


CLEAN ENERGY RESOURCE TEAMS

West Central Clean Energy Resource Team
Strategic Energy Plan

CERTS PARTNERS:

Minnesota Department of Commerce

The Minnesota Project

University of Minnesota Regional Sustainable Development Partnerships

Rural Minnesota Energy Board

Metropolitan Counties Energy Task Force

Resource Conservation and Development Councils

FUNDED BY:

The Legislative Commission on Minnesota Resources from the U.S. Department of Energy Oil Overcharge Money

The Carolyn Foundation

The Blandin Foundation

Minnesota Department of Commerce

U.S. Department of Energy

University of Minnesota Initiative for Renewable Energy and the Environment

University of Minnesota Regional Sustainable Development Partnerships

University of Minnesota, Morris Center for Small Towns

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Acknowledgements:
A special thank you to Laura Hildreth, Libby Jensen and Luke Zachmann, students at the University of Minnesota Morris whose work as student researchers for the CERTs project led to the formulation of this report. Laura, Libby, and Luke each spent a semester gathering and compiling data to be used in this regional report. There work was tremendously valuable to the WC CERT team.

Another special thank you to the West Central CERT Steering Committee that includes: Curt Kreklau, Dan Tepfer, Dean Schmidt, Dorothy Rosemeier, Duaine Flanders, Mike Reese, Randy Nelson and Steve Wagner. These individuals helped guide the team process, planned and facilitated team meetings, and provided tremendous resources, input and information for the regional energy inventory, assessment and Strategic Plan. Thank you!

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SECTION 1: INTRODUCTION TO CERTs

Section 1.1 Background on CERTs

The Clean Energy Resource Team (CERT) Project is designed to give citizens a voice in energy planning by connecting them with the technical resources necessary to identify and implement community-scale energy efficiency and renewable energy projects. The project is a multi-year initiative, begun in fall 2003.

The Clean Energy Resource Teams (CERTs) are a multi partner initiative, with each partner serving in different roles and bringing expertise critical to the success of the project. The project partners are:

- Minnesota Department of Commerce
- Minnesota Project
- University of Minnesota Regional Sustainable Development Partnerships
- Rural County Energy Task Force
- Metro County Energy Task Force
- Minnesota Resource Conservation and Development Councils (RC&Ds)

Figure 1: Clean Energy Resource Teams Map

Teams have been active in each of the seven CERT regions (Figure 1). Teams include between 30 and 200 stakeholders representing area local governments, farmers, utilities, colleges, universities, businesses, and environmental and economic development groups. Many team members are deeply involved, serving on CERT steering committees, taking on in-depth examination of topics of particular interest, and attending quarterly CERT meetings. Many more stay in touch attending meetings when possible and weighing in with opinions and ideas on the regional CERT listservs. The Metro County Energy Task Force is serving as the CERT in the metro area.

All of the teams are engaged in studying their region's energy system and identifying areas where conservation efforts and best-bet community scale renewable energy projects can create environmental improvements and economic development opportunities. Each team has had at least one workshop and has hosted a variety of speakers on energy related topics to help them understand the regional energy system and identify areas of regional economic opportunity. Tours of renewable energy and conservation projects in the region have also provided good examples of what can be done.

This plan is a result of careful study of the team's regional resource inventory. The inventory gave each team a good understanding of its best regional opportunities. Each team had extensive and thoughtful discussions of their vision for their region's energy future and the team's mission and goals. Each of the visions articulated by the teams in some way expresses a coupling of economic opportunity and environmental protection from the development of regional conservation and renewable energy projects. These visions, missions and goals, along with the inventory, form the basis for each region's plan. The final component of the plan is the discussion of best-bet projects: those that are best for the region and most likely to succeed.

The West Central CERT draft plan was widely discussed throughout the region and input sought from a broad range of community interests. Team members provided a tremendous amount of feedback on the report and ensured that this report was as accurate and representative of team activities as possible.

Section 1.2 Overall Purpose of CERTs

As mentioned above, the overall purpose of CERTs is to engage citizens in energy planning. It's about giving voice to the common citizen through a very open and inclusive process, connecting with people in the energy business, and having a say in how we can improve energy consumption and develop workable renewable energy projects.

The project outcomes are to:

- ***Convene Clean Energy Resource Teams*** in each of seven Minnesota regions with a range of stakeholders (Figure 1)
- ***Perform Regional Resource Inventories*** to examine current energy usage and renewable energy resources in the region
- ***Develop Regional Strategic Energy Plans*** that highlight each region's top energy priorities
- ***Implement Select Projects*** including both conservation/energy efficiency projects and renewable energy projects

Section 1.3 Overview of Regional Resource Attributes

To achieve the overall purpose of CERTs, each of the teams were tasked with developing a Regional Strategic Energy Plan. This report fulfills the Strategic Energy Plan requirement by presenting the results of the current energy use inventory, the results of the regional renewable energy resource assessment, and the regions best bet project ideas for the future. These project priorities were determined by evaluating the resources available in the region and blending these attributes with the team's overall objectives as reflected in their vision, mission and goals.

The West Central Region resource inventory reflects strong local wind, biomass and biogas capacity, as well as opportunities for continued solar and geothermal resource development. These resources will be discussed in detail in Section 6, but briefly, an analysis of distributed wind generation potential demonstrated that 10 of the region's 17 counties could produce more than 50% of their energy requirements from 10 kW turbines if each available residential site installed a turbine. An analysis of biomass potential found that there are tremendous biomass resources available throughout the region, with conservative estimates showing that nearly half the region's counties have over 200,000 dry tons of corn residue available.

Section 1.4 Overview of Regional Vision and Mission

The West Central CERT set a broad vision to "Build a resource base to make West Central Minnesota, and the state, energy self-sufficient." The team felt this gave the region an ambitious target and presented an exciting future to strive toward. In its mission the team laid out its priorities to "Increase energy conservation, energy efficiency, and renewable energy implementation to become more sustainable in terms of economic opportunities, the environment, and decreasing dependence on fossil fuels." They incorporated the statement "We want to change the way energy is produced and consumed," into their mission as well. This gave the team more concrete items to tackle with clear consequences for pushing this transition.

The Vision and Mission statements will be discussed further in Section 4.

Section 1.5 Overview of Best Bets

The regional resource attributes and regional vision and mission led the West Central CERT to develop five best bet project ideas for the West Central Region that focus on education and outreach for multiple resources: conservation, biomass, biogas, wind, and hydrogen/geothermal/solar. These are described in full in Section 7.

SECTION 2: INTRODUCTION TO THE WEST CENTRAL REGION AND REGIONAL DEMOGRAPHICS

To gain a better understanding of the region, its people, opportunities for increased conservation, and broader integration of renewable resources, each regional team preformed a general survey of regional statistics, land use, and demographics.

Section 2.1 An Overview of the West Central Region

West Central Minnesota is known for its great tall grass prairie. For the purposes of the CERTs project, the West Central Region includes Big Stone, Chippewa, Douglas, Grant, Kandiyohi, Lac Qui Parle, McLeod, Meeker, Nicollet, Pope, Renville, Sibley, Stearns, Stevens, Swift, Traverse, and Yellow Medicine. According to the Ecological Classification System these counties encompass parts of the Red River Prairie, Minnesota River Prairie and Hardwood Hills[1] and overlaps with parts of three major drainage basins, the Red River of the North Basin, the Upper Mississippi River Basin, and Minnesota River Basin.[2] Major waterways in the region include the Minnesota River, Chippewa River, Pomme de Terre River, Lac Qui Parle River, Redwood River, North Fork Crow River and Sauk River. These ecological systems and waterways will be critical in thinking about the relationship between renewable energy resource potential and local environmental impact mitigation.

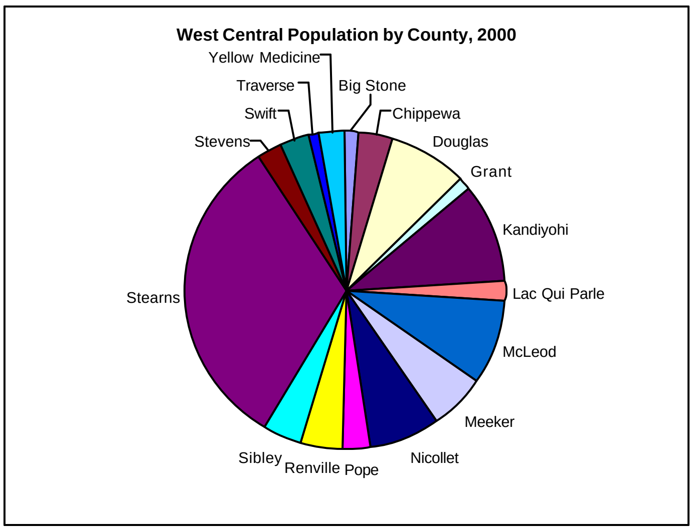

Figure 2: West Central Population by County, 2000

Section 2.2 Regional Demographics

There were a total of 904, 415 people living in West Central Minnesota during 2000. Stearns County had the largest population with 133,166 people while Traverse County had the smallest with 4,134 people (Figure 2).

Although Traverse County is the smallest county in the region, many of the counties are predominantly rural, agricultural counties with populations of less than 20,000. The breakdown between urban and rural populations in each county is depicted in Figure 3.

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[1] State of Minnesota, Department of Natural Resources. 1996. "Appendix 6: Upper Three Levels of ECS for Minnesota".

[2] State of Minnesota, Department of natural Resources. 2004. "Minnesota's Watershed Basins." Retrieved September 8, 2004 from: http://www.dnr.state.mn.us/watersheds/map.html.

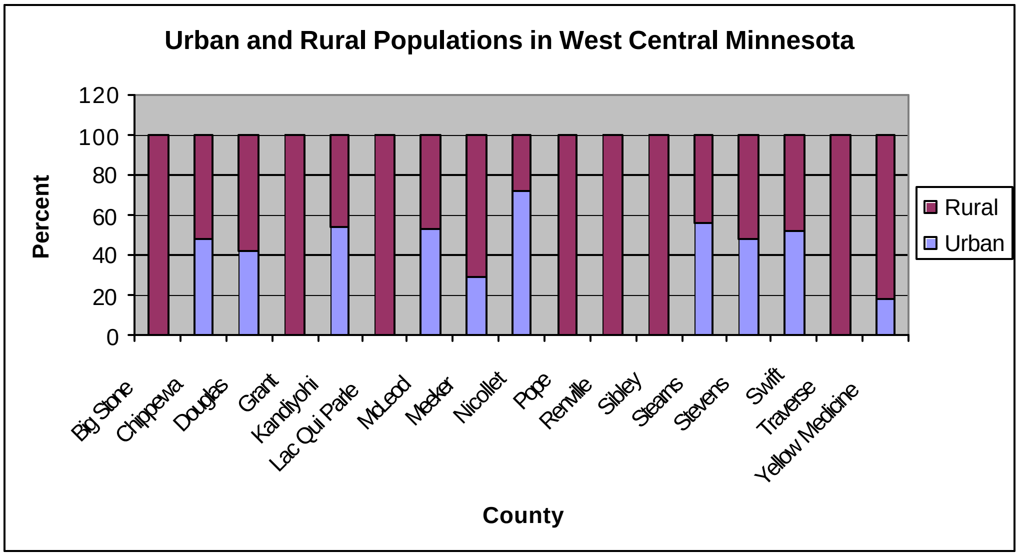

Figure 3: Urban and Rural Populations in West Central Minnesota

This data suggests that conservation and energy efficiency efforts will need to address multiple targets and populations including urban and rural residents, farmers, commercial businesses, particularly in Stearns County, and industries scattered throughout the region.

Five counties in the West Central Region (Big Stone, Chippewa, Lac Qui Parle, Traverse, and Yellow Medicine) face projected population declines between 2000 and 2030; the other 12 counties face anticipated growth rates between 1% (Stevens County) and 41% (Douglas County) between 2000 and 2030 (Figure 4).[3] The growth and decline figures are significant as they provide regional teams with a glimpse at potential changes in regional energy demand.[4] As population grows, so will energy use, thus better understanding where populations are expected to balloon, also helps better understand where energy efficiency efforts may make the biggest impact. Efforts to construct more energy efficient buildings should likely be targeted at the fastest growing counties, like Douglas, Stearns and Meeker. Efforts to get home owners and businesses to upgrade to more efficient lighting systems and appliances might be most effective in counties with slower population growth that will see distinct benefits from saving their energy dollars and recycling those dollars back into the local economy. In addition, WC CERT feels it is important to turn around the current population decline in rural counties. A vibrant renewable energy industry has the potential to reverse these depopulation and "rural brain drain" trends and could help ensure long-term viability to rural communities across the state.

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[3] Minnesota Planning, State Demographic Center. October 2002. *Minnesota Population Projections: 2000-2030*. Retrieved Spring 2004 from: http://www.demography.state.mn.us/DownloadFiles/00Proj/PopulationProjections02Intro.pdf.

[4] As population grows, energy demand increases.

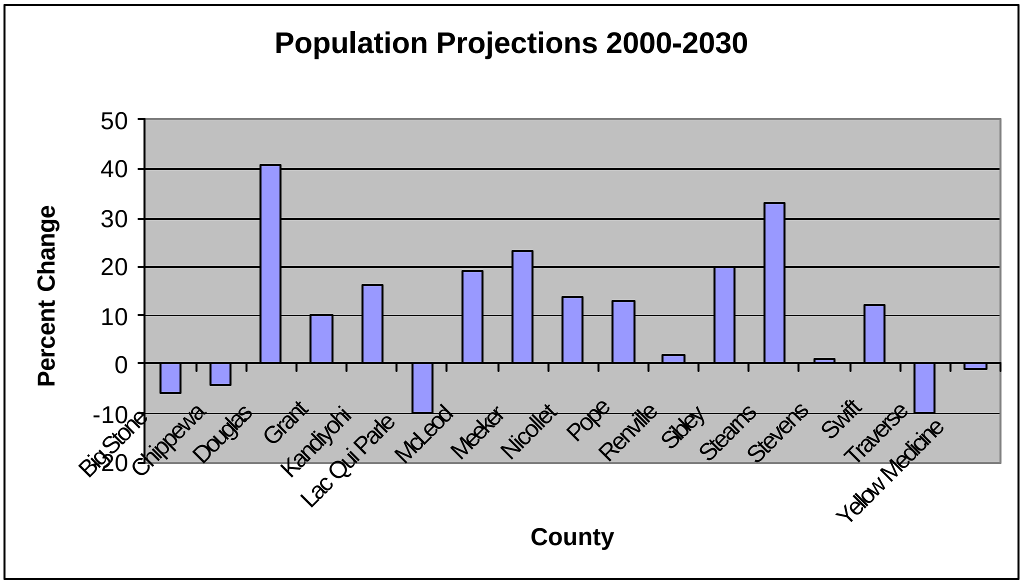

Figure 4: Population Projections 2000-2030

Section 2.3 Household Information

Based on figures from the Minnesota State Demographers Office there are 150,261 total Households in West Central Minnesota. There are 9.2% of families living below the poverty line in the United States; in the West Central Region, an average 5.7% of families are living below the poverty line.[5] Median household income for the region is, on average, $37,499;[6] the median value of owner occupied homes is $72,000.[7] Minnesota ranks 2nd nationwide in home ownership at 74.6%, and there is only two counties in the West Central Region with less than that, Stevens County with 70.4% and Stearns County with 73.8 %.[8]

All of these household and earning figures are important because owners may be more likely to make investments in energy efficiency improvements, and owners are less likely to make capital investments in their homes that they may not be able to recoup in the sale of their home.

Section 2.4 Land Use

[5] US Census Bureau. 2000. For more information, visit http://factfinder.census.gov. Information was retrieved by entering "Minnesota" and then searching Census Demographic Profile Highlights county by county. Retrieved May 13th, 2005.

[6] US Census Bureau. 2000. For more information, visit http://factfinder.census.gov. Information was retrieved by entering "Minnesota" and then searching Census Demographic Profile Highlights county by county. Retrieved May 13th, 2005.

[7] US Census Bureau. 2000. "Census 2000 Summary File 3, Table GCT-H9, Specific owners, Median Value for the West Central region counties is available at: http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US27&-_box_head_nbr=GCT-H9&-ds_name=DEC_2000_SF3_U&-_lang=en&-format=ST-2&-_sse=on . Retrieved May 13th , 2005.

[8] US Census Bureau. 2000. "Census 2000 Summary File 1, Table GCT-H6, Occupied Housing Units, Owner, for the West Central region counties is available at: http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US27&-_box_head_nbr=GCT-H6&-ds_name=DEC_2000_SF1_U&-_lang=en&-format=ST-2&-mt_name=DEC_2000_SF1_U_GCTH6_ST2&-_sse=on.

According to the 1990s Census of the Land[9] the West Central Region's dominant land use is cultivated land. Of the 7,706,298 acres in the 17 county region 5,865,962 acres are described as cultivated land. Hay/pasture/grassland is the next largest category of land use at just under 750,000 acres and forested land in third with just over 422,000 acres. Only 185,545 acres are listed as urban and rural development – less than 2.5% of the region. St. Cloud, North Mankato, Willmar and Hutchinson are the four largest Cities in the region. Alexandria, Montevideo, Litchfield and Morris are also population centers in the West Central Region.

These land use figures speak to what land is available for renewable energy and what resources might already exist. In the West Central Region cultivated land, hay/pasture/grassland and forestry are the dominant land uses. This suggests that biomass, either from agricultural residues, woody residues, or energy crops, and biofuels are ideal renewable energy resource fits for the region. These same agricultural lands may also be ideal areas for wind energy development.

Section 2.5 Regional Sector Breakdown

Based on figures adapted from the North American Industry Classification System (NAICS), the West Central Region's 7,338 business establishments paid out $2,298,531,000 in 2002.[10] County level data reveals that the dominant industries in the region, based on payroll figures, are construction, health care and retail trade, manufacturing and wholesale trade. It should be noted, however, that the data excludes data on self-employed individuals, employees of private households, railroad employees, agricultural production employees, and most government employees. Nonetheless, this data informs which sectors in the region might be some of the most important stakeholders and similarly where energy efficiency measures might be the most valuable. For more detailed information on the sector breakdown, please see Appendix A.

Section 2.6 Regional Environmental Concerns[11]

Much of the West Central Region is in the Upper Minnesota River watershed, where over 90% of the land is in crop production – primarily corn, soybeans and sugar beets, although the region also produces small grains and perennial crops to a lesser extent.[12] In certain areas of the West Central Region, large portions of land are also considered highly or extremely susceptible to soil erosion.[13] Thus, improved water quality in the Minnesota River has been a goal for the Pollution Control Agency and local watershed

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[9] Land Management Information Center. YEAR? Minnesota Land Use and Cover: 1990s Census of the Land. Retrieved from http://mapserver.lmic.state.mn.us/landuse/ on August 25, 2004.

[10] US Census Bureau. 2005. *2002 County Business Patterns (NAICS)*. Retrieved on March 29, 2005 from http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl.

[11] Much of the following paragraph is based on conversations and correspondences with Dorothy Rosemeier, Executive Director of the West Central Regional Sustainable Development Partnership, March 24-25, 2005.

[12] USDA National Agricultural Statistics Service. "2002 Census of Agriculture - Volume 1 Chapter 2: Minnesota County Level Data." 2002. http://www.nass.usda.gov/census/census02/volume1/mn/index2.htm.

[13] For more information on the Minnesota River Basin, visit: http://soils.umn.edu/research/mn-river/doc/mbtext.html

groups for the past 10 years. Despite this goal, progress has been slow. The poor cropping rotation, combined with run off and water contamination from feedlots and septic systems, phosphates and fertilizers from lake shore property owners and homes that use abundant fertilizer, and municipal discharge and runoff from paved surfaces has made reducing the sediment load, fecal coliform, unwanted phosphates/nutrients and other pollutants in the Minnesota River Watershed very challenging.

The ongoing challenge emphasizes the need to continue building and implementing creative methods and collaborations to address the region's issues with water quality, erosion and changing land use patterns. The Minnesota Institute of Sustainable Agriculture's (MISA) "Green Lands, Blue Waters" program is one such example of a creative collaboration throughout the Mississippi River Basin.[14] The program's goals are to improve water quality and habitat diversity, reduce the size of the hypoxic zone in the northern Gulf of Mexico, while simultaneously increasing rural economic vitality. The program's approach is to develop the technical, financial, market, social, human, and policy infrastructure necessary to support perennial systems.[15] WesMin RC&D, Minnesota agroforestry groups and RC&Ds in general are exploring farm bill changes that will allow for productive conservation programs. Productive conservation includes planting perennial crops, alternative crops or non-food crops that provide environmental benefits but still can be harvested for an economic return for our rural areas. Energy crops will play a major role in productive conservation but much education and a paradigm shift will need to occur to break the cycle of one and two-food-crop rotations.

These perennials systems have the potential to demonstrate that while no land use is without impact, there are growing opportunities to use renewable energy resources as a means of addressing erosion, water quality, and climate change while giving farmers another route to keep their agricultural lands working. Renewable energy development can be the tool that presents an economic incentive for farmers and rural communities to contribute to improving water quality for the Minnesota River. A few of these promising renewable energy development include:

- Planting biomass – woody plants such as hybrid poplars can be used to clean up wellhead areas, provide phytoremediation, diversify cropping, add aesthetic beauty to the landscape, serve as windbreaks, serve as snow fences to reduce road maintenance costs, sequester carbon, provide wildlife habitat and corridors, and can be used as energy or other high-value crops.
- Growing new biofuels – research has found that crops such as switch grass and perennials such as alfalfa and hybrid poplar can substitute for corn grain in the ethanol production process. Increasing these crops would help diversify the landscape, help reduce soil erosion in sensitive areas by providing land cover, and provide a more diverse crop rotation that may help improve soil health.

[14] For more information, visit: http://www.greenlandsbluewaters.org/.
[15] Text taken from the Sustainable Agricultural Newsletter, March/April 2005. Retrieved May 11, 2005 from: http://www.misa.umn.edu/sanews/FD2012.html .

- Utilizing biogas – methane from large dairies and other livestock farms is another possibility that could add diversity to the landscape (increase of alfalfa perennial) and if well managed, could reduce contamination to water supplies. Stearns County is, for example, the largest dairy county in Minnesota and also has major urban population.[16] These biogas systems could be a good tool to manage the conflict between urban vs. non-urban land use. The creation and use of biogas from large livestock farms addresses a possible use of an existing resource but must also be weighed with other factors in sustaining rural communities. Hopefully these biogas technologies will be able to be scaled down to work economically at smaller facilities and with community digester systems in the future.
- Harvesting the wind – West Central Minnesota is blessed with wind. This is an economic alternative for farmers that would rather have neighbors then more land to farm.

