



The Use of Wood Biomass for Distributed Energy Generation in Iowa

Presented At:
Forever Energy Biomass For Sustainable Energy Solutions

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Presentation Outline

- Purpose of study
- Types of wood waste
- Biomass supply curves
- Wood waste supply potential
- Existing wood-based CHP systems
- Contracting wood waste
- Summary



Purpose of Study

- Sponsored by the Iowa Department of Natural Resources
- Authored by Dr. Steffen Mueller, PhD, Midwest CHP Application Center
- Assesses the **potential use of wood biomass** as a distributed energy source in Iowa
- Study was modeled on the energy demand of a 100-million gallon-per-year ethanol production facility (or an industrial facility with similar energy needs)
- Looked both at the use of wood combustion (in a fluidized bed boiler) and wood gasification technologies for energy generation

Link to Study: <http://www.erc.uic.edu/PDF/mueller/iowaWasteWoodStudy.pdf>



Types of Wood Waste Analyzed

- Forest residues
- Primary mill residues
- Clean urban wood wastes



Forest Residues

- The types of waste wood included in this category are logging residues and land clearing for future developments
- Sources of information
 - Timber Products Output (TPO) Database from the USDA Forest Service and the Forest Inventory Analysis Program
 - TPO database is combined with projections from the Resource Policy Act (RPA) Assessment by the USDA Forest Service
 - Methodology is detailed in “Estimated U.S. Forest Residue Supply and Distribution – Documentation of Methodology and Data Sources” by Marie Walsh, November 18, 2007



Primary Mill Residues

- Primary mills convert logs into other wood products and include sawmills that produce lumber, pulp mills, veneer mills, and others
- In the process of converting trees into wood products, waste residues are generated consisting of bark and other fine wood residues
- Sources of Information
 - Wood biomass assessments from this source are largely based on the TPO database
 - Methodology is detailed in “Estimated U.S. Forest Industry Mill Residue Supply – Documentation and Methodology” by Marie Walsh, November 17, 2007



Source: <http://www.flickr.com/photos/darylm/51756794/>

Clean Urban Wood Waste

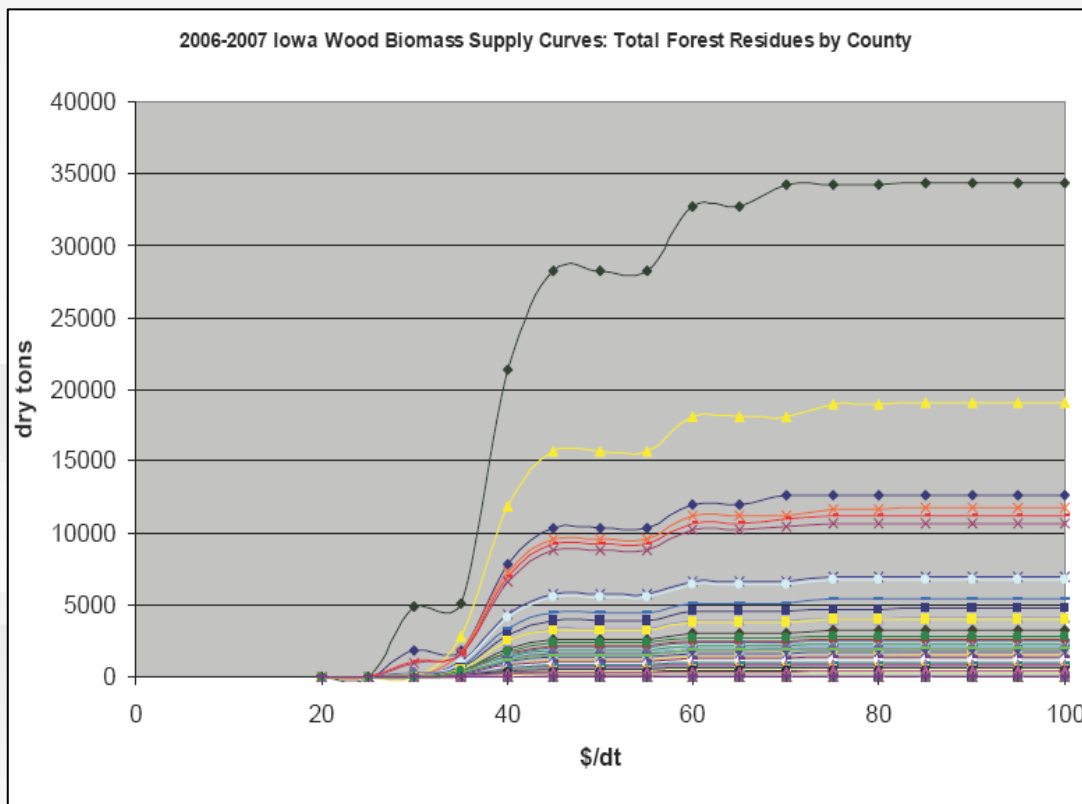
- This category includes the wood components of municipal solid waste such as pallets, yard trimmings, construction wastes, and others
- Sources of Information
 - Waste surveys conducted by the BioCycle Magazine, U.S. Census data, and other publications
 - Methodology is described in “Estimated U.S. Urban Wood Waste Supply – Documentation of Methodology and Data Sources” by Marie Walsh, November 17, 2007.



