






COMMUNITIES AND LOCAL ENERGY

Designing A Clean Energy Future: A Resource Manual

Developed for the Clean Energy Resource Teams

The Minnesota Project

University of Minnesota's Regional Sustainable Development Partnerships

Minnesota Department of Commerce

July 2003

The manual is available in electronic format on the following web sites:

The Minnesota Project
www.mnproject.org

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www.regionalpartnerships.umn.edu

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ABOUT THIS REPORT

This report was a collaborative project of The Minnesota Project, the University of Minnesota's Regional Sustainable Development Partnerships, and the Minnesota Department of Commerce. ***Melissa Pawlisch*** is a graduate of the Humphrey Institute of Public Affairs of the University of Minnesota. She worked on the report through a fellowship from the University of Minnesota's Regional Sustainable Development Partnerships and the Community Assistantship Project. ***Carl Nelson*** is a Program Manager and ***Lola Schoenrich*** is Senior Program Director at the Minnesota Project.

The Minnesota Project is a nonprofit organization dedicated to sustainable development and environmental protection in rural Minnesota. Since 1979, The Minnesota Project has worked to promote healthy rural communities through building broad-based coalitions, facilitating statewide, regional, and national networks, and connecting communities to resources and policy forums. Current program areas are renewable energy development, sustainable agriculture, water protection, and community sustainability.

The University of Minnesota's ***Regional Sustainable Development Partnerships*** bring together communities and University faculty and students to foster sustainable development in five rural regions. In collaboration with the University, citizens in these communities work through regional boards to develop innovative programs and projects that strengthen natural resources, agriculture, and tourism. Local energy and local foods are two areas of focus across regions. The Regional Partnerships program is a joint effort of University's Extension Service; the College of Agricultural, Food and Environmental Sciences; and the College of Natural Resources.

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Many thanks to all of the Regional Advisory Committee Members and Technical Committee Members for the time and effort they put into guiding the process of assembling this workbook, providing their insights into the many renewable energy opportunities available in Minnesota, and reviewing draft after draft of the text.

In addition, a special thank you to all of the case study contacts who shared the stories of their communities and took special time to review them. These case studies give readers a real sense of the important work already underway in Minnesota.

Funding was provided by the University of Minnesota's Regional Sustainable Development Partnerships, with the assistance of the Community Assistantship Program, Minnesota Department of Commerce, The Energy Foundation, The Surdna Foundation, The W. Alton Jones Foundation, and The Unity Avenue Foundation.

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PURPOSE OF THE WORKBOOK

This workbook was written for use by the Clean Energy Resource Teams and focuses on opportunities for communities to engage in energy planning regarding renewable and community energy projects. It is our hope that the workbook will be useful to a wide range of communities and a broad spectrum of audiences including local government officials, local utilities, businesses, farmers, community leaders, and individuals.

The focus of the workbook is to:

- *Provide quick reference material that details potential energy alternatives and the nuts-and-bolts of implementation*
- *Provide detailed case studies that illustrate how similar projects have previously been done in Minnesota*
- *Provide bibliographical references for further resources and lists of contacts*

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The following symbols are used in this book to help identify the ways in which the case studies illustrated may be of help to your community

- *Improves the environment*
- *Works well with agriculture*
- *Helps with reliability concerns*
- *Recycles waste materials and waste heat*
- *Offers community economic development*
- *Improves energy independence, local control, and energy security*
- *Promotes learning about energy*

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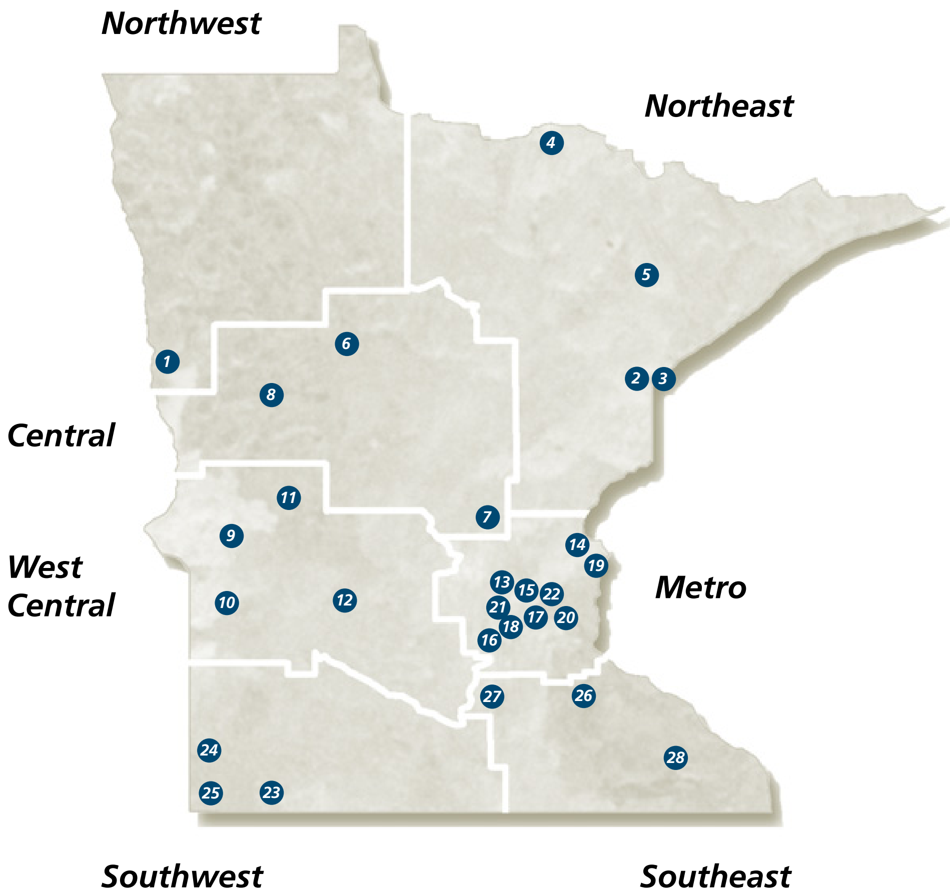

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HELPING MINNESOTA COMMUNITIES DETERMINE THEIR ENERGY FUTURE

A growing number of Minnesotans envision a future built upon a wide mix of renewable local energy sources – wind, biomass, solar and even hydrogen. The challenge is to bring technical resources to communities so that they can help to design this clean energy future. Many community and industry leaders interested in developing renewable energy alternatives do not have the technical background to evaluate the feasibility of potential energy projects. Community energy planning is too often piecemeal, with little linkage of strategic goals to outcomes. In addition, important stakeholders are often left out of the process.

To address these challenges, several organizations have joined together to launch an exciting and innovative project. These organizations are the Minnesota Department of Commerce, the Minnesota Project, the University of Minnesota's Regional Sustainable Development Partnerships, the Rural and Metro County Energy Task Forces, and the Resource Conservation and Development Councils. Named Clean Energy Resource Teams, or CERTS, the project seeks to engage regions and communities in planning and determining their energy futures. CERTS is patterned after the notion of regional resource management plans like county water plans.

The success of this project will rest upon the strength of collaboration between regional energy planning teams and technical resources. The regional teams will be comprised of community, industry, and government stakeholders. CERTS will match these teams with the technical expertise needed to accelerate development of renewable energy projects using local resources. The technical assistance will help the teams identify and prioritize renewable energy opportunities within their region. In this way, the regional teams will gain the knowledge and technical support needed to assess cost-effective energy options.

The outcome of the project will be a comprehensive and strategic renewable energy plan and vision for each region that reflects a mix of energy sources, such as biomass, solar, hydrogen, and wind. The plan will lay the groundwork for funding and implementing renewable energy projects that meet regional needs in a systematic and comprehensive way. CERTS is expected to begin in summer 2003.

PURPOSE OF THE WORKBOOK

This manual presents various energy technology options and discusses how communities have gone about shaping their energy future. The workbook provides users with quick reference material that details clean, local energy options as well as nuts-and-bolts for implementing community energy projects. It includes detailed case studies that describe how these projects have been implemented in the past and the level of success they have achieved. Lastly, the workbook provides lists of bibliographical references for those who wish to do more reading and research and lists of contacts for additional information.

CONTACT INFORMATION FOR CLEAN ENERGY RESOURCE TEAMS

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CHAPTER 1

Introduction

COUNTIES AND MUNICIPALITIES have started to take a more active role in defining their energy future over the past several years. There are many reasons for this new local interest, but whatever the impetus, the direction is clear. Communities are looking for more locally controlled energy supplies and more renewable energy resources and are increasingly interested in moving away from centralized power stations running on imported fossil and nuclear fuels. Community energy is not a new phenomenon, and in fact, this trend represents both a renaissance back to early 20th century traditions and an advancement made possible by 21st century technologies.

Minnesota is well aligned to be a leader in energy systems that meet community energy needs, keep dollars in the local community, and have long-term environmental benefits.

WHAT WAS COMMUNITY ENERGY?

Before 1900 nearly all power was generated locally. Small-scale onsite energy generators provided electricity all across America. Farmers relied on windmills to pump their water. Mills depended upon rivers and streams to power their operations. Onsite generators powered industries and theaters.

As economies of scale made centralized power stations cheaper and more efficient, the nation shifted toward purchasing electricity from these central suppliers and away from community energy. Between 1900 and 1930, the proportion of onsite electricity generation declined from 60% to 20%[1].

WHAT IS COMMUNITY ENERGY?

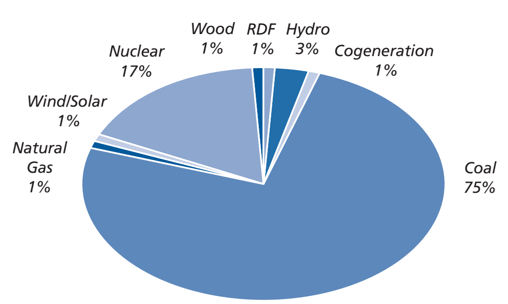
Community energy today is based on electricity generation that is located in or near the building, facility, or community where it is used. Electricity generated near where it is used is often called distributed energy. Community energy could be fueled by renewable resources, like wind, biomass, hydropower, and solar, or by fossil fuels, like diesel and natural gas. Throughout this workbook, community energy is defined as electricity that is generated from local, renewable resources and is located onsite or near the users.

There have been many changes in electricity generation technology in recent years. Whereas throughout much of the 1900's centralized power stations were by far the most efficient and cost effective, today distributed generation is becoming increasingly efficient and cost effective. Equally important, community energy can be fueled by a wide variety of renewable energy sources, providing long-term environmental benefits.

WHY RENEWABLE ENERGY?

The electric utility industry is the largest single source of air pollution in the United States because of coal burning. In Minnesota, 75% of the state's electricity is generated from coal and 17% from nuclear. The electric industry contributes 78% of the sulfur dioxide, 61% of the nitrogen oxide and more than half the mercury into Minnesota's lakes and streams, a very significant public health and economic issue. Air pollution from coal-fired power plants compromises our health, contributing to respiratory diseases such as asthma and causes acid rain.

Fuels used to generate electricity to serve Minnesota



Source: 2001 Energy Planning Report, MN Department of Commerce

Minnesota's only local energy resources are renewables. Homegrown energy offers:

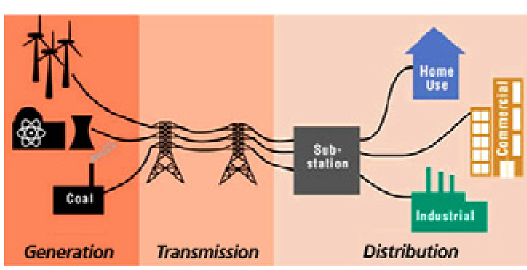
- *Opportunities for local economic development*
- *Greater community self-reliance*
- *Reduced reliance on volatile-priced foreign fuels*
- *A cleaner environment*

Global warming is another, growing problem. Burning fossil fuels is the main source of the increasing concentration of carbon dioxide in the atmosphere, the biggest factor in global warming. Minnesota scientists predict devastation of forest ecologies; disruption of agriculture by drought, flooding, pests, weeds, and reduced soil moisture; disruption of hunting and fishing habitat, including likely reductions in waterfowl and the loss of trout from Minnesota's streams.

Evidence is mounting that changes are already occurring. For instance, a recent study by the Department of Global Ecology of the Carnegie Institution of Washington in Stanford, California documented significant reductions in corn and soybean yield attributed to warming temperatures.[2] In addition to farming, forestry, hunting, and fishing, many of Minnesota's other industries, such as tourism and cold-weather performance testing, are totally dependent on a climate that is clearly rapidly changing.

Renewable energy from wind, biomass, solar and other local resources is clean, safe and abundant in Minnesota. Wind generated electricity has no emissions. Farm-grown biomass fuel sequesters carbon in the soil. Emission-free solar power can be ideal for remote locations. Anaerobic digestion generates electricity using manure from farms or waste from food processing and cleans up water and odor pollution at the same time. Many renewable community energy projects serve a dual purpose, generating electricity and improving the local environment.

The components of the electric grid



HOW IS THE ELECTRICAL ENERGY SYSTEM STRUCTURED TODAY?

Today our electric system has three components: generation, transmission and distribution. Most of the generation occurs at large centralized power stations. In Minnesota, most of these centralized power stations rely on coal and nuclear fuel to make electricity. They burn fuel to heat water and create steam that turns a turbine and generates electricity. High-voltage electricity is transported to local substations by a complex, and in places aging, electric grid,

Why the Shift Back to Community, Distributed Energy?

TECHNOLOGY CHANGES AND IMPROVEMENTS

- *Improvements in fuel conversion make smaller generators more efficient.*
- *Manufactured technologies are cheaper than big power plants.*
- *The future development of fuel cells and microturbines will make onsite generation reliable and affordable.*
- *Smaller "combined cycle" and combined heat and power generators are highly efficient.*

NEW RELIABILITY NEEDS OF THE INFORMATION ECONOMY

- *Technology-based businesses cannot afford power outages.*
- *Computerized industries require greater power quality.*

RELIABILITY NEEDS OF COMMUNITIES

- *Municipal utilities with only one incoming power line face outages due to weather and equipment failure.*

LOCAL ENERGY OPPORTUNITIES

- *Distributed energy generation fueled by local resources stimulates community economic development.*

ENVIRONMENTAL AND HEALTH CONCERNS

- *Renewable community energy improves air and water quality, and helps mitigate global warming.*
- *Cleaner electricity reduces the negative health impacts of the current system.*

also known as the transmission system. At substations, transformers reduce the electric voltage for distribution to our homes and businesses completing the three-tiered chain.

GETTING STARTED

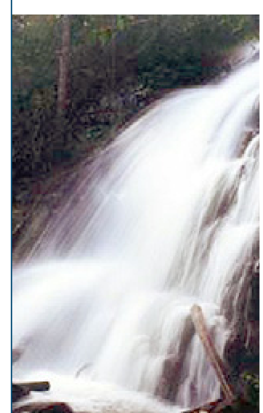
Start with Conservation and Energy Efficiency The common misconception that conservation and energy efficiency means sacrifice, turning down the heat until you're cold and turning off all but one light, needs to be corrected. Turning off lights and keeping the thermostat at 65° instead of 70° are good energy saving practices, but reducing use of electricity is more about using better technologies than about changing behaviors. In the *2001 Energy Planning Report*[3], the Minnesota Department of Commerce defines conservation as "primarily physical improvements that result in reduced energy consumption and that can be relied on, once they are installed, to continue to use less energy in the future."

Conservation and energy efficiency is the best place to start when crafting the 21st century energy future. Conservation is the cheapest and often the easiest way to modify resource usage. Conservation reduces overall energy consumption, minimizing the potential for shortages and reducing the negative environmental impacts of fossil fuel or nuclear generation. Before looking at new generation of any kind, individuals, community leaders, business leaders, and government should evaluate what steps could be taken to conserve and improve energy efficiency. This includes technological changes such as using more energy efficient light bulbs and appliances, constructing buildings to take advantage of natural light and natural heating, or installing better insulation, all of which save money as well as energy.

Move Toward Local Renewable Resources and Community Energy Production Even with significant conservation and efficiency improvements, there may still be interest in and need for new sources of energy for the community. Since Minnesota's only local energy resources are renewables, homegrown energy offers the potential for local economic development, greater self-reliance, and less reliance on foreign and volatile-priced fuels, and a cleaner environment.

Ethanol is a good example of the multiple benefits of using homegrown energy. Using ethanol increases energy security by utilizing a locally produced fuel that allows cars to burn "cleaner". In addition, the Minnesota model of small, farmer-based cooperatives that produce ethanol keeps profits in the community.

There are two key components to the community energy shift in Minnesota. The first is movement away from large, central station generating facilities to smaller, more flexible onsite or community generation. The second is the use of clean, local, renewable resources to generate electricity. Resources that make sense will spawn greater energy independence and mitigate, rather than exacerbate, environmental impacts. By moving toward these goals, Minnesotans are making choices today that will truly revolutionize our energy system in the future.



END NOTES

[1]Morris, David, *Seeing the Light*, Institute for Local Self Reliance, 2001, www.newrules.org

[2]Lobell and Asner, "Climate and Management Contributions to Recent Trends in U.S. Agricultural Yield", *Science,* 299: 1032, 2003

[3]Minnesota Department of Commerce, *Minnesota Energy Planning Report 2001*. St. Paul, MN, January 2002, www.commerce.state.mn.us

PHOTOGRAPHS

page 1 – American Wind Energy Assocation; page 2 – Minnesota Energy Planning report, 2001, MN Department of Commerce; page 3 – National Renewable Energy Laboratory (hay bales/bulbs), Eastern Waterfall Guide (waterfall), Lisa Daniels/Windustry (wind turbines)

Creating a Community Energy Vision

IN THE PAST, UTILITY COMPANIES MADE ALL OF THE DECISIONS about our energy system. They analyzed projected needs, decided on the best fuel source and built and owned the power plants and transmission lines. The rest of us – businesses, government, and residents – just flicked on the switch. The utility provided the power, and we used as much as we wanted. Today, there is increasing public interest in our energy system. Businesses and governments have very specific needs for reliability and quality of power. Many people are calling for greater reliance on home-grown renewable energy. Farmers and businesses are interested in developing renewable energy projects using local resources.

The types of energy used in the 21st century will be determined by the decisions and investments made in the next 20 years.

No one person, business, or group has the ability to design and build the system of the future alone.

In the future, a combination of utility decisions, with community input, and individual and business decisions will increasingly shape the electric system – decisions such as how much to conserve and whether or not to add on-site generation or small renewable energy projects. The decisions we make today are critically important because they will determine our electricity system for decades to come. The types of energy used in the 21st century will be determined by the decisions and investments made in the next 20 years.[1]

Everyone has ideas about what our future electric system should look like, but no one person, business, or group has the ability to design and build the system of the future alone. Even the utilities do not have that ability, because they cannot build power plants or transmission lines in the face of organized community opposition.

PURPOSES OF COMMUNITY ENERGY PLANNING

All of the community stakeholders need to be involved in creating a sustainable energy plan for the future. Broad involvement allows communities to establish priorities that will guide future energy acquisitions and to evaluate local resources to determine how best to keep energy dollars at home. In fact, instituting a community planning process is the best way to protect the public interest and ensure that all community stakeholders, rather than a select few, are deciding the design of the energy system of the 21st century.

Communities may have many different goals in energy planning. Local governments may want to reduce energy costs in public buildings. Community members or community institutions may initiate community energy planning because of an interest in using or developing renewable energy. Interest in energy planning may be sparked because of local concern about proposed power lines or new power plants. All of these and more are valid reasons for convening interested stakeholders and developing an energy plan.

STAKEHOLDERS

There are a variety of groups with interest in the future of a community's energy system. Any one of them could initiate an effort to examine and make changes in the local energy system, but the most successful planning efforts involve all of the community's stakeholders. Most projects require broad involvement and buy-in for implementation. Involving many players from the beginning ensures that everyone's voice is heard, that all good ideas get on the table, and that questions, concerns or opposition are understood and resolved early in the process.

Key stakeholders include :

- *Local Residents – individuals interested in renewable energy and prices of electricity*
- *Local Utilities – investor owned, cooperative, and municipal*
- *Local Government – county, city, and township*
- *Local Business and Industry – commercial business and factories*
- *Farmers – owners of windy land and producers of bioenergy*
- *Public and Private Community Institutions – schools, universities, colleges, experiment stations, non-profits, prisons, or others*

STAKEHOLDER ROLES

Local Residents Citizens often initiate community energy planning efforts because of an interest in developing local renewable energy sources or because of a concern about power plant or power line siting. Active citizens can mobilize and organize community support to initiate community programs and to keep them growing. Citizens may also get involved by electing local officials who support renewable energy development and by supporting policies that encourage their development. Citizens can play a role in purchasing "green electricity" at incrementally higher prices, showing a commitment to this type of energy. Lastly, citizens can reduce their own energy use at home, in schools, churches, synagogues, and in other community buildings.

Youth are important stakeholders because we are designing the energy system today that they will live with tomorrow. Students, with their special perspective and skills, can be involved in many ways. Youth can do research, help to design projects, voice their opinions, and be involved in many other ways.

Local Utilities Local utilities must be involved early in planning any community energy system. Almost all new sources of generation will need to plug into the transmission and distribution system. Utilities can make projects happen, but they do have a number of concerns and criteria that must be met. Utilities have several ways to support projects. They might actually own and operate a community's distributed generation system or they might simply buy the green power. If the utility purchases the power, the power purchase agreement will be a critical element in making the project economics viable. The local utility might provide technical help in meeting their interconnection standards. Utilities may also fund conservation, renewable energy demonstration projects, or even research. There are many options. Utilities are required by state law to fund conservation programs and to bring renewable energy online. So, while sensitive to electricity pricing, many utilities may look favorably on projects that help them fulfill their requirements.

Local Government Local government officials are key leaders in any renewable energy project. There are a number of ways local governments can promote the use of renewable energy technologies. They can use renewables to generate electricity for local government use. Some options include renewable projects at schools and government buildings or solar technologies at remote locations or in city parks. Local governments can also use combined heat and power

systems to generate electricity and capture the excess heat for use in government buildings or even in a broader district heating system. In communities with landfills or sewage treatment plants, local governments can collect and burn biogas to generate electricity.

Beyond developing their own resources, local governments can play a role by purchasing green electricity. Some options for purchasing include buying green power for specific buildings, greening up the entire government load, perhaps by giving price preferences for renewable electricity. Lastly, local governments can use economic development tools to promote local renewable development, recognize and promote the use of renewables by others, and incorporate energy issues in local planning or in green building design.[2]

Local Business and Industry Area businesses and industry play an important role in sustaining and growing local economies. They are also significant energy users. These businesses and industries are important stakeholders in the community energy planning process. Businesses can take the lead in making efficiency upgrades and improvements. Business and industry can also implement projects that turn a costly facility waste into an income-generating energy source. Another option is for a local industry to be a partner in a combined heat and power project supplying both electricity and steam for industrial use or for a district energy system.

Farmers Farmers can build on-farm renewable energy projects, installing wind turbines or anaerobic digesters, reducing their on-site electricity costs and/or selling power into the grid for extra income. Farmers can also lease their land to private wind developers. Typically, a landowner gets an annual payment of up to $5000 per turbine if they are on an annual payment system. Based on typical turbine spacing and size, harvesting the wind can increase annual farm income by $70 per acre. Most of the bioenergy of the future will be from farm-grown crops, another way that farmers will be involved in energy production.

Public and Private Community Institutions
Public and private community institutions like schools, colleges, universities, experiment stations, churches, synagogues and many others are often very interested in reducing costs through energy conservation. They may also be interested in developing renewable energy projects or in buying green power for their buildings or campuses. Institutions often serve as demonstration settings, building the renewable energy project into the curriculum and providing teaching and community outreach, making the project additionally valuable. They can sometimes find grants or other funding to help offset the up-front capital costs of projects. They may be a testing ground for more innovative research and development projects. These larger organizations may partner with others in the community to serve as a hands-on location for a pilot project that could spawn further developments down the road.

STEPS IN THE COMMUNITY ENERGY PLANNING PROCESS

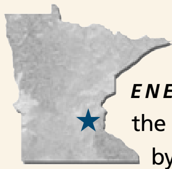
In Minnesota, at least one county has completed a formal energy plan, and interested citizens in many other communities have taken leadership roles to promote conservation, efficiency, and use of local renewable resources. Their experiences can be models for other communities contemplating energy planning. Several publications are also available which lay out steps for community energy planning (see Resources at the end of this chapter). Communities should design a planning process that will meet their own goals, but they need not start from scratch to create a workable methodology.

Steps in the community energy process include the following:

1. *Agree on common goals*
2. *Raise community awareness*
3. *Form a steering committee*
4. *Gather and examine information and data*
5. *Start with efficiency upgrades and conservation*
6. *Develop an action plan*
7. *Turn the plan into action*
8. *Evaluate and build on success*

CASE STUDY:

Phillips Community Energy Cooperative: Consumers Control of Energy Use



THE GOAL OF THE PHILLIPS COMMUNITY ENERGY COOPERATIVE, led by the Green Institute, and supported by Hennepin County and the Minnesota Department of Commerce, is to create an urban energy cooperative that gives energy consumers greater control over their energy usage and to link conservation programs with under-served populations. To achieve these aims, the Phillips Community Energy Cooperative will deliver energy conservation-related services at the reduced costs that can be achieved by the larger membership base associated with a cooperative.

Phillips Community Energy Cooperative will put into practice the idea that as more people come together, they are better able to influence their local energy system. By setting realistic goals and providing a mechanism for community members to get involved, the project makes success attainable and enables future growth. Phillips Community Energy Cooperative also plans to research the feasibility of a renewable biomass combined heat and power facility that would provide district heating and cooling to Phillips neighborhood businesses and residences.

This sort of visionary step could be a model for urban community redevelopment projects across the nation and could serve as an example to both urban and rural communities wanting to regain control of their energy future.

For more information contact:
Phillips Community Energy Cooperative
Andrew Lambert
Green Institute
612-278-7118
alambert@greeninstitute.org

Phillips Community Energy Cooperative distributing compact fluorescent light bulbs

Improves the environment

Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

Offers community economic development

Improves energy independence, local control, and energy security

Promotes learning about energy

Agree on Common Goals The organizers of the community planning effort must begin by defining their common goals. Is the project about conservation in public buildings, about finding the most appropriate renewable energy demonstration project for the community, about developing guidelines for assessing new power plant or power line proposals, or about something else? Defining the goals will help to define the universe of interested people in the community and determine the stakeholders that must be involved for the project to succeed.

Raise Community Awareness The next step is reaching out to identified stakeholders and others in the community and educating them about the energy issues and the contemplated planning process. Education and outreach efforts vary. It could be as simple as a letter to the editor in the local paper announcing an organizing meeting or more involved like a community meeting or conference on energy issues. Initial community outreach should be designed to spark interest in the issue, lay the groundwork for the planning process, and identify the people most interested in the issues and in the planning process.

Ongoing community awareness is critical as well. Project leaders must make sure that others in the community know what is happening throughout the process. There are many ways to accomplish this – signs advertising meetings, regular stories about the planning effort in the local paper, a regular column or letters to the editor, meetings on the local cable access station, and speaking engagements to local groups and clubs. Regular community outreach helps to increase the visibility and interest in your project and will help secure broad community support for the final proposals later on.

Form a Steering Committee The most successful community planning efforts involve people with a wide range of interests. A wide range of perspectives is most likely to result in proposals that meet all community needs. More diverse groups also hold greater political and fiscal leverage when it comes to getting approval for final plans. The more bridges that can be built, and the more perspectives that can be brought together, the more likely communities are to achieve success.

It is a good idea to look for people from within the stakeholder groups who are interested in and committed to your goals and who have respect and influence within their own organization. You will be counting on the people around your table to convince others in the community that all options were considered and that the final plan is a good one.

Gather and Examine Information and Data Every planning process has a fact-finding element. The project goals will, of course, dictate the needed information. If conservation is a goal, information about community and building energy usage and conservation potential will be needed. If the goal is developing renewable energy, a comprehensive resource assessment will identify the potential energy resources available and their economic feasibility. This is the place to involve technical experts: experts from within the community, utilities, University experts, state agency assistance, and consultants.

Start with Efficiency Upgrades and Conservation Before considering any alternative energy project, be sure to explore energy efficiency opportunities within the community. Although Minnesota has an excellent track record of conservation programs, there is still tremendous potential to reduce electricity use.

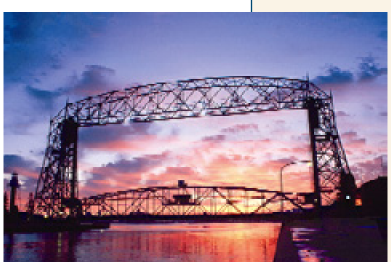
Small, successful, visible steps build a culture of success.

Develop an Action Plan Once the information about technologies and the facts about energy use and resource options have been analyzed, it is time to develop an action plan. The action plan will define the scope of the project. It should detail what will be done, why, how, and by whom. The action plan will include specific goals, objectives, actions, timelines, and responsibilities. It will identify costs, revenues, financing and include the business plan for the project.

CASE STUDY:

Duluth and the International Council for Local Environmental Initiatives: Local Climate Change Targets

THE INTERNATIONAL COUNCIL FOR LOCAL ENVIRONMENTAL INITIATIVES[3] is an international association of over 564 local governments working to combat global warming problems through local solutions. Its Cities for Climate Protection Campaign (CCP) is an international effort to reduce greenhouse gas emissions and improve community livability by assisting local governments with energy management and conservation programs. The program focuses on local government involvement because local governments influence and sometimes even directly control many of the activities that produce greenhouse gas emissions including: land use decisions, energy-efficiency building codes, waste-reduction, and recycling programs.



Duluth, St. Paul, and Minneapolis are all members of the CCP Campaign and have started reducing their greenhouse gas emissions by conserving energy and developing newer, cleaner systems for heating and electricity. Each of these Minnesota cities is taking a leadership role in educating their citizenry and motivating their communities to take action. Minneapolis and St. Paul were founding members of CCP in the early 1990's, and Duluth joined the Campaign in May 2001.