These solutions offer another means of bringing together diverse coalitions, as CERT has demonstrated, but to get these projects going, we must all continue to work together to articulate the range of potential benefits and services that renewables can provide, not just to the environment but to our communities as a whole.

Dennis Gibson talks to the West Central CERT about biomass during a tour.

[16] Dairy inventory data taken from: USDA National Agricultural Statistics Service. 2002. "2002 Census of Agriculture - Volume 1 Chapter 2: Minnesota County Level Data." http://www.nass.usda.gov/census/census02/volume1/mn/index2.htm.

A 1.65 MW wind turbine was commissioned April 22 at the West Central Research and Outreach Center.

SECTION 3: TEAM ORGANIZING

The CERTs are a regional, community-based organization that has engaged a variety of community stakeholders in crafting this energy plan and shaping regional project priorities. This section details how the team was formed, who is on the team and how the team works.

Section 3.1 Information Sharing and Recruitment

Individuals were recruited for the West Central CERT via letters of invitation, on-going press releases, announcements in the local paper prior to meeting, follow up stories in the local press and on local radio stations, announcements by the Sierra Club in their newsletters, on the CERTs website and by word-of-mouth. Individuals who attended and signed in at meetings were added to the West Central CERT mailing list and/or listserv. Paper invitations were sent out prior to meetings, and hard copies of meeting summaries were sent out after meetings. Over 180 people were on the regional mailing list. Electronic invitations were sent to the West Central Listserv (76 people) prior to each meeting. The meeting dates and locations were also posted on the CERTs website. Meeting summaries were sent electronically to the listserv and posted on the CERTs website. Presentations from meetings were also posted to the website when available.

Section 3.2 Team Members and Structure

The West Central Region team represents a wide variety of stakeholders including citizens, community developers, county commissioners, educators, economic developers, entrepreneurs, farmers, researchers, state legislators, state/federal agency employees, non-profit representatives, civic group representatives, and utility representatives. For a complete list of team members please see Appendix B.

Section 3.3 Team Activities

The West Central Region convened meetings throughout the initial two years of the project. The first meeting was held in November 2003. This first meeting served primarily as a way to inform participants about CERTs and ask them for input about how the process should proceed. The meetings that followed included full CERT meetings as well as Steering Committee Meetings, Working Group Meetings, conference calls and working group information sharing via email.

The following lists all the meetings and general topics:

- November 25th, 2004 – Full CERT Meeting – Introduction to CERTs
- January 15th, 2004 – Steering Committee Meeting
- March 5th, 2004 – Full CERT Meeting – Electric Utility Basics and Heating Fuels Basics
- April 14th, 2004 – Steering Committee Meeting
- May 20th, 2004 – Working Group Meeting
- June 16th, 2004 – Full CERT Meeting – Workshop and Tour of Renewable Energy Project Sites in West Central Minnesota.

- July 7th, 2004 – Steering Committee Meeting
- September 17th, 2004 – Full CERT Meeting – Selection of Best Bet Projects, Summary of Virginia/Hibbing Biomass Project
- November 22nd, 2004 – Project Updates, small group sessions to develop project priority task lists
- January 13th, 2005 – Renewable Energy "Update" Conference, sponsored by Kandiyohi County Agribusiness/Renewable Energy Development Committee, the City of Willmar Economic Development Commission, and several other partners including WC CERT
- February 28th, 2005 – Statewide Clean Energy Resource Teams Conference
- March 14th, 2005 – Full CERT Meeting – Discussions about project barriers and opportunities, small group working sessions to update task lists
- June 20th, 2005 – Full CERT Meeting – Project updates, project strategies for Phase II, and Tour of West Central Research and Outreach Center's facilities and wind turbine

A copy of each meeting agenda and each meeting summary is provided Appendix C. Select presentations from team meetings are available on the CERTs website: www.cleanenergyresrouceteams.org.

West Central CERT convenes community members for a tour of local clean energy projects. This is the team at the Chippewa Valley Ethanol Cooperative with General Manager, Bill Lee.

SECTION 4: TEAM VISION, MISSION, GOALS

After discussion and input at two full CERT meetings, discussion at one steering committee meeting, and a request for comment via email, the West Central Region CERT arrived at the following:

Vision:
Build a resource base to make West Central Minnesota and the state energy self-sufficient.

***Mission*:**
Increase energy conservation, energy efficiency, and renewable energy implementation to become more sustainable in terms of economic opportunities, the environment, and decreasing dependence on fossil fuels. *We want to change the way energy is produced and consumed.*

***Goals*:**

- Develop and maintain creative partnerships
- Identify real opportunities
  - ✓ Identify how people can get started with conservation and renewable energy (what are the various options and educating around these)
  - ✓ Identify opportunities that are available/educate participants and community members about existing opportunities
  - ✓ Determine areas of expertise within the CERT (and bring others in) that can serve as resource people to help identify these opportunities
  - ✓ Promote existing programs
  - ✓ Increase involvement in green pricing programs (would need current status from utilities and then to set a benchmark)
  - ✓ Increase levels of conservation (as above, baseline and target)
- Implement pilot projects on the ground. This will help the team and region find new opportunities to break new ground on sound projects.
- Use the plan as a point of engagement to outline all of these goals and provide a conceptual framework for sound and attainable goals.

Given the region's tremendous human resources and intense commitment to promoting renewable energy, the West Central CERT felt it needed to lay out an aggressive vision and mission. The team's vision, mission, and goals demonstrate how they are focused on building on their collective strengths, working collaboratively rather than competitively, to advance renewable energy. The West Central CERT participants see their region as a model for community-based renewable energy system development and these goals set forth ways that change can start today and steadily work to transform the future.

SECTION 5: CURRENT ENERGY USAGE

Each CERT began its assessment work with an inventory of current energy use in the region. In the West Central Region, several students from the University of Minnesota, Morris were critical in pulling this information together: Libby Jensen, Laura Hildreth, and Luke Zachmann. These current energy use profiles provided the team with an energy baseline and a better general understanding of regional energy use.

Having a current baseline and an historic understanding of energy use also helps the team better understand how critical conservation and energy efficiency efforts will be, and how much renewable energy must come on line to offset current energy supplies. Indeed, according to the 2001 Minnesota Utility Data Book, electric consumption has more than quadrupled since 1965 while the number of electric customers has not quite doubled and although electric energy use appears to be slowing, it's still on the rise.[17] In contrast, while the number of natural gas customers has more than doubled since 1965, Minnesota natural gas consumption has only grown by 25%.[18] These factors will be critical to future changes in the energy mix.

Section 5.1 Electric

The West Central CERT began its energy use inventory by gathering information about electric use, electric generation, and how all the utilities serving the region work together.

Section 5.1.1 Electric Utilities in the West Central Region

There are 28 electric utilities serving West Central Minnesota. Most of these utilities are municipal or cooperative utilities, however, two investor-owned utilities also serve parts of the region (Table 1). One of the West Central CERT's first team meetings involved inviting representatives from a number of these utilities to talk about their operations and explain how the whole electric system worked. The team felt it was imperative to have a general understanding of the electric utility system before moving forward with conservation, energy efficiency and renewable energy projects, as these projects would clearly impact the utilities serving their region. By engaging with these critical partners early in the CERT process, the team felt it was able to better collaborate and plan with local electric utilities. The utilities listed here will continue as critical partners in moving the West Central CERT's goals and project priorities forward.

Methods used to collect Utility Data are described in full in Appendix D.

Table 1: Utilities Serving the West Central Region

Utility Type	Utility
Investor Owned Utilities	Xcel Energy and Otter Tail Power Co.

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[17] Minnesota Department of Commerce. 2002. *The 2001 Minnesota Utility Data Book*. Tables 1 and 2. Retrieved on May 19, 2005 from http://www.state.mn.us/mn/externalDocs/Commerce/Utility_Data_Book,_1965-2000__030603120425_UtilityDataBook65thru01-2.pdf.

[18] Ibid. Tables 11 and 12.

Generation & Transmission Cooperatives	Great River Energy and East River Electric Cooperative
Distribution Cooperatives	Renville Sibley Coop Power Association, Traverse Electric Cooperative, Agralite Cooperative, Kandiyohi Power Cooperative, McLeod Coop Power Assn, Meeker Coop Light and Power Association, Runestone Electric Association, Stearns Coop Electric Association, Minnesota Valley Coop Light and Power Association
Municipal Utilities	Alexandria Light and Power, City of Arlington, Benson Municipal Utilities, Brownton Municipal Light and Power, Darwin Electric Dept, Elbow Lake Municipal Electric, Fairfax Pub Utilities, Glencoe Municipal Utilities, Granite Falls Municipal Utilities, Grove City Electric Dept, Hutchinson Utilities, Kandiyohi Municipal Utilities, Madison Municipal Utilities, Melrose Pub Utilities, Olivia City of, City of Ortonville, Willmar Municipal Utilities, City of Winthrop

Section 5.1.2 Regional Energy Consumption

In 2000, the West Central Region used 4,821,121 MWh of electricity (or 2,481,248 MWh excluding use by investor-owned utility customers).[19] This total was determined by summing the megawatt-hour consumption figures from each of the 17 counties. The consumption patterns among counties (Figure 5) mimicked the patterns illustrated in the population numbers (Figure 2). Roughly half of the load served in the West Central Region is served by the Investor Owned Utilities (Xcel Energy and Otter Tail Power Company), while the other half is served by local cooperative and municipal utilities (Figures 6 and 7). Stearns Coop Electric is the largest distribution coop in terms of power sold (Figure 6) while Hutchinson, Willmar, and Alexandria have the largest municipal utilities based on power sold (Figure 7).

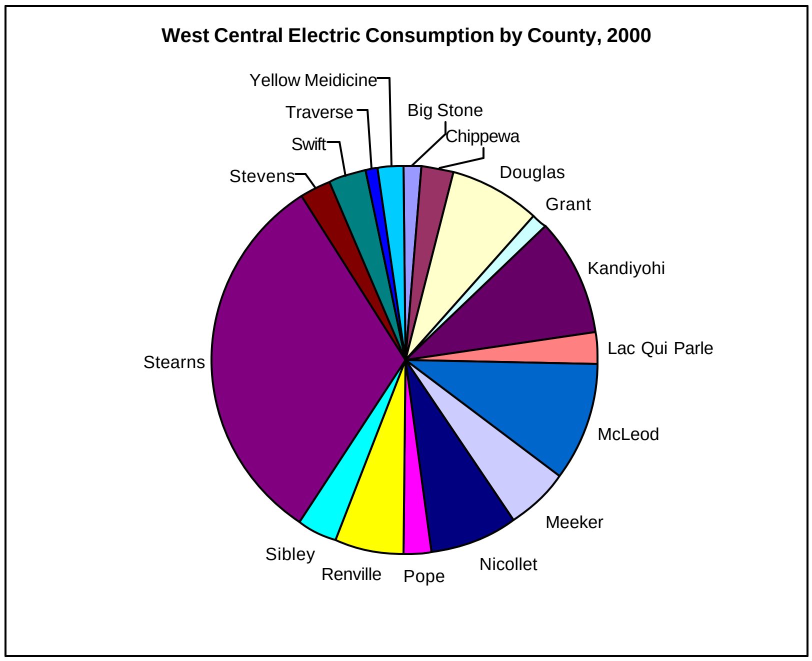

Figure 5: West Central Electric Consumption by County, 2000

A complete summary of the utilities serving the West Central Region and their respective consumption figures is shown in Table 2.

[19] Ibid. Table 4.

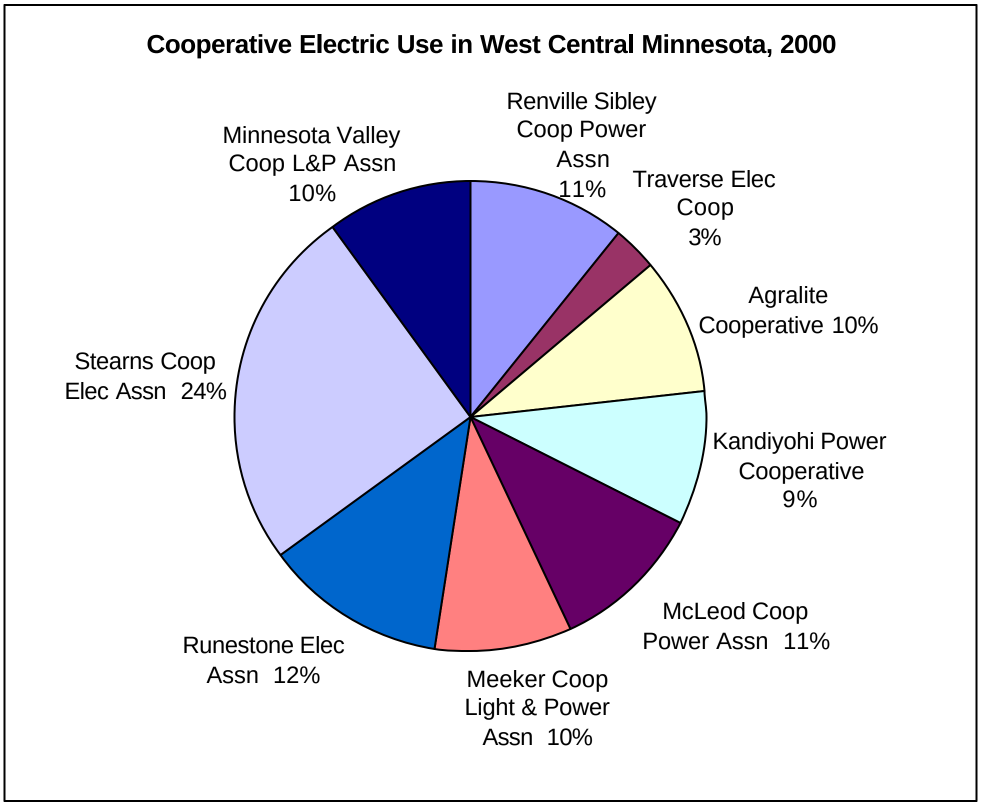

Figure 6: Cooperative Electric Use in West Central Minnesota, 2000

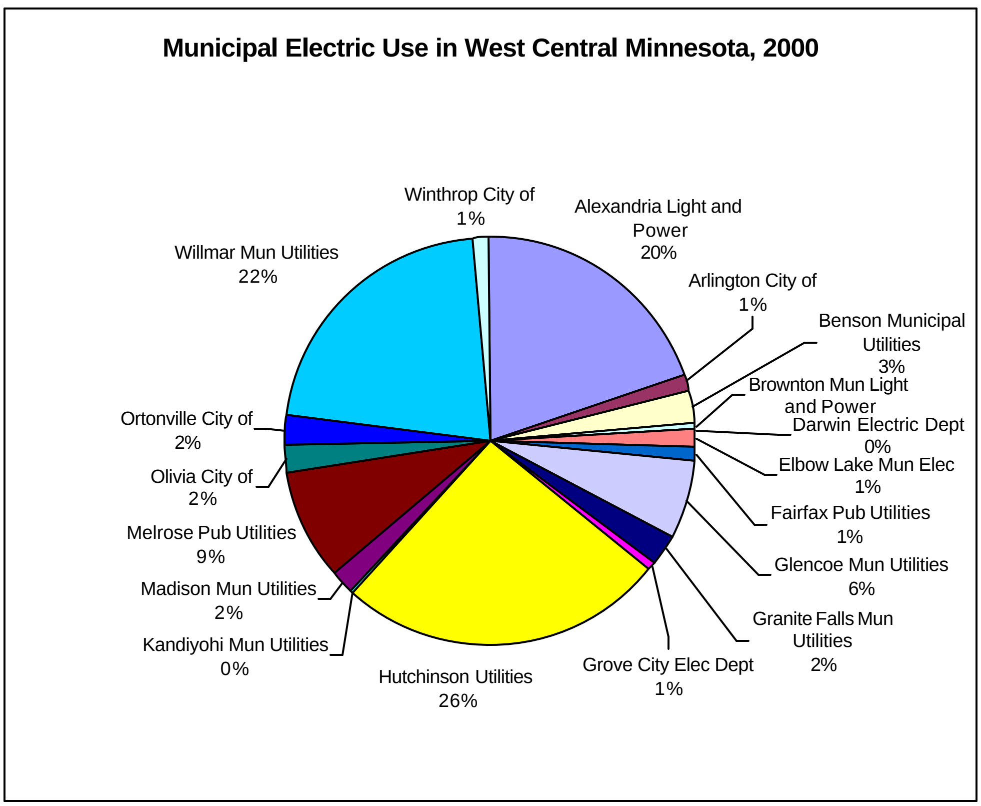

Figure 7: Municipal Electric Use in West Central Minnesota, 2000

TABLE 2: WEST CENTRAL MINNESOTA ELECTRIC CONSUMPTION IN 2000 (MWh)[20]

	Farm	Non-Farm Residential	Commercial	Industrial	Total
West Central Minnesota Electric Consumption for Investor-Owned Utilities					
Otter Tail Power Co (MN total)	0	456,616	655,436	702,951	1,815,003
Xcel Energy (MN total)	0	7,785,494	5,290,705	16,401,555	29,477,754
Otter Tail Power Co (WC share)[1]	0	182,646	262,174	281,180	726,001
Xcel Energy (WC share)[2]	0	425,867	289,402	897,165	1,612,433
Total: WC Investor Owned Utilities	0	608,513	551,576	1,178,345	2,338,434
West Central Minnesota Electric Consumption for Cooperative Utilities					
East River Electric Cooperative					
Renville Sibley Coop Power Assn	41,985	3,442	2,155	97,545	145,127
Traverse Elec Coop	26,360	-	*	*	38,902
Great River Energy					
Agralite Cooperative	72,135	-	26,936	27,495	126,566
Kandiyohi Power Cooperative	85,324	2,801	*	*	121,351
McLeod Coop Power Assn	90,909	-	10,269	38,685	139,863
Meeker Coop Light and Power Assn	57,348	49,964	20,622	-	127,934
Runestone Elec Assn	70,051	65,571	18,209	11,030	164,861
Stearns Coop Elec Assn	126,136	140,592	45,618	20,124	332,470
Other					
Minnesota Valley Coop L&P Assn	91,751	10,552	9,361	20,675	132,339
Total: Cooperatives	590,720	272,922	133,170	215,554	1,329,413
West Central Minnesota Electric Consumption for Municipal Utilities					
Other Municipals (Non-SMMPA)					
Alexandria Light and Power	-	58,826	57,694	110,188	226,708
Arlington City of	-	7,242	8,648	-	15,890
Benson Municipal Utilities	*	12,850	*	11,590	30,690
Brownton Mun Light and Power	-	3,298	1,103	214	4,615
Darwin Electric Dept	-	1,248	510	-	1,758
Elbow Lake Mun Elec	-	5,700	9,319	-	15,019
Fairfax Pub Utilities	48	6,013	3,989	1,949	11,999
Glencoe Mun Utilities	-	20,328	27,804	23,695	71,827
Granite Falls Mun Utilities	35	11,811	13,635	2,574	28,055
Grove City Elec Dept	449	3,189	3,439	-	7,077
Hutchinson Utilities	-	45,449	90,479	160,334	296,262
Kandiyohi Mun Utilities	-	2,500	1,500	-	4,000
Madison Mun Utilities	-	8,211	8,093	2,081	18,385
Melrose Pub Utilities	2,164	15,596	18,796	67,589	104,145
Olivia City of	-	11,225	2,935	11,596	25,756
Ortonville City of	96	11,164	12,140	-	23,400
Willmar Mun Utilities	-	60,158	77,753	113,771	251,682
Winthrop City of	207	4,841	*	*	14,567
Total: Municipal Utilities	2,999	289,649	337,837	505,581	1,151,835
Total: WC Minnesota	**593,719**	**1,171,084**	**1,022,583**	**1,899,480**	**4,819,682**

[20] Minnesota Department of Commerce. 2002. *The 2000 Minnesota Utility Data Book*: *Table 4.*

Note 1: Ottertail Power Co (WC Share) reflects Ottertail Power total consumption (statewide) multiplied by 40% as an estimate of the West Central region's fraction of Ottertail Power's overall MN consumption figures.

Note 2: Xcel Energy (WC Share) reflects Xcel's total consumption (statewide) multiplied by 5.5% as an estimate of the West Central region's fraction of Xcel's overall MN consumption figures.

* Withheld to avoid disclosure of individual company data. Data not included in regional totals.

Evaluating electric use by sector shows that while energy efficiency efforts should likely target the industrial sector as the largest electric energy use, they cannot ignore the residential, commercial and farm energy use sectors (Figure 8).

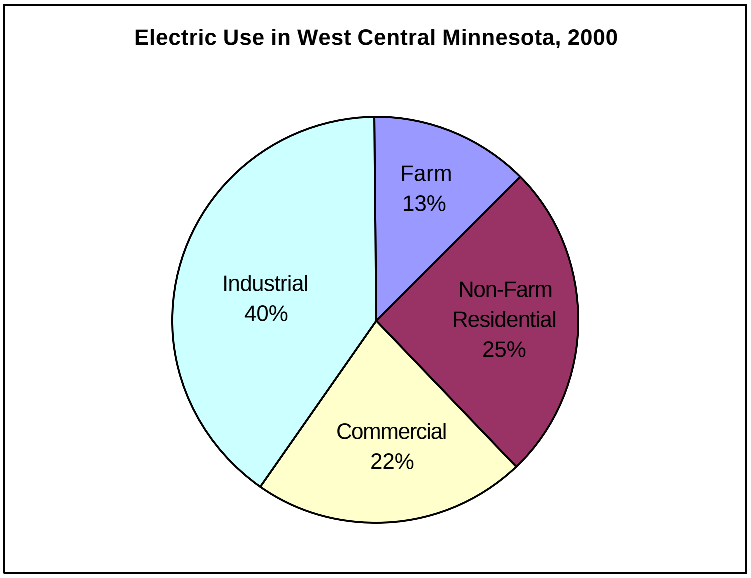

Figure 8: Electric Use in West Central Minnesota by Sector, 2000

Section 5.1.3 Energy Sources Used in Electrical Generation

Much of the electricity that supplies the West Central Region is generated at coal plants owned by Great River Energy, Xcel Energy, and Ottertail Power Company including Coal Creek, Stanton, Antelope Valley, and Leland Olds Stations in North Dakota, Big Stone in South Dakota, and Laramie River Station in Wyoming, although other resources also contribute to the energy mix.

There are also several smaller-scale generating plants in the West Central Region. Alexandria, Arlington, Benson, Fairfax, Glencoe, Granite Falls, Hutchinson, Melrose and Willmar municipal utilities all have their own generation facilities. Most of these facilities have total capacity factors of less than 10 MW. Glencoe, Willmar and Hutchinson have greater onsite capacity of approximately 32 MW, 35 MW and 99 MW, respectively. Much of the onsite generation is supplied by oil and gas, although Glencoe has three diesel generators, and Willmar has one coal/gas unit, one gas unit and six diesel units. Xcel Energy also has a power plant located in Chippewa County.

