


CLEAN ENERGY RESOURCE TEAMS

Southeast 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

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University of Minnesota Initiative for Renewable Energy and the Environment

University of Minnesota Regional Sustainable Development Partnerships

FINAL REPORT

Energy Use, Renewable Energy Resources and Potential for

Meeting the Energy Needs of the Fifteen Counties in SE/SC MN

from Local Renewable Energy Resources and Energy Efficiency

From the Citizens on the

THE SE/SC CLEAN ENERGY RESOURCE TEAM

Representing 15 Counties in SE/SC Minnesota:

Blue Earth, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Houston, Le Sueur, Mower, Olmsted, Rice, Steele, Wabasha, Waseca, Winona

JUNE 2005

Dedicated to Dick Broeker, 1942 - 2004

The SE/SC Clean Energy Resource Team (CERT) dedicates this report to the memory of Dick Broeker. As Director of the Experiment in Rural Cooperation in SE Minnesota, Dick was involved in establishing the CERTs Project. When the Clean Energy Resources Teams were formed in regions around the state in December 2003, Dick was instrumental in organizing our team and helping us with our work through June 2004, when he retired. During this time, we completed a Strategic Plan to guide our work and an Inventory and Assessment of the people, infrastructure and resources in our area.

Dick was our friend, mentor and cheerleader. He believed strongly that individuals could make a difference and that citizens working together in new public and private partnerships could make the world a better place. He helped us in myriad ways -- by connecting us with technical experts, finding resources for us and helping us think through and articulate complex issues.

Most importantly, Dick had great faith that we -- ordinary citizens in SE/SC Minnesota -- could design a clean renewable energy plan for our region and then shape an energy future based on that plan. Because he believed in us, we believed in ourselves. We've done -- and will do -- our best to live up to his vision.

This report is part of Dick's legacy, which will continue on as we use it to shape our work and create the clean renewable energy future for our region that we envisioned at the start of our journey together in December 2003.

PREFACE

"The thing to do with the future is not to forecast it, but to create it. The objective of planning should be to design a desirable future and to invent ways of bringing it about."
-Russele Achoff

We believe it is essential for citizens of the state to be involved in the decisions being made about our energy future and the type of energy future we want. Energy impacts every aspect of our lives; those decisions shouldn't be left to technical experts, politicians, government officials and/or executives at the power companies. Section 1 defines the type of clean, renewable energy future we want for our area. This includes an articulation of the values and principles that serve as the foundation or underpinnings of **the type of energy future and energy system we want – one that is clean, renewable, affordable, reliable and safe**.

The rest of the report sets out to accomplish five things: (1) provide information about the Clean Energy Resource Team Project and our SE/SC CERT; (2) paint a broad picture of the people, resources and infrastructure in our 15 counties in SE/SC Minnesota – things such as land use, how many people there are, where they are living, how they are moving about and the major economic activities they are engaged in; (3) describe briefly what energy is, how we use energy in different forms and amounts, where different sources of energy comes from and future prospects for their availability, the health and environmental impacts resulting from using different types of energy, external costs and subsidies masking the true costs of using different types of energy; (4) identify and assess the renewable energy resources in the region and the potential for saving energy and replacing conventional fuels with energy produced from those local renewable resources; and (5) identify barriers to implementing renewable energy projects in our region.

Hopefully this information will serve as a road map for designing and implementing a clean, renewable energy future for our region, our counties and our communities.

When we started this project, we weren't sure if we would be able to meet our energy needs in different forms from local renewable energy resources and using energy more wisely. We are now confident that we can do so and export energy to other regions. The question becomes do we have the

political will and fortitude to make it happen for our children and our grandchildren.

There are different reasons why members of our Clean Energy Resource Team support clean renewable energy and using energy more wisely. Some of us are interested in the good jobs and economic development benefits that accompany locating renewable energy and energy efficiency projects throughout our area. We estimate that well over a billion and a half dollars are leaving our area every year to import energy. By developing renewable energy projects within our area to meet our energy needs, we could keep those dollars at home. Some of us are farmers who want to earn more income from having wind generators on our farms and adding value to our commodities. Some of us are environmentalists concerned about global warming, mercury pollution and acid rain. Most of us are parents and grandparents concerned about what the future holds for our children and grandchildren.

The beauty of renewable energy is that it has something for everyone – Republicans and Democrats, liberals and conservatives, farmers and city dwellers, young and old, environmentalists and business people. Renewable energy makes good sense for everyone and good dollars and cents for our region. So if you read something in this paper that you don't agree with, please keep reading. You don't have to believe in global warming or be an environmentalist to support renewable energy. Renewable energy has something for everyone.

We decided not to assess the potential of renewable technologies that are on the horizon, such as fuel cells, producing ethanol from cellulose, hydrogen. We think that producing ethanol from cellulose and being able to charge fuel cells from locally-produced biogas hold great potential for our future. We are also interested in progress being made to extract hydrogen from water using wind-powered electrolysis for local and regional use. However, we do not think it is wise to be producing hydrogen from nonrenewable fuels, such as natural gas, other fossil fuels or nuclear power.

We hope the reader will keep in mind that this report was prepared by citizen volunteers, who took time from their regular busy lives over the course of a year and a half to prepare it and be part of designing and creating a clean renewable energy future for the 15 counties in SE/SC Minnesota. It is broad sweeping and was not meant to be highly technical or comprehensive or provide in-depth information about renewable energy technologies or energy efficiency programs that the reader could easily find elsewhere. We regret any errors.

Acknowledgements

Many individuals and organizations have supported our efforts and contributed to this report's content and preparation. We thank them and anyone we may have inadvertently forgotten.

Individuals we want to thank include Dick Broeker, Director of the Experiment in Rural Cooperation (the SE MN Regional Sustainable Development Partnership) through June 2004; Erin Tegtmeier, Director of the Experiment in Rural Cooperation (the SE MN Regional Sustainable Development Partnership) beginning July 2004; Joel Haskard, CERT Assistant Coordinator; Shannon Drake, our research assistant extraordinaire; David Morris and John Bailey from the Institute for Local Self Reliance for advising us on myriad topics throughout the project; Lola Schoenrich, Amanda Bilek, and Mark Lindquist from the Minnesota Project; Jamie Schultz for doing GIS work; Mike Michaud, Jeff Cook-Coyle, and Lee Dilley for their wind assessments; Douglas Tiffany from the University of Minnesota for his agriculture/energy use information; Rich Huelskamp for his assessment of conservation potential; Charles Peterson from the PCA for help in obtaining information about waste water treatment plants, biosolids, and feedlots for the potential biogas assessment; Jeff Cook-Coyle for his outline of the barriers issues and economic development potential for wind development in our region; Mike Michaud for helping identify barriers and working on how we might remove barriers we have identified; Carol Overland and Kristen Eide-Tollefson for their help in understanding transmission line issues; Ward Lutz for his help on the energy used in transportation in our region and the definitions of energy conservation and energy productivity; and Norm Erickson for all his comments and contributions.

We want to give special thanks to Nancy Adams, who chaired the SE/SC Clean Energy Resource Team with dedication and enthusiasm and wrote this report, and to Melissa Pawlisch, the statewide CERT coordinator, who has worked tirelessly on our behalf and helped identify, gather and assess important information, connected us with technical experts and resources, and cheered us on when we were overwhelmed with the enormity and complexity of the task at hand.

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SECTION 1: THE KIND OF ENERGY FUTURE WE WANT – ONE THAT IS CLEAN RENEWABLE, RELIABLE, AFFORDABLE AND SAFE – AND ITS UNDERLYING PRINCIPLES AND VALUES

During the course of the past year and a half, we have had several fruitful discussions about what kind of energy future we want for ourselves, our children and future residents of our region. Several principles and values emerged, as outlined below. We think it is imperative that citizens articulate the principles and values that are important to us and that these principles and values be the basis against which to weigh future decisions being made about energy. Politicians, government officials, and technicians can develop policies and technologies, but it is the citizens who should articulate the vision, principles and values on which to form those policies and develop those technologies. It was interesting to us that three of the attributes we identified are the same as the three pillars of the electric industry: safe, reliable and affordable.

The first thing we grappled with was a **definition of renewable energy.** We decided to accept the following definition: **renewable energy is a naturally occurring form of energy that has the capacity to replenish itself through ecological cycles and sound management principles.** These include wind, active and passive solar, geothermal, biogas, cogeneration, sustainably-grown biomass and biofuels, and low impact hydro.

Defining "clean", as in Clean Energy Resource Team, wasn't as clear-cut. Since all forms of energy, except the sun hitting the earth directly, disrupt the environment in one way or another while being produced, transformed or transmitted, we decided to weigh the issue of "cleanliness" on a continuum – some energy technologies definitely did less environmental damage over their lifecycles than other forms and were thus "cleaner" than other technologies.

PRINCIPLES OF A CLEAN, RENEWABLE ENERGY SYSTEM AND FUTURE

1. Efficiency. Our cheapest, safest, cleanest and most available energy resource involves using energy more wisely. We must use less energy, increase the efficiency with which we use energy, and increase the productivity of the energy we use to do more work. This applies to both renewable and nonrenewable energy resources. For definitions of these terms, see Section 8.1.

2. Sustainability. We must maximize the use of renewable energy resources and technologies that are sustainable. When people talk about something being sustainable, they usually consider three factors: the environment, society and economics.

Sustainable renewable energy systems:

- Come from a diverse mix of decentralized, local renewable energy resources
- Do the least amount of harm to the environment possible, make no net contribution of greenhouse gases and promote stewardship rather than exploitation of natural resources
- Are designed to contain and/or reuse their own waste, rather than release it into the environment
- Match energy technologies with the work to be done, taking scale into account (as Amory Lovins says, we don't need to use a chain saw to cut butter)
- Are affordable and enrich, rather than bankrupt, local communities and people; keep energy dollars at home to provide good jobs and taxes to be used for schools, roads, infrastructure and other societal needs in our state and local communities; are not rationed, with energy going to people who can afford to pay over those who cannot
- Are based on full cost accounting, or life cycle analysis, which include paying for external costs and not saddling future generations with debt; take a long-term view, rather than be based on short-term profit; consider the rights of future generations to have clean air, water, forests, productive land and wilderness areas
- Minimize risk and prevent harm from price volatility, unknown or unproven technologies, disruptions in supply and delivery from shortage, terrorist attack or overloading an antiquated, centralized grid system.

3. Equity and Place. We must maximize the use of energy sources that most benefit the local and regional community**.** These systems will include a mix of different types of smaller, decentralized renewable energy projects that produce energy as close to the place where they will be used as possible. Communities will own and manage their energy systems and keep their energy dollars at home to use for the betterment of their own communities. People who are impacted by the energy system will receive information about the system at every step and have some say about how it is managed.

Changes on the Horizon for Our Civilization. We and future generations will be dealing with two events that are changing life on this planet forever: the end of the cheap oil and global climate change. One way historians define different periods in history is by the predominant type of energy used. Using this definition system, our civilization is in transition – moving from the end of the Petroleum Age and into the dawn of the Solar Era. There is a great deal of discussion today about "Peak Oil." Peak oil is the point in time when extraction of oil from the earth reaches its highest point and then begins to decline. Some people believe that global oil production has already "peaked" or will in the next few years. At the time global oil production peaks, supplies of oil will decrease, oil prices will rise and shortages will occur. The world will probably never run out of oil, but we will reach a time when it is too difficult or expensive to extract. Every aspect of our lives in the past has been impacted by cheap oil, and increasing costs and shortages of oil will impact every aspect of our lives in the future.

In addition to the end of cheap oil, **our climate is changing**. We have only begun to see the changes that are coming as a result of global climate change – melting glaciers, rising sea levels, changing temperatures of ocean currents, more frequent and intense storms, flood and drought cycles, people dying from the heat and so on. Energy use and global climate change are intertwined. Global climate change is happening primarily because of the accumulation of greenhouse gases from burning fossil fuels in our power plants, factories, buildings and vehicles.

Plants capture and store solar energy. In the Solar Era the carbohydrates of plant materials will replace the hydrocarbons of petroleum to meet our needs for fuel and raw materials for industry, in addition to providing food. We will become more aware of how dependent we are on the **earth's biological systems – agricultural lands, fresh water, forests, air and fisheries, which are currently being degraded from overuse and exploitation.** We will become increasingly dependent on our agricultural lands and forests to grow crops and cellulose for biofuels in sustainable ways. Our ability to grow enough crops hinges on whether or not we will have enough water, either in our groundwater aquifers that we can use for irrigation or through adequate rainfall. The rainfall patterns and aquifer recharge patterns in Minnesota are changing because of global warming, and our climate is becoming hotter and drier. Thus, we are concerned about having adequate water resources in the future to support the carbohydrate economy of the Solar Era.

Plans are being made in Washington, St. Paul and utility board rooms around the world to move ahead to build new coal-fired plants, natural gas plants, nuclear plants and extensive transmission line systems to move energy from one region of the country to another. This business-as-usual approach to meeting future energy needs is advocated by many decision-makers. However, all of these big projects have tremendous social, environmental and economic costs that we have identified in Section 5. When these costs are taken into account, the business-as-usual approach offers no hope of a safe, reliable or affordable energy future.

These are not acceptable to us: going to war to maintain access to foreign oil, building more nuclear, natural gas and coal-fired plants, imposing tremendous environmental problems and debt on future generations and degrading the environment to obtain energy at any cost. Business-as-usual is a dark alley we cannot afford to go down. Future generations will judge us harshly if we do.

Fortunately, there is another way. We can change the wasteful ways we use energy in all forms without sacrificing our comfort or compromising the comfort of future generations. We can meet the needs of our region for energy in various forms from renewable resources located in our region and using energy more wisely.

In addition to providing the sustainable, clean energy future we need and want, investing in energy efficiency and developing the bountiful renewable energy resources found in our region would keep our energy dollars at home, create hundreds of small businesses and good jobs and spearhead economic development throughout SE/SC Minnesota.

Transitions are often difficult and perilous. The following table suggests the shift in values that will be necessary to guide us as we move from the end of the Petroleum Age into the Solar Era.

Table 1: A Change in Values[1]

	Petroleum Age Values	**Solar Era Values**
Earth's Resources	No Limits	Limits-resources under stress
	Pillage earth's resources	Stewardship
Relation to Nature	Domination of nature	Harmony with nature
Human Beings	Separate from nature	Part of nature
Economy	Materialism	Sustainability
	Throw-away society	Reuse, recycle
Nature of Products	Planned Obsolescence	Durability, high quality design and engineering
Scale	Bigger is better	Small has a place too
	Centralization	Decentralization
	Specialization	Diversity, Holistic thinking
Speed	Let's go faster	Where are we going?
National Security	Military might	People able to meet basic needs, protect ecosystems
Determinants of Status	Material Possessions	Personal development and social contributions
Happiness	Accumulation	Spiritualism
Relationships	Do what you want	Prudence, Self-restraint
	Competition	Cooperation
	Individual	Community

[1] Adapted from Brown, Lester. 1981. *Building a Sustainable Society*. Worldwatch Institute, p. 351

SECTION 2: INTRODUCTION TO THE CLEAN ENERGY RESOURCE TEAMS

The Clean Energy Resource Teams (CERTs) were established in the fall of 2003 to engage citizens and communities in planning and designing their own energy futures. The project is a partnership and collaboration between the Minnesota Department of Commerce, Minnesota Project, University of Minnesota Regional Sustainable Development Partnerships, Rural Minnesota Energy Board, Metro County Energy Task Force, Resource Conservation and Development Councils, and citizens in six regions around the state. One of the main goals of the project is to connect communities and citizens with the technical resources and expertise necessary to design and implement renewable energy projects.

Funding for the first phase of the CERTs project was provided by the Legislative Commission on Minnesota Resources, Minnesota Department of Commerce, U.S. Department of Energy, Carolyn Foundation, Blandin Foundation, University of Minnesota Initiative for Renewable Energy and the Environment, University of Minnesota Regional Sustainable Development Partnerships and University of Minnesota Community Assistantship Program.

A statewide coordinator, Melissa Pawlisch, was hired on September 29, 2003, and an assistant coordinator, Joel Haskard, was hired on November 3, 2004. The CERTs manual, "Designing a Clean Energy Future: A Resource Manual" provides case studies of renewable energy projects located throughout the state and information on available renewable energy technologies. The Minnesota Project manages the CERTs web page, which includes a wealth of information about different renewable energy technologies, team activities and ways to save energy and use it more efficiently and productively: www.cleanenergyresourceteams.com.

Seven Clean Energy Resource Teams are working throughout the state (see map). Teams include between 30 and 200 stakeholders representing area local governments, farmers, utilities, colleges, universities, businesses and environmental and economic development groups. Individuals are involved at different levels, ranging from serving on team steering committees, examining topics of particular interest, attending quarterly team meetings and weighing in with opinions and ideas on the regional CERTs list serves. The Metro County Energy Task Force is serving as the CERTs team in the metro area.

All of the teams are studying their region's energy systems and identifying areas where conservation efforts and community scale renewable energy projects can be introduced. Each team has had at least one workshop with expert speakers on various renewable energy topics or taken tours to help them understand the regional energy system and identify areas of regional economic opportunity.

Each CERT is developing a clean renewable energy plan for its region based on its vision of the kind of energy future it wants for the region and a careful study of its regional renewable energy resources and conservation potential. All of the visions articulated by the CERTs teams recognize the two-pronged potential of renewable energy to foster economic development in their regions and protect the environment.

SECTION 3: THE SE/SC CLEAN ENERGY RESOURCE TEAM (CERT)

Citizens from the following 15 counties in SE/SC Minnesota have come together to form the SE/SC CERT to develop a renewable energy plan for the region and begin some conservation and renewable energy projects in the area: Blue Earth, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Houston, Le Sueur, Mower, Olmsted, Rice, Steele, Wabasha, Waseca and Winona.

Section 3.1 Team Members, Recruitment, Structure, Meetings

3.1.1 Initial Team Membership Recruitment. The first meeting to organize the SE/SC CERT was held on December 16, 2003. Individuals were recruited by various methods: letters of invitation, press releases, announcements in local papers, follow up stories in the local press and on local radio stations, Sierra Club mailings to their members in the region and announcements in its newsletter and word-of-mouth. Individuals who attended signed in and the CERTs mailing list was started.

3.1.2 Team Members and Steering Committee. The SE/SC CERT represents a wide variety of stakeholders in the region. Around 150 names are on the core membership list. These are people who have attended meetings and/or indicated an interest in being kept apprised of SE/SC CERT activities at different events where SE/SC CERT has had a display table. A core group of around 20 steering committee members has been meeting monthly to develop a renewable energy plan for the region and to help establish projects throughout the region. The members of the steering committee as of May 2005 are as follows:

Table 2: Active Members of SE/SC CERT

Member		Town
Nancy Adams	Farmer/Citizen Activist	Le Roy
Bruce Anderson	President, ReNew Northfield	Northfield
Sig Anderson	Business Owner	Lake City
Jeff Cook-Coyle	Wind Developer	Rochester
Joe Deden	Director, Eagle Bluff Environmental	Lanesboro
	Learning Center	
Lee Dilley	Malt-O-Meal	Northfield
Kristen Eide-Tollefson	Clean Energy Advocate	Frontenac
Gael Entrikin	Citizen Activist	Rochester
John Helmers	Manager, WTE Facility	Rochester
Rich Huelskamp	Energy Consultant	Red Wing
Larry Landherr	Citizen Activist	Rochester

Ward Lutz	Citizen Activist	Rochester
Anne Morse	Winona County Recycling	Winona
Nick Nichols	Independent contractor	LaCrosse
Roger Wacek	Citizen Activist	Owatonna
Tim Wagar	Citizen Activist	Rochester
Katy Wortel	County Commissioner	Mankato

Section 3.1.3 Team Organization. The SE/SC CERT originally set up three committees that met independently from the steering committee: the Policy, Outreach and Education Committee (POE); the Inventory, Assessment and Planning Committee (IAP); and the Project Committee. After the completion of the Assessment and Inventory, the steering committee was expanded to include members from the three committees and met as a committee of the whole.

Section 3.1.4 Team Meetings

3.1.4.1 Steering Committee Meetings. The SE/SC Steering Committee met on the following dates: January 13, 2004; February 18, 2004; April 7, 2004; May 3, 2004; May 17, 2004; June 7, 2004; August 19, 2004; September 7, 2004; October 5, 2004; October 18, 2004; November 11, 2004; December 14, 2004; January 28, 2005; March 22, 2005; April 19, 2005, May 5, 2005; May 17, 2005.

3.1.4.2 Quarterly Meetings. The SE/SC CERT held seven quarterly meetings, as outlined below. Before each meeting, press releases were sent to regional media outlets and e-mail invitations were sent to the SE/SC CERT list serve and through the e-mail lists of some of our CERT partners in the region. Written letters of invitation and a SE/SC CERT brochure were sent to all legislators, Economic Development Authorities (EDAs) and Chambers of Commerce in the region prior to the quarterly meeting on Economic Development and Renewable Energy. The meeting dates and locations of all quarterly meetings were also posted on the CERTs website. Meeting summaries were sent to the list serve and posted on the CERTs website. Presentations from meetings were also posted to the website when available. Dates and topics for the SE/SC CERT quarterly meetings follow:

1. December 16, 2003: “An Introduction to CERTs” initial meeting

2. March 3, 2004: “SE/SC CERT Mission, Vision and Goal Statements,” Brainstorming Session.

3. June 26, 2004: "Principles & Possibilities of Renewable Energy in SE MN" and Assessment Findings. Key-Note Speaker: David Morris. Summary of Inventory and Assessment: Nancy Adams.

4. September 14, 2004: "Renewable Energy and Economic Development." Keynote Speaker: Kevin Knobloch, President, Union of Concerned Scientists. Panelists: Dean Harrington, President of the 1st National Bank of Plainview; Duane Johnson, Planning Director of Dodge County; Dan Hayes of Southeast Minnesota Public Power Association (SMMPA); and Tara Widner of the International Steelworkers Union.

5. January 11, 2005: Review of Work To Date and Plans for Moving Ahead. Committee Members.

6. February 5, 2005: "Agriculture as a Producer and User of Energy." Keynote Speakers: Alan Teel, "Biomass Energy - Opportunities and Challenges;" Linda Meschke, "Growing Renewable Energy Communities and Biomass;" Amanda Bilek, "On Farm Energy Use & Efficiency Potential;" Nancy Adams, "Changing Prospects for Minnesota Agriculture."

7. June 22, 2005: Tour of Renewable Energy Projects.

3.1.4.3 Statewide Meeting. Representatives from all of the CERTs met for a statewide meeting on February 28, 2005 in St. Cloud.

Section 3.2 Team Vision, Mission, Goal, and Strategic Plan with Strategies and Objectives

Vision: We envision citizens, businesses and communities producing a rapidly increasing share of the region's energy through locally owned renewable energy projects. This vision can only be realized through the wise and efficient use of all energy resources, e.g., energy conservation and energy efficiency.

Mission: The Southeast/South Central Minnesota Clean Energy Resource Team's mission is to lead our region toward energy self-sufficiency.

Goal: Our goal is to create a future for ourselves and generations to come based on clean, locally owned, renewable energy.

Objective 1: Conserve energy and use less energy. Every gallon of gasoline unburned and every watt of electricity saved will move us closer to our goal most efficiently and economically.

Strategy 1. Implement an education and public relations campaign regarding energy, the importance of conserving energy and using less energy and ways in which individuals, schools, businesses, etc. can save energy.

Strategy 2. Identify energy conservation opportunities being promoted by our power providers. Help publicize these and encourage the providers to change them if they aren't meeting the needs of the area.

Strategy 3. Implement energy-saving programs at targeted locations throughout the region.

Objective 2: Design a Renewable Energy Plan for the region based on the indigenous renewable energy resources of the region and the types and quantities of energy needed in the future.

Strategy 1. Carry out an assessment of the 15-county region. This will identify things like the population, cities and towns, number of households, schools, hospitals, airports, transportation methods, large energy users and natural resource base. Determine projected growth and future energy needs based on that growth.

Strategy 2. Understand the types, forms and amounts of energy currently used in the region. We consume energy primarily in the forms of liquid fuels, gas - natural gas and LP - and electricity. The electricity used in the region is generated largely by coal-fired and nuclear power plants. The major sectors using energy are transportation, residential, commercial, industrial (including as raw materials for other products) and agriculture.

Strategy 3. Identify critical points where existing energy supplies are likely to face constraints due to supply, delivery, cost, public health or other environmental factors over the next 20 years.

Strategy 4. Establish target goals for how much and what types of energy we will need in the future. Take the amounts we are now using, subtract the amounts we can save from conservation, add the needs from projected growth.

Strategy 5. Identify opportunities for renewable energy projects– large wind, small wind, photovoltaic solar, active and passive solar thermal, biomass including residues and potential for growing biomass crops on marginal lands, biogas, cogeneration and small low-head hydroelectric.

Strategy 6. Establish a renewable energy mix that will meet the future energy needs of the region, as determined above, from clean, renewable sources.

Objective 3: Facilitate in all possible ways the establishment of renewable energy projects throughout the region to meet our needs for clean renewable energy in the forms we will need – liquid, gas and electricity.

Strategy 1. Use the resources of the Regional Partnerships, CERTs and their associates to obtain information, technical expertise and ideas for and access to funding sources.

Strategy 2. Identify barriers to the implementation of renewable energy projects and identify ways to eliminate or get around them.

Strategy 3. Encourage Minnesota citizens and policymakers to support clean energy initiatives whenever and wherever they have the opportunity.

Section 3.3 Priorities for Work and Allocation of Resources

3.3.1 Work Plan. The SE/SC CERT members felt that they were being asked by the LCMR and their CERT partners to do several things, including:

(1) Complete a broad, sweeping inventory of the region, which included people, resource bases, land use, major economic activities and infrastructure;

(2) Complete an assessment of current energy use;

(3) Identify potential renewable energy technologies and renewable energy resources in the region;

(4) Identify potentials for using less energy and using energy more productively and efficiently;

(5) Develop a plan to meet future energy needs of the region using a three-pronged approach: using energy more efficiently and productively, reducing energy use and developing a decentralized mix of renewable energy projects around the region;

(6) Implement energy education, conservation programs and renewable energy projects in the region.

3.3.2 Allocation of Resources. Our SE/SC CERT received approximately $22,200 to accomplish our work. We allocated those funds in the following ways:

3.3.2.1 Student Researcher. We hired a student worker to help do research and compile information for the inventory and assessment and community outreach program.

3.3.2.2 Prepare Final Report. We interpreted our main responsibility to be to prepare a credible renewable energy plan for our area. We obtained the help of consultants to help us determine what kinds of information to gather for the assessment and inventory, help us understand technical information and give us ideas for renewable energy projects we could undertake in the region to replace conventional fuels and review the final draft to see that it was correct and as inclusive as a group of volunteers could be expected to make it.

