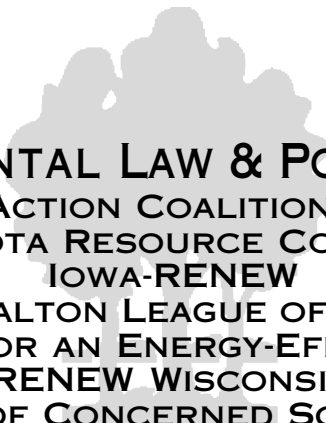




# **REPOWERING THE MIDWEST**

## **THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND**



**ENVIRONMENTAL LAW & POLICY CENTER**  
**CITIZENS ACTION COALITION OF INDIANA**  
**DAKOTA RESOURCE COUNCIL**  
**IOWA-RENEW**  
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**MINNESOTANS FOR AN ENERGY-EFFICIENT ECONOMY**  
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# TABLE OF CONTENTS

<b>Executive Summary .....</b>	<b>ES-1</b>
<b>1. Overview: Seizing the Opportunities to Invest in Clean Energy Development for the Heartland .....</b>	<b>1</b>
<b>2. Electric Power in the Midwest: Challenges and Opportunities .....</b>	<b>3</b>
2.1 The Midwestern Electricity Portfolio Under the Business-As-Usual Scenario .....	3
2.2 The Electricity Future Under Business-As-Usual Practices .....	4
2.3 The Price of Business-As-Usual .....	4
<b>3. The Clean Energy Development Plan: A Blueprint for Clean Power in the Midwest.....</b>	<b>8</b>
3.1 Energy Efficiency .....	8
3.2 Renewable Resources .....	10
3.3 Efficient Generation Technologies .....	14
3.4 The Clean Energy Development Plan for the Midwest .....	15
3.5 State-by-State Benefits Achieved by the Clean Energy Development Plan .....	17
<b>4. The Potential for Energy Efficiency in the Midwest.....</b>	<b>19</b>
4.1 Efficiency Potential in the Residential and Commercial Sectors .....	19
4.2 Efficiency Potential in the Industrial Sector .....	21
4.3 Summary of Energy Efficiency Potential .....	22
4.4 Case Studies of Energy Efficiency in the Midwest .....	23
<b>5. The Potential for Renewable Energy Resources in the Midwest .....</b>	<b>25</b>
5.1 Renewable Energy Opportunities .....	25
5.2 Wind Energy .....	25
5.3 Biomass Energy .....	33
5.4 Photovoltaics .....	39
5.5 Summary of Renewable Energy Resources Potential .....	43

<b>6. Efficient Generation Technologies: Making the Most of Natural Gas ....</b>	<b>45</b>
6.1 Fuel Cells .....	45
6.2 Combined Heat and Power .....	46
6.3 District Energy .....	47
6.4 Summary of Efficient Generation Technologies Potential .....	48
<b>7. Barriers to Implementing the Clean Energy Development Plan .....</b>	<b>49</b>
7.1 Barriers to Energy Efficiency .....	49
7.2 Barriers to Renewable Energy Resources .....	50
7.3 Barriers to Distributed Generation .....	51
<b>8. Public Policies to Remove the Barriers to Clean Energy .....</b>	<b>52</b>
8.1 Policies to Promote Energy Efficiency Development .....	52
8.2 Policies to Promote Renewable Energy Resources Development .....	57
8.3 Policies to Promote Clean Distributed Generation Development .....	63
8.4 CO <sub>2</sub> Reduction Policies .....	65
<b>9. Overcoming Specific Barriers to Developing Each of the Renewable     Energy Technologies .....</b>	<b>67</b>
9.1 Wind Power .....	67
9.2 Biomass Co-Firing .....	69
9.3 Biomass Combined Heat and Power .....	72
9.4 Photovoltaics .....	74
9.5 Fuel Cells .....	77
<b>Conclusion .....</b>	<b>80</b>
<b>Appendix 1. State Summaries .....</b>	<b>81</b>
<b>Appendix 2. Existing State Energy Efficiency and Renewable Programs ..</b>	<b>102</b>
<b>Appendix 3. Modeling Assumptions .....</b>	<b>106</b>
<b>Appendix 4. References .....</b>	<b>108</b>

## LIST OF FIGURES

Figure 2.1	Current Sources of Electricity Generation in the Midwest (2000) .....	3
Figure 2.2	Generation Fuel Mix by State (2000) .....	3
Figure 2.3	Portfolio of Electricity Generation Sources: Business-As-Usual Practices .....	4
Figure 3.1	Summary of Efficiency Savings in the Clean Energy Development Plan .....	10
Figure 3.2	Benefits of Efficiency Resources in the Clean Energy Development Plan .....	11
Figure 3.3	Portfolio of Electricity Generation Sources: Clean Energy Development Plan .....	15
Figure 3.4	Annual SO <sub>2</sub> and NO <sub>x</sub> Emissions (million tons) .....	16
Figure 3.5	CO <sub>2</sub> Pollution Reduction from the Clean Energy Development Plan .....	16
Figure 3.6	2020 Energy Demand by State: Business-As-Usual Case Compared to the Clean Energy Development Plan .....	17
Figure 3.7	New Clean Power Capacity Additions by State in 2020 .....	17
Figure 3.8	Generation Fuel Mix by State in 2020: Clean Energy Development Plan .....	18
Figure 3.9	CO <sub>2</sub> Emissions in 2020: Business-As-Usual Compared to the Clean Energy Development Plan .....	18
Figure 4.1	Efficiency Savings and Costs for Residential End-Uses (2010) .....	20
Figure 4.2	Efficiency Savings and Costs for Commercial End-Uses (2010) .....	20
Figure 4.3	Efficiency Savings and Costs for Industrial End-Uses .....	21
Figure 4.4	Efficiency Savings in Midwestern Industrial Sectors .....	22
Figure 4.5	Summary of Efficiency Savings in the Clean Energy Development Plan .....	22
Figure 5.1	Capacity of Grid-Connected Renewable Plants (1999) .....	26
Figure 5.2	Geographical Distribution of Wind Resources .....	27
Figure 5.3	Current and Projected Wind Energy Costs and Performance .....	32
Figure 5.4	Price Supply Curve for Biomass Feedstocks .....	34

Figure 5.5	Distribution of Biomass Resources at \$37.5/dry ton .....	35
Figure 5.6	Breakdown of Biomass Resources in Clean Energy Development Plan (2020) .....	35
Figure 5.7	Characteristics of Biomass Co-Firing Retrofits .....	36
Figure 5.8	Characteristics of Biomass CHP .....	37
Figure 5.9	Characteristics of Biomass Gasification Combined-Cycle Power Plants .....	38
Figure 5.10A.	Geographic Distribution of Solar Insolation .....	40
Figure 5.10B.	Coincidence of PV Output with Utility Peak Loads .....	40
Figure 5.11	Characteristics of Grid-Connected Fixed Flat-Plate PV Systems .....	42
Figure 5.12	Levelized Costs of Renewable Generation Technologies (¢/kWh) as Modeled in the Clean Energy Development Plan .....	43
Figure 5.13	Summary of Renewable Resources Included in the Clean Energy Development Plan (2010) .....	44
Figure 5.14	Summary of Renewable Resources Included in the Clean Energy Development Plan (2020) .....	44
Figure 6.1	Selected Fuel Cell Types .....	46
Figure 6.2	Efficient Generation Technologies Included in the Clean Energy Development Plan (2010) .....	48
Figure 6.3	Efficient Generation Technologies Included in the Clean Energy Development Plan (2020) .....	48
Figure 8.1	Policies to Promote Energy Efficiency Development .....	52
Figure 8.2	Policies to Promote Renewable Energy Resources Development .....	58
Figure 8.3	Policies to Promote Clean Distributed Generation Development .....	63
Figure 9.1	Coal-Fired Boilers >25 MW at Midwestern Utilities by Type .....	71
Figure A.1	Comparison of PROSYM and AEO 2000 Generation Fuel Mix .....	106

## ACRONYMS AND ABBREVIATIONS

AEO	Annual Energy Outlook, prepared by the DOE
AFC	alkaline fuel cell
ASTM	American Society for Testing and Materials
BIPV	building-integrated photovoltaics
CHP	combined heat and power
CO <sub>2</sub>	carbon dioxide
DES	district energy systems
DESP	District Energy St. Paul
DOE	Department of Energy
DSM	demand-side management
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPAct	1992 Energy Policy Act
GIS	geographical information system
GW	gigawatt
IEEE	Institute of Electrical and Electronic Engineers
ISO	Independent System Operator
LIEF	Long-Term Industrial Energy Forecast model
MCFC	molten carbonate fuel cell
MDF	Market Development Fund
MW	megawatt
NAECA	National Appliance Energy Conservation Act
NERC	National Electric Reliability Council
NREL	National Renewable Energy Laboratory
NGCC	natural gas combined-cycle
NO <sub>x</sub>	nitrogen oxides
NSR	New Source Review
O&M	operation and maintenance
P2	Pollution Prevention
PAFC	phosphoric acid fuel cell
PBC	public benefits charge
PBR	performance-based ratemaking
PEMFC	proton exchange membrane fuel cell
PTC	production tax credit
PV	photovoltaics
REC	Rural Electric Cooperative
REPI	Renewable Energy Production Incentive
RPS	Renewables Portfolio Standard
RTO	Regional Transmission Organization
SIC	standard industrial classification
SIP	state implementation plan
SCR	selective catalytic reduction
SO <sub>2</sub>	sulfur dioxide
SOFC	solid oxide fuel cell
TWh	one billion kWh





EXECUTIVE SUMMARY

# **REPOWERING THE MIDWEST**

**THE CLEAN ENERGY DEVELOPMENT  
PLAN FOR THE HEARTLAND**





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*As the 21<sup>st</sup> century begins, the Midwest can lead the way to a clean energy future, through strategic development of untapped energy efficiency opportunities and abundant renewable resources.*

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## CHALLENGES AND OPPORTUNITIES

The Midwest needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy makes both good environmental and economic sense for our region. Clean energy development will reduce pollution, improve reliability by diversifying our power supply and create new “green” manufacturing and installation jobs, as well as provide new renewable energy “cash crops” for farmers. *Repowering the Midwest* is a plan to seize these opportunities.

Modern life runs on electricity to power our homes and businesses. From refrigerators to computers to dairies, we depend on reliable electricity. However, at the dawn of the 21<sup>st</sup> century when rapid technological progress is transforming society, the Midwest is still saddled with polluting and inefficient 1950s equipment generating the energy to drive the “new economy.” This overdependence on aging coal and nuclear plants and many utilities’ underinvestments in modernizing their deteriorating transmission and distribution systems are causing both pollution and power reliability problems.

Many economists tell us that technological advances are shaping a new economy in which economic growth provides new jobs and creates greater wealth. The rapid technological progress should also result in modern processes that produce less waste and less pollution. While that is true enough in many industrial sectors, the electric industry lags behind. It is time for electric utilities and power generators to implement modern technologies that give the public

what we want: clean, reliable and efficient energy at a fair price. Can we keep the lights on without polluting the air and water and leaving radioactive nuclear wastes for future generations to clean up? The answer is yes and, perhaps surprising to some, the Midwestern heartland can lead the way if we put the right policies and practices in place.

Developing clean energy efficiency and renewable energy resources is the smart and sustainable solution to the Midwest’s pollution problems, to power constraints at summer peak demand times and to challenges in meeting the region’s overall electricity needs. Clean energy resources are the modern technologies for our 21<sup>st</sup> century energy future.

The cost of renewable energy is plummeting as wind, biomass and solar power technologies have improved dramatically. There are also abundant opportunities to install cost-effective modern energy efficiency technologies ranging from improved residential and commercial lighting to new industrial motors. The Midwest is poised to capitalize on these clean energy development opportunities.

When it comes to wind power, the flat lands of the Midwest are valuable assets. Wind power is the world’s fastest growing energy source, expanding about 35 percent in 1998. Tremendous design improvements in wind turbines have led to a huge drop in the per-kilowatt price of installed capacity. The cost is now less than one-third of the 1981 price and close to competitive with conventional power sources.

Six of the 10 states with the highest wind power potential are in the Midwest, according to the American Wind Energy Association. Iowa and Minnesota are leading the way with more than 500 megawatts (MW) of wind power (equivalent to the size of a typical coal plant) coming online since 1998. That includes the world’s largest wind farm, which provides enough energy to power 64,000 typical homes in northwestern Iowa.

More clean energy means more green jobs. Not coincidentally, two leading wind power businesses have recently located in the Midwest, providing well-paid manufacturing jobs and capitalizing on current and future market opportunities. That’s sustainable development in action for factory workers and farmers. Still, the enormous potential of this growing industry remains largely untapped.

Everyone already knows that Midwestern farmlands are ideal for growing the foods that energize our bodies. If we put the right policies in place, we can also count

on Midwestern farmers to grow high-yield “energy crops” to help power our economy. Expanding this biomass power will create new rural jobs and provide new markets for crops while reducing air and water pollution and deterring soil erosion.

Other advanced technologies such as fuel cells and industrial and commercial co-generation systems, which generate electricity and heat simultaneously, can also diversify our energy supply in the near term. And, yes, even in the often-gray skies of the Great Lakes, solar photovoltaic panels that convert sunlight to electricity can play a growing role, especially on sunny summer days when peak electricity demand is highest and in hard-to-reach remote areas where solar power provides a way around costly transmission and distribution line extensions. Natural gas plants are not entirely clean, but are generally less polluting than coal and nuclear power. When properly sited, they can also be an important part of a strategy to improve the overall environmental performance of the Midwest’s power sector.

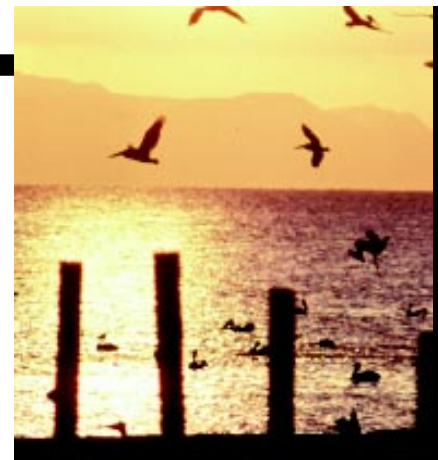
As for the demand side of the equation, many clean energy efficiency improvements are smart, economical and waiting to be tapped. Inefficient energy use continues to waste money and cause unnecessary pollution. That can be changed by deploying new, more energy-efficient heating and cooling systems, lighting, appliances and building designs and materials. Seizing these opportunities will save money, relieve electricity demand pressures and improve our quality of life. That is especially true in the Midwest where most utilities have underinvested in efficiency programs that save customers energy and money. Here, too, clean energy means more green jobs because Midwestern companies manufacture many of the new energy-efficient products.

Unfortunately, the electric utilities have failed to keep pace with these improvements and opportunities. Even though new technologies can generate power cleanly and efficiently, a staggering 95 percent of the Midwest’s electricity is produced by coal and nuclear plants – the two fuel sources with the worst environmental and public health impacts. These old power plants produce pollution that causes smog, acid rain and global warming, and they generate radioactive nuclear wastes and other toxic pollutants. Depending so heavily on business-as-usual coal and nuclear power locks in a high-pollution future and misses the opportunity to improve reliability by diversifying our power resources. Bypassing more energy-efficient processes and technological advances

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**Repowering the Midwest** is a blueprint for sustainable energy development that will produce economically robust and environmentally sound electricity throughout the heartland.

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not only increases businesses’ costs, but misses the job creation opportunities in the growing clean energy sector.

The Midwest’s clean energy resources are here and ready to be developed. Our region is blessed with abundant wind resources, untapped biomass production potential and relatively high levels of solar power availability. Likewise, new energy-efficient lighting and appliances operate at low costs while avoiding pollution, but have yet to capture a firm foothold within the industry or the marketplace.

*Repowering the Midwest* is a blueprint for producing economically robust and environmentally sound electricity in the 21<sup>st</sup> century by comparing two possible energy futures for the Midwest – one in which we continue to rely on conventional, or “business-as-usual” technologies, and a second in which the Midwest unleashes its homegrown clean energy development potential. This Clean Energy Development Plan quantifies the region’s untapped energy efficiency and renewable resources and lays out strategies, policies and practices to advance a cleaner electricity future from the industrial Midwest across to the Great Plains. These clean power options are technologically and commercially available today, and they can be obtained with only a modest increase in total electricity cost – 1.5 percent in 2010 and roughly three percent in 2020 – that is far offset by the environmental and public health improvements and the economic and employment gains for our region.

As engineering improvements continue to be made, many of the modern clean technologies await sensible policy shifts to reverse the incentives that prop up the polluting technologies of the past. It is no longer a question of engineering know-how, but, instead, a challenge of political will. It is time to leave the 1950s behind and realize the promises of homegrown clean energy in the Midwest to provide us with a healthier environment and a truly new economy. Now is the time to repower the Midwest for a clean energy development future.



*The Clean Energy Development Plan harnesses the Midwest's abundant renewable resources and implements underutilized energy efficiency measures, thus producing environmental, reliability and economic development benefits.*

## SUMMARY OF THE MIDWEST CLEAN ENERGY DEVELOPMENT PLAN

The Midwest Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only very modest increases in cost. Moreover, investing in clean modern energy efficiency and renewable energy technologies will diversify the region's electricity portfolio and thereby improve reliability. The Midwest Clean Energy Development Plan will:

1. Aggressively implement modern cost-effective energy efficiency technologies, including the newest as well as the tried-and-true approaches.
2. Develop and implement new clean renewable energy technologies, including wind power, biomass and solar photovoltaics (PV).
3. Develop and implement efficient natural gas uses in appropriate locations, especially combined heat and power, district energy systems and fuel cells.
4. Retire selected older, less efficient and highly polluting coal plants.
5. Apply sustainable development strategies to aggressively link these environmental improvement policies to economic development. Clean energy development means more green energy jobs for the Midwest.

## SUMMARY OF BENEFITS FOR THE MIDWEST

Taking these actions to implement the Clean Energy Development Plan will produce:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual policies and practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 56 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 71 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 51 percent.
2. Energy efficiency improvements for Midwestern consumers that save 17 percent of electricity use by 2010 and 28 percent by 2020. The average investment of 2.4¢ per kilowatt-hour (kWh) to achieve these energy savings is much less than the cost of generating, transmitting and distributing electricity from a coal plant or most other sources.
3. Renewable energy development that provides eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
4. Improved electricity reliability as a result of a more robust and diversified mix of Midwestern power resources compared to the region's historic almost-total reliance on coal and nuclear plants.
5. Economic development and job growth through new wind power and biomass energy "cash crops" for farmers, increased business for manufacturers of energy efficiency and renewable energy equipment and new skilled jobs for the installation and maintenance of this equipment throughout the Midwest.

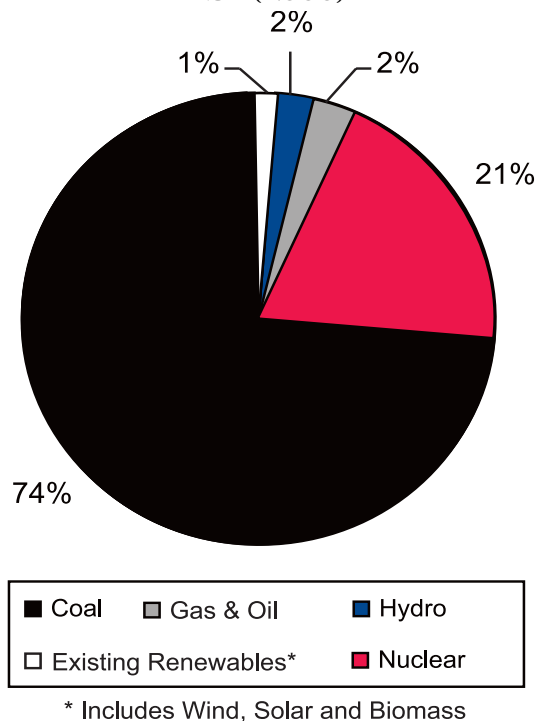
These benefits can be achieved with only slightly increased electricity costs across the Midwest: 1.5 percent in 2010 and 3.4 percent in 2020.

## THE MIDWESTERN ELECTRICITY PORTFOLIO UNDER THE BUSINESS-AS-USUAL SCENARIO

The Midwest relies almost exclusively upon coal and nuclear power for electricity supply, as shown in Figure 1. Coal plants produce 74 percent of the Midwest's electricity, and nuclear plants generate 21 percent, while natural gas and oil plants provide two percent. Renewable energy resources supply only three percent, mostly from hydropower dams,



**FIGURE 1. CURRENT SOURCES OF ELECTRICITY GENERATION IN THE MIDWEST (2000)**

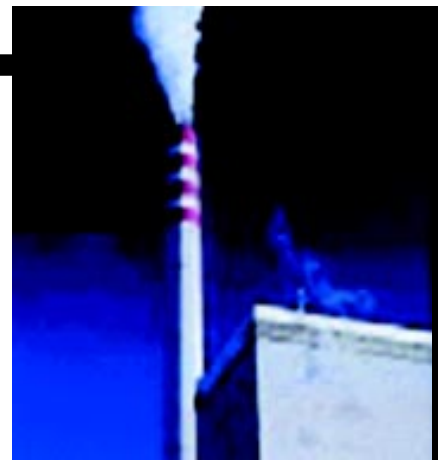


with relatively small contributions, thus far, from wind, biomass and solar photovoltaic power. Modern energy efficiency technologies and “tried and true” efficiency measures are significantly underutilized.

Most Midwestern coal plants were built between 1940 and 1970 and many have not been fully upgraded with modern pollution control technologies. Compared to other regions, the Midwest relies more heavily on these older, inefficient coal plants and thus produces a disproportionate amount of air pollution causing health and environmental problems. The Midwest generates 21 percent of the nation’s electricity, but produces 31 percent of the SO<sub>2</sub> pollution, 32 percent of the NO<sub>x</sub> pollution, and 26 percent of the CO<sub>2</sub> pollution from the nation’s electric industry sector.