Section 5.1.4 Environmental Impacts of Electrical Energy Generation

Electricity production, primarily from burning coal, is the source of most emissions of sulfur oxides (SOx), which are the main cause of acid rain. Electricity production from fossil fuels also emits nitrogen oxides that, in the presence of sunlight, combine with other chemicals to form ground-level ozone (smog) both of which can irritate the lungs, cause bronchitis and pneumonia, and decrease resistance to respiratory infections.[21] Burning of fossil fuels for electricity produces carbon dioxide emission that contribute to global warming, carbon monoxide emissions which can cause headaches, large particulates that contribute to respiratory disease, and small particulates which have been linked to chronic bronchitis, aggravated asthma, and premature death.[22] Coal combustion also contributes to mercury, arsenic and lead emissions. These toxic metals can accumulate in the fatty tissue of animals and humans leading to severe health problems.[23] Indeed, during 2004 the Minnesota Department of Health issued fish consumption advisories for every Minnesota Lake due to accumulation of Mercury in fish.[24]

Electricity generation from fossil fuels also results in environmental issues stemming from the harvesting and transportation of fuels for production, such as mining and shipping coal, drilling for, refining and transporting oil and drilling for natural gas. Each activity has the potential to pollute our lands and waters via spills, land degradation, and chemical leaching among others.

Hydroelectric generation also has environmental impacts. These impacts include disruptions of hydrology, disruption of nutrient and sediment cycling, blocking of fish and invertebrate migrations, alteration of communities, and alteration of water quality.

Nuclear-based electricity generation avoids many of the air emissions issues associated with fossil fuels. The concern with nuclear plants is instead focused on two key factors. First, there is great concern about the potential catastrophic impact of an accident at a nuclear facility. While the likelihood of one of these accidents is low, the impacts of the Chernobyl accident in 1986 and near meltdown of Three Mile Island in 1979 have cautioned the further expansion of the industry. Second, there are on-going issues with how to dispose of spent fuel rods and other radioactive waste. It has been difficult to find an acceptable way to contain these wastes for the tens of thousands of years that they will remain radioactive and in the interim many plants, included those in Minnesota, have been forced to keep their waste on site.

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[21] US Environmental Protection Agency. 1998. "NOx – How Nitrogen Oxides Affect the Way We Live and Breathe." Retrieved June 3, 2005 from: http://www.epa.gov/air/urbanair/nox/index.html .

[22] US Environmental Protection Agency. 2002. "Global Warming." Retrieved June 3, 2005 from: http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html.
US Environmental Protection Agency. 2000. "CO – How Carbon Monoxide Affects the Way We Live and Breathe." Retrieved June 3, 2005 from: http://www.epa.gov/air/urbanair/co/index.html.
US Environmental Protection Agency. 2005. "PM – How Particulate Matter Affect the Way We Live and Breathe." Retrieved June 3, 2005 from: http://www.epa.gov/air/urbanair/pm/index.html .

[23] Union of Concerned Scientists. 1999. *Powerful Solutions: Seven Ways to Switch America to Renewable Electricity*. Retrieved September 15, 2004 from http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=98.
Environmental Protection Agency. 2004. "What are the Six Common Air Pollutants?" Retrieved September 15, 2004 from http://www.epa.gov/air/urbanair/6poll.html.

[24] Minnesotans for an Energy Efficient Economy. 2004. "How Polluting is Your Power: A Guide to Your Utility's Environmental Disclosure Brochure." Retrieved September 15, 2004 from http://www.me3.org/projects/costs/disclosureguide.html#11.

Section 5.1.5 Existing Conservation and Energy Efficiency Programs

The Conservation Improvement Program (CIP) requires all of Minnesota's energy utilities to set aside a percentage of their revenues to be used in projects that will reduce electric and natural gas consumption. As part of this requirement all of the region's utilities put money aside, generally 1.5% of their revenues a year, for conservation.[25] These funds are generally used to help customers buy energy efficient products and processes.[26] The following are a few examples of conservation and energy efficiency programs that different utilities, including municipal, cooperative and investor-owned, are doing in the West Central Region.

Willmar Municipal Utilities' Energy Rebate and Credit Programs includes the following:[27]

- *Energy Star Appliance and Air Conditioner Rebate*: purchase an Energy Star-rated refrigerator, clothes washer or dishwasher and receive a $50 rebate for each appliance. Purchase an Energy Star-rated central air conditioner and receive a $200 rebate.
- *Off-Peak Water Heater Credit*: Customers with an 80-gallon or larger water heater can enroll in an off-peak water heater program and receive a $10/month credit.
- *Water Heater Rebate*: Purchase an 85 or 105-gallon Marathon water heater and receive a rebate of $1.25 per gallon capacity.
- *Interruptible Load Program*: Customers with a 100-kW or larger backup generator can sign up to have interruptible power during the six peak summer months (May-Oct) and receive $3/kW/month whether or not they are asked to use it.

Great River Energy and their member cooperatives spend more than $12.5 million a year on load management and energy conservation programs. Through the efforts of their 28 member cooperatives, Great River Energy saved more than 53 million kWh.[28] Their Energy Wise program provides energy saving tips and other useful information. Each of Great River Energy's member cooperatives also offer information targeted to their own customers. Agralite Electric Cooperative's website has links under their "Energy Savings Ideas" link that include how to save energy when using your fireplace, 10 ways to save energy at your job, energy efficient light bulb information, home building hints, ways to save energy on the farm, and ways to save energy costs in the

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[25] Xcel Energy is required to set aside 2% of its gross operating revenue because it operates nuclear facilities.
[26] State of Minnesota Office of the Legislative Auditor. 2005. *Energy Conservation Improvement Program.* Retrieved February 17, 2005 from: http://www.auditor.leg.state.mn.us/ped/pedrep/0504all.pdf
[27] For More information about Willmar Municipal Utilities energy programs, please visit: http://wmu.willmar.mn.us/energy_services.htm. Retrieved May 11, 2005.
[28] More information about Great River Energy's Energy Wise Program is available at: http://www.greatriverenergy.com/environment/env_ew.html.

bathroom.[29] Kandiyohi Power Cooperative offers numerous energy management programs including off-peak water heating, air source and ground source heat pumps.[30]

Xcel Energy and Otter Tail Power both have conservation programs as well. Xcel offers extensive libraries of resources for residential, business, and commercial and industrial customers. It also has an on-line "Home Energy Analyzer" to help customers identify potential energy savings.[31] A few of Ottertail's programs for residences include:[32]

- House Therapy- Income guidelines qualify customers for specific energy-efficient home improvements such as home weatherization.
- CoolSavings- Participants earn credit for allowing a radio receiver to cycle air conditioners on and off every 15 minutes to help manage summer electricity demand on peak days.
- Residential demand control conservation program - Minnesota customers may qualify for a $200 rebate.
- Heat pump conservation rebates for both air-source and ground-source heat pumps.

Section 5.1.6 Existing Renewable Energy Project/Programs

Each of the major utilities in the region currently operates a green pricing program. These programs allow customers to voluntarily pay more for "green" electricity.[33] The Wellspring Renewable Energy Program is a program offered by Great River Energy and its cooperatives.[34] The wind energy for this program comes from nine giant turbines from the Chandler Hills Wind Farm that generates six MW of electricity. These turbines are located on the Buffalo Ridge at Chandler, Minnesota. Customers who choose to participate in this program may choose to buy wind energy in 100 KWh blocks for a nominal monthly fee.

East River Electric Cooperative offers wind energy to its members via the Prairie Winds renewable energy program. This program draws on wind produced in Chamberlain, South Dakota and Minot, North Dakota.[35]

Xcel Energy customers in Minnesota can choose some or all of their electrical energy from wind generation, an extension of the energy provider's popular *Windsource* program (initially operative only in Colorado). Xcel Energy will build, or purchase energy from, as many wind turbines as is needed to produce the amount of electricity

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[29] More information about Agralite's programs is available at: http://www.agralite.coop/ideas.htm. Retrieved May 11, 2005.

[30] More information about Kandiyohi Power Cooperative's Energy Management programs is available at: http://www.kpcoop.com/budget.htm.

[31] More information about Xcel Energy's energy efficiency programs is available at: www.xcelenergy.com.

[32] A complete menu of Otter Tail's CIP programs for residents and businesses is available at: http://www.otpco.com/SaveEnergyMoney/ConservationImproveProg.asp.

[33] For more information about green pricing programs please see http://www.state.mn.us/mn/externalDocs/Commerce/Green_Power_012703040626_GreenPower.pdf.

[34] For more information please see: http://www.greatriverenergy.com/environment/renewables_wind.html

[35] For more information please see: http://www.eastriver.coop/Energy_Info/PrairieWinds/PrairieWinds/default.htm.

demanded by the consumers participating the program. Customers can purchase 100 kWh blocks for a price premium of $2 each; the average customer can pay up to $14 extra per month for switching over completely to wind-generated power.[36]

Ottertail Power Company provides green power through its TailWinds Program that buys power from a wind turbine located near Hendricks, Minnesota.[37] The 900-kw NEG Micon turbine was installed on December 28, 2001. Ottertail customers may enroll in the program by purchasing 100 kWh blocks for an additional $2.60. Ottertail states that it monitors a green power waiting list and that it will construct additional turbines as the list grows large enough to justify them.

Section 5.2 Heat

In Minnesota, heat is a critical resource. Minnesotans use tremendous amounts of energy to keep our homes, buildings, and industries warm throughout the winter. By examining where this heat comes from, we are able to better understand the impacts of our heating fuel use and assess where we can best make an impact with conservation, energy efficiency, and switching from expensive natural gas to locally grown heating fuels.

Section 5.2.1 Heat Sources

There are seven primary fuels used for heating in Minnesota:

- Utility gas: Also known as natural gas that is transported and distributed via pipeline (Figure 9). Natural gas, or methane, is a colorless, shapeless, and odorless gas in its pure form. Heat from natural gas is extracted in combustion.
- Bottled, tank, or liquefied petroleum (LP) gas: Also known as Propane. It is a colorless gas of mixed hydrocarbons. It is a by-product of natural gas processing and petroleum refining and can be delivered as a liquid making it easier to transport and a likely heating source for farm applications and in rural residences and communities that are not connected to a utility natural gas pipeline.

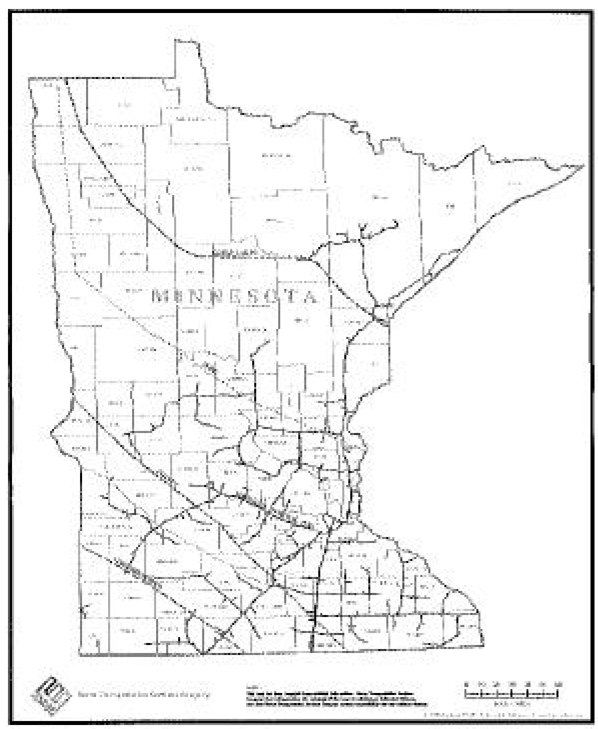

Figure 9: Natural Gas Pipelines

- Electricity: Electricity is the energy that is extracted from a number of different energy sources (like coal, nuclear, hydropower, and wind). When using

[36] Source: http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_15531_18513-3341-0_0_0-0,00.html

[37] From more information please see: http://www.otpco.com/ProductsServices/TailWinds.asp

electricity for heating, there are several different options available. Forced-air systems are electric furnaces that deliver heated air by fans through a network of ducts. Electric plenum heaters can be added to many existing forced air furnaces. Electric hydronic systems boil water and then circulate it, and its associated heat, throughout the house using an electric water pump. Hydronic systems employ electric room heaters, generally baseboard systems, which are installed in each room of the home and can be individually controlled. Electric heat can also be provided by portable and wall systems if baseboard systems are not feasible, and there are combinations of electric systems such as wood-electric and oil-electric systems. Electric storage heaters store heat during non-peak usage hours and then dispense the stored heat when it's needed. Lastly, electric heat pumps work by transferring heat from one area to another. The most common types of heat pumps are air-source and ground-source heat pumps that can be used for both heating and cooling.

- Fuel oil/kerosene: Both fuel oil (#2 heating oil) and kerosene are organic compounds that are separated out during the petroleum refining process. Both are used in residential heating and for backing up other energy sources in public and commercial buildings.
- Coal or coke: solid, readily combustible, fossil fuel. Coal is burned to directly produce heat in coal furnaces. There are several different kinds of coal that can be distinguished based on both their physical properties and heat content (bituminous, anthracite, lignite, and sub bituminous). Coke is a solid residue derived from low-sulfur bituminous coal ash.
- Wood: Wood is a form of biomass. Wood heating can be used from fireplaces either for show or use, masonry heaters which use a firebox to produce heat that is then channeled throughout the home, and fire stoves. Another form of biomass heating fuel is agricultural residue, like corn stover, leaves and straw. These residues can also be burned to provide heat.
- Solar energy: For heating used in solar thermal applications.

Section 5.2.2 Home Heating Usage

For home heating the primary fuel used in West Central Minnesota is utility gas, which supplies heat to nearly half the homes in the region (74,060). LP gas (32,488 homes), electricity (22,850 homes) and fuel oil (19, 252 homes) are the primary fuels used in the region although there are some homes using wood, coal and solar (Table 3).

Table 3: West Central House Heating Fuel[38]

County	Occupied Housing Units	Utility Gas	Bottled, tank or LP Gas	Electricity	Fuel Oil, Kerosene, etc	Coal or coke	Wood	Solar Energy	Other fuel	No fuel used
Big Stone	2,377	524	870	461	436	22	41	-	11	12
Chippewa	5,361	2,303	1,252	679	1,069	-	40	-	9	9
Douglas	13,276	5,412	3,586	2,341	1,282	-	488	-	113	54
Grant	2,534	34	1,038	410	978	-	58	-	14	2
Kandiyohi	15,936	7,609	3,348	2,465	1,701	12	251	5	319	226
Lac Qui Parle	3,316	1,279	967	549	474	-	27	-	7	13
McLeod	13,449	7,753	2,265	1,354	1,654	-	209	5	83	126
Meeker	8,590	3,303	2,390	1,571	1,008	-	267	-	37	14
Nicollet	10,642	6,956	1,560	1,171	719	-	153	2	51	30
Pope	4,513	1,708	1,551	397	659	-	141	-	29	28
Renville	6,779	2,940	1,711	727	1,245	-	106	-	26	24
Sibley	5,772	2,531	1,551	316	1,195	-	154	2	11	12
Stearns	47,604	26,221	6,600	8,370	4,163	5	1,534	11	494	206
Stevens	3,751	1,765	694	612	611	-	40	-	22	7
Swift	4,353	1,852	1,228	493	704	-	36	-	27	13
Traverse	1,717	17	745	313	615	-	19	-	4	4
Yellow Medicine	4,439	1,853	1,132	621	739	2	57	-	22	13
TOTALS	**154,409**	**74,060**	**32,488**	**22,850**	**19,252**	**41**	**3,621**	**25**	**1,279**	**793**

Section 5.2.3 Major Heating Fuel Users

The major fuel users in the West Central Region are highlighted in Table 3. While this table shows all boiler fuel use, not just heating fuel use, many of these facilities are using their boilers for heat. A quick glance shows that natural gas and coal are the most widely used fuels in industry. Two of the very largest fuel users in the region are the Southern Minnesota Sugar Beet Cooperative in Renville County and International Paper in Stearns County, which both use coal. There are several other facilities that also play a major role in regional heating fuel use. All of these facilities could be targeted for efficiency upgrades and/or possible fuel switching. With rising natural gas prices industrial users may now have greater incentives to pursue efficiency upgrades, integrate waste heat recovery technologies, and switch to cheaper fuels like biomass.

An increasing energy issue with large natural gas users is that they are subject to curtailment. Curtailment is when the natural gas provider will communicate with the energy user to switch to a more expensive back up fuel such as LP or fuel oil. The natural gas provider uses curtailment to control supply and meet the demand of residential customers. West Central Minnesota is literally at the end of the natural gas line and is subject to curtailment at an increasing level. Some counties in West Central

38 Source: U.S. Census Bureau, Census 2000 Summary File 3, Matrices H26, H27, H40, and H42
Data retrieved from the US Census, www.factfinder.census.gov, August 10, 2004
Tables QT-H8: Rooms, Bedrooms, and House Heating Fuel: 2000.

Minnesota such as Grant County do not even have natural gas available. This can be a major limitation in retaining and attracting industry, but it also presents an opportunity for bio-based resources that could substitute for natural gas and provide long-term supplies for a locked-in price.

Another option for heating fuel users is to begin blending coal-based systems with 10% biomass, as it appears International Paper is already doing (Table 4). Blending would "green" industrial operations, improve emissions, and in some instances could also help cut costs if the biomass could be provided for free from a local wood waste streams.

Section 5.2.4 Environmental Impacts of Heating Fuel Use

Fewer harmful byproducts are emitted from burning natural gas than in comparison to fossil fuels; nonetheless all produce emissions. Natural gas, in comparison to coal, emits fewer carbon dioxide emissions, fewer particulate emissions, fewer sulfur dioxide emissions, and fewer nitrogen oxide emissions. This generally makes natural gas a preferred fuel over fuel oil and coal. In some instances, where particulate emissions are of particular concern (e.g., indoor air quality), natural gas may even be preferred over biomass, although biomass is considered carbon neutral fuel and may therefore be preferable from a climate change perspective.

Table 4: Major Fuel Users and Amount of Fuel Used in 2001[39]

COUNTY	CITY	NAME	ADDRESS	ZIP CODE	NATURAL GAS	FUEL OIL	LPF/ PROP	WOOD WASTE	COAL	COKE	Annual Electrcity Generation
						Million British Thermal Units Consumed in 2001					(MWh)
Douglas	Alexandria	3M - Alexandria	2115 S Broadway St	563082741	38,457	455					
Douglas	Alexandria	Pope/Douglas Waste Management	2115 S Jefferson St	56308	2,282						
Grant	Barrett	TWF Industries Inc - Barrett	Highway 55	56311			6,956				
Kandiyohi	Raymond	Minnesota Valley Alfalfa Producers-MnVAP	7410 Highway 23 SW	56282	29,905						
Kandiyohi	Willmar	Ridgewater College	2101 15th Ave NW	56201	211,737						
Kandiyohi	Willmar	Willmar Municipal Utilities	710 Benson Ave SW	56201	41,798				1,033,780		
Kandiyohi	Willmar	Willmar Regional Treatment Center	1550 Highway 71 NE	56201	320,489	36,388					
Lac Qui Parle	Dawson	Ag Processing Inc - Dawson	800 Diagonal St	56232	491,209	63,425					
Lac Qui Parle	Dawson	Associated Milk Producers Inc - Dawson	E Highway 212	56232	262,747	72,801					
McLeod	Brownton	ISD 2887 - McLeod West High School	335 3rd St S	55312		9,292					
McLeod	Glencoe	Glencoe Light & Power Commission	305 11th St E	55336	20,683	2,607					
McLeod	Glencoe	ISD 2859 - Glencoe Senior High School	1621 16th St E	553361799	11,411						
McLeod	Glencoe	Seneca Foods Corp - Glencoe	101 8th St E	553362704	105,062						
McLeod	Hutchinson	3M - Hutchinson Tape Manufacturing Plant	915 Adams St SE	55350	407,304	516,790					
McLeod	Hutchinson	Haugen Furniture Co	25 Michigan St NE	553501901	4,585						
McLeod	Hutchinson	Hutchinson Manufacturing Inc	720 Highway 7 W	55350	7,124						
McLeod	Hutchinson	Hutchinson Technology Inc - Hutchinson	40 W Highland Park Dr NE	553509784	103,489						
McLeod	Hutchinson	Hutchinson Utilities Commission -Plant 2	1100 Industrial Blvd	55350	93						
McLeod	Lester Prairie	Poly Foam Inc	116 Pine St S	553541010	8,430			22,899			
McLeod	Plato	Plato Woodwork Inc	200 3rd St SW	55370	5,736						
McLeod	Stewart	ISD 2887 - McLeod West School - Stewart	301 Main St	55385	3,382	172					
Meeker	Grove City	Precision Fiberglass Products Ltd	102 Atlantic Ave E	56243	2,179						
Meeker	Litchfield	Litchfield Public Utilities Commission	421 W 3rd St	55355	1,378						
Nicollet	Nicollet	DAVISCO International Inc - Nicollet	734 6th St	56074	39,578						
Nicollet	St. Peter	Alumacraft Boat Co	315 W St Julien St	56082	2,642						
Nicollet	St. Peter	St Peter Regional Treatment Center	100 Freeman Dr	560823504	44,183	43,069					
Renville	Bird Island	Alliance Pipeline - Olivia 23-A	38884 870th Ave	55310	8,317						
Renville	Buffalo Lake	Minnesota Energy	777 W Borden Ave	55314	534,344		12,878				
Renville	Renville	Southern Minnesota Beet Sugar Coop	83550 County Road 21	56284	8,173	514,934			3,101,431	147,588	
Sibley	Arlington	Seneca Foods Corp - Arlington	300 3rd Ave SE	55307	43,556		498				
Sibley	Gaylord	MG Waldbaum Co - Gaylord	1121 Highway 19 E	55334	116,825	186	44				
Sibley	Winthrop	Heartland Corn Products	E State Highway 19	55396	844,841		6,411				
Stearns	Albany	Kraft Foods Inc - Albany	600 Railroad Ave	56307	143,509	68,169					
Stearns	Brooten	Lakeside Foods Inc - Brooten	500 Industrial Park Rd	56316			1,319				
Stearns	Cold Spring	Cold Spring Granite Co - Cold Spring	202 S 3rd Ave	56320	55,152						
Stearns	Cold Spring	Cold Spring Rocori High School	534 5th Ave N	56320	17,928						
Stearns	Cold Spring	Granit-Bronz Foundry	118 Main St E	563209515	1,604						
Stearns	Collegeville	St Johns University Order of St Benedict	Power Plant	56321	35,034	680			331,557		300
Stearns	Melrose	Melrose Dairy Proteins LLC	1000 Kraft Dr E	56352	385,397	144,720					
Stearns	Paynesville	Associated Milk Producers - Paynesville	200 Railroad St	56362	121,982	52,466					
Stearns	Sartell	International Paper - Sartell	100 E Sartell St	56377	103,828			584,806	1,920,404		
Stearns	Sartell	SPX Valves & Controls	250 Riverside Ave N	56377	10,383						
Stearns	St. Cloud	G & K Services - St Cloud	1250 Kuhn Dr	56301	28,167						
Stearns	St. Cloud	Grede - St Cloud Inc	5200 Foundry Cir	56303	1,439						
Stearns	St. Cloud	ISD 742 - St Cloud Apollo High School	1000 44th Ave N	56303	53,456	5,118					
Stearns	St. Cloud	ISD 742 - St Cloud Technical High School	233 12th Ave S	56301	54,093	5,197					
Stearns	St. Cloud	Nahan Printing Inc	7000 Saukview Dr	56302	23,223						
Stearns	St. Cloud	New Flyer USA Inc - St Cloud	6200 Glenn Carlson Dr	56301	66,334						
Stearns	St. Cloud	Park Industries	6600 Saukview Dr	56303	5,641	239					
Stearns	St. Cloud	Quebecor World St Cloud	660 Mayhew Lake Rd NE	56302	92,140						
Stearns	St. Cloud	St Cloud Hospital	1406 6th Ave N	563031901	144,496	2,238					
Stearns	St. Cloud	St Cloud State University	720 4th Ave S	56301	79,917	122,575					
Stearns	St. Cloud	St Cloud Technical College	1540 Northway Dr	56303	17,754						
Stearns	St. Cloud	St Cloud WWTP	524 240th St	56301	31	4,532					
Stearns	St. Joseph	Viking Waterbeds Inc	38169 County Road 2	56374				653			
Stearns	Waite Park	Martin Marietta Materials - St Cloud	1450 W Division St	56387		3,071					
Stevens	Morris	Diversified Energy Co LLC	227 County Road 22 S	56267	725,357		11				
Swift	Benson	Chippewa Valley Ethanol Co LLLP	270 20th St NW	56215	700,993		2,696				450
Swift	Benson	CNH Benson	260 Highway 12 SE	56215	33,996		381				
Swift	Benson	Glacial Plains Cooperative	260 20th St NW	56215	5,109						
Yellow Medicine	Canby	Sioux Valley Canby Campus	112 Saint Olaf Ave S	562201433	51	3,071					
Yellow Medicine	Granite Falls	Xcel Energy - Minnesota Valley	4064 E Highway 212	56241	7,175	49,374			5,148		
				TOTALS	6,625,028	1,721,568	31,193	608,358	6,392,321	147,588	750

Section 5.3 Transportation

[39] Source: PCA Boiler and Fuel Use database – Consolidated by Shalini Gupta, ME3 gupta@me3.org.

