SOUTH EAST WISCONSIN WOOD RESOURCE SURVEY AND UTILIZATION PROJECT REPORT - 2009 UPDATE

Final Report

To

We Energies

By

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EXECUTIVE SUMMARY

The Milwaukee School of Engineering and UW-Extension Solid & Hazardous Waste Education Center conducted a study of the potential uses of wood waste in 2004. This report provides an update to the information gained during that study, as well as summarizes the potential opportunities and challenges to establishing a wood waste facility in SE Wisconsin.

A number of changes have occurred to the wood waste supply during this 5-year interval. These include:

- The development of additional processing capability for construction and demolition debris recycling;
- Increased competition for wood waste resources as new biomass facilities and product uses have developed;
- Continued interest in high value uses for wood wastes based upon survey responses and stakeholder involvement; and
- The emergence of the emerald ash borer in Wisconsin and the potential for significant short term increases to the wood supply.

Based upon these trends, an estimated 179,000 tons of recoverable wood waste is available as a potential resource for biomass energy generation in SE Wisconsin.

A nine-month stakeholder process outlined the components of a future strategy for biomass energy development. The process indentified key opportunities and challenges as well as provided an opportunity for potential participants to begin establishing a working relationship for future activities. Results emerging from this process included:

- Identification of Johnson Controls Inc. as a potential performance contractor for the operation of a new biomass facility;
- The need for additional hot water resources for existing Menomonee Valley businesses as well as Milwaukee’s Growing Power for expanded urban food production;
- Support from the Wisconsin Office of Energy Independence for expanded biomass energy generation in SE Wisconsin; and
- The need for additional task specific research that further outlines the feasibility of a potential project.
The stakeholder process resulted in the submittal of a Southeastern Wisconsin Energy Technology Research Center (SWETRC) Spring 2009 Seed Grant to the US Department of Energy by the Milwaukee School of Engineering to assist in pre-feasibility tasks.

Other energy sources evaluated included food waste to anaerobic digestion and municipal solid waste. Although MSW is a fuel source which is readily available, produces a relatively constant supply over a year and has large energy potential, it was not included in the analysis part of the study.

Finally, the study recommended:

Continuation of a stakeholder process to facilitate future biomass energy development in SE Wisconsin;

- Conducting task specific research that addresses resource availability and siting considerations to further outline project feasibility during the summer, 2009; and
- Development of a RFP for biomass energy production based upon the project feasibility analysis.
INTRODUCTION

Biomass definition:
In Wisconsin biomass is defined as “energy derived from wood or plant material residue, biological waste, crops grown for use as a resource or landfill gases. Biomass does not include garbage or nonvegetation-based industrial, commercial or household waste” (Public Service Commission, State of Wisconsin, 2004).

2009 Assembly Bill 88
Assembly Bill 88 was introduced that changes the definition of “biomass” so that it includes, rather than excludes, garbage and such waste. As a result, a utility or cooperative may include electricity derived from garbage and such waste in determining whether the utility or cooperative has satisfied renewable portfolio standards (Wisconsin State Assembly, 2009). The bill was referred to the Assembly committee on Energy and Utilities (Wisconsin State Assembly, 2009).

Wood energy use by economic sector
Wood energy use has increased in Wisconsin between 1970 and 2007 by sector and trillions of Btu per year as shown in Appendix A. The residential sector uses about 63%, the industrial sector (primarily forest products) uses about 30%, the commercial sector uses about 0.590% and electric utility sector uses about 7%. The total Wisconsin wood energy use has increased from 22.1 to about 51 trillion Btus per year during this period (Wisconsin Office of Energy Indepandance, 2008).

Wood waste quantities:
Wood waste is generated in construction and demolition (C&D) (dimensional lumber, engineered wood, sawdust), yard maintenance (trees, branches, stumps, brush, bark), and industrial (pallets) activities. Information on wood waste quantities is incomplete and may be unknowable.
Based on the May 2003 report of Wisconsin Department of Natural Resources (WDNR) “Wisconsin Statewide Waste Characterization Study,” over 250,000 tons of clean wood waste went to landfill from the SE Wisconsin counties of Milwaukee, Waukesha, Racine, Kenosha, Walworth, Ozaukee, Washington and Sheboygan in 2001 (Cascadia Consulting Group, Inc., 2003). A new landfill study has been commissioned by the WDNR (Sheikholeslami, 2009) (Rossom, 2009). An additional 100,000 tons of clean wood was collected and recycled by municipalities, who are required to submit annual reports to WDNR (DNR - Waste Management Program, 2007). Based on recycling reports and the 2001 landfill study, roughly about 30% of the wood waste in SE Wisconsin is recycled and 70% is landfilled.

Table 1 indicates that over 360,000 tons of clean wood are either going into landfill or are being collected by municipalities in SE Wisconsin every year. Using assumptions from the Wisconsin Task Force on Global Warming (25% of the yard waste and C&D material and 100% of pallets are recoverable) and assuming that 100% of the municipally collected wood could be recovered, the local recoverable supply is just under 179,000 tons/year. Based on energy contents of wood waste components (Table 1) from the Energy Information Administration (Energy Information Administration, 2008) about 1.4 x10^{12} Btus are available per year.

Table 2 gives wood residue numbers for the SE Wisconsin survey unit from the 1994 wood residue study and a Terry Mace (Wisconsin Department of Natural Resources) estimate for 2008. The 2008 estimate of 275,000 tons/year falls between the maximum (366,000 tons/year) and the minimum recoverable (179,000 tons/year) given in Table 1.

Focus on Energy Environmental and Economics Research and Development Program for the 2009 funding cycle is funding an update to the 1994 study. The grant title is Assessment of Wisconsin’s woody biomass volume, Processing Capabilities and Availability. The plan of work is in Appendix B.
Table 1. SE Wisconsin clean wood tonnages, recoverable tonnages and energy content. (a)

<table>
<thead>
<tr>
<th>Clean wood</th>
<th>Tons/year</th>
<th>Mean%</th>
<th>Conf. Low</th>
<th>Conf. High</th>
<th>Million Btu/ton (c)</th>
<th>Recoverable tons (d)</th>
<th>Million Btu/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard Waste &lt; 6 in</td>
<td>34319</td>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
<td>6</td>
<td>8580</td>
<td>51479</td>
</tr>
<tr>
<td>Yard Waste &gt; 6 in</td>
<td>1691</td>
<td>0.1</td>
<td>0.0</td>
<td>0.3</td>
<td>6</td>
<td>423</td>
<td>2537</td>
</tr>
<tr>
<td>C&amp;D Wood-untreated</td>
<td>214178</td>
<td>12.4</td>
<td>8.5</td>
<td>16.4</td>
<td>10</td>
<td>53545</td>
<td>535445</td>
</tr>
<tr>
<td>Pallets</td>
<td>16005</td>
<td>0.9</td>
<td>0.3</td>
<td>1.6</td>
<td>10</td>
<td>16005</td>
<td>160050</td>
</tr>
<tr>
<td>Yard Waste-DNR reports 2006 (e)</td>
<td>100188</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>100188</td>
<td>601126</td>
</tr>
<tr>
<td>Total</td>
<td>366381</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>178740</td>
<td>1350636</td>
</tr>
</tbody>
</table>

(a) Data from 2001 (Cascadia Consulting Group, Inc., 2003)
(b) Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, Waukesha, Sheboygan (37.5% of population)
(c) Table 4. Heat Content of Materials in MSW, million Btu/T (Energy Information Administration, 2008)
(d) Wisconsin Task Force on Global Warming Policy Template (Assumes 25% recovery of landfilled yard waste and C&D waste and 100% recovery of pallets and municipally reported yard waste.) 7/3/08
(e) Table 1. Recyclable Materials Collected by Wisconsin Responsible Units (in tons) (DNR - Waste Management Program, 2007).

Table 2. 1994 Wood Residue Study Numbers for SE survey unit and 2008 Estimate (a).

<table>
<thead>
<tr>
<th>Clean wood</th>
<th>1994 tons/year</th>
<th>%</th>
<th>2008 tons/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallets</td>
<td>93,497</td>
<td>17</td>
<td>46749</td>
</tr>
<tr>
<td>Dunnage</td>
<td>49,902</td>
<td>9</td>
<td>24951</td>
</tr>
<tr>
<td>Sawdust</td>
<td>56,661</td>
<td>10</td>
<td>28331</td>
</tr>
<tr>
<td>Chips/shavings</td>
<td>90,547</td>
<td>16</td>
<td>45274</td>
</tr>
<tr>
<td>Edgings</td>
<td>51,846</td>
<td>9</td>
<td>25923</td>
</tr>
<tr>
<td>Bark</td>
<td>79,402</td>
<td>14</td>
<td>39701</td>
</tr>
<tr>
<td>Other</td>
<td>127,596</td>
<td>23</td>
<td>63799</td>
</tr>
<tr>
<td>Total</td>
<td>549,451</td>
<td>100</td>
<td>274726</td>
</tr>
</tbody>
</table>

(a) 1994 wood residue study (Everson & Hubing, 1993); 2008 estimate that these number are at least 50% less now (Mace, 2009)

Wood waste economics:

If one assumes that the quantity of landfilled wood waste indicated above is generated every year and it costs about $100/ton to collect and $30/ton to landfill, SE Wisconsin counties are spending over $30,000,000 every year to collect and landfill wood waste (Diggelman & Brachman). The wood waste stream is also an important source of revenue for waste haulers.

Drivers for utilizing wood as a renewable energy source—State and national incentives for using biomass to energy production

In March 2005, Wisconsin’s Governor Doyle announced an initiative to facilitate the use of renewable energy technologies and sources, including biomass, in Wisconsin (Public Service Commission, State of Wisconsin, 2004). In 2006, Governor Doyle and industrial,
environmental, and scientific leaders set strategic goals for Wisconsin to secure a clean energy future. These goals are: 25% of electricity and 25% of transportation fuel from renewable fuels by 2025; capture 10% of the market share for the production of renewable energy and bioproducts and become a national leader in groundbreaking research that will make alternative energies more affordable and available to all – and turn those discoveries into new, high paying jobs for Wisconsin workers (The Office of Governor Doyle, 2008).