Substantial changes in public policies and business planning are necessary to achieve the benefits of implementing the largely untapped energy efficiency and renewable energy technology opportunities. Otherwise, the current portfolio of old, highly polluting coal and nuclear plants will remain overwhelmingly dominant in the Midwest for decades. Figure 2 projects the likely sources of generation for the next 20 years if business-as-usual policies and practices continue. Although nuclear generation is expected to decline as some plants reach the end of their operating licenses, coal plant generation would steadily increase. New

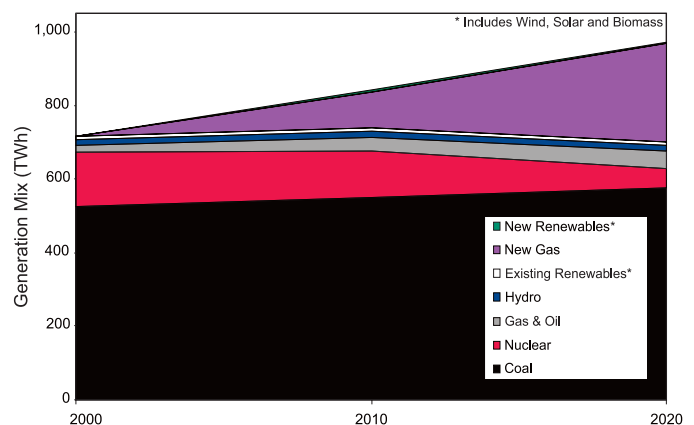
*The Midwest’s reliance on coal plants to generate electricity results in air pollution that causes serious health and environmental problems, including acid rain, smog, and global warming.*



natural gas plants would meet most of the growing demand for electricity, but might not replace much generation from old coal plants.

This combination of business-as-usual factors casts a pollution cloud over the Midwest. The harmful health impacts from air pollution impose social and economic costs on the public. The social costs are increased asthma and respiratory ailments (and deaths) especially for children, senior citizens and other “at risk” groups. In addition, there are high economic costs for the region and the nation from increased health care and insurance expenses and lower productivity due to missed work. Business-as-usual practices also lead to a risk of significant costs for compliance with future environmental regulations.

**FIGURE 2. PORTFOLIO OF ELECTRICITY GENERATION SOURCES: BUSINESS-AS-USUAL PRACTICES**



The harmful environmental impacts of the Midwest’s coal plants extend nationally and globally as air pollution drifts downwind to the Northeast and Canada. They cause smog, acid rain and global warming and impose associated public health, environmental quality and economic burdens. Running these coal plants on a business-as-usual basis will lead to a 30 percent increase in CO<sub>2</sub> pollution between 2000 and 2020.



*The Clean Energy Development Plan will result in renewable resources — such as wind power — providing eight percent of the Midwest's electricity generation by 2010 and 22 percent by 2020.*

## THE MIDWEST CLEAN ENERGY DEVELOPMENT PLAN: PRINCIPAL FINDINGS

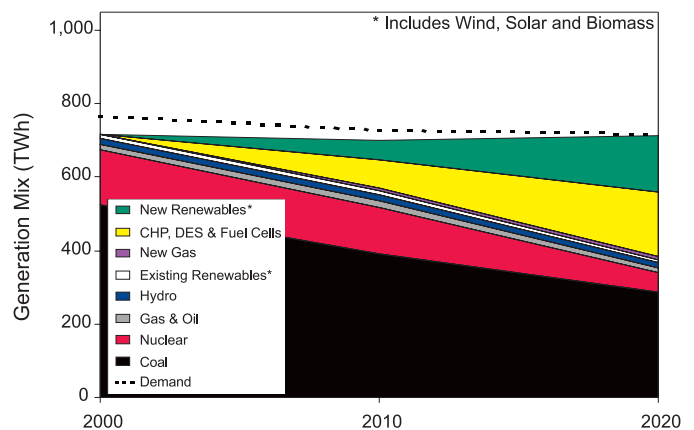
There are better courses for the Midwestern electricity sector than to continue along this shortsighted and damaging path. The Clean Energy Development Plan proposes developing underutilized energy efficiency measures and largely untapped homegrown renewable energy resources to form a cleaner, more reliable and more diverse electricity portfolio for the Midwest that can spur job creation in this emerging economic sector.

Figure 3 describes this preferable Midwestern electricity portfolio by 2020 under the Clean Energy Development Plan:

1. Energy efficiency measures reduce electricity generation from power plants because demand remains essentially constant over time, instead of growing steadily each year.
2. Renewable energy resources – wind, biomass and solar – supply roughly eight percent of generation by 2010 and 22 percent by 2020.
3. Coal generation declines significantly as renewable energy resources with increasingly lower operating costs generate more power in the Midwest.
4. New efficient natural gas generation provides 10 percent of generation in 2010 and 25 percent of generation in 2020.
5. Fewer new conventional natural gas plants are needed than under the business-as-usual scenario because less capacity is needed to meet demand due to energy efficiency.

6. Nuclear generation declines to the same extent as under the business-as-usual scenario, as the nuclear plants in the Midwest retire, on average, at their scheduled license termination dates. Some nuclear plants may operate longer by obtaining license extensions, while others may shut down earlier.

FIGURE 3. PORTFOLIO OF ELECTRICITY GENERATION SOURCES: CLEAN ENERGY DEVELOPMENT PLAN



## FINDINGS: ENVIRONMENTAL IMPROVEMENTS

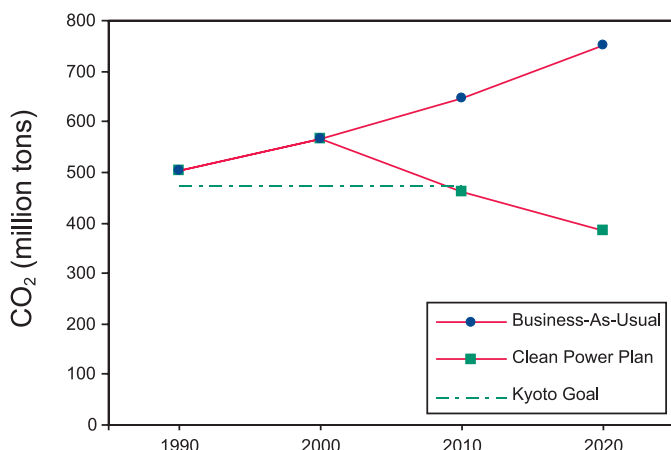
***The Clean Energy Development Plan reduces acid rain and smog by decreasing SO<sub>2</sub> and NO<sub>x</sub> pollution.*** By 2020, SO<sub>2</sub> emissions are projected to be 56 percent lower and NO<sub>x</sub> emissions 71 percent lower than under business-as-usual policies and practices, and 51 percent lower and 83 percent lower than in 2000, respectively. This will reduce acid rain falling in the Great Lakes and inland lakes and forests of the Upper Midwest and Canada, and it will reduce smog that harms public health. Because SO<sub>2</sub> emissions are subject to a “cap-and-trade” system under the Clean Air Act, and NO<sub>x</sub> emissions may also be governed by a trading regime under the U.S. EPA’s rules, the precise pollution percentage reductions in the Midwest may vary. However, it is clear that citizens in the Midwestern states will benefit from improved environmental quality and public health due to lower SO<sub>2</sub> and NO<sub>x</sub> emissions under the Clean Energy Development Plan.

**The Clean Energy Development Plan helps mitigate global warming by reducing CO<sub>2</sub> pollution.** By 2020, CO<sub>2</sub> emissions are 51 percent lower than under business-as-usual policies and practices, and 36 percent lower than in 2000. In 1997, the United States and other developed nations agreed to the Kyoto Protocol, which requires the United States to reduce CO<sub>2</sub> emissions to seven percent below 1990 levels over the period of 2008-2012. As indicated in Figure 4, the Clean Energy Development Plan puts the Midwest on target to meet the Kyoto Protocol goals by 2010, and it would continue to significantly reduce CO<sub>2</sub> emissions over the following years.

*Developing wind power in the Midwest will provide a “cash crop” for farmers and spur job growth in businesses that manufacture, install and maintain renewable energy equipment.*



**FIGURE 4. CO<sub>2</sub> POLLUTION REDUCTIONS FROM THE CLEAN ENERGY DEVELOPMENT PLAN**



Cleveland, Ohio, manufacture energy-efficient lighting. Honeywell Home and Building Control makes thermostatic controls in Golden Valley, Minn., and Johnson Controls in Milwaukee, Wis., makes energy-efficient motors. Andersen Corporation in Bayport, Minn., and Pella Corporation in Pella, Iowa, both make energy-efficient windows. Maytag manufactures energy-efficient refrigerators in Galesburg, Ill., and Trane Company manufactures high-efficiency air conditioning systems in La Crosse, Wis.

Implementing these modern energy efficiency technologies saves money for businesses to reinvest in their Midwestern operations. It saves money for residential consumers, which can then be spent for goods and services on the main streets of Midwestern towns. The Midwest regional economy benefits in all of these respects.

## FINDINGS: REGIONAL ECONOMIC DEVELOPMENT BENEFITS

**The Clean Energy Development Plan will promote job growth and economic development in the Midwest.** Wind and biomass power are “cash crops” for farmers in the heartland, supplementing their income from agricultural land. At the same time, manufacturing, assembling, installing and maintaining wind power and solar equipment are creating new jobs as well. For example, NEG Micon’s wind turbine assembly plant in Champaign, Ill., is the second largest in the country, and LM Glasfiber has created 400 new jobs manufacturing wind turbine blades in Grand Forks, N.D. Likewise, Spire Solar is creating 55 new jobs manufacturing solar photovoltaic panels on a former “brownfield” site on Chicago’s West Side.

The Midwest is also home to a large share of the nation’s energy efficiency manufacturing industry. Osram Sylvania in Lake Zurich, Ill., and GE Lighting in

## FINDINGS: COST IMPACTS

**The environmental and economic development benefits of a cleaner energy future can be achieved for the Midwest with only a modest increase in overall electricity costs.** Many energy efficiency measures, such as commercial lighting improvements, are highly cost-effective and are significantly less expensive than conventional power sources. The energy efficiency savings thus offset much of the cost of renewable energy resources, which are generally more expensive than running “cheap and dirty” coal plants.

The Clean Energy Development Plan is expected to increase total electricity costs across the Midwest by 1.5 percent in 2010 (\$765 million) and 3.4 percent in 2020 (\$1,780 million). On the other hand, the public will receive benefits in the form of lower health care costs and fewer health-related productivity losses.



*Energy-efficient appliances, such as this clothes washer, save consumers money, while reducing energy use, pollution, and the resulting health and environmental damages.*

## FINDINGS: ENHANCED RELIABILITY

***The Clean Energy Development Plan will improve electricity reliability by diversifying the Midwest's energy portfolio.*** Today, the Midwest relies almost entirely on older coal and nuclear plants to supply electric power needs. The Clean Energy Development Plan deploys a more robust mix of energy efficiency, renewable energy and natural gas resources, along with the coal and nuclear plants. Energy efficiency reduces demand for power and improves reliability by saving generation and alleviating strained transmission and distribution systems. Adding substantial wind, biomass and solar resources, along with natural gas plants, to the Midwest's energy portfolio enhances diversity and makes the region less vulnerable to swings in coal prices and to nuclear plant risks.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

An array of modern energy efficiency technologies – ranging from smart thermostats to new lighting ballasts to new motors – and “tried and true” measures, such as high R-value insulation and “Energy Star” appliances, are highly cost-effective, but greatly underutilized in the Midwest. Many energy efficiency opportunities can be deployed by business, residential and public agency consumers at less than the cost of electricity, thus saving them money and avoiding wasteful energy use. Businesses will free up dollars for investment and become more profitable. Residential consumers will have more disposable income to spend or save. Public agencies can use budget savings to meet other responsibilities and hold down taxes. The

public gains environmental and health benefits because implementing energy efficiency reduces pollution from coal and nuclear plants.

The most significant energy efficiency opportunities in the Midwest, by sector, are:

1. In the residential sector, the greatest potential is more efficient lighting (20 percent of potential residential savings) and water heating (nine percent). For example, compact fluorescent lamps (CFL) produce the same amount of light as conventional incandescent light bulbs, but use only one-quarter as much electricity and last 12 times longer. Replacing one incandescent bulb in a high-use area with a CFL will save a Chicago-area residential consumer about \$50 in electricity costs over the life of the CFL.
2. In the commercial sector, the greatest potential is efficient lighting technologies (50 percent of potential commercial savings) and space cooling (15 percent). For example, installing modern energy-efficient lighting ballasts in new commercial buildings, or through retrofits of existing buildings, produces rapid paybacks and operating cost savings in almost all settings.
3. In the industrial sector, the greatest opportunities for efficiency are found in the metals fabrication (28 percent of potential industrial electricity savings), rubber and plastics (13 percent), primary metals (12 percent), and agricultural (11 percent) industry sectors by deploying more efficient industrial motors and drives; more advanced heating, ventilating and cooling techniques; and better lighting technologies.

The major population centers and industrialized areas of the Midwest are the largest electricity load centers and provide the greatest opportunities to reap energy efficiency savings. Of the total efficiency savings in the Clean Energy Development Plan, about 24 percent are available in Ohio, 20 percent in Illinois, 16 percent in Michigan, and 14 percent in Indiana.

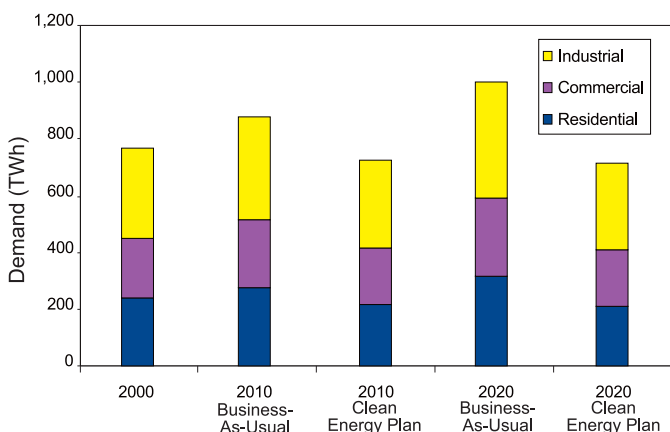


## FINDINGS: ENERGY EFFICIENCY

**The Clean Energy Development Plan enables Midwestern consumers to save up to 17 percent of electricity use through energy efficiency improvements by 2010, and 28 percent by 2020,** as shown in Figure 5. Electricity demand will decline slightly each year, rather than increase by more than one percent per year under the business-as-usual scenario. By 2020, these energy efficiency savings will avoid the need for 290 billion kWh (TWh) of generation – roughly equivalent to the output of 100 coal plants at 500 megawatts (MW) each.

**Implementing these energy efficiency measures is highly cost-effective.** On average, reaping the energy efficiency opportunities in the Clean Energy Development Plan requires a 2.4¢ per kWh investment. That is significantly less than the cost of generating, transmitting and distributing electricity to consumers. By 2020, the proposed energy efficiency measures will save \$12.1 billion in power plant and distribution system costs in return for a \$6.6 billion investment. The result is \$5.5 billion in net benefits or, put another way, savings of \$1.80 for every \$1.00 invested in energy efficiency. That, of course, does not include the economic and social value of the environmental and public health benefits.

**FIGURE 5. MIDWESTERN ELECTRICITY DEMAND REDUCTIONS DUE TO EFFICIENCY GAINS**



*Replacing conventional incandescent light bulbs with compact fluorescent lights, which use one-quarter as much electricity to produce the same amount of light, reduces pollution and energy costs.*



## DEVELOPING RENEWABLE ENERGY RESOURCES

The Midwest possesses abundant renewable energy resources. The Great Plains states have the best large-scale wind power potential in the nation, and there are also significant distributed wind power opportunities throughout the Midwest. Biomass potential is large in the agricultural belt of the heartland, and there are focused, though smaller, solar power development opportunities, especially to meet costly summer peak power demand, throughout the region. Dramatic technological improvements in wind turbines and solar photovoltaic panels have enhanced generating efficiencies and lowered power production costs over the past 20 years. Developing these clean renewable energy technologies avoids pollution from coal and nuclear plants and increases generation reliability by diversifying the region's energy portfolio and using local resources. Because renewable energy resources can also be deployed on a distributed basis – as relatively small generators located near customer demand – power delivery reliability is enhanced and new transmission and distribution upgrades and extensions can sometimes be avoided. Capital costs vary widely among types of renewable energy resources; however, even when their capital costs are high, the fuel and operating costs are typically very low.

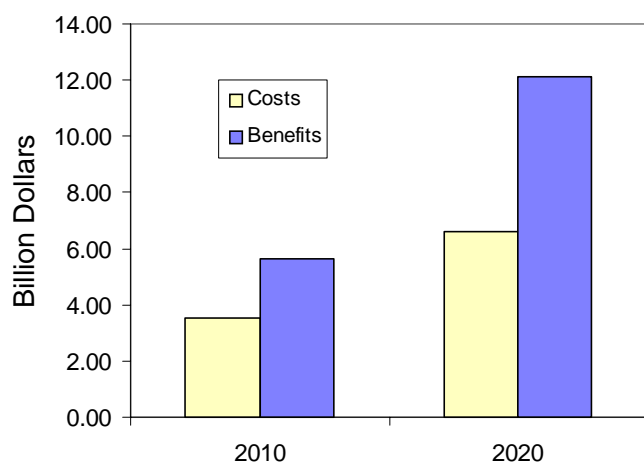
### WIND POWER

Large-scale wind energy generation has improved tremendously, both in cost and reliability, since the first wind energy boom in the early 1980s. Wind power is now the fastest growing energy resource in the world in large part due to substantial technological improvements. Modern wind turbines generate



*The wide open farmlands of the Great Plains states have been called the "Saudi Arabia of wind energy." Here farmers can reap "cash crops" for wind power development while their other farming operations continue uninterrupted.*

**FIGURE 6. NET BENEFITS FROM ENERGY EFFICIENCY INVESTMENTS IN THE CLEAN ENERGY DEVELOPMENT PLAN**



electricity at an average cost that is close to competitive with new coal and combined-cycle natural gas plants. The Midwest has been the nation's leader in wind power growth as Iowa, Minnesota and Wisconsin have installed a total of 500 MW of new wind capacity over the past few years, and are on their way to 1,000 MW of capacity. For example, about 400 MW of wind power is being developed in the Buffalo Ridge area of southwestern Minnesota (as part of utility commitments for 825 MW), a 112.5 MW wind power "farm" is operating in Alta, Iowa, and a new 30 MW wind power project is planned in Iowa County, Wis.

The Midwest is blessed with such an abundance of windy terrain, especially in the Great Plains states of North and South Dakota, Iowa, Minnesota and Nebraska, that it is sometimes referred to as the "Saudi Arabia of wind energy." There are also other windy areas scattered through Illinois, Indiana, Michigan, Ohio

and Wisconsin that offer strong opportunities for distributed wind power development.

Large wind energy machines have the most potential to replace coal plants, but small wind turbines designed for local residential and commercial uses are a growing market niche in the Midwest. Although their costs per kWh are usually higher than the larger wind turbines, they can still displace some higher-cost energy sources and also function well in lower winds.

Wind power costs have declined significantly over the past 20 years and continue to do so. In 2000, wind power was produced at a range of 3 - 6¢ per kWh (depending on wind speeds), but by 2020, wind power generating costs are projected to fall to 3 - 4¢ per kWh.

Wind power provides substantial environmental and public health benefits because it creates no air pollution, greenhouse gases or radioactive nuclear and other dangerous wastes. By applying responsible siting practices, wind projects can have minimal impacts on wildlife and natural resources. Wind is an intermittent power resource, fluctuating with daily and hourly wind patterns and velocities. Its energy supply can be made more consistent and balanced, if desired, by managing wind resources and gas plants together as is now being done with Northern Alternative Energy's major new 350 MW project in Minnesota, which combines 50 MW of wind power with 300 MW of natural gas generation.

Wind power development also provides a new cash crop – mostly for farmers – in the communities where it is located. In agricultural areas, farmers can often increase their incomes by 50 percent or more by leasing a portion of their land for wind turbines and access roads; farming operations on the rest of their land are unaffected. The opportunity to promote rural economic development and the support of farming communities have been critical to the recent expansion of wind power in Iowa and Minnesota. Likewise, the creation of new wind power manufacturing jobs by NEG Micon in Champaign, Ill., and LM Glasfiber in Grand Forks, N.D., has spurred interest and support.

## BIOMASS ENERGY

The Midwest has enormous untapped biomass energy potential from both crop residues (left over from farming) and energy crops (grown expressly for energy). The Midwest also has many coal plants that could be converted to use biomass for part of the fuel supply.

The Clean Energy Development Plan focuses on two leading near-term options to increase biomass energy production: (1) Co-firing with biomass in existing coal plants; and (2) Installing efficient combined heat and power (CHP) systems at large industrial facilities, especially pulp and paper mills. Co-firing with biomass directly reduces some of the coal use and the associated SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub> and other pollution. CHP is much more efficient than separately generating electricity and heat. Virtually all sizable pulp and paper mills in the Midwest already use their mill residues for energy, but many use inefficient steam- or heat-only boilers. Modern CHP equipment can convert biomass to steam, heat and electric power with close to 90 percent efficiency. In the future, biomass gasification may also become increasingly practical.

Increasing biomass energy will produce substantial economic and environmental benefits in the Midwest. Employment impact studies demonstrate that biomass is likely to create many more jobs than it would displace in other sectors because money flowing into agriculture creates a large number of jobs. Because biomass fuels are rarely shipped long distances, the money spent on this energy development tends to remain in rural communities.

Sustainably produced biomass provides significant environmental advantages because it generates no net CO<sub>2</sub>. The Clean Energy Development Plan relies only on biomass fuel sources that minimize environmental damages and assumes that biomass energy plants meet the same strict pollution limits as newer coal plants. It does not call for any increased logging for biomass feedstocks, but rather seizes the opportunities for use of energy crops such as switchgrass and crop residues. Biomass co-firing and CHP are the most cost-effective forms of renewable energy generation at roughly 2 - 3¢ per kWh.