Source: http://www.flickr.com/photos/stephen_downes/2364350823/



Woody Biomass Supply Curve (organized by county)



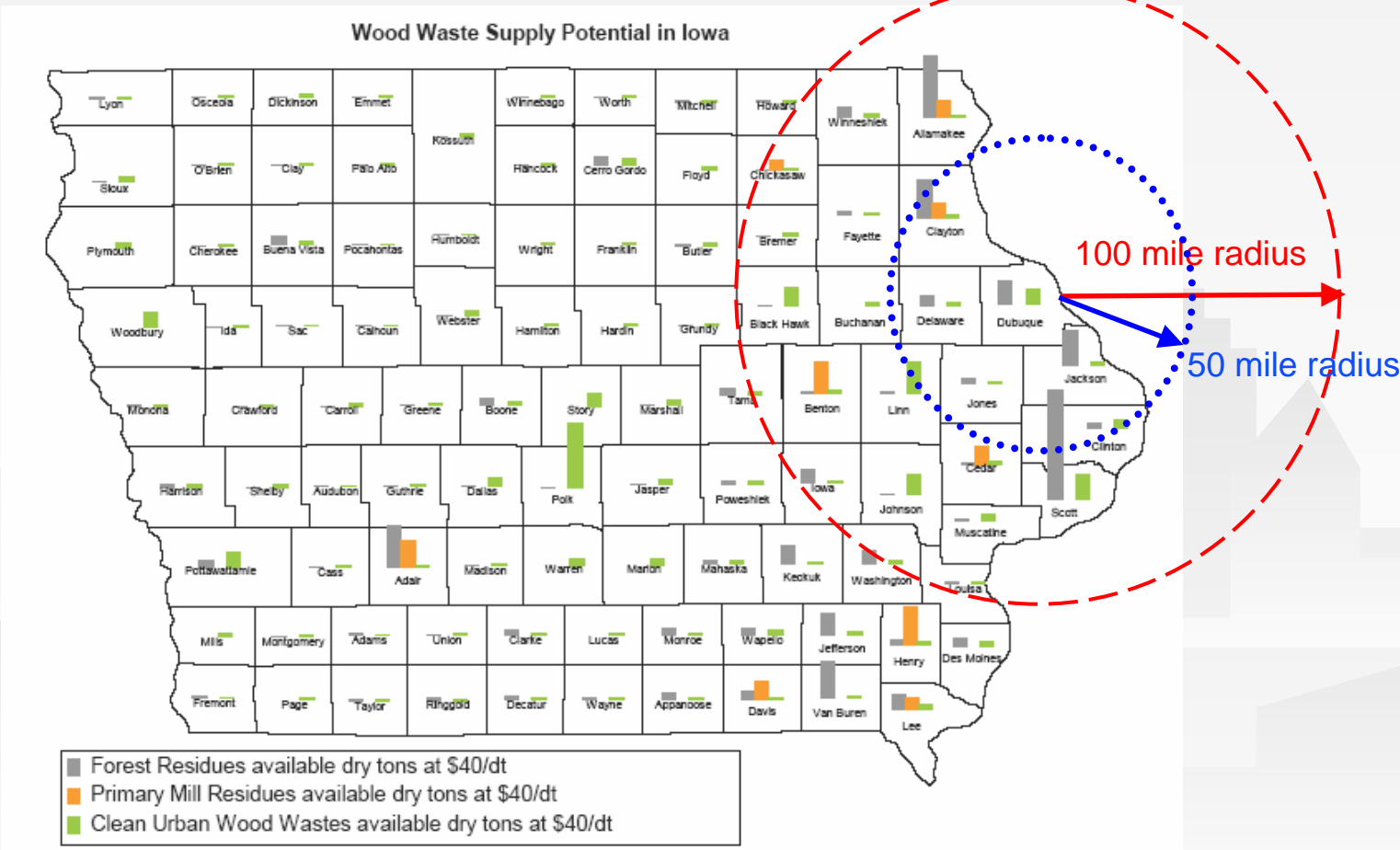
Adair	Adams	Allamakee	Appanoose	Audubon
Benton	Black Hawk	Boone	Bremer	Buchanan
Buena Vista	Butler	Calhoun	Carroll	Cass
Cedar	Cerro Gordo	Cherokee	Chickasaw	Clarke
Clay	Clayton	Clinton	Crawford	Dallas
Davis	Decatur	Delaware	Des Moines	Dickinson
Dubuque	Emmet	Fayette	Floyd	Franklin
Fremont	Greene	Grundy	Guthrie	Hamilton
Hancock	Hardin	Harrison	Henry	Howard
Humboldt	Ida	Iowa	Jackson	Jasper
Jefferson	Johnson	Jones	Keokuk	Kossuth
Lee	Linn	Louisa	Lucas	Lyon
Madison	Mahaska	Marion	Marshall	Mills
Mitchell	Monona	Monroe	Montgomery	Muscatine
O'Brien	Osceola	Page	Palo Alto	Plymouth
Pocahontas	Polk	Pottawattamie	Poweshiek	Ringgold
Sac	Scott	Shelby	Sioux	Story
Tama	Taylor	Union	Van Buren	Wapello
Warren	Washington	Wayne	Webster	Winnebago
Winneshiek	Woodbury	Worth	Wright	