The number and value of incentives for using biomass as an energy source have increased. The American Reinvestment & Recovery Act has a production tax credit that extends the date before which a renewable energy project must be completed in order to qualify for the 1.5 cents per kilowatt hour production tax credit through December 31, 2012 and the placed-in-service date for biomass renewable facilities is extended through December 31, 2014. Wisconsin Focus on Energy provides financial support for developing large renewable energy systems with a capacity greater than 20 kW or 5,000 therms per year. Biogas digesters and non-residential biomass combustion projects can qualify for a maximum grant of $250,000 for implementation and up to 25% of the project funding cost. Other incentives are available through the Internal Revenue Service and the U.S. Department of Agriculture. Wisconsin’s Office of Energy Independence publishes a report “Wisconsin Financial Incentives for the Production of Clean Energy” (The Wisconsin Office of Energy Independence, 2009).

Wisconsin Act 141, enacted into law on March 17, 2006 created a statewide renewable standard goal that 10% of retail electricity sold by utility companies comes from renewable energy by 2015. As the estimated statewide renewable energy sales in 2002 was about 4%, the act mandates that all electricity providers increase their sales of renewable electricity 2 percentage points over their 2001-2003 averages by 2010, and 6 percentage points by 2015 (Gad, 2006). For the years leading to 2015, Wisconsin utilities are required to report their progress in meeting the renewable milestones to the PSC (Public Service Commission of Wisconsin, 2007).

We Energies produces or purchases more than 140 megawatts (MW) of renewable energy capacity from a variety of sources inside and outside Wisconsin. Some of it is used for the company’s Energy for Tomorrow® renewable energy program for residential and commercial customers, while the remainder is used to meet the state’s Renewable Portfolio Standard. We Energies Renewable Energy Research and Development Grant Program – 2009 offers grants to its business and not-for-profit electric customers as well as to organizations teamed with We Energies business and not-for-profit electric customers. This program offers financial assistance in the form of a grant to conduct research on renewable energy technologies, or to help
demonstrate a renewable energy product or technology. Areas of research that will receive the highest funding priority include work in the following areas:

1. Improving existing renewable energy technologies such as wind, solar, and biomass.

2. Expanding renewable distributed-generation technologies and related technologies, such as energy storage and smart grid technologies that directly benefit the integration and distribution of renewable energy onto the grid.

3. Developing renewable energy technologies, products and services that provide more affordable electricity and improved reliability.

4. Conducting longer-term research on advanced renewable technologies that will help meet tomorrow's electricity needs and contribute positively to the renewable energy industry (Wisconsin Energy Corporation, 2006) (We Energies, 2009).
CASE STUDIES—WOOD—FIRED POWER PLANTS IN OTHER COMMUNITIES

French Island Generating Plant, LaCrosse, WI

French Island is a facility that uses wood and municipal solid waste to generate electricity. The plant’s two generating units burn wood waste, railroad ties and processed municipal solid waste. The municipal solid waste is processed into refuse-derived fuel (RDF) – a fluffy, burnable fuel produced on-site at a facility built specifically for that purpose. The fluidized bed boiler installed at French Island was the first in the United States to be used for commercial power production. The special boiler gets its name because it contains a bed of sand that behaves like a boiling pot when air is injected into it. As the RDF or waste wood fuel is fed into the boiler, it mixes with the sand and remains suspended in the air – being constantly scraped to reveal fresh combustion surfaces. Unlike conventional boilers, the fuel used in a fluidized bed boiler does not have to be uniform in size and moisture content to burn thoroughly.

Waste wood is hauled to the plant in trucks and dumped into a receiving hopper. It then is conveyed through equipment that crushes and grinds wood into small pieces. The fuel is placed in a storage bin until needed in the boiler.

French Island’s resource recovery facility has the capacity to process more than 100,000 tons of municipal solid waste each year. Garbage trucks dump solid waste on the tipping floor. Front-end loader operators then inspect trash and push it on the floor to a feed conveyor. The RDF processing facility removes recyclable materials and non-combustible items from the waste, then chops and shreds it into a uniformly sized fluffy product that is burned with waste wood. Since 1987, French Island has utilized more than 600,000 tons of RDF and over 1 million tons of waste wood and railroad ties.

Although French Island uses alternate fuels, it produces electricity the same as conventional plants – a source of heat turns water to steam, which drives a turbine-generator. Power production capability includes two units:

- Unit 1 - 143 Mw (1940);
- Unit 2 - 14 Mw (1948).

The French Island site also includes two combustion turbines that burn low-sulfur #2 fuel oil from a 5 million gallon storage tank located on site. Each unit has the capability of 72 MW (summer) and 100 MW (winter) (Xcel Energy).
On the average, French Island handles 60,000 tons of wood waste a year. Wood fuel is comprised of two main sources, wood waste and railroad ties. Table 3 breaks down the wood fuel supply based on desired and actual usages (Paitl, 2008).

<table>
<thead>
<tr>
<th>Table 3. French Island wood fuel supply and properties.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired %</td>
</tr>
<tr>
<td>Railroad ties</td>
</tr>
<tr>
<td>Actual %</td>
</tr>
<tr>
<td>Railroad ties</td>
</tr>
<tr>
<td>Btu/lb</td>
</tr>
<tr>
<td>Railroad ties</td>
</tr>
<tr>
<td>Moisture content %</td>
</tr>
<tr>
<td>Railroad ties</td>
</tr>
</tbody>
</table>

Since railroad ties have lower moisture content and a higher BTU output, burning more than 40% ties at one time can create combustion complications due to excessively high temperatures reaching roughly 1500°F (Paitl, 2008).

Currently, French Island maintains twelve contracts, three for railroad ties and nine for wood waste. For the railroad ties, the railroad company pays the supplier to remove the ties and then the ties are processed and contracted out. Due to the creosote treatment in railroad ties, additional air permits are needed between the railroad company and end user to ensure emission control is acceptable (Paitl, 2008). Wood waste supplied to French Island comes from a variety of sources. Approximately 2,500 tons a year of construction and demolition (C&D) waste is diverted from county landfill and brought to French Island. Problems however arise since the county landfill charges a lower price to accept clean, separated C&D waste. In this case, the landfill acquires the majority of C&D waste, processes it, and then resells it to French Island for a higher price making C&D waste an uneconomic choice (Paitl, 2008).

Through coordination with Xcel Energy, French Island obtains acceptable wood waste from power line tree trimmings; a supply provided free of charge to French Island. Additional wood waste supplies come from retail land clearing companies and curbside pick-up programs throughout the Lacrosse area. Similar to tree trimming supplies, curbside programs provide processed wood waste free of charge. Disadvantages include supply irregularity and the costs associated with reloading and transferring wood waste into the on-site hopper (Paitl, 2008).

After securing fuel supply contracts, suppliers trust French Island to set the price through sampling procedures. Engineer Dave Loberg, expresses how, “sampling of each and every truck load that comes across the scale” is performed to determine fuel characteristics (Loberg, 2008). Prices are set based primarily upon BTU content, but moisture content is also determined.
Typical prices range from seven to ten cents per BTU which comes out to five or six dollars per railroad tie. In the past French Island paid per ton, but found suppliers increasing moisture contents to raise prices. French Island may also start testing for ash content in the future to assist with emissions issues. Jason Thompson, president of the wood processing company American Property Experts, states that the majority of mill contracts specify a maximum of 7% ash content (Goldstein, 2006).

The multiple handling steps of wood waste are the significant variables in French Island fuel supply prices. As a result, French Island essentially pays twice for wood waste, once for their supplier to obtain and process it and then again for hauling and transportation costs. An ideal set up would involve the ability to process raw materials on-site. However, feasibly owning and operating processing equipment is difficult because of the space requirements and economics. The high operational and maintenance costs of grinding equipment can be over twice the cost of obtaining wood waste (Paitl, 2008).

Wood waste fuel proposals and suggestions were compiled into a contingency plan used to determine the best opportunities for increasing and securing future wood supplies. One of the highest rated proposals helps suppliers create stockpiles on their sites. French Island would support the initiative financially in order to secure that the new wood storage would be reserved specifically for French Island wood supply needs. Such an option is favored due to the fact that French Island can only support 300 tons of wood waste on-site at one time, which is only 2 days worth of fuel (Paitl, 2008).

Another alternative includes fuel cost adjustments for hauling and transport of wood waste to help secure existing suppliers. At French Island, all fuels except wood waste have an associated adjustment factor. Also, French Island will pay backhauling companies more if there is no available backhaul in attempt to maintain consistent supply (Paitl, 2008).

**Ever-Green Energy, Saint Paul, MN (76 Kellogg Blvd West, 55102-1611)**

Ever-Green Energy is a primarily wood-fired combined heat and power plant (CHP) in downtown St. Paul, Minnesota. Ever-Green Energy is a service provider to District Energy St. Paul. Ever-Green Energy, a three-in-one plant on a small downtown footprint, is an electrical plant, a heating plant and a cooling plant. The plant generates 25 MW of electricity which is sold to Xcel Energy and up to 65 MW of ‘waste’ thermal energy which is sold to District Energy St. Paul (Schill, 2008). Separate hot and cold water piping systems provide year-round hot water heat for heating, domestic hot water and industrial process heat to 186 commercial...
buildings (30.7 million square feet) and 298 homes and chilled water for air conditioning to 96 commercial buildings (from 12,000 square feet to over 650,000 square feet) in downtown St. Paul.

Figure 1 illustrates St. Paul’s centralized energy system (Ever-Green Energy, LLC, 2008), the largest biomass-powered system in North America. Biomass, primarily clean wood, provides nearly 70% of the system’s energy demand, approaching the goal of 75% (Schill, 2008). The remainder of the energy is supplied by coal and natural gas (Rydaker & Smith, 2008). The hot water district heating system is powered by a CHP plant (vibrating grate Detroit boiler), four gas/oil-fired boilers, backup plant and mobile boiler. One hundred five thousand six hundred feet of twin supply and return piping is highly insulated and has about 5% distribution losses. It replaced a steam-heat system with 50% distribution losses (Schill, 2008). There are about 35,000 feet of twin supply and return chilled-water pipelines circulating 970,000 gallons of water; six electric and two steam-absorption chillers at the main plant, two electric chillers at the 10th street cooling plant and several satellite chillers; and 6.7 million gallon chilled water storage systems to store chilled water produced at night using off-peak electricity for daytime distribution (Rydaker & Smith, 2008).