In the fall of 2001, Duluth reached its first project milestone, completing a greenhouse gas emissions inventory that allows the City to evaluate the impact of different energy-saving measures on emissions. With the inventory completed, the next steps in the CCP process are to identify which energy-saving measures are already having a positive impact, to formally adopt a greenhouse gas reduction target, and to develop a Local Action Plan to guide proposed measures for emissions reductions.

Program leaders at the City of Duluth felt it was imperative to engage a broad range of community members throughout the process. A community steering committee was seated to assist in developing the Local Action Plan and to ensure strong communication and organization throughout plan development.

The City also secured funding and installed a 2.4 kW solar energy system on the Duluth Public Library. The system will be hooked to a monitor in the library that will show the clean energy being produced and will serve as an energy resource center for the community. The new solar system was funded in part with a grant from the Rebuild Minnesota program, administered by the Minnesota Department of Commerce.

Other current projects include an LED traffic signal replacement that conserves 90% of the energy otherwise used by incandescent traffic lights, as well as a project in cooperation with Minnesota Power that will showcase three alternative energy systems to be installed at the Lake Superior Zoo in Duluth.

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ccp@ci.duluth.mn.us

Installation of solar panels atop the Duluth Public Library

CASE STUDY:

West Central Research and Outreach Center: Developing a Renewable Energy Center in Morris

THE WEST CENTRAL RESEARCH AND OUTREACH CENTER is leading a community effort to make renewable energy a reality in Morris, Minnesota. The Research and Outreach Center has put together a proposal to develop an integrated, community scale, research, demonstration and production Renewable Energy Center in close partnership with the University of Minnesota-Morris and other community and renewable energy collaborators. This would be a true community-wide effort involving many different components from installing renewable energy technologies, to researching technologies for conventional and cellulytic production of biofuels, to tying industry in with a community district heating system.

Many community institutions are already interested in getting on board. The Renewable Energy Center hopes to conduct research on biofuels and install a series of wind towers. The University of Morris is also interested in becoming a "Green University" by using a biofuel or biomass generator to meet its energy needs. The local school district is building a new elementary school that could incorporate a district heating system tied into the University.

DENCO, a producer/farmer owned corn ethanol plant located in Morris, is also pursuing opportunities to join the mix. They are evaluating the feasibility of installing a thermal oxidizer to reduce the facility's odors that would also produce a large amount of steam heat that could be sold for use in a district heating system. By selling some of the excess steam, they could recoup some of the oxidizer installation costs while contributing to a community-based renewable energy system.

The Research and Outreach Center is serving as the catalyst and facilitator of community efforts to incorporate renewable energy, but area institutions and businesses would own and operate the systems. A true community program like this would be a unique demonstration that could give people around Minnesota and across the nation a working model of a truly integrated renewable energy program.

To get the program moving, the Research and Outreach Center has hosted two Renewable Energy Workshops, each attended by over 200 people from a variety of backgrounds. A twenty-six member Community Steering Committee was seated after the first conference. The steering committee will provide a citizen's voice throughout project development and play a crucial role in ensuring public participation.

While this case study presents a somewhat different model for community-wide planning, it demonstrates another option. Community energy planning can follow many models with different community members and organizations playing a leadership role and moving towns in the "right" direction.

For more information contact:
Greg Cuomo or Mike Reese
West Central Research and Outreach Station
320-589-1711

Improves the environment

Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

Offers community economic development

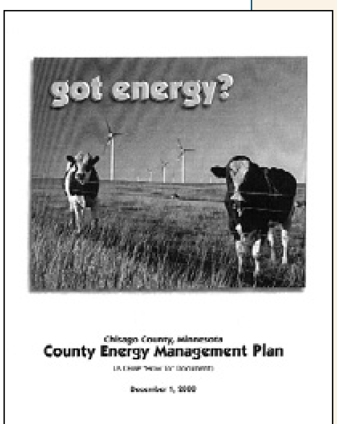
Improves energy independence, local control, and energy security

Promotes learning about energy

CASE STUDY:

Chisago County: A Community Energy Management Plan

IN DECEMBER 2000, Chisago County released its Chisago County Energy Management Plan.[4] The plan lays out a vision for the community and will guide future energy decisions. It outlines environmentally smart, sustainable, and economically defensible energy options. Developing the plan also allowed the public to become engaged in a broad planning process that laid the foundation for the comprehensive energy management strategy.



To facilitate stakeholder communication in the process, the county board appointed a citizen-based "Overlay and Essential Services" task force of 18 ommunity members. The task force's mission was to review existing energy conditions, including local use patterns and energy demand, and to provide detailed recommendations for several sectors. They set guidelines for everything from siting and permitting of power lines and generation facilities, to criteria for scenic resource protection, to provisions for conservation and alternative energy.

Several Chisago County community members had already been involved in local energy issues prior to involvement with the Chisago County Energy Management Plan. In 1996, citizens formed the Concerned River Valley Citizens to challenge Northern States Power (NSP), now Xcel Energy, regarding its proposed 230 kilovolt power line that would span the St. Croix River from Chisago County, Minnesota to Polk County, Wisconsin. NSP sought to construct this new line across the wild and scenic St. Croix River to strengthen the grid interface between Minnesota and Wisconsin.

Members of the Concerned River Valley Citizens viewed the siting of a large power line across the St. Croix River as a violation of the Wild and Scenic River Act of 1916, which protects the quality of the river and the land around it. In fighting the proposal, they learned all they could about the energy system, found funding and brought in expert witness testimony for a battle with NSP. In the process, group members learned the ins and outs of the energy business from siting and environmental requirements to technical and engineering issues. They succeeded in forcing a compromise on the power line, but did not stop there.

Concerned River Valley Citizens saw the need to develop a mechanism that would give the local governments greater control over energy development in their county forever. They needed a countywide energy plan. The County Energy Management Plan project was a community-led effort to learn more about energy issues and shape a plan that would ensure a citizen-centered, locally controlled, sustainable energy future.

The Overlay and Essential Services task force was the primary organizing and leadership group in the planning process. They worked with all members of the community including the general public and local elected officials. They brought in assistance from the U.S. Department of Energy, engineers, and other communities already doing sustainable community work. This combination of people and broad community involvement helped ensure the success of the project and created a coalition the community could build on in the future.

The county soon had an opportunity to use the plan. Xcel Energy filed a certificate of need with the Minnesota Public Utilities Commission in 2002 to install a different line across the St. Croix, now a lower voltage line with double the transmission capacity. The coalition built through the initial fight and through development of the energy plan, is now able to evaluate the proposal against the broadly supported criteria in the county energy plan.

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Bill Neuman
Concerned River Valley Citizens
651-257-6654
ayelink@earthlink.net

Improves the environment

Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

Offers community economic development

Improves energy independence, local control, and energy security

Promotes learning about energy

Turn the Plan into Action This can be one of the most important steps in the entire process. If the plan has several components, make sure that there are visible achievements early on. Even small, successful, visible steps build a culture of success. They build momentum, bring more people into the effort, and encourage others to support the work. If one of the first steps is erecting a wind monitoring station, for example, make sure that the event is well publicized and well reported. Involve community volunteers if appropriate and possible. Making the project happen will include getting bids for technology, finding grants, loans or other financing, construction, interconnection, resolving unexpected problems, and finally, bringing the project on line.

Evaluate and Build on Success Be sure to take time to reflect on what worked well and what could be improved next time. If there were problems, identify the barriers and look for creative ways to overcome them. First look to people from within the community who can help to resolve the problems and then look for outside technical help if it is needed. Learn from successes and from mistakes and share both widely within and beyond the community.

Communities can and do take on and accomplish what sometimes initially seems like unachievable goals. Building the 21st century community energy system takes vision, commitment, persistence, and strong leadership. It also requires broad community involvement and is likely to require some outside technical expertise. Working together, people in communities can design and build the local, renewable energy systems of the future.

END NOTES

[1]World Energy Council and International institute for Applied Systems Analysis, *Global Energy Perspectives to 2050 and Beyond,* London and Austria, 1996.

[2]Warner, Joshua and Schoenrich, Lola, *Plugging Into Green Power: Local Government Options for Renewable Energy*, The Minnesota Project, St. Paul, November 1999.

[3]For more information regarding the International Council for Local Environmental Initiatives, please see the website: http://www.iclei.org/.

[4]Chisago County Board of Commissioners. December 2000. *County Energy Management Plan: Chisago County, Minnesota*. Chisago County, Minnesota.

PHOTOGRAPHS

page 5 – Melissa Pawlisch/The Minnesota Project (upper), Amanda Bilek/The Minnesota Project (lower); page 6 – Melissa Pawlisch/The Minnesota Project; page 8 – Andrew Lambert/The Green Institute; page 9 – Lake Benton Valley Journal (upper), Lola Schoenrich/The Minnesota Project (lower); page 10 – Steve Forslund/City of Duluth (upper), Carin Skoog/Cities for Climate Protection (lower); page 11 – Teresa Hebert/West Central Research and Outreach Center; page 12 – Chisago County Board of Commissioners; page 13 – Lisa Daniels/Windustry

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Under Construction: Helpful Tools and Techniques for Local Planning. Minnesota Planning Agency, September 2002. This report provides information on local planning and includes several sections on energy. Additional information is available from Deborah Pile, Minnesota Planning, 651-297-2375 or deborah.pile@state.mn.us. (www.mnplan.state.mn.us)

Community Energy Workbook: A Guide to Building a Sustainable Economy. Alice Hubbard and Clay Fond, Rocky Mountain Institute, 1995. Provides a systematic approach to community involvement in building a sustainable energy future. The Rocky Mountain Institute, 970-927-3851. (www.rmi.org)

Smart Communities Network: Creating Energy Smart Communities. A project of the U.S. Department of Energy. Resources and information to help communities get started with energy planning and community-wide energy conservation. It focuses on managing energy costs with conservation programs, reducing production of greenhouse gases, and involving the whole community in energy management efforts. Includes success stories of sustainable communities in renewable energy and efficiency issues. (www.sustainable.doe.gov/municipal/intro.shtml)

Developing Your Community's Action Plan. U.S. Department of Energy, Rebuild America Guide Series, May 1998. Lays out a planning process to identify and implement energy conservation in buildings. 800-DOE-EREC. (www.eren.doe.gov)

Green House Gas Inventory Report with Recommendations for the Development of Duluth's Local Action Plan. October 2001. This report outlines both the CCP milestone process and details how the emission inventory was conducted. (www.ci.duluth.mn.us/city/information/ccp/GHG Emissions.pdf)

BC Energy Aware Committee. From British Columbia, Canada, the site addresses community energy planning and the role of local governments in energy planning. The website includes a "toolkit" introducing the basic concepts and issues involved in generating a community energy plan, provides a number of community planning strategies based on community size, and offers case studies that portray pertinent information for a variety of stakeholders. The toolkit is geared toward local government officials but could be used by anyone interested in community energy planning. (www.energyaware.bc.ca/welcome.htm)

The University of Minnesota's Regional Sustainable Development Partnerships. The Regional Partnerships draw together communities and University resources to foster innovations in sustainable development throughout greater Minnesota. One of the Partnerships' areas of focus is locally distributed renewable energy. Partnering with the Minnesota Project and the Department of Commerce, the Regional Partnerships help bring together communities and the resources they need to determine their energy future. For more information contact Cynthia Pansing, Statewide Coordinator, 612-625-8759, pansi001@umn.edu. (www.regionalpartnerships.umn.edu)

The Minnesota Project. A nonprofit organization dedicated to sustainable development and environmental protection in rural Minnesota. Since 1979, The Minnesota Project has worked to promote healthy rural communities through building broad-based coalitions, facilitating statewide, regional and national networks, and connecting communities to resources and policy forums. Current program areas are renewable energy development, sustainable agriculture, water protection and community sustainability. Minnesota Project is coordinating the technical teams for the Community Energy Resource Teams Project. Contact: Lola Schoenrich, 651-645-6159 or lschoenrich@mnproject.org. (www.mnproject.org)

Improving Energy Efficiency

BUILDING A BRAND-NEW, SHINY, RENEWABLE ENERGY POWER SOURCE in your own community has a lot of appeal. Doesn't everyone want to have the latest, greatest and cleanest power plant to supply their power and stimulate the local economy? New renewable energy sources, such as the wind turbines being erected all over Minnesota, *do* get a lot of attention. However, there is a much less glamorous way to "produce" energy that is often cheaper and smarter than building a new plant. This great, unsung hero is energy efficiency – consuming less energy by using it more efficiently. Because energy efficiency reduces energy bills, it's also dollars smart. Due to energy efficiency technologies adopted since the shock of the 1973-74 Arab oil embargo, it is estimated that the US saves $150 to $200 billion annually in energy costs.[1]

Minnesota could reduce future energy consumption 28 percent by aggressively implementing energy efficiency programs[3].

THE ENORMOUS POTENTIAL OF ENERGY EFFICIENCY

The capacity of engineers to think of ways to do things faster, cheaper and better is astounding. We are most familiar with this in terms of computers – it seems that in the time it takes to get from the factory to our house, a new computer is obsolete. But while our society has an obsession with gigahertz, we pay relatively little attention to kilowatts – the energy consumed by the products we buy.

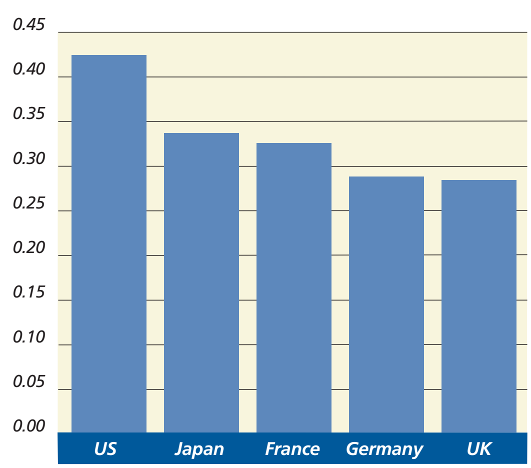
And yet just as computers continue to get faster and faster, so are there improvements in technologies and processes that can use less energy to provide the same level of service. These include compact florescent light bulbs, super-efficient appliances, variable speed motors, and ultra-efficient heating and cooling systems.

A compact florescent light bulb can produce the same amount of light as a standard incandescent bulb, but uses a quarter the power and can last 10 times as long. LED (light emitting diode) bulbs that are starting to enter the market are even more efficient and long lasting.

Simply replacing old light bulbs can result in significant energy savings. For example, at the University of Minnesota's Twin Cities campus, a light bulb replacement program resulted in savings of $800,000 per year, which the University will benefit from for many years to come[2].

There is enormous potential to further increase our energy efficiency. The United States' economy is the least energy-efficient among industrialized countries. One study estimated that Minnesota could reduce future energy consumption 28 percent by aggressively implementing energy efficiency programs[3].

Energy intensity of U.S. compared to other industrialized countries *(TWh/billion$GDP)*[4]



Source: International Energy Agency, 2002

IMPLEMENTING ENERGY EFFICIENCY

The approach to implementing energy efficiency will vary slightly depending on whether it is in the residential, commercial or industrial sector. Implementing an energy efficiency project for a homeowner may be as simple as adding insulation and installing some efficient light bulbs but may be more complex if it involves ventilation and other “house system” elements. For larger projects, a systematic approach to energy efficiency involves 5 basic steps:

1. Identify Energy Efficiency Opportunities: the Energy Audit Uncovering the hidden opportunities of energy efficiency is the first step, and energy audits are an excellent way to do this. A skilled energy auditor will complete a thorough examination of a facility to identify all the opportunities for energy efficiency improvements. The more complex the facility, the more expertise required by the auditor. For residential buildings in Minnesota, energy audits may be available at a subsidized cost from the local utility.

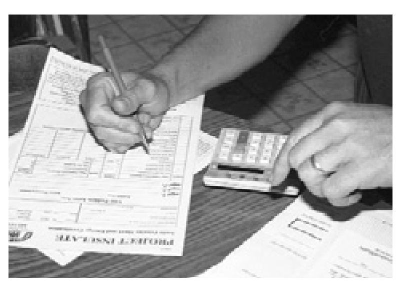
If you’re trying to decide whether or not to do an energy audit in a building, you might consider performing a benchmark evaluation to see how a building ranks in comparison to similar structures. A free benchmarking tool is available on the website of the Energy Star program of the U.S. Environmental Protection Agency (www.energystar.gov).

2. Decide which Opportunities to Implement
Often economic considerations dictate which opportunities are implemented. The most common criterion used is simple payback – how long does it take to pay back the cost of the improvement with the energy savings that result from the improvement? For example, if you buy a compact florescent light bulb for $6 to replace a less-efficient bulb, and the new light bulb saves $3/year in energy bills, the simple payback is 2 years.

The acceptable length of payback will vary depending on who is paying for it – businesses typically don’t consider anything longer than a 2-year payback, while institutions or individuals may have a longer time frame, perhaps 7 to 10 years, or even longer. It is important to remember that after the payback period, the project will continue to reap energy savings for the life of the project; the “profits” of investing in the project.

Because the simple payback method does not take into account environmental costs, an environmentally committed individual or institution may even implement efficiency projects that cannot be justified by economic payback alone.

3. Financing In the long run, carefully chosen energy efficiency projects will not only pay for themselves, but reduce overall spending on energy. However, for large facilities it is sometimes difficult to come up with the initial



An energy auditor at work

CASE STUDY:

Reducing the "Hassle" of Efficiency: the One-Stop Shop Approach

SPONSORED BY XCEL ENERGY, and administered by the Center for Energy and Environment, the One-Stop Efficiency Shop (One-Stop) is an innovative, full service lighting rebate program for the small businesses sector. Small businesses are difficult to serve with traditional lighting rebate programs due to limitations in financial resources, time, knowledge of lighting products, and access to quality contractors. One-Stop is structured specifically to address these needs and concerns. One-Stop offers qualified business owners a free, no obligation audit, lighting rebates, and below-market rate financing that is paid on the owner's utility bill, with loan payments structured to match the owner's monthly savings so that the owner does not experience any increase in monthly bills. Because One-Stop does not sell lighting products, auditors are able to offer customers unbiased recommendations. Yet, due to the collaboration with local electrical contractors, One-Stop is also able to offer standard program pricing quotes and a pool of qualified contractors to eliminate the hassle of collecting bids. This combination of services brings education, financial resources, and minimal time commitment directly to the customer.

Available in Xcel service territory.
For more information about this program, see www.mncee.org/oses.htm.

capital funds to finance these projects. There are several ways to overcome this problem:

- Set up a revolving loan fund for energy efficiency projects. Recognizing that the projects pay for themselves, the University of Minnesota Twin Cities campus set up a fund for energy efficiency projects that is replenished with the savings from previous projects.
- Consider having an outside company do the efficiency project. There are some companies that will do the assessment, implement and finance the project, in exchange for a share of the energy savings, which may make sense in certain situations.
- Grant and loan programs for energy efficiency projects. Utilities often offer rebate programs for high-efficiency products, and may have other programs – your local utility should know what programs you qualify for. Other financing programs exist; for example, schools have special financing available to them for energy efficiency projects, and the Minnesota Housing Finance Agency offers programs for qualifying homeowners and multi-family buildings.

4. Implementing the Energy Efficiency Projects Once you've made a plan for what projects you want to do, you have to decide if you want to do them yourself, use staff within your organization, or contract for services. If you contract the projects out, choosing a qualified contractor to install the energy efficiency projects is key to realizing the energy savings.

5. Maintenance In some cases, maintenance of an energy efficiency project will not be an issue, but in some cases it is worthwhile to consider how the project will be maintained. This is especially true in dealing with processes and systems. For example, many types of energy efficiency gains in complex Heating, Ventilation and Air Conditioning systems (HVAC) tend to diminish over time unless they are maintained.

Cooling system inspection

Improves the environment

Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

Offers community economic development

Improves energy independence, local control, and energy security

Promotes learning about energy

For every $1 spent on energy efficiency programs, about $3.50 in benefits are realized

BARRIERS TO ENERGY EFFICIENCY

So if energy efficiency is so marvelous and cost-effective, why aren't we doing more of it? Here is a summary of some of the main reasons.[5]

Information Gap Consumers and even contractors often aren't aware of energy efficiency options or the economic and environmental benefits they offer. Consumers also may not believe the potential saving estimates claimed by contractors and auditors.

Lack of Investment Dollars Residential, businesses and government customers may lack the up-front capital required to make investments in energy efficiency projects.

High "Transaction Costs" Making an informed purchase or considering energy efficiency measures often involves more time, money and hassle than the consumer is willing to invest.

Split Incentives If the person who pays the monthly energy bill is different than the person who pays for the equipment, there is a split incentive. This is most evident in landlord/tenant relationships. The landlord does not have an incentive to purchase the more expensive, higher efficient equipment because the landlord does not reap any of the benefits of lower operating costs. The tenant is often unaware of equipment upgrades and does not actually own the equipment; therefore the tenant does not invest in more efficient equipment even though they would capture significant savings. This same dilemma can also occur in large institutions where the person paying the energy bill is different than the person responsible for capital improvements.

Short Term Costs are Often Emphasized over Long Term Costs For example, builders try to keep construction costs as low as possible, without considering the long-term energy costs of inefficient construction methods.

OVERCOMING BARRIERS: POLICIES AND PROGRAMS TO ENCOURAGE ENERGY EFFICIENCY

Recognizing that some policy direction is necessary to overcome barriers and more fully capture the potential of energy efficiency, policymakers have created programs to stimulate energy efficiency. Below are some of the programs available in Minnesota.

The largest energy efficiency program in Minnesota is called the Conservation Improvement Program (CIP). In Minnesota, all gas and electric utilities are required to spend a percentage of their revenues on conservation efforts.[6] These efforts include funding energy audits, educational efforts, rebates for energy-efficient appliances and other equipment, and design assistance to make new buildings more energy efficient.

The Minnesota Department of Commerce estimates that because of the CIP program, every year Minnesota saves the amount of electricity consumed by 41,000 retail customers and reduces peak demand by about 128 megawatts. The CIP program is also very cost-effective: every $1 spent results in about $3.50 in benefits[7]. Local utilities can provide more information on programs that they provide under CIP.

The Minnesota Department of Commerce runs the Energy Information Center, which produces numerous publications for residential, small business/commercial sites, and institutional and municipal buildings. Each section lists publications that provide practical, easy-to-understand recommendations for energy saving strategies. The Energy

CASE STUDY:

Designing Energy Savings

FOR 10 YEARS, XCEL ENERGY has offered a program called Energy Design Assistance (formerly Energy Assets) to encourage energy efficiency to be included in the design of large buildings. Xcel pays for the services of a consulting firm to work with the building owner, architect and engineers (the design team). The program's goal is to improve the energy efficiency of new construction projects by encouraging the design team to implement an integrated package of energy efficient strategies. Using sophisticated computer modeling and their knowledge of energy efficiency practices and technology, the consultants analyze energy impacts and costs associated with a range of design options. The program has addressed almost 200 buildings with a total of more than 40 million sq. ft., saving well over $15 million per year, and nearly 60 megawatts in electrical peak demand. Savings, compared to code levels, averages about 30%.

For more information, see www.xcelenergy.com > business > (enter zip code) Go > Save Energy and Money > Energy Design Assistance.

Information Center also makes Energy Specialists available to customers that can assist with energy conservation questions (*see contact information on page 20*).

Another state program is Rebuild Minnesota,[8] a part of the US Department of Energy's Rebuild America Program that focuses on creating partnerships to implement conservation and energy efficiency projects. Rebuild Minnesota works with schools, municipalities and low-income family dwellings to identify solutions to meet local energy demand and build public and private partnerships among communities throughout the state. They provide assistance drawing community partnerships together and linking communities with the people and business that provide energy efficient products, services, information and strategies.

In addition, The Minnesota Department of Commerce, University of Minnesota and the Iron Range Resource and Rehabilitation Agency are beginning a state level Industries of the Future (IOF) program to improve energy efficiency, environmental performance, and industrial process productivity in two of the state's most energy intensive industries, forest products and mining.

END NOTES

[1] Interlaboratory Working Group, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond* (5 labs report), (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), LBNL-40533 or ORNL/CON-444. 1997. (www.ornl.gov/ORNL/Energy_Eff/labweb.htm)

[2] This savings estimate was made when the lighting retrofit program was 70 percent finished, at which time, costs of the program totaled $3.1 million. Minnesota Building Research Center, *University Energy Efficiency Program Evaluation*, June 1992.

[3] Environmental Law and Policy Center, *Repowering the Midwest*, Chicago, 2001.

[4] Chart presents electric energy intensity from 2000 data; units (TWh/billion$GDP) are terawatthours per billion 1995 dollars of gross domestic product, adjusted for purchasing power parity.

[5] Portions excerpted from Environmental Law and Policy Center, *Repowering the Midwest*, Chicago, 2001; and personal correspondence with Keith Butcher, Center for Energy and Environment, 3/3/03.

[6] The law requires all electric utilities to invest 1.5 percent of their state revenues in CIP (except Xcel Energy, which must invest 2 percent). Regulated natural gas utilities are required to invest 0.5 percent of their state revenues into conservation programs.

[7] Minnesota Department of Commerce, *Energy Planning and Policy Report 2000*, St. Paul, 2001.

[8] For more information regarding Rebuild Minnesota, see: www.commerce.state.mn.us.

PHOTOGRAPHS

page 15 – National Renewable Energy Laboratory;
page 16 – St. Paul Neighborhood Energy Consortium;
page 17 – National Renewable Energy Laboratory

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HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Minnesota Department of Commerce. Has information on the types of conservation programs available and provides useful publications on their website related to energy efficiency. In addition, they host the Energy Information Center, which has Energy Specialists waiting to answer questions you may have at the phone number below.
651-296-5175 or 800-657-3710 (toll-free)
(www.commerce.state.mn.us)

Energy Star. A program of the US Environmental Protection Agency and US Department of Energy. To use the free benchmarking tool, simply click on the button that reads "Benchmark your building's energy performance".
(www.energystar.gov)

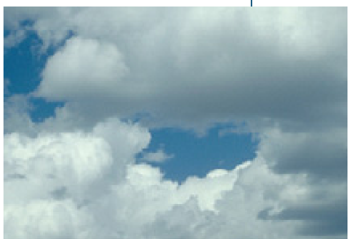
Utility conservation programs. Many utilities have websites on their conservation programs, some are listed below. Contact your local utilities to find out about their offerings.

- Xcel Energy
  (www.xcelenergy.com)
- CenterPoint Energy Minnegasco
  (www.minnegasco.centerpointenergy.com)
- Minnesota Power
  (www.minnesotapower.com/energy_tips)
- Ottertail Power Company
  (www.otpco.com/asp/energywizard.asp)
- Alliant Energy
  (www.alliantenergy.com)

Center for Energy and Environment (CEE). CEE is a nonprofit Minneapolis-based organization with a broad expertise in energy efficiency. CEE has provided energy, environmental and housing rehabilitation services to utilities, private corporations, neighborhood organizations, municipalities and public agencies for over 18 years. These services include financing, building audits, technical research, program design and delivery and evaluations.
Contact: Keith Butcher, Engineer, 612-335-5890, kbutcher@mncee.org
(www.mncee.org)

St. Paul Neighborhood Energy Consortium (NEC). The Neighborhood Energy Consortium is a non-profit organization involved with many aspects of energy efficiency. It offers an energy audit program, an insulation program, custom home energy analyses, and community education. They also run an innovative car-share program.
Contact: Jimmie Sparks, Energy Program Manager, 612-221-4462 ext. 123, jimmies@spnec.org
(www.spnec.org)

Wind



MINNESOTA IS ONE OF THE WINDIEST STATES in the nation, according to the Department of Energy. Wind power could theoretically generate many times more electricity than currently used in the state[1]. In 2003, Minnesota was fourth in the nation in wind power development, with only California, Texas and Iowa having built more wind turbines. Most of the wind development to date is on the very windy Buffalo Ridge in Southwestern Minnesota. There are many other promising wind sites in the state, with high elevations and minimal obstructions, many across all of southern Minnesota.

Wind turbines convert the kinetic energy in wind to mechanical power that runs a generator to produce electricity. Wind turns the blades, which spins a shaft connected to a generator that makes electricity. Major components include the rotor, nacelle, tower, and foundation. The rotor is at the center of the spinning part of the turbine and turns the electric generator in the nacelle. Large turbines are roughly 230 feet tall, where the winds are stronger and less turbulent.

WIND BASICS

Many people still think of wind power as the old farm windmills or the small wind spinners that help to power cabins or farm sites. Wind technology has made great strides in the past 20 years, however, and today wind is the fastest growing source of electricity in the world. The technology has developed to the point that wind is cost-competitive with other generation sources. The fuel is free, and environmental impacts are minimal. In the spring of 2003, Minnesota had an installed capacity of about 335 megawatts (MW), enough to power about 110,000 homes, or 1% of the total electricity used in the state.[2]

Utility-scale wind in Minnesota has been developed in response to state public policy. The first utility-scale wind projects on the Buffalo Ridge were developed in 1995 to fulfill a legislative requirement that Xcel Energy develop 425 megawatts of wind energy in exchange for additional nuclear waste storage at their Prairie Island nuclear plant. The Minnesota Public Utilities Commission has since added an additional wind requirement, for a total of 825 MW. In 2001, the Minnesota legislature required all utilities to make a “good faith effort” to supply 10% of their electricity from renewable sources by 2015 and required all utilities to offer customers a choice of green power[3]. Most of the green electricity programs use 100% wind power that can be bought in 100 kWh increments for between 2-3 cents more per kWh.

Wind turbines installed in Minnesota in 2002 were as large as 1.5 MW each with capacity factors of up to 40 percent. To put these turbines in perspective, each of the three blades weighs in excess of 12 tons and rotates at 20 revolutions-per-minute (compared to 1,000 rpms for a small, home-sized wind turbine and 4,000 rpms for a typical car engine at cruising speed). The towers are 200 feet tall or taller and can power over 650 average Minnesota homes each year.

