THE LEAGUE
OF WOMEN VOTERS
OF EDINA

A STUDY OF RENEWABLE ENERGY

April 2005

Introduction

About this study

In May 2004, the League of Women Voters of Edina (LWVE) adopted a one-year study on Renewable Energy in Edina. The committee was charged with looking at the current use of renewable energy within Edina with the scope to include the cost of clean renewable energy (including implementation and maintenance costs) to power city buildings, schools, park facilities, business and homes compared to the cost of energy sources currently used.

Renewable energy is energy that can never be used up either because its source is infinite or is constantly renewing. This study highlights six renewable energy forms: solar, hydro, wind, biomass, hydrogen fuel cells, and ground source heat.

Many sources used in this study cite the importance of both energy conservation and environmentally friendly or "green" technology. As important as these topics are, the study was not expanded to include these topics, and thus, comments only briefly on these subjects.

Lastly, this document contains energy related terms that may be unfamiliar. Refer to Appendix A for definitions.

This study was prepared for member consensus in April 2005. Committee members were Paulette Hastings, Suzanne Kerwin, Germana Paterlini and Julie Risser.

Related League Positions

Since the 1970s, conservation has been the crux of the national League's energy agenda. Nationally, two positions relate to energy: Resource Management and Environmental Protection and Pollution Control. These positions and their energy related history are reprinted in Appendix B. There are no local or state energy positions at this time.

Basic Utilities Information

Sixty-eight percent of Minnesota electricity is provided by five investor-owned utilities (including Xcel Energy). Municipal utilities and cooperatives provide 14% and 18% electricity, respectively.[1] Coal is the main fuel type used to generate electricity for Minnesota (see Table 1).

Table 1. Fuel Types Used to Generate Electricity in Minnesota

Coal	75%
Nuclear	17%
Hydro	3%
Wind/Solar	1%
Refuse-Derived Fuel	1%
Wood	1%

Source: 2001 Energy Planning Report, MN Dept. of Commerce

All of the coal used in Minnesota is hauled in by rail, mainly from Wyoming and Montana. Electricity from nuclear energy is generated at the Prairie Island and Monticello power plants. Minnesota purchases most of its hydro-generated power from Manitoba Hydro in Manitoba, Canada. The remaining 3% of power is obtained from renewable sources such as solar, wind, wood and refuse-derived fuels.

Most of the electricity consumed in the Twin Cities metro area, including Edina, is generated by power plants located within a 30 miles radius (see Table 2). Edina receives electricity from Xcel Energy, the largest electric utility in Minnesota.

Table 2. Xcel-owned power plants in the metro area

Power Plant	Type	Location	Capacity
Allen S. King	Coal	Oak Park Heights	529 MW
Black Dog	Coal	Burnsville	100 MW
Hennepin Island	Hydro	Minneapolis	12 MW
High Bridge	Coal	St. Paul	540 MW
Prairie Island	Nuclear	Red Wing	1000 MW
Red Wing Steam Plant	RDF	Red Wing	20MW
Monticello	Nuclear	Monticello	553 MW
Riverside	Coal	Minneapolis	616 MW

Source: www.xcelenergy.com

The electric grid is the national inter-connected transmission system. During the 1990s, US demand for electricity increased about 35% while the grid's capacity to transmit power increased only 18%.[2] These continuing demands will require the construction of new power plants as well as improvement and expansion of the transmission grid. The Mid-Continent Area Power Pool, an organization created to ensure reliability of the grid system anticipates this need by the year 2012. In Minnesota's main projected grid expansion is a proposal by Xcel Energy transmission to build power lines to transport wind-generated electricity from the Buffalo Ridge in Southwest Minnesota to the metro area.[1]

Xcel Energy asked permission from state regulators to produce another 3100 megawatts of electricity through 2019. Xcel indicated in a resource plan, filed November 1, 2004 with state regulators, that it still likes the economics of coal. Xcel did not endorse coal as its preferred fuel source and continues to explore a wide range of options including additional wind turbines, natural gas "peaking plants" and a gasified-coal plant in northern Minnesota.[3] Regulators will vote on this plan within the coming year.

President George W. Bush called nuclear energy "safe" and "clean" in his February 2, 2005, State of the Union Address. New technology has made nuclear fission safer, cheaper and easier to manage, but risks remain.[4] No nuclear power plants have been issued permits since 1973, but a Nuclear Energy Task Force made recommendations in February 2005 that include support and funding of up to $1billion for 4 new nuclear reactors in the U.S.[5]

The Power of the PUC[6]

The Public Utilities Commission (PUC) is charged with regulating certain electric, natural gas and telephone industries in Minnesota to ensure that these services are safe, adequate and reliable at fair, reasonable rates. The Commission may hold hearings, conduct investigations, make rules and issue orders regarding utility and phone services. The duties of the PUC include setting electrical rates, granting Certificates of Need for power plants and transmission lines, approving financial incentives for energy conservation and approving plans for large electric utilities, including the consideration of environmental effects of energy use.

The PUC consists of five people appointed by the governor to serve six-year, staggered terms. It is designed to have a great deal of decision-making autonomy and is subject to Open Meeting Law (M.S.471.705). No more than three of the members can come from the same political party. The Commission's Standards of Conduct includes restrictions on employment, investments and gifts.

The 2005 Bush budget proposes funding for electricity producing processes known as "clean coal," specifically the Clean Coal Power Initiative and FutureGen Program.[7] FutureGen aims to create the world's first zero-emissions hydrogen and electricity producing coal-based power plant.[8]

FutureGen is based on integrated gasification combined-cycle technology (IGCC), which is a

developing technology. These plants anticipate high efficiency and low emissions, but cannot at this time guarantee the capture of all carbon dioxide or mercury emissions.[7]

However, IGCC-based power plants cost about 20% more to build than conventional plants, and energy companies have been unwilling to take a chance on this new technology. Currently, the US has two pilot plants in Florida and Indiana, which have been subsidized by Department of Energy grants.[9]

Basic Energy Information

Fossil Fuels are Finite Resources

Fossil fuels are natural resources such as coal, petroleum and natural gas. Fossils fuels permeate every aspect of modern life, from heating and powering plants and cars to use in plastics and chemicals. However, fossil fuels are a finite resource that will run out and cannot be replaced. Global crude oil and natural gas are predicted to run out in the next 40 and 60 years, respectively, while US coal reserves are predicted to last 250 years. Profound changes in lifestyle as well in the products used everyday will occur when crude oil becomes scarce.[10]

Emissions & Environmental Impact

The burning of fossil fuels releases various gases, particulates and dangerous trace elements that contaminate air and water sources. For emission levels from fuels used by Xcel Energy, see Appendix C.[11]

- Carbon dioxide (CO_2) is the primary gas emission of coal, oil and natural gas burning (80%), and is linked to global climate change.
- Sulfur oxide (SO_2) and nitrogen oxides (NO_x) both contribute to acid rain. NO_x also contributes to smog.
- Particulate matter (soot) contributes to asthma attacks and other respiratory illnesses.
- Mercury accumulates in some fish to levels exceeding current health department guidelines.

As emission levels have increased, the environment has been unable to absorb them, resulting in greater atmospheric concentrations of these gases.

Nuclear energy does not produce these air emissions, but does produce both high- and low-level nuclear waste. One of the most dangerous by-products is plutonium, which has been linked to cancer.[12]

SUCCESS STORY:
Minnesota Emission Reduction Program
The Metro Emission Reduction Project (MERP) resulted from the need for a new emissions permit at an Xcel Energy coal plant, and dialogue between citizens, environmental groups and Xcel Energy officials.[13]

In 2001 the Minnesota Legislature passed Minn. Stat. 126B.1692 which encouraged Xcel Energy to reduce air emissions at coal plants by allowing Xcel to recover plant improvement costs by passing them on to customers. When Xcel applied to the Pollution Control Agency (PCA) to renew the air emissions permit for its Riverside coal plant, 207 comments from the public were sent to the PCA. Soon after a coalition of citizens, activists, and environmental groups lobbied Xcel and the Minnesota Public Utilities Commission (PUC) through a lawn sign campaign, letters to the editor, and rallies that coal plant emissions needed to be reduced significantly. People in favor of emissions reductions met with Xcel officials.

In part from these dialogues Xcel Energy produced MERP. MERP sets out a three stage plan: 1) install state-of-the-art pollution control equipment at the Allen S. King coal plant near Stillwater by 2007; 2) replace the existing High Bridge coal plant in downtown St. Paul with a modern natural gas plant by 2008; 3) convert the Riverside coal plant in northeast Minneapolis to natural gas by 2009. After unveiling MERP eight public meetings were scheduled throughout Minnesota during the fall of 2003. Doctors, elected officials, students, parents, children, environmentalists, and business people came forward to testify. On December 18, 2004, the Minnesota PUC approved MERP.[14] According to a 2004 news release from Minnesotans for an Energy Efficient Economy the estimated benefit in reduced health costs over the life of these coal plants alone is $1.2 billion.[15]

The Kyoto Protocol to the United Nations Framework Convention on Climate Change[16] was negotiated in Kyoto, Japan in December 1997. The Kyoto Protocol, with a goal of reducing greenhouse gas emissions by 2012, has been signed by over 130 countries and went into force on February 16, 2005. This cap and trade program is the selling and trading of emissions permits, e.g., if a country reduces emissions beyond the required 5% level, it can "sell" the excess reduction to a country that has not met the 5% reduction level. The United States is not a signer.