Several related businesses make up District Energy St. Paul, which recently celebrated its 25th anniversary. District Energy St. Paul and District Cooling St. Paul are independent, nonprofit organizations. Ever-Green Energy LLC is a for-profit affiliate, which operates the CHP plant with Duke Generating Services LLC, a subsidiary of Duke Energy Corp. Biomass procurement is handled by another for-profit business, Environmental Wood Supply (EWS) (Schill, 2008). District Energy St. Paul reports 99.99% reliability for heat and District Cooling St. Paul reports 100% reliability (Public Service Commission, State of Wisconsin, 2004). Every year District Energy St. Paul gives building owners predicted costs for the coming year within a range of +/- 5% (Rydaker & Smith, 2008). Currently, customers are paying $0.058/kWh, which is less than they were paying 25 years ago (Rydaker & Smith, 2008).
Environmental Wood Supply (EWS) was created in 2000 by Ever-Green Energy and Duke Energy Generation Services to locate and purchase clean wood waste to fuel the St. Paul biomass plant. EWS operates the City of Saint Paul's Wood Recycling Center located just a few miles from the CHP plant, saving the city around $300,000/year (Rydaker & Smith, 2008). Wood suppliers and producers pay EWS to drop off logs and brush. EWS pays vendors who drop off wood waste that has been processed into mulch. Workers then grind or screen the product once again in a final sizing process (4-inch maximum diameter) before transporting it to the CHP plant to be fed into the boiler (Ever-Green Energy, LLC, 2008). They supply about 280,000 tons per year by truck, about 40 trucks per day. Wood waste sources include urban wood from tree trimming and storm damage, clean industrial wood (pallets), construction debris and forest residues (Rydaker & Smith, 2008). There is one day wood silo storage at the site. When local wood supplies from the 13 county metropolitan area are inadequate, supplies are procured from the northern Minnesota forestry industry (Schill, 2008).
Figure 2. Ever-Green Energy, St. Paul, Minnesota.

**Wood waste markets**

Nearly six million tons of wood waste (e.g., urban wood waste, woody debris from suburban land clearing, and rural forestry residuals) were generated in 2003 according to the EPA. In fact, wood comprises the largest percentage of the residential construction and demolition materials (C&D) waste stream – approximately 40 to 50 percent of residential new construction materials – according to the National Association of Home Builders Research Center (U.S. Environmental Protection Agency, 2008).

Prior to 1990, there was limited recycling of wood waste in the United States. Today, EPA estimates there are more than 500 wood processing facilities across the country. Markets for recovered wood vary across the United States according to regional and local supply and demand. The current market, however, is dominated by mulch and fuel applications that pay between $12 and $24 per ton for processed wood. Wood waste from construction and demolition activities is attractive as a fuel because of its low moisture content. Processed or chipped wood is also used as a compost bulking agent and as animal bedding. Salvaged or reused wood products are the highest value items but typically require the highest costs for sorting and processing. In addition, recovered wood can be used to manufacturer value-added products such as medium density fiberboard and particleboard; these manufacturers demand high-quality feed stocks, however, which can be difficult to achieve on a consistent basis (U.S. Environmental Protection Agency, 2008).

The demolition industry is well established and is increasing its efforts to recover wood waste. In addition, the deconstruction industry continues to grow and salvage an increasing percentage of
materials from old buildings. Deconstruction efforts recover and reuse wood for flooring, doors, windows, and other applications. A number of independent lumber mills have retooled their operations to process reclaimed timbers, as well (U.S. Environmental Protection Agency, 2008).

Federal and local air and water regulations provide an incentive for wood recovery by discouraging inappropriate burning or discarding of woody debris. A major barrier to increased wood recovery, however, is the lack of grade standards for recovered wood. These standards include grading rules, engineering properties, and a grade stamp. There is also a need for technical performance testing to investigate the structural integrity of recovered wood (U.S. Environmental Protection Agency, 2008).

**Estimates of energy from other waste sources**

Energy was quantified for other waste materials including landfilled food waste and MSW and for We Energies discharge water. Municipal wood waste energy is included for comparison.

For wood waste, it was assumed that the high end of the range was all the landfilled material (except treated lumber); the low end of the range was $\frac{1}{4}$ of it. This calculation assumes information from “Milwaukee Biomass Energy Project” by Jeffrey DeLaune of Johnson Controls (Appendix C):

- 1.65 MW engine capacity
- 13,900 MW Hr/Yr/29,600 tons (as delivered) wood waste/year
- 6100 gallons of 200°F hot water/hr $\times 24$ hr/day $\times 365$ d/yr $\times 29600$ tons (as delivered) wood waste/year

As indicated in Table 1, Appendix D the range of energies from wood is from $2.6 \times 10^{11}$ and $2.7 \times 10^{12}$ Btu/year. The energy available in MSW is an order of magnitude higher and ranges from $5.0 \times 10^{12}$ to $2.0 \times 10^{13}$ Btu/year.

For food waste, it was assumed that the high end of the range was also all the food waste reported in the landfill study; the low end of the range was $\frac{1}{4}$ of it. Food waste is assumed to be 30% solids, this food waste went to an anaerobic digester and methane production is in the range predicted by actual methane production at the San Francisco’s East Bay MUD facility, from 6 to 8.5 ft³ methane/lb TS. As indicated in Table 2, (Appendix E) the energy in landfilled food waste ranges between $1.3 \times 10^{11}$ Btu/year and $7.6 \times 10^{11}$ Btu/year.
The calculation for the energy available in We Energies discharge water, found in Table 3, (Appendix E) assumes 160,000,000 gallons/day at 60°F. If that were reduced to 40°F, the annual energy available is:

- \(160,000,000 \text{ gal/day} \times 365 \text{ days/yr} \times 8.344 \text{ lb/gal} \times 1 \text{ Btu/lb}^\circ\text{F} \times 20^\circ\text{F} = 9.7 \times 10^{12} \text{ Btu/yr.}\)

This energy is about 5 times the sum of average (average of max and min) energies from wood (1.5E+12 Btu/year) and food (4.5E+11 Btu/year) waste. This source of energy, although great, can be highly variable and is usually greatest in the summer.

![Energy in Waste Materials](image)

**Figure 3.** Energy in waste materials, calculations in Appendix F. Table 1.
2008 WOOD WASTE SHWEC SURVEY RESULTS

In order to more fully estimate wood waste generation and usage rates, the UW-Extension Solid and Hazardous Waste Education Center conducted a survey of potential wood waste generators and processors in Southeast Wisconsin in 2008. There were a total of 43 respondents from both the public and private sectors. In contrast to the 2004 Wood Waste Survey, private operators and processors were much more responsive, represented over 58% of the total respondents. It is interesting to note that neither landfill operators nor contractors or subcontractors from the construction industry responded to the survey. However, this assessment of the wood waste sources generated some useful information, which is described below.

A wide variety of wood wastes was reported by the respondents, with stumps, logs and tree trimmings representing the greatest proportion of municipal wood waste, while private businesses managed a greater variety of material, including manufacturing scrap, pallets, particle board, shavings, sawdust and construction debris. Similarly, a wide variety of uses for the wood waste was reported, with chipping for on or off site applications being the primary application. Over $900,000 was spent in processing over 46,000 tons of wood waste as reported by survey respondents.

Several of the larger communities reported comprehensive information as part of the survey. Figure 4 below shows the total wood tonnages reported by the four largest municipalities, representing over 900,000 people. Wood waste generation rates vary greatly between the communities, which may reflect the nature of the communities (highly urbanized versus suburban) or the communities’ ability to track all wood waste.

![Wood Waste Tons](image)

Figure 4. Survey responses of wood waste, in tons.
STAKEHOLDER PARTICIPATION

Key to the success of most wood waste to energy projects is the participation of a wide variety of partners. The Milwaukee School of Engineering and the UW-Extension facilitated this activity through a series of discreet steps, including:

- An initial stakeholders meeting focused on creating a common project vision
- A series of periodic meetings with a cross section of partner groups, and
- The development of funding proposals including one to the Southeastern Wisconsin Energy Technology Research Center (SWETRC) Spring 2009 Seed Grant Program.

A brief description of each of these steps is described below.

Initial Stakeholders’ meeting

On August 21, 2008 key stakeholder from local government, industry and the non-profit sectors met to discuss the opportunities and challenges to the development of a wood waste to energy facility in SE Wisconsin. Attendees are listed in Appendix F.

Carol Diggelman provided an overview of key research findings to date and implications for the future (Appendix G). Steve Brachman then facilitated a stakeholder analysis of key challenges and opportunities facing the development of a wood waste facility in SE Wisconsin. Stakeholders were asked to list the key opportunities and challenges that were then posted for review. These challenges were then grouped as shown below:

What are the key challenges to developing a wood waste facility in SE Wisconsin?

The complete list of comments can be found in Appendix H.

- **Cost:** Comments from stakeholders include a need for higher Focus on Energy incentives for customer-sited biomass plants, because there are higher capital costs compared to natural gas plants. Source separation of wood will increase hauling costs at a time of increasing fuel and transportation costs. It is critical to find a thermal customer for the heat energy generated in a CHP plant, since heat is 60% of the energy content of wood waste.

- **Competition:** Comments include concerns centered around difficulties in procuring long term wood supplies. There are competing markets for wood from mulch that could outcompete fuel wood based on price, making the needed supply and the long term price difficult to control.
• **Material Specifications:** Comments included concerns over contaminants in construction and demolition debris like lead and asbestos; there are many small and not many major sources; and the input materials will require processing to meet facility specifications.

• **Regulation & Lack of Education:** Comments included concerns over NIMBY, air quality, regulatory approvals, the adequacy of the regulatory framework, learning all that is needed and the cost of getting started.

What strengths or opportunities exist in the SE Wisconsin area for a wood waste to energy facility?

The complete list of comments can be found in Appendix I.

• **Supply:** Comments included conflicting opinions about supply from supply is increasing, there is a growing diversion of C&D wood to there is an adequate wood supply to there is way more load than supply and there is lots of wood wasted. The municipal supply is consistent. The emerald ash borer is a 20 to 30 year event. Wood is a sustainable energy source with low ash output.

• **Infrastructure:** There is a transportation system in place, including roads, rail and water, with reasonable haul distances. Existing CHP facilities using wood, including UW system and Madison District energy plants. The waste processing infrastructure is developing.