WIND DEVELOPMENT

Wind developers, building large projects of tens or even hundreds of wind turbines, are developing most of the state’s wind projects. They are selling the electricity to Xcel Energy, Great River Energy and other utilities. Wind developers usually lease land from landowners, paying as much as $5,000 per turbine per year. Based on typical turbine spacing and size, harvesting the wind can increase annual farm income by $70 per acre.

Municipal and cooperative utilities have built smaller projects of two or three turbines each. In addition, several schools have built wind turbines, which offset some of the building’s electricity use and educate students and the community at large.

Wind is cost-competitive with other generation sources. The fuel is free, and environmental impacts are minimal.

FARMER OWNED WIND

In Denmark, much of the wind development is owned by farmer-owned cooperatives. This is an intriguing idea in Minnesota as well, and many are interested in the idea that farmers can develop and own wind projects, "harvesting the wind" on their own land. Locally-owned wind projects are appealing because they keep more of the revenue from the projects in the community. There are now several groups of farmers with small projects and a couple of models for farmer-owned wind.

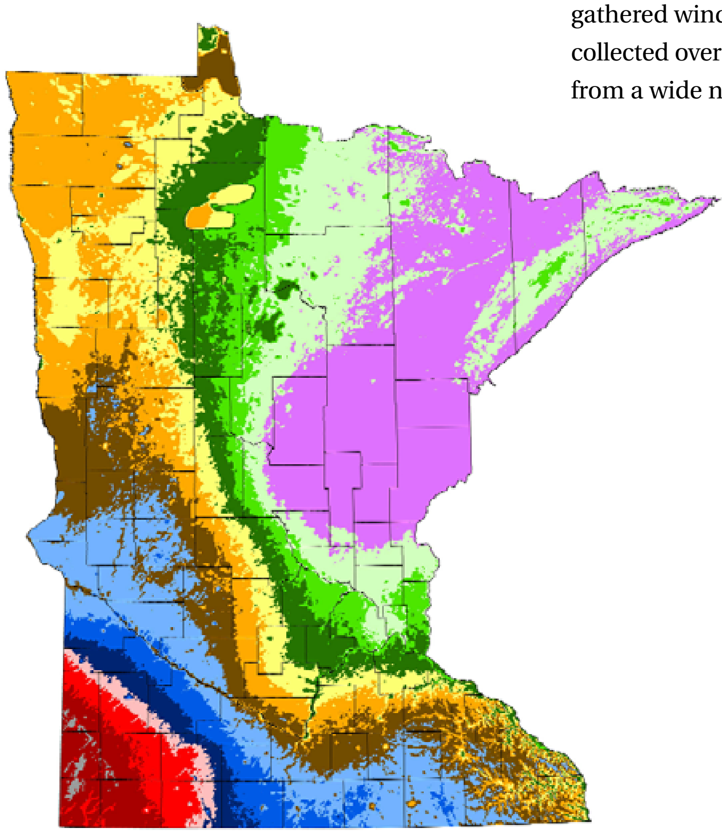
Farmer-owned wind projects have all of the same elements of any other wind project, and so must consider a number of different factors. One of the most important is the wind potential at the site. Second, the power purchase agreement defines the price and terms from the utility purchasing the electricity. The design of the project includes the type of turbine, tower and installation. Inter-connection and transmission access are another set of prime considerations. Most wind projects require some level of permitting. Legal structure, ownership, and financing are final considerations. Farmers developing wind work with lawyers, accountants, wind turbine manufacturers and other experts to put all of the elements of a project in place.

The farmer-owned wind projects in Minnesota are relatively new and much of the information about legal and ownership structures is proprietary. However, there are some resources available for farmers interested in developing projects and many consultants ready to help. Specific resource information is detailed at the end of the chapter.

ASSESSING WIND POTENTIAL

There are a few basic things to think about when considering whether a community wind project is viable.

1. How strong are the winds in the area? To begin, generally assess the wind speed of the area by looking at the Minnesota Department of Commerce wind maps of Minnesota. The Wind Resource Assessment Program has gathered wind speed and direction data collected over more than 10 years of monitoring from a wide network of data points.[4]



Minnesota's wind resource by wind speed at 70 meters[5]

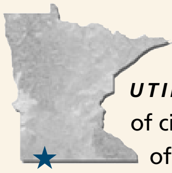
Wind speed meters/second

	0 – 4.80
	4.80 – 5.60
	5.60 – 5.87
	5.87 – 6.13
	6.13 – 6.41
	6.41 – 6.61
	6.61 – 6.81
	6.81 - 7.01
	7.01 – 7.17
	7.17 – 7.33
	7.33 – 7.51
	7.51 – 7.66
	7.66 – 8.01
	8.01 – 8.25
	8.25 – 8.41

Source: Minnesota Department of Commerce

CASE STUDY:

Worthington Public Utilities



IN SEPTEMBER 2000, THE WORTHINGTON PUBLIC UTILITIES assembled a task force of citizens to investigate the merit of wind power in Worthington. Windustry, a project affiliated with the non-profit Institute for Agriculture and Trade Policy, funded the effort through a grant from the Minnesota Department of Commerce. Investigation results were very positive, so Worthington Public Utilities joined with their public power agency, Missouri River Energy Services, and Wisconsin Public Power Inc., another power agency, to install four new 900 kW wind turbines. Worthington Public Utilities' two partners each own two of the turbines, allowing both to qualify for the Minnesota Renewable Energy Production Incentive for projects under 2 MW.

Energy generated by the wind turbines is fed into the power grid for the local community and the member cities of Missouri River Energy Services and Wisconsin Public Power, Inc. Worthington's electric customers can purchase this renewable energy in 100 kWh blocks for an extra $2.00/month (or 2 cents/kWh).

Worthington has found strong community support, strong government staff support, and broad community interest in the project. Worthington Public Utilities hopes to further encourage this interest by engaging the surrounding community through open houses that will educate citizens about how wind power works, and encourage them to stay interested in and involved with wind turbine development. Worthington Public Utilities has already set aside land for two additional wind turbines and plans to install them within the next few years.

For more information contact:
Don Habicht
Worthington Public Utilities
507-372-8680
dhabicht@worthingtonpublicutilities.com

Construction of Worthington wind turbine

Ideal wind sites are characterized by Class 4 or 5 winds or better, but wind projects can still be viable on Class 3 wind sites. If the site is characterized by Class 2 winds or below, wind is probably not a good option.

2. Do trees or buildings surround the site? If obstacles such as trees and buildings surround your proposed site, wind may not be your best option, but consider:

- If the wind blows primarily from the north and you have buildings to the south, it may not be as much of a problem.
- If the wind blows from the north and you have forest to your north, then wind may not hold much electrical generating promise.

3. Is your site higher than its surroundings (for 1 to 2 miles) or are you located in a valley?

- If you are located in a valley, wind is not a good option.
- If you are located on a prominent point or ridge, wind may be an option.

4. Will you be able to install a wind tower a minimum of 500 feet from any road or structure? There is a required 500-foot setback distance for facilities with 5 MW or greater capacity. Always check local zoning ordinances for siting specifications.

5. Are tall towers allowed in your neighborhood or rural area?

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CASE STUDY:

Moorhead's Capture the Wind *Success Story*

MOORHEAD IS HOME TO TWO 750-kW wind turbines, Zephyr and Freedom. Moorhead Public Service's *Capture the Wind* program has garnered national attention for its energy program innovation, high levels of participation, and low premium rates. Moorhead customers pay an extra half cent /kWh for green electricity, which is made up of 1/3 wind and 2/3 hydropower. Customers may choose to purchase renewables in 1000 kWh blocks or may choose to purchase all of their electricity from renewables. The average cost to customers is $5.00 per month. Subscribers to the wind program directly replace coal-generated electricity with electricity from wind. The utility estimates that the turbines reduce carbon dioxide emissions by 8,800 pounds per year.

The *Capture the Wind* program was initiated in 1998. It began with numerous preparatory activities including establishing a monitoring site to measure and analyze site wind speeds and directions, detailing wind turbine specifications, and arranging financing. The city was able to locate the turbines within the city limits, and charter subscribers' names are listed on a plaque on the turbines. The first green offering was fully subscribed in two and a half weeks, and a waiting list was quickly established. The second offering was fully subscribed with 490 members in four weeks. The first turbine, Zephyr, began generating electricity in May 1999 and the second, Freedom, came online in August 2001. Combined, the two turbines generate 3,600,000 kWh of wind energy a year.

In 2001 the *Capture the Wind* program received the American Public Power Association's Energy Innovator Award. It has been recognized by the National Renewable Energy Laboratory for having the highest customer participation rate in the nation with 7.4% of its customers participating in the green pricing program and for charging the second lowest premium rate for a customer driven wind energy program. This award-winning program is already serving as a model for other municipal utilities working to develop wind energy for their customers.

For more information contact:
Kevin Bengston
Moorhead Public Utilities
218-299-5224
kbengtson@mpsutility.com

Moorhead's 750 kW wind turbines

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CASE STUDY:

Lac Qui Parle Valley School: Wind and Schools Combine

LAC QUI PARLE VALLEY HIGH SCHOOL erected a 225 kW wind turbine in 1997. Minnesota Department of Commerce sponsored the turbine installation following a rigorous selection process in which Lac Qui Parle Valley High School was selected as an optimal location based on wind velocity and consistency and its rural location. The system was designed to start generating electricity when wind speeds hit 6 mph and to produce at full capacity at 25 mph. Since installation, the turbine has generated an average of 36,000 kW per month, approximately 25-30% of the amount of electricity used by the school. This project has come to serve as a model for wind power generation at local schools.

Of course, beyond the benefits of green power, the project had to be financially viable. Installation of the turbine cost $248,907, and the school received funding via a $60,000 grant and a 10-year, $188,907, interest free loan from the Department of Commerce. Lac Qui Parle Valley School expects to have a 10-year pay back based on electricity cost savings, sales of excess electricity, and government production payments. Since the turbine provides roughly one-third of the schools electricity needs, it has substantially reduced the annual electric bill (down from $80,000 to $60,000). In addition, electricity produced during non-peak school hours, such as nights and weekends, is sold to Ottertail Power Company at a rate of approximately 1.5 cents per kilowatt. This too has generated extra funds for the school. Lastly, the school receives payments from the state for each kilowatt sold (1.5 cents) and payment from the federal government for each kilowatt generated (approximately 1.5 cents).

Besides supplementing the school's energy needs, the wind turbine is used as an education and research tool. Students at Lac Qui Parle Valley High School have gathered information from the turbine for use in their economics, physics, and environmental class discussions.

For more information contact:
Robert Munsterman
Superintendent of Schools
320-752-4200
robertm@lqpv.com

Wind turbine at Lac Qui Parle Valley school

6. Are you located near an airport? FAA regulations stipulate minimum distances from airport runways for structures of various heights that apply to wind towers, especially those over 200 feet tall.

7. Data from Wind Monitoring[6] It is usually prudent to monitor actual wind speeds for six months to a year using an anemometer before investing in a wind project. Anemometers are sometimes mounted on existing towers or on a newly erected tower. The following data is needed to fully evaluate the feasibility and costs of a wind project.

- Site elevation (higher is better)
- Monthly average wind speed (to determine the amount of likely power generation)
- Wind Rose data (wind speed and direction frequency data help evaluate the site and where best to put the turbine)
- Site exposure information
- Height above ground (at what height the measurements were taken)
- Data recovery (number of hours of valid data vs. total possible hours – ideally 90% of total)
- Data record (year and months with measurements)
- Site location with respect to your property (wind speeds generally increase to the north and west)

CASE STUDY:

Pipestone-Jasper School District: Wind Energy and Education

IN FALL 2001, THE PIPESTONE-JASPER SCHOOL DISTRICT was awarded one of Xcel Energy's Renewable Development Fund grants to construct a wind turbine. Jack Keers, a Pipestone County Commissioner, and Dan Juhl, a local wind developer, had urged the Pipestone-Jasper School District to apply for a grant to install a wind turbine at the new school to supply part of the school's electricity needs. The District was ideally located and seemed like a perfect fit for a school wind turbine project. The school would be built on a very windy Buffalo Ridge location, funding for the new school was secure, and construction was significantly under budget. With the Renewable Development Fund grant in place, the District must contribute $150,000 toward the turbine construction and Xcel Energy contributes the remaining $850,000.

The new school property is a 55-acre piece of land on the edge of town, and the wind turbine will be located on the northwest portion of the property to take advantage of the prevailing winds. The school will install a 900 kW wind turbine that is expected to power all of the schools basic needs and then some. The District anticipates selling the excess energy back to Sioux Valley Southwestern Electric, which should allow them to payback their initial investment within 6 years and will also allow the school to raise a bit of money after the payback period.

In addition to the economic incentives, Jerry Horgen, Superintendent of Pipestone-Jasper School District, also sees "great benefit in having the school set an example for the community by using renewable energy". As an educational institution, the District has a major role in educating and bringing the community together. The wind turbine project provides an ideal educational project for students of all ages, and will be incorporated into learning activities within the science department. Dr. Horgen says that the wind turbines offer a great opportunity for "furthering environmental awareness in our kids." As of summer 2002, the project is moving along right on target. The new building is expected to open by January 2003 and wind tower construction is anticipated to begin in April 2003 and should be completed by July or August 2003.

For more information contact:
Jerry Horgen
Superintendent of Schools
507-825-5861 or
Dan Juhl
DanMar and Associates
507-562-1280

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WIND PROJECT COSTS

The amount of energy in the wind is a function of wind speed. The energy in wind increases with the cube of wind speed. This means that if you double the wind speed, the energy production increases eight times. In addition, wind speed varies with height above the ground, and generally speaking increases with height. How the wind speed varies with height depends on the terrain, season, time of day, and other meteorological factors.

The cost of wind energy relates directly to the average wind speed at the site and the size of the wind farm. For example, the turbine in Moorhead produces just under 1.5 million kWh/yr with a 14 mph wind, while the same turbine in southwestern Minnesota produces 2.1 million kWh/yr with a 16 mph wind – more than 50% more. Construction of commercial scale wind energy plants currently costs about $800 to $1,000 per kilowatt of nameplate capacity. From a production standpoint, large-scale wind is now cost-competitive with conventional electric generation and costs are projected to decline further by 2006. Xcel Energy wind contracts have achieved levels of 3 to 4 cents/kWh.

A power purchase agreement with a utility is necessary in almost every case. Even projects built to supply electricity to one building or a campus facility are usually interconnected to the utility grid. Because of this, the utility should be contacted very early in the project planning process. Utilities are becoming more interested in purchasing wind energy because of the state requirements for green electricity. Xcel Energy has set a standard small wind tariff, which includes a standard contract and interconnection agreement and a price of $0.033/kWh for wind projects under 2 MW. The Minnesota Public Utilities Commission is in the process of examining tariffs for distributed generation for other utilities, which might include small wind projects.

OTHER PROJECT ELEMENTS

Other project elements include electric interconnection and transmission, project design, permitting, ownership, financing, and operations and maintenance. All of these will require technical expertise. Depending on the size and complexity of the project, one or more consultants will likely be needed. Each and every one of these areas is critical to project success. These elements are discussed in more depth in Chapter 12.

Interconnection and Transmission Projects will be connected to the electric grid and utilities understandably have requirements related to standardization and safety. Transmission will be necessary if the project is designed to deliver power to a distant user. The state's transmission system has not been upgraded in recent years and is constrained in many parts of the state. Even small projects may need to go through a review of transmission availability.

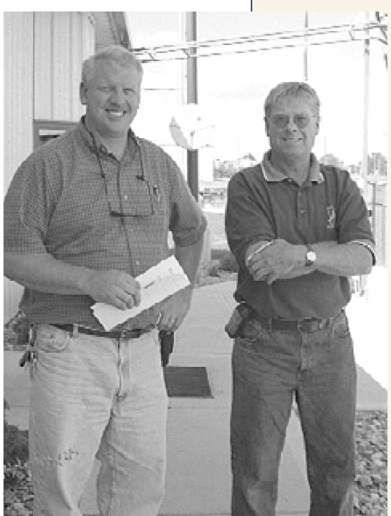
Project Design and Permitting Project design includes consideration of which size and type of turbine is best suited to the proposed site. The turbines from different manufacturers each have slightly different designs and features. There are different types and sizes of towers and different types of foundations. Road access to the turbine for operation and maintenance is another consideration.

Project elements include electric interconnection and transmission, project design, permitting, ownership, financing, and operations and maintenance.

CASE STUDY:

*Minwind I & II: Innovative Farmer-Owned Wind Projects**

IT TOOK ALMOST TWO YEARS, but in the fall of 2002 one of the first farmer-owned wind projects in Minnesota went on line in Rock County. "We wanted a farmer-owned project that would bring economic development, get farmers a return on their investment, and use local businesses and contractors to do the work," said Mark Willers, a project leader and farmer from Beaver Creek, Minnesota.



Mark Willers [left] and Tom Arends [right]

After extensive research, the group formed two limited liability companies, Minwind I and Minwind II. This maximized their ability to use tax credits and other incentives while maintaining the cooperative principles of voluntary and open membership, democratic member control, and concern for the greater community.

Sixty-six investors from the region snapped up all the available shares in both companies in just 12 days. Eighty-five percent of the shares must be owned by farmers, leaving the rest available for local townspeople and non-farmers who could someday inherit shares. Each share gives the owner one vote in the company and no single person can own more than 15 percent of the shares.

Although they coordinate closely, the two companies are governed by separate boards of directors, have different groups of investors and maintain separate financial books. Both groups relied heavily on expertise from consultants to develop the actual wind projects, negotiate the power purchase agreements, and determine the business structure.

With the shares sold, the companies began development of the two 1.9 MW wind projects. Each project consists of two Micon 950 kW turbines, and all four turbines are located on the same farm seven miles southwest of Luverne. The group wanted to use land owned by one of the project's investors, and the farm chosen had the best combination of wind resource and access to transmission lines.

According to Willers, the most difficult step in the projects was negotiating a power purchase agreement. Discussions with their rural electric cooperative proved fruitless. There were just too many issues including interconnection requirements, cost, and the cooperative's long-term exclusive agreement with another power supplier. Eventually, after months of negotiation, Minwind I and II entered into a 15-year contract with Alliant Energy, which will use the power to help satisfy renewable energy standards in Iowa or Wisconsin.

Finding capital for the hardware, consultants and legal fees was easy, because farmers were enthusiastic about investing from the very beginning. Willers believes that it is a myth that farmers do not have the money to finance projects on this scale (Minwind I and II will cost about $1.6 million dollars each and will be paid off in ten years).

Now that the current two 1.9 MW projects are operational, Willers says that there is so much interest from area farmers and other potential investors that they have already begun researching other potential sites and the possibility of doing much larger projects. Willers hopes expansion will allow many more farmers to participate in this innovative model for wind development. "This model is a way for farmers to take advantage of economies of scale in developing wind, just like the big companies do," said Willers. It's a model that can be used all over Minnesota.

For more information contact:
Mark Willers
507-962-3360

**Condensed from:*
Minwind I & II: Innovative farmer-owned wind projects, Windustry Newsletter, Fall 2002.
www.windustry.org/newsletter/2002FallNews.htm

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Almost every project will require some level of permitting. Larger projects are permitted by the state Environmental Project Board. Smaller projects will have to meet local siting requirements.

Ownership and Financing Financing is a critical element of any wind project since the bulk of the costs are up-front capital costs. The ownership structure and financing costs can be interrelated issues since the ownership may impact the financing available. Municipal, tax-free financing will be lower cost, for instance, than a bank loan available to a private owner. The federal Renewable Energy Production Incentive tax credit is a critical element of financing all wind projects.

Operations and Maintenance Someone will need to operate and maintain the wind project over time. Even though modern wind turbines are largely trouble free, arrangements for the occasional repairs and regular required maintenance would impact project costs.

SMALL-SCALE WIND PROJECTS

There are economies of scale in wind development, and in general, as might be expected, smaller wind projects have higher costs. There are, however, numerous programs to help improve the economics of small projects. Small-scale wind incentives for installations of 2 MW or less and programs offering special financial assistance for these small-scale wind installations are summarized on the tables provided in Appendix B. The Minnesota Renewable Energy Production Incentive is key to the financial viability of these projects, along with both property and sales tax exemptions.

Wind installations of 40 kW or less, home or farm systems, qualify for net metering. Net metering allows owners of these very small wind machines to consume electricity from the grid when they are not producing power, and sell electricity back to the grid at retail price when they are producing power.

END NOTES

[1] *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States*, Pacific Northwest Laboratory, 1991.

[2] Minnesota Department of Commerce, *Minnesota Energy Planning Report 2001*, St. Paul, Minnesota: MN DOC, January 2002.

[3] Renewable and High-Efficiency Energy Rate Options, *Minnesota Statutes 2002*, Section 216B.169 (2002).

[4] Minnesota Department of Commerce, *Wind Resource Analysis Program 2002*, October 2002. www.commerce.state.mn.us.

[5] The Department of Commerce prepared this map using the WindMap program, which takes into account wind data, topography, and land use characteristics. Data is averaged over a cell area 750 meters square, and within any one cell there could easily be features that could increase or decrease the results shown on the map. Regions with the greatest concentrations of monitoring sites show the most accurate results. This map shows the general variation of Minnesota's wind resources and should not be used to determine the performance of specific projects.

[6] Daniels, Lisa, *Harvest the Wind*, Sustainable Resources Center, Minneapolis, MN, 1996.

PHOTOGRAPHS

page 21 – National Renewable Energy Laboratory (lower); page 22 – Minnesota Department of Commerce; page 23 – Don Habicht/Worthington Public Utilities; page 24 – Moorhead Public Service, National Renewable Energy Laboratory; page 25 – Lac Qui Parle Valley High School; page 27 – Bruce Anderson/RENew Northfield; page 28 – Lisa Daniels/Windustry; page 29 – U.S. Department of Energy

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Minnesota Wind Resource Analysis Program Report – October 2002. Minnesota Department of Commerce presents data collected from 1995 through 2001. The Minnesota Wind Resource Assessment Program (MNWRAP) is an ongoing project sponsored by the Minnesota State Energy Office within the Department of Commerce. (www.commerce.state.mn.us)

Energy: Modern Technology – Wind. Minnesota Department of Commerce website including several wind maps that highlight wind potential around the state.
(www.commerce.state.mn.us)

Energy Information Center, Minnesota Department of Commerce, Energy Division. Additional information on wind, conservation and other renewables. email: energy.info@state.mn.us, 651-296-5175 or toll free at 800-657-3710.
(www.commerce.state.mn.us)

American Wind Energy Association. Web page with fact sheets and information about wind energy.
(www.awea.org)
Also available on this site are a list of small turbine manufacturers
(www.awea.org/faq/smsyslst.html).
A summary of programs, incentives and resources available regarding small-wind project development in Minnesota is available at:
(www.awea.org/smallwind/minnesota_sw.html)
Great Plains contact: John Dunlop, JRDunlop@igc.org

10 Steps in Building a Wind Farm. American Wind Energy Association. Outlines the items one should consider before moving forward with a wind project. This document also references other websites that list wind developers as well as wind consultants.
(www.awea.org/pubs/factsheets/10stwf_fs.PDF)

Windustry. A program providing information and education about small-scale and farmer-owned wind development. Web page includes information on financing and other aspects of farmer-owned projects, including a spreadsheet for assessing costs, production, and incentive numbers.
(www.windustry.org/calculator/default.htm)
Windustry contact: Sarah Johnson 800-946-3640 or 612-870-3461, sjohnson@windustry.org
(www.windustry.org)

Do It Yourself Small Wind Project Manual. enXco Midwest Office, 2003. A manual detailing the steps for developing a small wind project, including lists of consultants and suppliers. Call or write to request a free copy of the manual. enXco, 625 8th Avenue SE, Minneapolis, MN, 55414, 612-331-1486, 866-321-WIND
(www.enxco.com)

Farmers Guide to Farming Wind Energy as a Cash Crop. Dan Juhl and Harvey Washerman, 2002. A comprehensive guide for farmers interested in installing their own wind turbines. Includes all of the necessary documents and pro-formas for installing a system. Dan Juhl, djuhl@dtgnet.com, 507-562-1280; fax: 507-562-1279

Landowner's Guide to Wind Energy In the Upper Midwest. Nancy Lange and William Grant, Isaac Walton League of America, 1995. Midwest Office 651-649-1446.

Assessing Wind Resources: a Guide for Landowners, Project Developers and Power Suppliers. Michael Tennis, Steven Clemmer, and Jonathan Howland, Union of Concerned Scientists. An easy to understand and use summary of how to assess the wind potential.
(www.ucsusa.org/index.html).

Apples and Oranges. Mick Sagrillo, HomePower Magazine, detailed comparisons of various small wind turbines (from 50 watts to 20 kW).
(www.homepower.com/files/apples.pdf)

Hydroelectric

IN 2003, MINNESOTA HAS ABOUT 32 HYDROELECTRIC generating stations that produce slightly less than 150 megawatts of capacity. Most of these projects are smaller than four megawatts of capacity, although there are a few larger projects. About 3% of Minnesota's energy consumption is currently derived by hydroelectric power, but most of this comes from Manitoba Hydro, a large hydro project in Canada. Most of Minnesota's hydroelectric stations function as run-of-river operations. Manitoba Hydro and many of the hydroelectric stations in the Pacific Northwest operate in peaking or storage mode.

Minnesota communities may find the opportunity to develop hydroelectric power at formerly decommissioned dams.

The economics of hydropower development in Minnesota requires that the supporting infrastructure (i.e., transmission lines, site access, dam development) is either present or readily available for development. Suitable sites in Minnesota have limited capacity and most of the significant hydroelectric resources of the state have already been captured. There is not significant development potential for large hydropower projects, but a few small sites with the necessary infrastructure support do exist.

These sites could present potential small-scale electricity generation opportunities for rural areas. Indeed, the Idaho National Engineering Laboratory prepared a hydropower resource assessment for Minnesota in July 1996 that identified 40 sites with undeveloped hydropower potential.[1] Most of these sites are classified as small, in the range of kW of capacity, with 60% of the sites with capacities of 1 MW or less.

In Minnesota, communities may find the opportunity to develop hydroelectric power at formerly decommissioned dams that, in addition to storing water, could be used for electric generation. These sites hold the most promise for future hydroelectric power development in Minnesota.

HYDROPOWER BASICS

Hydroelectric power plants convert the potential energy in water pooled at a higher elevation into electricity by passing the water through a turbine and discharging it at a lower elevation. The water moving downhill turns the turbine to generate electricity. The elevation difference between the upper and lower reservoirs is called the "head". Hydroelectric power facilities are typically categorized as either low head (under 60 feet) or high head. Most of the facilities in Minnesota are low head, run-of-river operations.

OPERATIONAL MODES

Hydropower facilities operate via three primary operational modes. Many projects can function in more than one of these modes. The three types of hydropower operational modes include:

1. Run-of-River Mode uses the natural flow of the river by channeling a portion of the river to a canal to spin the turbine. This may or may not require the use of a dam, but technically requires that the flow in and out of the reservoir are equal.

2. Peaking Mode captures and releases water when the energy is needed.

3. Storage Mode captures and stores water during high-flow periods to augment the water available during low-flow periods, thus allowing power production to be more constant. Pumped storage mode allows hydropower facilities to store power by pumping water from a lower

CASE STUDY:

Byllesby Dam: Hydroelectric Power Revisited

THIS CASE STUDY IS A GREAT EXAMPLE of putting a decommissioned resource back to use. Construction of the Byllesby Dam was completed in 1911, and it generated electricity for Northern States Power Company (now Xcel Energy) until 1966. In 1968, the power company transferred ownership of the dam to Goodhue and Dakota Counties. The dam remained decommissioned until the mid-1980's when the two counties jointly decided to put it back into operation. In 1987, North American Hydro, a private firm, began to refit the dam for hydro production. The Byllesby Dam now provides 2.6 MW of renewable energy via three generators and a 56-foot head.

Dakota County manages the dam, but the generation itself, along with the paperwork and operation and maintenance details, are contracted out to North American Hydro. North American Hydro also provided the upfront capital to restart the project. The two counties and North American Hydro share the revenues from the electricity generation, which are generally put back toward dam maintenance costs. Although it does not generate a profit for the counties, it does help them cover their costs, while putting local, renewable energy back into the grid.

For more information contact:
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651-438-4960
bruce.blair@co.dakota.mn.us

Byllesby Dam on the Cannon River

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Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

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reservoir to an upper reservoir during periods of low-energy demand. During periods of high-energy demand the water can be re-released to the lower reservoir to spin the turbines and create electricity.

CURRENT TECHNOLOGY STATUS

Hydroelectric power generation is a well-developed technology and therefore is generally very reliable except during periods of sustained drought or in the presence of ice. Both limit the availability of water to turn the turbines. Hydroelectric plants boast an overall efficiency of about 80 percent, significantly higher than that of either coal or natural gas. The capital costs for constructing a hydropower facility are estimated to be in the range of $1,700 to $2,300 per kilowatt (1996 dollars). Operating costs of hydroelectric plants are often low in comparison to those of fossil fuel plants because the flowing river water generally has no direct cost associated with its use.

As a result of trying to control water levels in Manitoba for maximum power generation, flooding occurs causing debris to line the shore and large amounts of sediment to be deposited in once clear waters.

ENVIRONMENTAL AND SOCIAL CONCERNS

Large hydroelectric projects can have severe impacts on surrounding communities and on ecosystems. Some of the impacts can include complete dislocation of communities and flooding of surrounding villages or restriction of fish movement and local extinctions.

Smaller scale projects, like those possible within Minnesota, tend to have fewer impacts. To address the potential environmental and social concerns, it is imperative that project developers do an environmental analysis on their site that includes an analysis of the potential impact to flora and fauna. For projects of less than 5 MW, a formal environmental assessment is not required, but the developer should address potential environmental issues to ensure community buy-in.