3.3.2.3 Model home project at Eagle Bluff Environmental Learning Center near Lanesboro. Representatives from SE/SC CERT, the Initiative for Renewable Energy and the Environment (IREE) at the University of Minnesota and Eagle Bluff Environmental Learning Center began working together to design a conventional, energy-efficient home that would use renewable energy. The home is being designed with three purposes in mind: 1) serve as a model home that Eagle Bluff's participating students could see themselves living in; 2) provide an educational, renewable energy demonstration and classroom; and 3) serve as a residential home for Eagle Bluff's two graduate naturalists. The walkout basement will be used for classroom access (25 persons) and an energy center. The classroom will be able to show different loads in the house being switched from different sources, depending on their availability and use – wind, solar, storage. The home will be designed with real time monitors so students can monitor how the home is receiving its power and other conditions back in their classrooms via the Internet.

3.3.2.4 Address Barriers. We obtained the help of a consultant to address one of the major barriers we identified to getting renewable energy projects established throughout our area: being able to obtain access to the grid. He prepared and presented a statement on behalf of the SE/SC CERT at the Meeting of the Minnesota Transmission Owners in Rochester on October 6, 2004 and is preparing the outline of a paper that will address this issue.

3.3.2.5 Outreach and Education Campaign. We felt one of the most important things we could do was disseminate information throughout the region about (1) energy, (2) the findings from our inventory and assessment on how energy is being used in our region, how it can be used more wisely and renewable energy resources in the region, and (3) ideas for things individuals, schools, communities and businesses could do to use energy more wisely and start renewable energy projects across the region. We devoted part of our money to developing this Outreach and Education Campaign and compiling and printing materials to hand out at presentations in each county that could serve as the beginning of a county information center on renewable energy.

Section 3.4 Future Plans for Phase II of CERTs' Work

3.4.1 Phase 2. The original funding for Phase 1 of CERTs work ends on June 30, 2005. The SE/SC CERT intends to devote the next two years - Phase 2 - to working with citizens, utilities, schools, government officials, churches, economic development organizations, interested businesses and communities throughout the area to engage them in discussions about what kind of energy future they want and how we can work together to create a clean renewable energy future for our region. Phase 2 will begin with an education/outreach campaign with one meeting in each county to present the findings of the SE/SC CERT inventory, assessment and regional plan. Hopefully, citizens who attend these meetings will serve as a core group to help start renewable energy projects and energy conservation/efficiency programs in their communities. We are in the process of breaking out all the information we have compiled for our region by county for use in county planning efforts. We are also planning to contact all of the major energy providers in our region to learn more about their plans for renewable energy projects and conservation/efficiency programs and see how we might work together to create a clean energy future for our region.

3.4.2. County CERT Groups and Other Organizations are being formed to work on renewable energy throughout the 15-county region.

3.4.2.1 The Olmsted County CERT has been formed to focus on renewable energy efforts in Olmsted County. Their monthly newsletter can be found at: http://www.cleanenergyresourceteams.org/southeast.html. The group is currently working on county-wide energy awareness projects, such as supporting use of biodiesel beyond B2 in community fleets, lowering residential energy use and exploring partnerships for specific alternative energy projects. For more information contact Ward Lutz at lutz.ward@charter.net.

3.4.2.2. The Three Rivers Resource Conservation and Development Council has formed an Energy Committee to work within Region 9. Current participants include Nicollet County, Blue Earth County, Martin County, Watonwan Soil and Water Conservation District, Blue Earth River Basin Initiative, University of Minnesota Extension Service, Gustavus Adolphus College, Minnesota State University - Mankato, Region 9 Development Commission, Three Rivers RC&D, Greater Mankato Economic Development, Benco Electric, Windfinity and other interested parties. The group is identifying the area's current renewable energy resources, assessing current projects and working collaboratively to establish renewable energy projects and conservation projects in the area. For more information, contact Amy Stratton at amy.stratton@rcdnet.net.

3.4.2.3 Houston County citizens are in the process of forming a group to work on renewable energy projects in the Tri-County Co-op service area. They want to take the findings of the SE/SC CERT assessment and create renewable energy projects throughout the area to create positive economic change in their counties. For more information, contact Nick Nichols at dlbauman@aol.com.

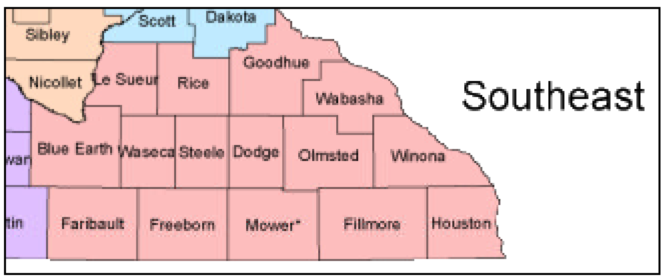
3.4.2.4 Winona County. Contact Anne Morse to learn about many exciting programs happening in Winona County at amorse@co.winona.mn.us.

SECTION 4: PEOPLE, RESOURCES, AND INFRASTRUCTURE IN THE SE/SC CERT REGION

The following is a summary of the broad inventory and assessment the SE/SC CERT undertook to learn more about the region, its people, resources, infrastructure and agriculture.

Section 4.1 Counties in the SE/SC CERT Region

The region of the SE/SC CERT includes the following 15 counties: Blue Earth, Dodge, Faribault, Fillmore, Freeborn, Goodhue, Houston, Le Sueur, Mower, Olmsted, Rice, Steele, Wabasha, Waseca and Winona.



Section 4.2 Regional Demographics, Households, Projected Growth

The 2000 Census showed that there were 577,176 people living in the 15 counties in 219,167 households. The population is spread out across the landscape as follows: 14.9 percent of the population lives in one city – Rochester; 38.8 percent of the population lives in six cities with populations over 20,000; 19.5 percent of the population lives in 17 cities with populations ranging from 3,000 to 19,000; and 41.7 percent of the population lives in 377 towns with fewer than 3,000 people. 23.2 percent of the people live in towns of less than 999 people (see Charts 1 and 2 in the Appendix).

The population of the region is expected to grow to 622,700 people with 244,810 households by 2010 and 704,930 people with 292,790 households by 2030. The fastest growth is occurring in Olmsted, Rice and Dodge Counties.[2]

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[2] Minnesota State Demographic Center. 2002. "Minnesota_Population Projections 2000-2030." Retrieved from: http://www.demography.state.mn.us/DownloadFiles/00Proj/PopulationProjections02Intro.pdf, June 12, 2005..

Section 4.3 Household and Household Occupant Information

Seventy-seven percent of the 219,167 houses in the SE/SC region are occupied by their owners. This is important because people who own the homes they live in are much more likely to invest in conservation and renewable energy projects to save money on their utility bills and enhance their property values. However, other factors impact on the willingness and/or ability of homeowners to invest in renewable energy/conservation projects, such as the age of the owner/occupant, median family income and value of the home. Twenty-six percent of the households in the region are occupied by one person and 25 percent of the households in the region have one member over age 65. Median family income in the region ranges from a high of $61,610 in Olmsted County to $41,793 in Faribault County. The percentage of families living below the poverty level range from less than four percent in Olmsted and Goodhue Counties to over 6 percent in Blue Earth, Mower and Fillmore Counties. Five counties have median house values over $100,000: Steele, LeSueur, Goodhue, Olmsted and Rice.[3]

Section 4.4 Land Use

The 15 counties encompass a large and diverse area: over 9,000 square miles or almost six million acres. The land varies from the hilly, forested area in the southeast to the flat prairie agricultural lands in the western part of the region. According to the latest land use census, 70 percent of the area is being cultivated, 14 percent is in forests, 10 percent is pasture and hay ground, 3.5 percent is taken up by urban and rural development, 2 percent is water and 1 percent is wetland.[4] Thus, 94 percent of the land in the region is being or can be used to produce biomass for energy in the form of intentionally planted energy crops and crop and forest products residues.

Section 4.5 Watersheds, Rivers, and Aquifers

The area has wonderful rivers and water resources. There are two major watersheds: the Lower Mississippi River Basin and the Minnesota River Basin. Major rivers include the Blue Earth, Cannon, Cedar, LeSueur, Minnesota, Mississippi, Root, Shell Rock, Upper Iowa, Wantonwan, Wapsipinican, Winnebago and Zumbro. It was not possible to get good information about the aquifers in the region, including sizes and aquifer

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[3] US Census Bureau. 1999. "Income and Poverty in 1999." Retrieved from: http://factfinder.census.gov in February 2005.

[4] Data Net. 1990. "Minnesota Land Use and Cover Statistics." Retrieved from: www.lmic.state.mn.us/datanetweb/landuse.html on June 12, 2005.

recharge rates. We are concerned about changing rainfall patterns and changing aquifer recharge patterns because of global warming and future residents of the area having enough drinking water and water to grow crops, produce biofuels and use for other purposes.

Section 4.6 Transportation Infrastructure

4.6.1 Major Highways. Two major interstates cross through the area: Interstate 90 runs east and west across the southern part of the region and Interstate 35 heads north and south. Other major state highways include 169, 218, 52, 63 and 61, which lead north to the Twin Cities, and 14, which crosses east to west.

4.6.2 Railways. The following railroads are operating in the area: from east to west, the DM&E (Dakota Minnesota and Eastern), UP (Union Pacific) and IMRL (I & M Rail Link) and, from north to south, the Canadian Pacific and Union Pacific Railways. As oil prices soar, railroads will play a much greater role in our transportation system in the future. Rail is one of the most efficient ways to move goods and people, and various fuel sources, including sustainably-grown wood, can be used to power the trains. Increasingly, goods will move through our area by rail to and from barges going up and down the Mississippi River and other major rivers.

4.6.3 Airports. The following eight commercial airports are located in the area: Albert Lea, Austin, Faribault, Mankato, Owatonna, Red Wing, Winona and Rochester (which is an international airport). Six municipal airports are located at Blue Earth, Dodge Center, LeSueur, Preston, Rushford and Waseca.

4.6.4 Public Transportation in and Between Cities. According to the Minnesota Atlas, the following cities in the area had fixed ride public transit systems in 2002: Faribault, Mankato, Red Wing and Rochester. Albert Lea, Northfield, Stewartville and Winona had Dial-A-Ride systems. Many counties had countywide public transit systems, including Dodge, Fillmore, Goodhue, Houston, Mower, Rice, Steele, Wabasha and Winona.

4.6.5 Vehicles. In 2003 there were 578,027 registered vehicles in the area, as follows: passenger cars (361,024), pick-up trucks (154,376), buses (1,720), other trucks (26,571), motorcycles (22,651), recreational vehicles (5,738), mopeds (1,372), van pool vans (6), state-owned tax exempt vehicles (513) and tax exempt vehicles (4,056).

Section 4.7 Agriculture

Agriculture production is the predominant use of land in the region (70 percent) and a major economic activity. In the latest agricultural census (2002), there were 16,748 farms in the 15 counties, utilizing 4,847,624 acres.[5]

4.7.1 Crop Production. In 2002, the region had 1,799,100 acres planted with corn, yielding 289,843,940 bushels; 1,362,400 acres in soybeans, yielding 72,600,900 bushels; 414,600 acres in hay, yielding 1,656,900 tons; 61,600 acres in oats, yielding 4,703,700 bushels; and 3,000 acres in wheat, yielding 133,600 bushels.[6]

Table 3: Crop Production 2002

Crop	Acres - 2002	Yield - 2002
Corn	1,799,100	289,843,940 bushels
Soybeans	1,362,400	72,600,900 bushels
Hay	414,600	1,656,900 tons
Oats	61,600	4,703,700 bushels
Wheat	3,000	133,600 bushels

4.7.2 Livestock Production. In 2002, there were 9,354 registered feedlots in the 15-county area (see Chart 3 in the Appendix). Livestock numbers for 2004 included 572,000 cattle, 131,000 milk cows in 1,494 dairies and 20,100 sheep and lambs.[7] In 2002, there were approximately 2,021,000 hogs and pigs, 3,359,000 turkeys and 2,874,000 chickens in the region.[8]

Table 4: Livestock Production 2004

Animals	NUMBERS 2002	Numbers 2004
Cattle	-	572,000
Milk Cows	-	131,000
Sheep & Lambs	-	20,100
Turkeys	3,359,000	-
Chickens	2,874,000	-
Hogs & Pigs	2,021,000	-

[5] USDA National Agricultural Statistics Service. 2002. "2002 Census of Agriculture". Retrieved from: http://151.121.3.33:8080/Census/Create_Census_US_CNTY.jsp#top in Fall 2004.
[6] USDA National Agricultural Statistics Service. 2004. "Minnesota Agricultural Statistics: Crop County Estimates." Retrieved from: www.nass.usda.gov/mn in Fall 2004.
[7] Minnesota Agricultural Statistics Service. 2004. "Minnesota Ag News." Retrieved from: www.nass.usda.gov/mn in Fall 2004.
[8] Feedlot and poultry statistics came from the Pollution Control Agency via personal conversation with Nancy Adams.

4.7.3 Processing of Crops and Livestock. The region has several grain, oil seed, dairy, fruit and vegetable, fat rendering and livestock processing facilities, which are listed by type and location below. Many of them are among the largest users of energy in the region and should be good candidates for using cogeneration, biomass, biogas, biofuels and other renewable energy technologies to replace the large amount nonrenewable fuels they are currently using. The processors who use the largest amounts of energy are listed in Table 20 along with the amounts and types of energy used. A list of the food processors by name, county and town as of January 2005 is in the Appendix, Chart 4.[9]

- **Oilseed Crushing Plants:** Two soybean-crushing plants are located in Mankato – ADM (4,200 T/Day) and Cenex Harvest States (3,600 T/Day). There is an oilseed crushing plant in Red Wing (usually sunflower or flax) with a capacity of 3,000 T/Day.

- **Soydiesel:** SoyMor is building a new biodiesel plant expected to produce 25 million gallons of soydiesel per year in Glenville in Freeborn County; it is expected to open in mid 2005. A second biodiesel plant is being considered for Eyota in Olmsted County.

- **Corn/Ethanol:** As of May 2005, approximately 202 million gallons of ethanol from corn are being produced in the region per year: Lake Crystal (50 million gallons), Winnebago (44 million gallons), Preston (40 million gallons), Albert Lea (38 million gallons) and Claremont (30 million gallons). A new ethanol plant is being proposed for Janesville that would produce 100 million gallons of ethanol per year and use 37 million bushels of corn every year.

- **Dairy Processing & Sales:** Faribault, Harmony, Houston, Le Sueur, New Prague, Owatonna, Pine Island, Preston, Rochester, Spring Valley, Wanamingo, Waseca and Zumbrota.

- **Fat Rendering Companies:** Blue Earth, Chatfield, Le Sueur and Mankato.

- **Fruit and Vegetable Processing & Sales:** Blue Earth, Caledonia, Dodge Center, Kenyon, Le Sueur, Mankato, Montgomery, Owatonna, Plainview, Rochester, Waseca and Wells.

[9] Figures taken from Texas A&M University "AgriNet" website: http://agrinet.tamu.edu/agbus/mnsic.htm.

- **Meat Processors & Sales:** Albert Lea, Alden, Austin, Brownsdale, Chatfield, Faribault, Good Thunder, Le Center, Lonsdale, Mankato, Montgomery, Northfield, St. Charles, Spring Valley, Wanamingo, Wells, Winona and Zumbro Falls.

- **Grain Processing & Sales:** Adams, Albert Lea, Alden, Austin, Blooming Prairie, Blue Earth, Brownsdale, Byron, Cannon Falls, Chatfield, Grand Meadow, Harmony, Hayfield, Janesville, Kiester, Lake City, LeSueur, Lewiston, Le Roy, Lonsdale, Lyle, Mankato, Mapleton, New Prague, New Richland, Northfield, Owatonna, Pine Island, Stewartville, Wabasha, Waldorf, Waseca, Wells, Windom and Winona.

4.7.4 Amounts of Local Corn and Soybeans Being Used in the Region and Processing Techniques.

*4.7.4.1 Soybeans Consumption in the Region and Prospects***.** In 2002, livestock consumed 28 percent of the soybeans produced in the region.[10] If the two soybean processing plants in Mankato ran at maximum capacity, the region would have to import 1,135,283 tons of soybeans (see Appendix, Chart 5). With the addition of the soydiesel plant at Glenville and talk of a new soydiesel plant at Eyota, it is clear that the area will be importing large quantities of soybeans for the soybean processing plants in the area.

*4.7.4.2 Soybean Processing***.** Soybeans are processed into oil and protein meal before being used. As a general rule, one 60-lb bushel of soybeans yields 11 lbs of soy oil and 47.5 lbs of soybean meal. The soybean meal is crushed and formulated into livestock feed.

4.7.4.3 Corn Consumption in the Region. In 2002, livestock consumed 34 percent of the corn produced in the region. Nineteen percent was used to produce ethanol and the remaining 47 percent was sold or used for other purposes.[11]

*4.7.4.4 Ethanol Production from Corn***.** Sixty percent of U.S. ethanol production uses a dry-grind technology, instead of a wet-milling process, because of lower capital costs. Basically, the process or recipe for making ethanol, as described by Matt Sederstrom, is as follows: Begin with # 2 yellow corn, grind a bushel (56 pounds), add water, make a mash, cook to kill the bacteria and expose the starch, add enzymes to convert the starches to sugars, add yeast to the sugars to begin fermentation and produce beer.

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[10] Douglas G. Tiffany and Jerry Fruin. 2001. *Filling the Livestock Feed Troughs of Minnesota*. Retrieved from: http://www.apec.umn.edu/faculty/jfruin/research.html fall 2004.
[11] Ibid.

Distill the beer into ethanol (2.75 gallons – requires heat to distill), carbon dioxide (18 pounds food grade) and distillers dried grains with solubles (18 pounds - generally requires drying). One hundred-fifty bushels of corn yield 413 gallons of ethanol per acre and 2,700 pounds of distillers dried grains with solubles (DDGS).[12] A complete description for making ethanol can be found at: http://www.cvec.com/making_ethanol.htm.

There is a huge debate about whether it takes more energy to produce ethanol than is in the ethanol that is produced. Net-energy balance figures vary because of how the studies to determine them are conducted (what they include) and when they were done. Recent technological advances in ethanol production have reduced the amount of energy needed to produce ethanol and changed the net-energy balance considerably. We refer the reader to the following website to read an objective analysis of this debate entitled "The Net Energy of Ethanol: An Introduction to the Studies," www.newrules.org/agri/netenergy.html.

4.7.5 Changing Prospects for Growing Corn and Soybeans and Minnesota Agriculture. We believe sustainability and diversity are two imperative principles. We are concerned that so much emphasis is currently being placed on corn and soybeans to produce biofuels and raw materials for industry to replace those currently being made from oil. We believe that ethanol from corn and biodiesel from soybeans are important transitional fuels to replace gas and diesel until future technologies, such as fuel cells and ethanol from cellulose, are commercially available. We also support local farmers owning and operating renewable energy facilities to keep energy dollars and control of energy production in our local communities.

However, we caution against putting too many of our eggs into the corn/soybean basket because the current production system for raising corn and soybeans is not sustainable. Dr. Gyles Randall, a well-respected soil scientist from the University of Minnesota, has stated that the current corn/soybean rotation is not sustainable – economically, socially, ecologically or environmentally. His reasoning is explained, in part, below. A press release explaining his reasoning can be found in the Appendix, Chart 6.[13]

4.7.5.1 Conventional agricultural production systems use a large amount of oil, petroleum products and natural gas to produce corn and soybeans. Oil and natural gas prices are skyrocketing and will continue to do so as global demand exceeds supplies in the

[12] Sederston, Matt. 2005. "Corn Processing in Corn Fields." Presentation at Grand Forks Renewable Energy Conference, February 2005, Grand Forks, ND.
[13] Randall, Gyles. 2001. "Commentary: Intensive Corn-Soybean Agriculture is Not Sustainable." Retrieved from: http://www.landstewardshipproject.org/pr/newsr_010927.html on June 12, 2005.

coming years. This will make it more and more expensive to grow agriculture commodities like corn and soybeans. In 2002 Minnesota farmers used approximately 123 million gallons of diesel fuel, 15 million gallons of gasoline, 74 million gallons of LP, 462 million kWh of electricity and 23 million CFA of natural gas to grow corn and soybeans (see Appendix, Chart 7).[14] Already dependent on government subsidies, our farmers can't cover their production costs when oil and natural gas prices rise. As pressures mount from the World Trade Organization (WTO) and others to curtail government subsidies to agriculture producers and the cost of production soars because of rising fuel prices, it is doubtful that the current high-energy input agricultural production systems can continue. This in turn casts doubt on whether we will have enough corn and soybeans in the future to be able to fulfill all the end uses being planned for them.

4.7.5.2 Rainfall patterns and aquifer recharge patterns in Minnesota are changing because of global warming. Annual row crop production depends on reliable rainfall and adequate water at critical times throughout the growing season. Because of global warming, weather patterns and rainfall patterns in Minnesota are changing. Many areas of the state are experiencing flood and drought cycles and more frequent and intense storms, which scientists predicted would result from global warming. Snow in the spring is melting and running off, instead of replenishing our aquifers. Rain events are not as gentle or evenly spread throughout the growing season as in the past, but rather sporadic and often torrential. These torrential downpours are running off the land rather than soaking in and recharging our aquifers and groundwater. As rainfall becomes sporadic, farmers growing annual row crops will need to increase irrigation. Because our aquifers aren't being recharged the way they used to be, it is questionable if there will be enough water in our aquifers to meet all the demands that will be placed upon them in the future, including growing crops, making biofuels and providing for the needs of people and industries in urban and rural areas.[15]

4.7.5.3 Our agricultural lands are being degraded or being lost to development. According to the American Farmland Trust, from 1992-1997, Minnesota lost over 27,000 acres of agricultural land and almost 47,000 acres of rural land **each year** to development, i.e., roads, parking lots, housing developments, etc. Of those 371,700 acres that were developed during this five-year period, 53,400 acres were irreplaceable prime

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[14] Derived from figures in: 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.

[15] ME3. 2002. *Playing with Fire*. Retrieved from: http://www.me3.org/issues/climate/withfire2002-03.html on June 12, 2005.
Kling, George, et. al. 2003. *Confronting Climate Change in the Great Lakes Region*. Retrieved from: http://www.ucsusa.org/greatlakes/glchallengereport.html on June 12, 2005.

agriculture land and 71,600 were prime rural land.[16] Due to all of the development that has taken place since 1997, we think it is safe to assume that we have been losing approximately the same amount or more of agricultural and rural land each year since 1997. In addition to losing our agricultural lands to development, the productivity of our soils is being compromised in several ways, as described below. If these trends continue unabated year after year, future generations may not have enough land or productive land to grow the crops they will need. In particular, future residents of the state will need green belts around all the major cities to grow food for people residing in the cities. Without cheap oil to grow food and transport it an average of 1,500 miles from where it is grown to where it is consumed, as is currently happening, our whole food production and distribution systems will change in the future. We will need every available acre of land in our region and Minnesota to grow energy crops, food crops and raw materials for industry to be used locally and replace food, energy and raw materials currently being shipped into the area.

Our agricultural lands are being degraded through erosion, burning of the humus in the soil from the application of harsh chemicals, lack of biodiversity and the buildup of diseases and pests from non-rotational plantings. In addition, Professor David Tillman from the University of Minnesota has warned that the corn/soybean rotation has broken down and in essence become a monoculture cropping system. As a result, diseases and pests from corn planting are remaining in the soil throughout the soybean planting cycle and remain present for the next planting of the corn crop and vice versa. This buildup of diseases and pests from both corn and soybeans in the soil is also leading to loss of productivity of Midwestern agricultural lands.[17]

4.7.5.4 Scientists have found that yields in the world's major crops, including corn and soybeans, are dropping because of higher temperatures and other factors due to global warming. Studies have found that increasing temperatures, particularly at night and during the grain filling period, negatively affected crop yields for rice, soybeans and corn.[18] The Intergovernmental Panel on Climate Change predicts that global warming may cause corn yields to crop by 15 to 30 percent across the U.S.[19] In addition, warming conditions attract different diseases and pests to move into new territories and stay for

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[16] American Farmland Trust. 2004. "Minnesota Statistics Sheet." Retrieved from: http://www.farmlandinfo.org/agricultural_statistics/index.cfm?function=statistics_view&stateID=MN on June 12, 2005.

[17] DeVore, Brian. 1998. "Biodiversity and Agriculture: A House Divided." *The Land Stewardship Letter*. Vol. 16, No. 5, November 1998. Retrieved from: http://www.landstewardshipproject.org/lsl/lspv16n5.html.

[18] Pore, Robert. 2004. "Global Warming Impacting Nebraska?" *The Independent*. July 3, 2004. Retrieved from: http://www.climateark.org/articles/reader.asp?linkid=33306 on June 12, 2005.

[19] Service, R.F. 2004. "As the West Goes Dry", *Science*. Vol. 303, pp. 1124-27. Retrieved from: http://climate.ntsg.umt.edu/html/science_western_water.pdf on June 12, 2005.

longer periods. Plants in those areas have no natural immunities to protect themselves against the invading pests and diseases. No one knows, for example, what will happen to soybean production in Minnesota because of the soybean rust that is currently impacting yields in the Southern U.S.

4.7.5.5 Prices and competition for Minnesota crops will increase in the coming years, which will make them more expensive and not as available for local use. Countries around the world with growing populations, particularly China and India, will compete to buy Midwestern corn and soybeans for food in the years ahead, when they can no longer grow enough to meet their local demands. Prices for corn and soybeans will more than likely increase. Selling larger quantities of corn and soybeans overseas to fill these growing markets and provide a favorable trade balance for our economy will mean fewer quantities left in Minnesota to convert to fuels and other products.

SECTION 5: DISCUSSION ABOUT ENERGY

In this section, we try to do several things: define energy, define renewable and nonrenewable energy, present some general information about energy and then look at renewable and nonrenewable energy technologies and assess them in terms of which energy technologies are the (1) cleanest, (2) most affordable if you weigh their true cost, i.e., if you take out government subsidies and add external costs, (3) safest and (4) most reliable.

SECTION 5.1 Definition of Energy. The capacity to do work.

SECTION 5.2 Best Energy Resource. Our cheapest, safest, cleanest and most available energy resource involves using less energy and increasing the productivity of the energy we use to do more work.

SECTION 5.3 Energy Can Be Renewable or Non Renewable.

5.3.1 Nonrenewable energy resources are finite and supplies will reach a point where they are exhausted or too expensive to extract. Nonrenewable energy resources are primarily hydrocarbons in fossil fuels (coal, oil and natural gas) and nuclear energy. They require drilling and/or mining to be extracted, and their sources are often located long distances from the power plants where they are used. Thus, they must be transported long distances via pipelines, ships, trains or other methods.

5.3.2 Renewable energy is obtained from sources that are virtually inexhaustible when managed properly, such as wind, solar, biogas, hydroelectric, geothermal and sustainably produced biomass and biofuels. Renewable energy can be provided from local resources located in the vicinity of end users.

SECTION 5.4 Energy resources come in and are used in many forms.