Separate from the Kyoto Protocol, companies such as DuPont, Ford Motor, American Electric Power (AEP), International Paper and Motorola established the "Chicago Climate Exchange" to gain experience in

buying and selling emission permits and in reducing their own emissions.[17]

President's Bush proposed "Clear Skies" program is a cap-and-trade program for reducing sulfur dioxide, nitrogen oxides and mercury emissions at coal-fired power plants. Critics argue that it would impose less stringent emission limits than currently established under the current Clean Air Act.[18] On March 9, 2005, the Senate Environment and Public Works Committee was deadlocked and thus voted against Bush's Clear Skies proposal.[19]

The Economics of Energy

If the utility cost of various energy forms were ranked, it would show coal as the cheapest energy form, followed by nuclear, wind, hydro, biomass, refuse-derived fuel, natural gas, and most costly, oil.[11]

However, it is difficult to quantify the total cost of energy because of unaccounted costs related to environmental and health issues. One example related to health is that the federal government has paid out $35 billion over the past 30 years to cover the medical expenses of coal miners who suffer from *black lung disease*. A Science magazine article reported that coal-fired electricity would cost 50-100% more if these and other costs were taken into account.[20]

Nuclear power and oil also have unaccounted costs. The potential cost of damages that might result from an accident at a nuclear power plant are too large for the insurance industry to cover, so the federal government has pledged to act as "insurer of last resort" above a certain level of cost. The cost of oil does not reflect expenditures related to oil spill clean-up or maintaining open shipping lanes[21]

Appendix D is a cost comparison for some energy technologies.

Security Issues

The North American electricity grid is a network of interconnected power plants and transmission lines. The electricity blackout on August 14, 2003, demonstrated the system's vulnerability when a few unrelated power line failures in Ohio escalated into the largest blackout in North American history. During this blackout, 50 million people were without power and the cost to businesses was $6 billion to $10 billion. These types of failures also impact heating and cooling systems, food storage, sanitation, and other utilities, especially if they continue for extended periods of time.[2]

Reliance on large power plants and transmission lines also makes us vulnerable to blackouts from terrorist attacks and other security threats. The United States has nearly 500,000 miles of bulk transmission lines that carry high voltage electricity to consumers. It would be nearly impossible to monitor and protect all of these lines, as well as new lines and power plants, against potential security threats.[22]

As the demand for electricity grows, consideration must be given to the idea that there is greater security with local generation and local control of energy production.

Renewable Energy Programs

State and National Programs

At of the end of 2003, 15 states had programs to encourage the development of renewable energy for electricity generation. Of the 17 programs (Minnesota and Wisconsin have multiple programs), 9 are renewable portfolio standards (RPS), 4 are renewable energy mandates, and 4 are voluntary renewable energy goals. Mandates require the construction of set amounts of new renewable capacity using specified technologies while RPS require that a specified share of electricity generation or sales come from qualifying renewable technologies.

As of the end of 2003, 86 % of new renewable energy capacity constructed in the 15 states was a result of mandates, and the vast majority (93%) of the new capacity consisted of wind power installations. Nearly 51% of all the new capacity was installed in Texas.[23]

At the federal level, the current budget funds Research & Development (R&D) of renewable energy sources, allocating $80 million per year to solar energy and $40 million for wind. By comparison, R&D funding for nuclear energy and "clean coal" are $100 and $447 million, respectively.[24]

Minnesota Programs

Minnesota instituted a voluntary "Renewable Energy Objective" to encourage, but not require, new renewable energy capacity. In Minnesota, utilities other than Xcel, including municipals and cooperatives, are subject to the 2001 Renewable Energy Objective (amended in 2003), which requires a good faith effort to increase renewable energy's contribution from 1% of sales in 2005 to 10% by 2015. By law, the objective is considered to be a mandate for Xcel (see below). At least 0.5% should be generated from biomass by 2005 and 1% by 2010.[25]

The objective accommodates basic renewable technology options as well as hydroelectric facilities

less than 60 megawatts, hydrogen fuel cells, and municipal solid waste. All utilities are required to develop for the PUC formal plans detailing how they will meet the 10% renewables objective.

Xcel Energy Mandates

In exchange for storing additional nuclear waste at its Prairie Island plant, Minnesota's 1994 mandate required Xcel Energy (then Northern States Power) to acquire 425 megawatts of wind capacity by December 31, 2003. In 2001, the Minnesota PUC ordered Xcel to build or contract for an additional 400 MW of wind by December 31, 2006. In May 2003, Minnesota enacted new legislation (HF 9 of 2003) requiring Xcel to build or contract an additional 300 MW of wind by December 31, 2010, raising the total amount of mandated wind power to 1,125 MW. At least 100 MW of the most recent increase must come from small wind resources (2 MW or less).

Additionally, in May 2003, Minnesota enacted legislation to extend nuclear waste storage at Xcel Energy's Prairie Island plant, and to increase the amount Xcel must pay toward the development of renewable-energy sources. As a result, Xcel now must pay $16 million into the Renewable Development Fund (RDF) annually, for as long as the Prairie Island plant is in operation. The 2003 legislation mandates that up to $6 million annually must be allocated to fund renewable-energy production incentives. Of this annual amount, $4.5 million will fund production incentives for wind energy, and approximately $1.5 million will fund production incentives for eligible on-farm biogas recovery facilities.

Xcel was also required to build or contract for 125 MW of electricity generated from biomass resources by December 31, 2002. Although HF 9 of 2003 reduced the amount of biomass energy that Xcel must purchase from 125 MW to 110 MW, this law also required Xcel to enter into a power purchase agreement by January 1, 2004, for 10-20 MW of biomass energy from a specific project.

Mandated wind capacity is being acquired on schedule but biomass acquisitions (25 megawatts through December 31, 2003) have not been accomplished because of difficulties encountered with the technology and financing for new biomass capacity. The 2003 legislation requires a power purchase agreement for 10 to 20 MW of biomass energy, operational by 2005, at no more than $55 per megawatt hour.

The Xcel Energy Renewable Development Fund (RDF)

Xcel Energy created the Renewable Development Fund (RDF) in May 1999 as an outcome of 1994 Minnesota legislation. The RDF is administered by the Renewable Development Board, which consists of two representatives from Xcel Energy, two representatives from Minnesota's environmental community and one representative from the Native American community. Funds are to be used for the development of renewable energy sources. Preference must be given to development of renewable-energy projects located in Minnesota.

In 2001 the Xcel Energy RDF program selected 19 research projects to receive nearly $16 million in funding. Funding was awarded for various projects in three categories: commercial technology, experimental technology, and research and development. In August 2004, 25 proposed renewable-energy projects featuring hydroelectric, biomass, wind, solar and biofuel technologies were recommended by the Renewable Development Board to receive more than $22 million in funding. This sum included $9.9 million for energy-production projects and $12. million for research and development. The new "Initiative for Renewable Energy and the Environment" at University of Minnesota receives funding from the RDF for their research.

On February 18, 2005, the PUC announced a controversial decision to overrule recommendations by the RDF Board and provide $10 million over 5 years to Excelsior Energy Inc. to fund a coal gasification plant on the Iron Range. Supporters of the decision say that this type of coal plant meets the 2003 legislative requirements of "innovative generation technology utilizing coal as a primary fuel," which means it qualifies for exemption from the standard certification of need, the ability to increase capacity without state review, and the power of eminent domain.[26] Critics suggest that it takes substantial funds from renewable energy projects in the future.[27]

SOLAR ENERGY

How It Works

Solar power describes a number of methods of harnessing energy from the sun. The simplest use of solar energy is generation of hot water by collecting incident rays using heat absorbing and insulating materials.

Solar energy can be used to generate electricity using photovoltaic cells (PV cells). These cells have semiconductor materials that conduct electricity upon

exposure to visible and ultraviolet radiation from the sun. The basic photovoltaic cell typically produces only a small amount of power (1 to 2 watts). To produce more power, cells are interconnected to form modules, which can in turn be connected into arrays to produce yet more power. Because of this modularity, PV systems can be designed to meet any electrical requirement, no matter how large or small. Concentrators are used together with PV cell to increase efficiency by focusing the solar rays onto the PV cells. A concentrator makes use of relatively inexpensive materials such as plastic lenses and metal housings to capture the solar energy shining on a fairly large area and focus that energy onto the smaller solar cell.

There are no air emissions in the production of solar energy.

Cost

Large PV manufacturers, such as Sharp Electronics and BP Solar are working to reduce the cost of PV materials. The cost of PV-generated electricity has dropped eight fold over the past 20 years, mostly because of increased efficiency and better manufacturing productivity and methods. Solar energy costs 10 times more than coal, four times more than natural gas twice as much as nuclear and three times more than wind energy.