END NOTES

[1]Francfort, James. *U.S. Hydropower Resource Assessment for Minnesota.* Idaho National Engineering Laboratory, Boise, Idaho, July 1996. This report can be accessed from: http://hydropower.inel.gov/state/mn/mn.pdf.

PHOTOGRAPHS

page 31 – Eastern Waterfall Guide; page 32 – Bruce Blair/ Dakota County Park Service; page 33 – JustEnergy; page 34 – Park Rapids Enterprise Newspaper (left), LuAnn Hurd-Lof/ Park Rapids Enterprise Newspaper (right); page 35 – Minnesota Historical Society

CASE STUDY:

Park Rapids: A Study of Options to Retrofit a Former Structure

A STUDY OF USING THE FISH HOOK RIVER DAM in Park Rapids to again generate electricity began in 2000 as part of a University of Minnesota Central Regional Sustainable Development Partnership energy project on alternative community energy generation possibilities. The study looked at local renewable energy generation at five community sites, including the Fish Hook River dam. The dam was originally built with a hydropower facility in 1909 but was decommissioned in 1943, and has sat unused ever since.

Park Rapids saw a great opportunity at their underutilized dam. After all, they had both the dam and the plant already there. While the upfront capital costs would be high to install the new turbines that would be needed, the project would generate renewable energy for the community and would reduce the amount of coal needed to generate electricity in Park Rapids. Additionally, the project could draw upon a 1982 feasibility study that had evaluated the potential of reactivating the site but never came to fruition.

In nearly every sense, the project seemed well aligned. If successful, the project could serve as an example to other communities around the state with inactive power facilities at existing dams. Unfortunately, plans to reactivate the power facility on Fish Hook River were dropped in April 2002. The Park Rapids City Council decided that the expected generation of only 100 kWh/hour meant that the project was not economically feasible. They believed that at least 200 kWh/hour would have been necessary for the project to move forward.

In the end, it appears that delayed research findings may have stalled the project too long and swayed council members to pass up an opportunity without ever getting the full story. Project supporters are now considering applying for an Xcel Energy Renewable Development Fund grant that could provide partial funding and help make the project a reality.

For more information contact:
Paul Imbertson
University of Minnesota
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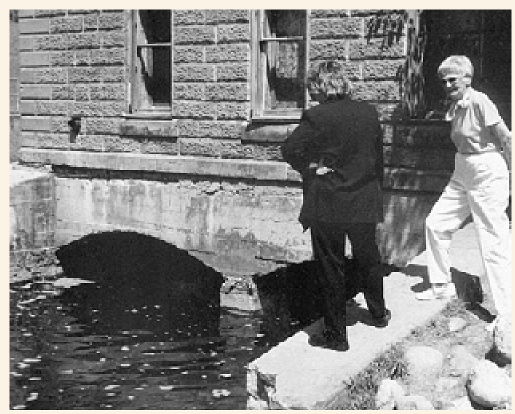
imber003@umn.edu



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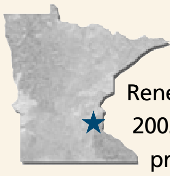
CASE STUDY:

Crown Hydro: Renewable Energy for Metro Markets



CROWN HYDRO received $5.1 million through Xcel's Renewable Development Fund in 2002 to renovate for hydropower production a section of the Minneapolis Mill Ruins located at the west end of St. Anthony Falls. The project will be a run of the river plant, consisting of a reconstructed upper canal and intake tunnel, a powerhouse room containing two Kaplan turbines with a total generating capacity of 3400 kW, an existing tailrace tunnel as well as a reconstructed tailrace tunnel, and an underground transmission line. The project will also improve a section of Minneapolis Park Board land with a new bridge, a boardwalk, landscaping, and public information structures featuring the hydro plant and history of the area.

As of January 2003 Crown achieved three major milestones: a completed 20 year power purchase agreement with Xcel, which awaits expected PUC approval this March; a settlement agreement with the Minnesota Department of Natural Resources for a fish restitution plan; and an agreement with the Federal Energy Regulatory Commission (FERC) for a cultural resources management plan affecting the historical site. A lease agreement with Minneapolis Park Board is under active negotiation. FERC intends to issue an order for construction in April, 2003, and Crown now expects to begin construction in June with start up projected for April, 2004.

Crown will take advantage of an existing untapped resource to provide additional capacity to the surrounding metro-area and provide clean, renewable energy to a highly populated, energy demanding community.

For more information contact:
Tom Griffin
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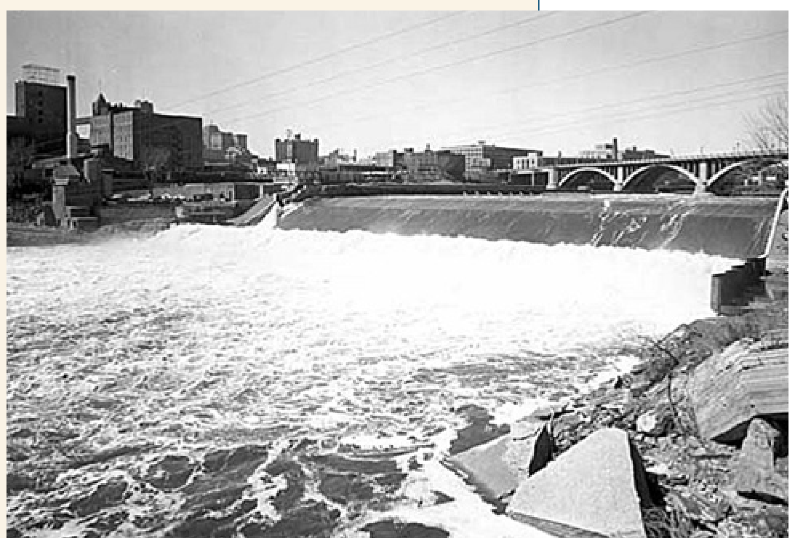
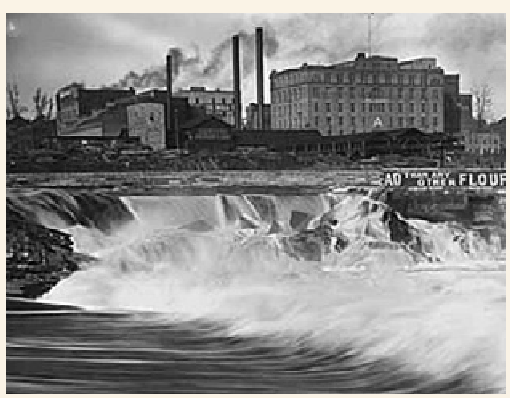
tgrifhydro1@usfamily.net



Crown Hydro facility will be located on the east end of St. Anthony Falls



Pillsbury Mill and St. Anthony Falls, circa 1897

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Office of Energy Efficiency and Renewable Energy: Hydropower Topics and Hydropower Basics. Sites include basic hydropower information and descriptions of types of turbines. (www.eren.doe.gov/RE/hydropower) and (www.eren.doe.gov/RE/hydro_basics.html)

U.S. Hydropower Resource Assessment for Minnesota, James E. Francfort, Idaho National Engineering Laboratory for the US DOE, July 1996. Outlines sites available in Minnesota with undeveloped hydroelectric potential by dam status group and by river basin. (http://hydropower.inel.gov/state/mn/mn.pdf)

Minnesota Department of Commerce 2001 Energy Planning Report. Includes basic information regarding hydropower projects in Minnesota and the potential associated environmental and social costs. (www.commerce.state.mn.us)

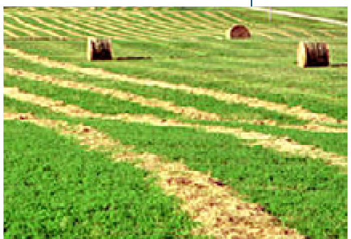
St. Anthony Falls Laboratory. Provides information, research and publications available from this University of Minnesota research laboratory. John Thene, Associate Director, Contract Research and Engineering, 612-627-4609, email thene@tc.umn.edu. (www1.umn.edu/safl/index.html)

Minnesota Department of Natural Resources Hydropower webpage. Provides links to pertinent licensing organizations, information about potential environmental impacts, and listings of Minnesota's hydropower facilities. (www.dnr.state.mn.us/waters/surfacewater_section/stream_hydro/hydropower.html)

Federal Energy Regulatory Commission: Hydropower. Outlines the preliminary and final permitting requirements as well as permit conditions reviewed (including environmental and safety issues) and parties that must be involved in any permitting process for a hydroelectric facility. (www.ferc.gov/hydro/docs/waterpwr.htm)

University of Minnesota, Department of Civil Engineering. John S. Gulliver, author of *Hydropower Engineering Handbook,* has worked on the feasibility of small hydropower, on hydraulic design, hydrologic studies, and water quality impacts of hydropower. 612-625-4080, email: gulli003@tc.umn.edu.

Biomass



BIOMASS IS ANY ORGANIC MATERIAL not derived from fossil fuels that can be converted to a fuel useful for generating electricity. Biomass can be waste products, as described in the Rahr Malting Case Study below, or crops planted expressly to produce energy ("dedicated crops"), like the poplar trees described in the case study below. Minnesota currently has 343 MW of biomass electric generation capacity.[1] The Union of Concerned Scientists estimates that with existing technology, biomass could provide 6,690 MW of capacity to Minnesota,[2] or well over half the state's current needs.

Biomass could provide 6,690 MW of capacity to Minnesota, or well over half the state's current needs.

Biomass generates electricity by combustion, which releases the stored solar energy contained in the plant matter.[3] Unlike wind or solar, a benefit of biomass is that it is "dispatchable" – that is, it can be turned on and off on demand. Utilities in particular like this feature, because it ensures that the power is available when they need it the most.

SOURCES OF BIOMASS

Also referred to as "feedstocks", biomass for a power plant can come from a wide variety of sources, including the following:[4]

Wood Residues This refers to leftover wood from other uses, and not wood harvested expressly for biomass. The lumber, pulp, and wood milling industries already extensively use wood waste to produce power. Wood residues can also come from forest thinnings, urban tree trimmings, residual construction material, demolition material, wood pallets, and other waste.

Agricultural Residues This includes primarily mill residues (waste from a processing plant, like nut hulls and oat hulls) and field residues (left in field after harvest, like corn stover and wheat straw). The removal of field residues for energy must be balanced with the benefit to soil quality that residues provide.

Energy Crops These are crops that are "dedicated" for energy production. The most promising include woody crops like willows, hybrid poplars, maple, and sycamore; and herbaceous crops like switchgrass and other prairie grasses. Often these types of energy crops offer environmental benefits over conventional crops, like less need for crop inputs, habitat for wildlife and reduced erosion and run-off.

Animal Waste Dry animal waste, primarily from poultry, can be burned directly for heat and power. Wet manure can be digested to produce biogas – see more in chapter 7.

Sewage Sludge Although the solids can be burned, a more common option for producing energy at a sewage treatment plant is anaerobic digestion, which produces energy while treating the waste (see chapter 7).

Biofuels Liquid fuels like ethanol and biodiesel are primarily used in transportation applications, but could also be burned to produce electricity. See more in the chapter 8.

Approximate Costs of Various Biomass Feedstocks[5]

Feedstock	Delivered cost ($/dry ton)
Urban wood wastes	<$25-$35
Wood mill residues	<$25-$55
Agricultural residues	<$35-$55
Hybrid poplars	<$55-$70
Willows	<$35-$75
Switchgrass	<$35-$55

CONVERTING BIOMASS TO ELECTRICITY

Usually raw biomass as it is harvested is not suitable to be used for power generation. It must go through a process to prepare it for use in an energy plant. If the biomass is being used in a conventional power plant, the biomass is usually "homogenized."

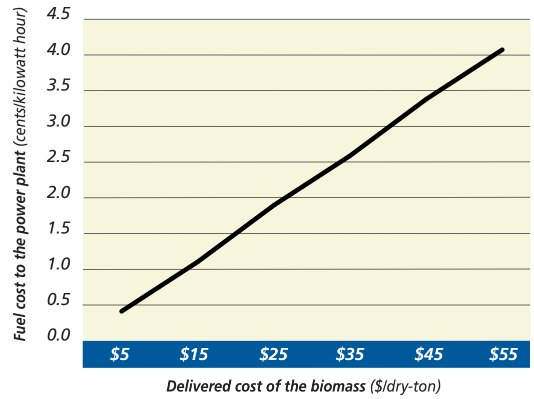
Homogenization converts materials of different sizes into a mixture of uniformly sized particles. Most commonly homogenization includes sorting and size reduction (by cutting, grinding, or pulverizing). Sorting helps eliminate contaminants and size reduction helps injection of material into combustor at a more constant rate and creates greater surface area for maximum burn efficiency.

Technology to convert solid biomass to electricity is based in large part on existing coal-fired technology, which is a well-developed technology. Biomass is generally cleaner burning than coal, as it typically contains less pollutant-forming components such as sulfur, nitrogen and heavy metals. It does present a few technical challenges in comparison to coal, however.

Often biomass is high in alkali metal, such as sodium, potassium and calcium. While the combustion of these materials is not generally considered an air pollutant, it can cause corrosion and deposits to form within the boiler, increasing the maintenance requirements of a biomass plant. The lower heat content of biomass also means that a larger volume of boiler is required to produce the same amount of energy as a coal-fired plant. The space for storage and handling are also greater than for coal plants.

Co-firing biomass with coal at existing coal plants (typically in percentages of less than 15 percent biomass) shows much promise in the near term for greatly expanding the use of biomass. Some modification of the existing

Approximate fuel costs of biomass used in a conventional power plant [6]



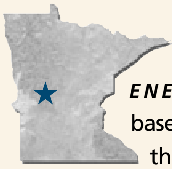
plant is necessary to allow co-firing, estimated to be around $180 to $200 per kilowatt of biomass capacity. Several coal plants around the country, including in Iowa and Wisconsin, are experimenting with co-firing.

An option that shows great promise for the future is gasification. Gasification generally involves pyrolysis, or heating the biomass to high temperatures in the absence of oxygen, which causes the volatile portion of the biomass (this can be 70 to 80 percent) to gasify. Much of the remaining biomass can be gasified through a steam injection process. After cleaning, the gas can be used in very efficient and low-polluting combustion turbines, such as those that are currently used for natural gas, or perhaps in fuel cells.

Biomass processing equipment at a co-firing plant in Iowa

CASE STUDY:

Minnesota Wood Energy Scale-Up Project



BEGUN IN 1994, THE MINNESOTA WOOD ENERGY SCALE-UP PROJECT, based in Alexandria, Minnesota, was the first biomass to electrical energy research project involving hybrid poplars. The project is a partnership between the Western Minnesota Resource, Conservation and Development Council (WesMin RC&D), the Oak Ridge National Laboratories Biofuels Feedstock Development Program, and local landowners. The project focuses on developing a biomass feedstock. Although there are no contracts currently established to use the biomass in an energy plant, several options are under consideration. Currently, the project consists of 1,800 acres of privately owned cropland, all located within 50 miles of Alexandria. Landowners are supported in their efforts by cost-share agreements for maintenance and pest control while the WesMin RC&D and the Minnesota Department of Natural Resources work with landowners to plant and maintain the poplars as well as measure and collect tree growth data. The Biofuels Feedstock Development Program calculates the hybrid poplars annual yield. All of this data is then combined with economic data to assess on-going feasibility of hybrid poplar projects. The Minnesota Wood Energy Scale-Up Project has brought together numerous stakeholders all working to take charge of their energy future by capitalizing on a locally grown, perennial, renewable energy resource.

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dean.Schmidt@mn.usda.gov

A tour group wanders among tress enrolled in the Minnesota Wood Energy Scale Up Project.

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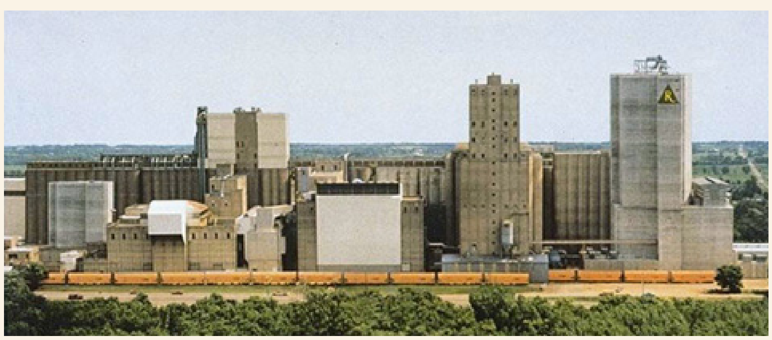
CASE STUDY:

Rahr Malting

RAHR MALTING IS A FAMILY-OWNED MALTING BUSINESS located in Shakopee, Minnesota. As a malting facility, the plant must have a reliable energy supply to operate its plant -- its two biggest processing costs are electricity and natural gas. Rahr Malting produces 50,000 tons of biomass annually, a low value by-product of the malting process. Within 50 miles are numerous facilities that could provide additional biomass by-products, as well as farms that could grow energy crops to supplement Rahr's biomass supply. Rahr is considering building a 20 megawatt combined heat and power facility that at full capacity would be able to provide for all of its electrical needs, generate an additional 12 megawatts for the surrounding community, and supply a minimum of 20 to 30 percent of its process heating needs.

According to Rahr, the project will have extensive direct and indirect effects on the local economy from jobs created at the plant, the construction of the project, increased agricultural demand, and the generation of electricity.[7] However, as of spring 2003, the project is still on hold. Rahr is currently awaiting the outcome of proposed federal legislation containing incentives for biomass energy generation. In addition, the company continues to seek a partner to buy the 12 MW of excess energy that will be produced. This power purchase agreement is a crucial component to the project, and will be key to establishing the project's economic viability. The avoided energy costs and reduced operating costs for waste material transportation and disposal cannot alone ensure the viability of the project.

For more information, see the report referenced at the end of this section, or contact:
Paul Kramer
Vice President, Rahr Malting
952-496-7002
pkramer@rahr.com



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Gasification could also result in high-value co-products along with electricity generation. However, gasification is still an emerging technology, and it may be some time before commercial gasification plants are available.

Some kinds of wet biomass can also be anaerobically digested to create methane-rich biogas. This option is discussed more in the chapter 7.

ENVIRONMENTAL CONSIDERATIONS

Accounting for the environmental impacts of biomass is perhaps more complicated than for any other energy source considered here. Although a renewable resource, biomass has a much broader effect on the environment than other renewable sources. For example, while there are no emissions from wind turbines, the combustion of biomass produces pollutants that can have effects on human health and the environment.

The environmental impacts we are most familiar with are those "from the smoke stack." The combustion of biomass can produce the same air pollutants as fossil fuel combustion.[8] These pollutants have been shown to cause asthma and other health and environmental problems. Depending on the type of generator and emission control technology that is used, pollutants can be kept to a level much below existing fossil plants.

One advantage that biomass has over fossil fuel emissions is reduced impact on global warming. Fossil fuels are the primary source of the greenhouse gas carbon dioxide. Plants take carbon dioxide out of the air as they grow, thus neutralizing the effect of releasing the carbon dioxide when the plant is burned, and thus biomass can be considered a nearly "carbon-neutral" source of energy.[9]

We are much less used to thinking about the environmental impacts of growing the biomass. These impacts can include fertilizer and pesticide use that pollute our water, and loss of a useful soil amenity (for example, manure that is burned). There can also be positive environmental benefits of growing biomass – for example, some biomass sources can reduce erosion, improving water quality near streams and providing habitat for wildlife.

When considering a renewable energy source as complex as biomass with multiple benefits and concerns, it is helpful to consider the net environmental benefits of a biomass energy project – that is, including all environmental effects from the project, both negative and positive, is there a net improvement in the environment? The following criteria have been developed to evaluate sustainable biomass energy production:[10]

Impact on Water Quality Biomass crop growth should minimize pollution due to erosion, pesticides, nutrients or waste products.

Impact on Soil Quality Soil quality should not be degraded.

Effect on Wildlife There should be no detrimental impact on local wildlife in comparison to alternative land uses.

Effect on Air Quality Biomass energy production should result in net reductions in air pollutants.

Net Energy Balance Does it provide more energy than is consumed in making the energy (such as the energy used to produce fertilizer, drive tractors, dry the crop, etc.)?

Biodiversity Does the biomass increase the diversity of our nation's genetic crop base?

ECONOMIC VIABILITY OF BIOMASS

The economic viability of biomass continues to increase. However, biomass facilities using dedicated energy crops currently cost more than traditional fossil fuel plants. Perhaps if the full environmental impacts of these fossil plants were included, the balance would change. In any case, just as for wind, the economics will improve over time as more plants are built.

There are many situations when biomass is economically viable on its own right. When low value sources of biomass are available as a byproduct of another process, or that have no other useful purpose, fuel costs can be dramatically reduced. This is why there are so many biomass plants at paper mills, where there is a lot of wood waste. Many studies also suggest that the most economic use of biomass is in co-firing at existing coal plants.

The economics also improve when waste heat from electric generation is used for other purposes (see chapter 11 on Combined Heat and Power). As was mentioned earlier, biomass has the advantage of being able to produce electricity on demand, which also adds value. With the proper nurturing, biomass can become an important part of our energy mix.

Biomass plants in Minnesota

Facilities in Minnesota currently utilizing "bioenergy" fuel sources often use milling and logging residues. Some examples include:

- *Blandin Paper – Grand Rapids*
- *Boise Cascade – International Falls*
- *Champion Paper - Sartell*
- *Potlatch Corporation – Cloquet*
- *Minnesota Power – Duluth*

In 1994, Xcel Energy (then NSP) was required to develop 425 MW of wind power and 125 MW of biomass projects, in exchange for continued operation of its Prairie Island nuclear plant. Projects that are being developed to fulfill this requirement include:

- *St. Paul District Energy – uses urban wood waste to produce electricity and heat (see case study in chapter 12)*
- *EPS/Beck Power – proposed to be built near St. Peter, using hybrid poplar trees*
- *FibroMinn – plant near Benson utilizing turkey litter*

Hybrid poplar wood chips being unloaded in Crookston, Minnesota

END NOTES

[1]2000 data from the Renewable Electric Plant Information System (REPIS, version 6.0), U.S. Dept. of Energy, Office of Energy Efficiency and Renewable Energy; www.eren.doe.gov/repis. Note that of the total biomass capacity, 151 MW is municipal solid waste, a fuel source that many do not consider renewable.

[2]Data provided by Steve Clemmer, UCS. Biomass potential is calculated based on data from Walsh, M.E, et. al. *Biomass Feedstock Availability in the United States: 1999 State Level Analysis*, Oak Ridge National Laboratory, January, 2000. Available online at: http://bioenergy.ornl.gov/pubs/econ_assess.html. Includes urban wood residues, mill residues, forest residues, agricultural residues, and energy crops (e.g., switchgrass) that can be produced for $50 per ton or less.

[3]Combustion of biomass is the only commercially viable option for generating electricity at present – however, researchers are working on ways to directly convert biomass to hydrogen fuel, where it can be used in a fuel cell without combustion. See chapter 10.

[4]Renewable Energy Policy Project, "BioEnergy: Biomass FAQs". Retrieved on October 21, 2002 from http://www.crest.org/articles/static/1/1004994679_6.html#bioc.

[5]Costs of feedstocks can vary widely depending on local conditions. From Bain, Richard, *Biopower Technical Assessment: State of the Industry and Technology*, Golden, CO: National Renewable Energy Laboratory, March, 2003; and Walsh, M.E, et. al. *Biomass Feedstock Availability in the United States: 1999 State Level Analysis*, Oak Ridge National Laboratory, January, 2000.

[6]Note this is fuel costs only and does ***not*** include capital costs or operations and maintenance costs of the plant. This chart assumes a biomass heat content of 8000 Btu/dry lb (actual heat content varies by feedstock, from about 6500 to 8500), and a conversion rate (heat rate) of 12,000 Btu/kWh, approximately the average for existing coal plants.

[7]Rahr Malting, *Rahr Malting 20 Megawatt Biomass to Energy Project*, Shakopee, Minnesota, October 2001.

[8]These emissions can include nitrogen oxides (NOx), low levels of sulfur dioxide (SO2), particulate matter or "soot" (PM), carbon dioxide (CO2), Volatile Organic Compounds (VOCs), and other pollutants. Emissions vary widely depending on the type of generator and emission controls used.

[9]Note that biomass may cause some carbon dioxide emissions through the production and transportation of the biomass (e.g., the trucks that deliver biomass to the plant consume fossil fuel), so may not be completely "carbon-neutral".

[10]Nelson, Carl, *Renewable Energy from Farms: Building on the principles of sustainable agriculture to achieve sustainable energy*, Minnesota: Midwest Sustainable Agriculture Working Group, June 2002. Available at www.mnproject.org

[11]From the U.S. Dept. of Energy – see reference 1.

PHOTOGRAPHS

page 37 – National Renewable Energy Laboratory; page 38 – Chariton Valley RC&D; page 39 – Dean Schmidt/WesMin RC&D (upper), National Renewable Energy Laboratory (lower); page 40 – Paul Kramer/Rahr Malting; page 41 – National Renewable Energy Laboratory; page 42 – National Renewable Energy Laboratory; page 43 – Dean Schmidt/WesMin RC&D

Hybrid poplars near Alexandria

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Biomass Energy Resources and Information from Minnesotans for an Energy-Efficient Economy. Information on biomass projects in Minnesota, including the Rahr Malting and hybrid poplar projects discussed in this chapter. Also a good source of general information on biomass. (www.me3.org/issues/biomass)

Energy from Biomass, Loni Kemp, The Minnesota Project. This article details the three crops Minnesota farmers have the most experience with (corn, alfalfa, and hybrid poplar) that could be used as biomass fuels. (www.mda.state.mn.us/crp/biomass.htm)

Biomass for Electricity Generation, written by Zia Hag, U.S. Department of Energy, Energy Information Agency. This article details biomass feedstock supply curves – how much the various feedstocks cost, the likely supply quantity, and how much it would cost to transport them – also provides predictions regarding energy generation potential. (www.eia.doe.gov/oiaf/analysispaper/biomass/index.html)

Bioenergy: Biomass FAQs. Included on the Renewable Energy Policy Project website that covers a broad range of biomass information from feedstock descriptions to prices to associated environmental impacts. (www.crest.org/articles/static/1/1004994679_6.html#biof)

Biopower Technical Assessment: State of the Industry and Technology. This recent (March 2003) and detailed (277 pages) study of biomass power by the National Renewable Energy Laboratory assesses barriers, feedstock supplies, environmental performance and lessons learned from existing biomass plants as well as an economic analysis of costs for biomass plants. (www.eere.energy.gov/biopower/bplib/library)

U.S. Department of Energy. Primary biomass energy page at the Department of Energy. (www.eren.doe.gov/RE/bioenergy.html)

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Contains detailed information regarding the various biomass resources. (www.eren.doe.gov/RE/bio_resources.html)

Short Rotation Woody Crops: A role for the state of Minnesota. Center for Rural Policy and Development at Minnesota State University, Mankato has published its policy paper on producing short rotation woody crops; discusses economic and environmental benefits and barriers associated with growing woody crops on agricultural lands. (www.mnsu.edu/dept/ruralmn/pages/Publications/publications.html)

Renewable Energy from Farms: Building on the Principles of Sustainable Agriculture to Achieve Sustainable Energy. Midwest Sustainable Agriculture Working Group Position Paper authored by Carl Nelson of The Minnesota Project and published in June 2002. (www.mnproject.org)

From Plants to Power Plants: Cataloging the Environmental Impacts to Biopower. This report from the Natural Resources Defense Council (NRDC), still in draft form, has a goldmine of both technical and environmental information of biomass. Contact Nathaniel Greene, NRDC, 212-727-4482, ngreene@nrdc.org

Biogas Digesters

BIOGAS DIGESTERS HAVE CAPTURED MANY IMAGINATIONS because they can turn organic wastes from our farms, factories and cities into a valuable source of renewable energy. In addition, the potential of this technology to reduce odors and other environmental concerns of animal feedlots has resulted in much recent interest from farmers. On-farm uses are not, however, the only digester options. Indeed, other industries have been reaping the benefits of digestion for years, particularly for wastewater treatment. While digesters can be a useful source of energy, they probably will never supply a significant portion of our state's energy needs – it's estimated that farm digesters could at most provide about one and a half percent of Minnesota's energy needs.[1] This chapter will discuss both on-farm and non-farm applications.

Anaerobic digestion is a natural process similar to composting that breaks down organic wastes to produce biogas.

ANAEROBIC DIGESTER BASICS

Biogas digesters work on the principal of anaerobic digestion – a natural, biological process similar to composting that breaks down liquid manure, sewage, or other organic wastes. In the process, biogas is produced. This biogas is about 55-70 percent methane (the primary component of natural gas) and therefore can make an excellent energy source. Anaerobic means "without oxygen," and the bacteria that produce the biogas can only survive if they are not exposed to oxygen in the air. These bacteria generally thrive at two temperature "zones" from 95-105° F, and from 125 to 135° F. Although anaerobic digestion occurs at lower temperatures, it is not as efficient at producing biogas.

ENVIRONMENTAL BENEFITS AND CONCERNS[2]

Anaerobic digestion offers several environmental benefits:

Odor Reduction Odors are significantly reduced in an anaerobic digestion system.

Green Energy Production Biogas is a renewable resource, and when it is converted to electricity it is replacing power than would otherwise be produced from fossil fuel sources.

Pathogen Reduction Harmful pathogens are also reduced – although not eliminated – through digestion.

Greenhouse Gas Reduction Methane produced naturally from animal manure storage is a contributor to global warming – methane is a powerful greenhouse gas 23 times more potent than carbon dioxide, the most common greenhouse gas. Capturing and burning this methane with an anaerobic digestion system reduces this agricultural source of greenhouse gases.

Reduction in Total Oxygen Demand of the Treated Waste Total oxygen demand (TOD) is a measure of potential impact on aquatic systems. In the case of a manure spill into a water body, manure with a high TOD will suck more oxygen from the water and thus kill more fish.