Although most of the focus of the CERT is on electric and thermal energy, transportation and petroleum usage issues are also important. The West Central Region is a leader in E-85 production and retail availability, making the region uniquely poised to lead the state in biofuels.

Section 5.3.1 Major Highways, Railways, Airports

There are several major roadways running through the West Central Region. Running east-west through the region are Interstate 94 in the north, US Highway 12 in the middle of the region, and US Highway 212 in the southern part of the region. US Highway 71, US Highway 29, US Highway 59, and US Hwy 75 all run north-south across the region. Highway 71 is the major route on the eastern edge of the region, Highways 59 and 29 through the middle, and Highway 75 along the Minnesota and North Dakota border.

There are 27 public airports in the region (Table 5).[40]

Table 5: Public Airports in the West Central Region

Alexandria Municipal Airport (Chandler Field)	Long Prairie Airport (Todd Field)
Appleton Municipal Airport	Madison - Lac Qui Parle Airport
Benson Municipal Airport	Montevideo - Chippewa County Airport
Brooten Municipal Airport	Morris Municipal Airport
Canby Municipal Airport (Myers Field)	Murdock Municipal Airport
Elbow Lake Municipal Airport	Olivia Regional Airport
Glencoe Municipal Airport (Vernon Perschau Field)	Ortonville Municipal Airport (Martinson Field)
Glenwood Municipal Airport	Paynesville Municipal Airport
Granite Falls Municipal Airport (Lenzen-Roe Memorial Field)	St. Cloud Regional Airport
Hector Municipal Airport	Starbuck Municipal Airport
Herman Municipal Airport	Wheaton Municipal Airport
Hutchinson Municipal Airport (Butler Field)	Willmar Municipal Airport
Litchfield Municipal Airport	

There are seven railways serving the region. These include Canadian Pacific Railway (CPR), Burlington Northern Santa Fe (BNSF), Dakota Rail, Inc. (DAKR), Twin Cities and Western Railroad (TCWR), Minnesota Prairie Line (MPL), Union Pacific (UP), and Dakota, Minnesota & Eastern (DME) (Figure 10).[41]

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[40] Source: http://www.dot.state.mn.us/aero/avoffice/ops/airdir/airports.html
[41] Adapted from http://www.dot.state.mn.us/ofrw/maps/statemap.pdf

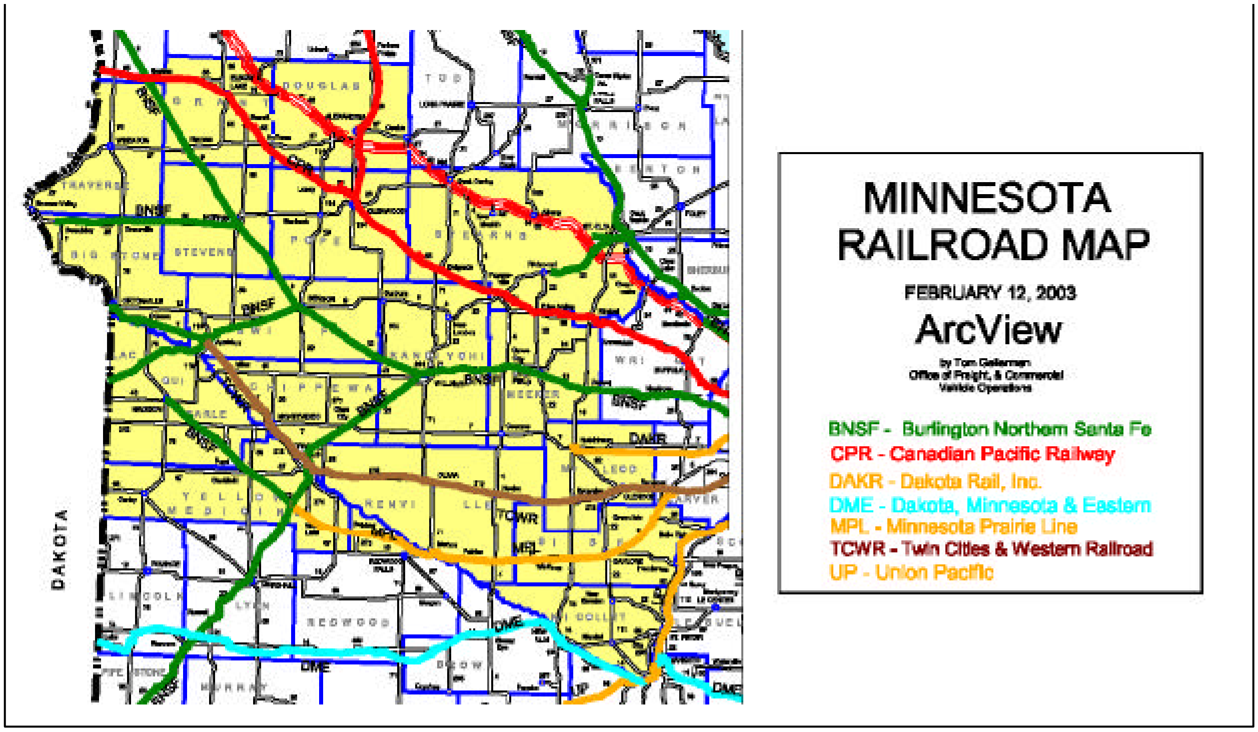

Figure 10: West Central Minnesota Railroad Map

Section 5.3.2 Origin of Fuels

As Minnesota has no petroleum reserves, all of transportation fuels used in the state, other than ethanol and biodiesel, must be imported. Shifting to greater percentages of ethanol and biodiesel, while also increasing the efficiency of our transportation operations, would allow Minnesotan's to keep more of their energy dollars local and therefore see more of those economic impacts in local communities and on local farms.

Section 5.3.3 Vehicles in Region

To better understand the amount of fuel used in each region, data from the Department of Public Safety was used to identify the number and type of vehicles used in each county (Table 6). Based on this data, fuel usage estimates based on type of vehicle were used to estimate the amount of fuel used in each region. The West Central Region is home to 252,840 passenger cars; 97,985 pick up trucks; 726 buses; 24,657 other trucks; 15,499 motorcycles; 4,006 recreational vehicles; 782 mopeds; 1,188 state-owned tax-exempt vehicles; and 3,328 tax-exempt vehicles for a total of 383,677 registered vehicles using fuel in the region.

Additionally, by assessing the number and type of vehicles in a region, the teams were able to target various vehicles for greater use of alternative fuels, fleet conversions, etc. This will be discussed further in Section 6.

Table 6: Minnesota Department of Public Safety 2003 Motor Vehicle County Summary[42]

County	Passenger	Pick Up Truck	Bus	Other Truck	Motorcycle	Recreational Vehicle	Moped	Van Pool	State Own Tax Exempt	Tax Exempt	No Registration	County Total
Big Stone	3,380	1,691	3	597	180	60	15	0	0	117	0	6,043
Chippewa	7,812	3,422	39	1,063	484	94	44	0	0	122	0	13,080
Douglas	21,651	8,473	24	1,673	1,324	394	45	0	780	86	0	17,116
Grant	3,904	2,030	3	651	244	54	8	0	0	78	0	6,972
Kandiyohi	25,990	9,353	83	2,432	1,505	400	103	0	70	450	0	40,386
Lac Qui Parle	4,895	2,553	1	703	244	95	22	0	0	144	0	8,657
McLoed	22,703	8,615	64	1,702	1,579	374	131	0	3	356	0	35,527
Meeker	13,966	6,197	89	1,202	1,001	301	63	0	0	128	0	22,947
Nicollet	17,980	5,555	55	1,070	1,223	246	60	0	112	171	0	26,472
Pope	6,869	3,247	11	727	530	105	20	0	0	106	0	11,615
Renville	10,323	5,202	8	1,603	654	166	49	0	0	149	0	18,154
Sibley	9,611	4,067	13	1,089	620	127	23	0	0	173	0	15,723
Stearns	82,869	27,612	273	6,958	4,730	1,261	133	0	198	841	0	124,875
Stevens	5,420	2,426	3	882	283	75	17	0	0	101	0	9,207
Swift	6,280	3,006	19	892	330	89	16	0	0	75	0	10,707
Traverse	2,438	1,337	14	569	115	41	10	0	0	91	0	4,615
Yellow Medicine	6,749	3,199	24	844	453	124	23	0	25	140	0	11,581
Totals	**252,840**	**97,985**	**726**	**24,657**	**15,499**	**4,006**	**782**	**0**	**1,188**	**3,328**	**0**	**383,677**
Gallons per Vehicle	551	645		4,637								
Total Gallons	**139,314,840**	**63,200,325**		**114,334,509**								**316,849,674**

[42] Bus is the total of all bus categories: Duluth Bus, Bus, Class 2 City Bus, Intercity Bus, and School Bus. Bus and School Bus categories are largest subcategories and determine overall number.

Other truck is the total of all non-pick up trucks, included categories: Farm Truck, Urban Truck, Prorate Truck, Comm'l Zone Truck, Commercial Truck, Prorate Foreign Truck; Farm, Prorate, and Commercial trucks are largest subcategories.

Gallons of fuel are calculated based on Energy Information Administration, "Annual Energy Review", Table 2.9 Motor Vehicle Mileage, Fuel Consumption, and Fuel Rates, 1949-2001, p 61.

All Trailers were removed from the list as none of the trailers are self-power. Fuel consumption is via another vehicle that tows the trailers.

Street Rod, Pioneer, Classic, Collector and Motorcycle (Classic) categories were all removed. Each of these is a type of collector vehicle that drives limited numbers of miles and cannot function as a regular use vehicle.

Retrieved 8/11/04 from http://www.eia.doe.gov/emeu/aer/pdf/03842002.pdf. The calculations employ 2001 data.

Section 5.3.4 Estimated Amount of Consumption

While it is difficult to obtain estimates for fuel use from each of the individual motor vehicle categories, the Energy Information Administration does provide fuel consumption (gallons per vehicle) estimates for passenger cars, pickup trucks, and other trucks. Combined these three categories alone account for over 315 million gallons of fuel consumption in the region. Bus, recreational vehicle and tax-exempt vehicle use surely pushes this number higher. At this time, we have been unable to assess fuel use associated with rail and air shipping/travel.

Section 5.3.5 Public Transportation in the Region

Each of the 17 West Central Minnesota counties has at least one public transit service provider (Table 7).[43]

Section 5.4 Agricultural Energy Use

Agriculture is both a user of energy and producer of energy. Section 6 of this report will touch on the many ways in which agriculture is a producer of energy, but this section tries to better understand how much energy actually goes into growing all of the crops in the West Central Region.

5.4.1 Major crops/livestock Grown in the Region

An inventory of West Central Minnesota's agricultural energy use examined some 8 major, and 9 minor agricultural commodities (Table 8).[44] The major commodities include such crops as corn, soybeans, wheat, and sugar beets as well as dairy, hog, beef, and turkey livestock operations. The minor commodities include hay crops, edible beans, and grains grown in the region, as well as sheep and chicken.

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[43] Note: Some of the counties are served by transit agencies in adjoining counties.
Source: http://www.apta.com/links/state_local/mn.cfm#A2

[44] Crop and livestock figures were taken from USDA National Agricultural Statistics Service. 2002. "2002 Census of Agriculture - Volume 1 Chapter 2: Minnesota County Level Data." http://www.nass.usda.gov/census/census02/volume1/mn/index2.htm.
On-farm, transportation, and processor energy conversion factors, as well as the inventory's estimation methods and assumptions, were taken, largely from Douglas G. Tiffany's work with agricultural energy use – specifically the report "Minnesota Agricultural Energy Use and the Incidence of a Carbon Tax" (April 1998), a Barry Ryan and Douglas G. Tiffany joint publication.

Table 7: West Central Minnesota Public Transit

County	City	Transit Agency
Big Stone	Montevideo	RIDES (Prairie Five RIDES Transportation Program)
Chippewa	Montevideo	MHE (Montevideo Heartland Express)
		RIDES (Prairie Five RIDES Transportation Program)
Douglas	Lowry	Rainbow Rider (West Central Multi-County Joint Powers Transit Board, RR)
Grant	Elbow Lake	Alpha Transit (Grant County Public Transportation Program)
Kandiyohi	Atwater	City of Atwater
	Willmar	KAT (Kandiyohi Area Transit)
Lac qui Parle	Dawson	DHE (Dawson Heartland Express)
	Madison	RIDES (City of Madison)
	Montevideo	RIDES (Prairie Five RIDES Transportation Program)
McLeod	Arlington	Trailblazer Transit
Meeker	Litchfield	MCPT (Meeker County Public Transit)
Nicollet	Mankato	MHE (City of Mankato Mass Transit Division, Mankato Heartland Express)
	New Ulm	BCHE (Brown County Heartland Express)
	Saint Peter	SPTS (City of Saint Peter Transit System)
Pope	Lowry	Rainbow Rider (West Central Multi-County Joint Powers Transit Board, RR)
Renville	Olivia	RCHE (Renville County Heartland Express)
Sibley	Arlington	Trailblazer Transit
Stearns	Minneapolis	NCCR (Northstar Corridor Commuter Rail Project)
	Saint Cloud	TRANSIT AGENCIES
		Transit Connection (Tri-CAP Transit Connection, Dial-a-Ride)
		Metro Bus (Saint Cloud Metropolitan Transit Commission, SCMTC)
		OTHER SITES
		CMSTC (Central Minnesota Shared Transportation Coalition)
		CMTA (Central Minnesota Transportation Alliance)
Stevens	Lowry	Rainbow Rider (West Central Multi-County Joint Powers Transit Board, RR)
	Morris	Morris Transit (MT)
Swift	Appleton	RIDES (City of Appleton)
	Benson	BHE (Benson Heartland Express)
	Montevideo	RIDES (Prairie Five RIDES Transportation Program)
Traverse	Lowry	Rainbow Rider (West Central Multi-County Joint Powers Transit Board, RR)
Yellow Medicine	Canby	RIDES (City of Canby)
	Granite Falls	GFHE (Granite Falls Heartland Express)
	Montevideo	RIDES (Prairie Five RIDES Transportation Program)

5.4.2 Estimated Energy Use by Crops and Livestock

All of the crops and livestock grown in the region require energy inputs. To understand how much energy they require the team used per acre fuel consumption estimates for diesel, gasoline, liquid petroleum (LP), electricity, and natural gas (Table 9).[45] These calculations show that electricity, LP gas and diesel are the major on- farm energy inputs in the region (Table 8). They also demonstrate that corn, soybeans and dairy cows require the largest amounts of energy inputs.

5.4.3 Opportunities for Greater Agricultural Energy Efficiency and Fuel Substitution

Per acre agricultural energy consumption has declined since the mid-1970s, but numerous opportunities and methods are still available to further improve agricultural efficiency. Mechanical advancements, such as more efficient pumps and motors offer great opportunities. Livestock operations can see major benefits from making their buildings more efficient with the conversion to more energy-efficient lighting and more efficient heating and cooling systems. Efficiency can also be improved by ensuring that all equipment is properly maintained.

[45] Tiffany, Douglas. "Minnesota Farm Energy Use and Kyoto Accord." Calculations are based on gallons of diesel per acre, gallons of gasoline per acre, gallons of LP per acre, kWh of electricity per acre and Mcf natural gas per acre.

Table 8: West Central Minnesota Agricultural Energy Use Inventory

WC MN Agricultural Production		WC MN On-Farm Energy Use					WC MN Transportation	WC MN Processor Energy Use			
Agricultural Goods	*Quantity*	Diesel (gallons)	Gasoline (gallons)	LP gas (gallons)	Electric (kWh)	Natural Gas (cf)	Gallons	Diesel (gallons)	Coal (tons)	NG (Mcf)	Electric (kWh)
Major Commodities											
Crops											
Corn for Silage or Greenchop and Grain	2,176,033 acres	20,389,429	2,502,438	20,846,396	77,532,056	8,584,450	3,525,111	-	-	610,137	15,440,740
Soybeans for Beans	2,154,317 acres	16,006,575	1,960,428	1,615,738	59,243,718	428,709	2,260,962	-	-	1,819,934	72,753,699
All Wheat for Grain	239,899 acres	1,736,869	213,510	196,717	7,168,182	419,583	520,860	-	-	-	13,353,589
Sugarbeets for Sugar	129,217 acres	3,736,956	258,434	0	13,018,613	381,190	1,484,767	-	133,262	1,341,148	20,687,188
Sweet Corn	48,500 acres	348,230	42,680	90,695	1,976,375	-	430,269	114,172	-	93,577	9,805,405
Livestock											
Milk Cows	131,300 head	4,529,850	393,900	2,166,450	78,780,000	-	2,062,659	-	-	1,603,865	35,464,000
Pigs	256,000 litter	2,444,800	284,160	1,039,360	37,952,000	-	14,884	-	-	-	-
Hogs	1,348,000 head	1,496,280	148,280	458,320	16,688,240	-	269,600	-	-	140,893	14,248,055
Beef Calf	42,840 head	272,891	31,702	69,401	2,538,270		12,681	-	-	-	-
Beef Cattle	67,900 head	324,562	31,234	73,332	2,673,902	-	67,900	-	-	69,681	7,046,609
Turkeys	7,160,484 head	716,048	71,605	3,580,242	8,879,000	-	82,585	-	-	63,592	6,430,179
	TOTAL (Major)	*52,002,490*	*5,938,371*	*30,136,651*	*306,450,355*	*9,813,933*	*10,732,279*	*114,172*	*133,262*	*5,742,827*	*195,229,466*
Minor Commodities											
Crops											
Alfalfa Hay	221,411 acres	2,169,828	179,343	0	8,243,132	1,591,945					
Hay - All Hay	275,112 acres	2,696,098	222,841	0	10,242,420	1,978,055					
Dry Edible Beans, Excluding Lima Beans	31,961 acres	234,434	28,765	25,089	916,961	31,130					
Barley for Grain	10,226 acres	74,036	9,101	8,385	305,553	17,885					
Rye for Grain	1,121 acres	8,116	998	919	33,495	1,961					
Oats for Grain	52,509 acres	380,165	46,733	43,057	1,568,969	91,838					
Livestock											
Sheep and Lambs	31,961 head	178,183	19,177	43,147	1,576,157						
Layers	1,043,913 head	104,391	10,439	521,957	1,294,452						
Broilers	1,460,846 head	146,085	14,608	730,423	1,811,449						
	TOTAL (Minor)	*5,991,335*	*532,005*	*1,372,978*	*25,992,588*	*3,712,815*	*568,981*	*0*	*0*	*287,079*	*11,252,091*
	TOTAL (Major and Minor)	**57,993,825**	**6,470,376**	**31,509,629**	**332,442,943**	**13,526,747**	**11,301,260**	**114,172**	**133,262**	**6,029,906**	**206,481,557**

Table 9: Energy Used in Minnesota Agriculture and Livestock[46]

Crop per Acre/ Animal	Diesel Gallon	Gas Gallon	LP Gallon	Electricity kWh	Natural Gas MCF
Corn	9.37	1.15	9.58	35.63	3.945
Soybean	7.43	0.91	0.75	27.50	0.199
Alfalfa	9.80	0.81	0	37.23	0.719
Dairy (15,000#)	34.50	3.00	16.50	600.00	
Turkey (head)	0.10	0.01	0.50	1.24	
Swine Finish (lit)	9.55	1.11	4.06	148.25	
Swine Finish (head)	1.11	0.11	0.34	12.38	
Beef Cow (head)	6.37	0.74	1.62	59.25	
Beef Finish (head)	4.78	0.46	1.08	39.38	

Precision farming could also help minimize waste, increase outputs and minimize environmental impacts often associated with over-application of chemicals because it tailors field management to site specific conditions rather than a whole field average.[47] Nutrient management practices that incorporate soil tests as means of determining optimal timing and rates for fertilizer application also allow farmers to tailor their on-farm management to current local conditions thereby decreasing field inputs, saving the farmer money, and avoiding fertilizer run-off.