## SOLAR POWER (PHOTOVOLTAICS)

Solar photovoltaic panels convert sunlight directly into electricity using semiconductor materials. They can be built in various sizes and placed in arrays ranging from watts to megawatts. Their simplicity and flexibility makes them suitable for a wide variety of applications, including central-station power plants, substation power plants for distribution support, grid-connected systems for home and business uses and off-grid systems for remote power uses.

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*Sustainably produced biomass crops, such as switchgrass, produce no net carbon dioxide (which causes global warming) and can be co-fired to reduce some coal use and the resulting pollution.*

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The amount of sunlight available to generate electricity varies by season, time of day and location. The wide-open spaces of Nebraska and the Dakotas have solar power resources comparable to parts of northern California and east Texas. Shading from buildings and trees, natural obstacles, and other variables affect local energy-producing potential. Although the Midwest is not usually considered an especially sunny region, solar power can provide economically valuable electricity because of the strong coincidence between its greatest availability on sunny summer days and the timing of peak power demands for air conditioning.

The cost of solar photovoltaics is now significantly higher than most other electricity generation, but rapid technological improvements and increased production leading to lower per unit costs are likely to make solar more cost-competitive in the future. At present, there are three markets in which solar photovoltaics are becoming economically viable. First, as mentioned above, the recent history of soaring summer peak energy price spikes makes solar a potentially attractive energy source during high energy use times on sunny days. Second, solar photovoltaics are cost-effective generation for particular off-grid uses, such as remote residences in rural areas that are far from power lines and hard-to-reach cellular relay towers. Third, solar photovoltaics may be useful and cost-effective distributed resources in specific locations that need grid support or would otherwise require costly upgrades to the existing transmission and distribution system. Moreover, solar photovoltaics may be a desired energy source for those businesses and residences preferring to buy “green power.”

Solar power development provides substantial environmental and public health benefits because it creates no air pollution, greenhouse gases or radioactive nuclear and other dangerous wastes. In addition, there are significant economic development opportunities for Midwestern solar companies that





*These solar panels, made by Spire Solar, provide clean electricity for Reilly Public School in Chicago. The manufacturing facility has created 55 new jobs on Chicago's West Side.*

manufacture both for domestic use and export to developing countries. Chicago, in particular, is seizing these solar development opportunities by supporting Spire Solar's new solar panel manufacturing plant on a former "brownfield" site, installing solar panels on the rooftops of nine major museums, and planning to build the largest single photovoltaic assembly (2.5 MW) in the country to provide cleaner and greener power for public use.

## DEPLOYING EFFICIENT GENERATION TECHNOLOGIES

Natural gas is a cleaner fuel than coal and will likely gain an increasing share of the electricity generating market. However, the market share will depend on the long-term price of natural gas, which has tended to fluctuate significantly, and fuel availability. Although natural gas plants produce less SO<sub>2</sub>, NO<sub>x</sub>, particulates and mercury pollution than do coal plants, the gas plants do produce considerable CO<sub>2</sub> emissions that exacerbate climate change. Moreover, it is important that community environmental values be respected in determining where to site these large power plants. Natural gas should be viewed as a transitional fuel from our current energy path to a more sustainable energy future, rather than as a long-term solution. The Clean Energy Development Plan includes three highly efficient technologies to use natural gas: fuel cells, combined heat and power and district energy systems.

1. *Fuel cells* combine hydrogen (from the fuel source) and oxygen (from the air) in the presence of a catalyst to generate electricity, heat and water. They have great promise as an efficient, modular,

combustion-free power technology. Over the next two decades, fuel cells can be used for central power plants or as on-site generators providing reliable distributed generation. Fuel cells are an especially strong option for "high-quality" power users – such as hospitals, financial institutions, data processing and other computer centers, museums, police and fire stations, and research labs – that have little tolerance for utility outages and interruptions. The superb reliability of fuel cells compensates for the added expense because outages can cause severe economic costs for those consumers and, in some cases, catastrophes. For this reason, the First National Bank in Omaha, Neb., recently installed four 200-kilowatt fuel cells to run its computer system, which processes \$6 million each hour in transactions. This high-reliability system is down less than four seconds per year. In the longer term, fuel cells are an essential component in a transition to a renewable energy economy.

2. *Combined heat and power (CHP)* brings together a conventional heat-producing industrial boiler or furnace with a turbine to co-generate electricity. This dual-production process harnesses waste heat and can generate electricity at efficiencies as high as 80 percent. Ongoing technological advances give CHP great potential for energy savings and economic benefits in industrial and community energy systems. For example, the McCormick Place Convention Center in Chicago uses a CHP system operated by Trigen Energy to achieve an 81 percent fuel efficiency rate, while reducing pollution from NO<sub>x</sub>, CO<sub>2</sub> and SO<sub>2</sub>. It has received a U.S. EPA Energy Star award for environmental performance.
3. *District energy systems* provide thermal energy through steam or hot water pipes to multiple customers within a specific geographic area for space heating, water heating, cooling and industrial processes. They often co-generate electric power along with thermal energy, and thereby create a highly efficient source of electricity generation. District energy systems also provide an excellent opportunity for biomass-fired CHP. For example, District Energy St. Paul supplies the downtown business district with electricity, heating and cooling. It recently announced plans to upgrade its

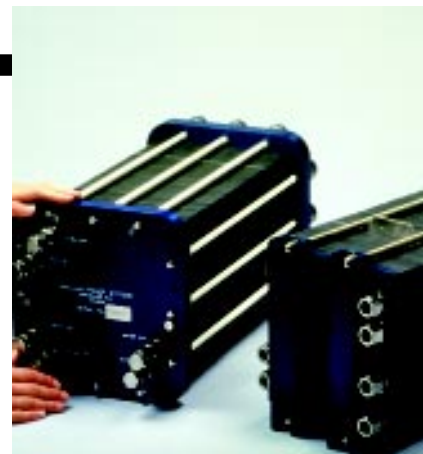
system by replacing the coal and natural gas boilers with a 98 MW wood chip-fired CHP plant that combines thermal and electricity production.

## FINDINGS: RENEWABLE ENERGY AND MODERN EFFICIENT GENERATION TECHNOLOGIES

Both renewable energy resources and modern efficient generation technologies can provide substantial clean power for the Midwest. Figure 7 presents the generation resources that are included in the Clean Energy Development Plan. Wind turbines account for the greatest new renewable capacity. Combined heat and power, using natural gas or biomass, provides the second largest source of new clean power potential. Solar photovoltaics, biomass gasification and fuel cells play a smaller role because of their relatively high costs, but, as these technologies rapidly improve, they are expected to be more cost-effective toward 2020.

Renewable energy technologies will generally be deployed in those areas with the best combination of resource potential, public policy support and business opportunities. As shown in Figure 8, the wind power potential is largest in the Great Plains states, and Illinois, Indiana, Michigan and Ohio will use more CHP because

*The remarkable reliability of fuel cells makes them ideal for users such as hospitals and financial institutions, where an uninterrupted power supply is critical and utility outages can be catastrophic.*



of their greater concentration of industrial facilities. Biomass potential is largest in Illinois, Indiana and Ohio because of the opportunities for co-firing in their large number of existing coal plants and their agricultural lands.

## POLICY RECOMMENDATIONS: IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN

These clean energy resources are now technologically achievable and economically realistic. They will not,

FIGURE 7. NEW CLEAN GENERATION CAPACITY INCLUDED IN CLEAN ENERGY DEVELOPMENT PLAN

Generator Type	2010			2020		
	Installed Capacity (MW)	Generation (GWh)	Generation (percent of total)	Installed Capacity (MW)	Generation (GWh)	Generation (percent of total)
Wind Turbines	6,698	21,283	3.0	24,510	80,795	11.3
CHP - Biomass	2,949	23,881	3.4	6,003	48,527	6.8
Biomass - Co-Firing	1,850	9,778	1.4	4,807	22,113	3.1
Photovoltaics	161	196	0.0	482	571	0.1
Biomass Gasification	<u>75</u>	<u>536</u>	<u>0.1</u>	<u>575</u>	<u>4,049</u>	<u>0.6</u>
Subtotal Renewables	11,733	55,674	8.0	36,377	156,055	21.9
CHP – Natural Gas	5,650	45,422	6.5	12,230	98,286	13.8
District Energy Systems	3,223	25,309	3.6	6,446	50,470	7.1
Fuel Cells	<u>282</u>	<u>2,267</u>	<u>0.3</u>	<u>3,257</u>	<u>25,925</u>	<u>3.6</u>
Subtotal Efficient Natural Gas	9,155	72,998	10.4	21,933	174,681	24.5
<b>Total</b>	<b>20,888</b>	<b>128,672</b>	<b>18.3</b>	<b>58,310</b>	<b>330,736</b>	<b>46.4</b>

*This includes all renewables added after 2000. The totals may not add up precisely due to rounding.*



*This light fixture is fitted with an energy-efficient compact fluorescent light bulb. Investing in energy efficiency produces significant environmental and economic benefits, without sacrificing comfort.*

however, reach their full potential without significant public policy support. Coal plants and nuclear energy currently receive enormous financial subsidies and policy benefits. Implementing the Clean Energy Development Plan will require thoughtful and aggressive action beyond business-as-usual practices and regulatory policies. Energy efficiency and renewable energy resources are also hindered by a variety of “market barriers” that prevent them from competing fairly against coal and nuclear plants on a level playing field. Public policies to overcome these market barriers are needed to obtain the benefits of more energy efficiency and wind, biomass and solar power for a more diversified electricity portfolio in the Midwest.

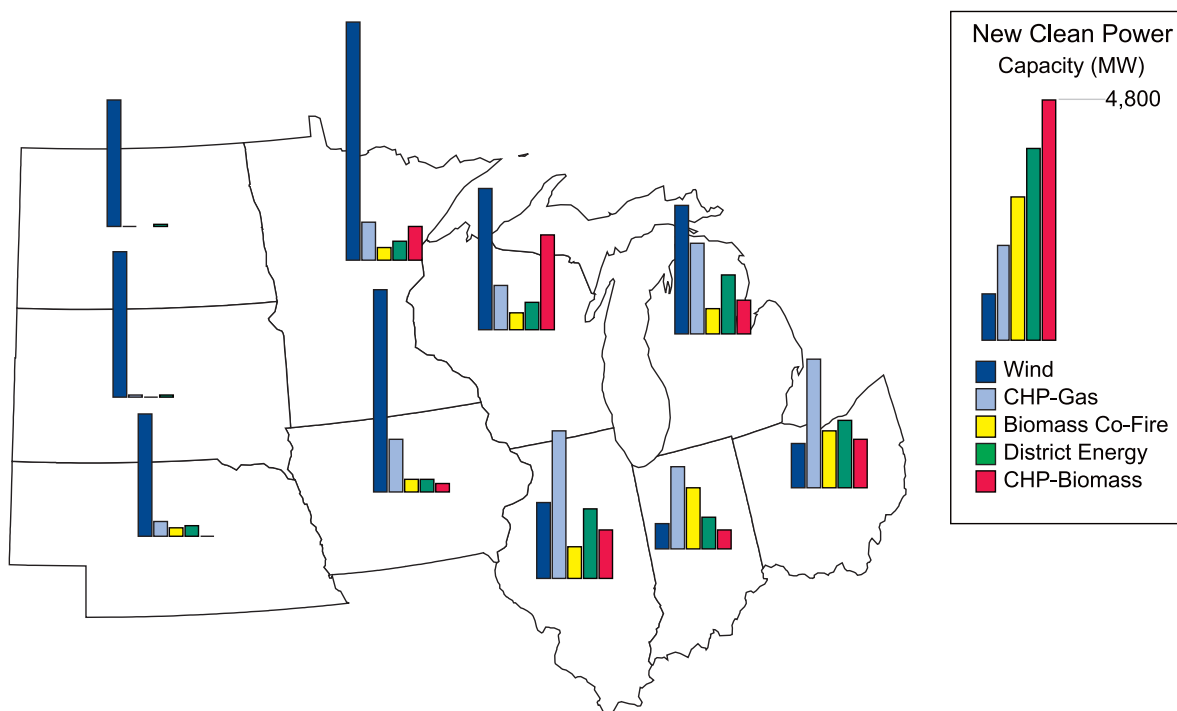
Several Midwestern states have recently taken important steps to promote clean energy, but much more remains to be done. The key policies and action

steps necessary to achieve the fundamental energy policy shift and reach the goals of the Clean Energy Development Plan are presented below.

## ENERGY EFFICIENCY

***Each Midwestern state should establish an Energy Efficiency Investment Fund, or an equivalent mechanism, supported by a non-bypassable charge of 0.3¢ per kWh*** (less than one-third of 1¢) to support the robust energy efficiency initiatives of the Clean Energy Development Plan. All electricity customers should invest in the Fund just as various decommissioning charges, franchise fees, utility taxes and other utility charges already apply to all customers on their electric utility distribution bills. All customers will benefit from the cleaner air and improved health resulting from developing energy efficiency opportunities. The Energy Efficiency Investment Fund should be implemented as soon as possible and maintained at this level until at least 2010. At that time, the impacts of energy efficiency investments should be evaluated, and public officials and stakeholders should assess whether to modify the funding levels in order to achieve the Clean Energy Development Plan’s energy efficiency target for 2020. Finally, ***Congress should enact legislation to provide substantial matching energy efficiency investment funds that can be used by states to supplement or partially offset their investment funds.***

FIGURE 8. NEW CLEAN ENERGY GENERATING ADDITIONS BY STATE IN 2020



***The Energy Efficiency Investment Fund should be managed by an independent and highly capable third-party administrator – a not-for-profit organization or foundation or an appropriate public agency.*** The Energy Efficiency Administrator should be overseen by a board including environmental and consumer organization representatives, state energy officials and energy efficiency industry representatives. The overall mission of the Administrator should be to transform the markets for energy efficiency products and services, and to maximize the long-term economic and societal benefits from energy efficiency. The new \$225 million Illinois Clean Energy Community Foundation with its mission to improve energy efficiency and develop renewable energy resources, among other things, is one model of an Energy Efficiency Administrator.

***More stringent energy efficiency standards and building codes should be applied throughout the Midwest.*** Commercial lighting improvements, more energy-efficient windows, daylighting, and heating and air conditioning efficiency are some of the most cost-effective opportunities for better environmental performance in the Midwest. Each of the Midwestern states should: (a) evaluate its current efficiency standards and building codes; (b) upgrade outdated codes and standards; and (c) establish monitoring and enforcement practices to ensure that revised standards and codes are implemented. States should coordinate their efforts to provide regional consistency.

## RENEWABLE ENERGY RESOURCES

***Each Midwestern state should promptly establish a Renewables Portfolio Standard (RPS) that requires all retail electricity suppliers to include a specified percentage of renewable resources in their generation mix.*** The RPS percentage requirement should increase steadily each year to reach eight percent by 2010, and then reach 20 percent by 2020. The RPS should require new renewable energy generation to meet the specified percentage target, not just a repackaging of already existing resources. In states that have adopted electric industry restructuring legislation, the RPS should apply to all customers, including “standard offer” or “default” customers served by electric distribution companies. The RPS should also include a renewable credit trading system, consistent with assuring improvements to local air quality through renewables development in all states, by

*Biomass gasifiers, which are an emerging renewable energy technology, can generate electricity using agricultural residues or sustainably grown energy crops as fuel.*



which qualifying renewable energy generators in the Midwest would produce credits that could be sold to retail electricity suppliers in the region. Ideally, a national RPS would be enacted, in addition to a regional RPS policy for the Midwest as a whole.

***Each Midwestern state should establish a Renewable Energy Investment Fund, or an equivalent mechanism, supported by a non-bypassable charge of 0.1¢ per kWh (one-tenth of 1¢) to support the robust development of wind, biomass and solar power.*** All electricity customers should invest in the Fund just as with the Energy Efficiency Investment Fund, because all customers will benefit from developing renewable energy resources. The Renewable Energy Investment Fund complements the Renewables Portfolio Standard, which largely supports technologies that are already close to commercial viability. The Investment Fund will also advance technologies that are still in the developmental stages. The Renewable Energy Investment Fund should be implemented as soon as possible and maintained at this level until at least 2010. At that time, the impacts of the renewables investments should be evaluated, and public officials and stakeholders should assess whether to modify the funding levels in order to achieve the Clean Energy Development Plan’s renewable energy resources target for 2020. ***Finally, Congress should also enact legislation to provide substantial matching renewable energy investment funds that can be used by the states to supplement or partially offset their investment funds.***

***The Renewable Energy Investment Fund should be managed by an independent and highly capable third-party administrator – a not-for-profit organization or foundation or an appropriate public agency*** – that should be overseen by a board including environmental and consumer organization representatives, state energy






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*Net metering laws allow consumers to sell electricity to the utility when their home or business system generates more power than they need. This promotes distributed resources and their benefits.*

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officials and renewable energy industry representatives. Competitive bidding processes, such as “reverse auctions,” should be emphasized to most effectively deploy these investment funds.

***Transmission pricing policies and power pooling practices should treat renewable energy resources fairly.*** They must account for the intermittent nature of wind and solar power operations, and their generally smaller scale and remote locations. The regional transmission Independent System Operators (ISO) and Regional Transmission Organizations (RTO) should have governance structures that reasonably include representation of both environmental organizations and renewable energy generators. “Pancaked” multiple transmission rates should be eliminated, and single “postage stamp” rates should be encouraged. Real-time balancing markets should allow generators to buy or sell firm transmission capacity that deviates from the amount reserved in advance. Spot-market bidding systems should not penalize renewable energy generators that have intermittent generating patterns. Net metering and fairer interconnection policies should be adopted as explained below.

## **CLEAN DISTRIBUTED GENERATION**

Distributed generation resources are small power plants that can be deployed at many locations throughout an electric distribution area. They can enhance generation reliability by providing power when and where most needed, as well as provide power in remote locations where it is costly and/or difficult to build new transmission lines. They can also enhance distribution reliability by providing grid support to relieve stress on aging electricity delivery systems, especially in urban and older suburban areas such as Chicago, that have recently been plagued by recurring power outages. In some cases, distributed resources may

avoid the need for transmission line extensions as sprawl pushes development beyond existing suburban areas. Policies should be designed to support clean distributed generation technologies, including small wind turbines, solar photovoltaic panels and fuel cells.

***Net metering should be enacted and implemented in all Midwestern states.*** Net metering should apply to all of the clean distributed generation technologies listed above. Net metering customers should be paid the retail rate for surplus generation that is provided back to the utility and the grid. Federal legislation to adopt net metering nationally is appropriate as well.

***Uniform safety and power quality standards should be developed throughout the Midwest*** in order to facilitate the process for customers and developers to reasonably, economically and safely interconnect to the electricity distribution system.

***Utilities and state utility regulatory commissions across the Midwest should work cooperatively to establish standard business and interconnection terms and conditions*** that will help to overcome existing institutional barriers to clean distributed generation technologies. Utilities should waive their interconnection charges for small wind power, solar photovoltaic panels and fuel cell installations because of the reliability and environmental benefits provided by these clean technologies. State utility regulatory commissions should require these steps if not undertaken voluntarily by the utilities.

***Federal and state environmental officials should apply clean air standards to small distributed generation sources so that clean power technologies are promoted and highly polluting diesel generators are discouraged.*** Congress should eliminate the exemption from federal Clean Air Act standards for small generation sources. In today’s circumstances, this exemption undermines the national air quality improvement goals, and it provides inefficient diesel generators with an unfair competitive advantage. Diesel generators, for example, produce up to 30 times as much NO<sub>x</sub> and particulate pollution as new combined-cycle natural gas plants and microturbines, but these old generators are often the first choice of some customers for standby and peak power. In addition to truly clean wind turbines, solar photovoltaic panels and fuel cells, there are also new relatively clean microturbines and other small generator technologies on the market that can achieve the benefits of distributed power resources without sacrificing environmental quality and public health.



## CO<sub>2</sub> REDUCTION POLICIES

Legislators, regulators and public stakeholders seeking to reduce CO<sub>2</sub> pollution from coal and natural gas plants should also look beyond these clean energy proposals. Aggressive energy efficiency and renewable energy resources development can, indeed, play an important role in offsetting increased CO<sub>2</sub> pollution. However, coal plants produce the largest share of the Midwest's air pollution and achieving significant CO<sub>2</sub> reductions will require reducing pollution from these plants. State and federal policymakers should consider three basic approaches to achieve CO<sub>2</sub> reductions:

1. Environmental regulations have traditionally treated each pollutant separately. Pollution regulations for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, particulates and mercury should be integrated in order to allow power plant owners to pursue efficient compliance strategies, including repowering with natural gas or retirement of older coal plants.
2. CO<sub>2</sub> pollution from fossil-fueled power plants should be subject to a cap-and-trade system similar to that currently used for SO<sub>2</sub>.
3. Legislatures, regulators and public stakeholders should establish policies to encourage or require the retirement of older, less-efficient coal plants. Retirements can be achieved through voluntary negotiations, explicit requirements and other mechanisms.

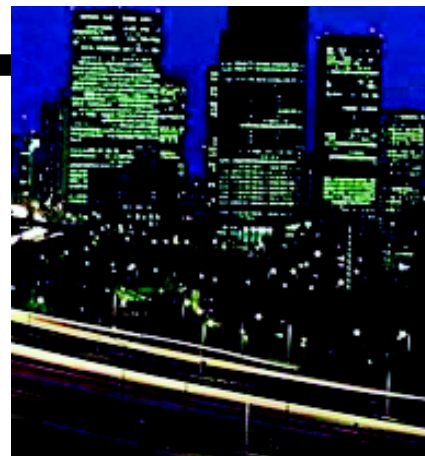
\* \* \*

The Midwest cannot do it alone. Air and water pollution cross state and regional lines. There is also an important federal role and responsibility to ensure that all regions contribute to solving pollution problems and obtaining the environmental, public health, reliability and economic benefits from clean energy development. Federal legislation should be enacted soon to provide a national renewables portfolio standard, matching energy efficiency and renewable energy resources investment funds as described above, sensible pollution reduction policies, net metering and targeted tax credits for clean energy technologies. These forward-thinking actions will provide significant added benefits for the Midwest and the nation.