Especially for on-farm digesters, there are also several potential environmental concerns of digesters:

Nitrogen and Ammonia Emissions Although digestion does not remove nutrients from the manure, is does convert organic nitrogen in manure to an ammonia form. This can be both a benefit – it is more easily available as a nutrient to plants – and a potential concern, as

CASE STUDY:

Haubenschild Farms: Making Electricity on the Farm[3]

HAUBENSCHILD DAIRY FARM is a 1000-acre, family owned and operated dairy farm located near Princeton, Minnesota. In 1999 the farm installed a biogas digester at a total cost of $355,000, including the engine and generator. It is a great example of a local waste to energy project, although owner Dennis Haubenschild would dispute the fact that manure from his dairy cows is a waste. “Manure is a valuable resource that we need to use to its fullest extent,” says Dennis.

The Haubenschild Dairy Farm collects manure from its approximately 750 cows. Over a period of about 15 days, the manure passes through a covered 350,000-gallon, in-ground concrete tank – the biogas digester. Suspended heating pipes heat the manure inside the digester to create the optimal conditions for creating biogas. A 135-kilowatt engine-generator set is then fueled with the biogas captured from the digester and used to generate electricity. The hot water used to heat the digester is recovered from the engine-generator’s cooling jacket and reused to heat the barn floor space. The digested manure is stored in a lined storage lagoon until it can be spread on the fields for fertilizer.

***The Haubenschilds: Dennis, Bryan, Marsha and Tom** (left to right)*

The farm produces enough electricity to meet all on-farm electric needs plus enough excess electricity to power about 75 homes. The excess electricity is sold to East Central Energy, the Haubenshild’s local electric cooperative, which markets the “cow power” as green electricity to its customers for a slight mark-up to cover its increased distribution expenses. Haubenschild Farms expect the value of the energy from the digester will pay back total project costs in about 5 years.

For more information, a full report on the Haubenschild digester is available at
www.mnproject.org
or contact:
Henry Fischer
East Central Energy
763-689-8055
Henry.Fischer@ecemn.com

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Three Primary Types of Digesters for On-Farm Use[4]

While engineers have developed many digester designs for use in treating sewage and industrial waste streams – some of them quite complex – there are three basic designs in commercial use on farms.

COVERED LAGOON

- *Least expensive*
- *Large lagoon covered with impermeable cover*
- *Best for liquid manure*
- *Does not work well for energy production in Minnesota because it is not heated, but does help curb odors*

COMPLETE MIX DIGESTER

- *Works for manure with 3 to 10 percent solids (swine or dairy)*
- *Manure processed in heated tank (above or below ground) and solids kept in suspension by mixer*
- *More expensive than plug-flow*

PLUG-FLOW DIGESTER

- *Works well for manure with solids concentration of 11 to 14 percent, such as cow manure*
- *Mixes manure then moves it through the digester in a "plug" (gummy clump of manure). Anaerobic digestion creates biogas that moves through digester; the digester is heated by suspended hot water pipes, and the gas is stored under an impermeable cover*

ammonia nitrogen can be more easily lost to the air, where it is a pollutant. Nitrogen loss can be minimized by using proper management practices such as: injecting the digested manure into the soil instead of spreading it; maintaining a crust on the storage pond; and reducing the surface area of the storage pond.

Digested Manure Storage Concerns Water pollution from potential surface water run-off or groundwater contamination from liner leakage. This is not a concern that is particular to digesters, however, but exists for all confined animal agriculture operations.

Air Emissions from Combusting Biogas The burning of biogas does produce emissions; however, these emissions are significantly cleaner than existing coal-fired power plants.

WILL A DIGESTER WORK FOR MY FARM?

The AgSTAR Handbook includes 5 criteria for preliminary screening of potential anaerobic digester projects at dairy or swine feedlots. For complete information on conducting a pre-feasibility assessment, farmers should see the Ag STAR Handbook.[5]

1. Do you have a "large" confined livestock facility? Ag STAR defines large as at least 300 head of dairy cows/steers or 2000 swine, although digesters have been successful at smaller farms.

2. Can you ensure year-round, stable manure production and collection? A digester needs to be constantly and regularly "fed" manure to maintain methane-producing bacteria.

3. Do you have a manure management strategy that is compatible with digester technology? Digester technology requires the manure to be: managed as a liquid, slurry or semi-solid; collected at one point; collected regularly; and free of large quantities of bedding and other materials (i.e., rocks, sand, straw).

4. Do you have a use for the energy recovered? Can a generator be installed to produce energy and will a local utility purchase it? Are your on-farm electricity costs high? Is there another use for the energy on-farm?

5. Do you have someone to efficiently manage the system? Successful digester operation requires an interested operator who will pay attention to performing the daily routines of digester maintenance and possesses basic "screwdriver friendliness."

CASE STUDY:

Perham Community Digester

WHEN IT'S BUILT, THE LITTLE PINE DAIRY DIGESTER will combine the waste stream of Little Pine Dairy, a 1400-cow dairy farm, with the waste stream of a food processing company a few miles from the farm. Currently the company, located in Perham, Minnesota, is paying fees to dispose of the waste that the digester will treat and produce energy from. This project promises to be an excellent opportunity to test the possibility of combining multiple waste streams, increase the profitability and efficiency of both the dairy and food processing company, increase local energy self sufficiency, produce renewable energy, and provide multiple environmental benefits. This agriculture and industry partnership exemplifies the ways in which communities can come together to address their energy needs.

For more information contact:
Ron Tobkin
Little Pine Dairy
rstobkin@eot.com

CASE STUDY:

Anaerobic Digestion of Food Waste at AnAerobics/Seneca Foods

ANAEROBICS PROVIDES treatment services for organic waste streams. Seneca Foods is a corn and pea processing plant located in Montgomery, MN. The two came together when Seneca Foods realized it would need to expand its land application base in order to renew its wastewater discharge permit, and decided instead to consider a contract with AnAerobics to treat its entire waste stream rather than continue land applying it. AnAerobics, although a wastewater treatment company, always recognizes the potential to generate energy from the tremendous volume of gas that is often produced at the treatment plant. So, while the primary goal of the project was to help Seneca Foods meet its waste stream requirements, AnAerobics realized that Seneca Foods was the perfect location for a complete waste-to-energy system.

Using a proprietary technology that simultaneously treats both the solid and liquid waste, AnAerobics estimates that 85% of the solids treated could be converted to useable gas. The gas would go through considerable cleanup, and then could either be piped back into the natural gas supply line, or used to power a 1.5 megawatt generator. As of Spring 2003, the project has been shelved, as the company considers alternative means of waste disposal.

For more information contact:
Sarah Ploss
Seneca Foods and Anaerobics
315-364-5062
sjp7@anaerobics.com

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OTHER TYPES OF ANAEROBIC DIGESTERS

Food Waste Wherever a large amount of food waste is generated there is potential for anaerobic digestion. In fact, many food processing industries are required to treat their waste streams, and digestion offers one way to accomplish this.

Often the energy potential of digestion can complement the need to treat organic wastes at a food processing plant. For example, the waste from rendering plants is high in organic wastes that could be treated through digestion.

Landfill Gas Significant quantities of biogas are emitted from municipal solid waste landfills. Landfill biogas has a methane content of approximately 40-55%, with the remaining gas made up of primarily carbon dioxide (CO_2), as well as some nitrogen (N_2) and hydrogen sulfide (H_2S).[6] The gas can be used to generate electricity at the landfill site by collecting the gas and burning it to power a gas turbine and produce electricity.

A large portion of the potential for landfill gas electric generation in Minnesota has already been realized with existing projects, but a study conducted in association with the Lakefield Junction natural gas plant suggested that some landfill gas-based generation potential still exists in Minnesota.

The study suggests that additional landfill gas projects could add roughly two additional megawatts in generating capacity. Existing municipalities and landfill facilities not yet incorporating such a process should explore the option to help lower their electric bills and to reduce the amount of methane they release.

Landfill gas systems are reliable and are expected to be available for combustion over 90 percent of the time. Capital costs for constructing a landfill gas facility are slightly less than $1,000 per kilowatt and annual operating costs are likely less than for a traditional power plant because the landfill would not have to purchase its own gas.

Wastewater Treatment Much like landfill gas, utilizing biogas generated from wastewater treatment can serve to improve the economics of wastewater treatment by producing onsite heat and electricity. Anaerobic digestion is often part of the treatment process at a wastewater treatment plant. These digesters produce biogas with methane contents ranging from 60-70%.[7] Because the treatment process is very energy intensive, most or all of the biogas energy may be used on-site. Often, the biogas is used for process heat or to directly power equipment at the plant, rather than in a generator.

END NOTES

[1]Assuming all manure in Minnesota was digested. See: Hinds, Paul, *DRAFT: Minnesota's Potential for Electricity Production Using Biogas Resources: Summary Report*, Minnesota Department of Commerce, January 2002. Digestion of additional wastes from food processing facilities, wastewater treatment plants and other sources would increase this amount.

[2]Nelson, Carl, *Final Report: Haubenschild Farms Anaerobic Digester Updated!*, St. Paul, Minnesota: The Minnesota Project, August 2002. Available at www.mnproject.org.

[3]ibid.

[4]ibid.

[5]Roos, K.F. and M.A. Moser, eds., *AgStar Handook, 1st Edition*, Washington D.C.:U.S. Environmental Protection Agency, 1997.

[6]Ross, Charles C., Thomas J. Drake, James L. Walsh, *Handbook of Biogas Utilization, Second Edition*, Atlanta: U.S. Department of Energy, July 1996.

[7]ibid.

[8]Soderberg, Kurt. "WLSSD Announces a New "Beacon" on the Harbor," Press Release, 23 July 2001. Retrieved June 18, 2002 from: http://www.wlssd.duluth.mn.us/PR72301.htm.

PHOTOGRAPHS

page 45 – Natural Resources Conservation Service; page 46 – Carl Nelson/The Minnesota Project; page 48 – Melissa Pawlish/The Minnesota Project; page 50 – Chet Welle/City of Rochester; page 51 – Karen Anderson/Western Lakes community relation's director (upper), Doug Fairchild/Western Lakes Environmental Program Coordinator (lower)

Some examples of existing landfill gas projects in Minnesota include:

- ***Browning Ferris Industries in Inver Grove Heights – Pine Bend Landfill***
- ***Neo Corp in Eden Prairie – Flying Cloud (Wood Lake Sanitary Services)***
- ***Neo Corp in Burnsville – Burnsville Sanitary Services***
- ***Power Recyclers Inc. in Anoka – Anoka Landfill***

CASE STUDY:

Rochester Water Reclamation Plant

THE ROCHESTER WATER Reclamation Plant has realized the value of making use of its existing resources. The Rochester Water Reclamation Plant generates biogas as a major byproduct of its wastewater treatment process, which includes anaerobic digesters. This biogas has the potential to provide the plant with a renewable source of fuel that saves money on energy costs. During the major plant expansion of 1980, two 400 kW generators were installed which used the biogas gas to produce electricity. In 2000, due to concerns of local energy shortages, plant staff got the Rochester Water Reclamation Plant prepared. Partnering with the local Rochester Public Utility, and utilizing the technical knowledge of its staff, plant management decided to look for ways to use the facility's gas more efficiently.

In its current configuration, the Rochester Water Reclamation Plant produces enough biogas to reduce its power purchasing needs by 25% during summer months, but it plans to increase this percentage with a number of upgrades. The two existing 400 kW generators are currently being upgraded to 1000 kW generators, both with turbocharged engines that will increase generator efficiency by 20%. The plan is to reroute the excess heat given off by the generators back to the anaerobic digesters. This added heat should increase biogas gas available for use in the engine generators by another 25%. Overall, the upgrades should allow the facility to supply 100% of its short-term power needs, and supply 50% of its on-going energy needs – making a significant dent in its fossil fuel energy consumption and making significantly better use of its on-site resources.

For more information contact:
Chet Welle
Rochester Water Reclamation Project
507.281.6190 x 3003
cwelle@ci.rochester.mn.us

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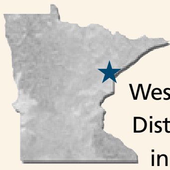
CASE STUDY:

Western Lake Superior Sanitary District[8]



ANOTHER FACILITY that has put its waste to work is the Western Lake Superior Sanitary District wastewater treatment plant in Duluth. In 1999, the Western Lake Superior Sanitary District began a major renovation to install a $32.6 million biosolids anaerobic digestion facility. In July 2001, Western Lake Superior Sanitary District permanently shut down its incinerator and started treating waste in four digesters, each with a million-gallon capacity. The new digesters use a high temperature process (120 to 140° F) to reduce the organic portion of the wastewater to a biosolids product rich in organic matter and nutrients. This biosolids product is used in agricultural and mine land applications. The plant uses a special biogas boiler to provide the heat needed for the digestion process as well as heating for the Biosolids Processing Facility. By using the waste gas without compression or treatment in a dedicated boiler, the District has reduced its costs. Ultimately, the biogas may also provide heat to additional buildings within the treatment plant and power a combustion engine that will generate a portion of electricity used by the Sanitary District.

For more information contact:
Kurt Soderberg, Executive Director
Western Lake Superior Sanitary District
218-722-3336 x. 213

Western Lake Superior Sanitary District wastewater treatment plant in Duluth, MN

Digester controls at a wastewater treatment plant

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Final Report, Updated: Haubenschild Farms Anaerobic Digester. The report, written by Carl Nelson and John Lamb of The Minnesota Project was updated in August 2002 and provides detailed information about the Haubenschild digester project. Contact: Carl Nelson, The Minnesota Project, 651-645-6159 x 5, cnelson@mnproject.org. Along with the report, The Minnesota Project website has a wealth of information on digesters. (www.mnproject.org)

University of Minnesota, Department of Biosystems and Agricultural Engineering have done a lot of work on odor control, as well as having expertise in anaerobic digesters. Contacts: David Schmidt, 612-625-4262, schmi071@umn.edu or Phil Goodrich, 612-625-4215, goodrich@tc.umn.edu. (www.bae.umn.edu)

Handbook of Biogas Utilization, 2nd Edition. Published in July 1996 for the US DOE, Southeastern Regional biomass Energy Program, Tennessee Valley Authority, Muscle Shoals, Alabama.

On-Farm Biogas Production. Written by Robert A. Parsons and published by Northeast Regional Agriculture Engineering Service. Ithaca, New York: 1984.

AgSTAR Handbook. This publication covers several chapters and appendices with pertinent information about how to go about designing and implementing an anaerobic digestion system. (www.epa.gov/agstar/library/handbook.htm)

Industry Directory for On-farm Biogas Recovery Systems. For farmers looking for companies that can build digesters. (www.epa.gov/agstar/library/ind2.pdf)

Agriculture Utilization and Research Institute (AURI) digester website. Contains an analysis of the benefits of using an on-farm digester to treat manure as well as a checklist for farmers to use to decide if it is a viable option. (www.auri.org/research/digester/diglead.htm)

Biofuels

THE LAST DECADE HAS SEEN A TREMENDOUS GROWTH in the use of biofuels to replace petroleum-based transportation fuels. Ethanol production has grown from 0.2 billion gallons in 1980 to over 2.1 billion gallons in 2002. Rural economies not only benefit from growing the raw material for biofuels, but can also benefit by being involved in the production of biofuels. Minnesota ethanol plants, many owned by farmers, produce over 400 million gallons of ethanol a year, nearly 20 percent of current U.S. production. Despite recent setbacks for the state payments Minnesota ethanol plants receive, state policy supporting ethanol and biodiesel has been a model for the nation.

Minnesota ethanol plants, many owned by farmers, produce nearly 20% of current U.S. ethanol production.

ETHANOL: A MINNESOTA SUCCESS STORY

Minnesotans began using ethanol as a standard blend in their gasoline in 1996. At first it was just used during the winter and Minnesotans actually had to import their ethanol. Now however, even with Minnesota auto fuel comprised of 10% ethanol year round, Minnesota is producing 40-50% more ethanol than it needs, and exporting the rest.

Besides the fact that it's a renewable source of fuel, ethanol is an environmentally benign fuel additive that can substitute for MTBE. MTBE is a fuel oxygenate that was found to pose a significant environmental threat to ground and surface water, enhanced by its ability to rapidly penetrate the ground.

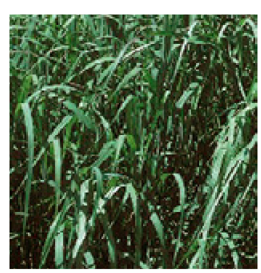
Corn is currently the primary feedstock for ethanol, although Minnesota also uses whey, and other states have incorporated other feedstocks. Corn-based ethanol can be produced by either the wet milling or the dry milling method. Dry milling is the most common process used in Minnesota, and consists of grinding up the corn and adding water to make mash. The mash is then cooked to kill off the bacteria and expose the starches. Enzymes are added to convert the starch to sugar, which is then converted to ethanol by yeasts. The ethanol is then purified for use as a fuel.

Because of policies enacted by the state legislature, the majority of Minnesota's 14 ethanol-processing facilities are actually owned by farmer cooperatives, which means that the farmer-owners benefit from the economic value added, rather than losing it to a large company that may not even be located in the state. This provides a mechanism to strengthen Minnesota's rural communities by keeping dollars spent on ethanol in the state. Minnesota's ethanol model could also be copied for other renewable energy resources.

ETHANOL'S FUTURE

Because of its high starch content, corn is a good candidate for the current fermentation methods used to create ethanol. However, corn is a fairly input-intensive crop (in terms of energy, fertilizer and chemicals) and the corn kernel is only a small percentage of the whole plant. In the long-term, other crops may be used to produce ethanol more efficiently and with less impact to the environment.

Methods to convert cellulose (the fibrous material in plants) into ethanol show the most promise for the future. Then perennial crops like switchgrass that don't need to be re-planted every year and have less input requirements could be used for ethanol.



Green switchgrass

The U.S. Department of Energy (DOE) estimates that with steady improvements over the next decade in cellulosic conversion technology, the cost of producing ethanol – now about 90 cents/gallon – could be as low as 60 cents/gallon. In contrast, the DOE concludes there is not much room for further cost reductions in corn/starch ethanol production.[1]

Cellulosic ethanol would also reduce greenhouse gases, because less fossil fuel is needed to produce it. Argonne National Laboratory estimates that using a 10% blend of cellulosic ethanol results in the reduction of 4 to 5 times more greenhouse gases than using a 10% blend of corn ethanol.[2] The first cellulosic ethanol plants might be paired with current corn-ethanol plants, utilizing the cellulose-rich byproducts of the corn/starch ethanol process.

BIODIESEL BASICS

Biodiesel is a fuel commonly made from a chemical reaction between soybean oil, methanol, and lye. Although soybean oil is the most common feedstock, other non-petroleum oils and greases (such as waste grease from cooking food) can be used. Biodiesel can be used in its pure form or can be blended with petroleum diesel. Any percentage of biodiesel

Soybeans can be converted to biodiesel

can be used, but 2 percent (B2) and 20 percent (B20) are the most common. Biodiesel's use as a transportation fuel in diesel engines is becoming more wide spread, but it can also be readily used in standby, emergency and remote diesel electric generators.

Using a biodiesel mixture rather than pure petroleum diesel to fuel emergency generators could help reduce many air emissions that result with use of diesel electric generators. However, as diesel generators are one of the most polluting sources of electricity there is, biodiesel electric generation is still a very dirty source of electricity, even compared to other fossil fuel sources. Therefore, traditional diesel generators using biodiesel fuel is a source suitable for backup power or other special situations, but is not suitable for generating a significant amount of our electricity needs.

Since 2000, the cost of biodiesel has dropped significantly due to a federal program to encourage biodiesel production. In 1998 the US Department of Energy modified the Energy Policy Act (EPAct) to allow the use of B20 to help facilities meet their alternative fuel vehicle mandate. Unfortunately though, cost is still one of the primary barriers to widespread adoption of biodiesel.

Ethanol Plants in Minnesota

Source: Minnesota Department of Agriculture, February 2002

CASE STUDY:

Brooklyn Park

THE CITY OF BROOKLYN PARK was not willing to wait around for a biodiesel mandate. When members of the National Association of Fleet Administrators started talking about alternative fuels and alternative fuel vehicles, Steve Lawrence knew it was time to act. Jon Thiel, his director, agreed. They wanted to be proactive and felt that by acting now they could save a lot of money and a lot of headaches in the long run. So, in Fall 2001 the City of Brooklyn Park initiated their biodiesel program.

After one winter of operation with absolutely no complications, they have expanded their program and as of August 2002, now have 88 vehicle units running on B20 – one of the largest such projects currently underway in Minnesota.

City administrators thought that this effort would show the community that it was spending money wisely and planning ahead while making their operations more environmentally friendly. While the fuel is a bit more expensive than standard diesel right now (about 4 cents higher), city staff feels it will reap the benefits of its forethought in the years to come. Brooklyn Park is now working with the University of Minnesota and Hennepin County to be "agents of change" in Minnesota and to further biodiesel development around the state. They have agreed to work with the University's Center for Diesel Research on testing fuel additives that should both reduce biodiesel emissions and enhance biodiesel's performance, making biodiesel an even better option in years to come.

For more information contact:
Steven Lawrence
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stevel@ci.brookly-park.mn.us

Currently most suppliers and providers charge an additional $0.01 per percentage point of added biodiesel per gallon, but this number varies. This cost increase can add up quickly for high biodiesel blends if you utilize a lot of fuel. The Cannon Valley Cooperative, located in Cannon Valley, Minnesota, is a rare example of a facility that actually offers solely biodiesel and does not charge any extra for its purchase.

Cannon Valley Cooperative

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Fossil Energy Balance of Biofuels[3]

FUEL	FOSSIL ENERGY BALANCE
Ethanol	**1.34**
Biodiesel	**3.2**
Petroleum diesel	**0.83**

For every unit of useful fuel that is produced by biofuels, a certain amount of energy is required to produce the fuels. For example, biodiesel produces the useful energy that drives truck engines, but energy is expended in planting, fertilizing, harvesting, transporting and processing the soybeans used to make the biodiesel. This energy is typically produced from fossil fuel sources. The fossil energy balance is the ratio of useful energy gained per unit of fossil energy consumed during the life cycle of the fuel (including the fuel itself, if it is fossil).

Biodiesel's fossil energy balance of 3.2 means that for every unit of energy used producing biodiesel, over 3 units are available to do useful work. In contrast, the consumption of one unit of fossil fuel energy produces just 0.83 units of useful energy from petroleum diesel.[4] Earlier studies reported that it took more energy to produce ethanol than it created (a fossil energy balance of less than 1), but recent studies such as the one cited above suggest a positive energy balance.[5]

BIODIESEL AND THE ENVIRONMENT

Although diesel – even biodiesel blends – is a very polluting fuel, biodiesel is less polluting than standard diesel. As the percentage of biodiesel goes up, there are reductions in many air emissions (including sulfur dioxide, carbon monoxide, volatile organic compounds and particulates).

The addition of biofuels to diesel and gasoline allows for more complete combustion, which therefore reduces the amount of carbon monoxide emissions and unburned hydrocarbon emissions, causing a reduction in some ground-level ozone causing pollutants.

However, the addition of oxygenated fuels causes combustion temperatures to rise, which results in increased formation of nitrogen oxides. Biodiesel blends of 100% or 20% also reduce visible smoke and odors. See table below for estimated amounts of air emission reduction.

The U.S. Environmental Protection Agency has been considering rules to drastically reduce emissions (especially fine particulates) from diesel. It's unclear what role biodiesel would play to help or hinder meeting any future diesel emissions rules. Like ethanol, biodiesel also results in a net reduction in greenhouse gases.

Emission Reductions from Replacing Diesel with Biodiesel *(20% and 100% blends)*[6]

Emission	***B-20***	***B-100***
Carbon Monoxide	*-13%*	*-43%*
Hydrocarbons	*-11%*	*-56%*
Particulates	*-18%*	*-55%*
Nitrogen oxides	*1%*	*6%*
Air Toxics	*-0.3%*	*-1.5%*

CASE STUDY:

Voyageurs National Park Biodiesel Program

VOYAGEURS NATIONAL PARK began its biodiesel program in September 2000 as part of a Department of Energy pilot program. Park maintenance officials were so pleased with how well the blend of 20% biodiesel (B20) worked in their pickups during the first winter that they expanded their biodiesel program the following year to include all of their diesel equipment, including a barge. Initially park staff were concerned about using biodiesel in the barge since it sits unused from October to June, but they have had no trouble restarting it, and the biodiesel has significantly reduced its smoke output and diesel odors. In fact, Park Maintenance Supervisor Bill Carlson says they would use a higher biodiesel blend if it weren't so expensive to get it and transport it to the park. Voyageurs feels it is setting a good example for environmental stewardship, especially on water ways, by incorporating biodiesel into its fuel mix.

For more information contact:
Bill Carlson
Rainy District Maintenance Supervision
218-283-9821
William_K_Carlson@nps.gov

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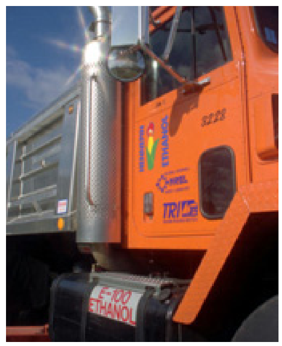
BIODIESEL IN MINNESOTA

Minnesota has been home to several demonstration projects that have put biodiesel to work in real applications. Some of these examples include:

- Voyageurs National Park has operated all of its diesel-equipped trucks on 20% biodiesel for two years as part of an experimental DOE program that was hoping to test the use of biodiesel in a "worst case" scenario for cold temperatures (see case study)
- Eureka Recycling (formerly a part of the St. Paul Neighborhood Energy Consortium) is running its fleet of recycling trucks on B20
- Brooklyn Park now operates its entire city fleet of diesel vehicles on B20 (see case study)



- Hennepin County operates 4 heavy-duty maintenance trucks on B20
- University of Minnesota operates two vehicles on biodiesel, one on B100 and the other on B20
- Dakota Electric purchased 1000 gallons of biodiesel to blend in with its petrodiesel and has thereby qualified for 2 EPAct credits
- Department of Commerce received federal funding to perform a demonstration project using B20 in school buses for the winter driving season in 2001 and 2002
- The State Energy Office in the Department of Commerce funded a successful demonstration project using biodiesel in over 15 diesel generators during the Taste of Minnesota in St. Paul in 2000.

In 2002, the state legislature took another step forward in biodiesel policy. Starting in June 2005, all diesel fuel sold in the state for use in internal combustion engines must contain at least 2 percent biodiesel, with a few exceptions.[7] The law also stipulates that Minnesota must have a minimum of 8 million gallons of in-state production.[8]

Incorporating biodiesel into our fuel mix would not only support the use of renewable energy resources and improve air quality, but it would also help provide additional income to farmers producing soybeans. Currently over 27 Minnesota facilities, focused on the transportation sector, sell biodiesel as a 2% biodiesel, 98% petrodiesel blend. Some of these facilities, located throughout Minnesota, will sell and deliver 100% biodiesel in bulk.

Minnesota is fortunate to have the Center for Diesel Research at the University of Minnesota that has been doing innovative research to test the potential for biodiesel in peaking and emergency generators. They have initiated a pilot project to measure the air emissions resulting from various blends of biodiesel, from 10% to 100%, and with use in various engines. This research will contribute significant data that should help optimize future generator designs and fuel blends such that our diesel generators, if they absolutely must be put to work, will do so using at least partially renewable, cleaner burning fuels.

The Center for Diesel Research is also involved in researching the use of raw soybean oil in gas turbines. This use would allow both reduced fuel processing and allow the use of biodiesel in larger power-production operations.

END NOTES

[1]DiPardo, Joseph, *Outlook for Biomass Production and Demand*, U.S. Department of Energy, Energy Information Agency, 2000.

[2]Wang, M., et. al., *Effects of Fuel Ethanol Use of Fuel-Cycle Energy and Greenhouse Gas Emissions*, Argonne National Laboratory, Center for Transportation Studies, Argonne, IL, 1999.

[3]Source for biodiesel and petroleum diesel: Sheehan et. al., “Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus,” sponsored by U.S. Dept. of Agriculture and U.S. Dept. of Energy, NREL/SR-580-24089, 1998. Source for ethanol: Shapouri, et. al, “The Energy Balance of Corn Ethanol: An Update,” U.S. Dept. of Agriculture, 2001.

[4]Alternatively put, for every gallon of petroleum diesel, the equivalent of about ¼ gallon of diesel is needed to produce, transport and refine it.

[5]Some of the strongest criticism over the net energy balance of ethanol comes from Cornel University’s David Pimentel, who recently reported a study showing a negative net energy balance of corn ethanol (2001). Critics feel the study fails to make a convincing argument about the current state of the industry, however, citing Pimentel’s use of older data that doesn’t account for advancements in the productivity of corn and ethanol production.

[6]US Department of Energy, Office of Transportation. *Biofuels and the Environment: Air Pollution*. Results in this table were rounded to the nearest percent (1/10th percent for air toxics). Retrieved from: http://www.ott.doe.gov/biofuels/environment.html#table.

[7]Exceptions to the mandate include railroad locomotives and off-road taconite and copper mining equipment and machinery; a temporary exception was also included for motors at electric generating plants governed by the nuclear regulatory commission.

[8]For more information see The Minnesota Session Laws webpage at: http://www.revisor.leg.state.mn.us/slaws/2002/c244.html.