Definition: A supply curve shows the amount that producers are willing to supply given a particular price.

Source: <http://www.econmodel.com/classic/terms/supply.htm>



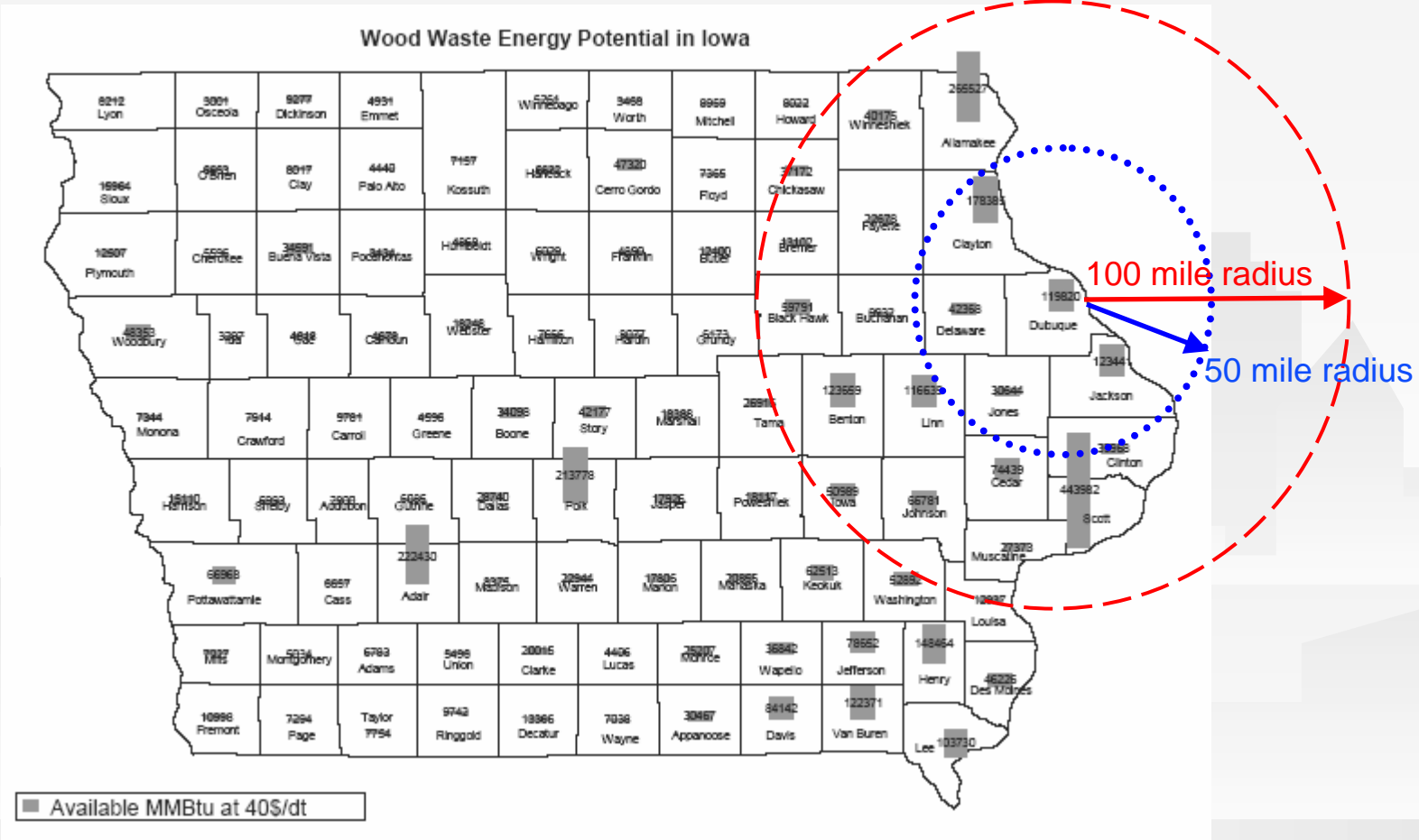
Wood Waste Supply Potential





Wood Waste Supply Potential

(Total Wood Waste Heating Quantities at \$40/dt)





Combined Heat & Power (CHP)

A Form of Distributed Generation



Source: Inland Power Group

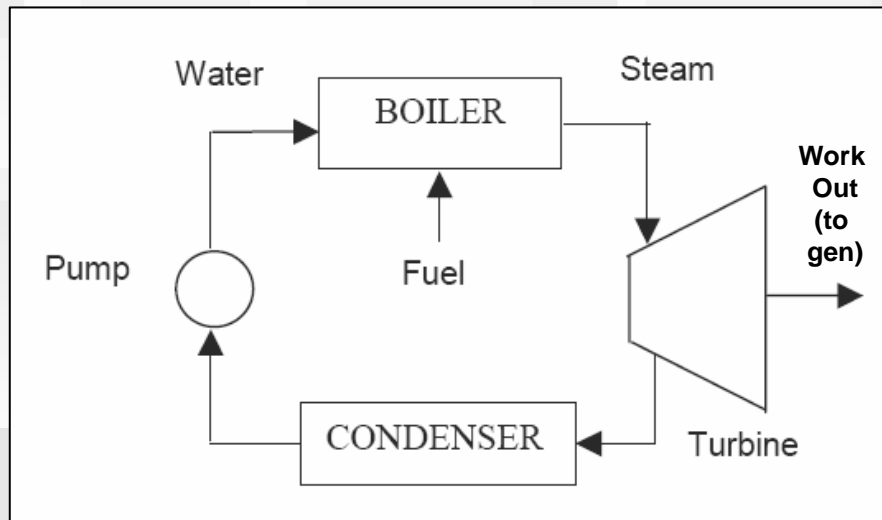
CHP is ...

- An Integrated System