• **Opportunity:** Legislation, including EPACT, PRS, 2007 Energy Act, and incentives are in place for biomass. There is a growing awareness and interest in sustainability, We Energies has facilities in Milwaukee and provides steam to buildings in downtown Milwaukee, many facilities in SE Wisconsin can use the heat and electricity, educational facilities (MSOE, MATC programs) that can serve as resources, and many individuals in the community who can be resources (DNR, FPL, MSOE, XCEL, and other companies MGE, Alliant Energy). Wood energy is captured when burned.
NEXT STEPS

After reviewing the opportunities and challenges described above, stakeholders identified several next steps to pursue. These included:

- Create a spoke and hub network of material processors to separate construction and demolition debris and to capture wood wastes.
- Research and develop contractual models that index wood resources to the price of natural gas.
- Establish the total aggregate of wood resources available in the region.
- Develop representative cost models for wood resources and establish the business case for potential customers.
- Support the development of the CleanTech Partners Biomass Commodity Exchange, and
- Determine the level of contamination of construction and demolition debris and it’s suitability as a fuel source.

Subsequent wood waste/Growing Power/hot water meetings

A series of stakeholder meeting were held throughout the 9-month period following the initial visioning session. Below is a listing of the dates and highlights of each of these meetings:

- **January 9, 2008** – additional information regarding the need for hot water by Menomonee Valley businesses was brought to light by Don Gallo of Reinhardt Boerner Van Deuren attorneys at law. The loss of Universal Foods as a source of hot water created this need. Key questions/issues that arose at this meeting where who would own a district heating and waste recovery project, the need to quantify the amount of hot water needed, and the need for a strong political will in order to garner additional business and governmental support.

- **January 21, 2009** – this meeting focused upon clarifying the vision for a successful biomass utility generation project. Stakeholders identified that the project could provide economic growth and stabilize energy costs, as well as serve as a prime example of Milwaukee’s emerging role as a water technology center. The economic development potential was also stressed since the project could serve as an urban model for replicable renewable energy production and water conservation. A number of key considerations were again highlighted including development (design/construction) considerations, ownership and operational responsibilities, as well as potential funding sources.
- **February 25, 2009** – Johnson Control’s Jeff DeLaune summarized key market research questions facing facility feasibility. In addition, Growing Power indicated an interest in the project, particularly if hot water could be a by-product for their urban food production efforts. In addition, components needed for a successful National Energy Technology Laboratory proposal submittal were also discussed. A follow up meeting with the Governor’s Office of Energy Independence to discuss funding opportunities was recommended.

- **March 11, 2009**—Judy Ziewacz, Executive Director, Wisconsin Office of Energy Independence, discussed her goals for the 30th Street Corridor. Ziewacz is looking to fund a “green laboratory” demonstration project that showcases renewable energy and new technologies in the 30th Street Corridor and indicated that an RFP would be forthcoming.

- **March 27, 2009**—Kevin Shafer, Executive Director, MMSD, met with the committee met to discuss the possibility of applying for grant funding to optimize the use of hot water among Menomonee Valley businesses. We also discussed the upcoming SWETRC proposal elements for which the due date is April 30, 2009.

- **May 28, 2009** – Diggelman presented the findings of the study and outlined potential student projects (Appendix K). Brachman led the stakeholders in a ranking process for the student projects.

**Southeastern Wisconsin Energy Technology Research Center (SWETRC) Spring 2009 Proposal**

The Milwaukee School of Engineering submitted a proposal April 30, 2009 to the Southeastern Wisconsin Energy Technology Research Center (SWETRC) Spring 2009 Seed Grant Program, “Taking the 1st Step—Transitioning Milwaukee from coal to an 22nd Century Integrated Energy Model—Prefeasibility Assessment of harnessing energy in wood and food waste, student power and local expertise to Support Growing Power’s Urban Agriculture Program”. Below is the project summary:

This project is the continuation of a 5-year collaboration between Steve Brachman, UW-Extension Solid & Hazardous Waste Education Center (SHWEC), Patrick Keily, We Energies and Carol Diggelman, Milwaukee School of Engineering (MSOE) to evaluate the local wood waste supply for a wood waste to energy facility. It is the beginning of a long-term, broader collaboration between Milwaukee area universities, the City of Milwaukee, Johnson Controls, Inc., We Energies, regional firms and Growing Power, Inc. that has powerful triple bottom line
(people, planet, profit) opportunities. This project will harness professional technical expertise with student power to solve issues related to developing wood waste and food waste infrastructure needs that must be met before advancing Growing Power’s urban agriculture business development.

The core issue addressed by this project and facing Milwaukee is how to reduce fossil-based energy consumption and production which are major contributors to greenhouse gas emissions. Given the dominance of fossil fuels as— a dominance that is projected to continue in coming decades – it is increasingly clear that meeting the challenge of climate change will require development and deployment of a wide range of strategies in the energy field to mitigate energy-related greenhouse gases. This project takes the 1st step in attempting to develop the infrastructure to capture energy that is mostly wasted when wood waste and food waste are landfilled.

Drivers for this project include the Massachusetts v. Environmental Protection Agency (Public Service Commission, State of Wisconsin, 2004), United States Environmental Protection Agency (USEPA) Appeals Board decision on Deseret Power Electric Cooperative (Wisconsin State Assembly, 2009), the Obama administration’s commitments to regulate carbon dioxide and other greenhouse gases (Gad, 2006), and the State of Wisconsin’s 25 by 25 commitments (The Wisconsin Office of Energy Independance, 2009).

This project proposes to identify and fund 10 student intern projects for summer 2009. We will convene a professional, technical committee to work with student interns. At the end of the summer, students are required to write reports and make presentations on their project results. The professional, technical committee will continue to meet monthly for the academic year to synthesize student reports into a draft report. The draft report will be disseminated to broader wood and food waste stakeholder community, who will be invited to give their input at a stakeholder meeting. After including this input the draft report, a stakeholder group of public officials will be invited for their input. With the benefit of this input, the committee will finalize the report for distribution.

The future reach of this project includes training inner city workers for green technologies, sustainable food production, reducing Milwaukee’s carbon footprint, energy efficiency, optimizing efficient use of renewable resources, and integrating a wide range of renewable energy technologies. A Diggelman/ Brachman/Keily trip to St. Paul’s District Heating and Cooling System powered by wood waste showed that an integrated energy model is not only
possible but has worked for 25 years. This collaboration has the broad support needed to justify funding future projects capable of developing a 22nd century integrated energy model tailored for Milwaukee.

Performance Contracting

Performance contracts can serve as a mechanism to implement energy efficiency improvements with minimal up-front costs, by utilizing savings resulting from the efficiency project to pay for the work over a period of time. The US Department of Energy has suggested that performance contracts be incorporated as a best practices approach when developing innovative energy solutions. Significant savings may accrue to a wood waste to energy facility through the use of performance contracting.

Typically, energy performance contract consists of the following key components, according to the US Environmental Protection Agency:

- **Turnkey Service** – An energy service’s company provides all of the services required to design and implement a comprehensive project at the customer facility, from the initial energy audit through long-term Monitoring and Verification (M&V) of project savings.
- **Comprehensive Measures** – The company tailors a comprehensive set of measures to fit the needs of a particular facility, and can include energy efficiency, renewables, distributed generation, water conservation and sustainable materials and operations.
- **Project financing** – The company arranges for long-term project financing that is provided by a third-party financing company. Financing is typically in the form of an operating lease or municipal lease.
- **Project Savings Guarantee** – The company provides a guarantee that the savings produced by the project will be sufficient to cover the cost of project financing for the life of the project.

There are a number of market drivers that have encouraged the development of performance contracts. These range from energy savings mandates to green building specifications and climate change goals. Financing can take a variety of forms as well, including tax-exempt lease purchase agreements, state or local government leasing pools or bonds, or utility purchase power agreements.

Utilization of performance contracts could be a key aspect of a wood waste to energy facility development in southeast Wisconsin, since a number of vendors are available which can provide this service. Due to the variability of the wood supply, however, it will be essential that long-
term users of hot water be secured as well as municipal providers of steady supplies of woody materials. In order to facilitate this process, it is recommended that key sources of hot water demand accompany the currently identifiable sources of wood as part of the overall project development.

**Johnson Controls and performance contracting**

Johnson Controls, the global leader in energy efficiency, manages the largest performance contracting portfolio in the U.S. - a portfolio of over $3.8 billion. Facility improvements are funded out of the guaranteed savings to which JCI commits after performing a professional engineering audit on a building(s). The savings and results projected are guaranteed for the duration of the contract (JCI pays any difference) and once the project is complete, an organization keeps the remaining savings. Through energy saving improvements an organization can reduce its energy consumption by 10% to as much as 50%. Performance Contracting makes it possible to improve a facility’s energy efficiency -- reduce emissions, reduce waste, decrease water use, lower energy use, lower operational costs -- without budgetary pressure. Performance Contracting can be applied to both public and private sector facilities (Johnson Controls, 2008).
ELEMENTS OF A WOOD WASTE TO ENERGY INFRASTRUCTURE

There are many elements of a wood waste to energy infrastructure, including policy initiatives, availability of services that provide source separation of wood waste, local wood waste processing capability, engineering and construction expertise.

Policy initiatives

The Governor’s Task Force on Waste Materials Recovery and Disposal urged the recovery of more construction and demolition debris and other sources of wood waste with the objective to recover as much of this waste as possible for beneficial reuse. Steps to be taken include:

- Initiating market development and research on the recovery and reuse of C&D waste and supporting the development of an infrastructure for recycling and marketing C&D waste in general and clean, untreated wood in particular,
- Removing regulatory barriers to waste reduction, reuse and recycling where environmentally appropriate (ICF International, National Association of Energy Services Companies, 2007).

At this time policy is in place to encourage wood recycling, but no landfill bans are proposed.

USEPA policy on waste to energy related to MSW

The majority of MSW that is not recycled is typically sent to landfills after it is collected. As an alternative, MSW can be directly combusted in waste-to-energy facilities to generate electricity. Because no new fuel sources are used other than the waste that would otherwise be sent to landfills, MSW is often considered a renewable power source. Although MSW consists mainly of renewable resources such as food, paper, and wood products, it also includes nonrenewable materials derived from fossil fuels, such as tires and plastics (U.S. Environmental Protection Agency, 2009).