PHOTOGRAPHS

page 53 – Natural Resources Conservation Service (upper), Chariton Valley RC&D (lower); page 54 – Core 4 Conservation; page 55 – Nathan Jensen/Cannon Valley Coop; page 57 – National Park Service; page 58 – National Renewable Energy Laboratory (upper), Eureka Recycling (lower)

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Clean Fuels: Developing Fuels to Benefit Minnesota's Environment and Economy. A brochure written by the Minnesota Department of Commerce includes descriptions of biodiesel as well as several other clean fuels, including ethanol and hydrogen. (www.commerce.state.mn.us)

Outlook for Biomass Production and Demand. This report from the U.S. Department of Energy analyzes the future of ethanol production and concludes that there is not much opportunity for reducing corn ethanol's production costs, but cellulosic ethanol production shows great promise in the future for reducing production costs. An overview cellulosic conversion technology and various feedstock options and a brief history of ethanol is also presented. (www.eia.doe.gov/oiaf/analysispaper/pdf/biomass.pdf)

The Biodiesel Plant Development Handbook. A 59-page overview of the steps involved in building a biodiesel plant. Prepared for the Agricultural Utilization and Research Institute (AURI) and the Minnesota Soybean Research and Promotion Council, and available from AURI by calling 320-589-7280.

Agricultural Utilization and Research Institute (AURI). AURI provides technical assistance to Minnesota businesses or cooperatives with projects that have the potential to create new uses or new markets for Minnesota agricultural commodities. AURI has been involved with many renewable energy projects, including a meat rendering plant that is working to produce biodiesel. Contact: Michael Sparby, Morris office, 320-582-7280, msparby@auri.org

National Biodiesel Board. Biodiesel basics, updates on current legislation and projects. (www.biodiesel.org)

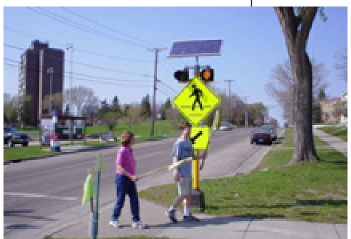
The National Corn Growers Association has information on Ethanol and the Farm Bill. (www.ncga.com)

Carbohydrate Economy. Website is a clearing house of resources on ethanol and other carbohydrate-based fuels. (www.carbohydrateeconomy.org)

Center for Diesel Research. Located at the University of Minnesota, the Center conducts research on the potential of biodiesel to generate electricity. They also staff a biodiesel helpline: 1-800-929-3437 or 651-330-0450. Contact: Kelly Strebig, 651-457-1404, streb002@umn.edu

Minnesota Department of Agriculture. The Department of Agriculture has been instrumental in supporting the ethanol industry in the state, and its staff are a wealth of information on ethanol. Contact: Ralph Groschen, Agriculture Marketing Specialist, 651-297-2223, Ralph.Grolschen@state.mn.us

Solar Energy



ALTHOUGH WE MAY FEEL IN THE DEAD OF JANUARY that the sun is scorning us, there are still plenty of opportunities for solar in Minnesota. Minnesota has more annual solar energy potential than Houston, Texas and nearly as much as Miami, Florida.[1] Although the cost of generating solar electricity is currently expensive relative to traditional sources, solar energy can be economic in many situations, such as for heating hot water and when it is impractical to connect to the electric grid. When buildings are designed to maximize the light and heating potential from the sun, significant "passive solar" energy savings can be realized.

Minnesota has more annual solar energy potential than Houston, Texas and nearly as much as Miami, Florida.

A study completed in 1992[2] identified several types of applications that would be most cost-effective for solar electric systems. These included:

Government

- Lighting, for public lake access, trails, and rest rooms
- Communications, such as emergency call boxes
- Vehicle battery charging for snow removal equipment, earth moving equipment, and emergency vehicles
- Monitoring, such as remote weather stations
- Warning signals
- Off-grid facilities such as state park residences, remote equipment storage buildings, and fire towers

Travel and Tourism

- Residences, such as remote cabins and hunting facilities
- Battery chargers for recreational vehicles, trolling motors, and sailing vessels
- Lighting for boat launches/docks and parking areas
- Water pumping for pond aeration and potable water

Agriculture

- Fence chargers
- Stock tank aerators
- Water pumps

Several case studies highlighted by the Center for Energy and Environment's study *Using Renewable Energy in Minnesota Parks*[3] emphasize similar applications integrating both solar electric opportunities as well as passive and active solar thermal water heating systems. An initial analysis by the Department of Commerce indicates that there is a roughly 15% difference between the lowest and highest solar resources across the state of Minnesota.[4] Regions of southwest Minnesota receive the most sunlight and northern Minnesota receives the least.

PHOTOVOLTAIC POWER

Photovoltaic systems, or PV, produce electric DC power from sunlight because of the photovoltaic effect (a semiconductive process that generates electricity without moving parts or emissions). Inverters can be added to convert the DC power to grid-compatible AC power.

PV panels (a combination of many cells) produce the most electricity under periods of high solar output, or insolation,[5] during sunny summer days. They are generally mounted on un-shaded south-facing exposures and have optimum energy production when the sun's rays are perpendicular to the panel.

The most common type of photovoltaic cell is constructed of semiconductor-grade crystalline silicon wafers that have grid contact structures on the front and back to create an electric circuit. Photovoltaic cells can be linked together to form panels or arrays.

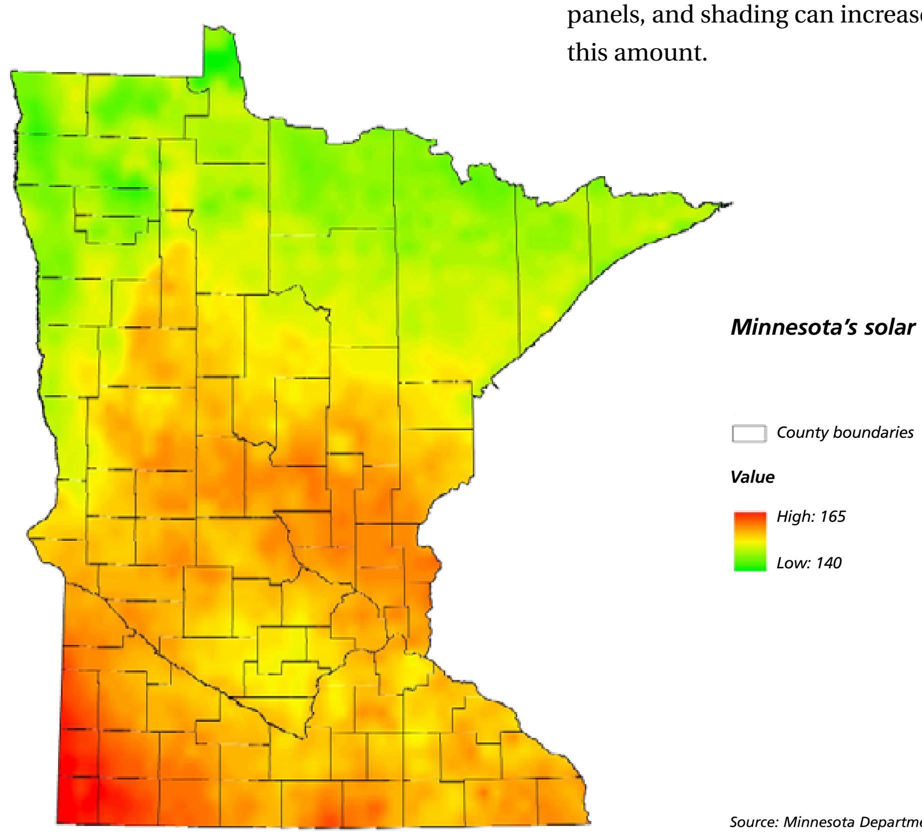
Electricity is generated when light photons excite the bottom wafer to donate an electron to the upper wafer, resulting in the flow of electricity when attached to an electric circuit. PV systems do not create noise, air or water emissions, or have any moving parts and the panels themselves are generally designed to last for 20 years.

One of the key benefits of incorporating PV systems into our electricity generating system has to do with timing. The amount of energy that solar electric systems generate directly correlates with the sunlight intensity and length. This peak condition occurs most often during hot, sunny, summer days, when electricity demand is also at its peak. This peak demand is when electricity is most expensive to generate and most valuable to the utility. Thus, although solar power is an intermittent power source, it provides power when it is most needed.

The cost of PV (15 cents/kWh or more) is not yet competitive with other sources of electric generation and the payback of a grid-interconnected system may take 30 years or more. PV can be cost-effective for off-grid applications, however.

PHOTOVOLTAIC SYSTEM FACTS[8]

- Installation costs are about $7,000-9,000/kW
- A typical solar installation in Minnesota can be expected to generate about 1,000 to 1,100 kilowatt hours per kW of installed capacity per year. For example, a 500 watt (.5 kW) PV system can be expected to produce approximately 500 to 550 kilowatt hours of electricity in one year. Solar generation will be greater in the summer than in the winter.
- Factors such as inverter and wiring efficiency, the orientation and tilt of the panels, and shading can increase or decrease this amount.



Minnesota's solar resources[7]

Source: Minnesota Department of Commerce

CASE STUDY:

Hennepin County Solar Traffic Signal

ONE APPROACH TO UTILIZING SOLAR ENERGY is to mimic the project implemented by Hennepin County. In 1996 a solar powered all-way stop traffic signal was installed above a 4-way stop intersection in western Hennepin County. A federal grant program funded the project that consists of 4 LED lights and 2 solar panels, which are mounted atop 2 wooden poles to avoid shading and maximize the amount of sunlight captured. Each of the solar panels is 4 by 6 feet in size, and is equipped to charge a battery pack that powers the signal flashers, which are not connected to the electric grid.

For more information contact:
Jerry Smrcka
Solar Traffic Lights
763-745-7740 or
Larry Blackstad
Hennepin County
612-348-5859

- The orientation and tilting of the panels can optimize for winter or summer, and morning or afternoon generation. A panel with a fixed orientation will receive the most potential for sunlight by orienting the panel due south and setting the tilt angle at the latitude of the site's location (this would be about a 45% angle in Minnesota).
- Single-axis and dual-axis tracking capabilities (automatically following the sun across the sky during the day and season) increase the capacity of fixed technologies during general summer demand periods.
- Panels can be mounted on the roof, on the ground, or on poles.

Solar panels in Burnsville, MN

- Off-grid applications can be cost-effective instead of building a new utility line, as can small signs, outdoor lighting, cabins, etc. On-grid applications, even with subsidies, need a non-financial basis for continuing with the project – for example a concern for the environment or a desire for energy independence.

SOLAR HOT WATER SYSTEMS

Direct use of solar energy can also be employed in active and passive water heating systems, which typically have shorter payback periods than PV systems. Depending on the cost of energy, the lifetime cost of a solar water heating system can be lower than heating water with gas or electric.

Tempering tanks are a low-tech passive solar system that can be used to heat water in Minnesota. Tempering tanks heat up water and save energy by reducing the amount of fuel needed to heat water in a water heater. Tempering tanks require less maintenance than active systems and are roughly 5 times less expensive.

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Active solar thermal applications use collectors and mechanical pumps to make the most of the sun's natural ability to heat water. Water is pumped into solar collectors stationed on south facing roofs, allowed to warm, and then stored in a pre-heat storage tank. This system requires a conventional water heater backup to ensure hot water on demand and during winter months.

Active solar thermal can save up to 50% of summer water heating needs. A large system serving a campground shower facility costs approximately $10,000, while residential systems can cost several thousand dollars installed.

Research is being conducted on solar thermal systems that generate electricity, and a few test plants exist, but unlike solar water heating and PV, solar thermal electricity generation is still a long way from being a commercial technology.

PASSIVE SOLAR DESIGN

Good building design with the sun in mind can save energy. Passive solar design integrates a combination of building features to reduce the need for heating, cooling and daytime lighting. The design often does not have to be complex, but does involve knowledge of solar geometry, window technology and local climate.

Solar panels at the Haubenschild dairy farm

Solar Electric Rebate Program

POWER FROM THE SUN, REBATE FROM THE STATE!

The State Energy Office is administering a Solar Electric Rebate Program for grid-connected solar electric energy installations that will rebate between $2,000 and $8,000 per participant at a rate of $2,000 per kWh.

Eligible participants currently include Xcel Energy customers. If money is still available in 2004, the program will be expanded to all of Minnesota. A short application form and site pictures must be approved before installation begins.

For eligibility requirements, detailed program information, and an application, check the Minnesota Department. of Commerce website or call the Energy Information Center at 651-296-5175 or 800- 657-3710. (www.commerce.state.mn.us)

Typical passive solar features include careful orientation of the building, careful positioning and selection of windows including additional window glazing, added thermal mass for heat storage, use of natural ventilation and larger roof overhangs.

Choosing an architect and builder knowledgeable of passive solar techniques is key to realizing savings from passive solar design. Although a passive solar design may initially cost more, savings are born out over the lifetime of the building, and the increased cost can often be paid back in several years through energy savings.

BRIGHTFIELDS: REDEVELOPING BROWNFIELDS WITH SOLAR ENERGY

A brightfield is an abandoned or contaminated property (brownfield) that incorporates solar energy when it is redeveloped. The idea, with backing from the U.S. Department of Energy, is designed to address economic development, environmental cleanup, and ongoing air quality concerns by combining emission-free solar energy with high-tech solar manufacturing jobs at formerly abandoned sites.

See www.eren.doe.gov/brightfields.

CASE STUDY:

Wild River State Park: Active Solar Thermal Water Heater

WILD RIVER STATE PARK converted the fuel oil-fired water heater at one of its campground shower facilities to a liquid propane and solar thermal water pre-heating system in May 1998. The system works by pumping water from the well to the solar storage tank and from there cycling it through the solar collector system which is comprised of 4 flat plate solar collectors. The water pump for the collector is powered by a 10-watt 12-volt PV panel. It operates from April to October, and requires virtually no maintenance; it even drains itself in the winter. During the week, the solar heating system can heat the water to 190° F, which eliminates the need to use the LP fuel. On the weekend, when the system is used more heavily, the system preheats the water to between 70° F and 80° F, minimizing the amount of additional heating required.

For more information contact:
Shawn Donais
651-583-2125
shawn.donais@dnr.state.mn.us

Solar panels collecting energy in Wild River State Park

These PV shingles offer a low-profile way to add solar to a residential home

END NOTES

[1]This is based on a comparison with Minneapolis using a solar energy calculator developed by the National Renewable Energy Laboratory. See: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1.

[2]Minnesota Department of Public Service, *A Cost Effective Market for Photovoltaics in Minnesota*, St. Paul, MN, 1992.

[3]Center for Energy and Environment, *Using Renewable Energy in Minnesota State Parks: A Guidebook for Park Managers*, Minneapolis, MN, October 1999.

[4]Minnesota Department of Commerce, *Minnesota Energy Planning Report 2001*, St. Paul, MN, January 2002.

[5]Insolation is a measure of the strength of a solar resource – the rate of delivery of direct solar radiation per unit of horizontal surface.

[6]Resource potential for flat plate collectors.

[7]NASA satellite based solar radiation data. Annual average solar insulation 1998-2000.

[8]Taylor, Michael Paul, "A Performance, Cost-Benefit, and Policy Analysis of Photovoltaic Technologies in Minnesota," Masters Thesis, University of Minnesota, May 2002.

PHOTOGRAPHS

page 61 – Carl Nelson/The Minnesota Project; page 62– National Renewable Energy Laboratory (upper), Rory Artig/Minnesota Department of Commerce (lower); page 63 – Advanced Systems from Klinge Cooperation and Associates (upper), National Renewable Energy Laboratory (lower); page 64 – Carl Nelson/The Minnesota Project (left), National Renewable Energy Laboratory (right); page 65 – Shawn Donais/Minnesota DNR (two upper), National Renewable Energy Laboratory (lower)

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All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

A Consumer's Guide to Buying a Solar Electric System. Published by the National Renewable Energy Laboratory. This document covers pros and cons of investing in a PV system, how to pick an installer, and how to fulfill permit requirements, how to get a net metering agreement and other topics.
(www.nrel.gov/ncpv/pdfs/26591.pdf)

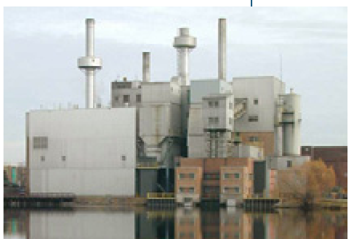
Minnesota Department of Commerce. Great source of general solar information as well as links to the rebates and incentives site. Contains a consumer's guide to solar energy systems, an article on hiring a renewable energy dealer and other valuable information to those considering a system. Phone: 800-657-3710 or 651-296-5175.
(www.commerce.state.mn.us – click on "consumer info," then "energy info," then "solar.")

Chicago Solar Partnership. Teaching tools for parties interested in either viewing primers or sharing information about solar power with others.
(www.chicagosolarpartnership.com/teaching_tools/index.htm)

Using Renewable Energy In Minnesota Parks: A Guidebook for Park Managers. A guide for renewable energy projects, including solar projects that have been and could be implemented at Minnesota State Parks.
(www.mncee.org/ceedocs/parkguide.pdf)

CHAPTER 10

Combined Heat & Power/District Energy



COMBINED HEAT AND POWER (CHP), also known as cogeneration, is based on the simple idea of recovering and utilizing the waste heat created from the generation of electricity. Typically 60 percent or more of the energy used to produce electricity in central-station power plants is wasted. CHP is utilized by industries or institutions that have a use for the waste heat produced from electrical generation, such as for industrial processes or space heating. District energy systems also achieve efficiencies by centrally producing the heat and/or cooling for multiple customers in a concentrated area, like a city center. When district energy systems include CHP, they can achieve the highest efficiencies. While CHP and district energy systems can utilize renewable energy fuels, they often use fossil fuels. Due to the increased fuel efficiency, even use of standard fossil fuels can have environmental benefits.

By using waste heat, CHP can realize system efficiencies as high as 80%, nearly three times the efficiency of a typical coal power plant.

Minnesota currently has the potential to generate 1,600 to 2,100 MW through CHP at existing facilities.[1] CHP can reduce air emissions from combustion since less fuel is burned when electricity and thermal energy are generated together. CHP also reduces the discharge of hot waters from cooling towers into community lakes and rivers because the water is reused. CHP and district energy are an opportunity for communities and local businesses to expand production of local energy and most efficiently use renewable or fossil fuel resources.

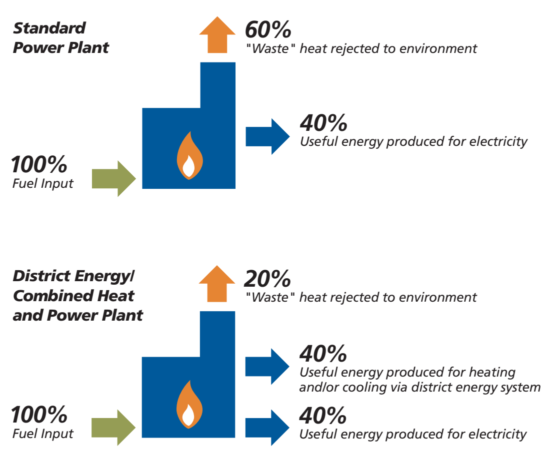
CHP AND DISTRICT ENERGY BASICS

CHP is actually a range of technologies that simultaneously produce electricity and useful thermal or mechanical energy from a single energy source. Typically, a CHP system first uses a gas turbine or reciprocating engine generator set to generate electricity. The thermal energy generated by the turbine or engine is recovered and recycled as usable steam or hot water. Since CHP systems are based on capturing and recycling this other-wise wasted thermal energy, a CHP system must be located at or near the facility or buildings that will be utilizing both the electricity and heat generated by the CHP system.

A district energy system traditionally refers to centrally producing heat and/or cooling for multiple customers in a concentrated area, such as a city center, a university campus, or a hospital complex. Normally, a district energy system is a prime candidate for adding CHP.

When CHP is incorporated into an industrial, commercial, institutional, or district energy application, system efficiencies as high as 80% can be realized, compared to typical coal power-plant efficiencies of about 30%. These increased efficiencies can provide energy cost savings and lower emissions, while providing higher reliability of electric service.

The advantage of efficiency in a CHP system



Source: U.S. Department of Energy

CASE STUDY:

District Energy St. Paul: CHP District Energy Fueled by Biomass

DISTRICT ENERGY ST. PAUL, INC., is a private, non-profit, community-based corporation located in downtown St. Paul. District Energy owns the largest hot water district heating system in North America in addition to a rapidly expanding district cooling system.

Since 1999, Market Street Energy Company (a District Energy affiliate) and Trigen-Cinergy Solutions have been working to build a CHP system that will burn urban wood waste to produce electricity while simultaneously generating energy for St. Paul's district heating and cooling needs. The new CHP plant, which will be operational in 2003, is a 25 MW wood-waste fired facility that will supply over 75% of the thermal energy required by district heating and cooling customers in downtown St. Paul. The 25 MW of electricity will be supplied to the local grid under a 20-year contract with Xcel Energy, and helps Xcel meet a mandate to produce 125 MW of biomass power.

A substantial portion of the wood waste used for CHP will come from downed trees, tree trimmings and branches from around the Twin Cities area. Using this material has several benefits. First, by turning regional wood waste into a useful product, the system will help keep energy dollars in the local economy, instead of importing fossil fuels. Second, using wood waste will help solve the ongoing environmental challenge of wood waste disposal, using approximately half of the 600,000 metric tons of wood waste generated in the metro area annually. Lastly, the project will significantly reduce air pollution by displacing 80% of the coal and oil District Energy currently burns every year, thereby reducing sulfur dioxide emissions by roughly 600 tons per year and reducing carbon dioxide emissions by roughly 280,000 tons per year. This efficient use of a renewable energy resource should serve as a model for communities looking to take similar steps.

For more information contact:
Trudy Sherwood
trudy.Sherwood@districtenergy.com

In January 2003, construction is almost completed at the new combined heat and power plant in Saint Paul

District Energy Tour Participants from left to right: Anders Rydaker, District Energy; Secretary of Energy Spencer Abraham; President George Bush; Jim Rogers, Cinergy; EPA Administrator Christine Todd Whitman; Mayor (now U.S. Senator) Norm Coleman; and Michael Burns, District Energy

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CHP TECHNOLOGY OPTIONS

Combustion turbines (simple cycle and combined cycle), reciprocating engines, and steam turbines are the primary technologies used to generate electricity for CHP systems. Fuel cells and microturbines are also suited for CHP, but can be expensive options.

If a facility is already producing steam from a boiler, it may be a candidate for a type of steam turbine called a back pressure turbine. Many industrial facilities generate steam at high pressures and during the industrial process will drop the pressure through pressure reducing valves. In these applications, a back pressure steam turbine is a relatively inexpensive way of utilizing the pressure drop to generate electricity onsite. Installed costs can be as low as $600 per kilowatt of capacity for the addition of a turbine to an existing boiler system.

Heat-recovery systems are also essential components of CHP systems, so that the waste heat can be recycled for use in industrial processes or in space conditioning the facilities. Absorption chillers can convert hot water or steam into chilled water for air conditioning. A desiccant dehumidifier can be utilized to remove moisture from the air which in turn can reduce air conditioning loads and provide better indoor air quality. In a CHP system, the recovered heat can be utilized to regenerate the desiccant material in the dehumidifier.

HOW DO YOU DETERMINE IF A CHP SYSTEM MIGHT BE APPROPRIATE?

The Minnesota Planning report[2] lists several factors to consider:

Consistency and Size of Thermal and Electric Loads Constant, level loads are best for a CHP system, since the CHP system can run as close to continuously as possible, increasing the economic payback. If the facility is closed for a portion of the year, or has widely varying thermal or electric loads, a CHP system is less likely to make economic sense. It is usually most cost effective to size a CHP system at less than peak demand so that the system is able to operate as much as possible at full capacity.

Planned New Construction or Upgrades It is best to plan CHP projects for new construction sites or sites in need of upgrades. These technologies are easier to incorporate with newer facilities that are likely to be more reliable and require less maintenance. If the avoided costs for upgrades or replacements can be put back into the CHP project, the project becomes more cost effective.

Cost of Purchased Power If the cost of power is high, it will make on-site generation more cost competitive.

Value of Sold Electricity If excess power can be sold at a sufficient price, it becomes more economical. Incentives can also help – the federal Investment Tax Credit (ITC) provides a 10% ITC for qualifying facilities; Production Tax Credits (PTC) are also under consideration by Congress.

Available and Affordable Fuel Supply If there is an opportunity to use lower-cost, easily accessible fuels with CHP as compared to current fuels used for thermal production, CHP presents an option to avoid higher costs.

CHP IN THE INDUSTRIAL SECTOR

There are several industrial facilities in Minnesota that have already incorporated CHP systems into their onsite operations. The paper industry in particular has significant experience operating CHP facilities and utilizing their biomass residuals (waste wood) to power their operations.

Companies with CHP systems include Blandin Paper (Grand Rapids), Boise Cascade (International Falls), and Champion

Sites Identified by MN Planning Study with CHP Potential[3]

GOOD PROSPECTS WITH GOOD DATA:

- *Rahr Malting Company (see case study on page 40)*
- *Chippewa Valley Ethanol Company (Benson)*
- *St. Mary's Duluth Clinic*
- *Duluth Steam Cooperative*

POTENTIAL PROSPECTS, BUT DATA INADEQUATE FOR ASSESSMENT:

- *Seneca Foods Corp. (Rochester)*
- *Hormel Foods Corp. (Austin)*
- *St. Olaf College (Northfield)*
- *Crown Cork and Seal (Faribault)*
- *Froedtert Malt (Winona)*
- *Dairy Farmers of America (Zumbrota)*
- *Heartland Corn Products (Winthrop)*
- *US Steel – Minnesota Ore Operations (Mountain Iron)*
- *Boise Cascade (International Falls), potential for additional capacity*

Existing CHP/District Heating Plants in Minnesota

PUBLIC UTILITIES:

- *Willmar (see case study on page 68)*
- *Hibbing*
- *Virginia (see case study on page 68)*
- *New Ulm*

OTHERS:

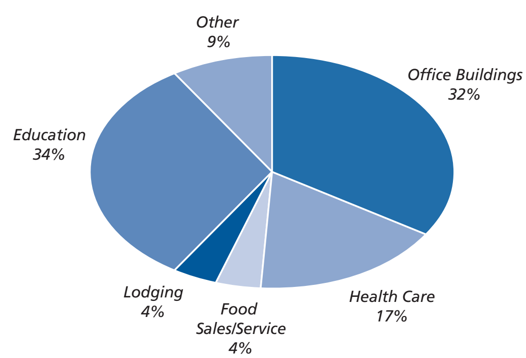
- *District Energy St. Paul Inc. (see case study on page 68)*
- *University of Minnesota (Twin Cities)*
- *Franklin Heating Station (Rochester)*
- *St. John's University (Collegeville)*

International (Sartell). The paper industry is not alone in its smart business use of CHP; several other industries including mining and agri-processing industries also reuse their waste heat to achieve more efficient energy use.

CHP IN THE COMMERCIAL AND INSTITUTIONAL SECTORS

Many people are not aware of the huge potential for increasing Minnesota's use of CHP in commercial and institutional buildings – altogether, there is the potential to generate over 1,100 megawatts of electricity (about 1/10th of Minnesota's current generating capacity) as well as serve heating and cooling loads.

Minnesota's potential to generate power in the commercial/institutional sector (1165 MW total)[4]

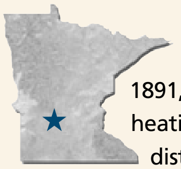


Institutional buildings are a large source of this potential. Schools and colleges have large heating loads that can be served by CHP systems. CHP paybacks tend to be in the 4 to 7 year range, which is more acceptable to the long term planning horizon of an institutional owner than a private for-profit company.

Buildings that need highly reliable or back-up power, such as hospitals, computer data centers and telephone switching centers, are an especially attractive possibility. A CHP system can serve as a backup power system that will pay for itself, rather than simply be an expense.

CASE STUDY:

Willmar Municipal Utilities CHP District Heating System



WILLMAR MUNICIPAL UTILITIES, established in 1891, currently provides district heating to 325 local customers. Its district heating system was built in 1913, and in 1982 the system was modernized to utilize hot water, rather than steam, to provide heating. Willmar's transition to hot water was based on Northern European technology and designed by engineers from Sweden. In making the upgrade to hot water, Willmar Municipal Utilities achieved higher efficiencies.

As part of the 1982 renovation, Willmar Municipal Utilities rebuilt the entire district heating distribution system. The district heating program started out serving only the commercial, institutional, and industrial buildings in the core business district, but began expanding in 1983 and continued expanding until 1990 to include its current customer base – 108 commercial, institutional and industrial facilities and 199 single family homes. When natural gas prices fell in the late 1980's, interest in district heating fell off, and there have been few expansions since.

Bart Murphy of Willmar Municipal Utilities said that for Willmar, "all the pieces just came together to make the expansion work." Although the upgrade was very capital intensive, they already had a heat source in place, and local citizens already had a good understanding of district energy. Existing customers liked the concept, so they didn't mind making a minor investment for the upgrades. In 1981, when they were planning to expand, the pricing was right for district heating because it would have cost significantly more to remove the whole system and connect every building to its own natural gas heating system.

While Willmar still uses coal in its system, there are other systems experimenting with other fuel sources, including various biomass materials.

For more information contact:
Bart Murphy
Willmar Public Utilities
320-235-4422
bmurphy@wmuwillmar.mn.us

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CHP AND DISTRICT HEATING

District heating does not necessarily have to produce both heat and power, but often this is the case. It is also not limited to just downtowns, but can also include “campus heating” of educational and other multiple-building facilities. St. Johns University near St. Cloud has a CHP campus heating system that uses a coal and waste wood fired steam unit. The Mayo Clinic in Rochester is also supplied by a CHP system.

Waste heat from local processing facilities also presents and opportunity for community-wide heating and cooling systems. This would both promote private-public cooperation and decrease the energy usage of the entire community.

The West Central Research and Outreach Center (see page 11 in chapter. 2) and the University of Minnesota Morris are working with DENCO, a farmer-owned ethanol plant, to utilize the waste steam heat that DENCO would generate. The University of Minnesota-Morris would use this waste steam in a district energy system that would serve its needs and those of a new elementary school while allowing DENCO to recover some of its costs.

Installing district energy systems is not without obstacles. These systems require significant capital investment to create the necessary infrastructure support. This means that district energy systems need community support, but district energy presents a real solution for improved energy efficiency and presents a tangible way for communities to reduce their fuel consumption.