5.4.1 Liquid. Sources include gasoline, oil, kerosene and used vegetable oil.

5.4.2 Solid. Sources include coal, wood, construction wood waste, garbage and biomass.

5.4.3 Gas. Sources include propane (LPG), landfill gas and natural gas.

5.4.4 Electricity. Electricity is generated from burning coal, wood, biomass and waste materials, nuclear fission, hydropower, wind, biogas or solar sources.

5.4.5 Geothermal. The heat of the earth is used as a seasonal source/sink for energy.

5.4.6 Sunlight/Solar. The energy from the sun that hits the earth can be used in active systems, i.e., photovoltaic solar panels which convert sunlight into electricity and hot water heating units and passive systems, i.e., orienting a building to take advantage of the sun's heat.

5.4.7 Biomass. Plants capture and store solar energy, which can be utilized by converting biomass to electricity, syngas or liquid fuels, i.e., ethanol from cellulose or corn, biodiesel from various organic products and soy-diesel and other biofuels from oil crops.

5.4.8 Wind. Wind, caused by the uneven heating of the earth by sunlight, can be used by large wind turbines to generate power for utilities or smaller wind turbines to generate electricity for individual homesteads. Great strides have been made in wind technology so that electricity can now be generated from winds in areas formerly thought to be unsuitable for wind generation.

SECTION 5.5 Conversion and Transmission of Energy. Energy may be converted from one form to another and moved from one place to another. In the conversion and transmission process, substantial amounts of energy may be required and/or lost and pollution in various forms and wastes may be created. The efficiency of most power plants is only around 30 percent.

SECTION 5.6 Energy Is Being Used By Various Sectors and energy information is kept by sector, as well as fuel type.

5.6.1 Residential. Energy is used in home heating and cooling, refrigeration, water heating, lighting, cooking and other appliances.

5.6.2 Commercial. Energy is used by hospitals, schools, offices, businesses and the service sector.

5.6.3 Transportation. Energy is used by cars, trucks, buses, planes, trains and boats.

5.6.4 Industrial. Energy is used in manufacturing and agriculture.

5.6.5 Generation of electricity. Electricity is generated from nonrenewable and renewable resources, i.e., coal, nuclear, natural gas, wood and wood waste, hydroelectric, solar, wind and biogas.

SECTION 5.7 Energy Measurements. Energy can be measured in different ways, i.e., BTUs, joules, kilowatt-hours. Electric energy in the U.S. is usually expressed in kilowatt-hours (kWh), which is 1,000 watt-hours, or in megawatt-hours (MWh), which is one million watt-hours or one-thousand kilowatt-hours. To compare different forms of energy, i.e., the amount of energy in a gallon of gas to the amount of energy in a cord of wood, both are converted to BTUs (British Thermal Units). A BTU is the amount of heat produced when you strike a match. A typical home in Minnesota uses around 650 kWh a month. The average size of US power plants is 213 MW. A 1000 MW power plant is a large power plant. One MW can provide electricity to 400-900 houses.

SECTION 5.8 Clean, Renewable, Safe, Affordable and Reliable Energy. The three pillars the electricity industry uses to describe the electricity they generate using coal, oil, natural gas and nuclear power are safety, reliability and affordability. In their analysis, they don't consider or include many important factors, such as (1) large government subsidies supporting the fossil fuel and nuclear industry, (2) external costs society and individuals have to pay for health and environmental problems stemming from power plant pollution, including global warming, acid rain, cancer and respiratory problems resulting from particulate pollution, toxins and mercury and (3) the costs of our military to protect oil fields in the Middle East. In addition, they don't consider the vulnerability we face from disruptions of energy supplies being shipped around the world, antiquated and overtaxed grid systems, future shortages due to increasing demand for finite resources, price volatility and price gouging or terrorism. Recent events show how vulnerable we are – from the blackouts on August 14th, 2003, that shut off power to the Eastern seaboard to bombings of oil refineries and pipelines in Saudi Arabia to skyrocketing natural gas and oil prices.

We believe, when you weigh all the issues, using energy more wisely and obtaining our energy from a variety of clean, renewable energy resources located in our region is an energy system that is truly safe, reliable and affordable. After completing an inventory and assessment of the renewable energy resources in our region, we now know it is possible to create such a system for our region.

For the purposes of this discussion, we are defining these concepts as follows.

5.8.1 Clean. Energy is being produced in a way that does the least amount of harm to the environment in terms of releasing pollution, including carbon dioxide.

5.8.2 Renewable. Energy is being provided by sources that are virtually inexhaustible when managed properly.

5.8.3 Safe. Energy technologies, production sites and transmission systems are not targets that would create widespread chaos if they were attacked or broke down; they are not too complex, big or dangerous to manage; they do not harm or threaten the current or future health of people, ecosystems and the planet.

5.8.4 Reliable. We can depend on getting energy and supplies when we need them, taking into consideration where they are located, how they are delivered, who controls them, if they will be subject to price volatility resulting from increasing global demand on diminishing finite resources; we can depend on the availability of required ancillary inputs, such as water.

5.8.5 Affordable. The actual cost of the energy resource is practical after full cost accounting methods are applied, i.e., subsidies are taken out and external environmental, health and security costs are factored in.

SECTION 5.9 Renewable Energy Resources are Clean, Safe, Reliable and Affordable.[20]

5.9.1 Clean. Energy is being produced in a way that does the least amount of harm to the environment in terms of releasing damaging emissions, including carbon dioxide.

5.9.1.1 Nonrenewable energy resources

According to Power Scorecard, the generation of electric power from conventional power plants produces more pollution than any other single industry in the U.S. There are five major types of emissions from power plants, as shown below in column one. The second column shows the percentage of the emissions power plants contribute to total U.S. emissions for the category, and the third column indicates a few of the many health and environmental problems they cause. In addition to these emission impacts, power plants also use large quantities of water for cooling processes that can impact local water resource availability.

[20]Power Scorecard. "Electricity and the Environment." Retrieved from: www.powerscorecard.org/elec_env.cfm January 2005.

Table 5: Power Plant Pollutant Emissions

Pollutants	% Attributable to Power Plants	Environmental & Health Problems
Sulfur oxides – SOx	67%	Acid rain and respiratory problems
Nitrogen oxide – NOx	33%	Smog, acid rain, depletion of the ozone layer particulates
Particulates		Acid raid, cancer, respiratory diseases and heart disease
Carbon dioxide – CO2	33%	Global warming and climate change
Mercury	34%	Nervous system damage in babies

5.9.1.1.1 Coal-fired Plants are the dirtiest – generating 97 percent of the particle soot and sulfur dioxide emissions, 92 percent of NOx, 86 percent of carbon dioxide and almost 100 percent of mercury emissions coming from power plants.[21] According to the Union of Concerned Scientists, a 500 MW coal plant produces 3.5 billion kilowatt-hours per year, enough to power a city of about 140,000 people. It burns 1,430,000 tons of coal and uses 2.2 billion gallons of water and 146,000 tons of limestone. One 500 MW coal-fired plant gives off the following every year:

- 10,000 tons of sulfur dioxide
- 10,200 tons of nitrogen oxide
- 3.7 million tons of carbon dioxide
- 500 tons of small particulates
- 220 tons of hydrocarbons
- 720 tons of carbon monoxide
- 125,000 tons of ash
- 193,000 tons of sludge from the smokestack scrubber
- 225 pounds of arsenic
- 114 pounds of lead
- 4 pounds of cadmium and many other toxic heavy metals, including mercury and trace elements of uranium[22]

Table 6 shows how many tons/pounds of pollutants are being given off by the two coal-fired power plants in the SE/SC CERT region and totals for Minnesota.

[21] Clear the Air. 2002. *Minnesota's Dirty Power Plants*. Retrieved from: http://www.cleartheair.org/regional/factsheets/factsheetMNfinal.pdf on June 10, 2005.
[22] Union of Concerned Scientists. 2000. "How Coal Works." Retrieved from: www.uscusa.org/clean_energy/renewable_energy/page.cfm?pageID=60 on June 8, 2005.

Table 6: Pollution from Two Coal Plants in the SE/SC CERT Region & Minnesota[23]

2002	Rochester Silver Lake	Austin	All Minnesota
Tons SO2	882	2,001	100,945
Tons NOx	224	407	86,408
Tons CO2	111,668	186,060	40,885,395
Lbs Mercury	4	Null	1,628

5.9.1.1.2 Nuclear power plants produce wastes that are among the most toxic substances known, and there is no way to store or safeguard them for two hundred and fifty thousand of years. Nuclear plants can release small amounts of airborne radioactive gases. Mining uranium contaminates local land and water resources with radioactive materials and poses radioactive contamination hazards for mine workers and nearby populations. In the enrichment process, large amounts of electricity are used, most of which is provided by coal-fired power plants, which release the above pollutants into the environment. Nuclear plants that rely upon water for cooling systems require two and a half times the amount of water used by a fossil fuel plant. Therefore, nuclear plants have substantial impacts on ecosystems and health – from mining to production.

5.9.1.1.3 Natural gas is the cleanest of all the fossil fuels, however, it is not clean. On a per BTU basis, burning natural gas produces about half as much CO_2 as coal, less particulate matter and very little sulfur dioxide or toxic air emissions. Burning natural gas also produces nitrogen oxides and carbon monoxides in quantities comparable to burning coal. Natural gas drilling and exploration can negatively impact the land and pollute nearby waters.

5.9.1.1.4 Oil. When oil is burned to produce electricity, it pollutes the air, land and water with nitrogen oxides, sulfur dioxide, particulates, carbon dioxide, methane and heavy metals, such as mercury, and volatile organic compounds. Drilling and refining oil produces a long list of pollutants that poison the air, land and water and threaten the health of workers, residents near the sites and ecosystems. Oil spill accidents during transportation can result in grave environmental damage to wildlife and ecosystems.

[23] National Campaign Against Dirty Power, "Power Plant Air Pollution Calculator." Retrieved from: http://www.cta.policy.net/dirtypower/map.html on June 10, 2005.

5.9.1.2 Renewable energy resources

5.9.1.2.1 Biomass. When biomass is burned, the two main emissions are particulates and NOx, depending on the type of biomass and technology being used. Carbon dioxide is also released, but if plants are grown sustainably, they will absorb CO2 to offset the amount of CO2 released when they are burned. Thus, there may be no overall contribution of greenhouse gases. However, unsustainable production of biomass crops would lead to the degradation of the soils, water resources, forests and other biotic communities. An example of the impact of unsustainable practices is the contribution of agricultural chemicals from farmlands throughout the Midwest to the "dead zone" in the Gulf of Mexico, via the Mississippi River.

5.9.1.2.2 Open-looped geothermal systems could pollute the water in pond or well outlets. Closed loop systems are preferred.

5.9.1.2.3 Landfills produce methane and give off methane, which is a greenhouse gas. Thus, it is better to capture and utilize the methane rather than simply release it into the environment.

5.9.1.2.4 Manufacturing solar PV cells involves the generation of some hazardous materials, which can be handled and contained to protect the workers and environment.

5.9.1.2.5 Wind power's most controversial negative impacts are noise and the impact of early wind turbines on bird and bat populations. Some people object to having turbines sited near their property. The manufacture of wind generation technology also creates some air emissions.

5.9.2 Renewable. Energy is obtained from sources that are virtually inexhaustible when managed properly.

By definition, oil, natural gas, coal and uranium for nuclear power are finite, nonrenewable resources. The world may never run out of them, but they will become too expensive to extract. Minnesota has none of these resources, so we must import them from long distances and at great expense. As global demand exceeds supplies in the years ahead, they will become more expensive and difficult to obtain on a regular basis or when needed at predictable prices.

By definition, solar, wind, geothermal, sustainably produced biomass and biogas are all renewable resources. We have them in great abundance in our region and state. If managed properly, they will provide energy as long as life endures on this planet.

Energy systems can be developed to insure that our electricity needs can be met from a mix of these renewable energy resources, i.e., disperse wind generators at many sites to take advantage of where the wind might be blowing that day, mix wind with biomass plants or biogas facilities and so on.

5.9.3 Safe. Energy technologies, production sites and transmission systems are not targets that would create widespread chaos if they were attacked or broke down; they are not too complex, big or dangerous to manage; they do not harm or threaten the current or future health of people, ecosystems and the planet.

5.9.3.1 Nonrenewable Resources

5.9.3.1.1 Coal, oil and natural gas. As we have seen in the previous paragraphs, burning coal, oil, and natural gas pollute the environment, cause serious health problems for people and destabilize global ecological systems. Global warming is causing glaciers to melt, sea levels to rise, currents to become warmer, thousands of heat-related deaths, more frequent and violent storms, floods and drought cycles around the globe. In our opinion, these things alone make burning fossil fuels unsafe. There are also safety concerns regarding potential terrorist attacks along pipelines and at liquid natural gas terminals (discussed more in Section 5.9.4, Reliability).

5.9.3.1.2 Nuclear waste is the most toxic substance known and there is no way to store it safely. In addition, nuclear plants in the U.S. and around the world are aging. Both nuclear power plants and nuclear waste facilities are targets for terrorists. Insurance companies in the U.S. have consistently refused to insure nuclear facilities. A major failure at a nuclear power plant and the release of massive quantities of radioactive materials would be a catastrophic accident that could injure or kill thousands of people, cause enormous environmental damage and create severe consequences for hundreds of thousands of years. The nuclear accidents at Three Mile Island and Chernobyl and several other serious malfunctions in nuclear plants around the world illustrate that these systems are not fail-safe.

Big centralized power plants, elaborate transmission systems that carry power around the country and transportation systems that carry supplies to power plants and wastes away from power plants are very vulnerable to terrorist attacks or being shut down because of disruptions of various types including malfunctions, lack of fuel, water or other needed inputs.

5.9.3.2 Renewable Resources, such as local, decentralized wind, solar, sustainably produced biomass and biogas, don't cause global warming. They don't require large grid systems. They do not encourage terrorist attacks. They rely on a variety of local energy resources that can be managed such that they are dependable. They do not emit toxic chemicals or toxins that harm human health.

5.9.4 Reliable. We can depend on getting energy and supplies when we need them, taking into consideration where they are located, how they are delivered, who controls them, if they will be subject to price volatility resulting from increasing global demand on diminishing finite resources; we can depend on the availability of required ancillary inputs, such as water.

5.9.4.1 Nonrenewable Resources

5.9.4.1.1 Coal. The U.S. has 25 percent of known coal reserves and the largest share of the world's recoverable coal. The former Soviet Union has 23 percent; China has 12 percent; Australia, India, Germany and South Africa combined have 29 percent. Within the U.S., supplies are evenly divided between low-sulfur coal in the West, medium-sulfur coal in the West and Appalachia and high-sulfur coal in the Midwest and Appalachia. Most bituminous coal comes from the Appalachian Basin and the Midwest, while western coals are mostly sub-bituminous. This means it takes almost twice as much western coal to provide the same amount of energy as coal from the East. Transportation of coal within the U.S. is primarily by barge and rail, and transportation costs comprise a high percentage of the cost of coal. Railroads have been increasing their rates to ship coal, and there are often not enough cars to transport coal within the U.S. Terrorists could attack rail lines, bridges, coal facilities and large coal-fired plants in the future, which would make both supplies and prices unstable. A 500 MW coal plant uses 2.2 billion gallons of water per year for cooling and steam production. Much of that can be recycled; however, the western states have been experiencing drought the last several years, which has impacted water availability. Droughts may impact Minnesota and affect Minnesota power plants in the future. Droughts in Canada and the Pacific Northwest curtailed production from hydroelectric plants. Minnesota buys 20 percent of its electricity from outside the state, and much of that comes from Manitoba Hydro in Canada.

5.9.4.1.2 Natural Gas. Most of the natural gas used in the U.S. currently comes from domestic supplies and Canada and is transported through natural gas pipelines. These supplies are being depleted, and we will need to import increasing amounts of natural gas in the future from other sources. Seventy-five of the known reserves for natural gas are located in the Middle East, Eastern Europe and the former Soviet Union. Russia, Iran and Qatar have about 60 percent of the world's natural gas supplies. Many of the world's natural gas reserves are located in isolated pockets away from pipelines and developed infrastructure; a further complication in the supply chain is the need to liquefy natural gas to transport it long distance. Qatar is setting up the facilities and infrastructure to produce and ship liquefied natural gas (LNG) from one city – Ras Laffan. The world currently doesn't have enough ships built to transport large quantities of LNG, and Japan, Korea and Taiwan have made long-term lease arrangements for the few ships that are available.[24] In addition there are only four terminals in the U.S. that can accept LNG. According to the Department of Energy, "The major challenge regarding the future of LNG in the U.S. is not the availability of terminals (a need that is slowly being met), rather it is the reliability of supply."[25] The plant in Qatar, freighters carrying LNG and ports where LNG is unloaded in the U.S. are all viable terrorist targets and demonstrate that reliable supplies could be shut down at one of several points.

5.9.4.1.3 Oil**.** The U.S. imports more than 60 percent of our oil needs. In 2003, we imported approximately 11.1 million barrels of oil per day for a cost of over $200,000 per minute. In March 2005 US oil imports came from, in order of quantity, from Canada, Saudi Arabia, Venezuela, Mexico, Nigeria, Angola, Iraq, Russia, the United Kingdom, and Algeria.[26] In the future, as oil reserves are depleted around the world, more of the world's oil supplies will become concentrated in the Middle East. Already five Persian Gulf nations control two-thirds of the world's proven oil reserves, but as these nations gain an ever increasing share of the market and further concentrate oil resources, the chance of supply disruption also increases.[27] China has recently become the world's second largest importer of oil and has been making long-term contracts around the world to buy oil in the future. Many people think that global oil production has peaked and from now on supplies will decrease as demand for oil increases. There is a shortage of refining capacity for oil in the U.S., which has put a strain on U.S. supplies of petroleum products. Prices for crude oil have doubled since 2001, which will negatively impact the economy at some point. When oil prices quadrupled in the 1970s, the U.S. experienced double-digit unemployment and double-digit inflation.

Since January 2000, there have been 105 reported grid failures in the U.S.; 11 of those impacted more than half a million people, which indicates that electricity being sent through large complex grid systems is not all that reliable. We believe a more reliable system is based on smaller, decentralized distributed generation projects using local

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[24] Duffin, Murray. 2004. "The Energy Challenge 2004 -- Natural Gas." Retrieved from: http://www.energypulse.net/centers/article/article_display.cfm?a_id=828 on June 10, 2005.

[25] US Department of Energy: Energy Information Administration. 2004. "International Energy Outlook 2004." Retrieved from: www.eia.doe.gov/oiaf/ieo/special_topics.html on June 10, 2005.

[26] American Petroleum Institute. 2005. "Estimated Crude and Products Imports to the US from Leading Supplier Countries." Retrieved from http://api-ec.api.org/filelibrary/USImports.pdf on June 14, 2005.

[27] __. 2005. "The Real Trouble with Oil." *Economist*. Vol. 375, No. 8424. April 30, 2005 – May 6, 2005.

renewable energy resources and located as near as possible to the people who are using it.[28]

5.9.4.2 Renewable Resources

5.9.4.2.1 Wind. Some people are concerned that the winds don't blow all the time and there isn't a good way to store the energy. In our area where the winds are good, wind is available at different speeds over 95 percent of the time. The annual rate of wind occurrence is now well understood at all areas of Southeast Minnesota. One day ahead wind occurrence can now be predicted for generation scheduling within 20 percent of actual generation, a similar accuracy used to predict current loads.[29] Along the wind turbine supply chain, steel can be a concern, as can transmission.

5.9.4.2.2 Solar. The primary reliability concern with solar is that the sun doesn't shine all the time.

5.9.4.2.3 Biomass. If we don't have enough rain or water for irrigation, we won't be able to grow biomass.

5.9.5 Affordable. The actual cost of the energy resource is practical after full cost accounting methods are applied, i.e., subsidies are taken out and external environmental, health and security costs are factored in.

*5.9.5.1 External Costs***.** Some costs attributed to energy production are not paid for by utilities that produce or sell energy or their customers; thus, their per kilowatt hour cost does not reflect the "true" cost of doing business. Some examples of "external" costs of production not being paid by the utilities include human health problems caused by air pollution from burning coal and oil; damage to the land from coal mining and to the miners from black lung disease; environmental degradation and property damage caused by global warming, acid rain and water pollution; and national security costs, such as protecting foreign sources of oil in the Middle East.

The chart below estimates the per kilowatt-hour external costs of select health and environmental impacts that utility companies do not pay. It does not include estimates from insurance companies for property damage caused by more frequent and intense storms attributable to global warming, which some believe were $55 billion in 2002, $60 billion in 2003 and over $100 billion in 2004. Nor does it include costs of approximately

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[28] Casten, Thomas R. and Brennan Downes, 2004. "Optimizing Power." Retrieved from: http://www.earthscan.co.uk/news/article/mps/uan/247/v/4/sp/ on June 10, 2005.

[29] Windlogics. http://www.windlogics.com/forecasting.html.

$60 billion a year to keep troops in the Middle East during peace time to protect our access to oil, the net $7 billion dollars spent for the 1991 Gulf War or the billions currently being spent on the war in Iraq – so far around $30 billion for deployment and $5 billion a month.[30]

The external costs for solar photovoltaics and wind are quite small because their impact on the environment and health are negligible. The external costs for coal are the highest. External costs for nuclear, coal and natural gas would have been much higher if they had included government subsidies. We were not able to find a per kilowatt-hour charge that included this.

Table 7: Costs of Electricity With and Without External Costs[31]

Electricity Source	**Generating Costs**	**External Costs**	**Total Costs**
	(U.S. cents per kilowatt-hour)		
Coal/Lignite	4.3 - 4.8	2.3 - 16.9	6.6 - 21.7
Natural Gas (new)	3.4 - 5.0	1.1 - 4.5	4.5 - 9.5
Nuclear	10.0 - 14.0	0.2 - 0.8	10.2 - 14.8
Biomass	7.0 - 9.0	0.2 - 3.4	7.2 - 12.4
Hydropower	2.4 - 7.7	0 - 1.1	2.4 - 8.8
Photovoltaics	24 - 48	0.7	24.7 - 48.7
Wind	3 - 5	0.1 - 0.3	3.1 - 5.3

Notes: Generating costs are for the U.S. and/or Europe. External costs are environmental and health costs for 15 counties in Europe and are converted to U.S. cents from eurocents at the 2003 average exchange rates of U.S. $ = 0.8854 Euros.

Casten and Downes identified an additional external cost for electricity generation. They estimated power outage costs of 105 reported grid failures in the U.S. since January 2000 to be $80 billion to $123 billion a year, which adds 29 to 45 percent to the cost of U.S. power.[32]

5.9.5.2 Government Subsidies, Research and Development, Tax Breaks, Liability Insurance. It is difficult to assess the true costs of different energy technologies because the oil, gas,

[30] Lovins, Amory. 2003. *U.S. Security Energy Facts*. (p2). Retrieved from: http://www.rmi.org/images/other/EnergySecurity/S03-04_USESFtext.pdf.

[31] Sawin, Janet L. May 2004. "Mainstreaming Renewable Energy in the 21st Century." Worldwatch Institute. p 13. Retrieved from: http://www.earthscan.co.uk/news/article.asp?UAN=25&v=1&sp=332124698508342383258.
[32] Casten, Thomas R. and Brennan Downes, 2004. "Optimizing Power." Retrieved from: http://www.earthscan.co.uk/news/article/mps/uan/247/v/4/sp/ on June 10, 2005.

coal and nuclear industries are so heavily subsidized by government policies. These subsidies distort the global economy, artificially lower energy prices and hold back the development of renewables.

Many different sources cite different levels of subsidies and government spending on energy resources, but the common theme depicted in each of these studies is that energy efficiency and renewable energy technologies are not receiving the same level of support as their more conventional fossil fuel and nuclear counterparts. The following depict a few examples.

R & D. According to the Green Scissors Campaign, the federal government spent $111.5 billion on energy research and development between 1948 and 1998. Sixty percent of this -- or $66 billion -- was spent on civilian nuclear energy research and 23 percent was directed to fossil fuel energy research.[33]

Subsidies Globally. In a report called "The Price of Power", the New Economics Foundation estimated that annual global fossil fuel subsidies (coal, oil and gas) were $235 billion a year.[34]

U.S. Tax Breaks. In "Energy Subsidies: How Do Energy Subsidies Distort the Energy Market?" the authors found that from 1999-2003 the oil and gas industries received tax breaks of $11 billion.

In a 1993 study called "Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts," author Douglas N. Koplow reported that in 1989 subsidies to the energy sector were $36 billion -$21 billion to fossil fuels, $11 billion to nuclear, $1 billion to renewables, $1 billion to energy efficiency and $600 million to hydro. He said the pattern of federal subsidies in 1989 promoted poor energy policy for several reasons:

> "First, it represented a radical tilt toward energy supply and away from energy efficiency. End-use efficiency received only $1 worth of subsidies for every $35 received by energy supply.
>
> Second, this pattern favors mature, conventional energy resources – fossil fuels, fission-nuclear, and hydroelectric – by more than eight to one ($32.3 billion to $3.8 billion) over emerging energy resources such as solar or

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[33] Green Peace. 2001. "Bush-Cheney National Energy Policy Delivers Another Blow To Earth." Retrieved from: http://www.greenpeace.org/usa/news/bush-cheney-national-energy-po on June 12, 2005.
[34] New Economics Foundation. 2004. "The Price of Power." Retrieved from: www.neweconomics.org/gen/news_pop.aspxwww.neweconomics.org/gen/news_pop.aspx.

> wind technologies. It may be appropriate to subsidize emerging energy resources, but mature resources should stand the test of the market. When this test is applied to subsidies in 1989, the pattern appears to be almost completely backward. In other words, the mature, conventional energy sources received almost 90 percent of the subsidies.
>
> This pattern of subsidies also represents poor environmental policy because it encourages the use of polluting and environmentally-risky energy sources. Fifty-eight percent of all subsidies ($21.1 billion) directly promote the use of fossil fuels – over 18 times more than subsidizes efficiency and 23 times more than subsidizes emerging renewable technologies. Given the growing concern in this country about global warming, acid rain, and other fossil-fuel related pollution problems, this imbalance is unwarranted…"[35]

In addition to these subsidies and targeted funding programs, the tax code also institutionalizes fuel preferences. One of the major cost differences between fossil fuel generation and fuel free wind and solar generation is the tax deduction for fuel consumed in generation. Natural gas now gets about 1.8cents/kwh tax deduction based on a typical Investor Owned Utility cost. This is a loss to Federal and state revenue that is permanent in the tax code.

All of this is not to indicate that renewable energy technologies do not get subsidies. They do. Renewable energy technologies are, however, not as mature as their fossil fuel and nuclear counterparts.

Liability Insurance. The Price-Anderson Act offers another massive subsidy for the nuclear industry by limiting the liability of the nuclear industry in case of a nuclear accident in the U.S. Not having to pay for liability insurance to cover the full costs of accidents saves the nuclear industry billions of dollars and distorts the "real" cost of nuclear power.