- Located At or Near a Building/Facility
- Provides at Least a Portion of the Electrical Load and
- Recycles the Thermal Energy for
 - Space Heating / Cooling
 - Process Heating / Cooling
 - Dehumidification
 - Domestic Hot Water

Forms of Wood Biomass Based CHP

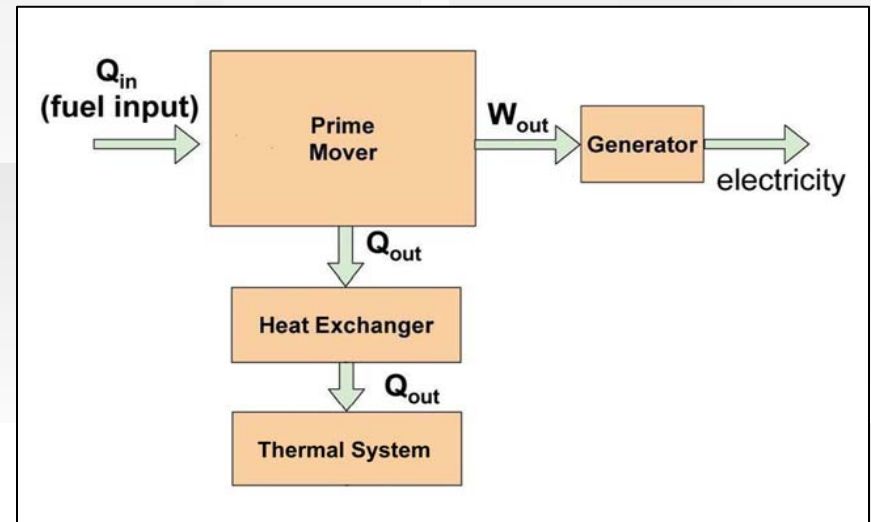
■ Combustion

- Typically wood is dried, cut into chips, and transported into a boiler where it is burned to produce steam that powers a steam turbine
- Co-firing sometimes used