END NOTES

[1] Minnesota Planning, *Inventory of Cogeneration Potential in Minnesota*, St. Paul, MN, August 2001. Generally includes facilities with larger than 1MW generating potential. Another study referenced in the above report concludes that the potential of small CHP systems (under 1MW) in MN is 842MW.

[2] ibid.

[3] ibid.

[4] *The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector*, Onsite Sycom Energy Corporation, for the US Department of Energy’s Energy Information Agency, Washington D.C., Jan. 2000.

PHOTOGRAPHS

page 67 – Virginia Public Utilities (upper), U.S. Department of Energy (lower); page 68– Nancy Toohey/ District Energy St. Paul; page 71 – Willmar Area Visitors and Convention Bureau; page 73 – Virginia Public Utilities

CASE STUDY:

Virginia Department of Public Utilities: CHP at a Local Utility

VIRGINIA DEPARTMENT OF PUBLIC UTILITIES is located in Virginia, Minnesota along Minnesota's iron range. The utility was originally founded in 1892; the city of Virginia purchased the utility in 1912 and then began producing electricity and steam. The current power plant operates a 30-megawatt CHP power plant that consists of three boilers and four turbines and burns primarily western coal and natural gas, depending on the boiler.

Electricity is produced by the power plant to fulfill the demands of the steam system. The steam district heating system supplies 2,500 customers including the downtown business area, city public buildings, and south side and north side commercial and residential areas while the electric system serves over 5,800 customers. Recent construction activities have forced the closing of steam lines to particular neighborhoods, reducing the number of homes served by steam heat. Overall however, the CHP district heating system in Virginia has proven to be a long lasting, and energy efficient success.

For more information contact:
Jeff Marwick
Power Plant Manager
218-748-2109

Virginia District Heating facility

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HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Inventory of Cogeneration Potential in Minnesota. Published by Minnesota Planning in August 2001. (www.mnplan.state.mn.us./eqb/pdf/2001/CogenInventory.pdf)

Opportunities to Expand Cogeneration in Minnesota. Written by Center for Energy and Environment and released in August 1996. (www.mncee.org/ceedocs/mmua_guide.pdf)

Midwest CHP Application Center. Located in Chicago and partially funded by the US Department of Energy, this is a premier center for technical assistance on CHP, such as determining the feasibility of CHP at a particular site. Contact: John Cuttica, 312-996-4382. Check their website for CHP evaluation tools. (www.CHPCenterMW.org)

Deployment of Distributed Energy Resources: Sources of Financial Assistance and Information. Published by the Federal Energy Management Program in January 2002. (www.eren.nrel.gov/femp/techassist/pdf/der_$available_1_24_02.pdf)

Consumer Energy Information: EREC Reference Briefs: Cogeneration or Combined Heat and Power. U.S. Department of Energy, Energy Efficiency and Renewable Energy Network. (www.eren.nrel.gov/consumerinfo/refbriefs/ea6.html)

Combined Heat and Power: Capturing Wasted Energy. A primer on combined heat and power technologies. R. Neal Elliott and Mark Spurr, 1999. Summary available at: (www.aceee.org/pubs/ie983.htm)

District Heating Planning in Minnesota: A Community Guidebook. Minnesota Department of Energy, Planning and Development, 1981. (www.hud.gov/offices/cpd/energyenviron/energy/library/ces/policyanalysis/c7.pdf)

Environmental Protection Agency: Combined Heat and Power. Provides general technology information as well as success stories from around the country. (www.epa.gov/CHP/index.htm)

District Energy Library. Website operated by the University of Rochester, providing a wide range of information on district energy and CHP including numerous links and publications. (www.energy.rochester.edu)

Minnesotan's for an Energy-Efficient Economy: Cogeneration. This website provides numerous links to pertinent information. (www.me3.org/issues/cogen/)

CHAPTER 11

Fuel Cells and Microturbines

FUEL CELLS ARE ON THE CUTTING EDGE OF FUTURE TECHNOLOGIES and have the potential to reshape our energy future. They use an electrochemical process to turn hydrogen and oxygen into pollution-free electricity and heat. Fuel cells have the potential to make the U.S. an energy independent nation, transforming our economy from one based on imported fossil fuels to a "hydrogen economy" fueled by hydrogen generated with local renewable resources. Fuel cells offer an opportunity for communities interested in pursuing renewable energy demonstration projects as the technology is still under development and all aspects of the technology and the supporting infrastructure are in need of pilot trials.

Fuel cells have the potential to make the U.S. an energy independent nation.

FUEL CELLS

Although the first fuel cell prototype was made in England in 1838, the modern version of fuel cell technology was developed as part of the Apollo moon program. NASA has demonstrated the commercial viability of fuel cells by continuing to use them to power space flights. Fuel cells can replace internal combustion engines in vehicles, batteries in all sorts of portable devices like cell phones and watches, and can generate electricity and heat for buildings and homes. Fuel cells are modular and can be small enough to fit in a watch or big enough to power large buildings.

The most immediate future applications for fuel cells will be in vehicles and replacing batteries in phones and other mobile electronics. All of the major auto manufacturers have fuel cell vehicles under development and Honda and Toyota began leasing fuel cell cars on a small scale in 2003. Fuel cells are also being used in pilot trials at schools and in city buses in Iceland, the U.S. and European cities. Stationary applications in buildings for heating and electricity will likely follow close behind.

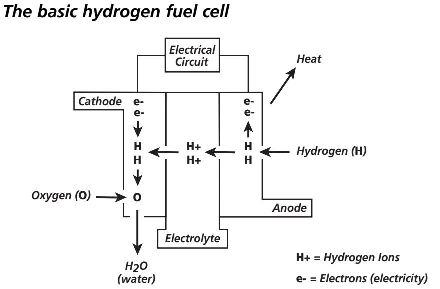
The market potential for fuel cells is estimated at $1.7 trillion by 2020. The private sector is investing $3 billion annually, and investment is

How Fuel Cells Work[1]

A fuel cell is an electrochemical energy-conversion device like a battery. Fuel cells produce electricity via a chemical reaction, harnessing the chemical attraction between hydrogen and oxygen. The oxygen is taken from the air, and hydrogen fuel can come from water via electrolysis or from fossil fuels like gasoline or methanol. A catalyst pries hydrogen atoms apart into a positive ion and an electron. The positive ions pass through a membrane to bond with the oxygen; the electron travels around the membrane and through a circuit, generating an electrical current. On the other side of the membrane, the oxygen, hydrogen ions and electrons recombine to form water.

There are a number of different fuel cell technologies under development to serve different needs. Different types of conductive materials or electrolytes are used. Proton exchange membrane (PEM) fuel cells are most common in vehicles and in small devices. Other types are alkali, molten carbonate, phosphoric acid, and solid oxide fuel cells.

The basic hydrogen fuel cell



CASE STUDY:

Iceland: A Demonstration of the Coming Hydrogen Economy

ICELANDIC NEW ENERGY, LTD. is a group made up of government, business, and academic institutions facilitating Iceland's transition from a fossil fuel based economy to a hydrogen economy. Chemistry professor Bragi Arnason originally proposed the idea of transforming Iceland into the world's first hydrogen economy. His idea, with the backing of Vistorka, an Iceland consortium, and three multinationals, Shell Hydrogen, Daimler-Chrysler, and Norsk Hydro (all part of Icelandic New Energy, Ltd.) is now becoming a reality.

Iceland will be the launching ground for testing hydrogen-powered vehicles and building a hydrogen-fueling infrastructure. All of the hydrogen will be produced using electricity from local renewable energy resources.

The world's first public access, hydrogen fuel station opened in April of 2003. The fueling station is the first of its kind to allow public access, and this demonstration is expected to yield critical information necessary toward establishing a hydrogen delivery infrastructure. Three hydrogen-fuel city buses, provided by Daimler-Chrysler, will be put in use in Summer 2003 and begin a two year pilot program.

For more information contact:
World Business Council for Sustainable Development
"DaimlerChrysler, Shell, and Norsk Hydro: The Iceland Experiment", a case study of Iceland and the Hydrogen Economy
www.wbcsd.ch

Completed hydrogen fueling station in Iceland

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growing each year. The high cost of fuel cells, however, still remains a barrier for widespread commercial use, but expectations are that they will be cost competitive with other technologies by the end of this decade.

Fuel cells can operate at conversion efficiencies as high as 80% for fuel cells running on hydrogen. Fuel cells running on methanol or gasoline are only 40% efficient, but all fuel cells have the added advantage of producing thermal hot water that can be integrated into a combined heat and power system. This makes them an efficient energy source that can evolve to serve multiple needs.

Fuel cells also provide the added benefit of providing a “clean” source of energy. Because the energy is generated by a chemical reaction, the electron stream generated from fuel cells is cleaner than that normally generated using conventional power plants. For many industries the quality of their power is not of extreme importance, but for some niche applications, such as computer chips, power quality is crucial.

HYDROGEN FUEL

Fuel cells have the potential to be pollution-free and to make the U.S. energy independent. Whether or not they live up to that promise depends on how the hydrogen fuel is generated. Hydrogen is all around us. Water is made of hydrogen and oxygen and hydrogen is in all living things, but it is rarely in the elemental form needed for fuel. It takes energy of some kind to generate pure hydrogen. Hydrogen can be produced via three primary mechanisms.

Electrolysis generates hydrogen by splitting the water molecule into its two components, hydrogen and oxygen, by passing an electrical current through the water and then capturing the hydrogen. The question is how to generate the electricity to do it. Will it be coal, nuclear power, or electricity from renewables?

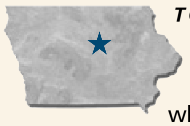
The cleanest and most environmentally friendly way of generating hydrogen is to use renewable energy resources, like wind, biomass, or solar, to generate the electricity to perform the electrolysis. This choice has the additional benefit of bringing economic development opportunities to Minnesota. Using wind and solar power to generate hydrogen makes these intermittent resources more valuable. They can be used when available to produce hydrogen, solving the dilemma of their intermittent nature.

Bio-chemical Conversion of Biomass The plant material all around us contains hydrogen. Demonstration projects are showing that hydrogen fuels can be made from plant waste materials using enzymes, fermentation, catalysts, and algae. Many communities have wastes from sugar beet plants, food processing plants, ethanol and biodiesel facilities, and even sewage treatment plants that may in the future be used to generate hydrogen fuels.

Reforming of Fossil and Bio Fuels requires pre-treatment of the fuel, which could be crude oil, methanol, ethanol, natural gas, or even gasoline or diesel fuel, in a “fuel reformer” that extracts the hydrogen for use in a fuel cell. The drawback to this method is that except for ethanol and methanol, it still requires the use of imported fossil fuels and still produces air pollution and greenhouse gases. On the other hand, reforming fossil fuels is a more efficient mechanism of using these fuels because it involves a chemical reaction rather than thermal production and results in more miles per gallon.

CASE STUDY:

Top Deck Holstein Dairy Farm's Microturbine



TOP DECK HOLSTEIN DIARY FARM, located in Westgate, Iowa, took a bold step in 2002 when it started using methane from its anaerobic digester to fuel a 30 kW Capstone microturbine and a 100 kW Waukesha engine. The digester converts manure from 700 cows into methane that is used to generate 130 kW of renewable energy, demonstrating the fuel versatility of microturbines and their on-farm applicability. The project generates electricity and puts waste heat to use while reducing manure odor and converting the manure into other usable byproducts. All of the electricity is sold to the grid as the generators are of the induction type. The heat produced from the engines is used to heat the digester to maintain mesophilic temperatures and in a heat loop to the milking parlor for preheating water and heating the milking parlor in the winter.

Top Deck Holstein Dairy Farm's project is supported through a partnership between farm owner Roger Decker, Alliant Energy, the Iowa DNR, and Iowa State University Extension.

For more information contact:
Bill Johnson
Alliant Energy
608-742-0824
billjohnson@alliantenergy.com

Farm tour of the Top Deck Holstein Dairy Farm's Microturbine

Digester pump (foreground) and gas house, which stores the engines

Minnesota has much to gain from the growth and development of fuel cells. There are a number of Minnesota businesses working on various aspects of fuel cell technology and the University of Minnesota has opened a new center for renewable energy research and development. Perhaps the greatest opportunity, however, is in the area of hydrogen fuel made using renewable power or biomass. Using wind, biomass, and solar power to make hydrogen fuel will increase the flexibility and reliability of these intermittent renewable resources, creating a larger market for the power.

MICROTURBINES: ON SITE GENERATION

Microturbines are small single-staged combustion turbines that generate between 25 kW and 500 kW of power, although their size varies. Microturbines are usually powered by natural gas, but can also be powered by biogas, hydrogen, propane or diesel. They are a renewable energy technology, if powered by biogas or hydrogen generated from renewables.

They produce electricity efficiently while keeping emissions low. Like fuel cells, microturbines can be paired with heat recovery systems to achieve efficiencies of up to 80%.

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A joint United States Department of Agriculture (USDA) and U.S. Department of Energy demonstration project announced in July 2002 will capitalize on the renewable potential by generating biogas, using anaerobic digestion of cow manure, as a microturbine fuel. Additionally, a small dairy farm in Iowa, Top Deck Holstein Dairy Farm (see case study), started using a 30 kW microturbine fueled by biogas in May 2002.

Microturbine designs evolved from automotive and truck turbochargers, auxiliary power units for airplanes, and small jet airplanes. A 30 kW microturbines is about the size of a small refrigerator, making them ideal applications for businesses with limited space. In addition to their small size, they offer benefits including: low initial costs, low maintenance costs, ability to put several together to build a reliable and independent system, few moving parts, lightweight, low emissions, high efficiency, and low electricity costs.

Microturbines are composed of a compressor, combustor, turbine, alternator, recuperator, and generator but have only one moving part. The turbine, compressor, and generator are all located on a single shaft. Microturbines use air bearings that do not require lubricating oil. Microturbines cost in the range of $1000/kW.

Further research on microturbine technology is underway to develop new “flex-microturbines” that can produce more electricity using low-energy, low-pressure biogas.

END NOTES

[1]Leo, Alan, *There's a Power Revolution Coming, and It Will Run on Hydrogen*. February 2002. Retrieved June 23, 2002 from: http://www.technologyreview.com/articles/wo_leo020502.asp.

PHOTOGRAPHS

page 75 – Toyota.com (upper), National Renewable Energy Laboratory (lower left), Schatz Energy Research Center (lower right); page 76– http://www.athygli.is/myndir.html; page 77 – National Renewable Energy Laboratory; page 78 – Alliant Energy; 79 – Jon Heer/CenterPoint Energy

Microturbine installation at a Minnegasco Facility

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Fuel Cells 2000: the Online Fuel Cell Information Center Website. A nonprofit organization providing extensive information on fuel cell technologies, including a listing of fuel cell vendors. (www.fuelcells.org)

How Stuff Works Website. Has general information about hydrogen and fuel cells. (www.howstuffworks.com/fuel-cell.htm) (www.howstuffworks.com/hydrogen-economy.htm.)

Minnesota Office of Environmental Assistance. Website has several fact sheets including, "Fuel Cells – Power Where It's Needed" and "Hydrogen – The New Fuel of Choice." (www.moea.state.mn.us)

National Fuel Cell Research Center. Information on how fuel cells work, lists manufacturers and researches, and provides detailed information on research projects. (www.nfcrc.uci.edu)

MIT Enterprise Technology Review. Technical descriptions about how fuel cells work. (http://www.technologyreview.com/articles/wo_leo020502.asp)

World Business Council for Sustainable Development. "DaimlerChrysler, Shell, and Norsk Hydro: The Iceland Experiment" a case study of Iceland and the Hydrogen Economy. (www.wbcsd.ch)

U.S. Department of Energy Hydrogen Information Network. (www.eren.doe.gov/hydrogen/features.html)

Distributed Energy Resources. Information on the DOE microturbine program can be found at: (www.eren.doe.gov/der/microturbines/microturbines.html)

Developing a Project

CHAPTER TWO COVERED THE BASIC STEPS of community energy planning. Once renewable energy potential has been assessed, and a decision made to move forward with a project, it's time to develop the project. This can be a very complicated and time-consuming process, and may take a year or more to complete. This section outlines some of the basic steps in developing a project, including conducting a feasibility study, ownership, environmental assessment, permitting, connecting to the grid, and financing. In many cases it will make sense to hire an experienced project developer who is familiar with the technical, legal and regulatory issues to guide you through the process.

In many cases it will make sense to hire an experienced project developer who is familiar with the technical, legal and regulatory issues to guide you through the process of developing a project.

FEASIBILITY STUDY

The first step in developing a project is to make sure it can be done with the technological, financial, managerial and other resources that are available. Although a feasibility study can be as simple as calculating the estimated cash flow of a project, it is often a more formal document. Lenders will typically require a formal feasibility study.

Feasibility studies consider a proposed project at a specific site. Both technical and financial feasibility are considered, as well as potential obstacles. Overall, the study should indicate whether or not the project should move forward, as well as providing the data and assumptions that led to that conclusion.

Many feasibility studies contain the following primary sections, although reports can vary as to their order and contents[1]:

Background This section will outline the motivation for conducting the project (the problem), the potential impacts/benefits of implementing the project, and a description of the facility, its components, and a site map; this section should also foreshadow how the option will be evaluated.

Technology Choice This section will outline the proposed system, how it would fit in with the existing facility, what gains the system would provide, and how these would be used; it would also outline other options that could be used instead.

Financial Analysis This analysis will evaluate how much the system would cost and how the owner would pay for it. Different entities, like state government and industry, may have different approaches and include different components when completing a financial analysis and therefore financial analyses must be tailored to the specific project. For instance, this section could also include a cost-effectiveness evaluation that would detail social, environmental, and avoided cost benefits in addition to the simple payback period. Usually included is a "pro-forma", or detailed year-by-year accounting of income and expenses for the life of the project.

Shortcomings This section should address the significant issues and potential pitfalls associated with the project and feasibility study analysis and propose solutions and recommendations to address these issues.

Conclusion Final opinion regarding whether or not the project should move forward (should not be overly positive if the data does not support it.)

Ideally, the lending organization will be able to read through the feasibility study, clearly follow the points and arguments, and arrive at the same final conclusion.

CASE STUDY:

Urban Biomass Plant Preliminary Feasibility Study

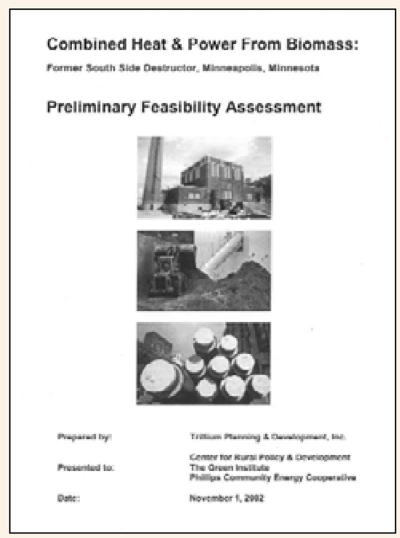
THE PHILLIPS NEIGHBORHOOD OF MINNEAPOLIS and The Green Institute are exploring a local renewable energy plant that would provide space heating to neighborhood buildings and homes and electric power to the grid. The Phillips Community Energy Cooperative (PCEC) is taking a closer look at this possibility. They commissioned a preliminary feasibility study to examine the opportunities and challenges associated with the development of a biomass combined heat and power plant in the neighborhood.

The purpose of a preliminary feasibility study is to summarize all aspects of the project to determine whether a full feasibility analysis is warranted. A Minneapolis consulting firm, Trillum Planning and Development, conducted the analysis.

The main topic of the 40-page study is the possible conversion of a former municipal waste incinerator, located in the Phillips neighbor-hood, to a biomass combined heat and power facility. The study is quite comprehensive. It examines such topics as fuel availability, cogeneration potential, facility adaptation, equipment choices, environmental considera-tions, production costs, regulatory framework, business models and financing. Each topic is described in the context of the project with challenges and opportunities being detailed for each category.

The conclusion of this analysis includes next steps and recommendations. The report recommendations that emerged include: conducting a comprehensive feasibility study, securing development rights and beginning negotiations for acquisition of land and improvements, securing funds for environmental investigation of site and facility, drafting an Environmental Assessment Worksheet, and beginning the MPCA Air Emission Permit process.

For more information contact:
Andrew Lambert
The Green Institute
612-278-7118
www.greeninstitute.org



Combined Heat & Power From Biomass:

Former South Side Destructor, Minneapolis, Minnesota

Preliminary Feasibility Assessment

Prepared by: Trillium Planning & Development, Inc.

Presented to: Center for Rural Policy & Development
The Green Institute
Phillips Community Energy Cooperative

Date: November 1, 2002

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OWNERSHIP

Ownership generally falls into two basic categories: public or private. As communities begin to select energy alternatives, they will also need to consider which ownership option will be most effective in accomplishing their goals. For some projects the choice is obvious, but for others, deciding who will own a project will be slightly more complex. For instance, when a particular entity within the community, either a private organization or a public institution, decides to move forward, they may automatically decide to own the project. Many of the school wind turbine projects are, for example, logically owned by the school district.

However, when a community sits down to establish a set of objectives for incorporating renewable energy into its energy future, its ownership options may be less clear. Communities must decide whether or not they want to own the generation, or partner with the local utility and share ownership, or simply buy renewable energy from the local utility. Often a local government's role will simply be to encourage and provide opportunities for renewable energy project development, rather than to develop projects themselves.

Mike Demchik, Central Lakes Agriculture Center, Staples, MN

When an individual farmer or an individual business is evaluating ownership possibilities, the issue can become even more complicated. Often, renewable energy operating equipment can have expensive upfront capital costs. This can make projects prohibitively expensive to do alone. Sometimes farmers will just lease their land to developers, rather than reaping the energy benefits for themselves. Cooperatives might in some cases present a collective option. The following sections consider some of these options.

PUBLIC OWNERSHIP

School Districts benefit from some funding options not available to private sector entities. First, the school districts are eligible for grants and funding opportunities, and even bonding opportunities that they would not qualify for as a private entity.

Also, school district budgets are able to benefit from the reduced electricity costs, the electricity sold back to the utility, as well as the federal and state production incentives. These financial mechanisms are discussed further in the financing section below.

Beyond financing, schools also have a unique opportunity to educate the surrounding community with the installation of a renewable energy system. By attaching a system to the school, the school suddenly takes on a leadership role in educating the community not only about the science and operating mechanisms behind renewable energy, but also about the environmental and potential economic benefits associated with such a system.

If schools can begin educating the younger generation of Minnesotans about renewable energy now, when these children become our future leaders they can make more informed decisions about renewable energy. On-site energy facilities can also serve as important learning tools for science and economics classes and can serve as a hands-on resource to students and the surrounding community.

Spirit Lake, Iowa

School districts may be a good ownership option for a wind project, because they are often able to take advantage of funding opportunities not available to other entities.

Paynesville Public School, Paynesville, MN

Counties and Municipalities Local governments have the potential to draw on a larger base of funding than individuals. They also have the benefit of being able to merge several smaller projects from many different buildings around their community into one larger project to secure a better overall bulk-quantity based price. See case study on page 87.

Counties and municipalities also have the benefit of having control over local land use and planning not specifically preempted by state or federal government. This allows these entities to exert some control over local energy planning matters and also engage the community around them in planning efforts. Aspects of this leadership role were emphasized in the Chisago County case study in Chapter Two.

PRIVATE OWNERSHIP

Individuals, Farmers and Businesses Private parties have the benefit of choosing their own motivation for the project and determining which conditions are most important to measuring the project's success. If the goal of the project is to be more environmentally conscious, then the metrics will be different than if the goal is to increase farming profits.

Financially, one of the benefits of private ownership is the eligibility for production tax credits for wind projects. These credits can make or break the financial feasibility of project and are therefore an important element to consider. Of course, the economic drawback of private ownership is that you and your business alone incur all of the upfront costs, but again, it depends upon your personal motivation.

In some scenarios, it may be possible to actually partner with a larger firm or simply contract out one's land. In any case, it will be important that individuals pursuing renewable energy projects seek the advice of experts, like project developers, engineers, and attorneys, to ensure that the process goes smoothly and that all necessary requirements are met.

Richard and Roger Kas built a wind turbine on their farm in Woodstock, MN

Cooperative Ownership The Minnesota Wood Energy Scale-Up Project (see page 39) and Minnesota's ethanol cooperatives are two examples of farmer-owned renewable energy cooperatives. The USDA provides information about how agricultural cooperatives work and how to form your own.[2]

Because cooperatives cannot take advantage of the federal production tax credit for wind, some farmers have set up Limited Liability Corporations (LLCs) to function very much like a cooperatives. MinWin1 and MinWin2, LLCs in Pipestone county, each have about 60 farmer/shareholders for each of their 2 MW wind projects (see page 28).

Businesses, farmers and individuals also have the ability to work more as a loosely knit agreement between like-minded parties rather than as a formal business entity. A group of farmers in Wisconsin has recently discussed jointly hiring an engineer to develop plans for an anaerobic digester. In this scenario, they will each install their own digester, but they will have shared the cost of developing an engineering design. This sort of approach has great potential to help individuals cut costs by sharing the financial burden.

ENVIRONMENTAL ASSESSMENT

Before proceeding with any project, it would be prudent to evaluate the potential environmental impact a project may have on local site conditions. For some projects this may not present a huge obstacle. After all, few wind projects or solar installations will have significant detrimental environmental impacts on their surroundings as long as they are sited appropriately.

However, biomass and other types of energy discussed here do have environmental impacts – some of which may be positive, and some negative. By evaluating the potential environmental concerns in advance, communities and property owners can avoid unexpected mishaps in the future.

For most small generation projects, a formal environmental assessment or environmental impact statement is not required. Minnesota Planning's Guide to Minnesota Environmental Review Rules[3] includes an exemption category for construction of an electric generation plant less than five megawatts. The report also outlines the difference between an Environmental Assessment Worksheet and an Environmental Impact Statement and when the two are required.

Anyone considering a new project should review these requirements and possibly talk with a representative of the Minnesota Environmental Quality Board to clarify what permitting and environmental review documentation may be required.

PERMITTING

In Minnesota, there are several governmental authorities that may require you to submit a permit. Permitting may be at the local, state, and/or federal level; be sure to check with all. One of the first permits that should be considered is the environmental rule outlined above.

In addition, for wind projects over 5 MW, the Environmental Quality Board has specific requirements for obtaining a wind-siting permit; for less than 5 MW it's a local issue.[4] The Federal Aviation Administration (FAA) also requires that wind projects complete a permitting process. For anaerobic digesters, operators will also need to contact the Minnesota Pollution Control Agency to complete their environmental review.

Other agencies that may need to be involved include the Department of Natural Resources, the Midwest branch of the US Fish and Wildlife Service, and the Minnesota Historic Preservation Office.

All projects will probably need to obtain building and electrical permits from either the city or county building department. In many cases the contractor installing the equipment can take care of these permits, but this should be negotiated in advance. Power developers will also need to address any necessary Federal Energy Regulatory Commission (FERC) permits.

Pope County Courthouse, Glenwood, MN

It is important to the success of a project to begin discussions with the electric utility early in the process.

Often it will be easiest to seek assistance from an experienced developer to help maneuver through the complicated array of permits, but it will always be prudent for any project to involve these agencies, or any other potential permitting agencies, prior to starting a project to ensure that it will not be halted somewhere further down the road.

CONNECTING TO THE GRID

It is very important to involve the local utility from the very beginning of any project that will tie into the electric grid. Each utility has requirements for interconnection in order to protect the safety of their line workers and maintain the integrity of the power system.

These requirements may vary with the size and type of generator. The utility may require the customer to pay for special engineering studies to determine the impact of adding additional generation to the grid, which can be expensive. Usually extensive studies are unnecessary for small projects (less than 1 MW or so).

The utility may also charge fees for services necessary for the generator to operate, such as upgrades to utility lines. Another charge that may apply for generators that serve a large load, such as a Combined Heat and Power facility, is a “standby fee”, or a charge for the utility to back up the load that the generator serves in case the generator goes down. Standby fees apply even if the facility does not actually use energy from the utility.

Many utility-required standards and studies are appropriate for larger generators, but may be unnecessary and burdensome for smaller generators. As well, requirements may vary considerably from utility to utility. Because of this, in 2001 the Minnesota legislature required the Minnesota Public Utilities Commission to develop generic interconnection standards and rates that will “promote the use of distributed resources… [and] provide for the low-cost, safe, and standardized interconnection of facilities.”[5] This process is expected to be concluded in 2003 or 2004.[6]

In other states that have adopted standardized interconnection agreements, including Texas and California, the standards have been successful in encouraging distributed generation. California, for example, has a “pre-certification” process for manufacturers of distributed generating equipment. Once a system is pre-certified, the utility cannot require an individual customer to pay for additional studies that have already been covered in the pre-certification process. California also has an exemption from standby fees for small generators.

NET METERING

Net metering allows qualifying facilities to consume electricity from the grid when they are not producing power, and sell electricity back to the grid when they are. This flow can typically be measured using your standard utility meter that spins forward when the utility is supplying energy and spins backward when the utility is taking energy.

Minnesota's net metering laws were established in 1983 and apply to all of the state's investor-owned utilities, municipalities and rural electric cooperatives. Renewable energy generators of 40 kW or less are eligible for the program, and there is no limit to total state-wide capacity allowed. Utilities are required to purchase net excess generation at the average retail rate, which can be twice as much, or more, than the standard utility buy-back rate.

CASE STUDY:

Metro Counties Energy Task Force

THE METRO COUNTIES ENERGY TASK FORCE is a great example of local governments coming together to work on energy issues and joint projects that are greater than the sum of what they could do individually. In response to the ongoing changes in the electric utility industry and other energy markets, Hennepin County initiated a Metropolitan Counties Energy Task Force in late 1999. The Task Force consists of one county commissioner from each of the seven metro counties.