Source separation of wood waste

WasteCap Wisconsin offers C&D Waste Management Services that includes planning, technical and educational assistance. They also monitor, measure, document and publicizes results of waste management efforts during construction and demolition projects. Specifically, WasteCap can:

- Provide draft construction or demolition waste reuse and recycling specifications
- Write and review bids for trash and recycling collection
• Develop a construction or demolition waste management plan (required for LEED)

• Help obtain exemptions from the WI DNR for recycling of wood, drywall, etc.

• Provide technical assistance, market information, and research support

• Instruct and educate contractor employees and subcontractors about their role in the program

• Conduct waste audits and monitor program including interviewing job site crews, checking for mis-sorted materials in recycling and trash containers and correcting problems

• Ensure proper placement, timing, and labeling of trash and recycling dumpsters

• Document construction waste management results (required for LEED). Document and calculate the types and quantities by weight and volume of trash and recyclables as well as the financial impact of the program’s implementation

• Share results. Share the story and promote results internally to employees and externally

• Complete a final construction waste management evaluation and report (Waste Cap Wisconsin, 2009).

**Wood waste haulers**

The revenue stream attributable to wood waste has a significant economic impact to haulers who have kept hauling costs low. There is a need to work with waste haulers to develop a business case for source separation of wood waste. If wood waste is to be source separated for diversion to a wood waste to energy facility It will be necessary to provide two containers where one was sufficient before—one container for wood and another for mixed municipal solid waste.

**Wood waste processing capacity**

John Hansen, Citywide Recycling LLC, is currently processing approximately 90-100 tons per day of wood at their North side facility, 10700 W. Brown Deer Road, Milwaukee, WI 53224. Of this amount, approximately 40-50 tons would be clean/unpainted dimensional lumber/plywood/OSB board. Hansen assumes that they would receive a similar amount at a new facility on the South side of Milwaukee.

This wood is ground at this facility to a 3” minus spec. and currently goes to a biomass facility in Wisconsin. The value of this wood has been moving in an upward direction for the past 6
months as more players have surfaced. The processed wood would demand anywhere from $25-45 per ton (Hansen, 2009). (Appendix J.)

Wood waste to energy facility

Johnson Controls has indicated that they are interested in building a wood waste to energy facility in Milwaukee, they have designs for a CHP wood waste gasifier as described in Appendix C. They have the capability to provide engineering and construction for this project. We learned that they need customers both for the electricity produced and the thermal (hot water) load. We Energies is required to increase their electric generation from renewables to over 8% of retail sales by 2015 and provided pricing is competitive with other renewable electricity generation. Growing Power has expressed willingness to be a customer for the hot water produced from the CHP facility.

In his capstone project draft report, Jason Talbot learned from a review and evaluation of biomass literature and discussions with facility managers that a successful biomass blueprint should address the following six main parameters, including fuel supply, financing, power purchase agreements (PPAs: electricity purchasers), engineering and construction processes, project process/systems, and project benefits. There are many elements of this project left to complete. There are also many potential benefits to quantify.

Conclusions and recommendations

There exists a significant opportunity for expanded renewable energy production from wood wastes in SE Wisconsin. There appears to be adequate amounts of wood to justify a scalable CHP wood waste to energy plant, but there is increasing competition for clean wood from every sector. Any project will need to address achieving a steady-state wood waste supply in SE Wisconsin with an aggressive tree planting (medians in boulevards, private yards, parks, suburbs and exurbs etc) program in the metropolitan area working with Greening Milwaukee and perhaps funded by We Energies Energy for Tomorrow program or Keep Greater Milwaukee Beautiful.

In order to develop a biomass energy facility, it is recommended that the stakeholder process be continued to oversee and support student task-specific research, which should be conducted during the summer of 2009. This research should focus on additional determinations of biomass resource availability, siting concerns and opportunities to capture residual energy from other biomass, including food waste. A detailed cost analysis should be developed to further
refine key components of the project. This cost analysis should lead to a “go-no go” decision to be made by the three key stakeholders—We Energies, Johnson Controls and the City of Milwaukee—followed by the issuance of an RFP for a biomass energy provision in SE Wisconsin and a determination on the potential feasibility of the project. The next step would be taken by a facility developer to contract for fuel supply and for steam and electricity.

The Diggelman Power Point presentation at the May 28, 2009 stakeholders’ meeting can be found in Appendix K.
Works Cited


DNR - Waste Management Program. (2007). Annual Recycling and Landfill Reports. Retrieved 2009, from Table 1: Recyclable Materials Collected by Wisconsin Responsible Units:
http://www.dnr.state.wi.us/org.aw/wm/recycle/recycleldfrept/table1ru.pdf


http://www.ever-greenenergy.com/about/story.html


Hansen, J. (2009, May 27). (P. Carol Diggelman, Interviewer)


Mace, T. (2009, February 10). Forest Utilization and Marketing Specialist, Division of Forestry, WDNR.


Sheikholeslami, B. (2009, May 27). WDNR. (P. Carol Diggelman, Interviewer)


Wisconsin Wood Use, by Economic Sector
1970-2007
(Trillions of Btu and Percent of Total)

Wood energy use in Wisconsin increased by 11.4 percent in 2007, primarily due to cold winter weather. The residential wood use is estimated using a variety of factors including heating degree days, cost of other winter fuels and gross domestic product, the efficiency factor of wood, and the number of households in Wisconsin. In this table, Commercial is used in a broad context to include schools, hospitals, wholesalers and retailers, and construction.

<table>
<thead>
<tr>
<th>Year</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Electric Utility</th>
<th>Total</th>
</tr>
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<td>0.2 (0.9%)</td>
<td>10.0 (45.2%)</td>
<td>0.0 (0.0%)</td>
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<td>11.8 (49.3%)</td>
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<td>11.9 (49.8)</td>
<td>0.0 (0.0)</td>
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<td>15.7 (35.7)</td>
<td>0.7 (1.7)</td>
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<td>3.5 (7.9)</td>
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<td>3.4 (8.6)</td>
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<td>3.5 (8.4)</td>
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<td>3.3 (7.8)</td>
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<td>3.5 (7.7)</td>
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<td>2007*</td>
<td>32.0 (63.1%)</td>
<td>0.2 (0.5)</td>
<td>15.0 (29.6)</td>
<td>3.4 (6.8)</td>
<td>50.7</td>
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* Revised.

P Preliminary estimates.

Wisconsin Timber Products Assessment

Awarded: 1/9/2009  
Grantee: WPS

<table>
<thead>
<tr>
<th>PLAN OF WORK</th>
<th></th>
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<tbody>
<tr>
<td><strong>Task 1</strong></td>
<td>Objective is to survey the primary and secondary forest industry in Wisconsin to identify the amount of wood residue they produce, if it is currently being utilized, and if it is utilized, and at what price per ton.</td>
</tr>
<tr>
<td><strong>Who</strong></td>
<td>Don Peterson, Terry Mace, Carol Whippler, Heather Ross</td>
</tr>
</tbody>
</table>
| **How**      | - Download all existing contact information from WDNR Primary and Secondary Industry Directories and create a spreadsheet with all pertinent company information and action achieved.  
- Complete a draft survey with review by WDNR, UW-Extension, and other interested parties and develop an agreed upon survey.  
- Send survey to a test group of companies with immediate follow-up to further refine the summary.  
- Send out surveys and also have online survey capabilities.  
- Collect surveys and enter into database.  
- After two weeks, follow up with phone surveys to non-respondents. |
| **Deliverables** | - Update/add information to the database as information changes/is gathered.  
- A minimum of 20% survey response from forest industry companies surveyed.  
- Compilation of surveys, with a calculated total of annual volumes produced. |
| **Start**    | 2/1/09 |
| **Finish**   | 8/31/09 |

| **Task 2** | Identify any entities involved with tree removal/trimming outside of the logging community and survey them to acquire information on their annual wood residue volumes and what they currently do with it. |
| **Who** | Don Peterson, Heather Ross, Terry Mace, Jerry Brown, Scott Bowe, Carol Whippler |
| **How** | - Download all existing contact information from WDNR Primary and Secondary Industry Directories and create a spreadsheet with all information and action achieved.  
- Complete a draft survey with review by WDNR, UW-Extension, and other interested parties and develop an agreed upon survey.  
- Send survey to a test group of companies with immediate follow-up to further refine the summary.  
- Send out surveys and also have online survey capabilities.  
- Collect surveys and enter into database.  
- After two weeks, follow up with phone surveys to non-respondents. |
| **Deliverables** | - Update/add information to the database as information changes/is gathered.  
- A minimum of 20% survey response from companies surveyed.  
- Compilation of surveys, with a calculated total of annual volumes produced. |
| **Start**    | 2/1/09 |
| **Finish**   | 9/30/09 |
### Task 3

**Purchase a Wisconsin Manufacturing Industry Directory and conduct a stratified sampling of manufacturing companies in Wisconsin to determine the amount of wood residue they accumulate on an annual basis, if it is currently being utilized, and if it is utilized, at what price and unit.**

<table>
<thead>
<tr>
<th>Who</th>
<th>Don Peterson, Heather Ross, Jerry Brown, Carol Whippler</th>
</tr>
</thead>
</table>
| **How**              | - Create a contact list of companies using the directory and the stratified sampling system that will be developed.  
- Create a spreadsheet with all information and actions achieved.  
- Complete a draft survey with review by WDNR, UW-Extension, and other interested parties and develop an agreed upon survey.  
- Send survey to a test group of companies with immediate follow-up to further refine the summary.  
- Send out surveys and also have online survey capabilities.  
- Collect surveys and enter into database.  
- After two weeks, follow up with phone surveys to non-respondents.  |
| **Deliverables**     | - Update/add information to the database as information changes/is gathered.  
- A minimum of 20% survey response from manufacturing companies surveyed.  
- Compilation of surveys, with a calculated total of annual volumes produced.  |
| **Start:**           | 2/1/09                                                |
| **Finish:**          | 9/30/09                                               |

### Task 4

**Identify all landfills in Wisconsin and survey them to assess the annual volumes of demolition wood and to determine any specifications/limitation on the wood they accept.**