■ Gasification

- In some cases, wood is liquefied into biogas





Energy Potential Assumptions

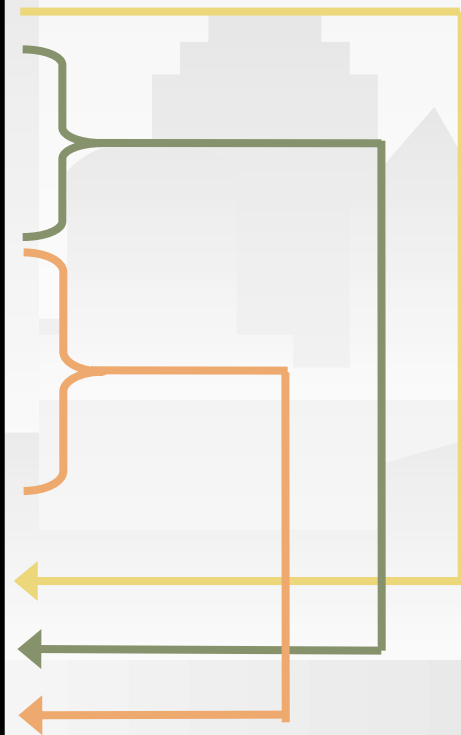
- Wood waste supply radius: 50 miles and 100 miles
 - Study completed for Iowa counties only
 - Study does not incorporate bordering states of IL, MN, and WI
- Energy value of wood waste: (on next slide)
- Electric generating efficiency: 30%
- Total CHP efficiency: 70%
- Number of Operating Hours: 6,000 hours

Source: http://www.eere.energy.gov/de/pdfs/chp_opportunityfuels.pdf



Heating Values of Selected Wood Biomass

Fuel Type	Moisture Content (%)	Heating Value (MMBtu/ton)
Green Wood	50.0	8.2
Seasoned Wood	20.0	13.3
Dry Sawdust	13.0	13.9
Wood Pellets	10.0	14.4
Dry Wood (Non-resinous)	0.0	16.3
Dry Wood (Resinous)	0.0	19.3
Dry Stemwood	0.0	16.4
Dry Bark	0.0	16.9
Dry Branches	0.0	17.3
Dry Needles	0.0	17.5
Primary Mill Residues		13.9
Clean Urban Wood Wastes		16.7
Forest Residues		17.0



Dubuque Wood Waste Energy Potential

(from Iowa counties only @ \$40 per dry ton)

	CHP Generator Capacity		CHP Heat Recovery Capacity		Annual Electricity Generated		Annual Thermal Energy	
Radius	50 miles		50 miles		50 miles		50 miles	
	MW		MMBtu		MWh		MMBtu	
Forest Residue	5.0		22.9		30,160		137,239	
Primary Mill Residue	0.7		3.1		4,050		18,430	
Clean Urban Wood Waste	1.4		6.2		8,229		37,446	
Total	7.1		32.2		42,439		193,115	



Dubuque Wood Waste Energy Potential

(from Iowa counties only @ \$40 per dry ton)

Radius	CHP Generator Capacity		CHP Heat Recovery Capacity		Annual Electricity Generated		Annual Thermal Energy	
	50 miles	100 miles	50 miles	100 miles	50 miles	100 miles	50 miles	100 miles
	MW		MMBtu		MWh		MMBtu	
Forest Residue	5.0	15.7	22.9	71.3	30,160	94,021	137,239	427,835
Primary Mill Residue	0.7	4.1	3.1	18.9	4,050	24,887	18,430	113,245
Clean Urban Wood Waste	1.4	7.8	6.2	35.3	8,229	46,509	37,446	211,634
Total	7.1	27.6	32.2	125.5	42,439	165,417	193,115	752,715

Dubuque Wood Waste Energy Potential

(from Iowa counties only @ \$70 per dry ton)

	CHP Generator Capacity		CHP Heat Recovery Capacity		Annual Electricity Generated		Annual Thermal Energy	
Radius	50 miles		50 miles		50 miles		50 miles	
	MW		MMBtu		MWh		MMBtu	
Forest Residue	7.8		35.3		46,602		212,058	
Primary Mill Residue	1.0		4.5		5,977		27,197	
Clean Urban Wood Waste	1.8		8.4		11,070		50,371	
Total	10.6		48.3		63,649		289,626	