Conservation tillage practices may offer the greatest room for improvement. Conservation tillage allows plant residue or stubble to remain on the surface of the field, rather than plowed into the soil. No-till practices that leave the prior year's entire crop residue on the field can save the equivalent of 3.5 gallons of diesel fuel per acre over conventional tillage methods. Mulch till, which leaves some material and breaks up the soil, would still result in savings of 2.5 gallons of diesel fuel per acre over conventional methods.[48] The drawbacks to using conservation tillage are that during wet years, no-till and conservation tillage can cause fields to retain more moisture and delay planting.

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[46] Figures taken from: "Agriculture Energy: Understanding Usage and Anticipating Policy Directions." Power Point Presentation, www.misa.umn.edu/ Go to programs, School of Agriculture Endowed Chair in Agriculture Systems, Power Point Presentations by Endowed Chairs, Douglas Tiffany

[47] Ryan, Barry and Douglas G. Tiffany. 1998. *Minnesota Agricultural Energy Use and the Incidence of a Carbon Tax*. Retrieved on April 24, 2005 from http://www.apec.umn.edu/staff/dtiffany/ILSRcarbontax.pdf.

[48] Ryan, Barry and Douglas G. Tiffany. 1998. *Minnesota Agricultural Energy Use and the Incidence of a Carbon Tax*. Retrieved on April 24, 2005 from http://www.apec.umn.edu/staff/dtiffany/ILSRcarbontax.pdf. p.37-38.

Grazing a permaculture practices offer another, less energy intensive, alternative to row cropping. Organic farming, or sustainable farming, where on-farm manure is used in place of fossil fuel-based fertilizer requires fewer petroleum-based fuels. Local food networks and farmers markets, where crops are grown and sold locally, also reduce petroleum fuel usage by reducing the distance crops must travel to market.

Farmers are also well equipped to substitute renewable fuels and supplies into their energy mix. Some changes are switches that farmers could literally make today, such as using biofuel substitutes like E-85 and biodiesel instead of gasoline and diesel, in on-farm vehicles, trucks and tractors.

Wind energy presents farmers with a means of offsetting their own electric use, or to develop an additional cash crop on their lands. Landowners have ample acreage to site wind turbines on their lands with only minimal impact to reducing their acreage available for food production due to the small footprint turbines require. Many landowners also have capital, management, and risk management skills to form cooperatives or limited liability corporations (LLCs) in order to raise the funds need to develop wind turbine systems.

Biogas from anaerobic digestions is a way that dairy farmers can either offset their heating fuel needs or, if paired with a generator, offset some of their electric requirements. Biomass from perennials or agricultural residues is another potential feedstock for heating, electricity, and ethanol. Solar technologies, such as solar water heating could cut down heating needs in barns by supplying pre-heated water. One of the most invisible uses of energy in agriculture is in the form of fertilizer. Currently, nitrogen fertilizer is produced from natural gas. Farmers could produce their own nitrogen fertilizer from renewable energy sources such as wind, biomass, or biogas.

SECTION 6: REGIONAL RESOURCE INVENTORY AND ASSESSMENT

Section 6.1 Conservation and Energy Efficiency

Installing a field of wind turbines on your land can get people in your community talking. Installing a whole building full of compact fluorescent light bulbs doesn't garner nearly as much attention. Despite the real dollar savings energy efficiency can provide, energy efficiency is often still neglected. Due to energy efficiency technologies adopted since the shock of the 1973-74 Arab oil embargo, it is estimated that the US saves $150 to $200 billion annually in energy costs.[49] That's both big money, and money that can be kept right here at home for other projects. Conservation and energy efficiency also help avoid having to invest in new power plants. The West Central CERT is trying to refocus attention on energy efficiency and conservation by helping people realize all the benefits these savings can provide.

6.1.1 Existing Model of Efficiency and Conservation

As mentioned in Section 5.1.5 utilities in the region offer several potential models for energy efficiency and conservation improvements and help link customers with incentives and information to become more energy conscious. The Minnesota Department of Commerce State Energy Office also provides extensive information on different energy saving ideas for citizens, communities, and businesses (www.commerce.state.mn.us, Energy Info Center). They offer monthly energy saving tips that any homeowner could utilize and a special "kids only" section designed to teach elementary and middle school age kids about energy and what they can do to utilize energy efficiently.

Another model energy efficiency program is the "The Change a Light, Change the World Regional Campaign". It is an annually coordinated consumer awareness campaign that promotes ENERGY STAR qualified compact fluorescent light bulbs (CFLs).[50] The program works with utilities and hardware stores throughout Minnesota and four neighboring states to provide discounted CFLs every fall. During 2004 the Change a Light, Change the World program facilitated the purchase of 305,441 ENERGY STAR qualified CFLs (in five states) that will result in savings of 141,113,742 kWh over the life of the CFLs.[51]

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[49] Pawlisch, Melissa, Carl Nelson, Lola Schoenrich. 2003. *Designing A Clean Energy Future: A Resource Manual*. P. 15. Retrieved on February 9th, 2005, from: www.cleanenergyresourceteams.org.

[50] For more information, visit the Midwest Energy Efficiency Alliance 2004 Summary Report at: http://www.mwalliance.org/programs/changealight/CAL04FinalReport.pdf. Referenced May 16, 2005.

[51] Midwest Energy Efficiency Alliance 2004 Summary Report, page 3: http://www.mwalliance.org/programs/changealight/CAL04FinalReport.pdf. Referenced May 16, 2005.

Programs like the Schools for Energy Efficiency program and JCI Academy target schools for efficiency upgrades while integrating classroom and educational activities to teach kids about energy use. The Schools for Energy Efficiency (SEE) program is designed to produce energy savings that result in economic savings schools can reinvest in educational programming. SEE focuses on no-cost and low-cost energy solutions, including behavior change, to help schools decrease their annual energy use by 10%.[52] Willmar Public Schools recently teamed up with the SEE program and will soon begin upgrades. JCI Academy of Energy Education links educational programming to systems upgrades performed by Johnson Controls. It strives to education students, teachers and administrators about their energy choices via curriculum as well as action-oriented activities such as energy patrols.[53]

Another possible model is performance contracting. Performance contracting is basically an alternative way to finance energy efficiency improvements by allowing business to pay off the project costs with money saved from efficiency improvements. Performance contracting entails a business hiring an energy service company to conduct and energy audit, determine potential for energy savings, and then make recommendations for improvements. These improvements are intended to save enough energy, and thereby money, to pay for all improvements over the life of the contract which is generally around 10 years.[54]

6.1.2 Potential for Energy Efficiency and Conservation Improvements

There is potential for improved energy efficiency and conservation in nearly every sector. The residential sector can be an easy place for individuals to start. Homeowners can replace incandescent bulbs with compact fluorescents, they can replace older appliances with energy efficient Energy Star appliances, they can make sure their homes are well insulated, and they can avoid doing non-essential chores during peak load hours.

On the commercial front, many commercial facilities could improve efficiency by simply upgrading their lighting fixtures to more efficient systems, like switching from T-12 style fluorescent light fixtures to T-8s. Businesses can, however, make improvements far beyond lighting. According to the American Council for an Energy-Efficient Economy, systems-based efforts like comprehensive commercial retrofit programs that integrate a range of retrofits, building upgrades, operations and

[52] For more information please see: http://www.hallbergengineering.com/SEE/SEE.pdf.
[53] For more information please see: http://www.johnsoncontrols.com/cg-education/academy.htm.
[54] Donahue, Patricia. 2000. "Energy Performance Contracting". Retrieved May 6, 2005 from: http://www.energyusernews.com/CDA/Article_Information/Fundamentals_Item/0%2C2637%2C8260%2C00.html.

maintenance improvements as well as their interactive effects can save up to 26% of total building energy use.[55]

Industrial users also have myriad ways to improve efficiency including making lighting upgrades and installing occupancy sensors. Industrial facilities, like schools, government buildings, and commercial structures, could also benefit from integrated control systems that allow facilities operators to stage equipment cycling and ensure that systems don't all come on at the same time, thus decreasing peak demand charges. Indeed, the American Council for an Energy-Efficient Economy estimates that optimizing motor systems alone could save 15-25% of US electricity.[56]

Enforcing existing building codes, in particular the energy code, may also yield better efficiency results. Another building improvement would be to design buildings to facilitate natural ventilation, with operable windows as is required by the Norwegian Building code. Continued and expanded tax credits for functional onsite energy production equipment such as wind generators and solar electric panels would not only integrate renewable energy technologies to further green building design, but would also improve overall system efficiency by minimizing electric transmission line losses.

6.1.3 Opportunities for Energy Efficiency Projects

There are such vast opportunities for efficiency and conservation improvements that sometimes it's hard to decide where to start. One likely possibility in the West Central Region is with lighting. Lighting improvements offer low-hanging fruit in all electricity end-use sectors. Lighting improvements are cost effective, tangible, and comparatively easy for homeowners and businesses alike.

One possible means of getting more customers to make the switch to compact fluorescents is to simply show them what's available. Willmar Municipal Utility has created a display that shows the great variety of compact fluorescent bulbs currently on the market. This display helps to dispel the myths that compact fluorescents don't really work, don't fit in my light fixture, and look funny. The display has come to several CERT meetings and related conferences. A potential team project could be to get this display out at county fairs, school events, and civic groups. Ideally the team would partner with a local group that could also sell compact fluorescents at these

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[55] Amann, Jennifer Thorne and Eric Mendelsohn. 2005. *Comprehensive Commercial Retrofit Programs: A Review of Activity and Opportunities.* Washington, DC: American Council for an Energy-Efficiency Economy. Retrieved May 9, 2005 from: http://aceee.org/pubs/a052.pdf.
[56] Nadel, Steven et. al. 2002. *Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities, 2nd Edition.* Washington, DC: American Council for an Energy-Efficiency Economy. Retrieved May 9, 2005 from http://aceee.org/Motors/mtrbk.htm

events so that people could make a change right away. Indeed, another idea the team has discussed is to have schools sell compact fluorescents as a school fundraiser rather than magazines or cookies.

The Center for Energy and Environment (CEE) also runs a model lighting program for commercial and business customers. The CEE program partners with local utilities and community groups to orchestrate daylong events during which local businesses replace their inefficient lighting systems with more energy efficient alternatives. Businesses are able to pay for the new lighting by combining cost savings on their utility bills with conservation improvement program dollars from the local utility. This model is currently being offered through Great River Energy member cooperatives in the West Central Region and continues to be a very popular program.

Section 6.2 Wind

Minnesota has one of the greatest potentials for wind energy in the nation, and wind power could theoretically generate many times more electricity than what is being used by the state. Minnesota has done a good job, particularly in the Southwest, of developing wind potential, but there is much more that could be done.

Section 6.2.1 Wind Assessment for the Region

Department of Commerce wind maps give a general picture of the wind resource across the state, but each site has its own characteristics and must be studied prior to development. Generally speaking the West Central Region has very significant wind power resources in comparison to the rest of the state (with the exception of the Southwest). According to the CERTs Manual, wind projects are viable options for regions characterized by Class 3 winds or higher, with higher-class winds preferable. According to the February 2000 "By Wind Speed Class (50 Meter)" Department of Commerce map, all counties in the region have Class 3 winds (Figure 11). The majority of the Department of Commerce wind maps pinpoint Yellow Medicine, Lac Qui Parle, Chippewa, Big Stone, Stevens and Renville Counties as the counties with the best wind potential in the region (Figure 12).

These wind maps, combined with the largely rural demographics (Figure 3) and the dominant cultivated land and hay/pasture/grassland land uses (Section 2.4) suggest tremendous large-scale wind potential in the West Central Region. Given the sheer number of potential sites, it seems the only barriers will be capital to invest in the turbines and transmission lines, although local options to use the energy may help overcome the transmission constraints. Currently, these local options have no proven model and this fact limits financing options.

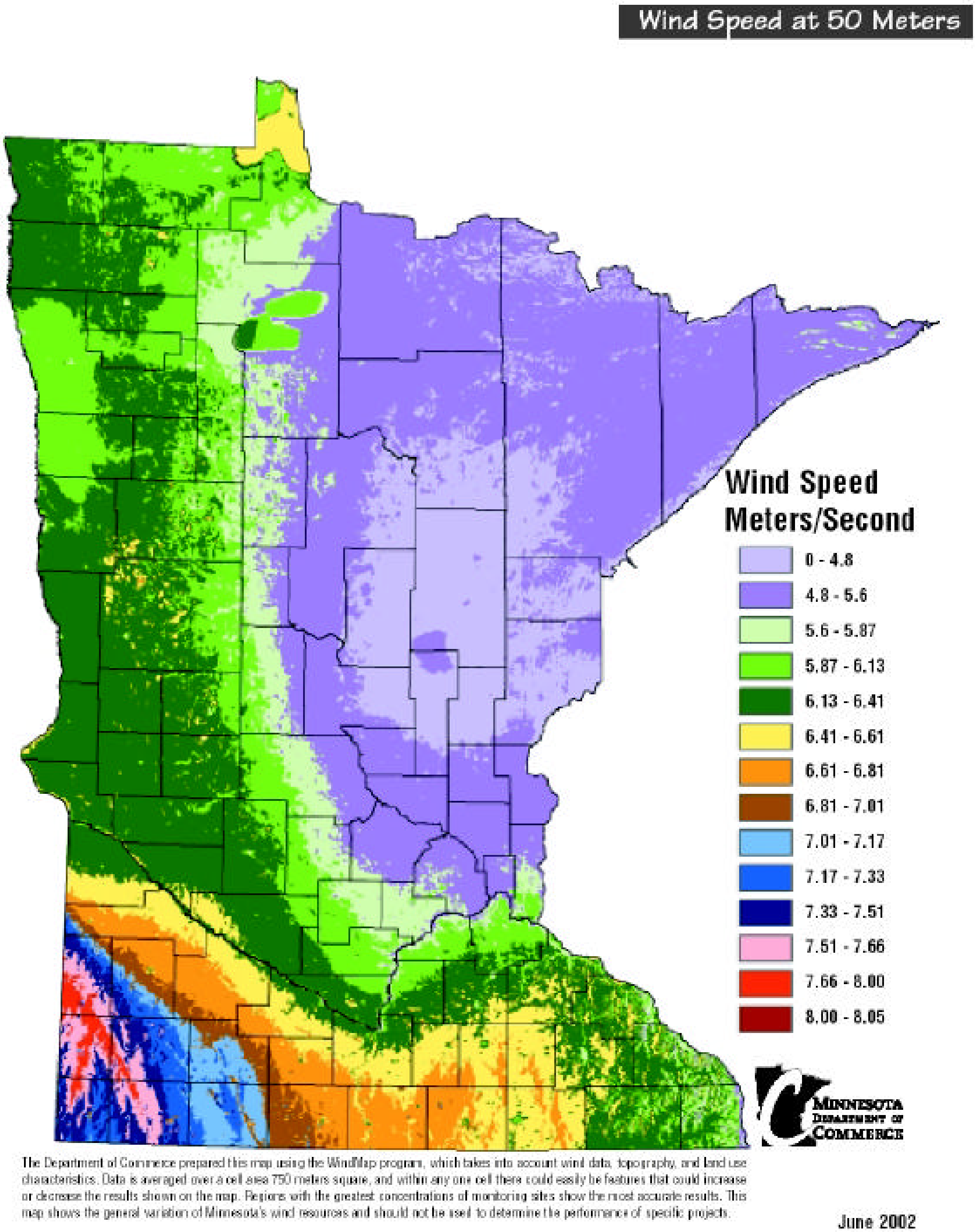

Figure 11: DOC Wind Map at 50 meters

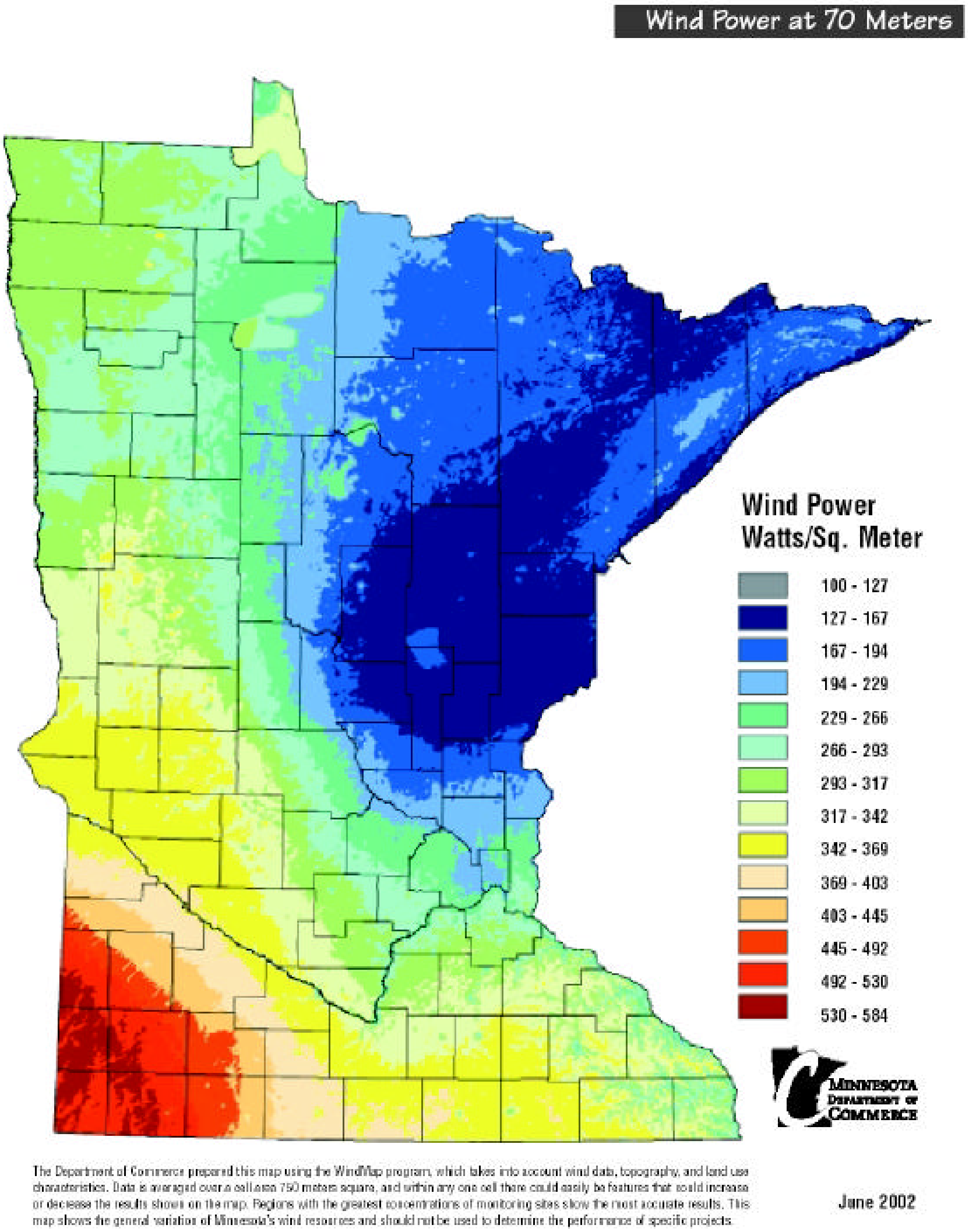

Figure 12: DOC Wind Map at 70 meters

6.2.2 Distributed Wind Energy Production Capacity in the Region

Mike Michaud, an independent contractor, developed a county-by-county analysis of the potential for small-wind energy production to meet rural energy requirements from distributed wind turbines across Minnesota. Using a distributed location approach, Michaud matched census data on rural households for each county with wind resource data from the Minnesota Department of Commerce to calculate total energy production capability.[57]

The results of the calculation are presented in Table 10. Based on Michaud's analysis there are approximately 88,680 available residential sites in West Central Minnesota. These 88,680 available residential sites could represent an installed nameplate capacity of 887 MW if all rural residents were to install 10 kW systems or 1774 MW if they were to install 20 kW systems, though not all of these locations will be technically or economically feasible locations for wind energy generation.

[57] Michaud, Mike. "An Examination of Distributed Wind Energy Production Capability in Minnesota." June 2004.

Table 10: Available Residential Sites in West Central Minnesota & Turbine Capacity Factor

County	% Area	Wind Capacity Factor		Households	Urban Pop	Rural Pop	Total Sites	Sites per area
Big Stone	1	28.1	29.5	2407		5820	2407	2407
Chippewa	0.67	28.1	29.5	5363	6322	6766	2772	1858
	0.33	29.6	31.2					915
Douglas	0.5	28.1	29.5	13241	13908	18913	7630	3815
	0.5	26.7	28					3815
Grant	1	28.1	29.5	2542		6289	2542	2542
Kandiyohi	0.6	28.1	29.5	15973	22253	18950	7346	4408
	0.4	26.7	28					2939
Lac qui Parle	0.25	28.1	29.5	3315		8067	3315	829
	0.5	29.6	31.2					1658
	0.25	31.3	33.2					829
McLeod	0.7	25.3	26.6	13478	18537	16361	6319	4423
	0.3	26.7	28					1896
Meeker	0.7	25.3	26.6	8563	6456	16188	6122	4285
	0.3	26.7	28					1836
Nicollet	0.2	25.3	26.6	10647	21440	8331	2979	596
	0.5	26.7	28					1490
	0.3	28.1	29.5					894
Pope	1	28.1	29.5	4520		11236	4520	4520
Renville	0.25	29.6	31.2	6759		17154	6759	1690
	0.5	28.1	29.5					3380
	0.25	26.7	28					1690
Sibley	0.5	25.3	26.6	5798		15356	5798	2899
	0.4	26.7	28					2319
	0.1	28.1	29.5					580
Stearns	0.25	26.7	28	47627	75041	58125	20788	5197
	0.75	21.8	23.7					15591
Stevens	1	28.1	29.5	3767	4861	5192	1946	1946
Swift	1	28.1	29.5	4368	6262	5694	2080	2080
Traverse	1	28.1	29.5	1720		4134	1720	1720
Yellow Medicine	0.3	29.6	31.2	4441	2005	9075	3637	1091
	0.5	31.3	33.2					1819
	0.2	33.3	35.3					727
						Total Sites:		88680

Year 2000 electric energy consumption data for the counties in West Central Minnesota are summarized below. The data show that if 10 kW turbines were installed at each residential site, 10 of the region's 17 counties could produce more than 50% of their electric energy requirements (Table 11). Similarly, if each site were to install a 20 kW turbine, 16 of the 17 counties could produce more than 50% of their electrical energy needs (Table 12). In fact, with 20 kW turbines, 10 of the 17 counties could actually be net energy exporters.