<table>
<thead>
<tr>
<th>Who</th>
<th>Don Peterson, Jerry Brown, Heather Ross, Carol Whippler</th>
</tr>
</thead>
</table>
| **How**              | - Download all existing contact information from WDNR Primary and Secondary Industry Directories and create a spreadsheet with all information and action achieved.  
- Complete a draft survey with review by WDNR, UW-Extension, and other interested parties and develop an agreed upon survey.  
- Send survey to a test group of companies with immediate follow-up to further refine the summary.  
- Send out surveys and also have online survey capabilities.  
- Collect surveys and enter into database.  
- After two weeks, follow up with phone surveys to non-respondents.  |
| **Deliverables**     | - A minimum of 20% survey response from landfills surveyed.  
- Compilation of surveys, with a calculated total of annual volumes produced.  |
| **Start:**           | 2/1/09                                                |
| **Finish:**          | 6/30/09                                               |

### Task 5

**Identify Wisconsin timber sales by ownership, timber type, sale type, etc.**

<table>
<thead>
<tr>
<th>Who</th>
<th>Don Peterson, Terry Mace</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How</strong></td>
<td>- Each major landowner sector will be surveyed with specific information being gathered on the acreage by timber type, the acreage by harvest type, and the acreage by sale type.</td>
</tr>
<tr>
<td><strong>Deliverables</strong></td>
<td>- Database of Wisconsin timber sales by timber type that will give specific information to help identify biomass availability.</td>
</tr>
<tr>
<td><strong>Start:</strong></td>
<td>2/1/09</td>
</tr>
<tr>
<td><strong>Finish:</strong></td>
<td>12/31/09</td>
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</table>

### Task 6

**Identify logging residue tonnage per acre by timber type and season.**

<table>
<thead>
<tr>
<th>Who</th>
<th>Don Peterson, Terry Mace, Heather Ross</th>
</tr>
</thead>
</table>
| **How**              | - 20 timber sales will be selected to be studied for amount of logging residue/acre that is currently left.  
- Intensive specific sized plots will be taken, with the logging residue being measured in the woods in each timber type. Plots will be taken in the growing and non-growing season for comparison of weights.  
- Logging residue available/acre will be compiled by timber type, season, sale type, and harvest type.  
- Compare results of this project to logging residue numbers compiled through the USDA Forest Service Forest Inventory.  
- Develop a tool for assessing residual volume availability by timber type and time of year.  |
<p>| <strong>Start:</strong>           | 2/1/09                   |
| <strong>Finish:</strong>          | 10/31/10                 |</p>
<table>
<thead>
<tr>
<th>Deliverables</th>
<th></th>
<th>Task 7</th>
<th>All information gathered previously will be compiled into a database with applicable reports being generated.</th>
<th>Start: 7/1/09</th>
<th>Finish: 10/31/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who</td>
<td>Terry Mace, Scott Bowe, Heather Ross</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| How | • All databases created throughout the project will be compiled into one large database that will be used for cross-referencing to ensure data accuracy as well as multiple industry-wide query capability.  
• This database will be used to compile information and raw data for accurately completing all documents created/updated through this project. | | | |
| Deliverables | • A method will be developed to accurately assess logging residue volume availability by timber type and create a document that addresses logged area residue in Wisconsin.  
• A database will be developed that will allow access to all information compiled in this project. | | | |
| Task 8 | Identify and collect appropriate information on all companies that process woody biomass chips. | | | |
| Who | Terry Mace, Don Peterson, Jerry Brown, Heather Ross | | | |
| How | • Work with all chipper/grinder manufacturers/dealers to identify that companies that currently own chippers.  
• Work with organizations such as Great Lakes Timber Professionals Association (GLTPA) and Forest Industry Safety and Training (FISTA) to identify other chipping operations that might have been missed through the dealer/manufacturer search.  
• Contact identified companies to determine if they process biomass chips, and if so, what is their annual production and capabilities. | | | |
| Deliverables | • A directory of woody biomass fuel processors, along with their contact information and capabilities. | | | |
| Task 9 | Update the 2005 “The Real Cost of Extracting Logging Residues for Biomass Fuels” | | | |
| Who | Terry Mace, Don Peterson, Heather Ross | | | |
| How | • All companies identified in Task 7 will be interviewed to update the information in the previous study.  
• All known manufacturers of woody biomass harvesting, extraction, and processing equipment will be contacted to update any information regarding innovations and production ratios.  
• Agencies and other landowner sectors will be contacted to update the section containing woody biomass policies. | | | |
| Deliverables | • A revised version of the “The Real Cost of Extracting Logging Residues for Biomass Fuels”. | | | |
| Task 10 | Revise the 1993 “Wisconsin Wood Residue Study” | | | |
| Who | Terry Mace, Scott Bowe, Don Peterson, Heather Ross, Jerry Brown, and pertinent company representatives. | | | |
| How | • Compile information from Tasks 1-4 and develop a user friendly study with critiquing of the study by the appropriate experts. | | | |
| Deliverables | • A 2009 “Wisconsin Wood Residue Study” | | | |
| Task 11 | Assist training/education organizations in developing and implementing workshops/conferences on biomass extraction, processing, utilization, and end-use strategies. | | | |
| Who | Don Peterson, Terry Mace, Scott Bowe, GLTPA | | | |
| How | • Pertinent topics, information and speakers will be identified and made available to workshop/conference organizers/planning committees.  
• The topics, information, and speakers will be identified throughout the project. | | | |
<p>| Deliverables | Conferences and workshops with current pertinent information on a variety of biomass topics (a minimum of 3 conferences and 2 workshops each in 2009 and 2010). | | | |</p>
<table>
<thead>
<tr>
<th>Task 12 Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Who</strong></td>
</tr>
<tr>
<td><strong>How</strong></td>
</tr>
<tr>
<td><strong>How</strong></td>
</tr>
<tr>
<td><strong>How</strong></td>
</tr>
<tr>
<td><strong>Deliverables</strong></td>
</tr>
<tr>
<td><strong>Deliverables</strong></td>
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<tr>
<td><strong>Deliverables</strong></td>
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<tr>
<td><strong>Deliverables</strong></td>
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<tr>
<td><strong>Deliverables</strong></td>
</tr>
<tr>
<td><strong>Deliverables</strong></td>
</tr>
</tbody>
</table>

Start: 5/1/09
Finish: 12/31/10
February 9, 2009

Milwaukee Biomass Energy Project

Here’s a preliminary snapshot of a minimum-size biomass energy project that produces both heat and electricity:

**Biomass Gasifier Units**
1 (16 ft diameter)

**Engine Units**
1

**Engine Capacity**
1.65 MW

**Availability**
96%

**OUTPUT**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Delivered</td>
<td>13,900 MWHrs/yr</td>
</tr>
<tr>
<td>Heat Available</td>
<td>9.2 MMBTU/hr</td>
</tr>
<tr>
<td>Hot Water Produced</td>
<td>6,100 gallons/hr (200 deg-F)</td>
</tr>
</tbody>
</table>

**INPUT**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass Requirement (wet (50% moisture) - as delivered)</td>
<td></td>
</tr>
<tr>
<td>Input/hr</td>
<td>30 MMBTU/hr</td>
</tr>
<tr>
<td>Input/hr</td>
<td>3.5 Tons/hr</td>
</tr>
<tr>
<td>Input/yr</td>
<td>29,600 Tons/yr</td>
</tr>
<tr>
<td>Input/day</td>
<td>3 Trailer Loads/day</td>
</tr>
</tbody>
</table>

**FOOTPRINT**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>140 Ft</td>
</tr>
<tr>
<td>Width</td>
<td>100 Ft</td>
</tr>
<tr>
<td>Area</td>
<td>14,000 sq-ft</td>
</tr>
</tbody>
</table>
### Appendix D. Table 1. SE Wisconsin—Landfilled wood waste, municipally reported wood waste, FPL estimated wood waste and Total MSW

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfilled yard waste≤6 in (1)</td>
<td>34319</td>
<td>8580</td>
<td>2.1E+11</td>
<td>5.1E+10</td>
<td>1.6E+04</td>
<td>4.0E+03</td>
<td>62</td>
<td>15</td>
</tr>
<tr>
<td>Landfilled yard waste≥6 in (1)</td>
<td>1691</td>
<td>423</td>
<td>1.0E+10</td>
<td>2.5E+09</td>
<td>7.9E+02</td>
<td>2.0E+02</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Landfilled C&amp;D wood untreated (1)</td>
<td>214178</td>
<td>53545</td>
<td>2.1E+11</td>
<td>5.4E+10</td>
<td>1.0E+05</td>
<td>2.5E+04</td>
<td>387</td>
<td>97</td>
</tr>
<tr>
<td>Pallets (1)</td>
<td>16005</td>
<td>16005</td>
<td>1.6E+10</td>
<td>1.6E+10</td>
<td>7.5E+03</td>
<td>7.5E+03</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Municipally reported wood (2)</td>
<td>100188</td>
<td>25047</td>
<td>6.0E+11</td>
<td>1.5E+11</td>
<td>4.7E+04</td>
<td>1.2E+04</td>
<td>181</td>
<td>45</td>
</tr>
<tr>
<td>Total wood</td>
<td>366381</td>
<td>91595</td>
<td>1.0E+12</td>
<td>2.7E+11</td>
<td>1.7E+05</td>
<td>4.9E+04</td>
<td>661</td>
<td>187</td>
</tr>
<tr>
<td>Terry Mace FPL 2008 estimate-SE WI</td>
<td>274726</td>
<td>68681</td>
<td>2.7E+12</td>
<td>6.9E+11</td>
<td>1.3E+05</td>
<td>3.2E+04</td>
<td>496</td>
<td>124</td>
</tr>
<tr>
<td>Total MSW (1)</td>
<td>1721362</td>
<td>430341</td>
<td>2.0E+13</td>
<td>5.0E+12</td>
<td>8.1E+05</td>
<td>2.0E+05</td>
<td>3108</td>
<td>777</td>
</tr>
</tbody>
</table>

(1) Table B-26 Wisconsin Statewide Waste Characterization Study (yard waste≤6 in; yard waste≥6 in; wood untreated and pallets) http://dnr.wi.gov/org/aw/wm/publications/recycle/wrws-finalrpt.pdf


(3) Terry Mace, Forest Products Laboratory, personal communications, sent Tue 2/10/2009 3:25 PM.

