development, Policy Analysis Input-Output Model



# FIBER FUELS INSTITUTE

3072 Ranchview Lane  
P.O. Box 41191  
Minneapolis, Minnesota 55447

Telephone: (612/559-8164)

## Fuel Cost Comparisons Per Million BTUs

Fuel	Price	Cost Per Million BTUs of Useable Heat
<b>Electricity</b>	Per KWH	Per MM BTUs
	\$ .035	\$10.79
3,415 BTUs/kwh	.045	13.87
	.055	16.96
	.065	20.05
Eff.=95%	.075	23.11
<b>#2 Oil</b>	Per Gal.	Per MM BTUs
138,000 BTUs/gal.	\$ .90	\$ 8.16
	1.00	9.06
	1.10	9.98
	1.20	10.88
Eff.=80%	1.30	11.79
<b>Propane</b>	Per Gal.	Per MM BTUs
90,600 BTUs/gal.	\$ .60	\$ 8.49
	.65	9.20
	.70	9.91
Eff.=78%	.80	11.32
<b>Natural Gas</b>	Per MCF	Per MM BTUs
1 million BTUs/MCF	\$4.00	\$ 5.00
	4.50	5.63
	5.00	6.25
	5.50	6.88
	6.00	7.50
Eff.=80%	6.50	8.13
<b>Firewood</b>	Per Cord	Per MM BTUs
20 million BTUs/cord	\$40.00	\$ 3.64
	60.00	5.45
Air Dried	80.00	7.27
	100.00	9.09
Eff.=55%	120.00	10.91
<b>#5 &amp; #6 Oil</b>	Per Gal.	Per MM BTUs
143,000 BTUs/gal.	\$ .60	\$ 5.25
	.65	5.69
Low Sulfur	.70	6.12
	.75	6.56
Eff.=80%	.80	7.00

Fuel	Price	Cost Per Million BTUs of Useable Heat
<b>Wood, Peat, Agri. Fuel Pellets or Briquettes</b>	Per Ton	Per MM BTUs
	\$50.00	\$ 4.00
	55.00	4.41
	60.00	4.81
8,000 BTUs/lb.	65.00	5.21
@ 8% M.C.	70.00	5.60
Eff.=78%	75.00	6.01
<b>Eastern Coal</b>	Per Ton	Per MM BTUs
13,250 BTUs/lb.	\$70.00	\$ 3.39
	75.00	3.63
	80.00	3.80
	85.00	4.11
Eff.=78%	95.00	4.60
<b>Western Coal</b>	Per Ton	Per MM BTUs
9,000 BTUs/lb.	\$40.00	\$ 2.96
	45.00	3.33
	50.00	3.70
	55.00	4.07
Eff.=75%	60.00	4.44
<b>Wood Chips</b>	Per Ton	Per MM BTUs
4,700 BTUs/lb.	\$18.00	\$ 2.95
	20.00	3.27
@ 45% M.C.	22.00	3.60
	25.00	4.09
Eff.=65%	30.00	4.90
<b>Lignite</b>	Per Ton	Per MM BTUs
7,000 BTUs/lb.	\$40.00	\$ 3.81
	45.00	4.29
	50.00	4.76
Eff.=75%	60.00	5.71
<b>Peat</b>	Per Ton	Per MM BTUs
Sods or Milled	\$20.00	\$ 2.45
6,000 BTUs/lb.	25.00	3.06
@ 30% M.C.	30.00	3.68
Eff.=68%	35.00	4.29

\*Useable heat costs are comparable. The cost per million BTUs as received (gross heating value) of each fuel is divided by the firing efficiency to yield the cost per million BTUs of useable (net) heat. For example: (1) #2 oil has 7.25 gal. per million BTUs. At 90¢ per gal., the as-received cost per million is 7.25 gal. x 90¢ = \$6.53.  $\$6.53 \div 80\%$  efficiency = \$8.16 per million BTUs of useable heat. (2) Fiber fuel briquettes or pellets have 16 million BTUs per ton as received. At \$60.00 per ton, the as-received cost per million BTUs is  $\$60 \div 16 = \$3.75$ .  $\$3.75 \div 78\%$  efficiency = \$4.81 per million BTUs of useable (net) heat.