In Europe and Japan, government incentives have greatly facilitated use and acceptance of solar energy. In 2003, the installation of PV units grew about 40% in these two areas. Japan started its solar program by initially giving 50% rebates of installed costs. More than 168,000 residential PV systems, generating 622 MW were installed under the program. Today if a new house in Japan has a 4 kW PV on the roof, it has zero energy bills.[28]

Availability

The Iowa Department of Natural Resources publishes a Yellow Book of solar unit retailers in the Midwest.[29] The yellow book currently lists 18 Minnesota retailers that sell either PV panels or heating systems and also provide installation and consulting services.

Minnesota Use and Incentives

Minnesota promotes the use of solar energy by providing incentives to individuals and businesses.

Solar Minnesota, a program coordinated by the Minnesota Department of Commerce State Energy Office, works to remove market and regulatory barriers to solar investment, identifies local and state incentives and provides educational services. Solar Minnesota is part of the Million Solar Roofs initiative started by the Department of Energy in 1997. The initiative goal is to have 1 million solar energy systems in the U.S. by 2010.[30] Solar Minnesota has committed to the installation of 500 solar systems by 2010. The program reached 48% of its goal in 2004 with 247 units installed. Of these, 62 are electricity-producing units (i.e. installation of PV panels), 15 units are used to generate hot water and 160 units are used for heating buildings.[30]

SUCCESS STORY:
Minnesota Solar Rebates

The Minnesota Solar Rebate program provides a rebate of $2,000 per kilowatt installed, up to $8,000 total. This incentive covers 20 to 25% of the total cost of an installed system. Excess electrical production can be sold back to the utility company. From July 2002 through April 2004, 43 participants received $237,000 in rebate funding, according to the Department of Commerce. These awards resulted in just over 120 kW of new grid- connected solar electricity in Minnesota, doubling the state's total solar-electric capacity as compared to the installed capacity before this rebate program began.

At the federal level, businesses get a 10% tax credit for investing in solar energy. In Minnesota, PV systems are exempt from the state sales tax. This exemption will expire August 1, 2005. The value added to a house or business by solar-electric (PV) systems is also excluded from property taxation.

WIND ENERGY

How It Works

A wind energy system produces either mechanical or electrical energy. Mechanical energy is most often used in rural areas for pumping water in rural or remote locations. Wind turbines can be used as stand-alone applications or connected to a utility power grid or combined with a photovoltaic (solar cell) system. For utility-scale sources of wind energy, a large number of turbines are usually built on one site to form a wind farm. The largest turbines sit high atop towers, taking advantage of the stronger and less turbulent wind at 100 feet (30 meters) or more above ground.

Wind turbines capture the wind's energy with two or three propeller-like blades, which are mounted on a rotor, to generate electricity.

A blade acts much like an airplane wing.

- When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade.

- The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift.
- The force of the lift is much stronger than the wind's force against the front side of the blade, which is called drag.
- The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity.[31]

Most modern wind turbines are able to produce power 95- 98% of the time.[32] No emissions are produced with wind power.

Cost

The cost of wind-generated energy from a wind farm is based on the size of the wind farm, the average wind speed at the site, and the cost of installing the turbines. Thus, consumer costs may vary from place to place based on the variations of these three factors.

The cost of wind energy has dropped approximately 80% in the past 20 years, due largely to advances in technology and the federally sponsored wind production tax credit (PTC). The PTC for wind energy was included in the Energy Policy Act of 1992.

Generally, the credit is a business credit that applies to electricity generated from wind plants and sold to a utility or other electricity supplier. An incentive similar to the PTC is made available to municipal utilities. The incentive is called the Renewable Energy Production Incentive (REPI) and it consists of a direct payment to a public utility installing a wind plant that is equal to the PTC.[21]

Utility companies throughout the country charge extra for wind-generated electricity. Reasons include recovering the cost of its marketing campaigns if a marketing company is selling the power, and managing the piecemeal sales. Often one turbine's output is sold, then another's, and another's. Also, the term of the sales to retail customers are short, typically a year or two. This is more expensive and riskier than buying all of the power from a 50-megawatt or 100-megawatt wind farm for 10 years.[21]

Availability

In 2003, Minnesota wind installations created about 335 megawatts, enough to power 110,000 homes, or 1% of the total electricity in the state. Edina's electricity is provided by Xcel Energy, of which about 2% comes from renewable sources, including wind, hydro and biomass. As of May 1, 2004, Xcel had 829 megawatts of wind energy capacity in service in the US.[33]

As Xcel Energy customers, Edina residents can support wind generated energy through the Windsource® program, which allows customers to designate part or all of their electricity use be generated by the wind. Windsource® is sold in 100 kWh blocks, and customers can choose to purchase any number of blocks up to 100% of their electricity usage. In January 2005, blocks cost $2 per month each and are added to the customer's current electricity bill.

Minnesota Use and Incentives

Xcel Energy Renewable Development Fund and the State of Minnesota have grant and tax incentive programs, respectively, to encourage additional programs.

In addition to wind farms in the state, several schools have installed wind turbines to provide energy for their campuses. *ReNew Northfield* was formed in 2001 with a goal of having all of Northfield's energy sources be renewable by the 2010's. As a part of this project, Carleton College began its wind system at the urging of students, who wanted 10% of the college's energy consumption to be from green sources. In September 2004, a $1.8 million wind turbine was dedicated. The school hopes to reduce their energy costs (40% of their energy can be produced by the turbine) or to make money by selling back energy to the utility company. The college expects the turbine to pay for itself in 12 years. Additionally, St. Olaf received a $1.5 million grant for a turbine installation in 2005. It is expected to provide 30% of the campus' energy.[34]

Wayzata High School received a $1.1 million grant from the Xcel Renewable Development Fund for a turbine. It will be the first large turbine in the metro area.

BIOMASS

How It Works

Biomass is a large and varied category of renewable energy, loosely defined as direct derivatives from plant and animal products or by-products. Wood waste, farm field residues, animal waste, dedicated crops and sewage sludge are all possible sources of biomass. Biomass energy production can be generally divided into three categories: combustion, digestion, and decay.[35]

Biomass Combustion

Biomass combustion refers to the burning of the biomass source to produce heat which is used directly, or for producing electricity. An example of biomass

combustion is the St. Paul Biomass Cogeneration Plant. The biomass plant burns area wood waste, solving the problem of disposal for several cities including Edina, and generating 25 MW of electricity from biomass. The biomass plant displaces 110,000 tons of coal per year which reduces sulfur dioxide emissions by 600 tons/year and carbon dioxide emissions by 283,000 tons/year.[36] Electricity is generated from a combined heat and power plant next to downtown St. Paul's thermal plant. The biomass plant recovers waste heat and can be up to 80% efficient compared to coal power-plant efficiencies of about 30%. It also achieves efficiency by providing heat for multiple customers in an urban area.

Combustion from biomass produces pollutants similar to burning fossil fuels. Plants take carbon dioxide out of the air as they grow and thus neutralize the effect of releasing the carbon dioxide when burned. Thus, biomass is sometimes considered a carbon-neutral source of energy but carbon dioxide emissions related to production and transportation of the biomass for energy production should not be overlooked.[37]

Biomass Digestion
Biomass can be anaerobically (without air) digested to produce biogas, a combination of methane, carbon dioxide and trace gasses. Biogas can be used for heating, and producing electricity.

Environmental benefits of anaerobic digestion are odor reduction, pathogen reduction, green house gas reduction from methane and reduced total oxygen demand of the waste. Concerns include nitrogen and ammonia emissions, digested manure storage and air emissions.

Biomass Decay
Significant quantities of biogas are emitted from municipal waste landfills. This 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. The landfill supplies some of its own power and reduces the demand for energy from traditional sources. A large portion of the potential for landfill gas electric generation in Minnesota has already been realized with existing projects, but a study in association with the Lakefield Junction natural gas plant suggested that some landfill gas-based generation still exists in Minnesota. Landfill gas systems are reliable and operating costs are less because the landfill supplies its own gas."[37]

SUCCESS STORY:
The Haubenschild Family Farm

The Haubenschild Family Farm in Princeton, Minnesota, uses the manure generated by its dairy cows to produce electricity, heat, and fertilizer through anaerobic digester machines. Installation funding for the biogas digester came from government resources and totaled $355,000.[38] Over a period of 15 days, manure from the farms dairy cows passes through a 350,000 gallon in ground concrete tank- the biodigester. Suspended heating pipes heat the manure inside the digester to create optimum conditions for creating biogas. An engine generator is fueled with the biogas captured from the digester and used to generate electricity.