5.9.5.3 Difference in Cost between Distributed Generation and Central Generation – Dollar Costs and Environmental Costs. In "Optimizing Power," Casten and Downes evaluated the costs of generating projected U.S. load growth to 2020 with decentralized generation and centralized generation. They found that full reliance on decentralized generation would be 39 percent less expensive than centralized generation (avoiding $326 billion in

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[35] American Wind Energy Association. 2000. "Energy Subsidies: How do Energy Subsidies Distort the Energy Market." Includes excerpts from the 1993 Alliance to Save Energy Report. Retrieved from: http://www.awea.org/faq/subsidi.html on June 10, 2005.

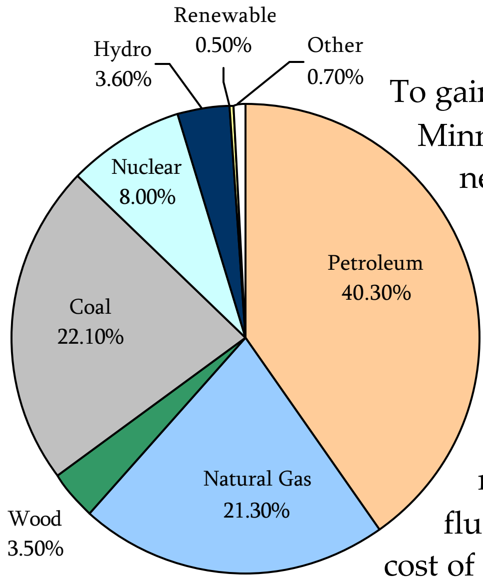
capital by 2020), reduce incremental power costs by 36 percent ($53 billion) and reduce emissions as follows: NOx by 58 percent, SO2 by 94 percent, CO2 by 49 percent and particulates by 43 percent. Power generated near the user avoids the costs of transmission and distribution systems and reduces line losses.[36]

5.9.6 Difference in Costs Based on Efficiency of Technologies. The efficiency today in most power plants is approximately 33 percent. Thus, two-thirds of the input energy is being wasted. This is not cost-effective or efficient. Combined heat and power (CHP) achieve 65 to 95 percent net electrical efficiency by recycling normally wasted heat and by avoiding transmission and distribution losses. These systems that recover as much energy as possible from a given resource are far more affordable, and we believe that new generation in our area should strive to incorporate combined heat and power so as to reach these high efficiency levels.

[36] Casten, Thomas R. and Brennan Downes, 2004. "Optimizing Power." Retrieved from: http://www.earthscan.co.uk/news/article/mps/uan/247/v/4/sp/ on June 10, 2005.

SECTION 6 ENERGY USE IN MINNESOTA

Graph 1: Minnesota Energy Sources



To gain a clear picture of how energy is being used in SE/SC Minnesota in different forms and by different sectors, it is necessary to look at state energy data. Electric consumption data was the only energy consumption data we could find that separated information by county. Thus, we are including information about statewide energy use by fuel type, cost, sector, and amount consumed in our report. Most of the data is for year 2000, but it still provides a reasonable baseline for energy usage. For reference purposes, in 2000 the cost of a barrel of oil fluctuated between $21 and $35 a barrel. In April 2005, the cost of a barrel of oil is around $56 – more than double the $21 price. When reviewing the fuel costs through the rest of this section, please keep this cost increase in mind.

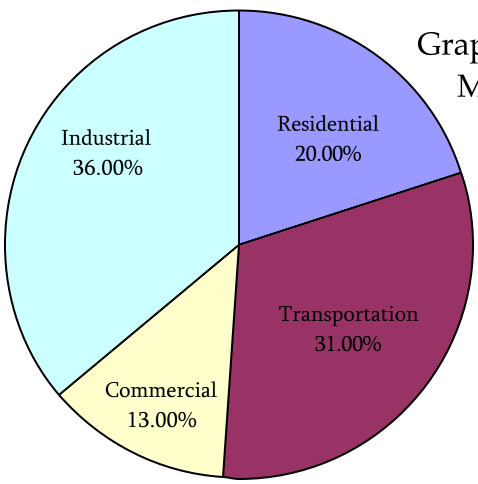
SECTION 6.1 MN Energy Use in 2000 by Type, Amount, Cost and Percent of Energy Consumed. In 2000, Minnesotans used 1,688 trillion BTUs of energy for a cost of $12,223.5 million. This energy was derived from fuels as shown in Graph 1: Minnesota Energy Sources. More than 92 percent of the state's fuel came from nonrenewable energy resources located outside the state. $6,722 million left the state to buy petroleum products; $1,954 million left the state to buy natural gas; $434 million left the state to buy coal; $43 million was used to buy wood and wood waste products; and almost $3,477 million left the state to buy 20 percent of the electricity used in the state. That works out to $2,485 per person in Minnesota that left the state to purchase energy in 2000, and this is before the rise in oil prices mentioned above. In 2000, the cost of a barrel of oil fluctuated between $21 and $35 a barrel.

Table 8: Minnesota Energy Use in 2000 by Fuel Type[37]

Fuel Type	Consumed	Amount	Trillion BTU	%	Cost Million $
Petroleum	125,560,000	Barrels	680.30	40.3	6,722.00
Natural Gas	354.4	Billion Cu Ft	359.70	21.3	1,954.00
Coal	20,700,000	Short Tons	373.80	22.1	434.00
Nuclear Fuel	13.00	Billion KWH	135.20	8.0	60.00
Wood & Waste	60.4	Trillion BTU	60.40	3.5	43.00
Total Primary			*1,609.40*		*9,213.00*
Other Renew	7.9	Trillion BTU	7.90	.5	
Hydroelectric	63.6	Trillion BTU	63.60	3.6	
Electricity					3,477.00
Less Fuel					-499.00
TOTAL		Trillion BTU	1,688.00		12,223.5

SECTION 6.2 MN Energy Use in 2000 by Sector

Graph 2: Minnesota Energy Use by Sector



Graph 2 shows how much energy was used by each sector in Minnesota in 2000, the percentage of state energy consumption, and the cost. Types of fuel, costs, and percentages of use by sector in Minnesota in 2000 are described in subsequent sections as follows: Residential, Section 7.4; Transportation, Section 7.5, Commercial, Section 7.6; Industrial, Section 7.7.

Table 9: MN Energy Use by Sector (2000)[38]

Sector	Cost Million $	Energy Used Trillion BTU	Per Cent Energy Used
Residential	2,683.70	345.70	20
Commercial	1,447.40	221.20	13
Industrial	2,543.20	603.80	36
Transportation	5,549.20	517.30	31
TOTAL	12,223.50	1,688.00	100

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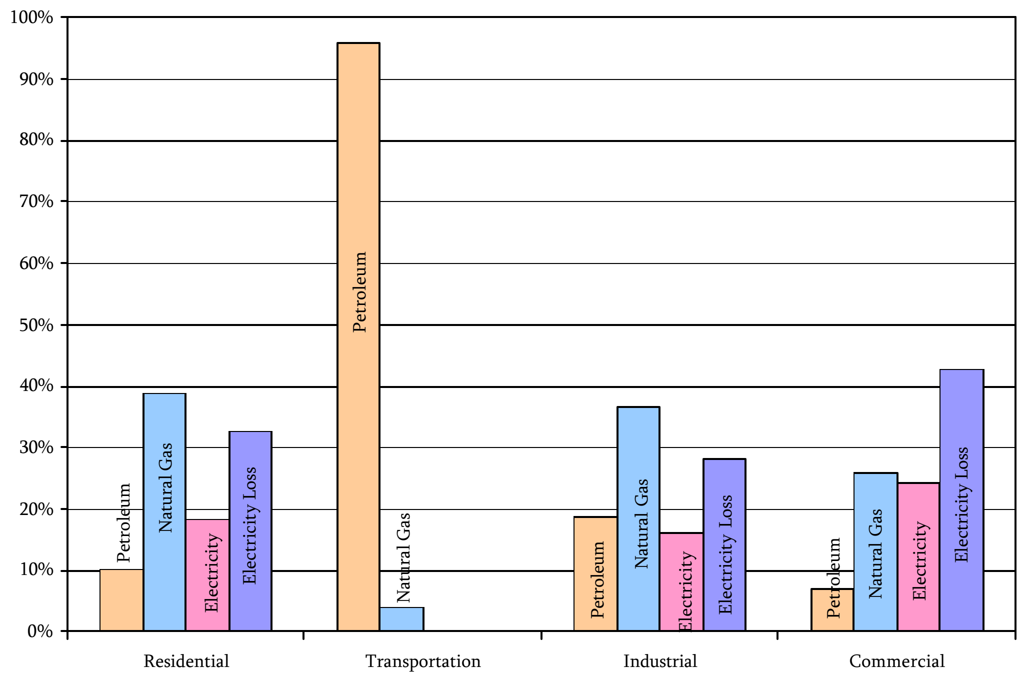
[37] US DOE: Energy Information Administration: www.eia.doe.gov/emeu/states/. Note: Totals don't add up due to rounding; costs for fuels used to generate electricity were subtracted (-499) so they wouldn't be counted twice.
[38] US Department of Energy: Energy Information Administration: www.eia.doe.gov/emeu/states/.

SECTION 6.3 MN Energy Use in 2000 for Petroleum, Natural Gas and Electricity. It's important to focus on three aspects of our state energy picture: petroleum, natural gas and electricity (Graph 3).

Graph 3: Comparative Use of Energy by Sector



6.3.1 Petroleum. Forty percent of the energy consumed in Minnesota in 2000 was derived from imported crude oil and petroleum products for a cost of $6.7 billion. Minnesota petroleum use contributed to end sector energy consumption broke out as follows: 96 percent of the energy used for transportation; 22 percent for industrial; 10 percent for residential; and 4.6 percent for commercial. Almost 14.5 million gallons of petroleum products (344,000 barrels) were used in Minnesota EACH DAY in the year 2000, as follows, totaling over five billion gallons per year.

Table 10: Petroleum Products Used in Minnesota[39]

	BARRELS/ Day	GALLONS/ Day	BARRELS/ Year	GALLONS/ Year
MOTOR GASOLINE	167,000	7,014,000	60,955,000	2,560,110,000
DISTILLAGE FUEL	69,000	2,898,000	25,185,000	1,057,770,000
JET FUEL	36,000	1,512,000	13,140,000	551,880,000
RESIDUAL FUEL	3,000	126,000	1,095,000	45,990,000
LPG	27,000	1,134,000	9,855,000	413,910,000
ALL OTHER	42,000	1,764,000	15,330,000	643,860,000
TOTAL	**344,000**	**14,448,000**	**125,560,000**	**5,273,520,000**

[39] US Department of Energy: Energy Information Administration: www.eia.doe.gov/emeu/states/.

6.3.2 Natural Gas. Natural gas accounted for 21.3 percent of the energy used in Minnesota in 2000. In the same year it contributed to end sector energy use in Minnesota as follows: commercial (43 percent;), residential (38 percent), industrial (17 percent) and transportation (4 percent).

6.3.3 Electricity. In 2000, Minnesota used approximately 60 million MWh of electricity. Eighty percent of the electricity used in the state was being generated within the state, while 20 percent had to be purchased from outside the state for a cost of almost $3.5 billion. In 2001, Minnesota's electrical mix was being generated from the following sources: 66 percent coal, 24 percent nuclear, 3 percent renewables, 2 percent hydroelectric, 2 percent natural gas, 3 percent other. Over 92 percent of the electricity was being produced with nonrenewable resources from outside the state. The other 8 percent was being generated with renewable energy resources, including hydroelectric energy generated at Manitoba Hydro in Canada and various renewable energy projects around the state.

6.3.3.1 Projected Growth Rates in Electrical Consumption. In the CAPX 2020 Report, the following electricity generating companies operating in Minnesota predicted the following annual growth rates in electricity consumption: Alliant Energy (1.6 percent), Xcel Energy (2.68 percent), MN Power (1.7 percent), SMMPA/RPU (2.7 percent), Great River Energy (3.05 percent), Otter Tail Power (2.7 percent) and Dairyland Power Coop (2.6 percent), for an average annual increase of 2.49 percent.[40]

6.3.3.2 Minnesota Electricity Rates in 2000 by sector were as follows. Electricity prices are different for different sectors because of volume of purchases, length of contracts, time of usage and other service options.

Table 11: Minnesota Electricity Rates in 2000 by Sector[41]

	Average Cents/kWh	Lowest Cents/kWh	Highest Cents/kWh	U.S. Average Cents/kWh
Residential	7.5	4.4	14.3	8.2
Commercial	6.4	3.7	8.7	7.4
Industrial	4.6	2.7	7.8	4.6

40 (CapX 2020) Capital Expenditures by the Year 2020. A Vision for Transmission Infrastructure Investments for Minnesota. p.12. Retrieved from: http://www.capx2020.com/Images/CapX2005_13.pdf on May 27, 2005.

41 US Department of Energy: Energy Information Administration. 2001. "Prices and Expenditures." Retrieved from: http://www.eia.doe.gov/emeu/states/main_mn.html on June 12, 2005.

6.3.3.3 Percentage of Minnesota's Electricity Coming from Renewable Resources in 2003 and the Potential for Renewable Energy to Provide for 17 Times Our Needs for Electricity in the Future. According to Mike Bull from the Minnesota Department of Commerce Renewable Energy Division, renewables provided 11 percent of Minnesota's electricity in 2003. This renewable energy came from: hydro (74.1 percent - mostly from Manitoba Hydro in Canada), wind (11.4 percent), biomass (3.2 percent), RDF (garbage) (11 percent) and other (0.3 percent).[42]

The Union of Concerned Scientists estimates that Minnesota has the capability of producing more than 17 times the electricity used in 2001 from renewable energy resources, as follows:

Table 12: Minnesota's Renewable Energy Potential[43]

Resource	(billion kWh)	% of 2001 Electricity Sales
Wind	991.3	1,644%
Solar PV	55.3	92%
Bioenergy	30.3	50%
Landfill Gas	0.3	1%
TOTAL	**1,077.2**	**1,787%**

6.3.3.4 Minnesota's Renewable Electricity Programs. Several state programs are fostering the development of renewable energy projects to produce an increasing amount of the state's electricity. These include a 10 percent Renewable Energy Objective by 2015, green pricing programs, net metering, solar and wind incentives and Xcel's renewable energy mandate. All of these programs are described briefly below.

6.3.3.4.1 Minnesota 10 Percent Renewable Energy Objective by 2015. Minnesota Statute requires that each electric utility make a good faith effort to generate or procure sufficient renewable energy such that one percent of the utility's total retail electric sales is generated by eligible renewable energy technologies. This percentage then increases one percent per year until 2015 when utilities are required to make a good faith effort to have a 10 percent renewable energy mix. [44]

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[42] Bull, Mike. 2005. "Minnesota: America's Renewable Energy Capitol." February 2005, Renewable Energy in the Upper Midwest, Grand Forks ND, p.5.
[43] Union of Concerned Scientists. 2003. "Renewing Minnesota." Retrieved from www.ucsusa.org in September 2004.
[44] Minnesota Statutes 2004. Chapter 216B. Retrieved from http://www.revisor.leg.state.mn.us/stats/216B/1691.html on May 27, 2005.

Eligible technologies include solar, wind, hydroelectric with a capacity of less than 60 MW, hydrogen (provided that after January 1, 2010, the hydrogen is generated from solar, wind or small hydro) or biomass.[45]

6.3.3.4.2 Green Pricing Programs. All power companies are now providing an optional service called green pricing, which allows customers to pay a small premium to purchase electricity generated from clean, renewable ("green") energy sources. The premium covers the increased costs incurred by the power provider when adding renewable energy to its power generation mix. We encourage readers to contact their local utility for more specific information about each utility's green pricing program.

6.3.3.4.3 Xcel Mandate. Xcel Energy, as an electric utility owning a nuclear generation facility in Minnesota, is required to generate or purchase electricity from renewable resources to account for one percent of its total retail sales by 2005. This required percentage of renewables will then increase by one percent per year until 2015, when it is required to have 10 percent of total retail sales. Beyond this standard for percent of retail sales, Xcel Energy, as a nuclear power generation utility, is also required to deploy an additional 1,125 MW of wind. The last 300 MW of this mandate must be installed by 2010 and require that 100 MW of this mandate be fulfilled via wind projects with nameplate capacities of 2 MW or less. Xcel Energy is also mandated to deploy 125 MW of installed biomass capacity.[46]

In addition, Xcel Energy created the Renewable Development Fund (RDF) in May 1999 as an outcome of 1994 Minnesota legislation concerning spent fuel storage at the Prairie Island nuclear power plant.[47] In May 2003, Minnesota extended nuclear waste storage at Xcel Energy's Prairie Island plant, and increased the amount Xcel must pay toward the development of renewable-energy sources. As a result, Xcel now must pay $16 million into the RDF annually, for as long as the Prairie Island plant is in operation. (Prior to this legislation, Xcel was required to contribute $8.5 million each year). The 2003 legislation mandates that up to $6 million annually must be allocated to fund renewable-energy production incentives. Of this annual amount, $4,500,000 will fund production incentives for wind energy, and approximately $1,500,000 will fund production incentives for eligible on-farm biogas recovery facilities.[48]

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[45] Ibid.
[46] Ibid.
[47] This information was taken from the Database of State Incentives for Renewable Energy (DSIRE). For more information, please visit: http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=MN09R&state=MN&CurrentPageID=1. Retrieved June 13, 2005.
[48] Ibid.

In 2001 the Xcel Energy RDF program selected a total of 19 research projects, during two phases, to receive nearly $16 million in funding.[49] In August 2004, 25 proposed renewable-energy projects featuring hydroelectric, biomass, wind, solar and biofuel technologies were selected by the Renewable Development Board to receive more than $22 million in funding; all selected projects are subject to final approval by the Minnesota Public Utilities Commission.[50]

During the 2003 Minnesota Legislative Session the University of Minnesota Initiative for Renewable Energy and the Environment (IREE) was awarded $10 million dollars from Xcel Energy's Renewable Development Fund. They were also awarded 5% of Xcel's CIP obligation annually for the next five years (estimated at $1.7 - $2.0 million dollars each year). [51]

6.3.3.4.4 Small Wind Production Incentive: 1.5 cents/kWh for 200 MW wind**.** In 1996, the State of Minnesota passed an incentive that paid the owners of small wind generators (under 2 MW) 1.5 cents per kWh sold to a utility. This incentive had a 100 MW cap on it. This cap was reached in 2002. In 2003, the legislature funded another 100 MW from Xcel Energy's Renewable Development Fund (RDF). This additional 100 MW was fully subscribed by November 2003.

The legislation stated that the generators had to be on-line within 18 months of listing with the state "queue" of projects eligible to receive the state incentive. Most of the projects in the second 100 MW didn't get built during the allotted time. In May 2005, the state legislature amended the rules of the Small Wind Production Incentive so that projects that missed their deadline, as well as projects that joined the queue after the second 200 MW was subscribed, could receive 1-cent/kWh. This is only true for projects that entered the queue before the end of 2004. Future expansion of this program appears unlikely as of May 2005.

6.3.3.4.5 Renewable Incentives – Rebates, Tax Credits, Sales Tax Waivers, etc**.** There are numerous incentives available for renewable energy and energy efficiency projects. For the most current information on these incentives, we recommend that readers visit the

[49] Ibid.
[50] Ibid.
[51] For more information, visit: http://www.moea.state.mn.us/p2/forum/040129hemmingson.pdf. Retrieved June 13, 2005.

Database of State Incentives for Renewable Energy (www.dsireusa.org). A summary of a few of the incentives as of May 2005 include:[52]

- Federal Production Tax Incentive $0.015/kWh tax incentive adjusted for inflation (currently $0.018/kWh)
- Accelerated depreciation
- LCMR Community wind rebates (2 active @ $150,000; 2 anticipated @ $200,000)
- Net metering (retail & average retail rates) for sub 40 kW systems
- Low-interest loan programs available to farmers developing renewable energy projects through the MN Department of Agriculture's Rural Finance Authority
- State sales tax exemption (Wind & Photovoltaics)
- State property tax exemption
- State production tax exemption for projects sited in Job Opportunity Building Zones (JOBZ)
- USDA 9006 funding (competitive) - $23 million FY04; MN has been successful at receiving significant portion in both years offered
- USDA Value Added Grant Program - $13.2 million FY04

6.3.3.4.6 Programs to Encourage Conservation or Using Energy More Efficiently and Productively are located in Section 8.2. These include utility Conservation Improvement Programs (CIP), Energy Service Companies (ESCOs) and Green Mortgages. Minnesota's Sustainable Building Guidelines, also referred to as Buildings, Benchmarks and Beyond (B3) encourage greater efficiency by requiring publicly funded buildings to exceed the existing energy efficiency guidelines by 30 percent.[53]

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[52] Minnesota Department of Commerce. 2004. "Minnesota's Leadership in Renewable Energy." Retrieved from: http://www.state.mn.us/mn/externalDocs/Commerce/Renewable_Energy_Objective_Report_020305041245_REOComplete-NoH1-13.pdf on May 27, 2005.
[53] Center for Sustainable Building Research. 2004. "The State of Minnesota Sustainable Building Guidelines." Retrieved from: http://www.csbr.umn.edu/b3/summary.html on May 2, 2005.

SECTION 7 ENERGY USE IN SE/SC CERT AREA

Other than records for electricity consumption, the Minnesota Department of Commerce and federal Department of Energy don't keep statistics on energy use by sector (residential, commercial, industrial, and transportation) by county. This has made it difficult to obtain accurate figures or even estimate total energy use in the region. For reference purposes, the SE/SC CERT 15-county region comprises approximately 12 percent of the population of the state, as well as approximately 12 percent of the households in the state, and 9.1 percent of the landmass of the state. This section includes information on energy users, power providers, electricity production and use in the region, Minnesota fuel usage by sector in 2000 and estimates, where possible, on how much energy is being used in the region by sector and fuel type.

Section 7.1 Largest Energy Users

A chart listing the major fuel users in the region and the amounts of various fuels they used in 2001 is located in the Appendix, Chart 8. The largest users of natural gas, fuel oil, coal and coke are listed below, along with the largest consumers of all forms of energy overall.

Natural Gas

The largest users of natural gas (over 100,000 million BTUs) were ADM and CHS Oilseed Processing (Mankato), Al-Corn Clean Fuel (Claremont), McNeilus Truck & Mfg (Dodge Center), Corn Plus (Winnebago), Pro-Corn LLC (Preston), Agra Resources Coop dba EXOL (Albert Lea), Land O'Lakes (Pine Island), ADM (Red Wing), Dairy Farmers of America, Inc (Zumbrota), Unimin Minnesota Corp. (Kasota), Le Sueur, Inc (Le Sueur), Unimim Minnesota Corp. (Le Sueur), Austin Utilities NE Power Station and Hormel Foods Corp (Austin), Associated Milk Producers, Crenlo Inc Plant 2, IBM, Mayo Medical Center Quest International, Rochester Public Utilities Silver Lake Plant, Seneca Food Corp (Rochester), Carleton College and Malt-O-Meal Plant 2 (Northfield), Crown Cork & Seal and Owatonna Public Utilities (Owatonna), Federal Mogul Corp Powertrain Systems and Lakeside Foods (Plainview), Brown Printing Company (Waseca) and Froedtert Malt (Winona).

Fuel Oil

The largest users of fuel oil (over 100,000 million BTUs) were CHS Oilseed Processing (Mankato), ADM (Red Wing), Hormel Foods (Austin), Associated Milk Producers, Mayo Medical Center (Rochester) and Minnesota Correctional Facilities (Faribault).

Coal and Coke

The largest users of coal and coke (over 100,000 million BTUs) were ADM (Mankato) USG Interiors (Red Wing), Austin Utilities NE Power Station (Austin) and Rochester Public Utilities Silver Lake Plant (Rochester).

Overall Fuel Users

Overall, the entities that used the most natural gas, coal, coke and fuel oil in our area (over 500,000 million BTUs) were ADM and CHS Oilseed Processing (Mankato), Al-Corn Clean Fuel (Claremont), Corn Plus (Winnebago), Pro-Corn LLC (Preston), Agra Resources (Albert Lea), USG Interiors (Red Wing), Austin Utilities NE Power Station and Hormel Foods (Austin), Mayo Medical Center and Rochester Public Utilities Silver Lake Plant (Rochester).[54]

Section 7.2 Natural Gas Providers. The following companies are providing natural gas in our area: Center Point Energy (Minnegasco), Aquila Networks (People's), Alliant Energy, Xcel Energy, Greater Minnesota Gas Company, Owatonna Public Utilities and Alliant Energy. They are listed in the Appendix on Chart 9, along with the electricity providers.

Section 7.3 Electricity

7.3.1 Regional and County Consumption of Electricity. In 2000, 6,319,734 MWH of electricity were consumed in the SE/SC region. The county breakouts with percentages consumed by county are shown below. Blue Earth and Olmsted Counties combine to account for 33 percent of the electricity consumed in the region in 2000.

[54] "Major Fuel Users and Amount of Fuel Used in 2001" by Shalini Gupta, ME3.

Table 13: Electric Consumption per County in the SE/SC CERT Region and Percent of Total Consumption 2000[55]

County	MWH	% Region
BLUE EARTH	723,929	11.46%
DODGE	148,264	2.35%
FARIBAULT	225,267	3.56%
FILLMORE	148,002	2.34%
FREEBORN	409,980	6.49%
GOODHUE	489,413	7.74%
HOUSTON	146,215	2.31%
LE SUEUR	270,334	4.28%
MOWER	394,730	6.25%
OLMSTED	1,372,514	21.72%
RICE	588,238	9.31%
STEELE	430,218	6.81%
WABASHA	221,536	3.51%
WASECA	224,953	3.56%
WINONA	526,141	8.33%
TOTAL	**6,319,734**	**100.00%**

7.3.2 Major Companies that Generate, Transmit and Distribute Electricity. Electric utilities in Minnesota are owned and operated by investors (IOUs), cooperatives (co-ops), municipalities (munis) and/or non-utility companies. Different entities generate, transmit and distribute electricity. Distribution to end-users is provided by each utility category as follows: IOUs (37 percent), co-ops (24 percent) and municipal utilities (39 percent). The major energy players in our region are the following:

- **Six Wholesalers:** Dairyland Power Cooperative (DPC), Great River Energy (GRE), Southern Minnesota Municipal Power Agency (SMMPA), Alliant Energy, Xcel Energy and Central Minnesota Municipal Power Agency (CMMPA).

- **Four Generating and Transmission Organizations:** Southern Minnesota Municipal Power Agency (SMMPA) , Dairyland Power Cooperative, Great River Energy and Central Minnesota Municipal Power Agency (CMMPA).

[55] Minnesota Department of Commerce, 2000. *The 2000 Minnesota Utility Data Book*.

- **Six Utilities that Own Transmission Facilities**: Great River Energy, Dairyland Power Cooperative, Interstate Power and Light Company, Rochester Public Utilities, SMMPA and Excel Energy.