The Task Force meets monthly to focus on energy issues relating to the Twin Cities area. The meetings serve to educate commissioners on topics such as wind energy, potential energy projects, and legislative issues relating to energy and conservation. The Task Force sponsors an energy workshop every summer.

The Task Force recently initiated a model energy conservation building in each county. The energy conservation program consists of each county selecting a building to which they would make energy conservation improvements as a demonstration for the public. In addition, they are developing models for energy efficiency procedures and financing that may be applied to a range of buildings throughout the region.

The Task Force is exploring others ways that it can become more active in guiding policy and initiating metro-wide programming relating to conservation and energy.

The meetings are attended not only by Task Force members but also by representatives from the Public Utilities Commission, the state Department of Commerce, local utilities and engineering firms. The meetings serve to break down barriers between the counties and other actors in energy policy and educate the attendees on all aspects of the issue. Working together, the Task Force hopes to effect positive energy policy for the metro area.

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The purchase of net excess generation at retail rates distinguishes Minnesota's net metering legislation from programs in most other states. Only Wisconsin also provides for the purchase of net excess generation at retail rates. It is also worth noting that Minnesota, Maryland, Nevada, New York, and California are the only states where net metering is mandated in statute by the state legislature. As of 2000, the Minnesota Department of Commerce reported that there were 110 facilities with net billing arrangements. Of these facilities, 23 were photovoltaic and 87 were wind facilities.[7]

FINANCING

Financing for renewable energy projects can come from multiple sources, including up-front equity, private lending sources, incentives payments and low-interest loans. The following gives a brief overview of some of the types of funding available.

State and Federal Incentive Payments Both federal and state production incentives exist for renewable energy. These may exist as a tax incentive, or a production payment. Eligibility and availability of funds is notoriously subject to change, so any project that relies on incentive payments will need to be sure that incentives will still be available when the project goes on-line.

Improves the environment

Works well with agriculture

Helps with reliability concerns

Recycles waste materials and waste heat

Offers community economic development

Improves energy independence, local control, and energy security

Promotes learning about energy

The end of this chapter contains links to websites with updated information on federal and state renewable energy production incentives and other programs.

State and Federal Loans and Grants Beyond production incentives, there are also numerous loan programs available to help finance renewable energy projects. The Minnesota Department of Agriculture has summarized many of these programs (see Appendix B), and see the end of this chapter as well.

Schools, municipalities, counties and other government units are eligible for State Loan Money through the Department of Commerce. These loans present borrowers with lower interest rates because the state has enough buying power to garner lower borrowing rates.

Schools are also eligible for "lease-purchase agreements", which are favorable interest rate loans available to schools because they are non-taxable, or can issue capital notes, which are like bonds but do not require election approval. Of course, schools can also open a renewable energy project to a general bonding referendum, which could then either be voted up or down by the community.

Grants are also likely available to schools through the U.S. Department of Education, U.S. Department of Energy, and through environmental education entities.

Farmers and rural small businesses are eligible to receive funding from the Renewable Energy Systems and Energy Efficiency Improvements Grant Program, administered by the U.S. Department of Agriculture. This grant can fund up to 25% of total project costs. See the end of this chapter for sources of more detailed information about each of these programs.

Private Lending Even if a project receives state or federal funding, some of the funds will probably need to come from private lenders,

Glenwood State Bank, Glenwood, MN

including banks and agricultural lenders like AgStar Financial Services. Before heading to the bank, project developers will need to have their project proposal materials, feasibility study, and site data ready.

In instances where part of the project objective includes selling power to the local utility, it will be important to have a power purchase agreement from the local utility. The purchase agreement will help the bank gauge the financial viability of the project and evaluate the potential payback period.

Local banks in Minnesota are becoming increasingly comfortable with funding renewable energy projects, especially in the southwest corner of the state, where local banks have funded many wind projects.

Renewable Development Fund Xcel Energy created the Renewable Development Fund as part of a legislative deal in 1994 allowing the company to store it's nuclear waste above-ground at the Prairie Island nuclear power plant near Red Wing. The fund currently provides about $8.5 million per year in grants for renewable energy projects.

Xcel Energy completed its first round of funding under this program in 2001. Grant applications can be submitted for wind, biomass, solar and hydro projects, but the fund currently gives special preference to biomass.

Funding is split between in-the-ground renewable energy projects and research and development projects that would lead these technologies toward full commercialization. For more information see www.xcelenergy.com.

MAKING IT HAPPEN

This chapter has covered some of the basic steps involved in getting a project off the ground, and some of the choices facing project developers. As you can see from reading this chapter, it can be a complicated process to see a project from start to finish, and many people choose to work with an experienced project developer who can guide them through the process. Although it comes at a price, this can reduce project risk. However the project moves forward, it is important to consider all the aspects of developing a project discussed here before beginning the project in order to avoid potential pitfalls.

Glenwood, MN

END NOTES

[1]McMurrey, David, *Online Technical Writing: Recommendation and Feasibility Reports*, http://www.io.com/~hcexres/tcm1603/acchtml/feas.html.

[2]For more information see their online documents: http://www.rurdev.usda.gov/rbs/pub/cir55/c55text.pdf and http://www.rurdev.usda.gov/rbs/pub/cir7/cir7.pdf..

[3]Minnesota Environmental Quality Board (division of Minnesota Planning), *Guide to Minnesota Environmental Rules*, St. Paul, MN, April 1998 (www.mnplan.state.mn.us/pdf/rulguid3.pdf).

[4]These rules can be found at: www.mnplan.state.mn.us/eqb/wind/index.html.

[5]Minnesota Statutes, Section 216B.1611 (2002).

[6]A comprehensive website on the status of the distributed generation rules in MN has been compiled by John Bailey at the Institute for Local Self Reliance: www.newrules.org/dgtariff/index.html.

[5]Database of State Incentives for Renewable Energy, Minnesota Incentives for Renewable Energy, www.dsireusa.org/.

PHOTOGRAPHS

page 81 – Spirit Lake Community School District; page 82– Trillium Planning and Development, Inc.; page 83 – Dwight Tober/NRCS Plant material center (left), Spirit Lake Community School District (right); page 84 – Carl Nelson/ The Minnesota Project (left), Lisa Daniels/Windustry (right); page 85 – Carl Nelson/The Minnesota Project; page 86 – National Renewable Energy Laboratory; page 87 – Lola Schoenrich/The Minnesota Project; page 88 – Carl Nelson/The Minnesota Project; page 89 – Carl Nelson/The Minnesota Project

HELPFUL RESOURCES FOR COMMUNITIES

All web links listed here are available (and updated if necessary) at www.mnproject.org (click on "publications")

Database of State Incentives for Renewable Energy. This website contains comprehensive information on state and federal grants, loans, tax credits and other incentives for renewable energy. (www.dsireusa.org)

Minnesota Department of Commerce Energy Information Center. Commerce's website has a list of incentives available for state renewable energy projects. Energy specialists are also available by phone: 651-296-5175 or 800-657-3710 (toll-free); email: energy.info@state.mn.us (www.commerce.state.mn.us)

U.S. Department of Agriculture, Renewable Energy Systems and Energy Efficiency Improvements Grant Program. This program was initiated under the Energy Title of the 2002 Farm Bill. In 2003, this program provided $23 million in grants for farmers and rural small businesses. (www.rurdev.usda.gov/rd/farmbill/9006resources.html)

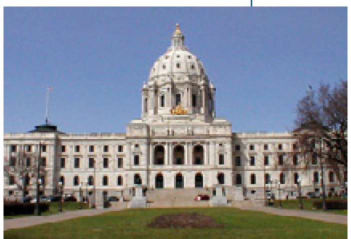
Environmental Review. Information from Minnesota Planning about environmental review process, documents, and how the Environmental Quality Board works for development and approval of new projects. (www.mnplan.state.mn.us/eqb/review.html#How%20it%20works)

Wind Turbine Siting. Information from Minnesota Planning regarding wind project permitting and siting for wind projects over 5 MW. (www.eqb.state.mn.us/EnergyFacilities/wind.html)

Online Technical Writing: Recommendation and Feasibility Reports. Used as an online manual for technical writing courses around the world. (www.io.com/~hcexres/tcm1603/acchtml/feas.html)

Xcel Energy: Interconnection Guidelines For Parallel Operation of Distribution Connected Customer-Owned Generation. This document applies to Xcel Energy territories in Michigan, Minnesota, North Dakota, South Dakota and Wisconsin. (www4.xcelenergy.com/EnergyMarkets/CustInterconnectGuide/TOC.asp)

Towns of Tomorrow – Vision for the Future



MINNESOTA IS RICH IN THE RENEWABLE ENERGY RESOURCES especially wind and biomass that will allow us to build a sustainable energy future. Using local, renewable energy will bring cleaner air and water, local economic development opportunities, and will help revitalize our rural and urban communities. This workbook has explored many of the energy technologies available to communities interested in diversifying their energy supply to include locally generated, clean, renewable energy. With wind, biomass, solar energy, and increased efficiency through conservation and cogeneration, the community energy system of tomorrow could be very different from the one we have today.

Using local, renewable energy will bring cleaner air and water, local economic development opportunities, and will help revitalize our rural and urban communities.

But could it really? After all, each community is part of a larger system. Our electric system is owned by multi-state, investor-owned utilities and large cooperatives. It is shaped and regulated by state policy. Our state system is interconnected with the regional electricity system and with the national system. National policy and regulation affect what happens in each city here. The way that we produce and use energy in the United States affects people and the environment all over the planet.

Sure, good ideas implemented on a local level make one community a better place to live and work. But does it really make a difference in the bigger picture?

SMALL CHANGES ADD UP

In fact it does. Creative vision for real change often comes from people at the local level. Think about the change in the national understanding of smoking, of campaigns against drunk driving, of recycling. Recycling programs started with a few scout troops collecting aluminum cans and newspapers. Today, everyone has a recycling bin out back. Successful vision and change at the local level inspires and drives changes at the state level. Success at the state level can drive national policy.

Vision from community energy projects is already impacting thinking within Minnesota state government. State legislators have gotten interested in a number of energy ideas pioneered at the local level including on-farm anaerobic digesters and farmer-owned wind developments. Legislators got interested in the idea of moving toward a hydrogen-based economy in Minnesota, in part, because of the vision and initiative of a citizen leader in Lake City.

Citizens in Lake City are looking at the feasibility of adding wind energy to the local municipal electric system. One of them came across information about the hydrogen fuel cell initiative in Iceland, and began a correspondence with officials there. Through this relationship, an Icelandic delegation visited Minnesota in the spring of 2002 to talk about their hydrogen initiative.

State officials, business leaders, and University researchers were inspired and have convened a working group to examine the potential role of hydrogen in Minnesota's future. State legislators are interested in positioning the state for the future and a number of hydrogen initiatives were passed during the 2003 legislative session.

Change begins with a vision of what might be possible for our state and for our communities.

IT STARTS WITH VISION

Minnesota is well positioned to lead the nation in supplying our industries, farms, homes and government with renewable energy that protects the environment for future generations while creating economic opportunity today. Minnesota has the renewable resources to take the next bold step. It begins with a vision of what might be possible for our state and for our communities.

Consider the following real examples illustrating bold visions of dramatically different energy futures that led to a cleaner environment and cutting edge business development. The first describes energy efficiency in Sweden, the second wind development in Denmark and the third the Icelandic hydrogen initiative. All are countries very like Minnesota in size, population, and heritage. Imagine what could happen if Minnesota did the same.

EFFICIENCY FOR THE FUTURE

Imagine a country where the government, businesses, and citizens all agreed that creating energy efficiency in all sectors, from residential, to commercial, to industrial, would be their primary energy focus. Efficiency would guide all their future energy planning. This country, not unlike Minnesota today, had a growing population and was faced with projected energy shortfalls within the decade. To make matters worse, it was almost completely dependent upon imported fossil fuels.

With government taking the lead, partnering with utilities and businesses, policies were enacted that transformed engineering and manufacturing practices. They built more efficient homes and buildings and produced goods more efficiently. Citizens supported these efforts by buying more efficient homes and autos, and by supporting legislation that encouraged continued efficiency improvements.

The place is Sweden, where energy efficiency has become the norm. Swedes, from government officials, to manufacturing leaders, to average citizens, decided that they would have the most efficient housing in the world. They made energy efficiency a priority. In roughly twenty years, they have been able to make housing manufacturing one of their most innovative and modern industries, and have become a model for the rest of the world.[1]

Minnesota too could make huge strides just by implementing greater efficiency improvements. If all state, county and municipal buildings were retrofitted with strict requirements for energy conservation; Minnesota would make good progress in reducing energy demand. If every person in the state bought only the most efficient Energy Star appliances, the state could make more progress in reducing consumption. If communities all around the state partnered with local utilities to improve the efficiency of homes and businesses, the state could make huge strides in reducing the amount of coal it burned. There are so many options. Minnesota just needs to lay out the vision and work to make it a reality.

Stockholm, Sweden

WINDS OF TOMORROW

Imagine yet another country. This one saw the future of its economy in wind power. It had good wind resources and the potential for significant wind development, like Minnesota It also had a strong manufacturing sector and was home to industry pioneers, much like Minnesota. Leaders of this country, including local government officials, business leaders, and community organizers, foresaw the need for renewable energy and decided to invest the country's resources in developing a new industry. The people of this country had a vision and positioned themselves to meet an inevitable future demand.

The country is Denmark. Leaders decided in the late 1980s to power the country with wind energy. Danish industries have since become the dominant manufacturers of wind turbines.[2] In fact, most of the wind turbines in Minnesota were manufactured and installed by Danish companies. Minnesota has the potential to duplicate the efforts of the Danes. The state is windier than Denmark, has a strong manufacturing base, and the technological know-how to become world leaders in wind manufacturing. Wind is the world's fastest growing energy source. Minnesota could take advantage of its position and capitalize on this burgeoning market.

We could decide today that at least 20% of our energy supply will come from renewable energy resources by 2020, creating a predictable market and encouraging business investment in the state. We could partner with other Midwest states to lay the groundwork for a new electricity system including wind power, so that by the end of the decade, there would be many thousands, say at least 6,500 megawatts of new wind energy in the region.

Wind turbines along the coast of Denmark

HYDROGEN: THE COMING REVOLUTION

While a world economy powered by hydrogen fuel cells is still in its infancy, what if a state or nation decided today to begin a transition in earnest? Imagine how well positioned that state would be in twenty years and what economic advantage it would have. It could begin by investing research dollars into using renewable resources to split water into hydrogen and oxygen and into developing fuel cells that could be used in automobiles and in homes. Perhaps it would start by implementing a pilot program that ran city buses on hydrogen fuel cells.

This concept is actually not far fetched. In 2001, Icelanders proclaimed their intent to become the world's first hydrogen economy – completely free of fossil fuels. Iceland plans to

Fueling up at hydrogen station in Iceland derive all its hydrogen via electrolysis powered by renewably generated electricity, rather than from fossil fuels. Rather than waiting for someone else to take the first step, Iceland stepped into the forefront, and became the world's leader in creating a vision for a fossil fuel-free energy future.

Community level initiatives could compel a new energy vision for Minnesota. What are we waiting for?

In fact, the plan is to begin this transition by using fuel cells on city buses and expanding from there. The first public hydrogen fueling station opened in Iceland in April 2003. By taking such a step, Icelandic developers will be able to begin building a nation-wide hydrogen infrastructure system – positioning themselves well ahead of the rest of the world and primed to market their knowledge as everyone else plays catch-up.

A VISION FOR MINNESOTA

Minnesota leaders, too, could articulate and embrace a vision of a very different energy future, including greatly increased conservation, electricity generated from renewable resources like wind, biomass, and solar, and eventually, an economy running entirely on hydrogen generated using renewable power. We could, as a state, as communities, as leaders, set these goals, plot a course, enact policies, and create incentives to achieve it. Community level initiatives could compel that vision. What are we waiting for?

END NOTES

[1]Noble, Michael. *Our Electricity System: Crisis of Vision*, Minnesota Journal Volume 19, Number 7 (2002): 1-2.

[2]ibid

PHOTOGRAPHS

page 91 – Chuck Roberts/Fokti.com (upper), National Renewable Energy Laboratory (lower); page 92– Yahoo Greetings; page 93 – Danish Wind Energy Information (upper), http://www.athygli.is/myndir.html (lower);

Appendix

APPENDIX A

Comparison of Costs for Selected Energy Technologies

APPENDIX B

Financial Assistance Programs for Renewable Energy Projects

The table presented in Appendix B was prepared in 2002 by the Minnesota Department of Agriculture. The first two pages list loan programs, and the next two pages list incentive payments, tax credits, and grants for renewable energy systems. In addition to the programs listed here, since this fact sheet was published, the following grant program was established:

USDA Renewable Energy Systems and Energy Efficiency Improvement Grant and Loan Program. This provides up to $23 million nationally for renewable energy projects and energy efficiency projects for farmers and rural small businesses. (www.rurdev.usda.gov/rd/farmbill/9006resources.html)

In addition, a federal tax credit is being considered in Congress that would provide a tax credit for each kWh generated from farm biogas systems.

A good source of up-to date information on both federal and state incentives is the Database of State Incentives for Renewable Energy (DSIRE) (www.dsireusa.org)

APPENDIX A: COMPARISON OF COSTS FOR SELECTED ENERGY TECHNOLOGIES

There are a wide range of cost estimates for various energy technologies, and the following table represents just one estimate. Please keep in mind the following when reviewing this table:

- The cost figures here are by no means definitive, but rather provide a rough estimate of costs across technologies. See also: *Renewable Energy Technology Characterizations*, EPRI/US DOE, 1997. (www.eere.energy.gov/power/techchar.html)
- The costs estimates below are for *new* plants – generating costs of existing plants may be substantially lower (especially for coal and nuclear)
- The costs also do not include operating subsidies, which may also lower the generating costs (e.g., wind energy is eligible to receive a 1.8 cent/kWh tax incentive, which is not included in the estimates here). It also does not include R & D subsidies, which would increase the real cost of some of the technologies – for example, from 1947 to 1999, the nuclear industry received about $145 billion in federal subsidies, or about 1.2 cents/kWh cumulative over that time period, which are not reflected in the costs reported here.
- The costs also do not include "externality costs," or health and environmental costs, which in the case of the non-renewable technologies can significantly increase total generation costs. For example, studies have calculated the health and environmental impacts of some existing coal plants to be over 2 cents/kWh.

	Technology	Investment costs ($/kW)	Total generating costs (¢/kWh)
Non-renewable			
	Natural gas combined cycle	500-700	3.0-4.0
	Coal	1,000-1,300	4.0-5.5
	Nuclear	1,200-2,000	3.3-8.0
Renewable			
	Wind	800-2,000	3.0-8.0
	Biomass (25 MW)	1,500-2,500	4.0-9.0
	Small hydro	800-1,200	5.0-10.0
	Solar thermal electric	4,000-6,000	12.0-18.0
	Solar PV	6,000-8,000	30.0-80.0

Source: Peter Langcake, "Getting a Clear View: Strategic perspectives for renewable energy companies," Renewable Energy World, *Vol. 6, No. 2, March/April 2003.*

Financial Assistance for Renewable Energy Projects

STATE FINANCING PROGRAMS

RURAL FINANCE AUTHORITY (RFA) AND MN DEPARTMENT OF AGRICULTURE

Requirements	**Wind Energy Pilot Loan Program**	**Value Added Stock Loan**	**Agricultural Improvement Participation Loan**	**Manure Digester Loan Program**	**Sustainable Ag Loan Program**
Residence:	Minnesota only	Minnesota only	Minnesota only	Minnesota only	Minnesota only
Borrowing Entity:	Individual	Individual	Individual	Individual	Individual
Loan Purpose:	Wind Turbine	Wind Generation Facilities	Any Improvement to Real Estate	Alternative Energy Utilization	Wind Turbine
Loan Amount:	(RFA – 45%) $500,000	45% Participation up to $24,000	45% Participation up to $125,000	$250,000	$25,000 - 7 yr.
Lending Entity:	Local Lenders (RFA Participation)	Local Lenders (RFA Participation)	Local Lenders (RFA Participation)	MN Dept. of Agriculture	MN Dept. of Agriculture
Security:	Real Estate	Stock Purchased Security Agreement	Real Estate	Negotiable	Negotiable
Interest rate:	1^{st} $125,000 @ 6% Balance - @ 7%	4%	6%	0% throught 6/30/03	6%
Amortization:	10 yr. on RFA Participation	8 yr. on RFA Participation	10 yr. on RFA Participation	10 yr.	7 yr.
Fees:	$50. Application (Non Refundable)	$50. Application (Non Refundable)	$50. Application (Non Refundable)	No Fees	No Fees
Farm Full Time?	Yes	Yes	Yes	Yes	Yes
Equity Required:	Negotiable	Negotiable	Negotiable	Negotiable	Negotiable
Web Site:	www.mda.mn.us/agfinance	www.mda.mn.us/agfinance	www.mda.mn.us/agfinance	www.mda.mn.us/agfinance	www.mda.mn.us/agfinance

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MINNESOTA DEPARTMENT OF AGRICULTURE
FROM THE FARM TO YOUR FAMILY

Financial Assistance for Renewable Energy Projects

FEDERAL FINANCING PROGRAMS					
Agency:	**Farm Service Agency (FSA)**	**Small Business Administration (SBA)**	**USDA RURAL DEVELOPMENT**		
Program Requirements	**Farm Ownership Guaranteed Guaranteed Loan**	**504 Certified Development Co.**	**Intermediary Re-lending Program**	**B and I Guaranteed Loans**	**Other Financing Considerations**
Residency:	Minnesota only	Minnesota only	Minnesota only	Minnesota only	USDA Rural Development has several other financing programs targeted at rural areas that may offer some opportunity under special circumstances. Most of these financial assistance programs involve a community based non-profit organization or a governmental agency as the coordinating lender. These programs are Rural Economic Development Loan and Grant, Rural Business Grant and B and I Direct Loan Programs. For further information on these programs, you can contact the web site listed below, or telephone: 651-602-7799. Commercial lenders are studying and researching their role in financing renewable energy projects, especially wind turbine installation, as a means of enhancing and promoting rural development. Long term production contracts that provide an excellent income stream are an important part of the criteria for their financial participation.
Eligible Entity:	Individual, LLC or LLP	Community based certified development company	Non-profits or local government	Real estate, machinery and equipment, buildings	
Loan Purpose:	Real Estate	Community economic development; i.e.: wind turbine. Fixed assets.	Community development. Innovative projects, land, buildings.	Create and maintain employment and improve economic climate.	
Dollar Parameter:	$731,000 OL & FO	$1,300,000	$2 million maximum/intermediary $750,000 initially. Recipient - $250,000.	Maximum $25,000,000	
Lending Entity:	Local lender	Local lender - 50%. CDC - (jr. lien) - 40%. Borrower - 10%.	USDA to intermediary. Intermediary to recipient.	Banks, credit unions, insurance companies, Farm Credit Services, savings and loan associations.	
Security:	Real estate	Assets being financed. Personal guarantees.	Real or personal property of intermediary or recipient.	Lender decision	
Interest Rate:	Set by lender	Based on 5 and 10 year treasury issues	1% to intermediary Negotiable to recipient	Negotiated by lender	
Amortization:	Up to 40 years	10 to 20 years	30 year maximum	Lender negotiated	
Fees:	Yes	3% of the SBA debenture (Non Refundable)		2% of guarantee	
Equity Required:	Negotiable	10%	Negotiable	Negotiated by lender	
Other Criteria:		Job creation	Areas of under 25,000 people. Unable to obtain credit elsewhere.	Rural area. Population under 50,000.	
Web Site:	www.fsa.gov/pas/default.asp	www.sba.gov	www.usda.gov	www.usda.gov	www.usda.gov

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MINNESOTA DEPARTMENT OF AGRICULTURE
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Selected Government Incentives for Renewable Energy in Minnesota – August 12, 2002

Type of Incentive	Incentive Provider	Description	Applicable Technology			Eligible Recipients	Effective Dates	Authority
			Biomass	Wind	Solar			
Incentive Payments	**Federal**	**Renewable Energy Production Incentive** Annual incentive payment of 1.74¢ per kilowatt-hour (in 2002 dollars; payment is adjusted annually for inflation) for the first 10 years of operation, as annual appropriations permit. Solar, wind, closed-loop biomass, or geothermal facilities receive priority; any remaining funds may be used for payments to open-loop biomass facilities, including anaerobic digesters. *US Department of Energy* www.eren.doe.gov/power/repi.html	x	x	x	Facilities owned by non-taxable entities such as state and local governments (e.g., municipal utilities) and non-profit electric cooperatives	For production started between Oct 1, 1993 & Sept 30, 2003	Code of Federal Regulations Citation: **10 CFR 451**
	State	**Minnesota Renewable Energy Production Incentive** A 1.5¢ per kilowatt-hour payment quarterly for up to the first 10 years of electricity generation from new on-farm anaerobic digesters and small-scale wind energy projects (2 MW or less, or 7 MW or less if owned by a cooperative with at least 51% local membership). The wind incentive is first-come first-served until a 100-MW statewide cap is reached. The payment rate is fixed. *Minnesota Department of Commerce: Jeremy DeFiebre, 651-297-1221,* jeremy.defiebre@state.mn.us	x	x		Small-scale producers in the commercial, industrial, residential, non-profit, utility, and tribal council sectors, regardless of tax liability	*Digesters*—Jul 1, 2001 through Dec 31, 2015. *Wind*—for production started before Jan 1, 2005, until program is fully subscribed	Mn Statutes 2001: **216C.41**
Income Tax Credits	**Federal**	**Renewable Electricity Production Tax Credit** A tax credit of 1.5¢ per kilowatt-hour for the first 10 years of operation for electricity generated by wind, closed-loop biomass and poultry waste. *Database of Incentives for Renewable Energy* www.dsireusa.org *IRS Form 8835* www.irs.gov/pub/irs-pdf/f8835.pdf	x	x		Taxable corporate entities in the commercial and industrial sectors	Expires Dec 31, 2003	US Code Citation: **26 USC 45 (1994)**
		Solar & Geothermal Business Energy Tax Credit Tax credit equal to 10% of the purchase and installation cost of solar heating, solar electricity, or active geothermal energy equipment. *Database of Incentives for Renewable Energy* www.dsireusa.org *IRS Form 3468* www.irs.gov/pub/irs-pdf/f3468.pdf			x	Same as above	Ongoing, no expiration date	US Code Citation: **26 USC 48 (1994)**
Accelerated Depreciation	**Federal**	**Accelerated Cost Recovery System** Allows qualifying renewable energy systems to be depreciated using a double-declining balance, five-year depreciation schedule. Businesses should consult their tax attorneys for details.	x	x	x	Taxable corporate entities in the commercial and industrial sectors	Expires Dec 2005 or as funds allow	US Code Citation: **26 USC 168 (1994)**
	State	**Renewable Energy Equipment Accelerated Depreciation** Same depreciation schedule as federal.	x	x	x	Same as above	Ongoing	Mn Statutes 2001: **500.30 (5)**

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Type of Incentive	Incentive Provider	Description	Applicable Technology			Eligible Recipients	Effective Dates	Authority
			Biomass	**Wind**	**Solar**			
Property & Sales Tax Exemptions	**State**	**Wind & Photovoltaic Property Tax Exemption** Exemption from local property tax of the value added by small-scale (up to 2 MW) wind or photovoltaic energy projects. Partial exemptions apply for medium-scale (between 2 and 12 MW) and large-scale (more than 12 MW) systems. *American Wind Energy Association* *www.awea.org/smallwind/minnesota_sw.html*		x	x	Residential, commercial and utility sectors	For wind systems installed after Jan 1, 1991 & solar systems installed after Jan 1, 1992	Mn Statutes 2001: **272.02 (22), (24)**
		Wind & Solar Energy Sales Tax Exemption State sales tax exemption for the full cost of wind energy equipment as well as materials used to manufacture, construct, install, repair or replace wind energy systems. Solar photovoltaic panels are also eligible if sold/purchased in Minnesota. *American Wind Energy Association* *www.awea.org/smallwind/minnesota_sw.html*		x	x	No restrictions	For solar panels sold/purchased before Aug 1, 2005. No deadline for wind facilities.	Mn Statutes 2001: **297A.68 (12)** **297A.67 (29)**
Rebates	**State**	**Solar Electric Rebate Program** Rebates of $2,000 to $8,000 for grid-connected solar-electric (photovoltaic) systems. *Minnesota Department of Commerce: Mike Taylor, 651-296-6830, mike.taylor@state.mn.us. Check for links in the future at www.commerce.state.mn.us/pages/Energy/MainModTech.htm.*			x	Xcel Energy customers in 2002 and 2003. Any Minnesota electricity customer in 2004 and 2005.	2002 to 2005, as funding permits	Mn Statutes 2001: **116C.779**
Regulatory	**State**	**Net Metering** State statute requires utilities to purchase excess energy at retail rates from qualifying renewable energy and cogeneration facilities of 40 kW or less. *US Department of Energy* *www.eren.doe.gov/greenpower*	x	x	x	Investor-owned utilities, municipalities and rural cooperatives	Ongoing since 1983	Mn Statutes 2001: **261B.164 (3)**
		Green Pricing State statute requires utilities to offer green power to their customers. Most programs so far involve premium pricing for wind energy, such as Moorhead Public Service's Capture the Wind program and Cooperative Power Association's Wellspring program. *US Department of Energy* *www.eren.doe.gov/greenpower*	x	x	x	Encourages development of renewable energy via premium pricing for customers	Ongoing, with goal of utilities obtaining 10% of the energy they supply from renewable sources by 2015	Mn Statutes 2001: **216B.1691**

Sources of information in this table: Minnesota Department of Commerce www.commerce.state.mn.us/pages/Energy/ModTech/taxincentives.htm and correspondence with Mike Taylor; Database of State Incentives for Renewable Energy www.dsireusa.org; US Department of Energy, Energy Efficiency and Renewable Energy Network www.eren.doe.gov and Green Power Network www.eren.doe.gov/greenpower/home.shtml; American Wind Energy Association www.awea.org/smallwind/minnsota_sw.html.

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