The farm produces enough electricity to meet all on-farm electric needs plus enough excess electricity to power about 75 homes. The local electric co-op markets the electricity it buys from the farm as "Cow Power" for a slight mark up to cover its increased distribution expenses. The system is expected to pay for itself in about 5 years. [37]

Environmental Impact

Growing biomass materials has environmental impacts both positive and negative. Fast growing trees and grasses can limit erosion, improve water quality near streams, and provide wildlife habitat. Fertilizers and pesticides can pollute water and certain farming techniques can cause erosion and runoff. The following criteria have been developed to evaluate sustainable biomass energy production:[39]

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

HYDROPOWER

How It Works

Hydropower (or waterpower) harnesses the energy of moving or falling water. This is usually in the form of hydroelectricity from a dam, but it can be used directly as a mechanical force. The term refers to a number of systems in which flowing water drives a water turbine or waterwheel.[40]

Cost

Hydropower can be far less expensive than fossil fuels or nuclear energy. Areas with abundant hydropower attract industries with low cost electricity. However, increased environmental and social concerns have begun to outweigh cheap electricity.

The Manitoba Hydro project in Canada is a striking example of the negative impact of hydropower on the environment and on the communities displaced by flooding. The 5,000 MW Manitoba hydro project consists of 12 dams, 14 generating stations, 2 large reservoirs and more than 12,000 miles of transmission lines. The projects were built starting in the 1960s and through the 1990s when the Churchill River (beginning in Alberta and emptying into Hudson Bay) was diverted backward over 200 miles, drained to 15% of its original flow and forced into the tracks of the Nelson River. This massive project was constructed without any baseline environmental or socioeconomic assessment, and without prior consultation of the indigenous people.[41]

Manitoba Hydro has made changes to reduce flooding in new projects. For example, the Wuskwatim project would have resulted in the flooding of 140 square kilometers (km_2) of land. After consultation with local communities, a new-generation, “runoff- river” design was chosen to greatly reduce and perhaps virtually eliminate flooding.[42] Environmental and societal factors remain a concern as the company is proposing to build another 500 MW of hydro power over the next several decades for export to Minnesota and the US.[41]

Availability

Minnesota utilities (mainly Xcel Energy) receive hydropower from Manitoba Hydro. In August 2002, Manitoba Hydro signed a 10-year agreement with Xcel Energy of Minnesota for the export of 500 MW of electricity from Manitoba to Minnesota, starting in 2005. The agreement builds on the long-standing arrangements with Xcel Energy and is expected to produce $1.7 billion in revenue over the life of the contract.[42]

Xcel Energy also produces 12 MW of power from the Hennepin Island hydro plant. Located in downtown Minneapolis, this 5-unit hydro plant was built in 1954-1955. Hennepin Island is also home to a major electric distribution center (Main Street substation) serving downtown Minneapolis.[43]

GROUND-SOURCE HEAT

How It Works

Frequently ground-source technology is called geothermal technology, which refers to energy systems that tap into energy contained in rock and fluid heated by radioactive decay. These technologies take advantage of temperatures ranging from 194-302° F.

In areas where these high temperatures are not accessible, ground-source heat pumps are an option. Ground-source heat pumps rely on the fairly constant temperature of the earth. Tubes run horizontally or vertically near a building. They are filled with liquid which is kept cool by the earth during summer months and warm during winter months.

According to the Geothermal Resources Council "ground-source heat pumps use the earth or groundwater as a heat source in winter and a heat sink in summer. Using resource temperatures of 4°C (40°F) to 38°C (100°F), the heat pump, a device which moves heat from one place to another, transfers heat from the soil to the house in winter and from the house to the soil in summer." A standard air-to-air heat pump uses the outside air to both expel and absorb heat. During the winter standard air-to-air pumps may extract heat from outdoor air that is extremely cold, 10°F or colder. Similarly during the summer standard air-to-air expels heat into outdoor air 90°F or hotter. Ground-source heat pumps are much more efficient as they cool or heat temperatures that on average start at 50°F.[44]

Types of ground-source heat pumps

Two kinds of ground-source heat pumps exist: closed-loop systems and open-loop systems. The closed-loop system consists of a long tube that runs to and from a heat pump. The tube typically runs under a home in a looped manner. With the open-loop system the tube takes advantage of a water source beneath the home. A tube runs from the pump to the water source and another tube from the water source back to the pump. A potential problem with the open-loop system is that the heat pump can alter the temperature of the aquifer. Obviously if the system is a small one belonging to a homeowner and it is the only one on the aquifer it will have a negligible impact. But if several homeowners or

a huge building use an open system it can have an impact on the environment.

According to the US Department of Energy the basic components of a heat pump are:

- the ground loop which is a "system of fluid-filled plastic pipes buried in the shallow ground, or placed in a body of water near the building";
- the heat pump which "removes heat from the fluid in the pipes, concentrates it, and transfers it to the building (for cooling this process is reversed)";
- the air delivery system which uses "conventional ductwork to distribute heated or cooled air throughout the building."[45]

Issues to consider
The composition and properties of the land will impact heat transfer rates. According to the U.S. Department of Energy "soil with good heat transfer properties require less piping to gather a certain amount of heat than soil with poor heat transfer properties." If there is below surface water it may be best to use an open system.[46]

Cost

According to the Department of Energy (DOE), a ground-source heat pump costs about $2,500 per ton capacity. The DOE's Federal Energy Management Program estimates homeowners will need a ton of capacity for every 550 square feet in heating-dominated climates, and a ton for every 450 square feet in cool-dominated climates. These figures mean that it would cost roughly $7,500 for a 3-ton unit (one suitable for a house approximately 1500 square feet). In comparison standard heating and cooling systems cost for the same sized home run about $4,000. The DOE clarifies that people wanting to invest in ground-source heat pumps can include the cost in their mortgage. Assuming there are no extraordinary costs in putting in the system the homeowner can experience a positive cash flow from the beginning. The DOE provides the following scenario:

"For example say that the extra $3,500 will add $30 per month to each mortgage payment. But the energy cost savings will easily exceed that added mortgage amount over the course of each year. On a retrofit, the GHP's high efficiency typically means much lower utility bills, allowing the investment to be recouped in two to ten years.[47]

Availability and Incentives

There are few incentives for ground-source heat pumps. Ground-source heat pumps that have the EPA ENERGY STAR label can now be financed with special ENERGY STAR loans from banks and other financial institutions.

SUCCESS STORY:
Southdale Ground Source Heat Pump[48]

In 1954-1956, Southdale developers determined that even in cold weather the mall would require air conditioning because of the number of shoppers and store lights. They developed an open-loop heat pump system by drilling an on-site well and using the 55°F water to cool the facility, thus eliminating the need for boilers.

Today, the pump system remains in use for the original structure of Southdale. As the mall has expanded, changes in building codes did not permit the expansion of the system, so these areas are on a separate system.

The water is treated minimally, with the addition of chlorine on the way into the system, and the removal of chlorine as it exits. Daily testing ensures no contamination prior to the water draining into the pond northeast of the intersection of 66th Street and Valley View Road. This pond never freezes in the winter, demonstrating the impact of open-loop systems on the environment. Also, this pond is connected to two water bodies to the west, including Lake Cornelia, so input of water from the Southdale system effects the water level in these bodies, too.

Passed in 1990 State Statute 103G.271, now prohibits once-through operations greater than 5 million gallons[49] annually for “comfort cooling,” so by 2010 Southdale will have to change to one that allows multiple uses of the water. The law’s intent is to reduce water waste. Trade-offs include the need for more electricity to cool the warmer water before it enters the system, increased use of chemicals to reduce fungus and mold that can grow in warm water, and more natural (lower) levels in the water bodies that previously collected the run-off.

Minnesota Use

An example of ground-source heat pumps can be found at the Phillips Eco-Enterprise Center in Minneapolis,[50] whose Geo-Exchange system with vertical well earth loop cost $48,000 but saved $4,428 per year, making the simple payback 10.8 years.

The DOE's Energy Efficiency and Renewable Energy website provides an example homeowner using ground-source heating. The resident installed a five-ton ground source heat exchanger that connected to five horizontal loops (3,000 feet of pipe), which are buried next to the home at a depth of eight feet. The home is 3,400 square feet and with the ground-source heat pump his electricity bills average $44/month.

HYDROGEN FUEL CELL

How It Works

A fuel cell is an electrochemical device that uses hydrogen and water to create electricity and heat. If pure hydrogen is used in a fuel cell the only by-products of the energy producing reaction are heat and pure water.

Cost and Availability

Astronauts drink the water generated by fuel cells powering the electrical system aboard the space shuttle.[51] Fuel cells are being currently being developed for different applications such as supplying electricity and heat for buildings, powering vehicles, and powering portable electronics.

Fuel cells are not commercially available and information on the costs associated with fuel cells is not readily available. Hoped for benefits of fuel cells include reducing air pollution, reliable electricity and heating, on-site energy supply, energy independence, long-term economic advantages, and security.

Minnesota Use and Research

There is a working example of a fuel cell at the Eden Prairie Library.[52] The fuel cell at the library is a Polymer Electrolyte Membrane (PEM) fuel cell. It generates 5 kilowatts of electricity, which is enough to power a typical house but not the library with all of its computers. The source of hydrogen for the library fuel cell is natural gas.

The main sources of hydrogen for fuel cells today are fossil fuels such as the natural gas used at the Eden Prairie Library. Integrated gasification combined-cycle technology (IGCC) is a new way to derive hydrogen from carbon-based materials that may be environmentally friendly and is featured in President Bush's "FutureGen" program.[7] Developing a hydrogen economy is based upon moving away from dependence on fossil fuels to using hydrogen as a primary fuel.