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*The Clean Energy Development Plan is an achievable vision for a robust electricity system that can improve environmental quality and public health, while promoting sustainable economic growth.*

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## CONCLUSION

The Midwest Clean Energy Development Plan is visionary, and it is practical and achievable. It will require a dedicated and concerted effort by governors, legislators, regulators, the electric power industry, consumers and citizens to replace current, outdated power plants and practices with modern clean technologies and policy innovations. It will require specific steps to adopt and aggressively implement the recommended new strategies, policies, and practices. The Midwestern public is ready to seize the opportunities to robustly develop our clean energy efficiency and renewable energy resources that will lead to better environmental quality and public health, improved electric system reliability and regional economic development gains.

One or two states alone cannot achieve the full benefits of the Midwest Clean Energy Development Plan. The electricity services market is regional, and successful energy strategies and policies for the Midwest require regional solutions and cooperation across state lines. The Clean Energy Development Plan is a smart policy and technical strategy for the Midwest that can also serve as a model for the rest of the nation. As federal legislators consider more aggressive clean energy development policies and practices to secure national environmental benefits, balanced fuel portfolios and economic growth, we can and should lead the way here in the Midwest – the nation's heartland.



# 1. OVERVIEW: SEIZING THE OPPORTUNITIES TO INVEST IN CLEAN ENERGY DEVELOPMENT FOR THE HEARTLAND

The Midwest needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy makes both good environmental and economic sense for our region. Clean energy development will reduce pollution, improve reliability by diversifying our power supply, and create new “green” manufacturing and installation jobs, as well as provide new renewable energy “cash crops” for farmers. *Repowering the Midwest* is a plan to seize these opportunities.

Modern life runs on electricity to power our homes and businesses. From refrigerators to computers to dairies, we depend on reliable electricity. Nevertheless, at the dawn of the 21<sup>st</sup> century, when rapid technological progress is transforming society, the Midwest is still saddled with polluting and inefficient 1950s equipment generating the energy to drive the “new economy.” This overdependence on aging coal and nuclear plants and many utilities’ underinvestments in modernizing their deteriorating transmission and distribution systems are causing both power reliability and pollution problems.

Many economists tell us that technological advances are shaping a new economy in which economic growth provides new jobs and creates greater wealth. The rapid technological progress should also result in modern processes that produce less waste and pollution. While this is true enough in many industrial sectors, the electric industry lags behind. It is time for electric utilities and power generators to make the technological advances to give the public what we want: clean, reliable, efficient energy at a fair price. Can we keep the lights on without polluting our air and water and leaving radioactive nuclear waste for future generations to clean up? The answer is yes, and perhaps surprising to some, the Midwest heartland can lead the way if we put the right policies and practices in place.

Developing clean energy efficiency and renewable energy resources are smart and sustainable solutions to the Midwest’s pollution problems, to power constraints at summer peak demand times, and to challenges in meeting the region’s overall electricity needs. Clean energy resources are the modern technologies for our 21<sup>st</sup> century energy future.

The cost of renewable energy is plummeting as wind, biomass and solar power technologies have dramatically improved. There also are abundant opportunities to install cost-effective, modern, energy efficient technologies ranging from improved residential and commercial lighting to new industrial motors. The Midwest is poised to capitalize on these clean energy development opportunities.

When it comes to wind power, the flat lands of the Midwest are valuable assets. Wind power is the world’s fastest growing energy source, expanding nearly 35 percent in 1998. Tremendous design improvements in wind turbines have led to a huge drop in the per kilowatt price of installed capacity. Currently, this is less than one-third of the 1981 price and close to competitive with conventional power sources.

Six of the 10 states with the highest wind power potential are in the Midwest, according to the American Wind Energy Association. Iowa and Minnesota are leading the way with more than 500 megawatts (MW) of wind power (equivalent to the size of a typical coal plant) coming online since 1998. This includes the world’s largest wind farm, which provides enough energy to power 64,000 typical homes in northwestern Iowa.

More clean energy means more green jobs. Not coincidentally, two leading wind power businesses have recently located in the Midwest, providing well-paid manufacturing jobs and capitalizing on current and future market opportunities. For factory workers and farmers, this is sustainable development in action. Yet,

the enormous potential of this growing industry remains largely untapped.

Everyone already knows that Midwestern farmlands are ideal for growing the foods that energize our bodies. If we put the right policies in place, we can also count on Midwestern farmers to grow high-yield “energy crops” to help power our economy. Expanding this biomass power will create new rural jobs and provide new markets for crops while reducing air and water pollution and deterring soil erosion.

Other advanced technologies, such as fuel cells and industrial and commercial cogeneration systems, which generate electricity and heat simultaneously, can also diversify our energy supply in the near term. And, yes, even in the often-gray skies of the Great Lakes, solar photovoltaic panels that convert sunlight to electricity can play a growing role, especially on sunny summer days when peak electricity demand is highest, and in hard-to-reach remote areas where solar power provides a way around costly transmission and distribution line extensions. Natural gas plants are not entirely clean, but are generally less polluting than coal and nuclear power. When properly sited, they can also be an important part of a strategy to improve the overall environmental performance of the Midwest’s power sector.

As for the demand side of the equation, many clean energy efficiency improvements are smart, economical and waiting to be tapped. Inefficient energy use continues to waste money and cause unnecessary pollution. This can be changed by deploying new, more energy efficient heating and cooling systems, lighting, appliances, and building designs and materials. Seizing these opportunities will save money, relieve electricity demand pressures and improve our quality of life. This is especially true in the Midwest, where most utilities have underinvested in efficiency programs that save customers energy and money. Here, too, clean energy means more green jobs because Midwestern companies manufacture many of the new energy-efficient products.

Unfortunately, the electric utilities have failed to keep pace with these improvements and opportunities. Even though new technologies can generate power cleanly and efficiently, a staggering 95 percent of the Midwest’s electricity is produced by coal and nuclear plants – the two fuel sources with the worst environmental and public health impacts. These old power plants produce pollution that causes smog, acid rain and global warming, and they generate radioactive nuclear waste and other toxic pollutants. Depending so heavily on business-as-usual coal and nuclear power locks in a

high-pollution future and misses the opportunity to improve reliability by diversifying our power resources. Bypassing more energy-efficient processes and technological advances not only increases businesses’ costs, but misses the job creation opportunities in the growing clean energy sector.

The Midwest’s clean energy resources are here and ready to be developed. Our region is blessed with abundant wind resources, untapped biomass production potential and relatively high levels of solar power availability. Likewise, new energy efficient lighting and electric appliances operate at low costs while avoiding pollution, but have yet to capture a firm foothold within the industry or the marketplace.

*Repowering the Midwest* is a blueprint for producing economically robust and environmentally sound electricity in the 21<sup>st</sup> century by comparing two possible energy futures for the Midwest – one in which we continue to rely on conventional, or “business-as-usual,” technologies, and a second in which the Midwest unleashes its homegrown clean energy development potential. This Clean Energy Development Plan quantifies the region’s untapped energy efficiency and renewable resources and lays out strategies, policies and practices to advance a cleaner electricity future from the industrial Midwest to the Great Plains. These clean power options are technologically and commercially available today, and can be obtained with only a modest increase in total electricity costs – 1.5 percent in 2010 and roughly three percent in 2020 – that are far offset by the environmental and public health improvements and the economic and employment growth for our region.

As engineering improvements continue, many of the modern, clean technologies await sensible policy shifts to reverse the incentives that prop up the polluting technologies of the past. It is no longer a question of engineering know-how, but, instead, a challenge of political will. It is time to leave the 1950s behind and realize the promises of homegrown, clean energy in the Midwest to provide us with a healthier environment and a truly new economy. Now is the time to repower the Midwest for a clean energy development future.

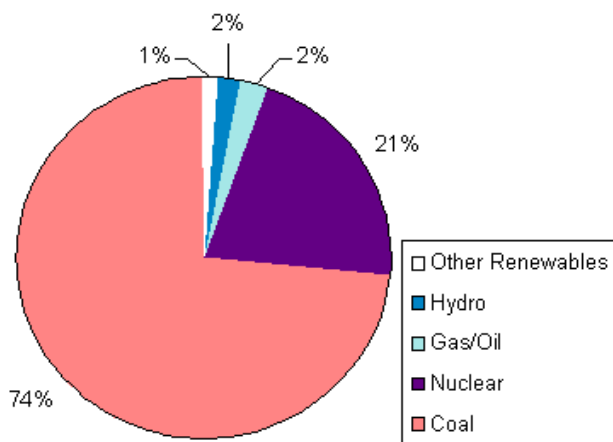
## 2. ELECTRIC POWER IN THE MIDWEST: CHALLENGES AND OPPORTUNITIES



### 2.1 THE MIDWESTERN ELECTRICITY PORTFOLIO UNDER THE BUSINESS-AS-USUAL SCENARIO

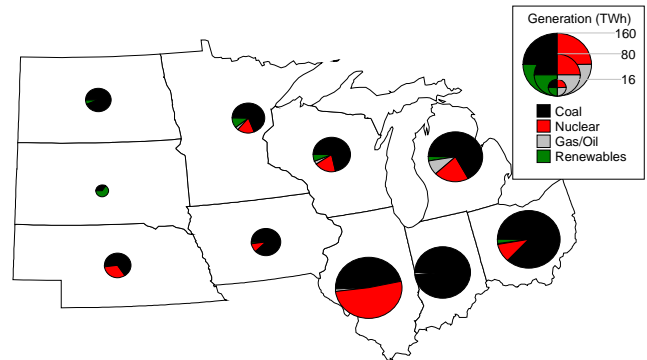
The Midwest relies almost exclusively upon coal and nuclear power for its electric power. As shown in Figure 2.1, coal plants generate roughly 74 percent of the region's electricity, while nuclear plants account for 21 percent. The nuclear units run as baseload whenever they are available, resulting in a capacity factor of 84 percent. The coal units have a capacity factor of 63 percent on average, indicating that some of them could operate at higher levels as electricity demand increases.

FIGURE 2.1 CURRENT SOURCES OF ELECTRICITY GENERATION IN THE MIDWEST (2000)



Oil and gas power plants provide two percent of the Midwest's electricity. Most of these plants are used for cycling and peaking purposes, and maintain a low capacity factor of seven percent on average. Renewable resources supply just three percent of the region's electricity. This is mostly (63 percent) from hydro-electric plants, with relatively small contributions from wind,

FIGURE 2.2 GENERATION FUEL MIX BY STATE (2000)



biomass and solar photovoltaic power. Furthermore, modern energy efficiency technologies and tried-and-true efficiency measures are significantly underutilized.

Figure 2.2 summarizes each Midwestern state's generation resources. Most electricity is generated in the five easternmost states. All Midwestern states depend on coal and most also rely on nuclear power.

Most Midwestern coal plants were built between 1940 and 1970, and many have not been upgraded with modern pollution control technologies. Approximately 37 percent of the coal plants predate 1960. These older coal plants operate at 28 to 32 percent average efficiency. Newer, combined-cycle power plants achieve far greater efficiency levels, sometimes reaching 50 percent.

Compared to other regions, the Midwest relies more heavily on these older, inefficient coal plants and thus produces a disproportionate amount of air pollution, causing health and environmental problems. The Midwest generates 21 percent of the nation's electricity, but produces 31 percent of the  $\text{SO}_2$  pollution, 32 percent of the  $\text{NO}_x$  pollution, and 26 percent of the  $\text{CO}_2$  pollution from the nation's electric industry sector.

The Midwest's easternmost power plants are among the nation's worst polluters. For  $\text{SO}_2$  emissions, power plants in Ohio, Indiana and Illinois rank first, third and fifth, respectively, in their contribution to 1999 U.S. power plant



emissions. For NO<sub>x</sub> emissions, Ohio, Indiana and Illinois rank first, third and seventh. For CO<sub>2</sub> emissions, Indiana, Ohio, and Illinois rank second, third and eighth, with Michigan not far behind at 11<sup>th</sup> (USPIRG 2000).

## 2.2 THE ELECTRICITY FUTURE UNDER BUSINESS-AS-USUAL PRACTICES

Most industry forecasts assume that natural gas power plants will be the primary source of new generation to meet future load growth. Combined-cycle natural gas power plants are much more efficient, cost less to build, and produce fewer air emissions than conventional coal power plants. The Department of Energy's Annual Energy Outlook (AEO) forecast estimates that nearly all of the new generation capacity in Midwestern states between 2000 and 2020 will be from natural gas power plants (DOE 1999).

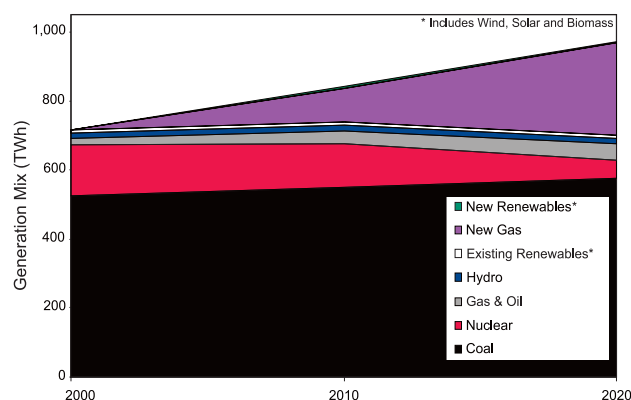
The AEO forecasts that Midwestern electricity demand will grow at an average annual rate of roughly 1.3 percent from 2000 to 2010, and about 1.0 percent from 2010 to 2020. While this is lower than the nearly two percent annual average growth rate during the 1990s, it still means much higher electricity demands. By 2020, Midwestern electricity demand will be nearly 26 percent higher than in 2000.

A reference case forecast indicates the Midwestern electric industry's likely future under business-as-usual practices. This is based primarily on the AEO forecasts, as described in Appendix 3.

The primary results of our business-as-usual forecast are shown in Figure 2.3. There is a modest decline in coal capacity expected by 2020, as some older coal plants are retired. The operating coal plants' capacity factors, however, should increase to as much as 71 percent, as existing coal plants operate more to meet new load growth. The net impact is a steady increase in coal generation over the next 20 years. There is a more significant decline in nuclear capacity by 2020, as some older units reach the end of their operating licenses.

The most significant shift between 2000 and 2020 is to new natural gas facilities. Over the coming 20 years, as much as 67.5 GW of new gas could be installed to meet new load growth and replace some retiring coal and nuclear capacity. By 2020 new gas facilities will be the second largest source of generation in the Midwest, providing up to 27 percent of all electricity. The price of natural gas and competing fuels will drive natural gas' relative contribution to future electricity generation.

**FIGURE 2.3 PORTFOLIO OF ELECTRICITY GENERATION SOURCES: BUSINESS-AS-USUAL PRACTICES**



The combination of new load growth, retiring nuclear units and new natural gas generation will result in much higher CO<sub>2</sub> emissions. Under business-as-usual practices, CO<sub>2</sub> emissions in the Midwest are likely to increase from 557 million tons in 2000 to 726 million tons in 2020, a 30 percent hike. This model assumes a decline in NO<sub>x</sub> emissions as power plant owners comply with the U.S. EPA's rules implementing the Clean Air Act. SO<sub>2</sub> emissions are expected to rise moderately as power plant owners comply with Phase II of the Acid Rain Program under the Clean Air Act.<sup>1</sup>

## 2.3 THE PRICE OF BUSINESS-AS-USUAL

The Midwest's dependence on coal and nuclear power plants exacts a heavy toll on local public health, environmental quality and the economy. Some costs specifically affect power plant owners – which could lead to higher electric rates – if not absorbed by shareholders because of rate caps. Other costs are imposed on society as a whole. In addition, as pollutants migrate from the Midwest to New England and the Mid-Atlantic, they carry a cloud of public health, economic and liability concerns along with them.

### ENVIRONMENTAL AND PUBLIC HEALTH CONSEQUENCES

#### Greenhouse Gases

The greenhouse effect occurs when trace gases in the atmosphere trap solar energy at the earth's surface

<sup>1</sup> SO<sub>2</sub> emissions are currently covered by a national cap-and-trade system under the Clean Air Act. This moderate increase in SO<sub>2</sub> emissions implies that some Midwestern power plant owners will purchase SO<sub>2</sub> allowances from elsewhere in order to maintain the national cap.

and warm the atmosphere. CO<sub>2</sub> is the most important greenhouse gas. Fossil-fired power plants produce roughly 40 percent of the total U.S. CO<sub>2</sub> emissions. Global warming will cause dire global consequences, including higher sea levels, coastal wetland floods, fish and bird habitat loss, prolonged droughts, lost crop production, increased hurricanes, increased heat-related deaths, and animal and plant extinction, as well as a spread in the geographical range of dangerous pests and diseases. In 1997, the United States and other developed nations agreed to the Kyoto Protocol, which requires the United States to reduce CO<sub>2</sub> emissions to seven percent below 1990 levels by the period 2008 to 2012.

## Ozone

Ground-level ozone, or “smog,” is created when nitrogen oxide and volatile organic compounds react in the presence of sunlight. Ozone causes upper respiratory illness, increased asthma attacks and reduced pulmonary function, especially in “at-risk” groups such as children and the elderly. It compromises resistance to infectious disease and has systemic effects on other organ systems (e.g., liver and immune system). Ground-level ozone causes several billion dollars in annual crop yield loss, as well as damage to forests and other ecosystems. In 1997, electricity generation contributed to roughly 26 percent of all NO<sub>x</sub> emissions in the United States. Illinois, Indiana, Michigan, Ohio and Wisconsin all have counties that do not comply with the National Ambient Air Quality Standards for ozone. One recent study found that residents in the Ohio River Valley experienced 83,000 asthma attacks, 1,909 emergency room visits and 636 hospitalizations because of smog levels in 1997 (OEC, OVEC and RCOVER 2000).

## Acid Rain and Visibility Impacts

Acid rain is caused by SO<sub>2</sub> and NO<sub>x</sub>, which react with other chemicals naturally occurring in the atmosphere. Acid rain has a serious impact on the Midwest, falling on the Great Lakes and the inland lakes and forests of the upper Midwest. It can damage human health, public and private property, and acidify lakes. SO<sub>2</sub> and NO<sub>x</sub> emissions also create sulfates and nitrates, which, along with particulate matter, impair visibility and create regional haze. In 1997, electricity generation was responsible for roughly 64 percent of total U.S. SO<sub>2</sub> emissions.

## Particulates

Particulate matter includes dust, soot and other solid materials, including secondary nitrates and sulfates, that enter the atmosphere during fossil fuel combustion. Particulate matter causes asthma and respiratory illnesses, and even premature deaths. Some studies show that as many as 60,000 U.S. residents may die prematurely as a result of particulates emitted at or below currently allowed levels, and that mortality risks are 15 to 17 percent higher in more polluted cities compared to the least polluted cities (EPA 1995).

## Air Toxics

Heavy metals, which occur naturally in coal and oil deposits, are released into the air during combustion of fossil fuels. The main metals emitted include arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel and selenium. Once in the environment, metals persist and can be deposited on soil, in lakes and in streams. Contaminated soil may present a health risk when directly ingested (by children) or indirectly ingested (by humans and animals) through crops that take up metals. Metal deposits in lakes and streams may harm fish, humans and other species that consume contaminated fish. Mercury poses one of the greatest health risks among persistent air toxics. Fossil-fired power plants accounted for roughly 33 percent of U.S. mercury emissions in 1995.

## Solid and Liquid Waste from Coal Combustion

Coal plants also create toxic pollution in the form of solid and liquid wastes. In fact, control technologies that capture air emissions can concentrate toxins in solid and liquid wastes. These waste streams can contain high mercury, arsenic, chromium and cadmium levels. No federal environmental laws govern disposal of such wastes, however, and only a few states have adequate waste disposal regulations. More than 100 million tons of solid and liquid wastes are generated at U.S. coal- and oil-fired power plants each year. Most of this waste is disposed of at power plant sites in unlined and unmonitored lagoons, landfills and mines (CCC, HEC and CATF 2000).

## Nuclear Fuel Cycle Impacts

Nuclear power plants create a significant risk of exposing the environment, industry workers and the general public to dangerous levels of radiation. Nuclear reactors release low levels of radiation to the air and water during routine operations, as does mining and processing nuclear fuel.

The long-term disposal of both high- and low-level radioactive nuclear wastes poses particularly difficult environmental problems. To date, six low-level nuclear waste sites have operated in the United States, and each has had major radiation leaks. Four of these six sites are now closed. There is no high-level nuclear waste site in the United States. The federal government had hoped to use the Yucca Mountain site in Nevada. Despite years of research, key concerns regarding cost, potential groundwater contamination, local seismic activity and nuclear waste transportation risks are not yet resolved. Nuclear power plants also create the threat of major radiation release through mechanical error and catastrophic accidents (REPP 4/2000; UCS 1999).

For specific estimates of environmental impacts of the Midwest's electric industry, see the Environmental Law and Policy Center's pollution calculator at [www.pollutioncalculator.org](http://www.pollutioncalculator.org). This Web site provides information on the impacts of varying levels of electricity generation and use in the Midwest.

## **Impacts of Restructuring**

Some observers contend that restructuring the electric industry will reduce pollution by promoting new, low-emission natural gas plants and forcing the retirement of inefficient coal plants with high air emissions. It is more likely, however, that restructuring will increase pollution until regulators adopt specific restructuring policies to prevent it (CCAP 1997; Tellus and RAP 1995). Highly polluting coal plants will continue operating into the future, perhaps at even higher capacity, as the markets expand under restructuring (Synapse 6/1998). Electric industry restructuring creates the opportunity to reduce pollution, but only if regulators adopt aggressive and focused policies designed to achieve cleaner energy development.