Table 11: 10 kW Production at Available Sites – Counties Ordered by Production Percentage

County	**Annual MW-hrs Prod**	**Total MW-hrs Consumed**	**% From Wind**
Pope	111263	112460	99
Big Stone	59250	61352	97
Grant	62573	67185	93
Yellow Medicine	99382	109110	91
Sibley	132766	157635	84
Traverse	42339	50908	83
Lac qui Parle	82366	119796	69
Renville	166525	272857	61
Meeker	137924	253977	54
Chippewa	69448	133568	52
Douglas	183140	373799	49
Stevens	47890	120372	40
Kandiyohi	177229	458898	39
Swift	51206	145915	35
McLeod	142367	490894	29
Stearns	419302	1548538	27
Nicollet	70052	343857	20

Table 12: 20 kW Production at Available Sites – Counties Ordered by Production Percentage

County	Annual MW-hrs Prod	Total MW-hrs Consumed	% From Wind
Pope	222526	112460	198
Big Stone	118500	61352	193
Grant	125146	67185	186
Yellow Medicine	198764	109110	182
Sibley	265532	157635	168
Traverse	84678	50908	166
Lac qui Parle	164732	119796	138
Renville	333050	272857	122
Meeker	275848	253977	109
Chippewa	138896	133568	104
Douglas	366280	373799	98
Stevens	95780	120372	80
Kandiyohi	354458	458898	77
Swift	102412	145915	70
McLeod	284734	490894	58
Stearns	838604	1548538	54
Nicollet	140104	343857	41

Although local siting conditions, distribution system technical issues, and the economic status of the household occupants will affect actual deployment levels, these estimates show the tremendous potential even small-scale wind development could provide for the region.

Section 6.2.3 Additional Monitoring Site Options

The Minnesota Department of Commerce monitors wind speed and power throughout the state. West Central wind data comes from six Department of Commerce wind-monitoring sites found in the West Central Region, with an additional non-affiliated monitoring site in Willmar (Kandiyohi County). The 2002 Minnesota Wind Resource Analysis Program (WRAP) report provides a summary of the Department of Commerce wind monitoring sites in the region with the exception of the Glenwood (Pope County) and Willmar data.[58] In addition, the University of North Dakota Energy & Environmental Research Center (EERC) analyzes Department of Commerce wind data, including some data not included in the WRAP report (such as the Glenwood data).[59]

[58] *Wind Resource Analysis Program 2002*. Minnesota Department of Commerce, October 2002. This report can be accessed at: http://www.state.mn.us/mn/externalDocs/Commerce/WRAP_Report_110702040352_WRAP2002.pdf .

[59] Energy & Environmental Research Center, University of North Dakota. This database can be accessed at: http://www.undeerc.org/wind/winddb/MNwindsites.asp .

Given these various monitoring sites, it appears that the location of wind monitoring sites has been relatively well distributed throughout the region, but project developers are always looking for better more site-specific data. One means of better understanding the relative strengths of one area over another is to look at local topographic data. While this technique can be problematic in regions of the state with significant tree cover, it can be more-or-less effective in the West Central Region where much of the land is covered by agricultural lands and prairie. Additional monitoring sites in the region are likely to be selected based on site-specific evaluations for future wind development projects.

Section 6.2.3 Existing Wind Projects & Plans

There are several smaller scale wind projects in the West Central Region (<40 kW). These include projects in Pope, Lac qui Parle, Sibley, Stearns, and Renville Counties (Table 13).

Table 13: Small Scale Wind Projects in West Central Minnesota[60]

City	County	Capacity (kW)
Albany	Stearns	20
Brooten	Stearns	8
Lake Henry	Stearns	18
Green Isle	Sibley	10
Green Isle	Sibley	10
Arlington	Sibley	10
Fairfax	Renville	10
Bellingham	Lac qui Parle	35
Bellingham	Lac qui Parle	35
Glenwood	Pope	35
Kerkoven (Hwy 12)	Swift	Unknown

In addition, Lac qui Parle High School has a 225 kW wind turbine[61] and the West Central Research and Outreach Center recently installed a 1.65 MW turbine. The Lac qui Parle turbine provides one-third of the school district's energy needs, educational and research opportunities for the region, and added income through the sale of

[60] Information taken from the National Renewable Energy Laboratory: Custom report: Plant name, utility, city, year operational, operational status, unit number, and capacity by state, technology and fuel. You may view the report at: http://analysis.nrel.gov/repis/online_reports.asp.Retrieved May 16, 2005. Additional information taken from http://www.cleanenergyresourceteams.org/westcentral/CS-Pope%20County%20Wind-WC.pdf and team member observations.

[61] *Designing A Clean Energy Future: A Resource Manual*. The Minnesota Project, et at, July 2003, p. 34. This report can be accessed at: http://www.mnproject.org/certs/certs-main.html#certs .

electricity to Ottertail Power Company. The West Central Research and Outreach Center's turbine will supply half of the University of Minnesota Morris's electric needs while also providing a testing ground for wind-to-hydrogen conversion and other hybrid renewable energy systems that can provide on-demand power.[62]

Planning for several larger scale projects is also underway. Three cities, Maynard, Clara City and Sacred Heart are exploring scenarios to mutually invest in a turbine that would serve the three cities and provide an additional revenue stream in the future. A farmer-based LLC is exploring the potential to install 10 MW of wind in Grant County. These sorts of projects demonstrate the great opportunity for community-based wind projects throughout the region.

6.2.4 Costs of Benefits of Potential Projects

Generally speaking the larger the wind project, the better the economics. A standard rule of thumb is that a small wind system will cost between $3,000 and $5,000 per kilowatt while a utility-scale turbine project will cost about a $1,000 a kW or $1,000,000 per MW (including the turbine itself and installation). Wind projects do, however, benefit from economies of scale both with regard to the size of an individual generator (the larger machines yield more output per dollar invested) and with regard to the number of generators to be installed at a particular site or particular point in time.

Joint ownership could be a powerful tool for increasing wind development throughout West Central Minnesota. Community-scale projects will make the most sense if communities can work together to install their generators at the same time or pair installation with a larger-scale development thereby minimizing one-time installation costs. New regulations that could allow the production tax credit to benefit community scale projects would also make these projects more economical.

While smaller wind projects do have longer payback periods, these projects do make sense for those individuals trying to simply offset their own electric energy needs.

6.2.5 Further Research Needs

While the technology for turbines is well developed, there is room for further research. One area of particular concern is with regard to financing community-based projects. What are the various mechanisms that communities could use? How can community take advantage of the tax benefits that currently fall to investors with high tax liability?

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[62] Morrison, Dean. April 22nd, 2005. UMNews, "*New Wind Turbine Powers Morris.*"This article can be found at: http://www1.umn.edu/umnnews/Feature_Stories/New_wind_turbine_powers_Morris.html. Retrieved May, 16th, 2005.

Other concerns relates to interconnection agreements and siting and zoning requirements for wind projects. While perhaps not research questions, it is imperative that utility interconnection agreements and county zoning ordinances become more harmonized. This will allow communities and developers across the region and across the state to benefit from lessons learned by others and facilitate more effective knowledge transfer and duplication. Since transmission of wind energy has become a huge problem in the state, alternative local uses for wind energy could also help in growing the industry.

Section 6.3 Hydroelectric

Hydropower is one of the most commonly used renewable energy resources. The first hydroelectric projects in the United States were built in the 1880s, but very few new hydropower stations are being installed today.[63]

Section 6.3.1 Existing Hydroelectric Facilities in the Region

There are 4 dams in the West Central Region, three of which have power (Table 14). Champion Paper in Sartell (Stearns County) operates the largest hydroelectric facility. The City of St. Cloud (Stearns County) and the City of Granite Falls (Yellow Medicine County) operate the two other hydroelectric facilities in the region. Idaho National Engineering and Environmental Laboratory also identified the decommissioned Hogo facility (Sauk Centre, Stearns County) as a potential source for hydroelectricity.

Table 14: West Central Hydroelectric Facilities[64]

Owner	Dam Name	County	River	Capacity (MW)
Granite Falls	Granite Falls	Yellow Medicine	Minnesota	1.2
St. Cloud	St. Cloud	Stearns	Mississippi	8.8
Champion Paper	Sartell	Stearns	Mississippi	9.5

Section 6.3.2 Opportunities for Hydroelectric facilities in the Region

Opportunities for hydroelectric power in the West Central Region can be found on the Minnesota, Mississippi, and Sauk Rivers. The strongest opportunity for further hydroelectric power in the region is the renovation of existing dams, as the "best" spots for hydroelectric power are often already taken by existing structures. Renovating existing dams also reduces environmental costs and damage caused flooding and natural habitat destruction.[65] However, as illustrated by the Park Rapids City Council's

[63] Hydro Research Foundation. "Frequently Asked Questions." Retrieved May 5, 2005 from http://www.hydrofoundation.org/research/faq.html#historical.

[64] Taken from http://www.dnr.state.mn.us/waters/surfacewater_section/stream_hydro/hydropower_sites.html

[65] Minnesotans for an Energy-Efficient Economy. This information can be accessed at: http://www.me3.org/issues/hydro/ .

2000 efforts to reactivate the Fish Hook River Dam in Park Rapids, research costs and feasibility studies are often expensive and difficult to conduct.[66] Furthermore, environmental considerations, such as impaired fish migration, stream flow, and safety concerns, will continue to hamper hydropower development. The emergence of micro-hydro technologies that generate less than 100kW and utilize flow-through mechanisms may present future opportunities, but will require significant study so as to avoid the same negative consequences previous hydroelectric technologies have encountered.

Section 6.4 Biomass

Biomass is any organic material not derived from fossil fuels that can be converted to a fuel useful for generating electricity, heat or even transportation fuels. For the purposes of this section, we are focused on examples like wood waste, energy crops such as hybrid poplar, switchgrass, and hazelnuts, and plant residues.

The chemistry of biomass conversion is converting plant-based material into a carbon-based fuel similar to fossil fuels. Simple combustion is one way to do this and is a common practice for wood. Annual plant based fuel stocks pose different chemical compositions that are more difficult to covert through simple combustion processes. These fuel stocks also have much more variability in the initial fuel characteristics. Pyrolysis and gasification technologies are currently being researched as a method of efficiently converting annual plant based fuel stocks into carbon based fuel stocks that can be used in conventional energy applications and at the same time provide cleaner emissions than comparable fossil fuel fired plants.[67]

Biomass has the potential to be a tremendous resource throughout the state of Minnesota as we have much agricultural land and much forestland. The Union of Concerned Scientists actually estimates that with existing technology, biomass could provide 6,690 MW of capacity to Minnesota, or well over half of the state's current needs.[68]

Section 6.4.1 Existing Biomass Projects

The National Renewable Energy Laboratory REPiS report states that International Paper in Sartell (Stearns County) operates a 24 MW timber residue biomass facility.[69] In addition, a turkey litter biomass facility is being planned at FibroMinn in Benson (Swift

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[66] *Designing A Clean Energy Future: A Resource Manual*, p. 34.

[67] Based on an e-mail sent from Lowell Rasmussen, assistant vice chancellor, UMM plant services administration. Received June 2nd, 2005.

[68] Pawlisch, Melissa, Carl Nelson, Lola Schoenrich. 2003. *Designing A Clean Energy Future: A Resource Manual. P.37. Retrieved on February 7th, 2005, from* www.cleanenergyresourceteams.org.

[69] REPiS, National Renewable Energy Laboratory. This database can be accessed at: http://analysis.nrel.gov/repis/online_access.asp .

County).[70] This 50 MW facility aims to burn poultry litter, as well as possibly alfalfa stems, oat hulls and waste wood. The CERTs manual also lists potential for energy crop (hybrid poplar) biomass energy in Alexandria (Douglas County) by WesMin Resource Conservation & Development (RC&D) Council, as well as possible anaerobic biogas digesters for very large dairy farms/feedlots in the area.[71,72,73]

The 2005 Minnesota Bonding Bill approved funding for a biomass research and demonstration center at the University of Minnesota, Morris (UMM) (Stevens County). The project aims to research and demonstrate a biomass-powered heating and cooling system on campus. UMM plans to specifically explore gasification technologies that can convert corn stover and perennial crops to a syngas that would replace or supplement natural gas. In addition to the research and demonstration component, the UMM system will be a functioning unit supplying heating and cooling to the campus buildings. Part of the research and testing will explore processes for collecting, transporting, and storing these agricultural-based biomass fuels for use in a centralized gasifier.

Section 6.4.2 Biomass Resource Assessment[74]

Based on preliminary estimates by Oak Ridge National Laboratory, the best biomass resources for the West Central Region appear to be corn and other agricultural residues as these are the most widely available at the lowest price throughout the region (Figure 13). Urban wood waste is found in very large quantities in Stearns County, presumably because larger urban areas are located in Stearns County than any other county in the region (Figure 14). Utilizing wood from community brush disposal sites for energy production could be low-hanging fruit as it can eliminate disposal costs while reducing the area's fire hazards. Other biomass resources graphs are provided in Appendix E.

[70] FibroMinn. This information can be accessed at: www.bensonmn.org/fibrominn/ .
[71] *Designing A Clean Energy Future: A Resource Manual*, p. 39.
[72] *The Minnesota Wood Energy Scale-Up Project.* Minnesotans for an Energy-Efficient Economy, 26 July 1995. This report can be accessed at: http://www.me3.org/issues/biomass/treeproj.html .
[73] Schmidt, D., Shogren, A., and M. Downing. *Minnesota Agro-Forestry Cooperative: A Minnesota hybrid success story*. WesMin RC&D. This report can be accessed at: http://bioproducts-bioenergy.gov/pdfs/bcota/abstracts/14/z293.pdf.
[74] Based on preliminary estimates made in 2003 by Marie Walsh at Oak Ridge National Laboratory.

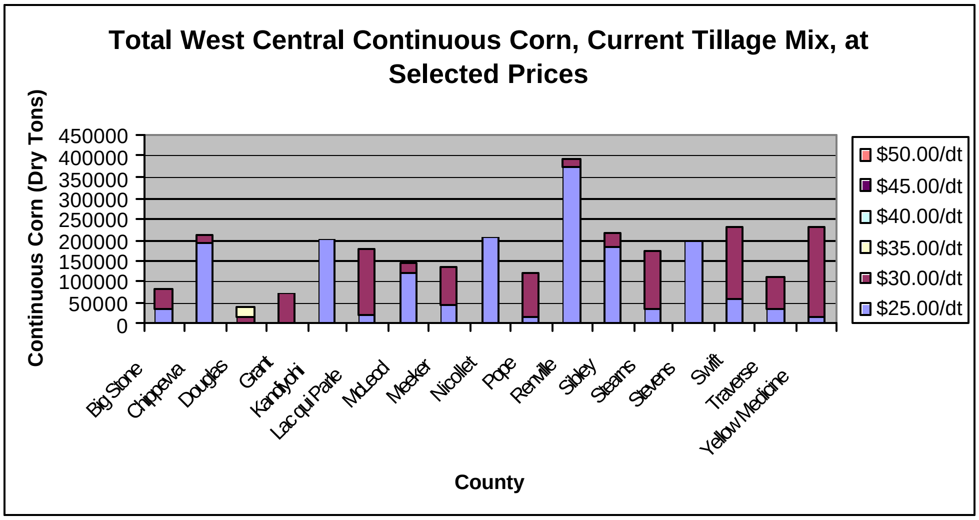

Figure 13: Total West Central Continuous Corn

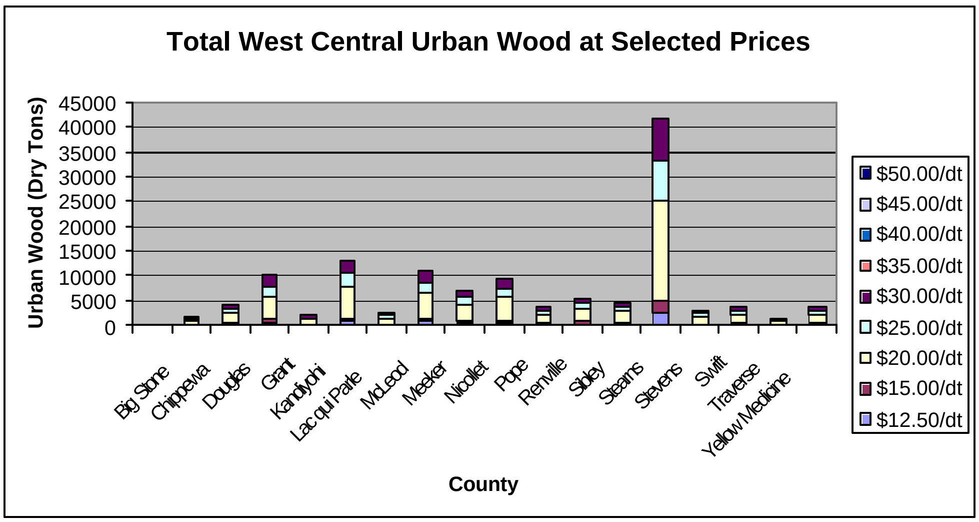

Figure 14: Total West Central Urban Wood

While this data indicate that biomass materials are plentiful in the region (Figure 15), much more research needs to be done. These data are based on a draft data set, compiled in 2003 by a department at Oak Ridge National Laboratory that has since dissolved. The Minnesota data is based on a national survey that cannot account for local conditions, such as transportation costs, tipping fees, and moisture content of fuels. In addition, some of the data appears incomplete. For example, the "corn quantities" and "agricultural residue" data are identical, although in Minnesota there would other agricultural residues to consider. As mentioned, transportation costs are not taken into consideration, nor is the possible location of new biomass facilities and the radius from which materials would be purchased. In addition, the availability and cost of these materials change very quickly due to weather conditions, demand, and changes in land use.

To best utilize the data we have, more research needs to be done into biomass energy to determine how much material is needed for the desired energy output, what an acceptable price for various biomass materials are, and if there is an upper price boundary that would make biomass-derived energy too expensive. Research is also needed to determine the optimal crop residue removal rate to balance economics with land sustainability.

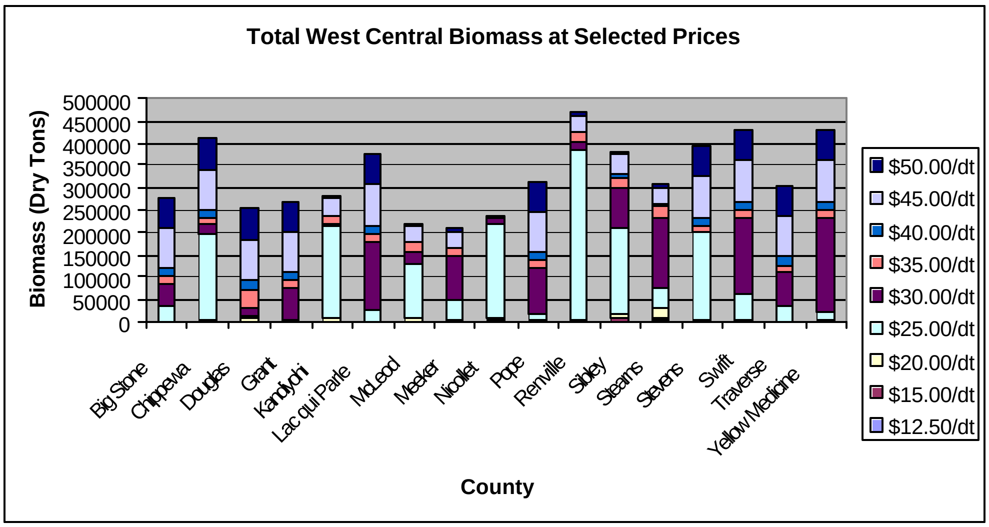

Figure 15: Total West Central Biomass

Section 6.4.3 Potential for Biomass Projects in the Region

At this point, there are no plans for other large biomass power plants in the region beyond the Fibrominn site, but with the vast amount of biomass available there may be opportunities for other well-sited facilities around the region. It may be that smaller-scale plants such as the University of Minnesota Morris facility could be more cost effective and easier to site than large-scale facilities as both transportation of the resource to a facility and distribution of the energy from a facility may be issues. Obviously the location of the plant needs to be in an area where a high amount of inexpensive biomass is accessible locally as the farther away the biomass resource, the higher transportation cost.

Similarly, the plant should be sited near a facility with either electricity or heat demand so that the energy could be used on site. Biomass projects may find, based on economic tradeoffs, that competing against natural gas for heat is an easier target than competing against coal for electricity. Converting biomass to heat is also more efficient that converting it to electricity. As more research is done on biomass plants, cogeneration plants may be able to provide multiple energy outputs including heat/cooling, electricity, and transportation fuel stocks (conversion of syngas to liquid fuels).

One other means of avoiding the distribution issues may be to co-fire biomass at existing coal burning facilities in the region, like at the Willmar Municipal Utility. Willmar is an interesting candidate because of the agricultural residue available in Kandiyohi County and because it already operates the only district heating system in the region. A recent report from ME3 suggests that utilizing biomass in district heating systems, which reach efficiencies of up to 90 percent when electrical and thermal energy are produced through co-generation, may allow biomass to be utilized as a more environmentally friendly heat and electricity source.[75] Although not all facilities will be able to reach the 100% ideal biomass blend achieved by Morris, there are numerous opportunities to utilize biomass more broadly.

Another biomass/cogeneration possibility on the horizon could be to develop a strategy with the Lamberton Garbage Burning Group, composed of 17 county commissioners, to help provide co-generation with agricultural products. An ethanol company in West Central Minnesota is also studying the possibility using corn stover for thermal energy, which would require corn stover from 200,000 acres of land. The ethanol company's management sees this as a first step towards a cellulose-based biorefining industry.

Section 6.4.4 Local Opportunities for Energy Crop to Mitigate Environmental Issues

There are numerous opportunities for growing energy crops in the region. As the Agroforestry Cooperative has already demonstrated, there are multiple benefits to be achieved from perennial growth including increased shallow aquifer filtration, well head protection, snow barriers, wind break crops, best management practices along rivers, streams, lakes, low production land and other productive conservation uses.

As productive conservation practices increase, which is to say, as agricultural lands are kept as working lands to grow biomass or woody crops that provide environmental services while providing farmers income, these new perennial biomass crops will be able to supply both high-value products like fertilizer and low-value products like heat and electric fuel. These productive conservation practices will become part of an integrated crop to market system with local crops going to a nearby facility to be broken down into its value added ingredients that can be extracted and sold high-value

[75] Gupta, Shalini. *Biomass-Fueled Community Energy Systems: A Viable Near-Term Option for Minnesota Communities.* Minnesotans for an Energy-Efficient Economy, March 2004, p. 2. This report can be accessed at: http://www.me3.org/issues/biomass/community.pdf .

markets. These systems will give true meaning to the local community's ability to generate new money from the land and create economic sustainability.