Electricity from renewable sources can be used to "crack water" and produce hydrogen for use in fuel cells.[53]Research into renewable sources (biomass, solar, wind) of hydrogen production is taking place at the University of Minnesota.

The technology for using hydrogen as a fuel works but we may be decades away from depending on hydrogen for our energy needs.[54] Convenient access to hydrogen limits its use as an energy source. Establishing a hydrogen delivery infrastructure will be costly. The current production capacity and distribution system for hydrogen do not come close to the capacity and distribution system for gasoline. Iceland has established a national goal to make the transition to a hydrogen economy by 2030 and will be the launching ground for testing hydrogen-powered vehicles and building a hydrogen-fueling infrastructure.[37]

CITY OF EDINA

Within the City of Edina, the study committee looked for specific examples of renewable energy use and conservation efforts. The findings within the government, school district, area businesses and homeowners are below.

Government

The new Edina City Hall, which was completed in 2004, was developed using a state funded program called the Energy Design Assistance Program. The goal is to use traditional construction and innovative energy design. Because of a change in the program's minimum space requirement, Edina City Hall was able to use this program.

Throughout the City Hall development, the city had a variety of choices related to lighting, heating and cooling, insulation and the like. The choices made by the city had a direct impact on the budget. For example, with the efficiencies selected, the annual cost for heating and cooling city hall is $80-$85,000. If the efficiencies were not included, this cost was estimated to have been $112,000 annually.

Additionally, installation of high efficiency lighting, windows, insulation and more resulted in CenterPoint Energy and Xcel Energy rebates totaling $35,000.

Overall, the city was pleased with the Energy Design Assistance Program and would consider using it in future projects.

At this time, the City of Edina is focused on energy conservation more than on use of renewable energy. The city relies on Xcel and CenterPoint consultants rather than a staff expert in this area.

Government interview summaries are in Appendix E.

School District 273

Edina School District 273 has focused its energy activities on conservation. A recent referendum has provided funding to update school facilities.

According to James (Jay) Willemssen, Business Services Director for the school district, the district works with consultants from both Xcel Energy and CenterPoint, meeting on a bi-monthly basis. Xcel and

CenterPoint rebates related to the referendum are estimated to exceed $100,000. Project specifics include new roofs for Countryside, Cornelia, Creek Valley, Valley View and the High School and new windows at Concord, Highlands, Community Center, Valley View, the High School and the Bus Garage. The windows and roofs are estimated to save over 10% in energy costs with a payback of between 15 – 20 years. For the most part these are not total roof and window replacements, just those in need.

"With regard to renewable energy use, solar power was never considered due to inefficiencies in colder climates and extremely long payback times." The school indicated that it would keep an eye on the Wayzata turbine situation before making a decision in that direction.[55]

Business

Outside of Southdale using a ground source heat pump, (see page 10) the study committee was unable to identify any Edina business using renewable energy. However, this is deceiving as there may be businesses enrolled in Windsource®, the wind energy program of Xcel (see page 8). Xcel does not differentiate between business and homeowner customers, so this could not be determined.

The American Institute of Architects (AIA) has begun addressing emissions issues through design, and four Edina businesses are noted as members on their website. In 2004 the AIA Minnesota Board and Government Affairs Committee adopted a statement that AIA commits to advocate for design practices and government policies that reduce greenhouse gas emissions.[56]

The Minnesota AIA Committee on the Environment (COTE) is currently working with the Center for Sustainable Building Research at the University of Minnesota and the State Department of Commerce to draft the "State of Minnesota Sustainable Building Design Guidelines". The new standards will be used in all new state buildings.[57]

Homeowners

Two Edina homeowners were identified who have solar panels for water heating. While one specifically built her home to accommodate solar heating and has had great success for more than 20 years, the other had problems arise three years after installation related to cold weather durability and equipment supplier exited the market.

Regarding wind energy use, 250 Edina customers have enrolled in the Xcel Windsource® program. Throughout the state more than 8,200 customers have required the installation of 10 new wind turbines in Minnesota (9.5 kW).[58]

All homeowners can reduce energy consumption by increasing the efficiency of their home. In an interview with Xcel Renewable Energy representative Andy Sulkko, he noted that an average Minnesota home uses 800 kW/month. A very efficient home in Minnesota uses 600 kW/month.

When asked about the cause of increased energy demands, he responded that while the factors are many, two are most significant: the increased use of electricity consuming appliances and technology in the home and a trend toward larger homes. Today's homes have many energy consuming appliances, such as big screen televisions and computers. All of these add up to more average energy use per home. Larger homes typically use more energy for lighting, heating, and cooling than smaller ones.

ENERGY POSSIBILITIES

Renewable Energy Standards

Legislation will be introduced at the Minnesota Capital in the 2005 session for a Renewable Energy Standard. A standard would require that a growing percentage of power generation must come from new, renewable energy sources. An example of a Renewable Energy Standard would be to require 20% of energy to come from new, renewable sources by 2020. The bill's sponsors cite harmful health and environmental effects and loss of economic investment opportunities from current energy production sources.[41]

Individual cities can adopt standards for their own communities. The Minneapolis City Council has committed to establish goals to address climate change and use more renewable forms of energy. The Mayor and City Council appointed a working group to recommend a renewable energy target and steps for implementation.

In a report submitted on February 18, 2005, the group set a target for the amount of the city's electrical power to come from renewable energy by 2025 at 50%. Recommended steps for implementation include aggressive conservation, consideration of a publicly owned utility in the city that is focused on energy conservation and developing renewable energy systems, and the purchase of green energy tags.[59] As of March 1, 2005, this recommendation has not been adopted by the Minneapolis City Council.

Other actions a city can take to increase renewable energy use and education include:

- During negotiations with the energy provider, include a percentage of renewable energy use in the contract.
- Establish a city commission on energy use.
- Join *Cities for Climate Protection (CCP)*, a campaign promoted by the International Council for Local Environmental Initiatives. The CCP offers resources to local governments that pledge to reduce emissions of greenhouse gases and air pollutants to improve community livability. Five hundred local governments worldwide are participating the Campaign, representing 8% of global greenhouse gas emissions.[60] The US has 150 participants, including the cities of Duluth, St. Paul and Minneapolis, and Hennepin and Ramsey Counties.[61]
- Sign statements in support of reduced emissions, increased renewable energy sources, and energy conservation. One example is the Mayor's Statement on Global Warming 2003 (see Appendix F).
- Take advantage of rebates, incentives and tax credits available to communities. One resource to identify these opportunities is www.dsire.org.

Conservation

Technology and processes have been developed that use less energy to provide the same levels of service. Examples include compact florescent light bulbs, super-efficient appliances, variable speed motors, and ultra-efficient heating and cooling systems.[62] Conservation and use of energy efficient products by all entities (city, school, business and residents) will reduce overall consumption. It is estimated that every $1 spent on energy efficiency programs produces $3.50 in benefits.[63]

In a June 15, 2004, Xcel Energy News Release, it was announced that 298,000 customers had enrolled in energy savings programs. The *Energy Savers Switch* and *Electric Reduction Savings* programs could help reduce electricity demand by 900 megawatts on hot, humid days in the summer, more than the combined capacity of the Allen S. King and Riverside coal plants.

Xcel also offers a conservation program for businesses called Peak Control. In this program, businesses agree to reduce their electrical use by using a generator on hot, humid summer days in return for reduced electrical bills throughout the year. Businesses purchase the generator (usually diesel, but may be natural gas), and can expect a 10-year payback for this expense. Xcel activates this program an average of 5-7 days annually, about 6-8 hours at a time. Because it is weather dependent, there have been summers when the program was not used, and others when there were as many as 17 days of use.

In Minnesota, North and South Dakota, 2,300 customers participate in Peak Control. Typical customers are hospitals, schools and businesses with energy reliability issues (such as grocery stores). Xcel was unable to identify specific participants in Edina. This program delays the need for additional base load capacity, i.e., building a new power plant.

ENERGY STAR is a government-funded program run through the Environmental Protection Agency and is available to homeowners and businesses. Established in 1992 for energy-efficient computers, ENERGY STAR has grown to encompass more than 35 product categories for the home and workplace, new homes, and superior energy management within organizations. ENERGY STAR products are labeled for identification and include product categories of office equipment, home electronics, heating and cooling appliances, home appliances, lighting and windows.[64]

Buildings can be awarded an ENERGY STAR rating. One example is the Green Institute in Minneapolis, which received the award in 2000 for saving 45% more energy as other buildings of comparable size. There are no designated buildings in Edina

In 2002, with the help of the ENERGY STAR program, Americans prevented greenhouse gas emissions equivalent to those from 14 million vehicles and avoided using the power that 50 300-megawatt (MW) power plants would have produced, while saving more than $7 billion.

Renewable Products

Plastic packaging materials find a myriad of uses, from preserving food to protecting and transporting consumer goods. Petroleum-derived polyolefins account for more than half of total plastics consumption in the developed world. Polyolefins are extremely versatile because they possess a successful combination of properties such as flexibility, strength, lightness, stability and impermeability.