## **Local, Regional, and National Effects**

Despite growing interest in emission cap-and-trade programs to alleviate pollution, these approaches can worsen environmental problems and health harms to people living near the coal plants in the Midwest. The existing SO<sub>2</sub> and proposed NO<sub>x</sub> allowance trading programs allow each power plant owner to exceed clean air standards, if their pollution is offset by allowances purchased from other generators, which might be located far away. For example, Illinois Power bought allowances from an Oregon utility; as a result, the costs of high air pollution continued near the central Illinois coal plants, while the benefits of pollution reduction were achieved in

the Pacific Northwest. These trading programs could increase Midwestern coal generation because of the region's concentration of older coal plants. While trading programs might help achieve regional or national ozone and acid rain goals, environmental and health costs will rise in the neighborhood of power plants. In December 2000, the Harvard School of Public Health published a study of nine coal plants in northern Illinois which found that health risks (e.g., premature deaths, asthma attacks and respiratory illness) were greatest near the power plants and decreased with distance from the source (Harvard 2000).

In addition to the local public health and environmental harms, the effects of the Midwest's electric plants reverberate beyond the region, as air pollution drifts downwind to the Northeast and Canada (EPA 1998), causing smog, acid rain and global warming. This pollution migration saddles other states with associated health and environmental costs and imposes an economic burden as they struggle to comply with environmental regulations, such as National Ambient Air Quality Standards for ozone (Synapse 7/1998). The health impacts of air pollution impose serious social and economic burdens on families and society. Greater illness, whether from asthma or cancer, affects "at-risk" groups such as children and the elderly disproportionately, and equals higher health care costs, higher health insurance premiums and lower productivity due to missed work (UCS 1999).

## **ECONOMIC CONSEQUENCES**

In addition to the economic costs of the health and environmental impacts discussed above, overdependence on coal and nuclear plants will likely raise the cost of future regulatory compliance. In the past, electric utilities consistently underestimated the costs of future environmental regulations, and their high-polluting resource portfolios reflect this gamble. Thus, generators face regulatory compliance costs that are higher than a clean resource portfolio would incur, and electricity customers must pay for poor planning and short-sightedness.

In coming years, the U.S. EPA will likely: (1) require compliance with the NO<sub>x</sub> SIP Rule; (2) apply more stringent National Ambient Air Quality Standards for NO<sub>x</sub>; (3) regulate fine particulates for the first time; (4) consider regulations regarding mercury and other air toxics emissions; and (5) implement a visibility rule regarding air emissions affecting national parks. Also likely in the near- to mid-term future is some form of a CO<sub>2</sub> reduction policy, whether voluntary or mandatory.

Likewise, relying so heavily on coal makes the region vulnerable to volatile prices and fuel supply interruptions that can cause reliability problems. The current nationwide interest in developing natural gas power plants could push up the price of natural gas over the long term. Even amateur investors in the stock market understand the need for maintaining a diverse investment portfolio. Unfortunately, this theory has been lost on many Midwestern electric utilities, which have mostly failed to diversify by developing renewable and energy efficiency resources as a significant part of their electricity portfolios. While a larger share of natural gas generation will diversify the fossil fuel portfolio, a truly prudent portfolio should include more than fossil fuels. Failing to diversify in this manner imposes another economic cost: the lost opportunity to invest in the emerging economic sector of energy efficiency and renewable energy. Developing these industries in the Midwest can spur job creation and promote economic development opportunities in the emerging clean energy sector.



### 3. THE CLEAN ENERGY DEVELOPMENT PLAN: A BLUEPRINT FOR CLEAN POWER IN THE MIDWEST



There are better courses for the Midwest's electricity sector than to continue along this shortsighted and damaging path. The Clean Energy Development Plan proposes developing underutilized energy efficiency measures and largely untapped homegrown renewable energy resources to form a cleaner, more reliable and more diverse electricity portfolio for the Midwest that can spur job creation in this emerging economic sector.

The Midwest Clean Energy Development Plan will:

1. Aggressively implement modern, cost-effective energy efficiency technologies, including the newest as well as the tried-and-true approaches.
2. Develop and implement new, clean, renewable energy technologies, including wind power, biomass and solar photovoltaics (PV).
3. Develop and implement efficient natural gas uses in appropriate locations, especially combined heat and power, district energy systems and fuel cells.
4. Retire selected older, less efficient and highly polluting coal plants.
5. Apply sustainable development strategies to aggressively link these environmental improvement policies to economic development. Clean energy development means more green energy jobs for the Midwest.

The building blocks of a blueprint for the Midwest's clean energy future are described briefly in the following sections, and discussed in greater detail in Chapters 4, 5 and 6.

#### 3.1 ENERGY EFFICIENCY

Today, there are many energy efficiency opportunities already available, with more developing every year.<sup>2</sup> Residential customers can purchase efficient lighting, refrigerators, air conditioners, water heaters and clothes washers. Residential building shells can be redesigned

or retrofitted to lower heating and cooling demand. Likewise, commercial customers can reduce energy consumption via efficient lighting, cooling, heating, refrigeration, ventilation and office equipment. They can use energy management systems to optimize technology and energy use patterns. Industrial customers can piggyback highly efficient motors and redesigned industrial processes on the above measures for added energy savings.

#### THE MANY BENEFITS OF ENERGY EFFICIENCY

Energy efficiency is highly cost-effective. Installing and operating efficiency measures costs significantly less per kWh saved than generating, transmitting and distributing electricity – sometimes by a factor of two or three. Some customers know the economic advantages of energy efficiency and adopt improvements on their own. Most energy efficiency opportunities remain untapped, however, due to a variety of market barriers. Strategies to remove these barriers are explained in Chapter 8.

Lower utility bills are not the only benefits of energy efficiency. New end-use technologies and designs can improve indoor environments and comfort levels, strengthen building safety, provide health benefits, reduce water and other resource consumption, and lower building operation and maintenance costs. Energy efficiency programs targeted to low-income customers reduce a variety of social ills and costs including public fuel assistance bills, health costs, fire dangers, kerosene fume hazards, utility terminations, homelessness and other low-income social services (NCLC 1999).

Energy efficiency also benefits electric utilities. Energy efficiency reduces demand for power and improves

<sup>2</sup> The term "energy efficiency" here refers to new technologies, designs, and practices that will reduce energy use without reducing the level of electricity service provided.

the reliability of generating plants and strained transmission and distribution systems. By reducing end-use electricity demand, energy efficiency avoids electricity transmission and distribution losses. For vertically integrated electric utilities, energy efficiency saves generation, transmission and distribution costs, and improves reliability. For distribution-only utilities, energy efficiency can help avoid or mitigate the costs of transmission and distribution system upgrades.

Energy efficiency also benefits the environment. Minimizing electricity generation, transmission and distribution limits environmental damages. Hence, the environmental impacts of coal and nuclear plants – CO<sub>2</sub> emissions, NO<sub>x</sub> emissions, SO<sub>2</sub> emissions, nuclear and solid waste generation, land and water use – are contained via energy efficiency. Because efficiency is cost-effective, the resulting environmental gains cost society nothing – a clear “win-win” situation.

Energy efficiency also promotes economic development and can spur job creation in the Midwest. First, energy efficiency creates new jobs in trades related to the design, production and installation of efficiency measures. The Midwest is home to a large share of the nation’s energy efficiency manufacturing industry. Osram Sylvania in Lake Zurich, Ill., and GE Lighting in Cleveland, Ohio, manufacture energy-efficient lighting. Honeywell Home and Building Control makes thermostatic controls in Golden Valley, Minn., and Johnson Controls in Milwaukee, Wis., makes energy-efficient motors. Andersen Corporation in Bayport, Minn., and Pella Corporation in Pella, Iowa, both make energy-efficient windows. Maytag manufactures energy-efficient refrigerators in Galesburg, Ill., and washing machines in Newton, Iowa. Trane Company manufactures high efficiency air conditioning systems in La Crosse, Wis.

Second, energy efficiency lowers bills, providing residential customers with extra disposable income for other goods and services, resulting in “responding” effects that promote economic development and create jobs. Commercial and industrial customers will be more competitive, and may pass on their cost savings to customers, thus expanding their market shares (Tellus 1995). Public agencies can use budget savings to meet other responsibilities and hold down taxes. One study estimates that aggressive energy efficiency programs implemented in Illinois, Indiana, Michigan and Ohio between 1995 and 2010 could create as many as 205,000 net jobs by 2010 (ACEEE 1995).

A few electric utilities in Minnesota and Wisconsin have historically tapped into energy efficiency resources

through demand-side management (DSM) programs. Most Midwestern utilities’ demand-side and energy management efforts have, however, lagged far behind those in other states (ACEEE 2000).

## ENERGY EFFICIENCY OPPORTUNITIES

### Residential and Commercial Sectors

The potential for energy efficiency in the residential and commercial sectors is comprehensively developed in *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, prepared by a working group of five national laboratories (Five Labs 1997). That study included an investigation of the costs and performance of energy efficiency technologies available throughout the United States to reduce energy consumption and achieve significant reductions in CO<sub>2</sub> emissions.

In order to estimate the efficiency potential for the Midwest Clean Energy Development Plan, *Repowering the Midwest* applies the Five Labs analysis to the residential and commercial end-uses in each Midwestern state. The savings estimates in the Five Labs study are increased to compensate for efficiency savings from measures that were not included. The Five Labs analysis also is adjusted here to reflect state implementation rates and electricity prices. Midwestern states that have already invested money in utility DSM programs are assumed to have slightly lower implementation rates, while those with less DSM experience are assigned slightly higher implementation rates. Similarly, *Repowering the Midwest* assumes that states with electricity prices above the national average achieve slightly more efficiency savings, and those with below average prices achieve less.

### Industrial Sector

The industrial sector end-use efficiency savings are based on the Long-Term Industrial Energy Forecast (LIEF) model, developed at Argonne National Laboratory. This model was used to estimate industrial efficiency in the Five Labs study, as well as several previous studies, including *Energy Innovations* (Energy Innovations 1997) and *America’s Global Warming Solutions* (WWF and EF 1999).

The analysis considers industrial energy efficiency technologies that cut across process- or product-specific operations in the industrial sector and include improved motor systems, more efficient heating and cooling technologies, better maintenance, greater process control, and increased feedstock recycling.

The LIEF model was applied to each Midwestern state, using that state’s electricity prices, the electric intensity for each sector (based on national data per unit of economic activity), each sector’s current economic activity (i.e., contribution to the gross state product), and each sector’s forecasted growth in that state.

SUMMARY OF EFFICIENCY POTENTIAL

The most significant energy efficiency opportunities in the Midwest, by sector, are:

- 1. In the residential sector, the greatest potential is in more efficient lighting (20 percent of potential residential savings) and water heating (nine percent). For example, compact fluorescent lamps (CFL) produce the same amount of light as conventional incandescent light bulbs, but use only one-quarter as much electricity, and last 12 times longer. Replacing one incandescent bulb in a high-use area with a CFL saves a Chicago-area consumer nearly \$50 in electricity costs over the life of the CFL.
- 2. In the commercial sector, the greatest efficiency potential is in lighting technology (50 percent of potential commercial savings) and space cooling (15 percent). For example, installing modern, energy-efficient lighting ballasts in new commercial buildings or through retrofits of existing buildings produces rapid paybacks and operating cost savings in almost all settings.
- 3. In the industrial sector, the greatest efficiency opportunities are found in the metals fabrication (28 percent of potential industrial electricity savings), rubber and plastics (13 percent), primary metals (12 percent), and agricultural (11 percent) industry sectors by deploying more efficient industrial motors and drives, more advanced heating, ventilating and cooling (HVAC) techniques, and better lighting technologies.

The major population centers and industrialized areas of the Midwest are the largest electricity load centers and provide the greatest opportunities to reap energy efficiency savings. Of the total efficiency savings in the Clean Energy Development Plan, about 24 percent are available in Ohio, 20 percent in Illinois, 16 percent in Michigan, and 14 percent in Indiana.

Figure 3.1 summarizes the potential efficiency savings for the Midwest, by customer sector. Under the Clean Energy Development Plan, Midwestern electricity consumers could save as much as 17 percent of electricity demand through efficiency measures by 2010, and 28 percent by 2020. Average annual electricity demand would decline slightly from 2000 to 2020, instead of increasing by more than one percent per year under the business-as-usual scenario. By 2020, efficiency savings will avoid the need for 290 TWh of generation – roughly equivalent to the output of 100 coal plants at 500 MW each.

Implementing these energy efficiency measures is highly cost-effective. On average, reaping the energy efficiency opportunities in the Clean Energy Development Plan requires a 2.4¢ per kWh investment. That is significantly less than the cost of generating, transmitting and distributing electricity to consumers. By 2020, the proposed energy efficiency measures save \$12.1 billion in power plant and distribution system costs in return for a \$6.6 billion investment. The result is \$5.5 billion in net benefits or a savings of \$1.80 for every \$1.00 invested in energy efficiency. That, of course, does not even include the economic and social value of the environmental and public health benefits.

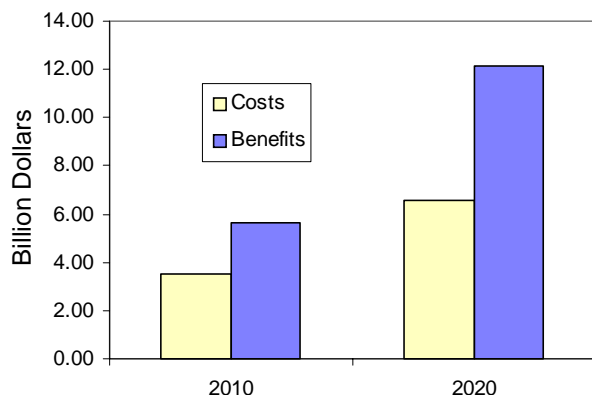
3.2 RENEWABLE RESOURCES

*Repowering the Midwest's* Clean Energy Development Plan focuses on three particularly valuable renewable energy technologies: wind energy, biomass (plant matter), and solar (photovoltaics). Other renewable

FIGURE 3.1 SUMMARY OF EFFICIENCY SAVINGS IN THE CLEAN ENERGY DEVELOPMENT PLAN

	2010 Savings (percent)	2010 Savings (TWh)	2020 Savings (percent)	2020 Savings (TWh)
Residential	22.3	61.9	33.8	107.1
Commercial	16.5	39.5	26.4	72.2
Industrial	13.4	48.2	26.8	110.3
Total	16.6	149.6	28.1	289.7

**FIGURE 3.2 BENEFITS OF EFFICIENCY RESOURCES IN THE CLEAN ENERGY DEVELOPMENT PLAN**



resources, including hydropower, geothermal and solar thermal energy, are not included for a variety of reasons.<sup>3</sup>

## WIND ENERGY

Wind energy is categorized as either large- or small-scale. Many utilities have favored large-scale wind power plants for bulk power generation. They use wind turbines of several hundred kilowatts capacity each, usually deployed in arrays of a few to several dozen machines tied to the power grid. A small-scale wind installation can consist of a single wind turbine generating up to 10 to 50 kilowatts and is designed to meet the localized needs of a farm or small business. Sales back to the grid are common, especially when net metering rates are available. Our study focuses on large wind plants because they displace the most fossil fuel use at the lowest cost, but small wind installations, as described in Chapter 5, also have a pivotal role in the development of clean energy in the Midwest.

Utility-scale wind generation technology has improved tremendously since the first wind energy boom in the early 1980s. Modern wind plants generate electricity at 3-6 ¢/kWh, depending on plant size, the site's windiness, the availability of incentives such as the federal production tax credit, and other factors. The lower end of this range is comparable to competing fossil-fuel plants such as new coal and natural gas combined cycle facilities. Over the last decade, this has helped make wind energy the fastest growing energy resource in the world. The Midwest has been the nation's leader in wind power growth as Iowa, Minnesota and Wisconsin have installed a total of 500 MW of new wind capacity over the past few years, and they are on their way to 1,000 MW of capacity. For example, about 400 MW of wind power is being developed in the Buffalo Ridge area of

southwestern Minnesota (as part of utility commitments for 825 MW), a 112.5 MW wind farm is operating in Alta, Iowa, and a new 30 MW wind power project is planned in Iowa County, Wis. Consistent with industry and government estimates, this study projects continued cost decreases and improvements in wind plant performance from 2000 to 2020, resulting in a levelized cost range in 2020 of 2.8 to 3.7 ¢/kWh (with no tax credit or other subsidy).

The Midwest is blessed with an abundance of windy land, especially in the Great Plains states of North and South Dakota, Nebraska, Minnesota, and Iowa. There are also other windy areas scattered through Illinois, Indiana, Michigan, Ohio and Wisconsin that offer strong opportunities for distributed wind power development. In principle, many states could generate far more than their current electric demand using wind, earning the region the moniker, "Saudi Arabia of wind energy." Of course, not all of this potential is likely to be developed. Three primary constraints and their implications for wind energy are considered in the Clean Energy Development Plan:

1. Wind plant output is variable as wind speeds rise and fall. Some observers have concluded that wind plants cannot displace conventional plant capacity, but only their fuel use. Many studies have proven the opposite: wind plants have a positive "capacity" value in addition to their "energy" value. Nevertheless, the intermittence of wind energy entails an added cost for the power system, which grows in proportion to wind's share of the system. This cost is accounted for in the study by applying appropriate statistical methods in the PROSYM model used to generate the Clean Energy Development Plan.
2. Sites that are distant from the existing power grid are less attractive for wind development because they require new transmission lines. This affects the site choice and wind development costs. A geographical

<sup>3</sup> (1) Hydropower is a well developed technology that is already widely used in the Midwest. The potential to expand hydropower use in the Midwest is limited, however, because of laws and regulations protecting many rivers from further development. (2) The Midwest lacks high-temperature geothermal resources suitable for power production, although low-temperature resources are useful for efficient heating and cooling of buildings using ground-source heat pumps. (3) Most of the Midwest does not have sufficient direct solar radiation on an annual basis to support solar-thermal power plants operating year-round. Solar thermal devices are effective, however, for heating water and buildings and for low-temperature industrial processes.

information system (GIS) is used to estimate such interconnection costs.

3. Deploying large amounts of wind capacity in the Clean Energy Development Plan will increase loads on both local and long-distance transmission facilities in some areas, particularly in the Great Plains and in the bulk power lines linking those states to points east. This has two implications for wind energy. First, there are added costs if transmission lines are upgraded specifically to carry the increased wind power and provide adequate security in case of line outages. Second, as transmission costs rise, there will be an incentive to locate wind projects closer to major load centers, even if that means placing them at less windy sites. Both effects were accounted for in this study, using a GIS to estimate the cost of line upgrades between wind project sites and load centers.

Wind energy provides substantial environmental and public health benefits because it creates no air pollution, greenhouse gases, or radioactive and other dangerous wastes. Nevertheless, environmental and siting issues deserve careful consideration in wind energy development. By applying responsible siting practices, wind projects can have minimal impacts on wildlife and natural resources. Wind projects in the Great Plains have not produced significant reported bird deaths. Siting issues may become more important, however, particularly in states with higher population densities and more limited wind resources. The absence of such problems in the Midwest to date and the relatively small fraction of land area designated for wind projects resulted in no specific siting constraints on wind development other than to avoid national parks and other federally protected areas.

The Clean Energy Development Plan includes 6,698 MW of new wind turbines in 2010, which is roughly four percent of the total generation capacity in the Midwest. By 2020 the amount of wind turbines increases to 24,510 MW, or roughly 13 percent of generation capacity.

## BIOMASS ENERGY

There are many biomass resources and conversion technologies, and it was not possible to consider them all in detail for this study. On the resource side, this study focuses on feedstocks with the most promise for future expansion: agricultural residues and energy crops. The most important agricultural residues - because they are produced in abundance in the Midwest and do not degrade quickly in the field - are wheat straw and corn stover. Energy crops, which are not yet commercially

produced, would be grown expressly to supply biomass power plants. The most likely cultivar for this purpose is switchgrass, a native of the Great Plains.

Logging residues are also evaluated as a fuel source. The study assumes no increase in logging activity but only better collection of residues currently left in the field and more efficient combustion of those resources. Municipal solid wastes are not included because of their environmental disadvantages. All in all, 49 percent of the Clean Energy Development Plan's biomass growth to its level in 2020 would come from switchgrass, an energy crop, 42 percent from agricultural residues, and nine percent from logging residues. The average delivered price is projected to be \$1.90 per million BTU (MBTU).

The Clean Energy Development Plan focuses on two leading near-term options to increase biomass energy production: (1) co-firing with biomass in existing coal plants; and (2) installing efficient combined heat and power (CHP) systems at large industrial facilities, especially pulp and paper mills. Co-firing has the benefit of directly reducing coal use and its associated CO<sub>2</sub> and other pollutant emissions. Wood and wood waste co-firing with coal has been practiced at a number of U.S. plants, including several Midwestern facilities such as XCel Energy's (formerly Northern States Power) Allen S. King facility. Co-firing agricultural residue and plant species like switchgrass is now being tested at a plant in Iowa. There is additional experience in Denmark and other countries. No fundamental technical obstacles appear to prevent co-firing at Midwestern coal plants.

This study assumes that only coal plants built since 1970 would be candidates for co-firing. This excludes many of the more polluting and less efficient plants, which also tend to run less often. This study further assumes that appropriate policies, such as a renewable portfolio standard, would lead to co-firing displacing 10 percent of the coal use at these plants. Federal studies indicate that co-firing rates of up to 15 percent at individual plants are technically feasible. The overall cost would be low - lower, in fact, than any other renewable resource option available on this scale except CHP. Based on DOE and private research, the estimated average cost of plant conversion is \$200 per kilowatt of biomass capacity, with a modest increase in operating costs. The resulting levelized cost of energy, at \$1.9/MBTU, is just 2.5¢/kWh.