(4) Wisconsin Task Force on Global Warming Policy Template (Assumes 25% recovery of landfilled yard waste, food waste, C&D waste and total MSW and 100% recovery of pallets.) 7/3/08


(7) Assumes Jeff DeLaune information (attachment below) of 1.65 MW engine capacity, 13,900 MW Hr/Yr/29,600 tons (as delivered) wood waste/year.

(8) Assumes Jeff DeLaune information (attachment below) of 6100 gallons of 200F hot water/hr *24 hr/day*365 d/yr/29600 tons (as delivered) wood waste/year.
### Appendix E. Table 2. Food waste energy (food waste to anaerobic digester to methane to CHP system)
**March 23, 2009**

<table>
<thead>
<tr>
<th></th>
<th>Total wet tons/year (1)</th>
<th>Dry tons/year (2)</th>
<th>Maximum ft³ methane/year (3)</th>
<th>Minimum ft³ methane/year (3)</th>
<th>Diggelman ft³ methane/year (4)</th>
<th>Maximum Btu/year (5)</th>
<th>Minimum Btu/year (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>food waste, maximum</td>
<td>149121</td>
<td>44736</td>
<td>7.61E+08</td>
<td>5.37E+08</td>
<td>5.08E+08</td>
<td>7.61E+11</td>
<td>5.37E+11</td>
</tr>
<tr>
<td>food waste, minimum</td>
<td>37280</td>
<td>11184</td>
<td>1.90E+08</td>
<td>1.34E+08</td>
<td>1.27E+08</td>
<td>1.90E+11</td>
<td>1.34E+11</td>
</tr>
</tbody>
</table>


(2) Assume food waste is 30% solids; 70% water.


(4) Based on calculation in Diggelman dissertation.

(5) 1000 Btu/ft³ methane Table ES-1 p.ES-3 footnote 3 reference (3)

### Appendix E. Table 3. Recovery of energy from We Energies hot water currently discharged to river (assumed 20°F Temp. reduction).
**March 23, 2009**

<table>
<thead>
<tr>
<th></th>
<th>gallons/day</th>
<th>gal/year</th>
<th>lb/year</th>
<th>Btu/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.6E+08</td>
<td>5.8E+10</td>
<td>4.9E+11</td>
<td>9.7E+12</td>
</tr>
</tbody>
</table>

Assume 160,000,000 gallons per day of 60°F water, 365 days/year, 8.344 lb/gallon, 1 Btu/lb °F and 20 °F temperature reduction.
Attendees at August 21, 2008 Stakeholder Meeting:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Brachman</td>
<td>UW-Extension Solid &amp; Hazardous Waste Education Center</td>
</tr>
<tr>
<td>Becky Curtis</td>
<td>City of Milwaukee Sanitation</td>
</tr>
<tr>
<td>Lloyd Davenport</td>
<td>Milwaukee School of Engineering</td>
</tr>
<tr>
<td>Jeff DeLaune</td>
<td>Johnson Controls, Inc.</td>
</tr>
<tr>
<td>Carol Diggelman</td>
<td>Milwaukee School of Engineering</td>
</tr>
<tr>
<td>Jeff Geipel</td>
<td>Certified Products</td>
</tr>
<tr>
<td>John Hansen</td>
<td>City Wide Recycling, LLC</td>
</tr>
<tr>
<td>Ken Hein</td>
<td>WI DNR</td>
</tr>
<tr>
<td>Pat Keily</td>
<td>WE Energies</td>
</tr>
<tr>
<td>Steve Keith</td>
<td>Milwaukee County</td>
</tr>
<tr>
<td>Alan Kirn</td>
<td>Johnson Controls</td>
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<tr>
<td>Jaime Kowalski</td>
<td>Certified Products</td>
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<tr>
<td>Connie Lindholm</td>
<td>WE Energies</td>
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<tr>
<td>John Lotes</td>
<td>WasteCap WI</td>
</tr>
<tr>
<td>Rick Meyers</td>
<td>City of Milwaukee Sanitation</td>
</tr>
<tr>
<td>Frank Schultz</td>
<td>WI DNR</td>
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<tr>
<td>David Sivyer</td>
<td>City of Milwaukee Forestry</td>
</tr>
<tr>
<td>Bill Snow</td>
<td>Waste Management Of Wisconsin</td>
</tr>
<tr>
<td>Rosemary Wehnes</td>
<td>Sierra Club Milwaukee Office</td>
</tr>
<tr>
<td>John Zerbe</td>
<td>Forest Products Lab</td>
</tr>
</tbody>
</table>
SOUTHEAST WISCONSIN WOOD RESOURCE SURVEY AND BASELINE ANALYSIS

PROJECT OVERVIEW

- **Project Goal:**
  - Determine the feasibility of siting a wood-to-energy facility in Southeastern Wisconsin

- **Project Outline:**
  - Biomass Background Information
  - Case Study: French Island Generation Plant
    - Successful Working Example
  - Methods and Processes
  - Literature Review: Wood-To-Energy Blueprint
  - Results

BACKGROUND INFORMATION

- **Renewable Energy:**
  - "Any source of energy that is sustainable and constantly replenished" (IWAS)

- **Wood Waste:**
  - Biomass: "Any organic material that can be used to create energy" (IWAS)
  - Unique and High Value Fuel Source
  - Natural Carbon Cycle
    - Biomass
    - Fossil Fuels

BACKGROUND INFORMATION

- **An Abundant Fuel Supply**
  - Largest Overall Waste in Wisconsin Landfills
  - 607,650 Tons Landfilled
  - 62,000 Tons Recycled
  - Total Wood Waste ~ 670,000 Tons

BACKGROUND INFORMATION

- **Current WI Electric Utility Wood Fuel Use**
  - 301,580 Tons in 2001
  - Sources Include:
    - Logging Companies
    - Land Clearing Companies
    - Railroad Ties
    - Green Wood Waste
  - Wisconsin Wood Waste
  - Recycling Rate ~ 30%

- **Natural Carbon Cycle**
  - Wood-to-Energy
  - Forests and Renewable
  - Biomass
  - Fossil Fuels
**Background Information**

- **Southeastern WI Wood Waste Availability**
  - Similar Recycling Rate = 30%
  - 290,000 Tons Landfilled
  - 115,000 Tons Recycled
  - 405,000 Tons Total
  - Wood Waste Redirected Towards Fuel Supply
    - 1/3 Landfilled/Waste = 100,000 Tons
    - 1/3 Recycled Green Waste = 35,000 Tons
    - Total Available Fuel Supply = 155,000 Tons

**Background Information**

- **Renewable Energy Goals and Standards**
  - Wisconsin Renewable Portfolio Standard (RPS)
    - Established in 1999
    - Required to meet increasing percentages of retail sales with qualified renewable resources
  - Wisconsin Act 141
    - 10% of retail sales from renewable resources by 2015
    - Required to report progress
  - Renewable Resource Credits (RRCs)
    - Awarded to overachieving companies

**Background Information**

- **To Summarize:**
  - Stringent Renewable Energy Goals and Standards
  - Renewable Portfolio Standard
  - Wisconsin Act 141
  - Abundant Wood Waste Fuel Supply
    - 155,000 Tons Reasonably Available To Be Redirected
  - Overcome Involved Challenges
    - Missing Infrastructure and Organization
    - Wood Waste Sources Spread Out

**Case Study**

- **French Island Generation Plant**
  - Xcel Energy Owned and Operated
  - Lacrosse, Wisconsin
  - 12 Megawatt (MW)
  - Mixed Fuel Supply 1:1 Ratio
    - ~50,000 Tons/year MSW
      - Refuse Derived Fuel (RDF)
      - ~40,000 Tons/year Wood
        - Railroad Ties
        - Wood Waste

**Case Study**

- **French Island Wood Fuel Supply Breakdown**
  - Based off Lacrosse County MSW Tonnages
  - | Desired % | Railroad Ties | Wood Waste |
  - |        |             |            |
  - | 50     | 60          | 40         |
  - | Actual %|             |            |
  - | 70     | 30          | 20         |
  - | Blunt   |             |            |
  - | 98     | 20          | 40         |
  - | Moisture Content %| |            |
  - | 30     | 50          | 20         |

  - Co-locating With Railroad Tie Companies
  - Competitiveness and Fluctuation of Wood Waste
    - Electricity has set costs
    - Other markets offset costs to customers
CASE STUDY

- Contracts: French Island Wood Fuel Supply
  - 12 Wood Fuel Supply Contracts
  - 3 Railered Ties
  - 9 Wood Waste Specific
  - 50-60 Mile Typical Hauling Radius
  - High Transportation Costs
  - Keeps Fuel Resilient
  - Backhauling Procedures
  - Expand Hauling Distances
  - Give Supplier Return Trail

CASE STUDY

- Testing: French Island Wood Fuel Supply
  - Prices Set Through Fuel Sampling
    - BTU Content
    - 7-10 BTU/kWh
    - Moisture Content
    - 7%
    - Ash Content
    - 2%

CASE STUDY

- Handling: French Island Wood Fuel Supply
  - Multiple Handling of Fuel Supply
    - French Island Essentially Pays Twice
    - Site Restriction
    - Transportation and Handling
    - On-site Processing Would Be Ideal, But...
      - Space Restrictions
      - High Costs
      - Maintenance
      - Operational

CASE STUDY

- Contingency Plan: French Island Wood Fuel
  - Selected Plans
    - Supplier Strategies
      - Financial Investment
      - Secure Steady Supply
      - Fuel Cost Adjustments (FCAs)
      - Wood Only Fuel Without FCAs
      - Secure Interest of Existing Suppliers
      - Backhauling Adjustments

LITERATURE REVIEW

- Wood-To-Energy Blueprint
  - Outline Primary Crucial Facets of Successful Projects
    - Fuel Supply Secured
    - Financing and Sponsorship
    - Power Purchase Agreements (PPAs)

- Fuel Supply: Wood-To-Energy Blueprint
  - At What Price Over The Financing Term
  - Processing and Handling Aspects
    - How Fuel Will Be Supplied
      - When?
      - Where?
      - How?
**LITERATURE REVIEW**

- Financing: Wood-To-Energy Blueprint
  - Sponsorship Goals:
    - Obtain Financing
    - Complete Construction
    - Ensure Long-Term Plant Operation
    - Lock in Revenue Stream
    - Suitable Amounts of Debt
    - Contingencies
  - Power Purchase Agreements (PPAs)

**LITERATURE REVIEW**

- Secondary: Wood-To-Energy Blueprint
  - Engineering and Construction Processes
  - Project Process/Systems
  - Project Benefits