Replacing plastics with biodegradable materials derived from renewable sources can both decrease dependence on petroleum and reduce the amount of waste sent to the landfills. The challenge is to find alternative materials that have the same desirable characteristics as those of petroleum-based plastics.

Examples on non-petroleum or environmentally friendly products abound. Examples are:

"Plastic" from Corn: Corn is a promising renewable agricultural product for producing packaging materials. Using a fermentation process, it can be transformed into plastic-like materials.

Minnetonka based NatureWorks LLC, a Cargill subsidiary has developed a process develop poly-lactic acid, or PLA, from corn. NatureWorks™ PLA and Ingeo Fabrics are the first commercially viable biopolymer derived from an annually renewable resource. Packaging made from NatureWorks PLA is 100 % nature-based and can degrade in compost facilities. PLA-made cups were used at the 2002 Winter Olympics and the 2004 Telluride Bluegrass Festival. Their packing products are been used in over 1,500 grocery stores and Ingeo fabrics can be found at stores such as Marshall Fields, Bed Bath & Beyond and Neiman Marcus.[65]

Green Roofing: Living rooftops are an option for buildings with flat roofs. The Edgewater is a 28-unit upscale condominium on Lake Cahoun to open in 2006 featuring a full green-roof system and a ground level rain garden to manage runoff. The green-roof system is a vegetation-covered rooftop that filters storm water runoff and makes the building more energy efficient.[66]

A green roof of sedum plants was a part of the renovation of the Ford plant in Dearborn, MI. Covering 10.4 acres, this flat roof is expected to last twice as long as conventional flat roofs, and is entirely recyclable.[67]

Conclusion

Every energy source has a cost -- environmental, economic, aesthetic – along with varying levels of reliability and security. As energy demands continue to increase, Edina community members should keep in mind:

- Fossil fuels are finite, with reserves of crude oil and natural gas estimated to last 40 and 60 years, respectively.
- Air and water emissions plus nuclear waste are by-products of the most commonly used energy sources, and these by-products have adverse effects on human health as well as the environment.
- There is an economic impact of paying to import fossil and nuclear fuels versus developing locally owned energy supplies.[68]
- There are security vulnerabilities within the transmission grid.

Huge amounts of energy are used every day. There are steps that individuals, businesses and government institutions can take to reduce the energy use. Technological improvements allow the same service to be done using less energy. Conservation efforts are equally important. Xcel Energy estimated in a 2003 brochure that conservation improvement programs in their northern region saved the electrical equivalent of two medium-sized power plants.

There is an exciting trend toward use of renewable energies. The opportunities to use local energy sources that bring economic benefit to the community, produce fewer environmental hazards, offer greater security for stable energy supplies, and which are constantly available are encouraging.

Municipalities, including Edina, must know their energy sources and costs, and consider active participation in energy efficiency measures, conservation and non-fossil fuel alternatives.

APPENDIX A: Definition of Terms

Biomass—Organic waste from agricultural, livestock, and lumber industry products, dead trees, foliage, etc., and is considered a renewable energy source. Biomass can be used as fuel and is most often burned to create steam that powers steam turbine generators. It is also used to make transportation fuels like ethanol and biodiesel, and chemicals that can be burned like oil to produce energy.

Cogeneration—(also Combined Heat and Power) Production of electricity from steam, heat, or other forms of energy produced as a by-product of another process.

Combined Cycle—An electric generating technology in which electricity and process steam is produced from otherwise lost waste heat exiting from one or more combustion turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for use by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

DC—Direct current.

Demand—The rate at which electric energy is delivered to or by a system or part of a system, generally expressed in kilowatts (kW), megawatts (MW), or gigawatts (GW), at a given instant or averaged over any designated interval of time. Demand should not be confused with Load or Energy.

Demand Charge—A fee based on the peak amount of electricity used during the billing cycle.

DOC—The Department of Commerce.

Distribution—The delivery of electricity to the retail customer's home or business through low voltage distribution lines.

DOE—U.S. Department of Energy.

EIA—The United States Department of Energy's Energy Information Administration.

Electric Energy—The generation or use of electric power by a device over a period of time, expressed in kilowatt-hours (kWh), megawatt-hours (MWh), or gigawatt-hours (GWh).

EMF—Electromagnetic fields.

Energy Conservation—Using less energy, either by greater energy efficiency or by decreasing the types of applications requiring electricity or natural gas to operate.

Energy Efficiency—Using less energy (electricity and/or natural gas) to perform the same function at the same level of quality. Programs designed to use energy more efficiently — doing the same with less.

EPA— U.S. Environmental Protection Agency.

Hydro Energy—The power of falling water that is collected and turned into electricity through hydroelectric power plants.

Federal Energy Regulatory Commission (FERC)—The Federal Energy Regulatory Commission regulates the price, terms and conditions of power sold in interstate commerce and regulates the price, terms and conditions of all transmission services. FERC is the federal counterpart to state utility regulatory commissions.

GWh—gigawatt-hour; the unit of energy equal to that expended in one hour at a rate of one billion watts. One GWh equals 1,000 megawatt-hours.

Geothermal Heat—The thermal energy contained in the rock and fluid that fills the fractures and pores with the rock in the earth's crust. Electricity can be generated from high temperature (194-302° F) resources.

Greenhouse effect— The process by which the atmosphere warms the earth. The natural greenhouse effect occurs due to plants and water evaporation. The enhanced (anthropogenic) greenhouse effect, results from human activities such as the burning of fossil fuels. Sometimes referred to as climate change, climate variability or global warming.

Greenhouse gases (GHG)—Greenhouse gases are water vapor, carbon dioxide, tropospheric ozone, nitrous (or nitrogen) oxide, methane, and chlorofluorocarbons (CFCs).

Grid—A system of interconnected power lines and generators that is managed so that power from generators is dispatched as needed to meet the requirements of the customers connected to the grid at various points. Gridco is sometimes used to identify an independent company responsible for the operation of the grid.

Ground Source System— Using the temperature of ground water or earth which is less than 100° F, a pump moves heat from one place to another, transferring heat from the soil to the house in winter and from the house to the soil in summer.

Hydrogen Fuel Cell— The use of pure hydrogen to generate energy with byproducts of heat and water.

Integrated Gasification Combined-Cycle Technology (IGCC) — In an IGCC gasifier, carbon-based raw materials like coal react with steam and oxygen at high temperature and pressure producing mostly hydrogen. The fuel leaves the gasifier, is further cleaned and then used in the system to run gas and steam turbines. Most pollutants are removed before combustion and are not created when the fuel is burned. In the case of sulfur, it can be collected in

a usable form. IGGC plants have similarities to a chemical plant rather than a power plant.

Interconnected System— A system consisting of two or more individual electric systems that have connecting tie lines and whose operations are synchronized.

Kilowatt (kW)— This is a measure of demand for power. The rate at which electricity is used during a defined period (usually metered over 15-minute intervals). Utility customers generally are billed on a monthly basis; therefore, the kW demand for a given month would be the 15- minute period in which the most power is consumed. Customers may be charged a fee (demand charge) based on the peak amount of electricity used during the billing cycle. (Residential customers are generally not levied a demand charge.)

Kilowatt-hour (kWh)—This is a measure of consumption. It is the amount of electricity that is used over some period of time, typically a one-month period for billing purposes. Customers are charged a rate per kWh of electricity used.

Load—An end use device or customer that receives power from an energy delivery system. Load should not be confused with Demand, which is the measure of power that a load receives or requires. See Demand.

Minnesota Public Utilities Commission (PUC)— The state agency with regulatory jurisdiction over certain Minnesota utilities.

MISO— Midwest Independent System Operator.

MAPP— Mid-Continent Area Power Pool. MAPP is one of nine members of the Electric Reliability Council (ERC), which represents the entire US electric grid.

MW—A megawatt equals 1,000 kilowatts or 1 million watts.

MWh—Megawatt-hour; the unit of energy equal to that expended in one hour at a rate of one million watts.

NOx—Nitrogen Oxides

Natural Gas—A combustible, gaseous mixture of simple hydrocarbon compounds, usually found in deep underground reservoirs formed by porous rock. It is a fossil fuel composed almost entirely of methane, but does contain small amounts of other gases, including ethane, propane, butane and pentane.

PV—Photovoltaic. A photovoltaic or solar cell is a device, often made of silicon, which converts solar radiation directly into electricity.

Peaking Plants—Power plants used to add generating capacity for brief periods of (peak) energy consumption.

Peak Load or Peak Demand— The electric load that corresponds to a maximum level of electric demand within a specified time period, usually a year.

Public Utility—By Minnesota Statute, an investor owned utility regulated by the PUC. “Public utility” excludes municipal utilities, cooperatives, and power marketing authorities.

Refuse Derived Fuel (RDF)—An energy source composed of processed garbage that is used in some electric generation plants.

Renewable Development Fund (RDF)—A fund created in 1999 by Xcel Energy as an outcome of 1994 Minnesota legislation. Funds are to be used for the development of renewable energy sources. Preference must be given to development of renewable-energy projects located in Minnesota.