Combined heat and power offers similar costs and benefits. Virtually all sizable pulp and paper mills in the Midwest already use their mill residues for energy, but

most use relatively inefficient steam- or heat-only boilers. With modern CHP equipment, biomass can be converted to steam, heat and electric power at nearly 90 percent efficiency. The Clean Energy Development Plan assumes that all pulp and paper mills that currently convert their wastes will adopt new equipment by 2020, substantially increasing power generation. Wastes probably won't supply all of the mills' fuel demand; thus fuels will have to be purchased on the market. Nevertheless, the leveled cost of electricity remains a very attractive 2.3¢/kWh.

Eventually, dedicated biomass-fueled power plants will develop. One promising option is biomass gasification combined-cycle generation. Although this technology is relatively expensive, its cost will likely decrease over time through technological improvements and economies of scale. The Clean Energy Development Plan deploys limited amounts of such capacity to encourage gasification's development. These deployments would be supported by targeted subsidies or research and development programs.

The potential adverse environmental impacts of using biomass must be carefully considered. For example, this study restricts projections for logging and agricultural residue removal in order to protect soil quality. No increase in logging activity is envisioned. Energy crops are limited to perennial species that minimize erosion such as switchgrass. In fact, switchgrass is widely used as a cover crop for lands enrolled in the Conservation Reserve Program. The same strict pollutant emissions limits were assumed for co-fired power plants, CHP, and dedicated biomass plants as were applied to conventional power plants. Sustainably produced biomass provides significant environmental advantages because it generates no net CO<sub>2</sub>; in some cases, however, the assumptions that assure sustainability may require specific regulations to ensure compliance.

The Clean Energy Development Plan includes 2,949 MW of new biomass-fueled CHP and 1,850 MW of biomass co-firing in 2010. By 2020 these amounts increase to 6,003 MW for biomass-fueled CHP and 4,807 MW for biomass co-firing.

## SOLAR PHOTOVOLTAICS

Solar photovoltaic panels convert sunlight directly into electricity using semiconductor materials. They can be built in sizes and placed in arrays ranging from watts to megawatts. Their remarkable simplicity and flexibility makes them suitable for a wide variety of applications,

including central-station power plants, substation power plants for distribution support, grid-connected systems for home or business use, and off-grid systems for remote power use.

*Repowering the Midwest* focuses on grid-connected PV systems because they offer the most long-term potential for displacing fossil-fuel use. Early applications are likely to be of intermediate size (10-100 kW) and designed to enhance the distribution grid. Later, rooftop commercial and residential systems could become common. Off-grid applications are the most important near-term market for PV systems, however, and should be a policy priority to stimulate the PV industry's growth.

The amount of sunlight available to generate electricity varies by season, time of day and location. The wide-open spaces of Nebraska and the Dakotas have solar power resources comparable to parts of northern California and east Texas. Shading from buildings and trees, natural obstacles, and other variables affects local energy-producing potential. Although the Midwest is not usually considered an especially sunny region, solar power can provide economically valuable electricity because of the strong coincidence between its greatest availability on sunny summer days and the timing of peak power demands for air conditioning.

The cost of solar photovoltaics is now significantly higher than most other electricity generation, but rapid technological improvements and increased production leading to lower per unit costs are likely to make solar more cost-competitive in the future. At present, there are three markets in which solar photovoltaics are becoming economically viable. First, as mentioned above, the recent history of soaring summer peak energy price spikes makes solar a potentially attractive energy source during high energy use times on sunny days. Second, solar photovoltaics are cost-effective generation for particular off-grid uses, such as remote residences in rural areas that are far from power lines and hard-to-reach cellular relay towers. Third, solar photovoltaics may be useful and cost-effective distributed resources in specific locations that need grid support or would otherwise require costly upgrades to the existing transmission and distribution system. Moreover, solar photovoltaics may be a desired energy source for those businesses and residences preferring to buy "green power."

This study assumes costs and performance typical of fixed, flat-plate PV systems. The current cost of \$5,416/kW (37¢/kWh with a capacity factor of 23 percent) for large installations is projected to decrease to \$2,877/kW (20¢/kWh) by 2010 and \$2,275/kW (15 ¢/kWh) by 2020.



The projected costs remain too high for wide-scale grid-connected applications of PV; however, the Clean Energy Development Plan envisions targeted policies that would lead to deployment of 482 MW of cost-effective PV in specific locations by 2020.

### 3.3 EFFICIENT GENERATION TECHNOLOGIES

Natural gas will play a key role in any future electric industry scenario. But, depending on natural gas carries the risk of rapid fuel price increases and fuel shortages. Plus, natural gas generation produces CO<sub>2</sub> emissions that exacerbate climate change. Natural gas should be viewed as a transitional fuel to a more sustainable energy future, rather than a long-term solution. Therefore, it is essential to use natural gas as efficiently as possible. Moreover, community environmental values must be respected in determining where to site these large power plants. The Clean Energy Development Plan includes three highly-efficient technology types that use natural gas: fuel cells, combined heat and power, and district energy systems.

#### FUEL CELLS

Fuel cells combine hydrogen (from the fuel source) and oxygen (from the air) in the presence of a catalyst to generate electricity, heat and water. As a modular, combustion-free power technology, fuel cells hold great promise for the future. Over the next two decades, they can be used in cars, basements, and central utility generating stations, replacing engines, boilers, and turbines, and producing almost no noise or pollution. Over the longer term, fuel cell technology could be an essential ingredient in a major transition to a hydrogen-based renewable energy economy.

Less than 30 MW of fuel cells are currently installed nationwide, but with recent major breakthroughs, and more pending, research budgets are skyrocketing. Today, the phosphoric acid fuel cell (PAFC) is commercially available at roughly \$3,000/kW, but costs continue to drop for all fuel cell technologies. Proton exchange membrane technologies could, if mass-produced, reach levels as low as \$200/kW once the technology matures.

The other major challenge with fuel cells is the hydrogen supply. Although solar and wind systems are the ultimate hydrogen sources (achieved by converting intermittent electricity into a dispatchable hydrogen resource through electrolysis of water), fossil fuels may be the only affordable hydrogen sources in the near-term.<sup>4</sup>

Fuel cells are expected to be relatively expensive throughout our study period; however, a small number of fuel cells are likely to be developed in markets where uninterruptible power supply is especially valuable, and as an outgrowth of public policies. The policy drivers could be technology learning, market development, local pollution reduction, and improved reliability.

#### COMBINED HEAT AND POWER

Combined heat and power (CHP) combines a conventional heat-producing industrial boiler or furnace with a turbine to co-generate electricity. This dual-production process harnesses waste heat and can generate electricity at incremental efficiencies as high as 80 percent. CHP is a well-understood technology with a long history. Ongoing technological advances give it great potential for energy savings and economic benefits in industrial and community energy systems.

New, efficient gas turbine technologies, in a range of sizes for a variety of manufacturing, thermal and electricity needs, have increased the opportunities for industrial CHP at reduced costs. In conjunction with advanced combustion turbines – or in the future with fuel cells – very high efficiencies, plus low air emissions, are possible.

Estimates of CHP additions for the Clean Energy Development Plan are based on national analyses in *America's Global Warming Solutions* (WWF and EF 1999). National process steam load and energy projections in the manufacturing industries were adjusted to reflect each state's mix of industries and their energy use. This analysis assumes that the electric capacity, generation and fuel inputs in the industrial CHP are incremental to meeting the thermal demands, and that there is no fuel switching. The study also assumes that natural gas is used in the displaced boilers and that additional natural gas is used to produce the same thermal output plus electricity in the CHP facilities. The net effects are incremental electricity output, natural gas input, emissions, and capital and operating costs – all of which occur on site. There is a corresponding drop in electricity, fuel inputs, emissions and costs from central station power plants.

<sup>4</sup> Most hydrogen today is produced from natural gas using well-established conventional chemical processes, at a conversion efficiency of roughly 70 percent. Another renewable option is to produce hydrogen from biomass, using an analogous process, but costs are likely to be much higher in the near term.

## DISTRICT ENERGY SYSTEMS

District energy systems provide thermal energy via steam or hot water pipelines to multiple customers within a specific geographic area for space heating, water heating, cooling or industrial processes. The district may be as small as several adjacent buildings within a commercial or industrial complex, or as large as a whole city. Frequently, district energy systems co-generate electric power along with thermal energy, for use by district energy customers or for sale to a local electric utility.

During the first half of the 20<sup>th</sup> century, citywide district heating systems were common in many northern U.S. cities. Citywide DES are still common in several European countries, including Denmark, Finland and the Netherlands. With the proper incentives, DES could see a major resurgence in this country. Today, low-emitting natural gas combined cycle plants can be sited in even the smoggiest of urban areas. DES have great potential to reduce energy costs and pollutant emissions by replacing building boiler systems and central station electricity with co-generated heat and power.

Average construction costs for district energy systems are about one-third above those for conventional heating and cooling technologies (DOE 1999). Significant fuel savings over the project's lifetime can offset the higher initial capital costs. In order to guarantee eventual capital recovery, however, DES developers must procure long-term contracts from potential district heating or cooling customers and/or power sales agreements with local utilities.

The DES potential in the Clean Energy Development Plan is based on assumptions and estimates in *America's Global Warming Solutions* (WWF and EF

1999). That study indicates that 45.2 TWh of DES could be installed in the 10 Midwestern states by 2010. *Repowering the Midwest* assumes that this amount of DES will be installed in the region by 2020 – a conservative estimate. DES replace building level commercial gas boilers and the resulting electricity is generated with a marginal efficiency of 73 percent – far higher than typical existing or new power plants.

## 3.4 THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE MIDWEST

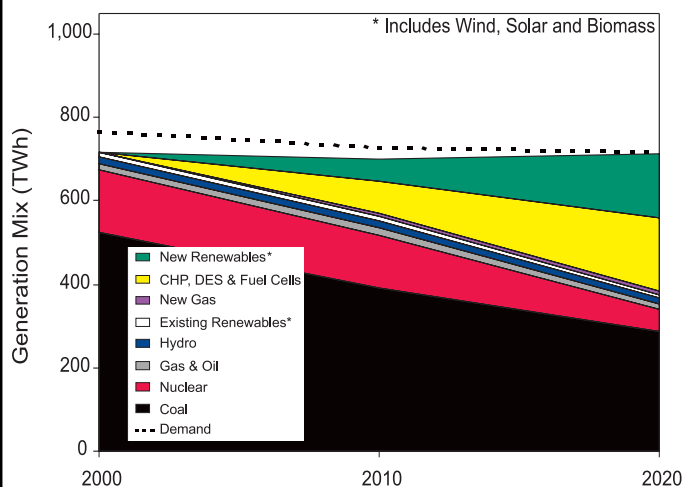
### OVERVIEW

The Clean Energy Development Plan presents an electric industry with much more diverse, sustainable and environmentally friendly practices than the business-as-usual forecast. The plan proposes developing underutilized energy efficiency measures and largely untapped homegrown renewable energy resources to form a cleaner, more reliable and more diverse electricity portfolio for the Midwest that can spur job creation in this emerging economic sector. These new clean power options displace substantial coal plant generation and reduce the need for new gas power plants. Appendix 3 discusses the methods and assumptions in the Clean Energy Development Plan model.

Figure 3.3 describes this preferable Midwestern electricity portfolio by 2020 under the Clean Energy Development Plan, which features the following changes from the business-as-usual scenario:

1. Energy efficiency measures reduce electricity generation from power plants in the Clean Energy Development Plan. Instead of growing steadily at 1.0 to 1.3 percent per year in the business-as-usual case, electricity demand declines slightly after 2000.
2. Coal generation declines significantly as renewable energy resources with increasingly lower operating costs generate more power in the Midwest.
3. Nuclear generation declines to the same extent as under the business-as-usual scenario, as the nuclear plants in the Midwest retire, on average, at their scheduled license termination dates. Some nuclear plants may operate longer by obtaining license extensions, while others may shut down earlier.
4. New, efficient natural gas plants provide 10 percent of generation in 2010 and 25 percent of generation in 2020.

**FIGURE 3.3 PORTFOLIO OF ELECTRICITY GENERATION SOURCES: CLEAN ENERGY DEVELOPMENT PLAN**





**FIGURE 3.4 ANNUAL SO<sub>2</sub> AND NO<sub>x</sub> EMISSIONS (MILLION TONS)**

	2000	2010	2020
SO <sub>2</sub> : business-as-usual case	3,409	3,550	3,771
SO <sub>2</sub> : Clean Case	3,409	2,350	1,670
NO <sub>x</sub> : business-as-usual case	1,555	794	924
NO <sub>x</sub> : Clean Case	1,555	395	271

5. Fewer new conventional natural gas plants are needed than under the business-as-usual scenario because less capacity is needed to meet demand.
6. Renewable energy resources – wind power, biomass and solar photovoltaics – supply roughly eight percent of generation by 2010 and 22 percent by 2020.

### ENVIRONMENTAL IMPROVEMENTS

The Clean Energy Development Plan cuts SO<sub>2</sub> and NO<sub>x</sub> emissions, as shown in Figure 3.4. In the business-as-usual scenario, SO<sub>2</sub> emissions increase slightly by 2020 from increased coal capacity, while NO<sub>x</sub> emissions decline significantly in 2010, as states comply with the U.S. EPA regulations. Emissions rise thereafter. In the Clean Energy Development Plan, both SO<sub>2</sub> and NO<sub>x</sub> emissions are far less, due to lower load growth and the increased use of renewables. Decreasing SO<sub>2</sub> emissions reduces acid rain falling on the Great Lakes and the inland lakes and forests of the upper Midwest, while the reduced NO<sub>x</sub> emissions will decrease smog and its associated public health impacts.

SO<sub>2</sub> emissions are currently covered by a cap-and-trade system under the Clean Air Act, and NO<sub>x</sub> emissions in the eastern Midwestern states also are likely to be covered by a cap-and-trade system. When Midwestern coal plants reduce emissions of these pollutants, they may be able to sell the allowances to power plant owners in other states or regions. Consequently, the regional or national emissions of SO<sub>2</sub> and NO<sub>x</sub> will not be reduced as much as implied by Figure 3.4. Nonetheless, Midwesterners will benefit from reduced SO<sub>2</sub> and NO<sub>x</sub> pollution, because cleaner air means fewer local health and environmental problems.

Over time, the Clean Energy Development Plan also yields dramatic CO<sub>2</sub> emission cuts, thereby mitigating the harmful effects of global warming. By 2020, emissions are half the level as under business-as-usual practices, and 36 percent lower than emissions in 2000. As shown in Figure 3.5, the Clean Energy Development Plan puts the Midwest electric industry on target to exceed the goals of the Kyoto Protocol in 2010 and would produce significant CO<sub>2</sub> emission reductions in later years.

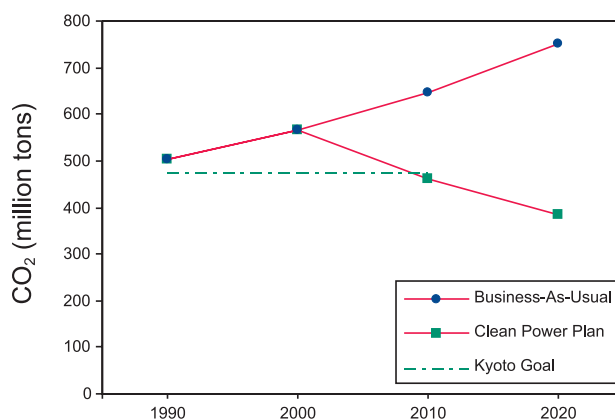
### RELIABILITY IMPROVEMENTS

The more diversified electricity portfolio in the Clean Energy Development Plan will improve electricity reliability throughout the Midwest. Today, the Midwest relies almost entirely on older coal and nuclear plants to supply electric power needs. In contrast, the Clean Energy Development Plan deploys a mix of energy efficiency, renewable energy and natural gas resources, along with the coal and nuclear plants. Energy efficiency reduces demand and improves the reliability of generating plants and strained transmission and distribution systems. Adding substantial renewable resources, along with natural gas plants, makes the region less vulnerable to dramatic changes in coal supply and to nuclear plant risks.

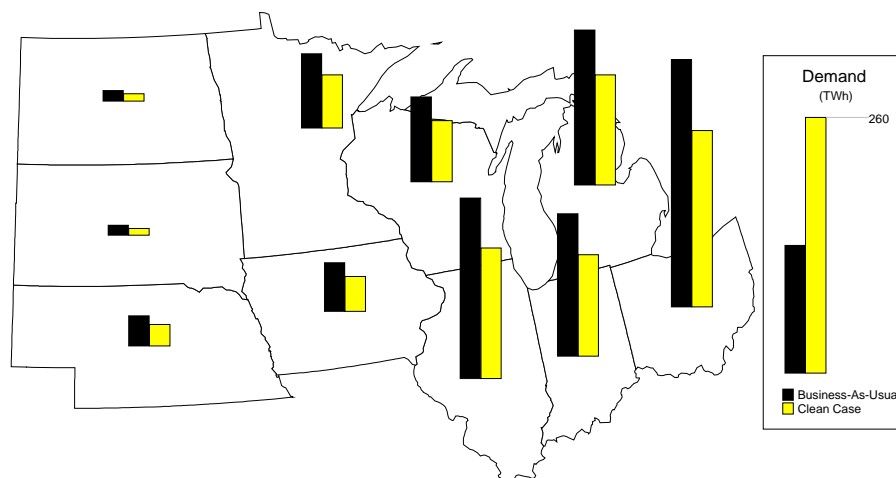
### COSTS

This cleaner, more efficient energy future is achieved with only a modest increase in electricity costs. Implementing energy efficiency measures costs far less than conventional power sources, thereby offsetting any increased marginal costs associated with renewables. The Clean Energy Development Plan is projected to increase total electricity costs by \$765 million in 2010 – which represents a 1.5 percent increase across the Midwest on average. By 2020 the Clean Energy Development Plan will increase total electricity costs by \$1,780 million – a 3.4 percent increase. The actual impact

**FIGURE 3.5 CO<sub>2</sub> POLLUTION REDUCTION FROM THE CLEAN ENERGY DEVELOPMENT PLAN**



**FIGURE 3.6 2020 ENERGY DEMAND BY STATE: BUSINESS-AS-USUAL CASE COMPARED TO THE CLEAN ENERGY DEVELOPMENT PLAN**



on a customer's electricity bill will depend upon the extent to which the customer adopts energy efficiency measures, as well as future regulatory policy and market behavior regarding electricity rates and prices.

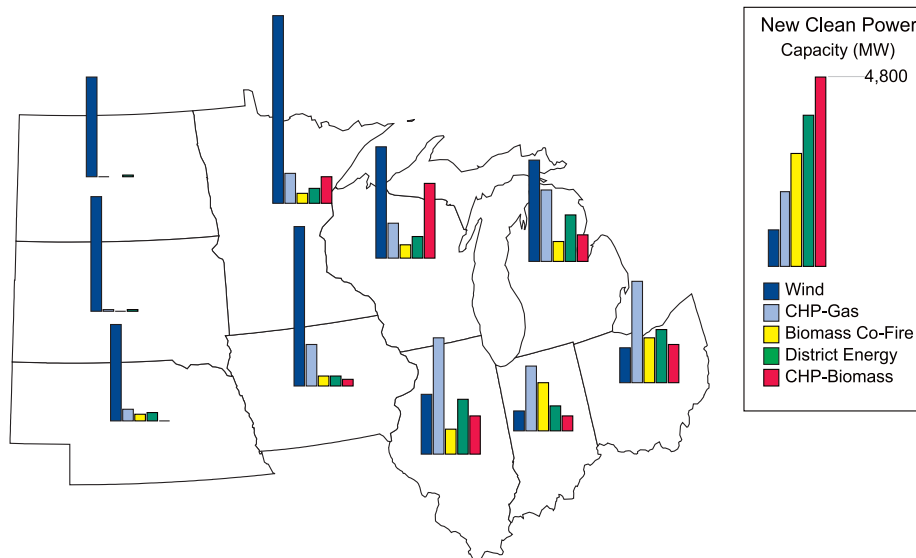
These cost estimates do not account for the federal production tax credit (PTC) for wind and biomass, and thus may overstate the costs incurred by renewable generators. Although the PTC is scheduled to expire at the end of 2001, there is broad bipartisan federal support to extend it to at least July 1, 2004, and to expand it to include additional biomass resources, biomass co-firing and residential solar technologies. If the PTC is extended through 2010, it would reduce the cost of the Clean Energy Development Plan by \$433 million in 2010. If the tax credits are extended through 2020, the cost of the Clean Energy Development Plan would be reduced by \$1,634 million in 2020. Extending these tax credits should be a priority for the Midwest's congressional delegation.

### 3.5 STATE-BY-STATE BENEFITS ACHIEVED BY THE CLEAN ENERGY DEVELOPMENT PLAN

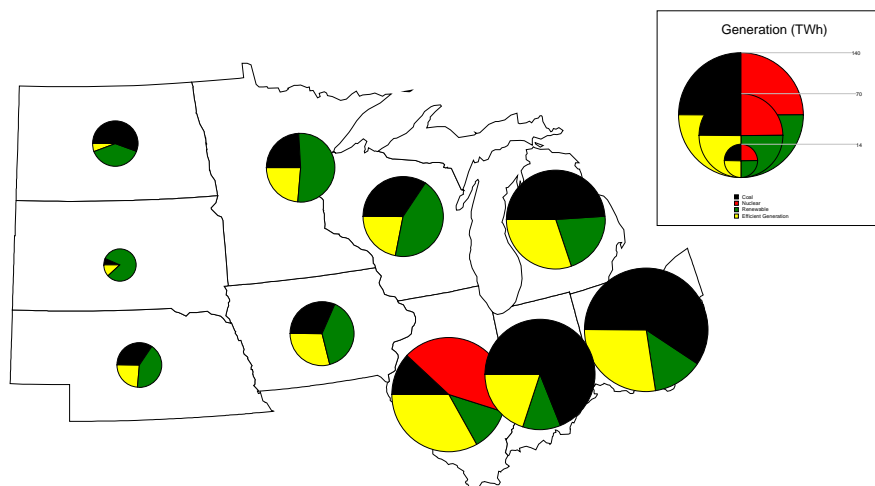
The study's electricity system model includes three National Electric Reliability Council (NERC) regions, containing all 10 Midwestern states plus all or parts of Kentucky, Missouri, Pennsylvania and West Virginia. State-by-state modeling requires two steps: (1) subtracting the electricity load and electricity generation of the four states outside of the Midwest; and (2) allocating the electricity load and generation of the remaining region to the 10 Midwestern states.