- **Twenty-seven Munis:** (16 Non-SMMPA, including CMMPA): Blue Earth, Caledonia, Eitzen, Harmony, Janesville, Kasota, Kasson, Kenyon, Lake Crystal, Lanesboro, LeSueur, Mabel, Rushford, Spring Grove, St. Charles, Whalen. (11 SMMPA): Austin, Blooming Prairie, Lake City, New Prague, Owatonna, Preston, Rochester, Spring Valley, St. Peter, Waseca, Wells.

- **Eight Co-ops:** Freeborn Mower, Peoples, Tri-County Electric, BENCO, Goodhue, Minnesota Valley, Steele-Waseca, and Dakota.

- **Two IOUs**: Alliant, Xcel.

Chart 10 in the Appendix shows the regional power provider' service territories. Chart 11 in the Appendix shows how much electricity the municipalities and cooperatives in the region are providing to various customers by sector, i.e., industrial, commercial, farm, non-farm residential, and number of customers in each category. We were not able to find out this information for the 37 percent of the electricity being distributed by IOUs in the region.

7.3.3 Power Plants in the Region: Coal, Nuclear, Natural Gas, Gas and Oil. Power generators located in the SE/SC CERT region are located at Montgomery, Austin, Blue Earth, Janesville, Kenyon, Lake Crystal, Lanesboro, Rochester, Blooming Prairie, New Prague, Owatonna, Preston, Spring Valley, Waseca, Wells, Key City, Prairie Island, Red Wing, West Faribault, Dexter and Mankato. Chart 12 of the Appendix lists the names of the power facilities located in the region, along with fuel source, type of generator, nameplate capacity and year the facility was built. The SE/SC CERT region has two of the state's coal-fired power plants: Austin Utilities Northeast Plant in Austin and the Rochester Public Utility Silver Lake Plant in Rochester. The Prairie Island Nuclear Plant is located near Red Wing.

7.3.4 Renewable Energy Facilities and Projects in the Region. A chart listing the renewable energy projects identified in the region as of June 2004, including solar homes and smaller wind generators, is in the Appendix in Chart 13. The region has three hydroelectric dams at Lanesboro, Lake Zumbro and Mankato, three Waste-To-Energy projects at Rochester, Red Wing and Mankato, Waste Water Treatment Plants at Rochester and Owatonna that collect and utilize their own biogas for both heat and electric resources and several larger wind turbines and wind farms at Dodge Center, Adams, Rochester, Northfield and Owatonna. There are two large geothermal facilities: the school at Grand Meadow and the correctional facility in Steele County.

7.3.5 Plans to Build or Expand Area Power Plants and Larger Wind Farms. Plans for building or expanding new power plants or undertaking serious energy conservation/efficiency programs in our region that we could identify as of May 2005 include:

- Faribault Energy Park, LLC proposes to build, own and operate a 250 MW combined-cycle, natural gas fired plant 2.5 miles north of Faribault, Rice County.
- Mankato, Calpine Project plans to install two 320 MW natural gas fueled combustion turbines.
- Cannon Falls, Invenergy, a power plant developer from Chicago, has a contract with Xcel Energy to deliver 350 MW of peak power from a natural gas-fired power plant.
- Rochester's Silver Lake Plant has increased its capacity utilization significantly as natural gas prices have escalated. Its energy output up to its 100 MW capacity is wholesaled to the Minnesota Municipal Power Association for use by ring suburbs on the south side of the Twin Cities. The MMPA contract is being stepped down to free up capacity for Mayo steam sales and future local utilization of Silver Lake Power Plant generated power.
- In May 2005 we learned about a proposal from Simon Industries to locate a 325 MW natural gas peaking plant for Blooming Grove Township in Waseca County.
- The Olmsted County Waste to Energy facility announced in May 2005 that it would be adding a third boiler and doubling its operation.
- Rochester Public Utilities (RPU) is planning its energy resources for the next thirty years, 2005 - 2034. It hired Burns & McDonnell as consultants to identify the lowest cost and optimal way to meet the energy and power needs of RPU's customers. Burns & McDonnell concluded that the energy mix that created both the lowest customer bills and the lowest customer rates was an intensive focus on energy efficiency and load management. Burns & McDonnell recommended that RPU's various customer classes save $577 million worth of electricity over the next thirty years. By doing so, they would delay the construction of two natural gas combustion turbines by two years and the construction of a coal-fired baseload power plant by five years. In addition, the baseload plant would only need to be half the size that it would be without an intensive energy efficiency effort.[56]

[56] Rochester Public Utilities. 2005. "Discussion of Phase II and Phase III, RPU Public Meeting, March 29, 2005." Retrieved from: http://www.rpu.org/pdfs/032905_Infrastructure_Plan_Phase2&3.pdf on June 10, 2005.

- Additional wind projects being discussed for the SE/SC Region include a minimum of 400 MW from Zilkha Wind Energy and 500 MW from another developer for Mower County, 80 MW for the Northfield area, a 100 MW project in Steele County, a 100 MW project in Goodhue County, a 40 MW project in Olmsted County and another 100 MW of distributed projects across the region – for a total of 1,320 MW.

7.3.6 Transmission Lines and Substations. The region's transmission system consists of 345 kV, 161 kV, 115 kV and 69 kV lines (Chart 14 in the Appendix). According to the 2003 MN Biennial Transmission Projects Report:

> The 345 kV system is used to import power to the SE Planning Zone for lower voltage load service from generation stations outside of the area. The 345 kV system also allows the seasonal and economic exchange of power from Minnesota to the east and south from large generations stations that are located within and outside of the zone. The 161 kV and 115 kV systems are used to carry power from the 345 kV system and from local generation sites to the major load centers within the zone. From the regional load centers and smaller local generation sites, 69 kV lines are used for load service to the outlying areas of the SE Planning Zone.[57]

A list of approximately 159 substations located on 69kV transmission lines in our region by county is in the Appendix, Chart 15. This list will be helpful in locating potential sites of distributed generation renewable energy projects that might be connected to the grid at or near these substations.

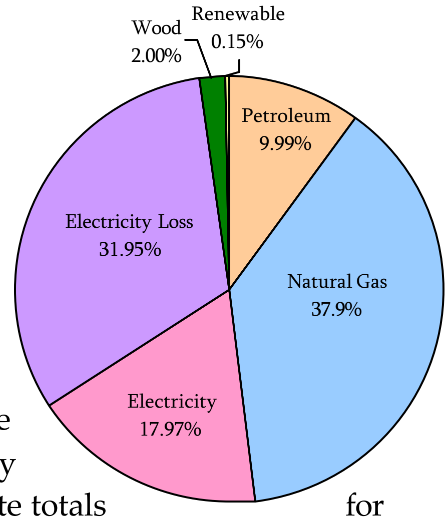
[57] Rochester Public Utilities. 2003. "2003 MN Biennial Transmission Projects Report," p. 131-132. Retrieved from: http://www.rpu.org/pdfs/032905_Infrastructure_Plan_Phase2&3.pdf.

Section 7.4 Residential Energy Use

Energy use in homes generally breaks out as follows:

- 44 percent heating and cooling
- 33 percent lighting
- 14 percent hot water heating
- 9 percent refrigeration

Graph 4: Sources of Residential Energy Use



The following chart shows the different types, amounts and costs of residential energy use in Minnesota in 2000. The numbers of households in the 15-county SE/SC CERT area comprise approximately 12 percent of the state totals. Thus, to obtain estimates of total residential energy use in our area by fuel type, we took 12 percent of the state totals for residential energy use (Table 14).

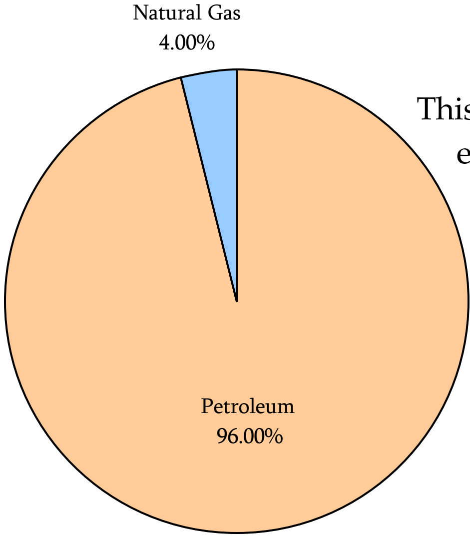
Table 14: Residential Ener gy Use in Minnesota (2000)[58]

	Residential Quantity	**Residential Amount**	**SE Region Residential Amount (12% of state)**	**Residential Trillion BTU**	**Residential Million $**	**SE Region Residential Million $ (12% of state)**
FUEL TYPE						
Coal	Short Ton	1000				
Natural Gas	Billion Cu Ft	120	15.48	131.4	923.2	110.78
Distillate Fuel	Barrels	2,260,000	271,200	13.2	116.8	14.02
Kerosene	Barrels	33,000	3960	0.2	1.8	0.22
LPG	Barrels	5,436,000	652,320	19.6	230.3	27.64
Total Petroleum	Barrels	7,730,000	927,480	33.0	348.9	41.87
Wood	Cords	409,000	49,080	8.2	11.5	1.38
Geothermal				0.2		
Solar				0.3		
Electricity	Million KWH	18,629.0	2,235.48	63.6	1,400.1	168.01
Elect Losses	Million KWH	31,941.0		109.0		
TOTAL				**345.7**	**2,683.7**	**322.04**

[58] US Department of Energy: Energy Information Administration. Retrieved from: www.eia.doe.gov/emeu/states/.

Section 7.5 Transportation Sector

Graph 5: Sources of Transportation Energy



This table below shows how much energy, what kind of energy and the total costs of that energy that were used in Minnesota transportation in 2000. Petroleum products accounted for 96 percent of fuels used in the transportation sector, with motor gas use at 61 percent, followed by distillate fuel use at 19 percent and jet fuel use at 15 percent.

Table 15: Transportation Energy Use in Minnesota (2000)[59]

	Transportation Quantity	Transport Amount	Transport Trillion BTU	Per Cent	Transport Million $
FUEL TYPE					
Natural Gas	**Billion Cu Ft**	21.00	21.40	4%	(s)
Aviation Gas	**1,000 Barrels**	136.00	0.70	.1%	7.2
Distillate Fuel	**1,000 Barrels**	17,191.00	100.10	19%	1,093.2
Jet Fuel	**1,000 Barrels**	13,301.00	75.40	15%	492.2
Lubricants	**1,000 Barrels**	831.00	5.00	1%	90.6
Motor Gas	**1,000 Barrels**	60,074.00	313.00	61%	3,857.8
Residual Fuel	**1,000 Barrels**	270.00	1.70	.3%	7.8
LPG	**1,000 Barrels**	7.00	(s)		0.3
Total Petroleum	**1,000 Barrels**	91,809.00	496.00	96%	5,549.1
Ethanol	**1,000 Barrels**	5,589.00	19.80	4%	**
TOTAL			**517.30**		**5,549.2**

**The ethanol was blended into gasoline, so the cost is not figured separately. (s) value less than .05 million nominal dollars.

There were 578,027 registered vehicles in the SE/SC CERT area in 2003. These vehicles included the following: 361,024 passenger cars, 154,376 pickup trucks, 1,720 buses,

[59] US Department of Energy: Energy Information Administration. Retrieved from: www.eia.doe.gov/emeu/states/.

26,571 other trucks, 22,651 motorcycles, 5,378 recreational vehicles, 1,372 mopeds and 4,575 other vehicles.[60]

According to the Energy Information Annual Energy Review 2002, in 2001 passenger cars used an average of approximately 547 gallons of gasoline per year; vans, pickup trucks and sport utility vehicles used on average 633 gallons per year; trucks used on average 4,491 gallons per year; and miscellaneous vehicles combined together used 692 gallons per year.[61] Using these figures and the data on registered vehicles, we calculated that fuel uses in our region for VEHICLES ONLY totaled almost 416 million gallons of liquid fuel in 2003. If the category "other trucks and buses" can be assumed to be diesel fuel, the region used approximately 122 million gallons of diesel and 294 million gallons of gasoline. None of these figures include oil for lubrication, etc.

We were not able to estimate fuel figures for airplanes, trains, barges or other forms of transportation for our region.

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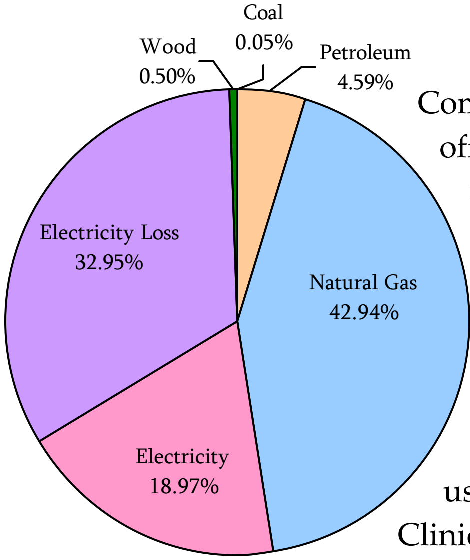
[60] Minnesota Department of Safety. Transportation Roadway Data Section Retrieved from: http://www.dot.state.mn.us/tda/html/roadwaydata.html .

[61] US Department of Energy: Energy Information Administration. 2002. "Annual Energy Review." p.61.

Section 7.6 Commercial Energy Use

Graph 6: Sources of Commercial Energy in Minnesota



Commercial energy is the energy used in hospitals, schools, offices and the service sector. Data on commercial energy use in Minnesota in 2000 is listed below. As you can see in Table 17, the commercial sector used primarily electricity and natural gas. We were not able to estimate commercial energy use for the SE/SC region at this time. Commercial use of electricity being provided by the co-ops and munis in our region (67 percent of the electricity) are shown on Chart 11 in the Appendix. One of the largest users of energy in our area is a commercial user: the Mayo Clinic. Our region has approximately 20 hospitals and 300 schools that fall under this sector.

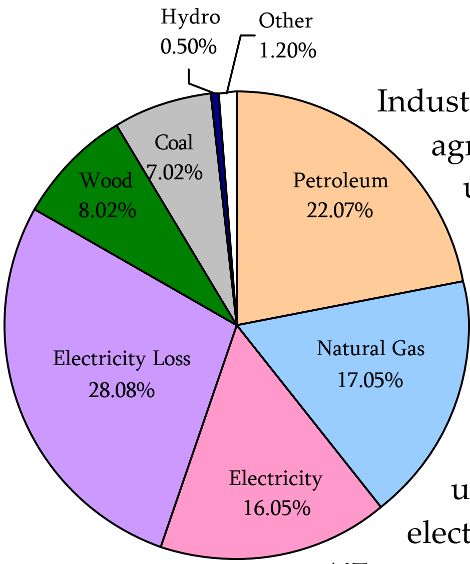
Table 16: Commercial Energy used in Minnesota (2000)[62]

FUEL TYPE	Commercial Quantity	Commercial Amount	Commercial Trillion BTU	Per Cent	Commercial Million $
Coal	**1,000 Short Tons**	5.0	0.1	.05%	0.1
Natural Gas	**Billion Cu Feet**	95.0	96.0	43.00%	566.2
Distillate Fuel	**1,000 Barrels**	875.0	5.1	2.00%	37.0
Kerosene	**1,000 Barrels**	55.0	0.3	.10%	2.9
LPG	**1,000 Barrels**	959.0	3.5	1.60%	40.9
Lubricants	**1,000 Barrels**				
Motor Gasoline	**1,000 Barrels**	50.0	0.3	.10%	3.2
Residual Fuel	**1,000 Barrels**	167.0	1.0	.50%	4.4
Other	**1,000 Barrels**				
Total Petroleum	**1,000 Barrels**	2,106.0	10.2	4.60%	88.2
Wood	**1,000 Cords**	50.0	1.0	.50%	1.4
Hydroelectric	**Million KWH**				
Geothermal			0.0		
Other					
Electricity	**Million KWH**	12,311.0	42.0	19.00%	791.5
Net Energy			149.2	67.00%	
Elect Losses	**Million KWH**	21,107.0	72.0	33.00%	
TOTAL			**221.2**		**1,447.4**

62 US Department of Energy: Energy Information Administration. Table 3. Commercial Sector Energy Price and Expenditure Estimates, 1970-2001, Minnesota. Retrieved from: http://www.eia.doe.gov/emeu/states/sep_prices/com/pr_com_mn.html.

SECTION 7.7 Industrial Energy Use

Graph 7: Sources of Industrial Energy in Minnesota



Industrial energy is the energy used by manufacturing and agriculture. The types, amounts and costs of energy being used by the industrial sector in Minnesota in 2000 are shown in the chart below. Electricity (16 percent), petroleum (22 percent) and natural gas (17 percent) are the main energy sources for this sector. The estimates for energy use in our region for agriculture and livestock production and some agricultural processing follow. We were not able to estimate the amount of energy by type used for manufacturing in our region. The amount of electricity being supplied by the coops and munis to industrial users (67 percent of the electricity being used in the area) is shown on Chart 11 in the Appendix. The largest energy users in our area, most of which are industrial users, are listed on Chart 6 in the Appendix.

Table 17: Industrial Energy Use in Minnesota (2000)[63]

FUEL TYPE	Industrial Quantity	Industrial Amount	Industrial Trillion BTU	Percent	Industrial Million $
Coal	**1,000 Short Tons**	2,091.0	40.4	7.0%	63.7
Natural Gas	**Billion Cu Feet**	104.0	105.5	17.0%	440.1
Asphalt/Road	**1,000 Barrels**	7,420.0	49.2	8.0%	216.7
Distillate Fuel	**1,000 Barrels**	4,784.0	27.9	5.0%	220.9
Kerosene	**1,000 Barrels**	4.0			0.2
LPG	**1,000 Barrels**	3,442.0	12.4	2.0%	147.7
Lubricants	**1,000 Barrels**	338.0	2.0	.3%	36.8
Motor Gasoline	**1,000 Barrels**	996.0	5.2	.9%	63.9
Residual Fuel	**1,000 Barrels**	522.0	3.3	.5%	8.3
Other	**1,000 Barrels**	5,557.0	33.3	5.5%	31.2
Total Petroleum	**1,000 Barrels**	23,062.0	133.4	22.0%	725.7
Wood	**1,000 Cords**		47.0	8.0%	28.2
Hydroelectric	**Million KWH**	296.0	3.0	.5%	
Geothermal					
Other			7.4	1.2%	
Electricity	**Million KWH**	28,842.0	98.4	16.0%	1,285.6
Net Energy			435.0	72.0%	
Elect Losses	**Million KWH**	49,451	168.7	28.0%	
TOTAL			603.8		2,543.3

7.7.1 Agriculture Energy Use. Over the past 30 years, agriculture has consistently accounted for about 6 percent of the state's energy use.[64] Unfortunately, the state no longer breaks out energy use for agriculture in its statistics; rather, agriculture energy use is included in with Industrial Use in state energy data. Douglas Tiffany, an agriculture economist working at the University of Minnesota, identified the following amounts of various forms of energy being used in crop and livestock production in Minnesota. We used these formulas to estimate the amounts of energy being used to raise crops and livestock in our region.

[63] US Department of Energy: Energy Information Administration. Table 10. Industrial Sector Energy Consumption Estimates, 1960-2001, Minnesota. Retrieved from: http://www.eia.doe.gov/emeu/states/sep_use/ind/use_ind_mn.html.
[64] *Minnesota Energy Data Book* – "Energy Trends from 1960-1993", p. 21.

Table 18: Energy Used in MN Agriculture and Livestock[65]

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	

The types and amounts of fuel to grow corn, soybeans and alfalfa are summarized below.

Table 19: Fuel Expended on Major Crops (2000)

2000 Fuel or Energy	TOTAL CROPS Corn, Soybeans & Alfalfa
Diesel (gal)	31,043,279
Gasoline (gal)	3,644,575
LP (gal)	18,257,178
Electricity (kWh)	117,003,491
Natural Gas MCF	7,666,664.5

7.7.2 Energy Being Used for Crop and Livestock Processing in 2001. The following chart shows the amount of natural gas, fuel oil, propane, wood/wood wastes and coal that was used in 2001 by the major crop and livestock processing facilities in the SE/SC CERT region.

[65] Tiffany, Douglas. "Agriculture Energy: Understanding Usage and Anticipating Policy Directions." Retrieved from: http://www.misa.umn.edu/programs/EnergyFair81702Rev.ppt#2 on June 12, 2005.

Table 20: Energy Used in Major Crop Processing Facilities (2001)[66]

CITY	NAME	NAT GAS	FUEL OIL	PROP	WOOD	COAL
Million British Thermal Units Consumed in 2001						
Mankato	ADM - Mankato	293,720	23,624			1,427,031
Mankato	CHS Oilseed Processing - Mankato	815,584	397,660			
Claremont	Al-Corn Clean Fuel	659,976				
Blue Earth	Seneca Foods Corp - Blue Earth	36,391				
Winnebago	Corn Plus	879,968				
Preston	Pro-Corn LLC	769,365		137		
Albert Lea	Agra Resources Coop dba EXOL	745,290				
Pine Island	Land O'Lakes Inc - Pine Island	202,979	32,258			
Red Wing	ADM - Red Wing	105,576	164,659			
Zumbrota	Dairy Farmers of America Inc - Zumbrota	178,461	22,241			
Montgomery	Seneca Foods Corp - Montgomery	70,202				
New Prague	ConAgra Flour Milling Co - New Prague	5,397	165			
Austin	Hormel Foods Corp - Austin	306,985	364,530		2,330	
Rochester	Associated Milk Producers Inc -Rochester	119,762	108,061			
Rochester	Pace Dairy Foods Co	30,778				
Rochester	Seneca Foods Corp - Rochester	133,198				
Northfield	Malt-O-Meal Co - Plant 2 - Northfield	342,735				
Plainview	Lakeside Foods Inc - Plainview	101,320	15,525			
Winona	Froedtert Malt - Winona	321,456				

[66] "Major Fuel Users and Amount Fuel Used in 2001" Source: PCA Boiler and Fuel Use database. Consolidated by: Shalini Gupta, ME3.

7.7.3 Ethanol Production. The chart on the previous page shows that the four ethanol plants operating in SE/SC MN in 2001 used 3,054,599 million BTUs of natural gas and 137 million BTUs of propane. This does not include the Lake Crystal Plant (50 million gallons) that began producing ethanol in May 2005.

7.7.4 Soybean Crushing Facilities. The chart on the previous page also shows that in 2001 the two soybean crushing facilities in Mankato used 1,109,304 million BTUs of natural gas, 421,284 million BTUs of fuel oil and 1,427,031 million BTUs of coal. This does not include the Glenville soydiesel plant that is expected to begin production in Summer 2005.

SECTION 8 ENERGY CONSERVATION, PRODUCTIVITY AND EFFICIENCY

Our cheapest, safest, cleanest and most available energy resource involves using less energy and increasing the productivity of the energy we use to do more work.

We use energy in various forms to do work. We think we can reduce energy consumption in all sectors by at least 20 percent by reducing energy use, using energy more productively and using energy more efficiently.

We all can take steps to conserve energy and use it more productively in our homes, schools, churches, businesses, buildings, communities and industries. If we use less energy and use energy more productively, we will save money, reduce the number of new power plants that need to be built, be able to retire old cold-fired and nuclear power plants, reduce pollution and greenhouse gases that harm our health and environment, reduce our reliance on energy imports from abroad and secure a safer, healthier future for our children and grandchildren.

Because of energy efficiency programs undertaken during the oil crisis in the mid 1970's, the U.S. gross national product grew 36 percent between 1973 and 1986 with no appreciable increase in energy use. As a result of efficiency programs implemented then, the U.S. saved 13 million barrels of oil each day, didn't have to build 250 large power plants that would otherwise have been required and saved $150 billion in energy costs each year.[67]

Amory Lovins says that since 1975, the U.S. has doubled the economic activity wrung from each barrel of oil. He claims from 1977 to 1985 GDP rose 27 percent, oil use fell 17 percent, net oil imports fell 42 percent and imports from the Persian Gulf fell 87 percent. The key to this huge savings was Detroit's 7.6 mile per gallon improvement in new cars and light trucks, which use 70 percent of oil imports. The overall savings of doubling the economic activity from each barrel of oil has meant an overall energy savings of $365 billion in 2000 alone. **The Rocky Mountain Institute estimates that the U.S. today has an overall energy-efficiency potential, mostly in oil and electricity, exceeding $300 billion per year.**[68]

Section 8.1 Definitions. Energy Productivity, Energy Conservation and Energy Efficiency

[67] Wilson, Alex and John Morrill . 1998. "Consumer Guide to Home Energy Savings." American Council for an Energy-Efficient Environment: p5.
[68] Lovins, Amory. 2003. "U.S. Energy Security FACTS (for a typical year, 2000)."

8.1.1 Energy productivity for the purpose of this discussion is defined as **the amount of energy used to perform a given task**. Examples include miles per gallon of fuel and kilowatt-hours of electricity per unit of air conditioning. When we increase gas mileage in a vehicle from 25 miles per gallon to 50 miles per gallon, we can go twice as far with the same amount of energy. Thus, we increase the productivity of the energy in a gallon of gas. If we replace an older air conditioner with a newer more efficient model, we can leave the air conditioner on longer and cool our building longer but still use the same amount of energy as the older model. In essence, we get more bang for our buck. We believe one of the most important things we can do in our region to increase productivity of energy is to find creative ways to use the heat being produced during electric generation via combined heat and power, or cogeneration, arrangements. We look forward to fueling such units with renewable resources from our plentiful local wind, biomass and biogas potential.

8.1.2 Energy conservation is defined **as using less energy to accomplish a given task**. If we decide to walk to work every day, rather than drive, we are using less energy to accomplish a given task, i.e., get to work. Thus, we are conserving energy. If we leave the air conditioner off and use shade trees, green roofs and blinds to cool our houses, we accomplish our objective of having a cooler home but use less energy. The task gets done; we just don't have to use as much energy to do it.

8.1.3 Energy efficiency combines energy productivity and energy conservation. Obviously, a **combination of increased energy productivity and increased energy conservation will result in the greatest reduction in overall energy use – energy efficiency.** If we live in the country and need to drive, using the most efficient hybrid car with the best gas mileage and using it only when absolutely necessary will reduce overall energy use and be the most efficient use of the energy we do use.

Section 8.2 Embarking on a Campaign to Conserve Energy and Use It More Productively. After you have decided to implement an energy-savings program in your home, school or place of work, there are several important things to do.

1. Gather Information. The Minnesota Department of Commerce has a wealth of information on how to save energy and use it more productively. In addition to fact sheets and bulletins around particular topics like "lighting," they have several comprehensive CD ROMs full of good ideas and information available for the public. One CD ROM provides specialized Commercial and Industrial Energy Efficiency Information. Their web site is www.commerce.state.mn.us. They also have a monthly tip that outlines energy saving action that any homeowner could utilize, along with a program called "kids only" to teach elementary and middle school age kids about energy and what they can do to utilize energy efficiently. A second outstanding web site is the Energy Star website: www.energystar.gov. That site has information about energy efficient products and appliances, home improvement, new energy efficient home construction and ways different groups can save energy and use renewable energy, such as businesses, congregations, schools and other institutions. Two excellent books are "Consumer Guide to Home Energy Savings" by Alex Wilson and John Morrill and "Homemade Money, How To Save Energy Dollars in Your Home" by Richard Heede and the staff of the Rocky Mountain Institute. There is wonderful information that you can find about almost any topic on the Internet if you do a "Google search" – just be sure the source is reliable.