Utility— A regulated entity that exhibits the characteristics of a natural monopoly. For the purposes of the electric industry, “utility” generally refers to a regulated, vertically integrated monopoly electric company. “Transmission utility” refers to the regulated owner/operator of the transmission system only. “Distribution utility” refers to the regulated owner/operator of the distribution system that serves retail customers.

Watt— The unit of measure for electric power or rate of doing work. The rate of energy transfer equivalent to one ampere flowing under pressure of one volt.

Wind Energy System—A system that transform the kinetic energy of the wind into mechanical or electrical energy.

Resources:

2001 Energy Planning Report, Minnesota Department of Commerce

Geothermal Resources Council

American Wind Energy Association. www.awea.com

American Gas Association, www.aga.com

APPENDIX B: National League Positions

The national League has two positions that relate to energy. Key sections of history as well as the position statements are below. All League statements can be found at: www.lwv.org/elibrary/pub/impact/ImpactonIssues2002.pdf

Resource Management: History

League work on energy began in the early 1970s; in 1975 the LWVUS adopted a position supporting energy conservation as national policy. In 1976, the LWVUS board approved guidelines to implement the position. Since then, the League has made conservation the crux of its energy agenda, recognizing that the conservation of energy guarantees major long term benefits—environmental, economic and strategic —to individuals, to the country and to the world.

The 1976 League convention authorized a study to "evaluate sources of energy and the government's role in meeting future needs." This study climaxed in 1978 in a broad position on energy policies and sources (including conservation) that is the basis for action on a wide variety of energy issues at all government levels. The 1979 League council recommended that the LWVUS board review application of the Energy position to nuclear energy. The board subsequently determined that the League would work to minimize reliance on nuclear fission.

The League advocates a national energy policy emphasizing increased fuel-efficiency standards for automobiles, opposition to oil drilling in environmentally sensitive areas including the Arctic National Wildlife Refuge and support for government action in the development and use of energy conservation and renewable energy sources."

Resource Management: Position Statement

Resource management decisions must be based on a thorough assessment of population growth and of current and future needs. The inherent characteristics and carrying capacities of each area's natural resources must be considered in the planning process. Policy makers must take into account the ramifications of their decisions on the nation as a whole as well as on other nations.

To assure the future availability of essential resources, government policies must promote stewardship of natural resources. Policies that promote resource conservation are a fundamental part of such stewardship. Resources such as water and soil should be protected. Consumption of nonrenewable resources should be minimized. Beneficiaries should pay the costs for water, land and energy development projects. Reclamation and reuse of natural resources should be encouraged.

The League believes that protection and management of natural resources are responsibilities shared by all levels of government. The federal government should provide leadership, guidance and financial assistance to encourage regional planning and decision making to enhance local and state capabilities for resource management.

The League supports comprehensive long-range planning and believes that wise decision making requires:

• Adequate data and a framework within which alternatives may be weighed and intelligent decisions made;

• Consideration of environmental, public health, social and economic impacts of proposed plans and actions;

• Protection of private property rights commensurate with overall consideration of public health and environmental protection;

• Coordination of the federal government's responsibilities and activities;

• Resolution of inconsistencies and conflicts in basic policy among governmental agencies at all levels;

• Regional, interregional and/or international cooperation when appropriate;

• Mechanisms appropriate to each region that will provide coordinated planning and administration among units of government, governmental agencies and the private sector;

• Procedures for resolving disputes;

• Procedures for mitigation of adverse impacts;

• Special responsibility by each level of government for those lands and resources entrusted to them;

• Special consideration for the protection of areas of critical environmental concern, natural hazards, historical importance and aesthetic value;

• Special attention to maintaining and improving the environmental quality of urban communities.

Environmental Protection & Pollution Control: Nuclear Waste History

The League pushed for congressional passage of the Low-Level Waste Policy Act in 1980 and the Nuclear Waste Policy Act in 1982 as means of ensuring a national policy that incorporates adequate environmental safeguards with a strong role for public

participation in nuclear-waste repository citing decisions. Leagues across the country have used League positions to support their involvement in the citing of low-level nuclear waste sites, high-level waste sites and nuclear plant citings. The LWVEF has published a wide range of materials, including the acclaimed *Nuclear Waste Primer*. Following passage of the Nuclear Waste Policy Act of 1985, the LWVEF sponsored a public policy training program and published *The Nuclear Waste Digest*. In 1992, the LWVEF signed a five-year cooperative agreement with the Department of Energy (DOE) to publish a third edition of *The Nuclear Waste Primer* (1993) and to conduct citizen education programs on nuclear waste. In 1995, the LWVEF launched a second five-year cooperative agreement with DOE to focus educational and citizen involvement efforts on defense waste management issues. In June 1998, the LWVEF held two regional intersite discussions on nuclear material and waste and issued a report to DOE.

In 1995, the LWVUS opposed congressional efforts to designate Yucca Mountain, Nevada as a permanent or temporary repository for nuclear waste before studies verified its suitability. In 1997 the LWVUS urged members of Congress to oppose the Nuclear Waste Policy Act of 1997, which would have mandated an interim storage site at Yucca Mountain. In 2002, the League lobbied both the House and Senate in opposition to Congressional attempts to support the decision of the Secretary of the Department of Energy to make Yucca Mountain a permanent repository site for nuclear waste. Despite vigorous lobbying by the LWVUS, Congress passed resolutions in support of the Energy Secretary.

Environmental Protection & Pollution Control: Position Statement

The League supports the preservation of the physical, chemical and biological integrity of the ecosystem and maximum protection of public health and the environment. The League's approach to environmental protection and pollution control is one of problem solving. The interrelationships of air, water and land resources should be recognized in designing environmental safeguards. The League's environmental protection and antipollution goals aim to prevent ecological degradation and to reduce and control pollutants before they go down the sewer, up the chimney or into the landfill.

The League believes that although environmental protection and pollution control are responsibilities shared by all levels of government, it is essential that the federal government provide leadership and technical and financial assistance. The federal government should have the major role in setting standards for environmental protection and pollution control. Other levels of government should have the right to set more stringent standards. Enforcement should be carried out at the lower levels of government, but the federal government should enforce standards if other levels of government do not meet this responsibility. Standards must be enforced in a timely, consistent and equitable manner for all violators in all parts of society, including governmental units, industry, business and individuals. Environmental protection and pollution control, including waste management, should be considered a cost of providing a product or service. Consumers, taxpayers and ratepayers must expect to pay some of the costs.

The League supports policies that accelerate pollution control, including federal financial assistance for state and local programs. The League supports:

• Regulation of pollution sources by control and penalties;

• Inspection and monitoring;

• Full disclosure of pollution data;

• Incentives to accelerate pollution control;

• Vigorous enforcement mechanisms, including sanctions for states and localities that do not comply with federal standards and substantial fines for noncompliance.

Further Energy Guidelines and Criteria

The League supports:

• Energy goals and policies that acknowledge the United States as a responsible member of the world community;

• Reduction of energy growth rates;

• Use of a variety of energy sources, with emphasis on conserving energy and using energy- efficient technologies;

• The environmentally sound use of energy resources, with consideration of the entire cycle of energy production;

• Predominant reliance on renewable resources;

• Policies that limit reliance on nuclear fission;

• Action by appropriate levels of government to encourage the use of renewable resources and energy conservation through funding for research and development, financial incentives, rate-setting policies and mandatory standards;

• Mandatory energy-conservation measures, including thermal standards for building efficiency, new appliance standards and standards for new automobiles with no relaxation of auto-emission control requirements;

• Policies to reduce energy demand and minimize the need for new generating capacity through techniques such as marginal cost or peak-load pricing or demand-management programs;

• Maintaining deregulation of oil and natural gas prices;

• Assistance for low-income individuals when energy policies bear unduly on the poor.

Source: "Impact on Issues 2002-2004, A Guide to Public Policy Positions," League of Women Voters of the United States, 1780 M Street NW, Washington, D.C., 20036-4508.

APPENDIX C: Air Emissions

This chart shows the level of air emissions of various fuel types used by Xcel Energy.

Air Emissions by fuel types (pounds per thousand kwh)

	Carbon Dioxide (CO_2)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Particulate Matter	Mercury
Coal	2358	6.3	5.3	0.41	0.00006
Natural Gas	1344	0.03	1.8	0.06	0.00000001
Oil	1909	2.1	9.1	0.43	0.000007
Refuse-Derived Fuel	6300	1.3	9.4	0.34	0.0001
Biomass	3139	0.4	7.9	0.88	0.00003
Purchases	1839	5.5	4.0	0.33	0.00004

Source: Brochure, "Your Electricity: Fuel Sources, Air Emissions, Your Choice," Xcel Energy Inc., 2004

Nuclear, wind, solar power and hydropower do not produce air emissions. Please see individual discussions of renewable energy types for more by-product information.

APPENDIX D: Cost Comparison

This cost comparison came from "Designing A Clean Energy Future: A Resource Manual, Developed for the Clean Energy Resource Teams," by Melissa Pawlisch, Carl Nelson and Lola Schoenrich, The Minnesota Project/University of Minnesota's Regional Sustainable Developments Partnerships/Minnesota Department of Commerce, Appendix A, July 2003.