Electricity generation, as well as associated costs and emissions, is allocated to states based on the physical location of power plants. Thus, a plant's generation and impacts are assigned to the state where it is sited, even if its output crosses state boundaries. Electricity demand is allocated based on each state's historic fraction of demand in the NERC regions and utility transmission areas.

**FIGURE 3.7 NEW CLEAN POWER CAPACITY ADDITIONS BY STATE IN 2020**



**FIGURE 3.8 GENERATION FUEL MIX BY STATE IN 2020: CLEAN ENERGY DEVELOPMENT PLAN**



It is noteworthy that most states show a difference between electricity demand and electricity generation. Some states will be net exporters, where electricity generation exceeds demand; others will be net importers. This section provides an overview of the modeling results for the different states. More detailed state-by-state results are described in Appendix 1.

Figure 3.6 shows electricity efficiency savings per state by 2020, as a result of comparing the business-as-usual demand to the Clean Energy Development Plan demand. The total amount of saved energy (in TWh) is greater for states with more electricity demand. Hence, electricity savings are largest for eastern states, and lowest for western states.

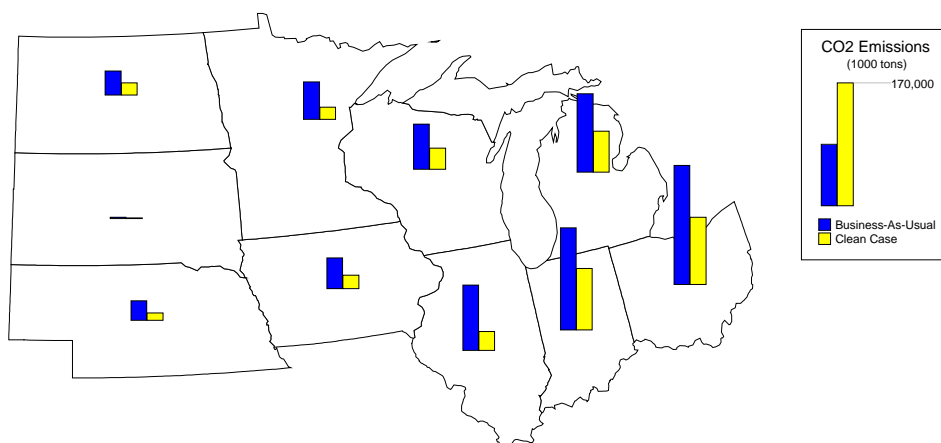
Figure 3.7 summarizes new clean power capacity additions by state in 2020. The western states show the highest amount of new wind installations, because of greater resource availability. Ohio, Illinois, Indiana and Michigan have higher amounts of CHP because of their

concentration of industrial facilities. These states also have more biomass co-firing than other states in the region because of their higher numbers of existing coal plants.

Figure 3.8 illustrates electricity generation under the Clean Energy Development Plan by fuel type for 2020. This figure is comparable to Figure 2.2, which shows generation by fuel type for the year 2000. In the Clean Energy Development Plan far more electricity is generated by renewable resources. In Minnesota, South Dakota and Nebraska, most electricity is generated by renewable resources and efficient gas generation by 2020.

Figure 3.9 summarizes CO<sub>2</sub> emissions in 2020, comparing the business-as-usual scenario and the Clean Energy Development Plan. Most CO<sub>2</sub> emissions are produced in the eastern states. Accordingly, most of the gross CO<sub>2</sub> emission cuts are for eastern states. Minnesota obtains large CO<sub>2</sub> reductions as a byproduct of its wind power installations.

**FIGURE 3.9 CO<sub>2</sub> EMISSIONS IN 2020: BUSINESS-AS-USUAL COMPARED TO THE CLEAN ENERGY DEVELOPMENT PLAN**





## 4. THE POTENTIAL FOR ENERGY EFFICIENCY IN THE MIDWEST

### 4.1 EFFICIENCY POTENTIAL IN THE RESIDENTIAL AND COMMERCIAL SECTORS

The estimate of the potential for energy efficiency in the Midwest is based primarily on the study entitled *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, prepared by a working group of five national laboratories (Five Labs 1997). That study included an investigation of the costs and performance of energy efficiency technologies available to reduce energy consumption and achieve significant reductions in CO<sub>2</sub> emissions.

The Five Labs study relies upon the EIA's 1997 AEO for a forecast of energy under a "business-as-usual," or reference, scenario. It then identifies the efficiency savings that are technically achievable and cost-effective, relative to this reference scenario. The AEO reference scenario forecast used in the Five Labs study includes reductions in electricity demand due to naturally occurring efficiency improvements, as well as efficiency standards, building codes and utility DSM programs.

The Five Labs study identifies hundreds of technically and commercially available efficiency measures that can be installed when existing electricity end-use measures naturally reach the end of their useful lives. Efficiency measures also include technologies, designs and practices that can be applied when buildings are renovated or new buildings are constructed. The study assumes that at times of stock turnover or building renovation the most efficient cost-effective measures available in 1997 are installed, instead of measures that represent the typical practice in 1997 (Five Labs 1997).

The Five Labs study estimates the cost of saved energy for each efficiency measure, by dividing the annualized incremental cost of the efficiency measure by the lifetime energy savings of the efficiency measure. The potential

for cost-effective savings is estimated by ranking the measures from lowest to highest cost, and then eliminating the highest-cost measures (Five Labs 1997).

The Five Labs study goes one step further to identify the amount of energy efficiency savings achievable in practice. The study assumes two levels of efficiency savings could be achieved, as a consequence of two different levels of public policy support. The "Efficiency Scenario" assumes that 35 percent of the technically achievable, cost-effective measures are implemented, through a moderately vigorous effort to reduce energy use and carbon emissions. The "High Efficiency/Low Carbon Scenario" assumes that 65 percent of the technically achievable, cost-effective measures are implemented, through a vigorous effort to reduce energy use and carbon emissions.

This study applies the results of the Five Labs analysis to each Midwestern state by first identifying the demand of each relevant electricity end-use for residential and commercial customers and then using the energy efficiency savings potential associated with each end-use from the Five Labs study. These residential and commercial end-uses and the percentage of their respective loads that can be reduced through efficiency (efficiency savings potential) are listed in Figures 4.1 and 4.2.

The Five Labs study does not account for certain currently available cost-effective efficiency measures, such as duct sealing, commercial office equipment, commercial building shell measures, ground source heat pumps, and advanced heat exchangers. In addition, the study does not account for any new measures that have become available since 1997 or that will become available over the next 20 years. The Five Labs study also does not account for substantial efficiency savings available from retrofitting existing end-uses. In order to compensate for these opportunities missed by the Five Labs study, the Clean Energy Development Plan assumes that, on average, 85 percent of the efficiency measures are implemented by 2010, instead of the 65 percent assumed in that study.

Not all Midwestern states are assumed to achieve the same efficiency savings (in terms of the percent of load

**FIGURE 4.1 EFFICIENCY SAVINGS AND COSTS FOR RESIDENTIAL END-USES (2010)**

<b>End-Use Type</b>	<b>Efficiency Savings Potential (percent)</b>	<b>Cost of Saved Energy (¢/kWh)</b>
Space Heating	10	4.3
Space Cooling	14	4.3
Water Heating	29	4.1
Refrigeration	13	4.3
Lighting	51	3.7
Other	30	4.5

*Notes: The "Other" category includes: cooking, clothes drying, freezing and miscellaneous uses.  
Cost of saved energy is in 1999 dollars.*

that can be reduced through efficiency). Those Midwestern states that have invested more money in utility DSM programs in the past are assumed to have slightly lower efficiency savings, while those with less DSM experience are assumed to have slightly higher savings. Similarly, states with electricity prices that are higher than the national average are assumed to achieve slightly more efficiency savings, while those with lower than average prices are assumed to achieve fewer savings. Most Midwestern states have lower than average electricity prices.

The Five Labs study provides little guidance regarding the potential for efficiency savings in 2020. While it contains a description of the many measures and designs that are expected to produce substantial efficiency savings by 2020, it does not provide quantitative estimates. The Clean Energy Development Plan assumes that advancements in efficiency savings potential will continue after 2010, but that the increase in efficiency savings potential (relative to a business-

as-usual scenario) will slow down as efficiency measures become more frequently used in common practice. Consequently, this study assumes that the efficiency savings potentials presented in Figures 4.1 and 4.2 will increase by 60 percent by 2020.

The estimated costs of saved energy also are presented in Figures 4.1 and 4.2. These are based on the saved energy costs in the Five Labs study, increased by 20 percent to represent the implementation costs that may be necessary to achieve the higher adoption rates we assume. Commercial lighting measures are assumed to have negative costs (i.e., net savings) due to reduced labor costs associated with less frequent lightbulb replacement. The Five Labs study does not estimate saved energy costs in 2020, so this study assumes that they remain unchanged from 2010, in real terms.

For the residential sector, the greatest efficiency savings can be found in more efficient lighting and

**FIGURE 4.2 EFFICIENCY SAVINGS AND COSTS FOR COMMERCIAL END-USES (2010)**

<b>End-Use Type</b>	<b>Efficiency Savings Potential (percent)</b>	<b>Cost of Saved Energy (¢/kWh)</b>
Space Heating	25	0.5
Space Cooling	27	0.5
Ventilation	26	0.5
Water Heating	7	4.1
Lighting	21	-3.1
Cooking	0	4.5
Refrigeration	25	2.0
Office Equipment	0	4.5
Other	33	4.5

*Notes: The "Other" category includes: ventilation, transformers, traffic lights, exit signs, telecommunications equipment, medical equipment, and miscellaneous uses.  
Cost of saved energy is in 1999 dollars.*



water heating. For example, compact fluorescent lamps (CFL) produce the same amount of light as conventional incandescent light bulbs, but use only one-quarter as much electricity, and last 12 times longer. Replacing one incandescent bulb in a high use area with a CFL saves a Chicago-area consumer almost \$50 in electricity costs over the life of the CFL.

The greatest efficiency potential for the commercial sector is found in lighting technology and space cooling. For example, installing modern, energy-efficient lighting ballasts in new commercial buildings or through retrofits of existing buildings produces rapid paybacks and operating cost savings in almost all settings.

## 4.2 EFFICIENCY POTENTIAL IN THE INDUSTRIAL SECTOR

The calculation of the industrial sector end-use efficiency savings relies on the Long-Term Industrial Energy Forecast model developed at Argonne National Laboratory. This model was used to estimate industrial efficiency in the Five Labs study, as well as several previous studies, including *Energy Innovations* and *America's Global Warming Solutions*.

The LIEF model is based on fits to historic data on industrial energy investments and use, using a variety of parameters, including energy prices, hurdle discount rates (which reflect the cost of money, capital constraints and various market barriers) and capital recovery period (together reflected in capital recovery factors), and the

implementation rate for efficiency measures. These fits result in a different relationship (e.g., elasticity) between these factors for both electricity and fossil fuel use for each industry analyzed. The industry specification broadly follows the 2-digit standard industrial classification (SIC), but departs somewhat by groupings into energy-intensive, fast growing and general manufacturing. These are then re-aggregated to the usual SIC groupings and the totals summed up for each state.

The Clean Energy Development Plan analysis included a range of efficiency technologies that cut across process- or product-specific operations in the industrial sector, including improved motor systems, more efficient heating and cooling technologies, better maintenance, greater process control, and increased feedstock recycling.

The LIEF model was applied to each state in the region, using that state's electricity prices, the electric intensity for each sector (based on national data per unit of economic activity), each sector's current economic activity (i.e., contribution to the gross state product), and each sector's forecasted growth in the state. The hurdle discount rate of 27.8 percent was used in the business-as-usual case projections for each state's industrial sector electricity demand. This hurdle rate was also used to benchmark the national industrial electricity demand to the AEO 1999 projection. This method resulted in a region-wide projection in agreement with AEO projections for the region.

To estimate the potential for electricity efficiency improvements, the industrial customer hurdle discount

FIGURE 4.3 EFFICIENCY SAVINGS AND COSTS FOR INDUSTRIAL END-USES

	2010 Efficiency Savings (percent)	2010 Cost of Saved Energy (¢/kWh)	2020 Efficiency Savings (percent)	2020 Cost of Saved Energy (¢/kWh)
Illinois	12	2.4	26	2.1
Indiana	13	1.8	25	1.6
Iowa	15	1.8	28	1.6
Michigan	14	2.3	29	2.1
Minnesota	14	2.1	28	1.9
Nebraska	16	1.7	30	1.5
North Dakota	17	2.0	32	1.8
Ohio	13	2.0	26	1.8
South Dakota	17	2.1	32	1.8
Wisconsin	14	1.8	27	1.6
Midwest Region	14	—	27	—

Note: Cost of saved energy is in 1999 dollars.

rate is reduced to 12.3 percent. The reduced hurdle rate represents reduced market barriers, fewer capital constraints and reduced transaction costs as a consequence of aggressive policies to promote energy efficiency. These policies are described in Chapter 8. The LIEF model is neutral on the policy mechanisms used to achieve these savings.

The results are given in Figure 4.3. The table shows, for each state, the percentage savings in industrial electricity use in 2010 and 2020 from additional energy efficiency beyond that in the business-as-usual case, along with the costs of saved energy in that year. For each year, the energy savings are from additional investments in more efficient equipment made between 2001 and that year, and the cost of saved energy represents the annualized cost in that year for those additional equipment purchases.

Because some of the model's parameters are based on national averages for various industries, the results of this model may overcount the savings available in some states, while undercounting others. Yet regionwide, the results for 2010 are comparable with the Five Labs study projections for that year.

There is significant potential for cost-effective electric savings across all industrial sectors, by deploying more efficient industrial motors and drives; more advanced heating, ventilating and cooling; and better lighting technologies. The highest potential reduction in electricity usage is in the metals fabrication industry, with 28 percent of the total industrial electricity savings in the region. This is followed by rubber and plastics (at 13 percent), primary metals (at 12 percent), and agricultural industries (at 11 percent). These savings are shown in Figure 4.4.

The state with the largest absolute savings in industrial energy usage was Ohio, which represents about one-quarter of the region's total industrial electric savings in 2020. The metals fabrication industry led in Ohio, representing nearly one-third of the energy saved in that state's industrial sector. The two states with the highest

**FIGURE 4.4 EFFICIENCY SAVINGS IN MIDWESTERN INDUSTRIAL SECTORS**

Industrial Sector:	Percent Reduction 2010	Percent Reduction 2020
Agriculture	17.1	33.3
Mining	16.5	31.8
Construction	17.2	33.7
Food	14.8	28.3
Paper	6.8	12.8
Chemicals	6.8	12.9
Petroleum Refining	6.8	12.9
Rubber & Plastics	25.0	46.4
Stone, Glass, Clay	5.7	11.0
Primary Metals	8.7	17.0
Metals Fabrication	17.7	33.8
Other Mfg.	17.2	33.2
Total Reduction	13.4	26.8

percentage of industrial electricity saved, however, were the Dakotas, which are each capable of cost-effectively reducing their industrial electric demand by almost one-third. The total electric savings in 2020 in North and South Dakota were highest in their agricultural sectors.

### 4.3 SUMMARY OF ENERGY EFFICIENCY POTENTIAL

Figure 4.5 summarizes the efficiency savings available for the Clean Energy Development Plan by customer type. In total, implementing new, as well as tried-and-true, energy efficiency measures can reduce electricity demand by nearly 17 percent by 2010 and roughly 28 percent by 2020. These efficiency savings will result in the average annual electricity load declining by roughly 0.5 percent from 2000 to 2020, instead of increasing by roughly 1.0 to 1.3 percent.

**FIGURE 4.5 SUMMARY OF EFFICIENCY SAVINGS IN THE CLEAN ENERGY DEVELOPMENT PLAN**

	2010 Savings (percent)	2010 Savings (TWh)	2020 Savings (percent)	2020 Savings (TWh)
Residential	22.3	61.9	33.8	107.1
Commercial	16.5	39.5	26.4	72.2
Industrial	13.4	48.2	26.8	110.3
Total	16.6	149.6	28.1	289.7

By 2020 the efficiency savings in the Clean Energy Development Plan could reduce electricity demand by almost 290 TWh. This amount of energy is roughly equivalent to the output of 100 coal plants at 500 MW each.

#### **4.4 CASE STUDIES OF ENERGY EFFICIENCY IN THE MIDWEST**

##### **Minneapolis Public Housing Authority**

The Minneapolis Public Housing Authority (MPHA) operates 4,856 apartments in 40 high-rise buildings located throughout Minneapolis. All of these buildings were constructed between 1958 and 1974, when little or no consideration was given to achieving low levels of energy and water consumption. As the buildings aged, frequent failures in the mechanical, electrical and plumbing systems caused high maintenance costs and increased resident discomfort.

In 1994, the MPHA began taking advantage of the U.S. Department of Housing and Urban Development's (HUD) Energy Savings Contracting Opportunities program. This is a shared savings program, where an energy services contractor guarantees annual savings on utility bills that, at a minimum, equal the cost of the efficiency improvements. The savings due to lower utility bills are shared between the housing authority and the contractor.

The financing for the MPHA efficiency improvements was achieved through a \$3.2 million bond sale and a \$2.8 million lease agreement. A frozen baseline of energy consumption was developed for a 10-year financing period. Utility bill savings relative to this baseline are guaranteed by the contractor, and are used to pay the debt service from the bond sale and lease agreement. In addition, MPHA (80 percent) and the contractor (20 percent) share any savings in excess of those guaranteed by the contractor.

Efficiency measures were applied to both the high-rise apartment buildings and the agency's staff office buildings. The contractor targeted electricity, natural gas, water and sewer systems. The electricity savings were achieved by installing energy efficient lighting in all common areas, installing variable frequency drives on ventilation fans and pump motors, and installing constant air regulators. The latter two measures allow for optimal usage of, and reduced demand on, boilers and furnaces, resulting in gas and electricity savings. An energy management system (EMS) also was installed to monitor equipment remotely, allowing staff to not only control the equipment but also to diagnose and anticipate problems.

The total project cost was \$5 million, and the guaranteed utility savings were set at \$5.4 million over the 10-year financing period. The contractor originally projected that actual savings would exceed these guaranteed savings by roughly \$1.1 million dollars. Experience with the first years of the program indicates that actual savings will be much greater, and are expected to exceed the guaranteed savings by roughly \$3.7 million. This means that the overall benefit-cost ratio for the project is 1.82. Other benefits of the project cited by the MPHA include improved resident comfort levels, improved ability to respond to resident complaints due to the EMS, reduced maintenance costs, freed-up funds to be used for other housing improvements, and environmental benefits.

The MPHA is so pleased with the success of the project that it has begun a second phase, using a similar financing approach. This will include roof top fans, super-efficient refrigerators, and additional improvements to the heating, ventilation and air conditioning system. The MPHA is also considering a third phase, with additional efficiency measures to be installed in the future (MPHA 2000; MPHA 1999).

### **Fifth Third Center Tower, Cincinnati**

Fifth Third Center Tower is a 32-story office building in downtown Cincinnati, with a five-story attached building. One of the principal owners of the building, Fifth Third Bank, is also one of its largest occupants. Hence, the owners have a financial stake in improving the efficiency of the building in order to reduce energy bills. The owners invested their own money to achieve the efficiency upgrades, based on the expectation of lower operating costs in the future.

The project has included the following efficiency improvements:

1. A computerized Energy Management System (EMS) was installed to optimize energy consumption patterns.
2. The heating, ventilation and air conditioning system was upgraded. The former constant-volume reheat system was replaced with an efficient variable air-volume system controlled by the EMS. The EMS allows single floors to be isolated for after-hours heating and cooling, if necessary.
3. Efficient T-8 fluorescent light bulbs and electronic ballasts were installed and connected to the EMS to provide zone control on various floors. High pressure sodium lamps were installed on the loading dock and parking garage. Exit signs and interior "can" lights were retrofitted with efficient bulbs.
4. High efficiency motors and variable speed drives were installed on fans and pumps as the old equipment was replaced.
5. To address concerns about air quality and proper ventilation, CO<sub>2</sub> sensors were installed and linked to the EMS.

As a result of these measures, the building's electricity consumption has been reduced by 58 percent and gas usage has been reduced by 83 percent. These savings have reduced annual electric and gas bills by \$400,000. All of these savings were highly cost-effective – each efficiency project had a payback period of two years or less. Additional benefits include better quality lighting, comfortable temperatures and improved indoor air quality. The lighting measures also resulted in reduced cooling requirements (Power Boosters 1995; Fountain Square Management Company 1996).



## 5. THE POTENTIAL FOR RENEWABLE ENERGY RESOURCES IN THE MIDWEST

used in this study are then summarized and several case studies of successful projects that can be replicated elsewhere are presented.

### 5.1 OVERVIEW

Reducing the Midwest's reliance on fossil fuels demands not just an improvement in energy efficiency but also a sustained commitment to the use of clean, renewable energy resources. Fortunately, the Midwest has clean renewable energy in abundance. Wind power, biomass (such as energy crops and conventional crop residues) and solar energy can all play an important part in moving the Midwestern states toward a less polluting mix of energy resources.

Several states have already taken steps toward developing renewable sources of electricity (Figure 5.1). Minnesota and Iowa have moved to the forefront of wind energy development with the installation of more than 500 MW of wind capacity.<sup>5</sup> Wisconsin, though it starts with much less windy land than its neighbors to the west, has already installed 23 MW and plans an additional 30 MW. Michigan leads in the use of biomass for electricity generation with nearly 400 MW of capacity, about 40 percent of the total for the region, and Wisconsin is not far behind. In a few states, small solar systems have been connected to the power grid, and many more are used in situations where grid connection is impractical or very expensive.