Work is, however, needed to enhance the ability of biomass to produce energy and other high valued products. Areas requiring further study include: harvesting, drying, storage, and transportation. Work is also needed on densifying cellulose or biomass materials. As these processes are better-understood and commercialized, biomass crops will moves from the "waste" category to a niche crop with a specific economic value and long-term demand.

In Swift County, Benson is a good example of how this concept works. Benson is home to an ethanol plant that delivers $0.50-$1.00 per bushel back to its stock investors from crops that are harvested and processed in the area. In the same area, Fibrominn will demonstrate how generation of energy can enhance the value of turkey litter while creating jobs, a co-generation opportunity, and a market for the fertilizer that is developed from the ashes of the process. Both of these projects add new value to the rural community. The new uses of agricultural products stabilize local incomes, the tax base and the population of the community and area.

Section 6.5 Biogas Digesters

Biogas digesters present an opportunity to capture methane to use for heat or electricity. There are four main types of biomass that can be used for biogas: manure, sewage sludge, landfill materials, and underutilized agricultural products.

6.5.1 Current Facilities

At present, there are no known biogas facilities in the West Central Region.

6.5.2 Regional Opportunities for Biogas Production

West River Dairy is currently operating a 5,000 head dairy located less than 8 miles from the city of Morris. The cows will produce 7.9 million cubic feet of manure per year. A very preliminary study conducted by the Energy and Environmental Research Center in Grand Forks, ND indicated a need for a technical and economic feasibility study. The project, led by the Agriculture Utilization Research Institute (AURI), City of Morris, University of Minnesota, and other stakeholders is conducting a study looking at the technical and economic feasibility of a methane digester located at the dairy and the gas sold to the ethanol plant (DENCO), the main natural gas user in the industrial park in Morris.

The objective of this project is to assess the economic, technical and environmental benefits of converting animal waste into biogas to displace natural gas in the industrial park. This project will determine if the City of Morris can construct and operate a digester and offer a long-term biogas contract to the local ethanol company. If the feasibility indicates the project is viable, the city of Morris would then move forward to secure financing for the project.[76]

The Kandiyohi County Value-added Agriculture Business Development group is also considering a community-based anaerobic digester. They see this digester as a component in their bio-energy future. They envision a future where biotechnology fulfills many unmet needs in healthcare and the production of fuels, chemicals and materials, where biotechnology helps create sustainable industrial activities, where bio-refineries take their place alongside oil refineries. Kandiyohi County will bring together economic, environmental and social factors that form a renewable energy economy. The county is considering a community-based digester as one of the initial building blocks in the venture.

Section 6.6 Biofuels

Ethanol and biodiesel are the two alternative transportation fuels available to Minnesota customers. All gasoline in Minnesota is mixed in with a 10 percent blend of ethanol (total of 260,000,000 gallons). Ethanol is also available in an 85 percent blend at select gas stations across the state. Biodiesel, where available, is generally provided in either 2% (B2) or 20% (B20) blends. Beyond use in transportation applications, there is also potential for using biodiesel as a substitute in diesel generators used in electricity generation.

Section 6.6.1 Biofuel Facilities in West Central Minnesota

Minnesota is home to fourteen ethanol plants with a production capacity of 389 million gallons. Four of these plants are located in the West Central Region (Table 15). These four plants alone have capacity to produce 85 million gallons of ethanol per year, nearly a quarter of Minnesota's production capacity. Minnesota also has the largest E85 (85% ethanol) fueling network in the world with around 110 stations. Minnesota's network makes up almost half of the stations in the United States. As of May 2005 the West Central Region was home to 30 of these E-85 stations (Table 16, Minnesota Gas Stations with E-85).[77] Combined these stations provide the West Central Region with an extensive network of fueling stations equipped to fuel flexible fuel vehicles. Chippewa Valley Ethanol Company located in the West Central Region is the largest direct supplier of E-85 in the state.

Table 15: Ethanol Plants (from the Minnesota Department of Agriculture)[78]

City (plant name)	Capacity	Million Bushels	Start-up	New Generation

[76] AURI's "Feasibility Study to Determine Economic and Environmental Benefits of Converting Animal Waste to Biogas."

[77] For more information about E-85 in Minnesota, visit the Clean Air Choice website at: http://www.cleanairchoice.org/outdoor/E85InCounty.asp?County=Nicollet. Retrieved May 13, 2005.

[78] *The Minnesota Ethanol Program.* Minnesota Department of Agriculture. This report can be accessed at: http://www.mda.state.mn.us/ethanol/ngcnote .

	Million Gallons/year	**Corn/year**	**year**	**Co-op Members ****
Morris (DENCO)	22	8.1	1991	345
Benson (CVEC)[79]	42	15.5	1996	850
Melrose (Dairy Proteins)	3.0	Cheese whey	1986	(Regional Coop)
Buffalo Lake (MN Energy)	18	6.7	1997	325

Today over two hundred Minnesota fueling stations offer a two percent biodiesel blend. While this is a more plentiful representation than most states, biodiesel is not universally available in Minnesota. The state has, however, established a biodiesel mandate that would require all diesel to contain a two percent biodiesel blend by 2005, and although there are currently no biodiesel production facilities in Minnesota, the biodiesel (B2) mandate does require 8,000,000 gallons of in-state capacity before taking effect (total mandate would require 13,000,000 gallons). None of the biodiesel facilities currently in the planning stages are located in West Central Minnesota.

Section 6.6.2 Existing Biofuel Projects in West Central Minnesota

At present, overall state consumption of E-85 is nearing 2 million gallons per year. Certainly the West Central Region has made a tremendous contribution to this consumption, as the number of station in West Central Minnesota is second only to the number of stations located in the Metro Region. Currently there are thirty stations in the West Central Region that sell E-85, with Lac Qui Parle County as the only county in the region without an E-85 Station (Table 15).[80]

[79] Chippewa Valley Ethanol Company, LLLP. For more information, please see: http://www.cvec.com/

[80] For more information about E-85 in Minnesota, visit the Clean Air Choice website at: http://www.cleanairchoice.org/outdoor/E85InCounty.asp?County=Nicollet. Retrieved May 13, 2005.

Table 16. E-85 Stations in the West Central Region

County	City	Station
Big Stone	Graceville	Cenex Country Corner
Chippewa	Montevideo	Cenex
Chippewa	Clara City	Farmers Coop Oil Cenex
Douglas	Alexandria	Cenex
Grant	Ashby	Ashby Equity Association Cenex
Kandiyohi	Willmar	Cenex Ampride
Kandiyohi	Willmar	Walt's 66 Carwash
McLeod	Glencoe	AMPI Ag Services
McLeod	Hutchinson	Freedom Valu Center
McLeod	Hutchinson	Hutchinson Coop Cenex
Meeker	Litchfield	Consumers coop Cenex
Nicollet	New Ulm	United Farmers Coop Cenex
Pope	Glenwood	Cenex C-Store
Renville	Danube	212 1-Stop Shop
Renville	Fairfax	Fairfax Mobil Mart
Renville	Buffalo Lake	Farmers Coop Elevator Cenex
Renville	Renville	Farmers Coop Oil
Renville	Sacred Heart	Farmers Coop Oil Cenex
Renville	Olivia	Honzay's Cenex
Sibley	Gaylord	Ag Land Coop Cenex
Stearns	Belgrade	Belgrade Coop
Stearns	St. Cloud	Cenex
Stearns	Paynesville	Paynesville Cenex
Stevens	Morris	Jerry's U-Save Conoco
Swift	Appleton	Cenex C-Store
Swift	Benson	Glacial Plains Coop Cenex
Traverse	Wheaton	Tri-County Coop
Yellow Medicine	Clarkfield	Consumers Coop Oil Company
Yellow Medicine	Canby	Farmers Cooperative Association Cenex
Yellow Medicine	Granite Falls	Tri-County Cenex

Beyond the use of biofuels in transportation application, there are no other biofuel-based projects currently underway in the region. The West Central Research and Outreach Center in Morris is, however, working with the Agricultural Utilization Research Institute to develop a pilot project that would pair a wind turbine with a biodiesel-fired generator for backup. The USDA Agricultural Research Service Laboratory in Morris is researching an alternative crop, cuphea, which has the potential to reduce dependence on imported oil by replacing crude oil derived lubricants.

Section 6.6.3 Opportunities to Use Biofuels

There are opportunities to use biofuels in both transportation and electric applications. With regard to transportation, a number of passenger vehicles are already equipped to run on alternative fuels. These vehicles are called Flexible Fuel Vehicles. All readers should review the list of vehicles developed by the Department of Commerce to determine if their current vehicle could be fueled using E-85 (Appendix F). Several Ford, Daimler Chrysler, and General Motors vehicles are equipped to run on E-85. The inside of each car's fuel lid should indicate whether or not your vehicle could be fueled using E-85.

The other opportunity for using biofuels in transportation is with buses and with tax-exempt vehicles. Currently the Department of Commerce is running a B20 School Bus Demonstration project at three school districts to test the viability of using B20 in winter months. The overall results from this project show that for at least 9 months of the year, avoiding the three coldest months, B20 is viable fuel for school buses, and may actually be viable on all but the very coldest days. Another example is the use of biodiesel in the entire City of Brooklyn Park fleet, over 100 vehicles using a B20 blend. The same sort of program could be used at city and county fleets throughout the West Central Region.

Beyond use in transportation applications, a biodiesel blend could also be used to fuel existing diesel generators and internal combustion engines running on fuel oil. Glencoe Light and Power Commission currently has three diesel units. If these units could be converted to a 20 percent biodiesel blend, air emissions of carbon monoxide, hydrocarbons, and particulates could all be lowered. Otter Tail Power, along with Alexandria, Arlington, Benson, Fairfax, Glencoe, Hutchinson, Melrose, and Willmar municipal utilities, all have internal combustion engines running on fuel oil that could be converted to biodiesel blends. Even a 10% blend would help these utilities meet their renewable energy objective requirements while also cutting emissions.

Another opportunity for biofuels resides in converting the fuel used at ethanol plants, particularly for heating, from natural gas, coal, and other hydrocarbons to biomass. In the Central region, the Central Minnesota Ethanol Coop (Little Falls, Morrison County) is planning a wood waste gasification facility as an alternative to using natural gas for heat. By using finely chipped hardwood as fuel, the plant will be able to better control its fuel costs by eliminating the need for natural gas; biomass-derived energy will generate 50-75% of the plant's own electricity requirements. Ethanol plants throughout the state could look into biomass-derived fuels to reduce their consumption of non-renewable fuel sources.

Section 6.7 Solar Energy

There are varying types of solar technologies: passive solar building design (which includes high efficiency construction and specific building orientation, window sizing and placement), solar thermal and solar electricity (photovoltaic (PV) systems). Solar thermal technologies can be subdivided into solar pool heating, hot water collectors for space heating or domestic hot water, reflective sun-tubes for interior lighting, or collector panels for the preheating of ventilation air.[81]

Section 6.7.1 Identify Existing Solar Installations

Since passive solar building design and solar thermal installations are typically private transactions between a buyer, seller, and perhaps a local building authority, very little concrete data exists about how many such systems are installed across the state. Similarly, as off-grid solar electric applications are by their nature decentralized, data is largely unavailable.

Anecdotally, the largest applications are a) solar thermal and PV off-grid cabins and homes, b) portable PV-powered highway construction signs, c) small, remote power applications such as for lighting, emergency highway call boxes, traffic and stream monitors and railroad crossings. A drive through the West Central Region demonstrates that there are indeed many of these types of installations throughout the region. Along Highway 212 alone there are seventeen railroad crossings with 3 panels of about 125 watts each for a total of 2.125 kW.

On-grid applications are much easier to track because they are generally larger and involve a fourth party, the electric utility. Before the solar electric rebate program began in July 2002, an estimated 120 to 130 kilowatts of solar electricity were installed in Minnesota, primarily in the Twin Cities area. Between July 2002 and July 2004 the solar rebate program catalogued an additional 150 kilowatts of solar electricity, primarily in the Twin Cities and Arrowhead regions of Minnesota, for a total of about 275 installed kilowatts.

Section 6.7.2 Solar Potential

While Arizona and the Pacific Northwest have the best and worst solar resources respectively, the rest of the country is largely in the middle, including Minnesota.

[81] For more information about solar technologies please see: www.homepower.com/files/featured/107_18.pdf

Indeed, Minneapolis has an annual solar resource roughly equivalent to that of Houston, Texas and Miami, Florida (solar resource and temperature are not necessarily correlated). Data analysis indicates that there is only a 10% difference between the highest (southwest Minnesota) and lowest (Northeast Minnesota) solar resource in Minnesota. Solar resources are very site specific, however, and locating whatever solar technology is used (solar building design, solar thermal, or solar electric) in un-shaded areas is extremely important. Trees, buildings, power lines and poles, and other structures will significantly affect solar electric installations and to a lesser but still significant amount, solar design and solar thermal.

Section 6.7.3 Solar Incentives

Several incentives are available for solar systems (Table 17). Minnesota's Solar Rebate program offers $2,000 per kilowatt (about a 20-25% buy down). Current incentives are limited to solar electric and do not include solar thermal applications.

Table 17: Solar Incentives

Type	State	Federal	Limitations	Benefit
Sales tax exemption*	X		Electric only	~5%
Property tax exemption	X			Varies
5-yr depreciation**	X	X		Varies
10% tax credit**		X		10%***
MN Rebate Program	X		Electric only	~20-25%

* Solar panels only; ** Businesses only; *** After other incentives are applied

Section 6.7.4 Identify Specific Opportunities for Solar Projects

Opportunities for solar are plentiful, but often depend upon budgetary and cost-benefit requirements. New construction provides the greatest opportunity for incorporating solar into an overall project, and at a minimum newly constructed buildings should be highly efficient and designed for passive solar heating and lighting. Community-based solar projects should likely focus on cost-effective applications and/or locations where educational curriculum can be incorporated such as nature centers, schools, community centers, etc.

Other opportunities for solar may include:

- Cooperation with electric utilities to site solar electric installations in areas of transmission or distribution line needs, i.e. solar has a positive correlation with demand and can help alleviate constraints to some extent;
- Cooperation with natural gas and electric utilities to recognize solar hot water as another method of energy conservation;

- Cooperation with government to ensure public buildings meet state guidelines for increased efficiency;
- Cooperation with government to reduce barriers to solar development and perhaps provide incentives through codes or permitting;
- Cooperation with businesses to look at cost-effective niche markets such as solar hot water in Laundromats (or other high water users), solar pools in club and municipal pools, and solar walls (ventilation air preheat) on commercial and institutional buildings.

Jason Edens' Rural Renewable Energy Alliance (RREAL) in the Central Region is an example of a solar project that could be applied throughout the state. The organization strives toward making renewable energy accessible to people of all income levels. RREAL has three main projects: 1) Solar Assistance, 2) Youth Training, and 3) Sun Dog Solar Contracting (contracting service for solar installations). The Solar Assistance Program provides and installs solar heating equipment for low-income households who qualify for federal heat assistance, thereby helping these households reduce dependence on federal heat assistance and lower their energy bills. The Youth Training Program involves at-risk youth in solar installations; it also runs the Solar Show Mobile, a mobile solar electric and solar heating project used by students to teach at schools, power fairs, and other events.

Section 6.7.5 Cost and Benefits of Solar

Solar technologies generally have higher up front costs and low operating costs. Payback periods range from short on the low end for incorporating solar design into new construction to long on the high end for installing solar electric systems (Table 17).

Table 17: Solar System Benefits and Costs

Technology	Benefit Window	Cost	Payback	Market	Appeal
Design	Year-round	Low	Short	Large	Medium
Thermal					
- Pool	Summer	Med-low	NA	Small	Low
- Ventilation	Fall, winter, spring	Med-low	Med-low	Medium	Low
- Hot Water	Year-round	Medium	Medium	Large	Medium
- Heating	Fall, winter, spring	Med-high	Medium	Med-low	Medium
Electric	Year-round	High	Long	Large	High

Solar design can provide over a third of a Minnesota home's heating requirements for very little additional cost since conventional materials are still being used in conjunction with some additional planning by the building designers.

Solar thermal applications have a bit longer payback than solar design projects, as they generally require some type of additional equipment, such as solar panels to circulate air or water that is heated by the sun. Solar thermal for hot water can provide roughly 50% of the winter and 100% of the summer hot water heating needs of a home, but can also be additionally sized and designed to provide space heating, using in-floor radiant heat or coupled with baseboard hot water heating. Generally, solar hot water systems will have 8 to 12-year paybacks when replacing electric or propane hot water heaters and 12 to 15-year paybacks when replacing natural gas hot water heaters.[82]

Section 6.8 Combined Heat and Power

Combined heat and power (CHP) refers to recovering waste heat when electricity is generated and using it to create high temperature hot water or steam. Steam or hot water can then be used for space heating, producing domestic hot water, or powering dehumidifiers and water chillers for air conditioning. Commercial biomass plants, once developed, may be able to expand the concept of combined heat and power to also produce the raw feedstock (syngas) to covert to hydrogen, clean diesel, and basic petrochemicals for fertilizer and industrial applications.

Section 6.8.1 Assessment of Combined Heat and Power Opportunities in the Region

In August 2001, Minnesota Planning and the Minnesota Environmental Quality Board conducted a study of combined heat and power (cogeneration) potential.[83] The

[82] Information in this section provided by Mike Taylor, Minnesota Department of Commerce, State Energy Office.
[83] *Inventory of Cogeneration Potential in Minnesota.* Minnesota Planning, Minnesota Environmental Quality Board, August 2001.

Chippewa Valley Ethanol Company plant in Benson (Swift County) was identified as a site with high cogeneration potential. This study examined the potential impacts of cogeneration at CVEC through combustion turbines fueled with natural gas. Natural gas is not a renewable resource, and the researchers did not look into biomass cogeneration options for the CVEC plant. In addition, their study was based entirely on survey response, and no other respondents from the West Central Region were selected as sites with high cogeneration potential. This research, however, does not rule out cogeneration potential for the rest of region; high potential sites could have simply not responded to the survey and not yet been identified.

As mentioned previously, ME3 is currently conducting research into biomass-fueled district heating systems in Minnesota. As stated in Gupta's ME3 report, the City of Willmar operates a municipal-based district heating system, and the cities of Alexandria (Douglas County), Benson (Swift County), Litchfield (Meeker County), and Winthrop (Sibley County) operated district heating systems prior to 1980.[84] ME3 suggests fueling these systems through biomass materials for a more environmentally friendly, and in some cases more cost-consistent, heat source.

Section 6.9 Geothermal Energy

Geothermal energy refers to the natural heat from beneath the earth surface. Because the ground heats and cools at a slower temperature than the air, it is possible to circulate antifreeze in wells (vertical) or coiled pipe (horizontal) underground to a heat pump that is used to cool the building during the summer and heat it during the winter.

Section 6.9.1 Current and Potential Projects

Geothermal heat pumps are becoming more popular for homeowners and in public buildings for heating and cooling. While there is not comprehensive data on how many heat pumps have been installed in the West Central Region, there is a great deal of potential in using them for public buildings as well as private homes. The ability to spread the initial investment over several years makes geothermal well suited for public buildings. Examples in the West Central Region include the West Central Research and Outreach Center Office building, the Morris Public Library and the Free Church in Morris. Many electric companies are now offering incentives to put heat pumps in buildings, and the Minnesota State Legislature is currently considering providing a sales tax exemption for ground source heat pumps.

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[84] Gupta, p. 3.

Section 6.9.2 Costs and Benefits

Although the installation costs for a geothermal heat pump system can be high, these systems can reduce operations and maintenance costs. Geothermal systems are more efficient than their gas-fired furnace and central air-conditioning counterparts and are not subject to fluctuating natural gas prices. On average, a geothermal heat pump system will cost about $2,500 per ton of capacity (a typical residential unit will have a 3-ton capacity). If such a system were included in a home mortgage, perhaps adding an additional $30-$50 per month, the energy cost savings over a one-year period would easily exceed the added yearly mortgage costs.[85]

Section 6.10 Fuel Cells and Hydrogen

Development of mechanisms to capture hydrogen using renewable resources is making steady progress. While hydrogen can be captured from a variety of sources including natural gas petroleum and coal, it can also be harvested via hydrolysis. The source of electricity to fuel this hydrolysis impacts whether or not the hydrogen harvesting is environmentally friendly or not.

The West Central Research and Outreach Center will begin a Wind to Hydrogen project on July 1, 2005, pending funding from the Legislative Commission on Minnesota Resources. Phase one of the three-phase demonstration will include hydrogen production utilizing wind energy, hydrogen storage, and generation of electricity in an internal combustion engine generator set. This hybrid wind energy model will demonstrate the use of hydrogen to store wind energy during high wind but low energy demand periods and demonstrate production of electricity from hydrogen during low wind and high energy demand periods.

[85] US Department of Energy: Energy Efficiency and Renewable Energy. 2004. "Geothermal Heat Pumps Make Sense for Homeowners." Retrieved September 21, 2004 from http://www.eere.energy.gov/consumerinfo/factsheets/ghp_homeowners.html.

SECTION 7: PROJECT PRIORITIES

The West Central Team has targeted its efforts toward 5 focal areas: conservation and energy efficiency, biomass, biogas, wind, and geothermal/solar/hydrogen. For each of these five focal areas the team has formed a working group to set project priorities, develop task lists, and implements tasks. Much of the team's efforts have focused on how to provide better education to the general public around each of the topic areas. This focus has led the team to develop project priorities that focus on demonstration, applied research and educational initiatives within each focal area. Their project priorities are the following:

7.1 Conservation and Energy Efficiency

Goal: Get conservation back into people's conscience.

Tasks: Educate! The Group focused on two prongs for education.

1) Working with Dave Pederson and the Prairie Woods Environmental Learning Center as a potential location to reach many students from multiple schools with demos and energy audits.
2) Focusing on the 4th-6th graders at the Willmar Public Schools with energy audits used as homework assignments that they could do at home with their parents.

7.2 Biomass

Goal: Education, for both the general public and those interested in economic development.

- General public will need to learn about and understand: 1) energy costs, 2) environmental issues, and 3) the economics of alternatives. The public should be equipped and empowered to move ahead with renewables.
- Develop a system of creating news stories that would keep people in the region and around the state informed about cellulosic or biomass project development.
- Economic developers will need to understand the technology and how to transfer the technology to the commercial sector. Develop educational or training sessions for economic development professional to inform and educate them regarding the benefits of renewable projects in their communities and how they might get assistance in developing them.
- Develop state and local incentives for short-term and long-term investment by both private investors and local banks. Funds will be used for projects that add value to agricultural products by utilizing cellulosic processes that can convert these products into their highest value components (given existing market demand).
- Encourage each new facility that incorporates a new process or enters a new marketplace to create an educational component that would allow their site to

serve as a demonstration. These demonstration sites would showcase how local investment produced returns for investors as well as local communities.
- Develop a "how to" booklet based upon existing operations and how they were created. Create a simple path that lays out the steps to successful project development including waypoints, decision points, and the tools necessary for a developer to evaluate a potential project throughout the development process. List all potential groups and individuals who might be helpful in concept development.