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 & I 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 (25MW)	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

APPENDIX E: Government Interviews

Interview #1: On November 3, 2004, an interview of city employees was conducted. City representatives included City Manager Gordon Hughes, Parks and Recreation Director John Keprios, City Engineer Wayne Houle, Public Works Coordinator Steve Johnson, Park Maintenance Superintendent Vince Cockriel. A summary of responses is below.

1. What, if any, renewable energy is used by the City of Edina. How are these projects working? What is their cost impact?

Biomass: The St. Paul wood burning plant looks to cities for their wood excess. However, cities must stock pile the wood until it is needed in St. Paul. Edina doesn't have space for long-term stock piling, so are in the process of finding a contractor to haul and store Edina's wood as well as compost materials (from fall and spring street cleaning). All three vendors bring wood to the biomass plant.

Vehicles: No renewables used at this time. Larger vehicles are cost prohibitive, but my have hybrid options in the future.

2. Do you have someone on staff or as a consultant who is familiar with implementing renewable energy opportunities?

No. They use Xcel and CenterPoint as their consultants on related issues. Also, for electrical questions.

3. Are you aware of incentives or obstacles to increasing the use of renewable energies by the city?

They are always happy to learn of incentives available. Xcel provides grants for field light and LED traffic lights with increased efficiencies, (conservation, not renewable energy use).

4. Are renewable energy issues considered for new construction in the city?

Solar: Zoning laws require that roofs have solar access. This means have access to the sun, not that they have to use it. Geothermal: Building codes allow for the underground portion of a building to go beyond the easements. This code was put on the books when earth homes were popular (1970s).

5. Is there a future expectation built into city plans with regard to use of renewable energy?

- No. Conservation only.

- Park Shelter Buildings: considering solar & temperature control by pushing liquid into the ground for cooling, then bringing it back up into the shelter. Mainly price driven.

- Solar panel powered lighting of hard-to-see stop signs and speed signs may be coming. They have a solar pack on the back of the sign. Are batteries required for solar packs bad for the environment?

6. What conservation efforts are in effect by the city?

- Lighting Efforts: Roof "holes" at Braemar station (hole 15/16) to reduce need for lights being on. Motion detectors in comfort stations – lights on only when needed. High efficiency LED traffic lights. High efficiency metal halide hockey and field lights, up to 10x more efficient (change as needed). Natural light incorporated in City Hall to reduce need for lights and improve working conditions.

- To reduce vehicle/gas usage, keyless entry systems installed in the park comfort stations. Allow them to be locked and unlocked remotely (will be in 11 stations next summer). Public work stations (sanitation, wells, water treatment buildings, water towers) will be handled remotely as well. About ¾ this SCADA system is complete. Previously had 2 people and trucks making daily rounds to these locations.

- Heat Recapturing: At City Hall and Fire Training Building

- Water: Watering bans in place from April – Sept. 15, higher rates for higher water use in all buildings in the city. High efficiency (less water use) toilets. Improved citywide inspections for pipes, sump pumps, etc. to reduce infiltration needs. Also, changed manhole covers to have fewer holes (to keep rain/clear water out so don't have to pump it through the system).

- Buildings: New windows installed at Arneson's, Grange Hall, Old Cahill School. Furnaces well maintained, replaced when needed with high efficiency furnaces. Furnaces timed for increased heat during day hours only.

- More efficient big trucks & sanders focus salt and sand in the drive lane, reducing the volume used. This reduces need to resod boulevards, resand, dredge ponds, etc.

7. What is the budget for energy by the city? Is there a long-range number for 5 or 10 years?

Will have to get back to us.

8. Is the city interested in receiving public input on this topic from a community board?

Yes. Ideas welcome!

Interview #2: A second interview regarding the design of the new Edina City Hall was provided by

Assistant City Manager Eric Anderson. It was followed by a tour of the facility. A summary of the interview is below.

Eric Anderson was the city's point person to coordinate the design and construction of the new Edina City Hall. Throughout the process he worked closely with the architects, construction and mechanical contractors, engineers and the Weidt Group, an energy consultant.

The facility was designed using the Energy Design Assistance Program. Shortly before work began on city hall, the Energy Design Assistance Program dropped the minimum square footage requirement to 50,000 square feet, thus making Edina City Hall eligible. Funded by the state of Minnesota, it aims to use traditional construction with innovative energy design. Edina City Hall was the first public building developed under the Energy Design Assistance Program.

The program has ten strategies. The strategies and some of the city hall selections are below:

1. Window Glazing and Frame Alternatives

2. Daylighting Controls

- Automatic lighting sensors were installed inside and outside the building. This allows the lights to dim when the area is brightened by the sun.
- In consideration of neighbors on the north side of the building, exterior lights are extinguished daily after 9 pm and on holidays and weekends.
- Use of high efficiency light bulbs
- Use of indirect lighting, i.e. exterior wall offices have a window on their interior wall to bring light into the inner office areas.

3. Envelope Insulation Alternatives

4. Lighting Controls

5. Lighting Design Alternatives

6. Cooling Efficiency

7. Heating Efficiency

A heat recovery system was installed to recover 44% of the heat inside the building.

For safety, the system also brings outside air into the system.

8. Motor Efficiency

9. Load Responsive Equipment and Operation

10. Conditioning of Outside Air

A sophisticated computer system controls lighting and heating/cooling needs. Sensors were placed throughout the facility to monitor needs.

Many options were offered under each of the strategies. Decisions had to consider the impact on employees and aesthetics as well as energy conservation. For example, the boiler selected for the facility was not the most efficient option (86%), but higher levels of efficiency would have caused significant vibrations to the offices immediately below this installation.

APPENDIX F: U.S. Mayors' Statement on Global Warming 2003

The following letter was sent to President George W. Bush, along with signatures of mayors from across the U.S. Ten Minnesota mayors were signatories, representing the cities of Apple Valley, Burnsville, Dayton, Duluth, Mankato, Minneapolis, Minnetonka, Morris, Rochester and Virginia.

Mayors from across the U.S. are concerned about the impacts of global warming on our communities. Many of us are actively pursuing reductions at the municipal level, but know it will take leadership at the national level to slow the rate of global warming. We urge the Federal Government to focus attention and policy efforts on this critical issue.

Global warming poses significant threats to communities across the country. We are already feeling impacts in the form of heat waves, shrinking water supplies and snow pack, increased rates of asthma, floods and storms, and coastal erosion.

The scientific community is very clear in its warning – we must act now to significantly reduce greenhouse gas emissions below current levels or we will quickly reach a point at which global warming can not be reversed. This issue requires an effective response from the U.S. Federal Government.

Many local governments across the country have made it a policy priority to reduce greenhouse gas emissions. As mayors, we know that actions that promote energy conservation and efficiency, sustainable transportation (such as expanded mass transit, alternative fuel vehicles, and bike and pedestrian safety amenities) and reduce solid waste also reduce greenhouse gas and criteria pollutants emissions and bring a host of benefits to our communities. These actions reduce financial waste for local governments, businesses and citizens; they make our communities more livable; they increase spending and economic investment in our communities; and they increase the quality of life for current and future generations.

In addition to these benefits, two other reasons have recently emerged that put reducing greenhouse gas emission at the top of the policy priority list. The first is energy security. Switching to cleaner energy sources, practicing conservation and maximizing energy efficiency will ease U.S. dependence on foreign fossil fuel-based energy, and at the same time improve local air quality and public health.

The second driver is the simple fact that the people in our communities are calling on us as elected leaders to address global warming. A public mandate is emerging in cities and towns across the country calling for governments at all levels to protect the global climate.

As mayors responsible for the well being of our communities, we urge the federal government to maintain, enhance and implement new domestic policies and programs that work with local communities to reduce global warming pollution.

Initial Signatories

Mayor James Garner, Hempstead NY
Mayor Ed Garza, San Antonio TX
Mayor R.T. Rybak, Minneapolis, MN
Mayor Vera Katz, Portland OR
Mayor Dick Murphy, San Diego CA

Contact

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Anderson, Eric, Assistant Edina City Manager

Balow, Rick, Director of Operations, Southdale Shopping Center

Brown, Ken, Office of Energy Assistance for the State of Minnesota

Cockriel, Vince, Edina Park Maintenance Superintendent

Grimsby, Nan, Edina Resident

Hamilton, J. Drake, Minnesotan for an Energy-Efficient Economy (ME3)

Houle, Wayne, Edina City Engineer

Hughes, Gordon, Edina City Manager

Jackson, Jeff, Key Account Manager, Xcel Energy

Johnson, Steve, Edina Public Works Coordinator

Keprios, John, Edina Parks and Recreation Director

Krause, Michael, The Green Institute

Petersen, Lou, Edina Resident

Schumann, Debra, Permit Writer, Minnesota Pollution Control Agency

Sulkko, Andy, Xcel Renewable Energy Department

Willemssen, James (Jay), Business Services Director, Edina School District

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