2. Conduct an Energy Audit. You need to know how you use energy and then figure out what you can do to reduce your energy consumption or increase the productivity of the energy being used. There are worksheets to do this on your own, but it would be beneficial to have a trained professional conduct an energy audit. Some power providers have technicians who conduct energy audit for their customers, either someone who works for their company or one who has been contracted to do the work. Energy Services Companies are described at the end of this section.

3. Get Everyone on Board. Be sure that your family members, students, staff or employees know about the campaign and will participate enthusiastically. This involves getting them to think about energy and change their behavior, if necessary, by turning off lights when they leave a room, turning off computers when they are finished using them, combining errands and reducing the number of trips they take and carrying out routine maintenance on appliances or machines. These small steps can add up to big energy savings and savings of dollars.

4. Turn Things Off.[69] Although it may seem like a simple measure to take, remember that every 1,000 kilowatt-hours (kWh) that you save by turning things off equals US$70 off your utility bill (assuming average electricity costs of seven cents/kWh).

Lights. Turn off lights when they are not in use. Occupancy sensors can help, but a less expensive alternative is to train staff and family members to turn off lights when they leave unoccupied rooms.

Computers. Computers are used intermittently in laboratories and offices and should employ sleep-mode settings or be shut off when the machines are not in use. The typical desktop computer, monitor and shared printer draw about 200 watts, with the monitor

[69] NSTAR, 2004. "Managing Energy Costs in Office Buildings" Retrieved from: http://www.nstaronline.com/your_business/energy_advisor/CEA_03.html on June 8, 2005.

alone drawing about 100 watts. "Smart" power strips with built-in occupancy sensors are available to shut off plugged-in devices like printers and monitors when no users are present. Television sets, entertainment centers and the like use energy when they are "off" to be ready to come on in an instant when you hit the "on" button. Energy savings can be realized if plugs for all entertainment equipment are put in a power strip and turned off at one time when they are not in use.

Air-handling units. There may be large fan systems serving areas unoccupied at night—such as the cafeteria, educational areas or offices—that can be shut off.

5. Turn Things Down.[70] Some equipment cannot be turned off entirely, but turning it down to minimum levels where possible can save energy.

Room temperature setbacks. Not all rooms in a building are occupied 24 hours a day. Such rooms should have programmable thermostats that turn temperatures up in the cooling season and down in the heating season during hours of no occupancy.

6. Do Routine Cleaning and Maintenance.[71] Making sure that your HVAC system is regularly cleaned and serviced can help to prevent costly heating and cooling bills.

Check the economizer. Many air-conditioning systems use a dampered vent called an economizer to draw in cool outside air when it is available to reduce the need for mechanically cooled air. If not regularly checked, the linkage on the damper can seize up or break. An economizer stuck in the fully opened position can add as much as 50 percent to a building's annual energy bill by allowing in hot air during the air-conditioning season and cold air during the heating season. About once a year, have a licensed technician check, clean and lubricate your economizer's linkage, calibrate the controls and make repairs if necessary.

Check air-conditioning temperatures. With a thermometer, check the temperature of the return air going to your air conditioner and then check the temperature of the air coming out of the register nearest the air-conditioning unit. If the temperature difference is less than 14° Fahrenheit (F) or more than 22°F, have a licensed technician inspect your air-conditioning unit.

Change filters. Filters should be changed on a monthly basis; they should be changed more often than this if you are located next to a highway or construction site where the air is much dirtier.

[70] Ibid.
[71] Ibid.

Check cabinet panels. On a quarterly basis, make sure the panels to your rooftop air-conditioning unit are fully attached with all screws in place, and also check to see that gaskets are intact so no air leaks out of the cabinet. If chilled air leaks out, it can cost $100 per year in wasted energy per rooftop unit.

Clean condenser coils. Check condenser coils quarterly for debris, natural or otherwise, that can collect there. Thoroughly wash the coils at the beginning or end of the cooling season.

Check for airflow. Hold your hand up to air registers to ensure that there is adequate airflow. If there is little airflow or if you find dirt and dust at the register, have a technician inspect your unit and duct work.

7. Commissioning.[72] Commissioning is a process in which engineers observe a building and perform a tune-up to ensure that its systems are operating appropriately and efficiently. Studies have shown that continuously monitoring a building's energy systems can lead to reductions of 10 to 15 percent in annual energy bills. For the typical 100,000 square foot hospital, that's equal to about $34,000 in savings per year! Savings typically result from resetting existing controls to reduce HVAC waste while maintaining or even increasing comfort levels for occupants. Commissioning usually costs between five and 40 cents per square foot.

8. Upgrade to More Efficient Lighting.[73] Take advantage of daylighting where possible to reduce the need for electric light; proper design is critical to avoid glare and overheating. If your facility uses T12 fluorescent lamps, relamping with modern T8 lamps and electronic ballasts can reduce your lighting energy consumption by 35 percent. Adding specular reflectors, new lenses and occupancy sensors or timers can double the savings. Paybacks of one to three years are common. Compact fluorescent lamps (CFLs) can replace incandescent lamps in many applications, reducing energy use by two-thirds and saving up to $20 per lamp per year. Light-emitting diode exit lights that consume only two watts represent a great energy savings over incandescent fixtures, and they are easier to maintain because of their long service life.

9. Install Occupancy Sensors.[74] Many facilities have many rooms that are used periodically, such as restrooms, storage rooms, break rooms and offices. For work areas, a combination of occupancy sensors, time switches and local override controls can accommodate people who arrive early or stay late.

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[72] Ibid.
[73] Ibid.
[74] Ibid.

10. Buy Energy Star appliances, office equipment, lights, appliances, media equipment, etc. when you are buying new items and think about replacing appliances more than 15 years old with new energy-saving ones. See: www.energystar.gov for a listing of appliances and products that have earned the Energy Star label. They may cost a little more, but using them can reduce energy use from 30 to 50 percent because they are more efficient to use. The Union of Concerned Scientists estimated that if every household and business switched to Energy Star appliances in the next 15 years, it would save $100 billion in energy bills and reduce carbon dioxide emissions equivalent to taking 17 million cars off the road for each of those years.[75]

11. Buy Energy Efficient Windows and Doors. Replace old, single-pane windows.

12. Improve Insulation, Fill Cracks. If you have an attic that is used for storage, increasing the level of insulation from two to three inches (R5) to eight to 14 inches (R30) can save $100 to $150 per year for every 1,200 square feet of ceiling area.

13. Replace Inefficient Vehicles with Energy Efficient Cars or Hybrids

8.2.1 Residential Energy Efficiency. Residential energy use comprises 20 percent of the energy used in Minnesota. Energy use in the home generally breaks out as follows: heating and cooling (44 percent), lighting (33 percent), heating hot water (14 percent), and refrigeration (9 percent). Energy efficient homes generally use one-third to one-fourth less energy than conventional homes. If your home energy bills are high, you can cut them by 20 to 30 percent by taking the following steps.

- Replace older appliances with Energy Star Appliances, appropriately sized
- Replace older furnaces with more efficient ones
- Clean and replace air filters
- Switch to a solar hot water heater or on-demand water heater
- Turn the temperature on your hot water heater down, insulate it with a blanket, insulate exposed hot water pipes
- Replace older windows with energy-efficient ones
- Put more insulation in the attic, basements and crawl-ways
- Fill in cracks and holes with caulk
- Keep thermostats low, add a clock thermostat that sets your thermostat back automatically at times when you won't be in a particular part of the house
- Generate electricity on site with a small wind generator or solar panels
- Install a geothermal system or air-to-air heat exchanger

[75] Ibid.

- Plant shade trees around your house
- Add a sun room on a south-facing side of the house
- Turn lights off when you leave a room
- Unplug your TV and other media equipment when they aren't in use; they use a lot of electricity to keep the machines ready to turn on in the instant the "on" button is pushed
- Wash your clothes in cold water and hang dry them

Once you've completed these energy saving measures, you can also undertake some renewable energy projects to reduce conventional energy.

Chart 16 in the Appendix illustrates the amount of energy – and money – that can be saved in different types of homes. A typical older home with a less than 75 percent efficient furnace, less than R11 insulation in the walls and less than R20 insulation in the ceilings would use around 120 million BTUs of energy per year. A solar home of the same size that is super-insulated in the walls and ceiling and had a furnace with greater than 95 percent efficiency would use around 30 million BTUs.

Section 8.3 Transportation Energy Efficiency. Transportation accounts for 31 percent of the state's energy use. Ninety-six percent of the fuel is petroleum based (including four percent ethanol) and four percent is natural gas. You can reduce the amount of energy you use for transportation by taking the following steps.

- Reducing the number of trips you take in your vehicle, combining errands into one trip
- Taking public transportation when possible
- Carpooling
- Undertaking routine maintenance to keep filters and lubricants clean
- Keeping the tire pressure at the correct amount
- Buying a smaller more efficient car, such as a hybrid, that gets better mileage and/or uses biofuels
- Traveling at reduced speeds

Section 8.4 Commercial Energy Efficiency. Commercial energy accounts for 13 percent of the state's energy use. This category includes schools, hospitals, nursing homes and the service sector. Our area has around 300 schools and 20 hospitals. Natural gas accounts for 44 percent of the energy used by this sector, followed by electricity and petroleum products.

8.4.1 Commercial and Industrial Energy Efficiency Information. The Department of Commerce has a CD ROM that provides information on ways business and industries can save energy entitled "Commercial and Industrial Energy Efficiency Information." Their web site is www.commerce.state.mn.us.

8.4.2 Schools. The Energy Smart Schools Program (www.energysmartschools.gov) has prepared a handbook entitled "School Operations and Maintenance: Best Practices for Controlling Energy Costs." This 132 page *Guidebook for K-12 School System Business Officers and Facilities Managers* offers strategies and opportunities for reducing energy costs and increasing energy efficiency at existing schools that can reduce energy costs up to 20 percent.

8.4.3 Hospitals and Nursing Homes.[76] The first six steps hospital and nursing homes should take are the same as those described in items 4 through 9 in Section 8.2:

- Turn Things Off
- Turn Things Down
- Cleaning and Maintenance
- Commissioning
- Upgrade to More Efficient Lighting
- Install Occupancy Sensors

Two other important steps for hospitals and nursing homes include exploring other laundering options and considering cogeneration options (described further in the next section). Laundry systems consume large amounts of energy to heat water. Following are some options to consider that are more energy efficient.

Use ozone laundering. This method performs better than traditional technology on some stains—including Betadine and blood—but worse on others. It saves energy, requires less detergent and uses much less water. Although this technology does have a different cost structure than the conventional methods (an ozone generator is required and the system needs more maintenance), a two-year payback period is often possible. It is important to select a vendor that has an effective maintenance support network.

Reduce temperatures. Hospital laundry can be safely washed at lower temperatures. The common practice of laundering in water at 160° Fahrenheit (F) is outdated. Modern detergents and bleaches allow hospital laundry to be effectively washed at 120°F.

[76] Ibid.

Recycle water and heat. Another efficient laundry system uses a storage tank or pit to extract the heat energy from the washer's wastewater to preheat incoming raw water. Additionally, final rinse water can be recovered in a holding tank and used for the first wash cycle of the next dirty load. Micro-filtration systems remove particles as small as 0.5 microns from laundry wastewater so that the water can be reused. This not only saves heat energy but also cuts down on your water bill.

8.4.4 Consider Cogeneration and Other Sources of Heat Recovery. Cogeneration systems provide both heat (for space or water heating) and power. They have more applications and offer more savings potential for hospitals than for any other class of commercial building. Some hospitals are installing advanced incineration systems to destroy medical waste. Capturing and using the waste heat from incinerators can be cost-effective in some cases. The University of Michigan saved $400,000 in yearly steam bills by coupling medical waste incinerators with cogeneration.

Sterilization equipment, laundry and kitchen operations can all benefit from heat-recovery systems. Waste heat from boiler exhaust stacks can also be effectively recovered and used to preheat boiler makeup water.[77]

Energy use can be reduced in the commercial and industrial sectors by the following amounts if the steps indicated are taken:

- zero to five percent by changing the behavior of the occupants, such as having them turn off lights when they leave a room
- five to 10 percent from better operation and maintenance of building equipment and schedules
- 10 percent to 15 percent from equipment efficiency improvements
- 15 percent to 25 percent from energy production equipment strategies

Section 8.5 Industrial Energy Efficiency. The Department of Commerce has a CD ROM that provides information on ways business and industries can save energy entitled "Commercial and Industrial Energy Efficiency Information." Their web site is www.commerce.state.mn.us. The items below identify 20 steps plant managers can take to make their plants more energy efficient.

Industrial energy accounts for 36 percent of the state's energy use. Petroleum accounts for 22 percent of the energy used, followed by electricity and natural gas at 17 percent. As described above, industries can find major savings by taking steps to change behavior and upgrade equipment.

[77] Ibid.

The following ideas were taken directly from a brochure from the Department of Energy entitled "20 Things Industry Plant Managers and Engineers Can Do to Save Energy."[78]

All Combustion Systems

1. Operate furnaces and boilers at or close to design capacity
2. Reduce excess air used for combustion
3. Clean heat transfer surfaces
4. Reduce radiation losses from openings
5. Use proper furnace or boiler insulation to reduce wall heat losses
6. Adequately insulate air or water-cooled surfaces exposed to the furnace environment and steam lines leaving the boiler
7. Install air preheat or other heat recovery equipment

Steam Generation Systems

1. Improve water treatment to minimize boiler blow down
2. Optimize deaerator vent rate
3. Repair steam leaks
4. Minimize vented steam
5. Implement effective steam trap maintenance program
6. Use high-pressure condensate to make low-pressure steam
7. Utilize backpressure turbine instead of pressure-reducing or release valves
8. Optimize condensate recovery

Process Heating Systems

1. Minimize air leakage into the furnace by sealing openings
2. Maintain proper, slightly positive furnace pressure
3. Reduce weight of or eliminate material handling fixtures
4. Modify the furnace system or use a separate heating system to recover furnace exhaust gas heat
5. Recover part of the furnace exhaust heat for use in lower-temperature processes.

8.5.1 Energy Savings in Agriculture. Agricultural energy consumption has declined since the mid-1970s, but numerous opportunities and methods are still available to further improve agricultural efficiency. Mechanical improvements, such as more

[78] Brochure is available at: www.eere.energy.gov/consumerinfo/industry/20ways.html?print.

efficient pumps and motors and use of diesel rather than gasoline-powered tractors, 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 maintained by ensuring that all equipment, from tractors to grain driers to irrigation engines, is in good working condition. Farmers should ensure that tires are properly inflated, air filters, fans and screens are cleaned or replaced and all moving parts are well lubricated.

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.[79] 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 is a farming practice that allows plant residue or stubble to remain on the surface of the field, rather than being 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. While this method may not be realistic in Northwestern Minnesota, where farmers generally need to do some tilling to speed spring soil warming, mulch till practices may be an option and would still result in savings of 2.5 gallons of diesel fuel per acre over conventional methods.[80]

Farmers are also well equipped to substitute renewable fuels and supplies into their energy mix. Some changes that farmers could literally make today include using biofuel substitutes like E85 and biodiesel instead of gasoline and diesel in on-farm vehicles, trucks and tractors. Other changes might require a little more time, but are also readily available options. Wind energy presents farmers with a means of offsetting their own electric use and/or developing an additional income-generating use of their lands. Biogas from anaerobic digestions is a way that dairy farmers can either offset their heating fuels needs or, if paired with a generator, offset some of their electric requirements. Biomass from perennials or agricultural residues is another potential

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[79] 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.
[80] Ibid, p.37-38.

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.

SECTION 8.6 Conservation Improvement Program

As part of the Conservation Improvement Program (CIP), all of Minnesota's energy utilities are required to set aside a percentage of their revenues to be used in projects that will reduce electric and natural gas consumption. Accordingly, Great River Energy, SMMPA, Dairyland Power Cooperative and Alliant Energy put aside 1.5 percent of their revenues a year for their CIP energy efficiency programs. Because it operates nuclear facilities in the state, Xcel is required to put aside two percent of its gross revenues for conservation purposes. Some of the types of services and rebates Xcel and Alliant Energy provide to their customers are outlined below. People who receive electricity from cooperatives and municipalities should check with their local power providers to see what kind of incentives and programs they offer to promote energy conservation and efficiency.

Xcel Energy provides information for its customers to assess their energy use and ideas on how they can reduce it and use energy more efficiently. To encourage customers to use compact florescent light bulbs (CFL) Xcel provides $0.50 coupons to offset the cost of recycling the CFL bulbs. More information about Xcel Energy and its programs can be found on its website at http://www.xcelenergy.com.

Alliant Energy provides its customers with an online questionnaire to help them assess their energy usage. Alliant processes the questionnaire and sends the customer a personalized report that highlights opportunities for that customer to save energy. Alliant also provides rebate incentives for their customers who purchase high-efficiency furnaces, central air conditioners, efficient lighting, washers and efficient replacement windows.[81]

Section 8.7 Energy Services Companies (ESCO)

Private companies offer services to businesses and industries where they visit your enterprise, assess how energy is being used, recommend energy efficiency improvements and install the upgraded equipment. They receive payment from the amount of money the business saved by implementing the recommendations for so many years. Once the contract is fulfilled, the economic savings go directly to the customer.[82]

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[81] For more information visit Alliant's website at: http://www.alliantenergy.com/stellent/groups/public/documents/pub/au_env_ec_index.hcsp.

[82] For more information, go to: http://www.energyusernews.com/CDA/Article_Information/Fundamentals_Item/0%2C2637%2C8260%2C00.html.

Section 8.8 Green Mortgages

Fannie Mae is promoting "green" mortgages through its energy-efficient mortgage (EEM) program. To qualify for the program, homeowners must either buy a new energy-efficient home or commit to upgrades of an existing building as recommended by a certified HERS (Home Energy Rating System) inspector. The projected savings from energy efficiency are considered part of the borrower's income and can help homebuyers qualify for larger mortgages. Such factors like window efficiency, heating and cooling efficiency, wall-to-wall ratios, insulation levels, local climate and the solar orientation of the home determine a home's HER rating. The cost of the energy improvements can be included in the homeowner's mortgage but cannot exceed 15 percent of the home's values. A borrower with a new home can qualify for an EEM if the house was built according to guidelines set by the Energy Star Builder Option Program (BOP).83

Section 8.9 Building Codes

The Building Code Division of the Minnesota Department of Administration is responsible for establishing the minimum efficiencies of residential, multifamily and commercial buildings built in Minnesota. Homeowners, architects, engineers and builders are required to complete paperwork so the local building inspectors can see that the design will meet the minimum structural, energy efficiency, electrical and HVAC requirements. Local inspectors visit the construction site to verify that the minimum requirements are being installed per the design plans submitted.

Home/building owners need to be aware that these are the absolute minimum requirements. With today's energy costs and building material choices available, the minimum is not good enough. The consumer believes they are getting the best building possible, since it meets the Minnesota building code requirements. However, for another five percent investment, the consumer can have a building that is much more efficient, healthier and durable and should last for 75-100 years. There is less chance for moisture intrusion from wind driven rain or interior air leaks that cause mold and rapid deterioration problems, better control of room temperatures and humidity throughout the whole building, and better indoor air quality.

A 1990's study by the Minnesota Dept. of Commerce reports that an estimated 15 to 20 percent of new homes will have failures in the building envelope, indoor air quality and/or mechanical systems due to design errors and improper installation. In addition,

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[83] Scheer, Roddy. "Borrowing Power: Financing Energy Efficiency Through 'Green Mortgages'." Retrieved from: http://archives.postgresql.org/pgsql-sql/2005-05/msg00264.php.

building owners are not educated on how to operate and maintain the home. Instead they are being informed that they are now the proud owners of a maintenance free home. Today's homes and material choices can fail and cost tens of thousands of dollars to repair/rebuild.

Houses can also be built today that are net zero energy homes. With the installation of solar electric systems, the house's annual electric bill can be close to zero. One can sell an equivalent amount of electricity to the utility as what is being used. This can be a real benefit to the utility during the peak summer electricity loads. When the sun is shining, and when air conditioning requirements are the highest, the solar electric system is producing its maximum output.

High performance homes using natural products, long life products, durable products, renewable energy products and more sustainable products can be designed and built to greatly out perform the minimum building code built house with an on average additional investment of five percent. These houses will have a higher resale value, lower insurance costs and can be eligible for an energy efficient mortgage.

SECTION 9: RENEWBLE ENERGY RESOURCE INVENTORY AND ASSESSMENT FOR THE SE/SC CERT REGION

This section summarizes our findings of the assessment and inventory of renewable energy resources in our 15-county SE/SC CERT region and estimates, where possible, the contribution we believe they can make toward providing for the energy needs in our region and export energy to other areas. **We are confident that we have the renew able energy resources in our region that, when coupled with wise energy use, can meet our energy needs in different forms.**

The clean renewable energy resources we have identified for our region include **solar energy**, which falls everywhere; **geothermal energy** that can capture and utilize the warmth of the earth almost everywhere; abundant **wind** resources showing 55 percent of our area has winds that can be commercially developed; **biogas** potential from livestock, food processing plants, sanitary landfills, waste water treatment plants and stab ponds distributed throughout the region; **biomass** from energy crops and residues from crops throughout our area, from urban wood waste and from the forests and forest products industries; **combined heat and power/cogeneration** from various sources; and **biofuels.**

For some of our findings, we are simply listing the resources we have been able to identify. We have not estimated their potential for generating electricity or producing biofuels and hope that we will be able to find the technical assistance to evaluate the data in the future. Chart 13 in the Appendix lists the renewable energy projects identified in our region as of June 2004 by type, size and location.

Section 9.1 Wind Resources and Potential for SE/SC MN

Wind energy resources have national, regional, local and site-specific variation and can vary greatly from location to location. Wind resources can be used with both large wind turbines for utility applications and with small wind turbines for on-site generation. Below are estimates for the resource potential of large and small wind resources in SE/SC MN.

9.1.1 Assessment of wind from smaller turbines. In his report entitled "Distributed Wind Production Capability in Minnesota," Mike Michaud identified **91,775 potential homestead sites in the SE/SC CERT region capable of hosting a 10 kW wind turbine. Development of all of these sites would result in an annual energy production capability equal to 34 percent of the total energy consumed in the region.** While the development of every residential household is unlikely, the magnitude of the energy produced in this scenario points out that many distributed resources, even this small, can in aggregate significantly affect future load serving needs in the region (Chart 17, Appendix).[84]

9.1.2 Assessment of wind from larger wind turbines. The following analysis of wind from larger wind turbines was provided by SE/SC CERT team members Jeff Cook-Coyle and Lee Dilley. The wind energy resources in the SE/SC region are such that the newer wind turbines, designed for lower class wind regimes, can be installed successfully in many parts of the SE/SC CERT region. As shown in the following chart, **55 percent of the 15-county SE/SC CERT region has good wind resources that could be developed commercially for a total maximum capacity of 17,549 MW**. We are using a conservative estimate of 80 acres per MW. This number will not get larger as turbines grow in size. As wind turbines grow, the spacing between them will grow as well. The chart below shows the counties in the SE/SC CERT region and the percent of good wind, the acres that could be developed as wind farms and the MW wind capacity we estimate per county.

Table 21: Wind Potential by County -- SE/SC CERT

County	Acres in County	Unusable Acres	Available Acres	% Good Wind	Wind Farm Development Acres	MW Capacity
Blue Earth	489,696	71,436	418,260	15%	62,739	392
Dodge	281,135	23,051	258,084	92%	237,437	1,484
Faribault	461,618	32,237	429,381	99%	425,087	2,657
Fillmore	551,478	125,873	425,605	50%	212,803	1,330
Freeborn	461,959	44,971	416,988	98%	408,648	2,554
Goodhue	498,672	127,804	370,868	55%	203,977	1,275
Houston	363,909	164,802	199,107	10%	19,911	124
Le Sueur	303,018	58,945	244,073	1%	2,441	15
Mower	455,034	30,752	424,282	97%	411,554	2,572
Olmsted	418,409	72,463	345,946	60%	207,568	1,297
Rice	329,809	64,594	265,215	35%	92,825	580
Steele	276,540	26,243	250,297	92%	230,273	1,439
Wabasha	351,373	115,621	235,752	20%	47,150	295
Waseca	276,910	27,698	249,212	70%	174,448	1,090
Winona	410,296	173,791	236,505	30%	70,952	443
Total	**5,929,856**	**1,160,281**	**4,769,575**	**0.5493333**	**2,807,813**	**17547**

[84] Mike Michaud. 2004. "Distributed Wind Production Capability in Minnesota."

Mower County has the best wind resource located closest to the Twin Cities load center. We could easily envision over 1,000 MW of development there if transmission were available to the Twin Cities. About 12 MW of wind projects are already installed in Mower County. Additional wind projects being discussed for Mower County include a minimum of 400 MW from Zilkha Wind Energy and 500 MW being proposed by other developers. Wind projects being proposed in other places of the SE/SC CERT region include an 80 MW project for the Northfield area, a 100 MW project in Steele County, a 100 MW project in Goodhue County, a 40 MW project in Olmsted County and another 100 MW of distributed projects across the region. The wind projects in the MISO interconnection request queue are indicators of the desire for generation projects in the SE/SC region.

The SE/SC CERT believes that 1,675 MW of wind could be developed and utilized with existing markets and transmission systems in the next ten years in the region, as follows.

1. 475 MW for regional consumption. Experts believe that wind can provide up to 15 percent of the electrical capacity in a region. Based on electricity consumption of 6,319,734 MWH in 2000, the region can carry 475 MW of wind production for regional consumption.

2. 800 MW of wind energy could be produced in the region and sent to the Twin Cities. Significant south-north transmission capacity exists presently from Mankato and Mower County to the Twin Cities.

3. 400 MW of wind energy could be produced to send eastward to Milwaukee/Chicago. Wind on the Wires predicts that 1,200 MW of wind energy development will take place in Iowa, south of the SE/SC CERT area to serve the Milwaukee/Chicago metropolitan area. Our area could provide an additional amount to add to that.

The following chart lists **21 potential sites for large wind and wind/biomass projects and their interconnection points to the grid that could be developed in the next 10 years in the SE/SC CERT region to provide an additional 2,100 MW of electricity in the region.** The list doesn't include facilities that have already entered into commercial operation. The chart lists both capacity (MW) and annual energy production (GWh). It includes both conventional wind energy generating stations (35 percent capacity factors) and wind energy combined with biomass (70 percent capacity factor). It is our belief that it will become technically and economically feasible to combine the operations of wind energy and a "filling" generation resource before 2015.