Dubuque Wood Waste Energy Potential

(from Iowa counties only @ \$70 per dry ton)

Radius	CHP Generator Capacity		CHP Heat Recovery Capacity		Annual Electricity Generated		Annual Thermal Energy	
	50 miles	100 miles	50 miles	100 miles	50 miles	100 miles	50 miles	100 miles
	MW		MMBtu		MWh		MMBtu	
Forest Residue	7.8	24.4	35.3	111.2	46,602	146,567	212,058	666,937
Primary Mill Residue	1.0	7.5	4.5	34.2	5,977	45,089	27,197	205,174
Clean Urban Wood Waste	1.8	10.3	8.4	47.1	11,070	62,045	50,371	282,331
Total	10.6	42.3	48.3	192.4	63,649	253,701	289,626	1,154,442



Existing Wood Biomass CHP Installations (Iowa and neighboring states)

	State	City	Organization Name	Application	Op Year	Prime Mover	Capacity (kw)
1	IA	Waterloo	Bertch Cabinet Manufacturing	Wood Products	1992	B/ST	279
2	IA	Bettendorf	Jacobs Energy Corporation	Wood Products	1992	B/ST	3500
3	IL	Moline	Jacobs Energy Corporation	District Energy	2003	OTR	600
4	MN	Bemidji	Potlatch Corporation	Pulp and Paper	1992	B/ST	11,000
5	MN	Duluth	Lake Superior Paper Co	Pulp and Paper	1986	B/ST	10,600
6	MN	Grand Rapids	Blandin Paper Company/Fletcher Challenge	Pulp and Paper	1969	B/ST	31,500
7	MO	Mountain View	Smith Flooring, Inc.	Wood Products	1989	B/ST	500
8	MO	Neosho	La-Z-Boy Chair Company, Inc.	Furniture	1984	B/ST	750
9	WI	Bangor	Webster Industries	Wood Products	1998	B/ST	550
10	WI	Land O' Lakes	Nagel Lumber Company, Inc.	Wood Products	1990	B/ST	675
11	WI	Neenah	Minergy Neenah	Pulp and Paper	1999	B/ST	6,500
12	WI	Park Falls	Flambeau Paper Company	Pulp and Paper	1983	B/ST	5,700

Source: <http://www.eea-inc.com/chpdata/index.html>



Contracting Wood Waste

- Invitation to Bid for Biomass Fuel Supply
 - Example found in Appendix D of Mueller study
- Pay special attention to biomass specifications
 - Type of waste (i.e. coniferous & deciduous trees)
 - Size of waste (i.e. up to 3” in any dimension)
 - Waste not permitted (i.e. fine powder or greasy)
 - Moisture content (i.e. less than 45% wet weight)
- Surcharges and Penalties



Other Biomass Resources

- **Don't forget there are many other potential biomass resources that can fuel CHP systems and/or be co-fired with wood biomass resources**
 - Examples: straw, animal waste, vegetables, greases, etc.
- Some Biomass Studies and Resources
 - US DOE EERE “Biomass Publications” web site
 - <http://www1.eere.energy.gov/biomass/publications.html>
 - ORNL's “Billion Ton Study” (April 2005)
 - http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf
 - ORNL's “Bioenergy Feedstock Information Network” web site
 - <http://bioenergy.ornl.gov/>
 - Washington State University's “Biomass Inventory and Bioenergy Assessment” (Dec. 2005)
 - http://www.pacificbiomass.org/documents/WA_BioenergyInventoryAndAssessment_200512.pdf



Summary

- Wood waste can be an attractive fuel source
- Iowa is not known for an abundance of wood waste, but there is potential in Dubuque and other Iowa cities along the Mississippi River
 - 7.1 MW (27.6 MW) capacity @ \$40/dt
 - 10.6 MW (42.3 MW) capacity @ \$70/dt
- Generating capacity would increase (maybe double) if bordering states' wood waste is accounted for
- Rising gas prices can have significant impact
- Don't forget other biomass resources for co-firing opportunities
- Be careful when developing contracts for biomass supplies to ensure the feasible operation of the on-site combustion equipment using various biomass feedstock



Questions / Discussions

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www.chpcentermw.org

Link to Study: <http://www.erc.uic.edu/PDF/mueller/lowaWasteWoodStudy.pdf>