Objective: Hold renewable energy conferences/symposiums. Symposiums would be held in a variety of communities and at different times during the year, but would always take place at an existing value-added operation. Possible sites could range from an ethanol plant that produces unique co-products to sites creating energy from other biomass ingredients or via innovative conversion technologies. Each session would focus on how the business innovation came about and what obstacles it encountered from concept development to the market place. Several key sites to visit would include:
- Central MN Ethanol Coop in Little Falls, where an actual group of producers/investors are installing technologies that will curb the facility's natural gas use.
- Wood processing facility in Glenwood, where the facility turns wood into bedding. This site would expose producers to other potential markets for perennial/cellulosic biomass crops on their agricultural land.
- A dairy with an actual working digester in place to collect biogas and then utilize this gas for heat, electricity or another value-added commodity.
- University of Minnesota Morris where they will demonstrate the use of wind and its conversion to hydrogen.

All of these site visits would create enthusiasm and show people the range of possibilities. Talking and planning is one thing, but actual demonstration is the most effective way to generate action in local communities.

7.3 Biogas

Goal: Community financing models

The team is starting with the Morris Community Digester feasibility study that is currently underway and will try to include some of their questions into this feasibility study. Then they will focus on the Willmar Community Digester feasibility. The idea is to have a better understanding of whether or not the fuel has more value as either a natural gas substitute or electricity.

Tasks:

- Explore more options for business models – municipal financing, production tax credits, grants (9006), rural equity model, utilities (rate payers), rural develop loans, etc.
- Proof the various models – with IRS, SEC, etc.
- Look at alternative ways to utilize biogas on the farm including for hay drying, absorption refrigeration, electric generation, or fertilizer production.

7.4 Wind

Goal: Help get a turbine on the ground.

The team approached this goal from several different perspectives with the recognition that multiple audiences must be engaged to get an actual project on the ground. Some of the options ranged from developing an LLC to help finance community projects and educating the public about wind. The two focal points will be:

- Educating the public, city and county officials, and farmers about wind turbine technology.
- Assessing priority wind development areas with the use of GIS mapping to correlate strong wind regimes with topographic highs and available transmission lines and substations.

7.5 Hydrogen/Geothermal/Solar

Goal: Focus on geothermal and air source heat pumps, but continue to explore opportunities for integrated building systems that could include solar and opportunities to educate the public about hydrogen.

Short-term tasks:

- Comparative cost/benefit analysis for heating systems to assess payback
- Checklist regarding heating systems – facts you should know (have a warranty, etc).
- Educating contractors at Builder's shows
- West Central CERT sponsored tours
- Assist Prairie Woods with their air source heat pump evaluation
- Look at Morris as an option for a Zero-energy building

Long-term tasks:

- Put cost/benefit tool on-line
- Get systems installed at Prairie Wood and Morris
- Get interpretive signage up at existing facilities that already have geothermal

Section 7.6 Commonalities Between Project Priorities in the West Central Region and other CERT Regions

The West Central CERT shared several overlapping goals with other regions: biomass perennial crops as a means of providing fuel and environmental benefits, biomass as possible heating fuel replacement, exploring innovative financing mechanisms, and educational programs around energy efficiency and conservation, public outreach, demonstrations at environmental learning centers and work at local schools. One of the key strengths of the CERTs program is the sharing of information and programs between citizens across the state. Currently, the West Central Region is a leader in researching and testing new biomass-based heating systems, studying the feasibility of community-based digesters and developing hybrid wind systems. Other regions will be anxiously awaiting the results of these examinations. Similarly, the West Central Region may be able to take advantage of materials developed in other regions, like the Northwest's Heating Fuel Comparison Calculator that is currently under development.

SECTION 8: OBSTACLES AND OPPORTUNITIES

The West Central CERT has talked about potential obstacles and opportunities throughout its two years of meetings, but on March 14th, the team decided to really focus in on the obstacles and opportunities it may face with regard to its five key project areas. Team members noted that even "small" changes like getting more CFLs in use or LED traffic lights in place can bring about significant changes both in energy dollars saved and pollutants avoided. This simply indicates that the team should capitalize on any opportunity, no matter how small, as these small changes could lead to big results. The following sections highlight, by project area, the major obstacles and opportunities they identified.

Section 8.1 Obstacles and Opportunities for Conservation and Energy Efficiency

The single largest barrier the team identified for conservation and energy efficiency was apathy. As described in Section 6.1 and again in Section 7.1, the major hurdle is getting people to care about how much energy they use. Not surprisingly, the team feels like education and outreach offer the greatest opportunities to improve conservation and energy efficiency. To take advantage of this opportunity the team is pursuing projects at local schools, like the Schools for Energy Efficiency program underway in Willmar, and programs like "Change a Light, Change the World" that promote energy efficient lighting for both businesses and residents.

Lighting conversion is one of those examples of the big impact relatively simply actions can make. Indeed, if every American home replaced their five most-used lights that have incandescent bulbs with compact fluorescents lights (CFLs), each family would save around $60 annually in energy costs and together would keep more than *one trillion* tons of greenhouse gases out of the air. That amounts to $6 billion in energy savings for Americans and is equal to the annual output of 21 power plants.[86]

The group also feels that homebuilders often overlook energy conservation and renewable energy technologies. To address this obstacle, the West Central Region is looking into ways to best educate building contractors. One easy program to take advantage of is Energy Star Homes, a program that is currently not being utilized by many builders. Another opportunity would be to partner with energy efficient technology contractors to host a booth at community "Home and Garden Shows" that could showcase existing technologies that homeowners could incorporate that would help conserve energy.

Section 8.2 Obstacles and Opportunities for Biomass

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[86] Retrieved March 30, 2005, from: http://www.energystar.gov/index.cfm?c=lighting.pr_lighting.

As natural gas prices continue to climb, opportunities for biomass-based heating fuel substitutes grow. Similarly, new requirements governing total maximum daily loads (TMDLs) in waterways may provide an economic incentive to grow filter crops and cover crops to prevent run-off. Combined, these opportunities could allow farmers to find a new market for some of their agricultural residues. They could provide farmers with an incentive to grow perennial crops that can be used as fuel, while also greening the landscape. The West Central Region recognizes that these opportunities must be seized, as the biomass industry will also spur job creation as entrepreneurs step forward to create businesses to collect and haul the various biomass fuels and engineer and build specific tools needed for this growing market. Biomass fuels will help rural communities keeping their energy dollars at home, allowing that money to be spent in local businesses, and lastly, it has the potential to increase our energy independence. Continued research may result in biomass plants that use renewable fuel stocks, produce less pollution and provide the basis for sustainable agricultural production of fuel.

Despite the win-win-win nature of many biomass fuels, there are still many obstacles. Biomass facilities will need to be able to accept a diverse range of fuels. While this is certainly an opportunity from a landscape perspective, it is also a barrier. It means that we must figure out how to harvest the materials, how to collect them, how to store them, and how to transport them. It means we must have the right equipment to tolerate diversity and have the supply mix mapped to provide the right amount of fuel from a variety of different sources through the entire year. While certainly not insurmountable, these obstacles will require that the first biomass projects go through feasibility and planning studies.

Another "new technology obstacle" is permitting. Because these biomass fuels, particularly agricultural residues and perennial crops, are new fuels, the Minnesota Pollution Control Agency (MPCA) has yet to establish process for biomass permitting, making the process for the first biomass-based projects onerous. Permitting is mentioned as a big barrier for many biomass and biogas projects because the technology seems to be getting ahead of the currently-used permits. This is something that will need to be streamlined if Minnesota hopes to get more biomass projects online. In an effort to move past these obstacles, the University of Minnesota Morris is working with MPCA on several biomass applications. These efforts should give the agency some working experience in how to manage future permit applications dealing with annual plant based fuel stocks.

Lastly, despite the economic potential some of these projects may offer to farmers in the long-term, there are serious financial barriers in the short term. As with new industries there will be new challenges. Biomass plants may give farmers a new market, but they must be able to compare the bushels per acre against BTU's per acre to decide which crop has more value to them. Farmers need to know they will have a market to convince them to stop growing corn and soybeans and instead grow perennial crops that will need to grow for several years before harvest. While the Conservation Reserve Program may be a tool for some farmers, we will also need to explore other joint financing options. One model that could be duplicated for other crops is the Agroforestry Loan Program that provides low-interest loans and annual payments to landowners for growing hybrid poplar or other short rotation woody crops. In the case of agricultural residues, farmers will need a stable market to make investments of time and equipment to harvest these residues.

Section 8.3 Obstacles and Opportunities for Biogas

Feasibility studies are currently underway for community digester systems in Morris and Willmar. One of the goals of these feasibility studies is to discern what specific barriers may exist for community-biogas projects. Barriers already noted include project permitting, negotiating power purchase agreements, project financing and system operation.

- Permitting: facilities are wary of opening themselves up to new rounds of inspection when they are simply attempting to improve their waste management practices.
- Power purchase agreements: farmers do not feel they are getting a fair price for the on-demand renewable energy resource they provide.
- Financing: community-digester systems seem promising because one can combine multiple waste streams to make a higher BTU-content gas, but there are not good, existing models for financing these projects. It would be helpful to more fully explore how the ethanol cooperative models or the community-wind ownership models might work for biogas projects. The Southwest Minnesota Foundation is currently creating a series of seminars focusing on the bankers and lending institutions in the area to familiarize them with the biogas projects and how they work.
- Farmers do not want to baby sit the systems. There is a need for more automated systems or for separate management entities. This would enable farmers to concentrate on the core aspects of their farming business.

As with biomass, opportunities for biogas may lay in steadily climbing natural gas prices. While expensive today, changing technologies and rising natural gas prices may make scrubbing biogas and using it as a natural gas substitute more viable. While using biogas as a heating source is more efficient than converting it to electricity, farmers typically don't need all the heat produced to run their own operation. They have instead looked to electricity as a means of using this excess gas and converting it to a revenue stream. With climbing natural gas costs it may be possible in the future for farmers to team up with local industries to pipe cow-based methane instead of natural gas. Alternatively, there may be future on-farm uses that have gone unnoticed such utilizing the methane for grain drying or in nitrogen fertilizer production.

Eventually, it would be ideal to extract hydrogen from biogas and utilize the hydrogen to store excess biogas, power fuels cells for electricity, and power fuel cells to run farm vehicles.

Section 8.4 Obstacles and Opportunities for Wind

The West Central Region has great wind potential, and the team sees excellent opportunities in the area to expand current wind production. One of major barriers for wind projects is financing. Many landowners, communities, and schools are interested in putting up a wind turbine, but they are expensive. If there were mechanisms available where several people could invest a $1,000 to a project or ten people could invest $100,000, it would be easier to get projects going. The wind models being developed in the Southwest seem to present an opportunity for replication, but there is still a need to change how the production tax credit is allocated and a need to ensure more stability for these incentives. Although land lease payments are a good source of additional income for farmers, the West Central CERT would like to encourage local ownership of wind turbines, keeping a greater share of the dollars generated in the local economy.

Electric utilities currently have green pricing programs, as mentioned in Section 5, where customers can voluntarily pay a slightly higher electric rate in order to purchase wind energy. These programs are wonderful, but several team members have noted that given a choice to either purchase wind energy for a higher price from their utility or simply invest in and become part owner in an actual turbine, many would choose the latter. Many individuals want to touch and feel their own project and are willing to share in the risk, and hopefully the benefit, of that investment. Unfortunately, the federal production tax credit is geared to large corporations, not average citizens. We need long-term incentives to enable Minnesota citizens to become owners and investors in Minnesota wind. Encouraging local ownership will boost the rural economy, create jobs, and help farms to become more sustainable.

Another financial barrier to local ownership of small community based projects is the expense associated with the transmission line (MISO) study necessary to connect power generated by the turbine to the electric grid. This is one area the state could become involved in to facilitate and encourage local ownership of community scale systems.

Gathering the site-specific wind data can also present a financial hurdle to wind development. Erecting a monitoring station can be quite expensive, and may seem particularly expensive if you're not very sure about your wind resource. While the West Central Region generally appears to have cost-effective winds, Steve Wagner from the USDA-ARS Lab in Morris and a student intern are currently working to enhance the Department of Commerce wind maps with more detailed topographic data for townships. These three-dimension topographic models will help landowners compare the relative strengths of their site against others and hopefully allow them to feel more comfortable with an investment in site specific monitoring. The team noted that another opportunity to gain better wind data would be to gather detailed production figures from existing turbines throughout the region.

The largest issue facing community-based wind energy development is the ability to obtain a reasonable Power Purchase Agreement with a utility and to do so in a timely fashion.

Besides the financial and economic obstacles, permitting issues and transmission availability can also be significant barriers. These are generally site-specific issues that must be evaluated on a case-by-case basis. The CERTs project is providing an opportunity for individuals to network with one another and with their local utility to better understanding these obstacles and prepare for them early in project preparations.

Lastly, the public also has to both understand and want these projects. Issues like bird and bat kills and "vision or eye pollution" –people who don't want to see the towers in their view—need to be addressed. The public needs to understand the real environmental and economic benefits of wind. Generally when we compare the cost of wind to that of more traditional sources of energy, like coal, we only see part of overall economic picture because we do not place any dollar value on the coal facility's emissions. If the public put a dollar value on emissions, wind energy would appear much more cost competitive and the public would have some means of quantifying wind's environmental benefits. Wind energy will not eliminate the need for electricity generated from coal, but it can stretch the coal reserves we have.

The team is working to educate the general public now on the great possibilities that wind holds for the region; team members have already made a wind presentation to the League of Women Voters and displayed GIS maps in poster format at the WROC wind turbine dedication celebration. By focusing on the excitement of renewable energy vocations, their potential for good paying jobs and added income for farmers, and by getting more wind turbines operating on school campuses, the West Central CERT hopes to set the course for more wind development in their region.

Section 8.5 Obstacles and Opportunities for Geothermal

The two primary obstacles facing ground source heat pumps are high initial cost for installation and lack of knowledge. Sales tax exemptions or tax credits could help homeowners and businesses look past the first cost barrier. These incentives should also stay with the homeowner even if the home changes hands, as the environmental benefits continue to accrue no matter who lives in the home or building. Making the large initial investment in a ground source heat pump system can be a risk if the homeowner anticipates moving before the system would pay for itself. It the homeowner was able to capture the entire economic benefit of installation, even after moving, the investment may seem less risky.

Tools that allow for easy-to-understand cost comparisons between heating systems would also help. The West Central Team has worked on such a calculator and the Northwest CERT is developing a web-based version of the calculator that will eventually be supplied to all the CERTs regions. In addition, the public and building contractors need more information about geothermal systems in general. Since these systems are installed underground and not visible to the public, the team suggested that educational displays on existing public buildings using geothermal would be one way to help the public better understand their use.

Section 8.6 Obstacles and Opportunities for Solar

There is an excellent opportunity at Prairie Woods to display a solar demonstration project. Obstacles for solar installation include the high cost of PV systems. Although the Minnesota Solar Rebate is aimed at minimizing this obstacle, many feel that solar tax incentives are somewhat unreliable. As mentioned in Section 6.7.4 there are, nonetheless, many opportunities for solar that do not require substantial incentives. All new building should utilizing passive solar design. While there are no existing rebates for solar thermal heating, it is one of the most cost effective ways of using solar power. The advent of reliable tubing (i.e., PEX tubing) embedded in concrete floors in new construction may also lend itself to solar power storage heating.

The West Central Team has identified home solar thermal installations that were installed during the energy crunch in the 1970s when there were incentives available to install these systems. When energy prices dropped, the incentives went away, and the number of systems installed declined. With solar and all renewables, there is an opportunity for longer-term thinking and policy. Imagine how much more solar we would have, and how much better the technology would be, if we had continued to install those systems at the same pace for the last thirty years. We must get the incentives for these renewable energy systems right.

Section 8.7 Obstacles and Opportunities for Hydrogen

The biggest obstacles for hydrogen are misinformation, where to get the hydrogen, and how much it will cost. In some respects, hydrogen still seems like a far-off technology. This has led the team to focus its efforts on the opportunities to simply educate people about the potential of hydrogen, its myriad uses, and its safety record.

The Morris project has a great opportunity to dispel notions regarding hydrogen. While hydrogen has been in use for many years, there are still issues that challenge its viability. The Morris site can overcome these issues and demonstrate how this fuel might be used in conjunction with other projects in different locations across the state. West Central Minnesota may have a key component in developing the production capabilities and infrastructure needed for the coming hydrogen economy. This key step is in the production of nitrogen fertilizer and the infrastructure already in place to store and transport this commodity. The West Central Research and Outreach Center will pursue research and demonstration in the production and use of hydrogen. Morris's funding from the state of Minnesota gives them an opportunity to lead rather than follow the crowd.

SECTION 9: A COMMUNITY-BASED ENERGY FUTURE

During 2004, the West Central CERT set forth its vision to "build a resource base to make West Central Minnesota and the state more energy self-sufficient". This vision reflects the team's desire to build an energy resource base that is economically viable, socially responsible, environmentally sound, and that will truly sustain the region.

Section 9.1 Emerging Opportunities

With the leadership provided by the West Central Research and Outreach Center (WCROC) and the University of Minnesota Morris (UMM), the West Central Region is poised to be the state's leader in innovative usage of renewable, community-based energy. By integrating wind energy into campus, moving forward to heat the campus using biomass, and pursuing a community biogas project, the WCROC and UMM are demonstrating how a variety of renewable energy resources can be paired to power a community. By linking these types of projects, communities are able to take advantage of their local resource strengths and draw on a complimentary set of resources that can provide energy while also providing an economic boost to local farmers and landowners.

Kandiyohi County's Agribusiness/Renewable Energy Development Committee is also looking at renewable energy options, and could implement a similar diversified community-energy strategy that incorporate biomass, biogas, wind and solar. A natural starting point may be helping supply biomass to Willmar Municipal Utilities that could be co-fired in their coal boilers. They could also move forward on local biogas initiatives.

Benson, located in Swift County, is already home to the Chippewa Valley Ethanol Coop, which is pumping out renewable fuels. It will soon be home to the Fibrominn project that plans to utilize local turkey litter (which consists of biomass bedding), local waste wood, and hopefully locally grown perennial crops. Upon appropriate testing from the Caterpillar Corporation, Benson Municipal Utility could also begin converting its existing internal combustion municipal generation units to a biodiesel blend. With these projects in place, Swift County becomes a leader in renewable energy.

Beyond these regional centers, these types of community-based efforts could also take hold in smaller communities or in collaborations between smaller communities. Often we focus our attention on a few select locations, forgetting that the potential of renewable energy can raise all boats. We must be mindful of examining how these models can be translated to smaller communities and more rural areas to provide all members of our region with the means to take advantage of our renewable energy potential.

Other emerging opportunities include cellulosic ethanol and renewably-harvested hydrogen. Cellulosic ethanol, which could use any plant material to create ethanol, rather than simply corn, could transform the ethanol industry. Already farmers in West Central Minnesota are growing perennial crops. Cellulosic ethanol could provide a valuable market for these crops and could create opportunities to use perennial crops to both fuel the ethanol facilities and make the ethanol itself. This idea has been talked about for years, but this technology could be just around the corner. Iogen, a Canadian company, is currently producing cellulosic ethanol from wheat straw[87] while University of Minnesota researchers are currently working on new enzymes to bring down the cost.

Renewably-harvested hydrogen is possible through a variety of technologies including wind and solar-powered electrolysis and reformation of biogas and biomass-based methane. Today, the WCROC sells the excess wind power UMM cannot use into the grid, but in the future, WCROC envisions this excess wind energy being used for electrolysis to split hydrogen from water. The hydrogen could then be stored and used in fuel cells or for localized fertilizer production.

Section 9.2 A Community-based Energy Future

The connection between energy and the environment, agriculture, rural community sustainability, and economics has been emphasized throughout this plan. These connections demonstrate the potential community gains that a geographically dispersed energy system can provide. The West Central Region is uniquely situated to take advantage of four key renewable energy resources: wind, biomass, biogas, and biofuels. Other regions around the state and around the nation have other resource strengths. Renewable energy offers a unique benefit to rural areas, towns and cities throughout the country – it's everywhere. These sorts of community models can work everywhere, they just require pairing of different resources.

This last section highlights how the resources of West Central Minnesota can be pulled together to facilitate a true shift toward a more efficient and self-sufficient region.

- *Efficiency and Conservation*: West Central Minnesota communities will need to be models of energy efficiency. They will utilize combined heat and power and will co-locate processes and businesses to allow them to better take advantage of each

[87] For more information please see: http://www.iogen.ca/.

other's heat and power usage to power their own operations. They will plan new buildings and structures so as to integrate passive solar design, construct high-efficiency building envelopes, and integrate energy efficient technologies. They will retrofit older structures to be energy efficient with energy efficient lighting, appliances, occupancy sensors, and upgrades to Heating Ventilation and Air Conditioning (HVAC) systems.

- *Heating*: West Central communities, including residential structures, businesses and industry, will consider their local resource options including biomass and biogas as alternatives to natural gas and propane and integrate their heating systems so as to take advantage of air source and ground source heat pump systems.

- *Transportation*: West Central Minnesota communities will continue to grow biofuels, but not simply from corn and soybeans. They will also integrate waste materials from food processors and perennials like switch grass, alfalfa, and poplar in the supply mix. They will grow perennial crops on lands that are not ideally put into crop production, along waterways and along slopes to allow landscape diversification, soil protection, and water quality benefits.

- *Electric*: West Central Minnesota will become a model for true community-based electric systems that link multiple renewable energy resources to provide on-demand power. Communities will be innovators in developing hybrid wind-biomass, wind-biogas, wind-biodiesel, and wind-hydrogen options. They will look to pair solar resources in well-sited locations. These communities will assess how all the available resources can work together to compliment one another in terms of energy potential, availability, and timing.

West Central Minnesota will pioneer integrated energy systems that allow everyone in the community to see the benefits of locally grown energy resources. As these changes and options begin to ripple through rural communities, our children, our farmers, our towns, our land, and our water will all reap the benefits. The West Central CERT has already demonstrated the unique characteristics of the people in the West Central Region – a group of people who want to work together and learn from each other to ensure healthy, livable communities. There is tremendous potential for growth. The team must simply keep moving forward and be ready to serve as a catalyst for these changes.