Table 22: Possible Renewable Energy Generation Sites in SE/SC

Interconnection Points and Delivery Points that Could Be Established 2005-2015

High side Voltage Existing Substations	Interconnection Point	County	MW	GWh	Fuel	Delivery Point
161	Hayward	Freeborn	100	300	Wind	Hayward
161	Winnebago	Faribault	100	600	Wind, Biomass	Dickinson
161	Al-Corn	Steele	200	900	Wind, Biomass	Prairie Island
161	West Faribault	Rice	100	600	Wind, Biomass	Black Dog
161	Rochester	Olmsted	100	600	Wind, Biomass	Rochester
69	Lewiston	Winona	50	300	Wind, Biomass	Prairie Island
161	Austin	Mower	50	300	Wind, Biomass	Austin
161	Albert Lea Ethanol	Freeborn	100	600	Wind, Biomass	Prairie Island
161	Harmony	Fillmore	200	600	Wind	Prairie Island
345	Adams	Mower	200	600	Wind	Prairie Island
345	Pleasant Valley	Mower	100	300	Wind	Pilot Knob
161	Cannon Falls	Goodhue	50	150	Wind	Prairie Island
161	Wabaco	Olmsted	10	30	Wind	Wabaco
161	Harmony	Fillmore	10	30	Wind	Harmony
161	Twin Lakes	Freeborn	10	30	Wind	Hayward
161	Adams	Mower	10	30	Wind	Adams
161	Harmony	Houston	10	30	Wind	Harmony
New Substations						
161	Rice Lake	Steele	150	450	Wind	Prairie Island
161	Blue Earth	Faribault	150	450	Wind	Dickinson
161	Grand Meadow	Mower	100	300	Wind	Prairie Island
345	Dexter	Mower	200	600	Wind	Prairie Island
345	Goodhue	Goodhue	150	450	Wind	Prairie Island
Total			**2100**	**8100**		

Please address any questions about this analysis to Jeff Cook-Coyle at jeff@winergie.com or Lee Dilley at leedilley@iglide.net. They prepared the analysis of potential for larger wind projects for our region and this chart.

9.1.3 Potential for Future Wind Development if Transmission Were Available. If all 17,549 MW of wind energy capacity in the 15 counties in SE/SC Minnesota were developed, it would provide approximately 10 percent of the energy for Minnesota, Wisconsin, Illinois, Indiana, Ohio and Michigan, plus the Dakotas, Iowa and Nebraska. While this may be highly desirable, it isn't realistic. If the region were to provide 10 percent of Minnesota's generation, it would produce 2,500 MW of wind energy. This seems like a much more realistic target. However, there isn't transmission capacity to get all of this energy from the wind areas in our region up to the Twin Cities loads.

Section 9.2 Solar

"In 15 hours the sun delivers as much energy to the Midwest as its inhabitants consume in a year."[85] "Minnesota has more annual solar energy potential than Houston, TX and nearly as much as Miami, FL."[86]

There are many ways to use solar energy that generally fall into two categories: passive and active. The number of homes/buildings that can profitably utilize solar applications is somewhat limited by solar access/shading, building orientation, topography, restrictions in building covenants, landlord/renter interests and space limitations. Ideally, building codes would be modified to require the use of solar energy for water and space heating wherever feasible. Prices of solar panels, solar shingles and solar hot water heaters would drop if volume of sales rose. For utility-scale solar projects, a square kilometer of PV panels would provide between 20 and 60 MW of electricity.

9.2.1 Passive solar design uses a building's orientation, materials and structure to capture the sun's energy, store it and releases it when it is needed after dark in the cool months and to provide ventilation and shade to cool the building in the hottest months. A building can be built into a hill or underground to use the earth for insulation; a sunroom can be built on a south-facing wall to capture the heat of the sun and move it into the main structure; and planting trees around a structure can provide shade and protect a building from the intensity of the sun.

An elaboration on passive solar design implements the concept of Seasonal Thermal Energy Storage to capture and store energy through the spring, summer and fall for use during the winter. Massive earth storage is coupled to the building as an energy source/sink. A more modest amount of windows and the absence of window shading enable the energy to be collected without overheating the space.

9.2.2 Active solar energy can be used in two important ways. First, the rays of the sun can provide hot water through a solar hot water heating system. The sun heats a fluid that is flowing through the solar panels to a heat exchanger in the home. That heat is used to heat hot water that is then stored in the home. Second, the rays of the sun can

[85] Union of Concerned Scientists. 1993. "Powering the Midwest, Executive Summary." p. 6.
[86] Pawlisch, Melissa, Carl Nelson, Lola Schoenrich. 2003. "Designing a Clean Energy Future: A Resource Manual." p. 61. Retrieved from: www.cleanenergyresourceteams.org.

generate electricity through the use of photovoltaic cells or panels made from semiconductor materials. The electricity can be used directly, stored in batteries for use when the sun is not providing power or moved onto the grid and sold to utilities.

9.2.2.1 Potential of Solar Hot Water Heaters. Heating water accounts for approximately 14 percent of residential energy use. In 2000, residential household energy use in Minnesota was 345.7 trillion BTUs. The households in our region comprise approximately 10 percent of state households. **If each house in our region installed a solar hot water heater and saved 14 percent of its home energy use by replacing their current water heater, our region would save approximately 4.84 trillion BTUs per year**.

A Heliodyne HX Freeze-Proof Solar Hot Water System for cold climates costs between $2,580 and $3,580 depending on the size of the system. This does not include the cost of the copper tubing, a 50- to 120-gallon water heater tank or installation fees. Homeowners could reduce this cost considerably by making their own solar panels and installing the system themselves.

In the past, solar domestic hot water (DHW) systems using cheap fuel oil or natural gas didn't make financial sense. However, since natural gas and oil prices have skyrocketed and will continue to escalate dramatically in the near future because of depletion of resources in the U.S. and Canada, solar domestic hot water heating is going to make financial sense for many more homeowners.

*9.2.2.2 Potential of PV Solar***.** Solar PV panels can be placed on tops of buildings or on racks on the ground – in large or small-scale arrangements. We didn't try to assess the potential of locating large-scale solar projects in our region. However, if all of the houses and commercial structures in SE/SC Minnesota were to install solar PV panels, it is estimated that they could generate around 1170 MW of electricity. Of this, homes would account for 688 MW and commercial/industrial facilities would add another 484 MW. It is not likely that all of the homes and businesses in the region would install solar panels, so a conservative estimate of developing 3.5 percent of the potential by 2025 would give 24 MW for homes and 17 MW for businesses – for a total of 41 MW.[87]

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[87] These figures were derived from the following study: "PV Grid Connected Market Potential under a Cost Breakthrough Scenario", by Maya Chaudhari, Lisa Frantzisa and Dr. Tom E. Hoff for the Energy Foundation, http://www.ef.org/documents/EF-Final-Final2.pdf, September 2004. The authors based their calculations on Minnesota having 2,078,775 residential customers and 231,313 commercial customers in 2001. The authors concluded that overall roof space available for PV installations in Minnesota in 2010 is around 671 million sq. ft for residential and 472 million sq. ft. for commercial. This leads to a technical market potential of 6,883 MW (residential) and 4,843 MW (commercial) for the entire state. SE/SC MN has around 10% of the total households in

Section 9.3 Biomass

9.3.1 Definition of Biomass. For our purposes, we consider biomass to be plants and plant residues – trees, grasses, crops and all the byproducts or residues left after they are harvested and processed. Included in this definition is urban wood waste, such as wood from houses that have been torn down or left over after the construction of new buildings. As plants grow, they capture and store solar energy and that energy is released when the plant material is burned or converted into biofuels. Municipal solid waste is also a form of biomass. Estimates are that 70 percent of municipal trash consists of paper based products, yard wastes and wood, which produce energy when burned.[88] Refuse-derived fuel can be burned directly or co-fired in coal plants to reduce coal emissions.

9.3.2 Ways Biomass Can Be Used as an Energy Source. Biomass, such as wood, can be burned directly in stoves and furnaces of various sizes. There are a number of efficient furnaces on the market that burn pellets made from different biomass sources, such as wood chips, sawdust and switchgrass. Although we don't advocate burning food for fuel, some people in our region are buying furnaces which burn corn to heat their homes and buildings.

There are three primary ways to convert biomass into electricity. The first is direct combustion, where the biomass is burned to create steam that runs a turbine to generate electricity. The second is to convert the biomass into a liquid or gas fuel that can be burned in a combustion turbine, i.e., gasification. The third is to extract oil from the crop seed and use it to power a diesel engine that drives a generator. Some diesel engines can burn the raw oil without coking problems, other engines require a blend of vegetable oil and petroleum diesel or the conversion of the raw vegetable oil to an ester form prior to use (a simple DIYS process). The latter is low tech, simple and suitable for distributed power generation on farms.

Research is being conducted to develop the most effective and efficient ways to use biomass to replace or reduce the use of fossil fuels. A power plant that burns whole, fast-growing poplars was being planned for our region but was not able to move forward. Chipped wood and sawdust from a variety of sources and switchgrass are being co-fired with coal in different ratios in coal-fired plants. Researchers have had success combining 15 percent switchgrass with coal. However, when it is burned,

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the state; and we estimated 10% of the commercial users. Thus, we estimated that SE/SC MN has the potential for having 688.3 MW of solar potential for residences and 484.3 MW for commercial.

[88] Franklin Associates. 1992. "Characterization of Municipal Solid Waste in The United States: 1992 Update, Prairie Village, Kansas."

switchgrass leaves four to ten percent ash, which has been causing problems for the coal plants. An alternative method of co-firing that is being tried is burning the switchgrass separately in between periods when coal is burned, rather than mixing the two.

In Little Falls, Minnesota, the Central Minnesota Ethanol Coop 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. They estimate that the biomass-derived energy will generate 50 to 75 percent of the plant's own electricity requirements. This use of biomass holds great promise for our area because of the large amounts of natural gas being used by our five and soon to be six ethanol plants. The ethanol plants in our area and the amounts of natural gas they are using can be found in Table 20.

9.3.3 Resource Base in SE/SC MN to Produce Biomass Sustainably and Potential Biomass Resources. According to the latest Land Use Census in 1990, 94 percent of the approximately six million acre area in our 15-county region (5,640,000 acres) was being used to grow crops, trees or grasses and would be available to grow energy crops or provide forest and crop residues for biomass energy. Thus, our region currently has extraordinary biomass resources and the potential to produce biomass for energy production along with current crops. This should bode well for the future, if there is enough water to grow the crops, the land remains productive and in sufficient quantities and the crops can be grown sustainably without petroleum, petrochemicals, and natural gas inputs. We believe it is essential to be growing and harvesting biomass sustainably, so that the resource will continue to produce more biomass after it has been harvested. Switchgrass is currently receiving a great deal of attention as a biomass resource for the future. We don't believe that growing hundreds of acres of switchgrass as a monoculture crop is sustainable. Switchgrass requires heavy annual inputs of fertilizer comparable to corn, and a monoculture cropping system invites the buildup of diseases and pests in the soil, which lead to a loss of productivity in our soils. It is also not sustainable to clear-cut forests or take every blade of corn stover from the fields.

Several studies are now being conducted to evaluate the state's biomass resources. The Institute for Local Self-Reliance did a comprehensive study of the state's biomass resources in 1997. A summary of that study for the counties in our SE/SC CERT region is located in the Appendix at Chart 18. We added current crop yields from 2002 to that chart. An assessment of biomass resources in our area compiled by Marie Walsh from the Oak Ridge National Laboratory in 2003 is in the Appendix at Chart 19. These can be compared by resource to the ILSR assessment.

Evaluating the potential of all the biomass resources we have identified in our area to produce electricity or biofuels is a complex task and the data presented here, showing various types of biomass resources at different prices per ton, are based on varying assumptions. As prices for oil and natural gas skyrocket and the costs to produce these forms of biomass increase, the figures for their prices will change drastically. Thus, we question the wisdom of making decisions based on them. We do have two estimates of biomass potential to produce biofuels, electricity and heat based on corn stover and urban wood waste, which are below. We will simply include the resources we have identified and hope to find technical help to assess their potential later and return to this section when the other estimates of biomass resources are completed.

*9.3.3.1 Farmland in SE/SC MN and Potential Biomass Resources***.** According to the 2002 Agriculture Census, our 15-county area has 4,847,642 acres of farmland. Of this, 3,640,700 acres or just over 75 percent was planted to corn, soybeans, alfalfa/hay, oats and wheat. The other 25 percent, or 1,206,942 acres, have huge potential for growing energy crops sustainably.

Table 23: Major Crops

Crop	Acres	Yield
Corn	1,799,100	289,843,940 bu
Soybeans	1,362,400	72,600,900 bu
Alfalfa./Hay	414,600	1,565,900 tons
Oats	61,600	4,703,700 bu
Wheat	3,000	133,600 bu
Total:	3,640,700	

<u>9.3.3.1.1 Major Crops Planted on 3,640,700 Acres and Their Crop Residues – 75 percent Farmland</u>. Based on the ratios used by ILSR in its earlier assessment, we estimate that in 2002 our region produced 8,652,810 tons of crop residue and hay as follows: corn (6,637,426 tons), soybeans (239,583 tons), hay (1,656,900 tons), oats (112,889 tons) and wheat (6,012 tons). According to an analysis done by David Morris of the Institute for Local Self-Reliance, if half the corn stover in the 15-county SE/SC CERT region were used, it alone could provide over 202 million gallons of ethanol per year and the left-over cellulose from making the ethanol could be burned to produce up to 2.1 billion kWh of electricity each year (27.9 trillion BTUs). We estimate that the region currently uses around 300 million gallons of gasoline and 122 million gallons of diesel fuel for transportation. The ethanol from half the corn stover would provide approximately 67 percent of the gasoline currently used in the region and 37 percent of the electricity currently consumed in our region.

9.3.3.1.2 Farmland Not Being Planted to Corn, Soybeans, Alfalfa Hay, Oats and Wheat – 25 Percent Farmland and Potential Biomass Resources. There is potential to grow massive amounts of sustainably produced biomass on the 1,206,942 acres of farmland not being used to produce the major crops outlined above. Researchers are developing sustainable cropping systems for what are called "Third Crops," such as fast-growing trees (poplars and willows), mixes of prairie grasses and legumes, flax, hazelnuts and other crops that can be grown sustainably on farms in our region. These can be burned directly or converted into ethanol when the technology is perfected to use cellulose to produce ethanol.

9.3.3.1.3 CRP Lands. There are approximately 167,000 acres in SE/SC MN that are currently enrolled in the Conservation Reserve Program (CRP). This is a voluntary set-aside program run by U.S. Department of Agriculture. Farmers and/or landowners receive cost-share funds and a small annual payment to plant grasses and trees or bushes as permanent cover to protect sensitive areas, such as lands on steep slopes that are threatened by erosion, marginal pasture lands and wetlands, and take them out of annual row crop production. The trees, grasses and other woody perennial crops stabilize the soils and water tables and provide wildlife habitat and diversity to the landscape. Nationally, there are currently a total of 34,819,557 acres enrolled in various CRP programs.[89] Although there is a rule that prohibits biomass on CRP land from being harvested or sold, there is discussion about allowing the trees and grasses on CRP lands to be harvested for energy production and exemptions have been granted in some areas to allow this to happen.

9.3.3.2 Forest and Forest Products and Potential Biomass Resources. In 1990, 14 percent of the land (804,149 acres) in the 15 counties in SE/SC Minnesota was covered with of forests.[90] The largest forested areas were in the following counties: Winona, Houston, Fillmore, Goodhue and Wabasha. Wood from the forests can provide biomass for energy in several ways: (1) forests can be harvested sustainably and the logs can be burned directly, chipped or pelletized for fuel, (2) forest residues from logging operations can be collected and burned and (3) mill residues, such as sawdust, can be collected and burned. Wood and wood waste products provided for 3.5 percent of the fuel used in the state in 2000 and accounted for 2 percent of the residential heating in the SE/SC CERT area.

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[89] USDA, Farm Service Agency Newsroom. 2005. "USDA Celebrates Earth Day 2005." Retrieved from: www.fsa.usda.gov/pas/printstory.asp?StoryID=2134.on April 2005.

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

The following table lists the location of the major sawmills and other primary wood producers in SE/SC MN by county. Some of them produce fuel wood, sawdust and wood chips that could be used for biomass energy production. Chart 20 in the Appendix lists the names of the facilities in the SE/SC CERT area and a list of their products.[91]

Table 24: Sawmills and Other Wood Producers

County	Sawmills and Other Primary Wood Producers in SE/SC MN
Blue Earth	Janesville, North Mankato
Fillmore	Chatfield, Lanesboro, Peterson, Preston (2), Rushford
Freeborn	Alden, Glenville, Oakland
Goodhue	Cannon Falls (2), Goodhue, Red Wing, Wanamingo, Welch
Houston	Caledonia, Hokah, Houston
Mower	Brownsdale, Walthan
Olmsted	Byron (2), Elgin, Oronoco, Rochester, Stewartville
Rice	Kilkenny, Webster
Steele	Blooming Prairie, Ellendale, Medford, Owatonna
Wabasha	Kellogg (2), Lake City, Millville, Plainview, Wabasha, Zumbro Falls
Winona	St. Charles, Utica

Table 25: Sawmill residue by county in the SE/SC CERT Region[92]

Sawmill survey 2001 data (green tons)					
MN County	Bark	Bark mixed with Slabs/edgings	Slabs/edgings with Chips	Sawdust and Shavings	Total Residues (green tons)
Blue Earth	0	38	0	16	54
Faribault	0	48	0	20	67
Fillmore	5,130	10,792	14,070	12,597	42,589
Freeborn	0	19	0	8	27
Goodhue	1,425	50	3,350	1,970	6,795
Houston	5,796	764	10,945	6,683	24,188
Olmsted	86	61	201	131	479
Steele	0	96	0	128	223
Wabasha	257	1,439	603	944	3,243
Total	**12,694**	**13,307**	**29,169**	**22,497**	**77,665**

[91] *2002 Minnesota Primary Forest Products Directory*.
[92] Data provided by Keith Butcher, Minnesota Department of Natural Resources based on 2001 Sawmill Survey of Available Sawmill Wood Residue.

9.3.3.4 Urban Wood Waste. Urban wood waste that can be used for fuel comes from trees that are cut down or trimmed for maintenance and wood products that are disposed of during construction or demolition of structures. It has been estimated that urban wood wastes in the SE/SC Region alone could produce significant resources for electricity and heat.

*9.3.3.5 Waste to Energy Facilities***.** Our region currently has three waste-to-energy facilities in Rochester (4,200 kW), Mankato (24,750 kW) and Red Wing (22,770 kW). The Olmsted County Waste to Energy facility announced in May 2005 that it would be adding a third boiler and double its capacity. We didn't assess potential for increasing the size of these facilities or adding new ones.

Section 9.4 Biogas

When liquid manure, sewage or other organic wastes or organic materials are placed in a container (biogas digester) with no oxygen, bacteria break down the materials and create biogas through a process called anaerobic digestion. The biogas contains from 55 to 70 percent methane, which can be burned directly or used to run diesel generators to produce electricity after it has been "cleaned." There are several sources of materials in the SE/SC region that could be used to produce biogas: wastes from food processing facilities, waste water treatment facilities, biosolids from stab ponds, landfill gas and animal manure – dairy and beef cows, swine, poultry. In addition to generating electricity, experiments are being conducted at the Haubenschild 800-cow dairy in Princeton, MN, to use biogas from their successful biogas digester to charge a fuel cell. Fuel cells that use renewably-derived local fuel sources hold great promise in the medium or long term horizon for on-site electricity and heat production. At the moment, they are too expensive to be used.

9.4.1 Livestock Manure. In 2002, there were 9,345 registered feedlots in our region (Chart 3 in the Appendix). Livestock totals for our region by animal and county can be found on Chart 21 in the Appendix. Using these totals, we estimate that over 75 million pounds of manure are being generated by the livestock in the 15 counties in SE/SC Minnesota per day. This manure could be collected and used to generate electricity for on-farm use or to sell to the local utility. The heat generated in the process could be used on the farm directly or to support other activities, such as heating a greenhouse. In the digestion process, the weed seeds and pathogens in the original manure are destroyed. However, all of the nutrients in the original manure remain. That residue can be turned into bedding material, composted and sold, or put directly back on the land to enrich the soil.

Through anaerobic digestion something considered a waste is turned into three valuable resources: electricity, heat and a nutrient-rich residue. In addition, anaerobic digestion contains the waste streams of larger concentrations of animals and processing plants and can help reduce problems, such as odor, flies and air and water pollution. Although we understand the benefits of biogas digesters, many of us are opposed to large concentrations of animals for a variety of reasons. The SE/SC CERT does not advocate constructing large CAFO's (concentrated animal feedlot operations) to generate electricity.

According to a report, "Minnesota's Potential for Electricity Production Using Manure Biogas Resources," the numbers of animals it takes to make a project economically viable depend on the financial incentives, tax credits, power purchase agreement, grants and other incentives a farmer receives. In general, the authors of the report believed it took at least 500 dairy cows for an operation to break even and more than 800 cows for a project to be economically viable. They estimated that it would take more than 12,000 swine for a digester to be economically feasible.[93]

Dairyland Power Cooperative has developed a creative "cookie cutter model" to establish biogas digesters on dairy farms with 800 to 1,000 cows in its service area in Wisconsin, Minnesota, Iowa and Michigan. There are three partners in the project: (1) the farmer who has the farm, cows, manure and owns the digester, (2) Dairyland Power and its member cooperatives that own the electricity generation set and buys the electricity and (3) a company called Microgy Cogeneration Systems that works with the farmer and builds and manages the digester from its operations in Colorado and Europe. Dairyland Power in essence offers a Power Purchase Agreement to buy the electricity, which enables the farmer to pay off the $1,000,000 digester in 10 years. A digester of this size will produce 775 kW of electricity 24 hours a day, seven days a week and provide electricity for approximately 600 average-sized homes.

Microgy indicated that they are currently working on developing a similar "cookie cutter model" to use manure from hogs to generate electricity but couldn't estimate how many hogs would be necessary to create enough manure for the model at this point.

We have feedlot information from the year 2002 by animal type, size and location by township, range and section that is available to estimate how many of these model

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[93] Minnesota Department of Commerce State Energy Office. 2003. "Minnesota's Potential for Electricity Production Using Manure Biogas Resources." p. iii. Retrieved from: http://www.state.mn.us/mn/externalDocs/MN_Biogas_Potential_Report_041003013143_biogasfinal2.pdf..

digesters could be established throughout the SE/SC MN region. Rather than just relying on one operation to have the necessary numbers of animals, i.e., 800 to 1,000 dairy cows, 1,600 to 2,000 beef cows or 12,000 hogs, central digesters could be built within a township and manure from several different farms could be brought into a central digester. We think the potential for creating dozens of centralized digesters in our area is quite large and will analyze that potential at some point. The numbers we have include all sizes of animals per farm, but for this analysis we are just counting "big" dairy, "big" hogs and steers. We are not counting numbers of animals categorized as little dairy, dairy heifer, dairy calf, beef heifer, beef cow-calf, beef calf, medium swine or little swine, even though there are thousands of these animals in our area that are producing manure. We will need technical help to analyze this information.

From a quick analysis of the feedlot permits in the 15 counties in SE/SC MN, there are **16 dairies with approximately 25,525 cows where one of the Microgy digesters could be located. If 1,000 cows produce 775 kW of electricity, these 16 dairies with 25,525 cows could produce 19,782 kW or 19.8 MW capacity per year**.

Table 26: Dairies in SE/SC Region

Dairy Size	Number of Cows per Farm
> 2000 cows	One with 4,160; one with 3,480; one with 2,400; one with 2,140
1,285 – 1,426 cows	One with 1,415; one with 1,315; one with 1,426; one with 1,285
1,000 – 1,070 cows	Two with 1,067; one with 1,070; one with 1,000
800 – 999	Two with 999; one with 900, one with 800

Section 9.4.2 Agricultural Processors. There are several crop and livestock processors in the SE/SC Region, which are listed in Table 20. The waste stream of many of these processors could be used to produce biogas to heat and provide fuel for their plants and use the "waste" heat for entirely different purposes, such as heating a greenhouse to produce food. In addition to providing useful energy, anaerobic digestion can serve another important function of treating organic wastes at food processing plants before they are released into the environment. Six food processors in our region have waste water treatment facilities: Seneca Foods at Blue Earth, Land O'Lakes at Pine Island, Seneca Foods at Montgomery, AMPI and Seneca Foods in Rochester and Lakeside Foods Inc in Owatonna.

Section 9.4.3 Wastewater Treatment Plants. A chart listing waste water treatment plants, stab ponds and amounts of and disposition of biosolids by county is located in the Appendix in Charts 22 and 23. The potential of these resources for producing energy has yet to be assessed.

9.4.3.1 Waste Water Treatment Plants with Biosolids Applications are located at the following locations: Blue Earth County (Amboy, Lake Crystal, Madison Lake, Mankato, St. Clair), Dodge County (Dodge Center, Hayfield, Mantorville, West Concord), Faribault County (Blue Earth, Blue Earth-Seneca Foods, Winnebago), Fillmore County (Canton, Chatfield, Fountain, Harmony, Lanesboro, Mabel, Preston, Rushford, Spring Valley), Freeborn County (Albert Lea, Emmons), Goodhue County (Cannon Falls, Goodhue, Kenyon, Pine Island, Pine Island-Land O'Lakes, Red Wing, Zumbrota, St. Charles), Houston County (Brownsville, Caledonia, Hokah, Houston, LaCrescent, Spring Grove), Le Sueur County (Le Center, Le Sueur Cheese Pretreatment Facility, Montgomery, Montgomery-Seneca Foods, Waterville), Mower County (Austin, Austin-Hormel), Olmsted County (Byron, Rochester, Rochester-AMPI and Seneca Foods, Stewartville), Rice County (Faribault, Morristown), Steele County (Blooming Prairie, Medford, Owatonna, Owatonna-Lakeside Foods Inc), Wabasha County (Lake City, Plainview-Elgin), Waseca County (New Richland, Waseca), Winona County (Lewiston, Winona).

9.4.3.2 Waste Water Treatment Plants with Stab Ponds are located at the following sites: Blue Earth County (Good Thunder, Madison Lake, Mapleton, Pemberton), Faribault County (Bricelyn, Delevan, Elmore, Frost, Kiester, Wells), Freeborn County (Alden, Clarks Grove, Freeborn, Geneva, Glenville, Hartland, Hollandale, Oakland, Twin Lakes), Houston County (Eitzen), Le Sueur County (Elysian, Kilkenny, St. Peter, Waterville), Mower County (Dexter, Elkton, Grand Meadow, Lansing, LeRoy, Lyle, Racine, Rose Creek, Sargeant, Waltham), Olmsted County (Rochester), Steele County

(Ellendale, Medford, Owatonna), Wabasha County (Kellogg, Zumbro Falls), Winona County (Lewiston, Rollingstone, Stockton, Utica).

9.4.3.3 Waste Water Treatment Plants Generating Electricity & Using Digesters for Heat. Two waste water treatment plants in our region are generating electricity – Owatonna and Rochester. The plant is Rochester has two generators – one 400 kW generator and one 1,000 kW generator.