**RESULTS**

- Primary Wood-To-Energy Blueprint Parameters
  - Secondary

**EV 892 Goals**

- Cost Calculations
  - Wood Waste Collection
  - Landfill Fees
- Life Cycle Impact
  - Environmental Aspects
    - Emissions
    - Fuel Costs
- Final Conclusions

**QUESTIONS OR COMMENTS?**

**CASE STUDY**

- Contract Beach Island Wood Fuel Supply
  - Long-Term Fuel Supply
  - Renewable Energy Systems
  - Local Community Benefits
- **Engineering and Construction Processes: Wood-To-Energy Blueprint**
  - Turn Key Construction Methods
  - Preferred by Financiers
  - Problematic
  - Economic Fluctuations and System Complexities

- **Cost Plus Construction Methods**
  - When Long Term Quality Is Key
  - No Incentive To Cut Corners
  - Must Anticipate Excess Costs

- **Project Process/Systems: Wood-To-Energy Blueprint**
  - Based On Numerous Factors
  - Fuel Size Requirements
  - Moisture Content
  - On-Site Processing
  - Optional Co-Firing Systems
  - Emissions Concerns
  - Operationally Similar To Coal Fired Plants

- **Project Benefits: Wood-To-Energy Blueprint**
  - Renewable Energy Credits (RECs)
  - Industrial Development Bonds
  - Solid Waste Disposal Facility
  - Credit Worthy Support
  - Low Interest Rates
  - Production Tax Credits (PTCs)
    - 1.5 cents/kwh Credit
    - First 10 Years of Operation
What are the key challenges to developing a wood waste facility in SE Wisconsin?

Cost
- Higher Focus on Energy money for customer-sited biomass plants are needed
- Source separation will increase costs
- Transportation costs
- Higher capital costs compared to natural gas (3)
- Energy density is lower than coal
- Rising fuel and transportation costs
- Perceived economic risk
- Low landfill tip fees
- Need funding for support of new technologies
- Small plants are costly and not scalable
- Wood waste to energy facility must use heat generated in addition to electricity, since heat is 60% of the energy content of wood waste

Competition
- Competing uses for wood could make supply difficult to control (variable cost)
- Ability to secure long-term sources of material
- Quality/stability of supply
- Questionable supply of the long term
- Timing on supply contracts
- Other markets will absorb fuel wood
- Long term price stability

Material Specifications
- Contaminants in construction and demolition debris (lead/asbestos)
- Lots of small suppliers; not many big sources
- Will require additional processing to meet facility specifications
- Wood is often mixed with other materials

Regulation & Lack of Education
- NIMBY (2)
- Regulations and rules regarding definition of “renewable”
- Minimal incentives of biomass thermal plants
- Air quality concerns (public)
- Regulatory approval process
- Air regulations
- Cost of getting started
- Learning all that is needed to know
- Regulatory framework needs to be adjusted to keep up with technology (e.g., Public Service Commission rate structure)
What strengths or opportunities exist in the SE Wisconsin area for a wood waste to energy facility?

Supply
- Supply is increasing
- Sustainable energy
- Growing diversion of C&D wood
- Supply of low ash materials (C&D)
- Road network (infrastructure)
- Lots of wood waste
- Population density
- Relatively high volumes of C&D waste
- Contaminated wood increase supply
- Way more load than supply
- Density
- Adequate wood supply
- Consistent municipal supply of green wood waste
- Emerald ash borer – 720 million trees at risk statewide (regional volume?)
  20-30 year event

Infrastructure
- Logistics
- Transportation infrastructure – expressways, multi-modal
- University of Wisconsin system (CHP application)
- Madison District Energy Plants (CHP application)
- Potential existing combustion/energy facilities
- Transportation system in place – roads, water (Lake Michigan), railroads
- Transportation infrastructure
- Reasonable haul distances
- Developing waste processing infrastructure

Opportunity
- Incentives for energy from biomass
- Legislation - EPACT, PRS, 2007 Energy Act
- Increasing interest in sustainability – growing awareness
- Many opportunities in S.E. Wisconsin to supply heat & electricity to facilities
- WE Energies
  1. Oak Creek Power Plant
  2. Steam in downtown Milwaukee
- Knowledge
- Learn from paper industry experience = Park Falls
- Several smaller biomass plants using heat is better than one large electronic plant that throws away heat
- Educational facilities are resource – MSOE, MATC programs
- Resource people are available – DNR, FPL, MSOE, XCEL, and other companies MGE, Alliant
- Waste is available in Milwaukee and Madison - Landfilling is expensive and wasteful of land – so this adds to supply (avoid landfilling)
- Wood energy captured when burned.
May 27, 2009

Carol Diggelman, PhD
MSOE
1025 N. Broadway
Milwaukee, WI 53202

Dear Carol,

We are currently processing approximately 90-100 tons per day of wood at our North side facility. Of this amount, approximately 40-50 tons would be clean/unpainted dimensional lumber/plywood/OSB board. We assume that we would receive a similar amount at the South side facility.

This wood is ground at our facility to a 3” minus spec. and currently goes to a biomass facility in Wisconsin. The value of this wood has been moving in an upward direction for the past 6 months as more players have surfaced. I am not sure of the timing of your project so a firm number per ton of wood picked up at our facility is difficult to predict. I would guess that the processed wood would demand anywhere from $25-45 per ton.

John Hansen
City Wide Recycling, LLC
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Wisconsin Wood Resource Survey and Utilization Report

2009 Update
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Wood Waste Availability

- Wood is the **Largest Single Category** of landfilled material
- **366,000 tons** collected per year
  - 179,000 tons assumed to be recoverable
  - Currently, only 30% is recycled

Sources
- Construction and demolition
- Yard maintenance
- Industrial activities

Wood Waste Availability

Table 2. 1994 Wood Residue Study Numbers for SE survey unit and 2008 Estimate

<table>
<thead>
<tr>
<th>Wood Type</th>
<th>1994 tons/year</th>
<th>%</th>
<th>2008 tons/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallets</td>
<td>72,596</td>
<td>7%</td>
<td>274,720</td>
</tr>
<tr>
<td>Damages</td>
<td>49,957</td>
<td>6%</td>
<td>160,099</td>
</tr>
<tr>
<td>Sawdust</td>
<td>53,544</td>
<td>7%</td>
<td>142,000</td>
</tr>
<tr>
<td>Chips/shavings</td>
<td>25,923</td>
<td>3%</td>
<td>68,331</td>
</tr>
<tr>
<td>Edgings</td>
<td>23,456</td>
<td>3%</td>
<td>49,957</td>
</tr>
<tr>
<td>Bark</td>
<td>23,456</td>
<td>3%</td>
<td>19,482</td>
</tr>
<tr>
<td>Other</td>
<td>127,586</td>
<td>17%</td>
<td>63,798</td>
</tr>
<tr>
<td>Total</td>
<td>340,251</td>
<td>50%</td>
<td>274,720</td>
</tr>
</tbody>
</table>

Energy Content

Table 1. SE Wisconsin clean wood tonnages, recoverable tonnages and energy content.

<table>
<thead>
<tr>
<th>Wood Type</th>
<th>Tons/Year</th>
<th>Mean</th>
<th>Conf.</th>
<th>Conf.</th>
<th>Million</th>
<th>Recoverable</th>
<th>Million</th>
<th>Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard Waste &lt;6 in</td>
<td>1,360,636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yard Waste &gt;6 in</td>
<td>1,360,636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C&amp;D Wood untreated</td>
<td>1,360,636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pallets</td>
<td>1,360,636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yard Waste-INR reports 2006</td>
<td>1,360,636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>51,470</td>
<td>51,470</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Energy Content

- **1,360,636 million BTU/yr**
- Possible uses for this energy
  - Steam or hot water
  - Electricity
  - Cooling
- Each use has precedent
  - French Island Generation Plant → Electricity
  - Evergreen Energy Plant → Heating and Cooling

Project Purpose

- Update 2004 study
- Identify infrastructure elements for wood waste to energy system
- Investigate other community systems
- Identify and survey stakeholders
- Summarize results

Appendix K

5/28/2009
Economics

- $30,000,000 per year to landfill wood waste, assuming:
  - $100 per ton to collect
  - $30 per ton to landfill
- Significant revenue stream to waste haulers

Energy in waste materials and water

Energy Comparison

- Materials landfilled in Wisconsin in 2001 (average between all and $)
  - Wood waste to WTE
  - Food waste to anaerobic digester
  - Municipal solid waste to WTE
- Discharge water (160,000,000 gallons of water/day and T reduced from 60°F to 40°F)
- MSW ≥ hot water ≥ wood waste ≥ food waste

Conclusions

- Opportunity for expanded renewable energy production from wood waste in SE Wisconsin, although there is competition for wood waste
- Elements of infrastructure exist, including WasteCap WI construction waste services and Citywide Recycling LLC
- ICT wants to build biomass energy project in Milwaukee, We Energies wants to purchase biomass produced electricity, Growing Power is a customer for the thermal (hot water) load
- Many challenges remain, including getting construction industry and waste hauler buy-in and making a business case strong enough to support financing

Recommendations

- Need to reach steady-state wood waste supply with aggressive tree planting (medians in boulevards, private yards, parks, suburbs and exurbs etc) in the metropolitan area
- Continue stakeholder process over the summer and next academic year
- Develop a detailed cost analysis to further refine key components of the process
- Estimate value of carbon credits

QUESTIONS?
Growing Power: 2009 Facts

People
- Volunteers—2,500
- Staff--36
- Youth Corps members--36
- Visitor tours of site--10,000

Products and Produce
- Tilapia--63,000; Lake Perch—47,000
- Compost—over 12 million pounds
- Worm castings—400,000 pounds
- Greens—150 different varieties; 25,000 pots/flats
- 12 bee hives—150 lbs of honey per hive produced

Market Baskets
- Milwaukee and Chicago—average of 400 a week for each city; over 40 pick-up sites

Training workshops
- 16 weekend workshops

Rainbow Farmers Coop
- 300 farmers

Revenue
- 2009--$2,000,000 (projected)
- 2008--$2,000,000
- 2007--$1,600,000
- 2002--$300,000

Site
- Growing Power operates 8 farms
- 5 acre composting facility
- Gross income per square foot—$5