Municipal waste water treatments plants at Rochester, Austin, Albert Lea, Blue Earth, Mankato, Fairbault, Red Wing, Pine Island, New Richland, Harmony, Hokah and Owatonna are using the anaerobic digestion of biosolids for heating the digesters. All but Blue Earth are using the heat for their buildings. Six of the plants are flaring excess gas.

9.4.4 Open and Closed Sanitary Landfills. Municipal solid waste contains organic materials that produce a variety of gases when they are dumped, compacted and covered in landfills. Anaerobic bacteria thrive in the oxygen-free environment and break down the organic materials, producing carbon dioxide and methane. Carbon dioxide leaches out of the landfill because it is soluble in water. Methane, which is less soluble in water and lighter than air, is likely to migrate out of the landfill. Landfill gas energy facilities capture the methane (the principal component of natural gas) and combust it for energy. The potential to generate electricity from landfill gas in our region has yet to be assessed.

*9.4.4.1 Open Sanitary Landfills***.** There are four open landfills in our 15-county area: Ponderosa Sanitary Landfill in Blue Earth County, Kalmar Sanitary Landfill in Olmsted County, Rice County Sanitary Landfill and Steele County Sanitary Landfill. They are described more fully in the chart below.

Table 27: Open Landfills

Facility	**Location**	**Capacity Filled**	**Waste Volume**	**Methane**
Rice Cty SLF	Dundas	60/100 acres	2.8 mill cu yds	No
Steele Cty SLF	Blooming Prairie	40/70 acres	1.3 mill cu yds	No
Ponderosa SLF	Mankato	290/416 acres	2.0 mill cu yds	Flaring
Olmsted Cty SLF	Rochester	160 acres	1.3 mill cu yds	No

Table 28: Closed Sanitary Landfills

County	Facility	City	Acres Filled/Total	Waste in Volume
Blue Earth:	Hansen SLF	Mankato	14.7/40	240,000 cu yd
	City of Mankato	Mankato	13.7/17	100,000 cu yd
Dodge:	Dodge County SLF	St. Peter	11/23	328,000 cu yd
Faribault:	Faribault. Cty SLF	Blue Earth	23.2/40	785,000 cu yd
Fillmore:	Ironwood SLF	Spring Valley	12/123	200,000 cu yd
Freeborn	Albert Lea SLF	Albert Lea	27/36	1.77 million cu yd
Goodhue	Goodhue Coop SLF	Goodhue	5.5/85	90,000 cu yd
Houston	Houston Cty SLF	Houston	5.7/30	303,000 cu yd
Le Sueur	Sun Prairie SLF	Montgomery	20/80	130,411 cu yd
Le Sueur	Tellijohn SLF	Le Sueur	27.5/80	1.35 million cu yd
Le Sueur	MN San Serv SLF	St. Peter		178,000 cu yd
Mower	Red Rock	Austin	35/80	234,000 cu yd
Mower	Adams SLF	Adams	2/3 acres	50,000 cu yd
Olmsted	Olmsted Cty SLF	Rochester	51.1/290	2.8 million cu yd
Wabasha	Wabasha Cty SLF	Wabasha	8/8.3	272,000 cu yd
Waseca	Waseca Cty SLF	Waseca	24.3/133	400,000 cu yd
Winona	Geisler's SLF	Stockton	6/10 acres	50,000 cu yd

Section 9.5 Hydroelectric

Hydroelectricity was the first large-scale source of energy and electricity in our region. Hydro-powered dams ran numerous grain mills and municipal power stations. Hydroelectric facilities in our region include Rochester Public Utility's 2,680 kW plant on the Zumbro River, Lanesboro Public Utility's 240 kW plant at Lanesboro and Rapidan's 3,400 kW plant at Mankato.

We didn't include any new hydroelectric facilities in our assessment. However, we are intrigued with new technologies being developed that use the natural flow of rivers to generate electricity on a flow-through basis, so that large hydroelectric dams and reservoirs aren't needed. Since there are a large number of rivers in our area, this technology holds potential for the future. If electricity supplies tighten dramatically in the future, this resource may prove to be useful again, as long as it doesn't adversely impact the river and its ecosystems.

Section 9.6 Cogeneration or Combined Heat and Power (CHP)

When electricity is produced, large amounts of heat are also produced. Cogeneration, or combined heat and power (CHP), allows the waste heat to be used for some other useful purpose, like hot water heating, space heating, heating a greenhouse or some other thermal application. Using the heat increases the productivity of the energy used in the power plant from a relatively low efficiency of 30 percent to one as high as 90 percent. Fuels commonly used in cogeneration include natural gas, oil, diesel fuel, propane, coal, wood, wood-waste and biomass.

9.6.1 Potential for CHP in the SE/SC CERT Region. The potential for CHP in our area has not been assessed. We think there is large potential for CHP in communities that have processing plants and a municipal utility which has an electricity generating facility. The processing plant can make use of the heat being generated, and the municipal utility is likely to have skilled staff available to manage the operation. The following chart shows which communities have munis and/or electrical generation capability and/or crop and livestock processing plants in the SE/SC CERT area.

Municipal Utility	Electrical Generation	Processing Plant(s)
Austin	Yes	Meat, Grain
Blooming Prairie	Yes	Grain
Blue Earth	Yes	Fat, Grain, Fruit/Veg
Janesville	Yes	Grain, Ethanol
Kenyon	Yes	Fruit/Veg
Lake Crystal	Yes	Ethanol
Lanesboro	Yes	
New Prague	Yes	Dairy, Grain
Owatonna	Yes	Dairy, Fruit/Veg, Grain
Preston	Yes	Dairy, Ethanol
Rochester	Yes	Dairy, Fruit/Veg
Spring Valley	Yes	Diary, Meat
Waseca	Yes	Dairy, Fruit/Veg, Grain
Wells	Yes	Meat, Grain, Fruit/Veg
Caledonia	No	Fruit/Veg
Harmony	No	Dairy, Grain
Lake City	No	Grain
LeSueur	No	Dairy,Fat, Fruit/Veg,Grain
St. Charles	No	Meat

The following communities have municipal power agencies, but to our knowledge don't have generation facilities or crop or livestock processors: Whalen, Eitzen, Kasota, Kasson, Mabel, Rushford, Spring Grove and St. Peter.

9.6.2 Two Examples of CHP/Cogeneration Projects in Rochester. According to "Opportunities to Expand Cogeneration in Minnesota," Rochester has two cogeneration projects – one in operation and one being developed in May 2005. First, Rochester Public Utilities is planning to supply electrical and thermal energy to the Mayo Clinic and a portion of the Kahler Hotel. The system should supply all of the heating and cooling needs for the five million square foot hospital campus, as well as one-half of the approximately 20 MW electrical load. A coal fired boiler will supply 800 psig steam to three turbines. Low pressure steam at 10 psig will be used for space heating. The largest of the three turbine generators is a 6.6 MW backpressure turbine, while the other two are extraction turbines with condensers. Second, Olmsted County operates a cogeneration/district heating system with a 3 MW refuse-fired plant that came on line in 1987. They sell excess power to the Southern Minnesota Municipal Power Agency and thermal energy to the city district heating system.

9.6.3 Example of a Possible Commercial CHP Project in Rochester. There is a large commercial laundry located south of Menards South in Rochester. The facility could generate power with natural gas, use waste heat to heat water and power a heat pump to recover energy from waste water to aid in drying the laundered fabrics. In a commercial operation, power could also be used to create a modest vacuum to accelerate the drying of the fabrics. A similar application exists in the maple sugar industry where sap is batch heated under vacuum to accelerate the evaporation process. An energy transfer/desiccant wheel could be powered by waste heat and be used to pull moisture from inbound dryer air.

9.6.4 Example of Utilization of CHP on Farms. A farmer could use a biodiesel powered generator to generate electricity and use the waste heat from the engine to heat water and space. Massive Earth Seasonal Thermal Energy Storage could store heat for winter space heating of living and shop space. It might also be adapted for crop drying in the fall. Low cost units would probably not be acceptable to grid interconnection (synchronization, power factor, harmonics, etc.), so an either-or switch between line and local power would have to be utilized. As time-of-day metering is implemented by utilities, on-site power generation during peak demand periods could save energy costs substantially. As mentioned previously, heat from the process of turning manure into biogas and generating electricity can be used on the farm to heat buildings or water.

Section 9.7 Geothermal Ground Source Heat Pumps, Geothermal Water Source Heat Pumps and Air-to-Air Heat Exchangers. We were unable to find a recent, comprehensive assessment of the potential for ground, water or air source heat pumps in Minnesota. A study by the EPA found that ground source heat pumps are the most energy efficient and environmentally clean heating and cooling system available, and they are 72 percent more efficient than electric heating and cooling systems.[94]

Depending on the existing heating and cooling systems that are replaced, installing a geothermal energy system can save homeowners and businesses between 25 and 50 percent of their annual energy costs. Taking information from the Geo-Heat Center and assuming that five percent of the households in the SE/SC CERT area installed heat pump systems over the next 20 years, we calculate the potential for using heat from the earth in the region at 250 billion Btu/year.[95]

9.7.1 Air to Air Heat Exchangers. An air to air heat exchanger takes air from one source and transfers the heat in the air to another source through a contained fluid. In the winter, a heat pump takes heat from outside air and brings it inside the home. When the outside air temperature drops below 25 to 30 degrees Fahrenheit, the air source heat pump uses electric resistance heat. In the summer, the heat pump reverses the process. It cools the house by transporting heat from inside the home to the outside. Electric resistant heating is very expensive and inefficient from a total system perspective because of the huge losses between the energy source in the ground and delivery to the end users.

9.7.2 Closed Loop Geothermal Heating and Cooling Systems. Geothermal heating and cooling systems work a little differently. They use the seasonal average 50 degree temperature of the soil six feet or more beneath the earth's surface to heat and cool buildings and heat water. Tubes that are coiled into loops are buried beneath the frost line. The tubes can be placed horizontally or vertically in boreholes or wells, depending on space limitations. A heat transfer fluid circulates through the tubes. During the winter, heat energy is conducted from the ground (the heat source) to the fluid and then to the geothermal unit in the home. In the home the heat can be distributed through either a conventional duct system or hydronic radiant heat system. During the summer,

[94] Union of Concerned Scientists. Retrieved September 2004 from: www.uscusa.org/clean_energy/renewable_energy/page.cfm?pageID=81.
[95] Geo-Heat Center. Retrieved from: http://geoheat.oit.edu/. Using a coefficient of operation (COP) of 3.0 and 1,000 full-load hours per year in the heating mode, a 12 kW (3.4 ton) heat pump unit removes approximately 27.2 million Btu/yr from the ground.

the process is reversed to cool the house. Heat is removed from the home and transferred to the loop fluid. As the warm fluid travels through the pipe in the earth, it is cooled. In the cooling mode, the earth serves as a "heat sink," a place to deposit the heat removed from the home. A hot water heater can be added to the geothermal systems to replace conventional electric or gas hot water heaters.

9.7.3 Open Loop Geothermal Heating and Cooling Systems. Open loop geothermal systems have outlets in wells, lakes, or streams and work in a similar fashion as described above.

Legislation is pending and will most likely be passed in Minnesota in 2005 that would provide geothermal energy equipment with a sales tax exemption.

9.7.4 Larger Geothermal Systems in Our Region. Steele County installed a geothermal system in its recently constructed detention center. County officials believe that the geothermal system will pay for itself by 2007 through the energy savings.[96] The school in Grand Meadow also has a large geothermal system.

9.7.5 Geothermal Power Plants and Systems Can Be Established On a Community Scale. A consortium including Environment Canada and a number of other organizations recently announced a pilot program near Calgary, Alberta, to build 52 homes, put solar panels on the garages and collect and store energy throughout the year in a shared earth storage area using boreholes. Their goal is to demonstrate the viability of seasonal thermal energy storage for space and water heating of a group of homes.

SECTION 9.8 Biofuels and New Technologies for Transportation (Hybrids).

We are concerned about the sustainability of using corn and soybeans to produce biofuels over the long term; however, they are important transitional liquid fuels until new technologies, such as fuel cells and producing ethanol from cellulose, are perfected and commercially available.

***9.8.1 Using* Biofuels**. Ethanol from corn and biodiesel are the two alternative transportation fuels available to Minnesota customers in May 2005. A number of passenger vehicles - called Flexible Fuel Vehicles - are equipped to run on alternative fuels. Several Ford, Daimler Chrysler, and General Motors vehicles are equipped to run on E85 and diesel cars like the VW Jetta can easily be converted to using biodiesel.

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[96] Mary Overlee Olson – Steele County Recycling Coordinator, 507-444-7476

9.8.2 Ethanol. All gasoline in Minnesota is mixed with a 10 percent blend of ethanol, and the legislature passed a mandate in May 2005 that fuel must contain 20 percent ethanol blends. Under the legislation, a new E20 mandate would take effect in 2013 unless ethanol has already replaced 20 percent of the state's motor vehicle fuel by 2010. The rule would expire at the end of 2010 if Minnesota is not granted federal approval to use E20 gasoline blends. Ethanol is also available in an 85 percent blend (E85) that is sold at select gas stations across the state. The stations in our region that we identified as of April 2005 are listed in the Appendix at Chart 23. Ethanol is being produced at five plants in the SE/SC Region, and a new plant is being constructed at Janesville.

9.8.3 Biodiesel. Biodiesel fuel is made from vegetable oil or animal fats and is usable in any unmodified diesel engine. Most U.S. biodiesel is made from soybean oil. Biodiesel, where available, is generally provided in either two percent (B2) or 20 percent (B20) blends. Minnesota law requires that diesel fuel sold in Minnesota contain two percent biodiesel after June 20,2005, when eight million gallons of biodiesel are being produced in the state.

Diesel off-road equipment, buses, trucks and passenger vehicles, such as VW Jetta and Passat, TDIs and diesel pickups, may burn biodiesel blended at any percentage with regular petroleum diesel or even straight ("B100") biodiesel. 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 nine 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, where over 100 vehicles are using a B20 blend. The same sort of program could be used at city and county fleets throughout the SE/SC Region

Combustion of B100 yields no net increase in atmospheric carbon dioxide, since the carbon dioxide released during combustion is equal to the carbon dioxide taken out of the atmosphere to grow the soybeans. The lifecycle carbon dioxide emissions of B100, taking into account all fossil fuel inputs in the soybean growing, harvesting, transportation and biodiesel production process, total about 22 percent that of petroleum diesel according to a recent study by the U.S. Department of Energy and USDA.

Farm Country Co-op of Wanamingo is one of the few retailers in the region selling B100 at this time. That biodiesel is being made from animal wastes. B100 should become more readily available when new Minnesota biodiesel facilities begin production later in 2005. Blended biodiesel may be purchased at a number of retail facilities in southeastern and south central Minnesota (see http://www.mnsoybean.org/Biodiesel/Retailers.cfm for a relatively comprehensive list).

SoyMor is building a 25 million gallon soydiesel plant in Glenville, with production planned to begin in the spring/summer of 2005. There is discussion about building another biodiesel plant in our region in Eyota.

*9.8.3.1 Electric applications for Biofuels***.** There is also great potential for using biodiesel as a substitute for petroleum-based diesel in diesel generators used to generate electricity. Converting diesel generators to use a 20 percent biodiesel blend, would reduce air emissions of carbon monoxide, hydrocarbons and particulates.

*9.8.3.2 Homescale Production of Biofuels***.** The production of biofuels requires growing, storage and processing space that puts it out of reach for the majority of Minnesota residents. However, for the rural residents, it is possible to raise oil crops, press the oil, and process it to fuel tractors, trucks, cars and generate electricity. Diesel engines do not have to be modified to use biodiesel, in fact they last longer because of the increased lubricity of the fuel. Small stills can be purchased to process used vegetable cooking oil from restaurants.

SECTION 9.9 Alternative Cars and Hybrid Electric Vehicles (HEVs)[97]

9.9.1 How Hybrids Are Different from Traditional Vehicles. Hybrids offer fuel economy and emissions benefits because they operate differently than conventional gasoline-fueled cars. In a **gasoline vehicle,** the heat energy obtained by burning gasoline powers the engine, which drives the transmission that turns the wheels. In an **electric vehicle**, a set of batteries provides electricity to a motor, which drives the wheels.

9.9.2 There are different types of hybrid vehicles, depending on the ways the engine motor, generator and battery are combined. Three basic hybrid configurations are the series, parallel and split (or through-the-road) designs.

1. Series. The engine never directly powers the car. Instead, the engine drives the generator, and the generator can either charge the batteries or power an electric motor that drives the wheels.

[97] US Department of Energy. "Technology Snapshot". Retrieved from: www.fueleconomy.gov/feg/tech/TechSnapPrius1_5_01b.pdf.

2. Parallel. The engine connects to the transmission, as does the electric motor. Thus, both the engine and the generator/motor can supply power to the wheels, switching back and forth as driving conditions vary. This configuration may run battery-only in town, engine plus battery/motor while accelerating and engine-only while cruising at constant speed.

3. Split. The engine drives one axle and the electric motor drives the other. There is no connection between the engine and the motor except "through the road."

The Toyota Prius combines features of both a series and parallel hybrid electric vehicle, and it is the world's first mass-produced HEV. The Prius is a breakthrough in many ways, combining an efficient gasoline fueled internal combustion engine with a clean, quiet electric motor powered by a battery. Like other HEVs, the Prius has many innovative features.

- Regenerative braking: The motor recovers energy from the brakes when they slow down or stop the vehicle and uses it to recharge the battery.
- Lighter, smaller engine: To improve efficiency, the Prius engine is sized to accommodate its average power load, not its peak load. Most gasoline engines are sized for peak power requirements, yet most drivers need peak power only one percent of the time.
- Better fuel efficiency: The Prius consumes less fuel than vehicles powered by gasoline alone, partly because the engine is turned off when it's not needed. Conventional gasoline engines run constantly, regardless of power requirements.
- Lower emissions: The Prius reduces regulated tailpipe emissions by up to 90 percent and greenhouse gas emissions by about 50 percent compared with Tier 2 standards.
- More aerodynamic: The streamlined Prius exterior (0.29 coefficient of drag) reduces drag by about 14 percent compared with the typical family sedan.

Other Hybrid cars include the Honda Civic and Ford Escape. Many more hybrid models are expected to be introduced in the near future, including Toyota and Ford SUVs.

SECTION 10. BARRIERS TO ENERGY EFFICIENCY AND RENEWABLE ENERGY DEVELOPMENT

Section 10.1 Economic Barriers

Perhaps the major barrier to widespread development of energy efficiency and renewable energy projects is the difficulty of establishing their cost effectiveness in the current economic environment. Several factors are at work.

Energy efficiency projects are simple in that just the capital cost and financing of the project hardware and the value of the energy that is saved are at issue. For renewable energy projects, three principal factors affect a project's economic viability. These are (1) the availability of the renewable energy resource, (2) the capital cost and financing of the project hardware and (3) the value of the energy that is produced. The availability of the renewable energy resources is addressed elsewhere in this report and will not be discussed here.

10.1.1 Raising Capital and Financing. Raising the initial capital cost of the installed renewable energy system can be a substantial barrier, depending on the technology type and size of the project. Smaller size projects have a relatively higher capital cost burden per unit of energy produced than larger projects because of a lack of economies of scale. Because these emerging renewable technologies are new to the banking and investment community, they are naturally cautious about providing debt or equity financing. Educating bankers about the risks and economic performance of various technology types is one of the barriers that must be overcome. Often there is a need for developmental capital, which is money necessary for engineering and cost estimates, system integration studies or even economic performance predictions that create additional barriers to finding enough initial capital to get a project going. Ideally, investments in efficiency and renewables should be part of a mortgage. Energy savings may then be shows to be equivalent to an income generator that will pay off the mortgage.

10.1.2 Determining the Value of the Electricity To Be Sold. The relative value of the energy produced is often determined by the avoided fuel cost for what the most competitive fossil fuel alternative to provide the energy would be. In the case of electricity, most situations will have the price of obtaining or selling electricity to or from the grid as the market competition. However, the value assigned typically ignores the value of the energy when provided during periods of peak loads. The avoided demand charge contribution should be recognized in the rate paid for the renewable energy.

The complex state and federal regulatory structure regarding purchase and sale of electricity from the grid can make a barrier out of determining the prices one could get for electricity sold or purchased when an on site generator is present. Often the dollar value of energy delivered to the grid is substantially lower than the dollar value of energy purchased. One exception in Minnesota is the case of a renewable generator rated less than 40 kW, where the selling price of energy produced locally is essentially the retail purchase price.

Historically, a project developer has either had to accept the utilities "avoided cost" rates, which have seemed artificially low to some, or individually negotiate a contract price arrangement with the utility. Negotiating rates and other contract terms and conditions with the utility adds time and cost to the process. Simply off-setting normally purchased kWhs with energy produced locally on a kWh equal price basis has not been an option in Minnesota.

Utility rates for backup power may not properly reflect actual costs. Retail rate structures in place for providing back up power to a generating facility when the unit is out of service have had large negative economic impacts on local generation projects.

Recently, Xcel Energy has offered a special tariff (at $0.033 per kWh) available to only wind energy technologies. Other special retail tariffs may be in development for clean energy technologies and for community based energy systems. The time it takes for these items to move through the regulatory approval process will continue the status quo of pricing for some time yet.

Generally, commercial and industrial customers purchase about two-thirds of the electricity produced each year. Focused on the bottom line, most commercial and industrial customers want to purchase the cheapest energy available, rather than more expensive green energy with long-term benefits, such as environmental protection.

At this time, distributed generation customers can't easily sell power directly from on-site generation to the utility through a competitive bidding process to a wholesale marketer or to other retail customers.

The generally low prices available for energy produced create an impression that renewable energy doesn't save enough money to be worthwhile. Low electricity prices lead to long simple payback periods. Life cycle costing analyses that factors in the probability of increasing costs of grid energy in the future are rarely used to evaluate project economics.

Creative financing structures that would allow for a positive cash flow in the early years of a project life are not available from the financial community.

Section 10.2 Regulatory Issues

10.2.1 Siting and Permitting. Getting zoning permits from local governments for wind turbines solar systems and biogas digesters can be problematic because the standards for green energy are still developing. Many communities lack wind or solar access protection ordinances, and thus do not yet know how to deal with requests to build wind turbines or are currently in the processes of formatting ordinances with regard to many green energy programs. Wind plants over 5 MW in size must get a siting permit from the state Environmental Quality Board.

10.2.2 Subsidies. The government subsidizes nuclear and fossil fuel technologies to a much greater degree than it does renewables, making it all the more difficult to mainstream renewable energy.

10.2.3 Taxes. Current property tax law in Minnesota assesses an in-lieu of property tax fee on wind energy projects based on their size. Since the mid-1990s, almost every single medium to large-scale fossil-fueled energy project has sought and received a property tax exemption from the state legislature. This is a form of barrier to renewable energy, since the major renewable energy technology (wind power) pays a form of property taxes and other conventional technologies don't. The "Biomass Mandate" energy projects in Minnesota have also received legislative property tax exemptions.

Section 10.3 Institutional Barriers

10.3.1 Monopoly status. Utilities have little incentive to voluntarily buy energy from distributed generation projects or allow reduced energy purchases from customer-sited generation. The utilities are in the business of selling electricity, so they will tend to be adversarial toward efforts to move toward on-site, self-generation of energy. Of course, they also have to keep the safety of all of their line workers in mind, and this can also cause utilities to, understandably, put up barriers.

10.3.2 Older Planning Standards. Utility planning for energy and capacity needs (known as Integrated Resource Planning in Minnesota) is done in isolation from distribution system and transmission system planning, and neither generally considers distributed generation options as a viable planning tool.

10.3.3 New Technology Issues. Emerging technologies are usually met with some resistance: "Everything works the way it is now." We have to overcome inertia to implement change. Resistance from utility and/or building inspector can be simply due to unfamiliarity with the technology.

10.3.4 Information. Most electricity customers don't have enough information to make informed decisions about the type of energy they would prefer to purchase and/or don't know how to find a competent contractor or technician to help them sort it out. Among the potential users of the new technology there can be a general lack of perceived benefits, a perception that it will cause inconvenience or hardship or that it is just to hard to try to figure out. This can result in a lack of commitment to make it happen.

10.3.5 Implementation Gap. Even when people are given a choice about the type of electricity they can purchase and are provided with information about renewable energy "green pricing programs," they don't participate. This can result in the public benefit/free rider dilemma described next.

10.3.6 Free Rider Dilemma. Currently, green energy suffers the free rider dilemma. Even though most people respond when surveyed that they would be willing to pay higher electricity bills if the energy they were purchasing was from renewable sources, many do not to participate in the voluntary programs. People who choose not to buy into green energy programs still receive the benefit of clean air and water without the cost.

10.3.7 The Interests of Landlords Run Counter to the Interests of Renters. Building owners are interested in realizing minimum costs of operating their buildings and reducing their capital investment/mortgage. The occupants/renters of a building typically are not part of the initial building design process and have few options regarding building efficiency and utilization of renewable energy.

Section 10.4 Commercial Barriers

10.4.1 Prospecting. It takes time to locate and evaluate applications for green energy programs. Wind site evaluation can take a long time, especially for a larger turbine system, perhaps several years of monitoring. Getting access to sufficient land and/or associated wind rights can also take substantial time.

10.4.2 Marketing. New green energy companies have to compete in the current established energy industry with high level of marketing. This is expensive and marketing alone raises the cost of this new green energy considerably.

10.4.3 Installation & Upkeep. People must be trained to install, operate maintain and trouble shoot new technologies. Some renewables operate differently in different climates, thus training has to be very thorough and specific. This lack of infrastructure creates a classic "chicken and egg" problem for industry growth.

10.4.4 Assembly Line. Most nonrenewable energy technologies are manufactured in an assembly line. Mass production could greatly reduce the per item cost. However, there is not a high enough demand yet for renewable energy products to mass produce them and realize cost savings from volume production.

Section 10.5 Interconnection Barriers

Minnesota now has developed technical safety and reliability standards for connections to the distribution system in the entire state, but tariff rates for projects under 10 MW are still being developed. For small-scale, onsite projects there may be problems getting an interconnection with the local distribution utility. A lack of historical experience with the new standards at many utilities could lead to delays in getting a project completed.

Transmission system interconnection studies and waiting in queue for this analysis do be done by Midwest Independent System Operator (MISO) can be time consuming and expensive to implement. For medium- or commercial-sized projects, transmission bottlenecks can limit the potential locations for projects or may require additional transmission line investments before moving forward.

Potentially financially burdensome liability insurance requirements may be part of the interconnection process. This may be especially burdensome to smaller-sized projects.

Evolving federal interconnection standards for small generators (less than 20 MW) at MISO and the Federal Energy Regulatory Commission (FERC) are also a barrier to interconnection when the energy produced by a project impacts the transmission grid. The time it takes to get these uniform standards adopted will continue uncertainty for these type projects.