Still, compared to its potential, renewable energy is not being widely installed. The Clean Energy Development Plan shows how it is both practical and affordable for the Midwest to obtain 22 percent of its electricity from renewable energy resources by 2020. This is not pie-in-the-sky – there are plenty of wind, biomass and solar resources to produce far more than that at a reasonable cost, and the technologies to do so are already on the market or near at hand.

The following sections describe the three key renewable resources in this study – wind, biomass and solar – in-depth and assess their market prospects, the quantity and distribution of resources, and technological advancements. The assumptions

### 5.2 WIND ENERGY

#### MARKET ASSESSMENT

Wind energy has come a long way since the boom-and-bust period of the 1980s. For the past 10 years it has been the fastest growing energy resource in the world, with installed capacity rising annually at a 25 percent clip. Worldwide sales of wind turbines and related equipment and services already measure in the billions of dollars. Although U.S. installations have not been growing as fast as in other parts of the world – largely because of comparatively weak and inconsistent federal and state policies – the United States began to experience renewed growth in the late 1990s, much of it in the Midwest. For example, nearly 400 MW of wind power is being developed in the Buffalo Ridge area of southwestern Minnesota (as part of utility commitments for 825 MW), a 112.5 MW wind farm is operating in Alta, Iowa, and a new 30 MW wind power project is planned in Iowa County, Wis.

What is driving the growing use of wind energy in the United States? A combination of factors, including growing awareness of the environmental and economic benefits of wind energy, the declining cost and improving performance of wind plants, and a variety of federal and state policies.

#### Federal and State Policies

The federal production tax credit (PTC) has been vital to the financing of many wind projects. The PTC is currently valued at about 1.7¢/kWh. Since it only applies for the first 10 years of a plant's life, however, its impact on the levelized cost of wind energy (calculated over 20 or 30 years) is less. The PTC was originally enacted through mid-1999, but has been extended by Congress.

<sup>5</sup> Because wind plants do not run often at full capacity, the output of 500 MW of wind capacity is roughly equivalent to that of a 200 MW coal plant.



**FIGURE 5.1 CAPACITY OF GRID-CONNECTED RENEWABLE PLANTS (1999)**

	<b>Hydro MW</b>	<b>Biomass MW</b>	<b>Wind MW</b>	<b>PV MW</b>	<b>Total MW</b>	<b>Fraction of Total (percent)</b>
Illinois	40	114	0	0.03	155	0.5
Indiana	91	6.4	0	0.00	102	0.5
Iowa	134	7.5	258	0.01	410	5.1
Michigan	2,412	384	1	0.08	2,896	12.4
Minnesota	213	111	275	0.07	743	8.1
Nebraska	184	0	4	0.00	188	3.3
North Dakota	518	9	1	0.00	528	11.2
Ohio	129	42	0	0.00	211	0.8
South Dakota	1,741	0	0	0.00	1,741	62.9
Wisconsin	511	246	23	0.09	818	6.3
<b>All</b>	<b>5,974</b>	<b>920</b>	<b>560</b>	<b>0.27</b>	<b>7,790</b>	<b>5.3</b>

*Source: National Renewable Energy Laboratory Renewable Electric Plant Information System (online). Note: Biomass capacity excludes municipal solid waste.*

State directives have played an even more important role. For example:

1. Minnesota's Prairie Island Mandate requires XCel Energy (formerly Northern States Power) to develop 825 MW of wind by 2012 in return for permission to store nuclear waste in dry casks. Virtually all of Minnesota's 275 MW of wind capacity in 1999 was developed in response to this law.
2. Iowa required that utilities purchase or generate the equivalent of two percent of their electricity from renewables by 1999. Though once challenged by utility companies, the law has led to the installation of 258 MW of wind in the state.
3. Wisconsin required the state's four eastern utilities to install or purchase the output of 50 MW of renewable capacity by the end of 2000. Wisconsin also adopted a renewable portfolio standard requiring that 1.7 percent of the state's electricity come from renewable resources by 2011. So far, most of the capacity that has been installed or planned is wind power.

## Technological Trends

In the early 1980s wind energy had a reputation for being costly and unreliable. These criticisms are no longer true. The long-run cost of wind energy from large machines has dropped from more than 30¢/kWh in the early 1980s to 3-6¢/kWh today (DOE 2000). The cost of wind energy includes the annualized capital cost and ongoing operating costs. The range of costs reflects the windiness of the site, the size of the plant, the availability of tax credits and other factors. The lower end of this range compares favorably with wind's leading fossil fuel competitor, natural gas-fired combined-cycle plants. At the same time, the efficiency and reliability of wind equipment has soared. Today, individual wind turbines are typically available for operation 98 percent of the time - better performance than many fossil-fueled power plants.

## Environmental Benefits

The fact that wind turbines produce no air pollution, greenhouse gases or solid wastes makes them an attractive option for states and communities interested in addressing these problems. Furthermore, by applying responsible siting practices, wind projects can have minimal impacts on wildlife and natural resources. Minnesota's Prairie Island Mandate, for example, endorsed wind energy as a way to offset the perceived environmental and safety risks of dry cask nuclear fuel storage.

## The Algona Wind Project

Although wind energy is a proven technology, not every utility company manager feels comfortable embarking on a large wind project without first gaining some experience on a smaller scale. The Algona, Iowa, wind project shows that effective federal and state policies can help even small municipal power companies overcome this initial hurdle - and generate a substantial amount of clean power at the same time (DOE 1999a).

The instrumental policy was the U.S. Department of Energy's Wind Turbine Verification Program (TVP), which provides funds to demonstrate new wind turbines. But the groundwork was laid much earlier by an Iowa law requiring investor-owned utilities to use wind-generated electricity. Municipal utilities were not bound by this law, but many saw the writing on the wall and expected to eventually become wind producers themselves. They were also responding to strong customer support for clean power initiatives.

Seven municipal utilities were thus primed to respond to a 1996 TVP request for proposals. The project they proposed cost \$2.8 million, of which \$1.3 million was funded by TVP while the rest was paid by the utilities. The result was the Iowa Distributed Wind Generation Project. The lead utility is Cedar Falls Utilities, and the project is located in the service territory of Algona Municipal Utilities, which maintains the turbines. The other participating utilities are Ellsworth, Esterville, Fonda, Montezuma and Westfield, Iowa.

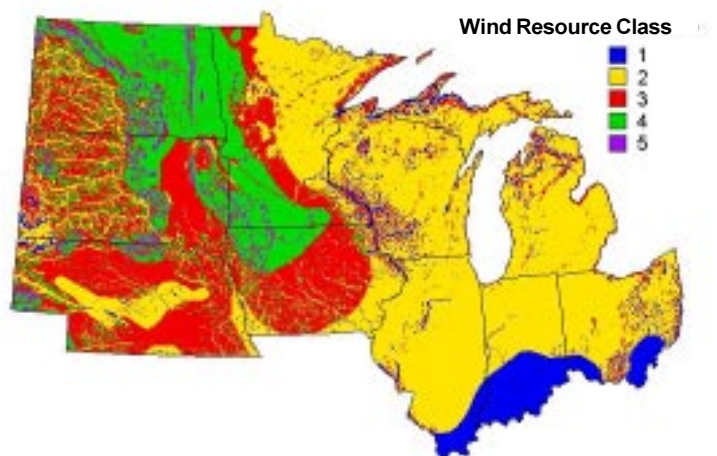
The Algona project, which went into operation in September 1998, uses three Zond 750 KW turbines mounted on 160-foot (50 meter) towers, creating a total (peak) plant capacity of 2.25 MW. The power output at the plant has already exceeded expectations thanks to good winds, high turbine performance and high equipment reliability. From November 1998 to October 1999 the plant ran at a 33.1 percent average capacity factor, almost 13 percent higher than projected (EPRI 12/1999).

## Economic Benefits

The economic benefits of wind energy for the communities where plants are located are another important factor behind its resurgence in some Midwestern states. In agricultural areas, farmers can increase their incomes by 50 percent or more by leasing a small portion of their land for wind turbines and access roads; farming operations on the rest of the land are unaffected. For example, a wind energy company has paid \$1 million to farmers in Edgeley, N.D. for five-year options to lease their land for wind turbines. Wind energy can also help the local economy by increasing the tax base. The opportunity to promote rural economic development and the support of farming communities has been critical to the success of wind energy in states such as Minnesota and Iowa. Likewise, the creation of new windpower manufacturing jobs by NEG Micon in Champaign, Ill. and LM Glasfiber in Grand Forks, N.D. has spurred interest and support.

Wind energy nonetheless faces challenges in making further inroads into Midwestern markets. Where state directives do not exist, wind projects must usually compete on cost alone; and although the cost of wind energy has

FIGURE 5.2 GEOGRAPHICAL DISTRIBUTION OF WIND RESOURCES



## Wind Energy Environmental and Siting Issues

Wind energy is a clean source of energy but that does not mean it raises no environmental or siting issues. Fortunately, the once widespread concerns that wind power plants might result in the deaths of many birds or have other serious impacts on wildlife have gradually diminished with experience in many different settings. The only wind plant area in the United States where bird deaths have been reported as a serious problem has been the Altamont Pass in California (Biosystems 1996); no serious problems of this nature have been reported in the Midwest. Since 1992 the National Renewable Energy Laboratory has worked with environmental groups, utilities, government agencies, university researchers, consumer advocates, utility regulators, government officials and the wind industry to study wildlife-wind energy interactions. While it may be too early to lay the issue to rest, it appears likely that with careful, responsible siting practices, wind projects will have minimal impacts on wildlife (NWCC 1997).

Public concerns about visual and noise impacts of wind plants may place limitations on where wind projects can be developed. This is an especially important challenge for the wind industry in densely populated states with fewer good wind resource sites to choose from. In Wisconsin, for example, concerns have been expressed about the impact of wind projects on property values. Some people object to the sight of wind turbines either near their communities or in scenic areas or are concerned about the noise turbines may generate.

Several positive trends in wind turbine design may help mitigate these problems. For instance, as wind turbines get bigger, far fewer are needed to supply the same power - and 10 large turbines have a much smaller visual impact than 50 small ones. And the tubular tower design of modern turbines is more pleasing to the eye than the old lattice towers. Modern wind turbines also are far less noisy than their predecessors. A single turbine located 400 feet away actually produces less noise than wind rustling trees only 40 feet away (NWCC 1997). With appropriate setback distances from houses and buildings, noise should not pose a serious problem.

come way down and is continuing to drop, it is still not low enough to beat new natural gas combined-cycle facilities in most cases. The intermittence of wind output complicates the cost equation. Although studies show that wind makes a valuable contribution to the reliability of power supply (Tellus Institute 1994), power companies sometimes regard it merely as an energy saver and accordingly pay less for it.

Other challenges include transmitting power from distant windy sites to major load centers; a lack of familiarity with the technology among decision-makers such as power company managers; obstacles to Native American tribes developing wind on their land; and contracts that limit the flexibility of municipal and cooperative utilities to choose their power suppliers. These barriers - as well as ways to overcome them - are discussed in more depth in Chapters 7 through 9.

## THE WIND RESOURCE

The wind blows often and strong in many parts of the Midwest. Figure 5.2 depicts the geographical distribution of the wind resource according to the latest nationwide assessment (UCS 1993).<sup>6</sup> This map assigns areas a range of predicted average annual wind speeds. With today's wind technology, most utility-scale wind plants are being installed in class 4, 5 and 6 areas, but projected improvements should make class 3 areas attractive in the future. (Smaller wind turbines for residential and farm applications are designed to run in lower wind speeds.) The windiest areas are in the Great Plains, including western Minnesota, Iowa, Nebraska and the Dakotas. Portions of other states - particularly

<sup>6</sup> The Union of Concerned Scientists' resource map was developed through a GIS-based analysis of the National Wind Resource Atlas (DOE 1987). Although the Great Plains have been extensively studied, the lack of wind resource maps developed using up-to-date methods remains a significant barrier to wind development in other parts of the Midwest.

hilltops and the shores of the Great Lakes – have favorable winds as well. A wind measurement program in Wisconsin, for example, has revealed areas of class 3-4 suitable for wind projects.

However it is measured, the wind energy potential of the Midwestern states is enormous. Even after excluding environmentally sensitive areas and considering only class 3 and better resource areas, several states could theoretically supply all of their electricity demand with indigenous wind resources – and still have plenty for export. In addition, many windy areas are quite close to existing transmission lines, making it relatively inexpensive to connect them to the power grid (NREL 1994).

### Assumptions for This Study

A GIS was used to identify suitable wind sites and rank them in order of increasing cost for the Clean Energy Development Plan. First, the annual output of a wind turbine located at any point in the region was estimated using the wind resource map. Second, the cost of constructing a wind plant of 100 MW size at any point, including the cost of building a new line to connect with the existing transmission grid, was calculated. (National parks and forests were excluded.) Third, the levelized cost of electricity was estimated by combining the output and the capital and operating costs. A cost-supply curve with this information was constructed for each state. Finally, the effects of bulk transmission constraints and wheeling charges, as well as the cost of wind generation itself, on the likely distribution of wind plants among the states in the region were considered.

In developing this scenario, several possible constraints on wind energy, including difficulties in siting new wind projects, the cost of wheeling power to load centers, and possible constraints on transmission capacity were considered.

**Siting Issues.** In the Great Plains, where most Midwestern wind development has taken place, siting issues have not been a serious problem. Many farmers are eager to have wind turbines on their properties to increase their income, and wind plants in general are a good fit with agricultural uses of land. Given the extraordinary abundance of windy agricultural land in those states, siting difficulties are unlikely to pose a major constraint until well after 2020 (the end point of the Clean Energy Development Plan), if at all.

The same cannot necessarily be said for states in the eastern part of the Midwest, where population densities

are higher and the number of suitable wind sites smaller. Potential issues include the visual and noise impacts of wind plants, possible conflicts with other environmental interests such as endangered species protection, and perceptions that property values will go down. These challenges can be met if the states and communities concerned and the wind industry follow some important guidelines. Foremost among them is the need to involve the affected public early in the process and in a significant way. The importance of addressing this issue is discussed further in Chapter 9.

**Transmission Constraints.** Wind developers often lack choice about where to build a wind project – they must go where it is windy and where landowners and communities are receptive. This means that wind projects must sometimes pay a significant cost to send power where it is to be used. In fact, the Clean Energy Development Plan includes a large increase in transfers over certain parts of the transmission grid because of wind energy. The increase in transmission of wind energy will be offset to some degree by reductions in the transmission of conventional power. Three types of wind-related transmission costs were considered:

1. An assumed average construction cost of \$240,000 per mile (DOE 1999), was added to the construction cost of the wind projects to address the cost of building a transmission line from a wind project to the nearest point on the transmission grid.
2. Many regions face constraints on transmission capacity.<sup>7</sup> With the moderate wind deployments projected for 2010 in the Clean Energy Development Plan, only a portion of the transmission grid would need upgrading at an average cost of \$32,000 per mile. By 2020, however, the upgrades will be much more extensive and will cost an average of \$120,000 per mile. The distance is calculated along the existing transmission grid from each wind project to the nearest major town or city.

<sup>7</sup> A study of the transmission constraints on wind energy in the Dakotas conducted by the Western Area Power Administration and the National Renewable Energy Laboratory concluded, “The MAPP region (covering western Minnesota, Iowa, the Dakotas and Nebraska) is limited by the ability of the (transmission) interfaces...to transfer power after a disturbance without severe swings in voltage or power, rather than by facility thermal overloads.” Specifically, the study found that at most interconnection points wind additions were limited to about 100 MW without the need for grid strengthening (NREL/WAPA, 2000).

3. The Clean Energy Development Plan places substantial wind capacity in the windy Great Plains states where power demand is relatively modest. Much of the power produced would be exported to points east, resulting in likely transmission bottlenecks. The cost of overcoming this limitation was estimated with the PROSYM model by estimating the change in energy transfers between transmission areas, and then increasing the line capacity between certain areas to keep line loadings within tolerable levels. The average upgrade cost

was estimated to be \$500 per MW-mile (EIA 1999a).

Overall, the transmission upgrades add almost \$75/kW, or almost 10 percent, to the total cost of wind energy in 2020 in the Clean Energy Development Plan.

In addition to addressing these constraints in the technical analysis of wind energy, options for mitigating these transmission issues are discussed further in Chapters 8 and 9.

### Hydrogen Transmission Opportunities

Renewable resources, such as wind power, are often located far from electricity load centers. Generation from remote renewables can be carried to loads by electrical transmission wires. A promising alternative, however, is energy transmission in the form of hydrogen delivered by pipeline. For example, it is possible to convert wind-generated electricity in the Dakotas to hydrogen by electrolysis, and transmit the hydrogen by pipeline to population centers such as Chicago, where it can be used to produce electricity in fuel cells. Despite the conversion losses and additional technology costs involved in using hydrogen as the long-distance energy carrier, this hydrogen transmission scenario is worth considering for several reasons: (1) the Dakotas' wind energy is an underutilized resource; (2) the electrical transmission system in the Dakotas is potentially insufficient to handle large-scale introduction of wind-generated electricity to the grid; (3) hydrogen offers useful storage that can help match the timing of intermittent wind generation to the timing of loads; and (4) transmission of energy by hydrogen is less costly than transmission of electricity by wire.

An analysis of hydrogen transmission was conducted as part of this study. The analysis found that while transmission of wind energy by hydrogen is not currently economic, there are various developments that could make it attractive by 2010. Specifically, with substantial improvements in fuel cell technology, increases in natural gas prices, and higher than expected pricing of CO<sub>2</sub> emissions, transmitting wind power as hydrogen can be realized at a lower cost than transmitting wind power as electricity.

It is important to note that the development of hydrogen as an energy carrier is likely to be driven by developments in the transportation sector. If policies and technology for hydrogen-fueled vehicles evolve quickly, then hydrogen's role in the electric sector will be enhanced as well. Key uncertainties affecting hydrogen's success in the transportation sector include fuel cell technology cost reductions, fuel cell efficiency improvements, and climate change policy.

The report, *Transmitting Windpower from the Dakotas to Chicago: A Preliminary Analysis of a Hydrogen Transmission Scenario*, is available online at [www.synapse-energy.com](http://www.synapse-energy.com) and [www.repowermidwest.org](http://www.repowermidwest.org).



## WIND TECHNOLOGY

Utility-scale wind power plants consist of one or more individual wind turbines, each of which generates electricity through a generator in its housing. The power output of the turbines - carefully modulated by power electronics - is collected and the voltage is boosted at a transformer to the correct level for long-distance transmission. An above-ground transmission line may be required to bring the power from the site to the grid.

Although in the early years of the wind industry companies experimented with many different designs, most of today's wind turbines are of the horizontal-axis type, with two or three blades facing upwind on a tubular or lattice tower. While their basic design has not changed much in the past decade, wind turbines have become larger as companies have sought to capitalize on economies of scale. In 1981, a typical new wind turbine produced a maximum of 25 kW, had a rotor 10 meters (32 feet) in diameter, and cost \$2,600 per kilowatt. Today's turbines typically generate 750-900 kW, have rotors spanning 50 meters or more, and cost around \$800 per kilowatt. Despite their growing size, today's wind turbines are far less noisy and more attractive than their predecessors.

Wind plants range enormously in size, from a single turbine for a small community to hundreds of turbines producing enough power to supply thousands of homes. The largest wind plant in the world is a 112.5 MW plant located near Alta, Iowa. Although there are economic advantages to building large wind plants with many turbines, smaller facilities have a different kind of appeal. There is increasing interest in this development path, more common in Europe, which features individual or small clusters of large machines owned by landowners, farmers' cooperatives or similar groups and connected to the low-voltage distribution system for power sales to the local utility. In addition, some Midwestern utilities have installed small wind clusters supported by revenue from utility-run "green pricing" programs.

Although the focus of this study is on large wind turbines and power plants because they offset the most fossil fuel use, small wind turbines have an important part to play. The United States is a leading manufacturer and exporter of these systems, which are aimed primarily at two markets: remote or off-grid power, such as villages in developing countries; and grid-connected residential or farm applications. Small wind turbines designed for residential and commercial

applications occupy a significant and growing market niche in the Midwest. (See Sacred Heart Monastery below.) Although their costs per kilowatt-hour tend to be higher than their larger cousins, small turbines have the virtue of operating near, or at the end of, the distribution grid where they displace higher-cost energy and capacity. They also function in lower-speed winds. The installed cost for a typical 10 kW turbine on a 30-meter tower is approximately \$3,300 per kilowatt, including all parts, shipping and installation (Bruce Bailey, AWS Scientific, personal communication). This cost may decrease in the future as the industry's production grows.

### Small Wind Turbines: The Sacred Heart Monastery

The Sacred Heart Monastery in Richardton, N.D., has been generating wind power since June 1997.<sup>8</sup> Using two used Silver Eagle turbines (which were upgraded with new components) that each generate around 90,000 kWh annually, the monastery has managed to reduce its annual electricity bill by almost \$12,000, or one-third. The savings reflect one of the key advantages of small wind systems compared to their larger cousins: they offset electricity at retail rates (in this case 8.75¢/kWh) rather than much lower wholesale rates.

Of course, the monastery sees many benefits of its wind project aside from just saving money. Their members have the satisfaction of knowing they are helping to reduce their contribution to air pollution and global warming. The project has also drawn much attention and interest from people who spy the turbines from a nearby interstate.

The main complaint associated with the project is that the utility company does not pay the full retail rate, or anywhere near it, for electricity produced in excess of the monastery's needs. If it did, the monastery would be able to earn a greater return than what is possible by simply reducing the amount of power they draw from the grid. Net metering is a key strategy for increasing the use of small wind systems around the Midwest and is discussed in more detail in section 8.3.

### Assumptions for This Study

There is substantial experience with wind energy in the Midwest to provide ample data on current costs,

<sup>8</sup> Mick Sagrillo, "Monastery Pleased with Wind Turbine Performance," American Wind Energy Association (2000). Information can also be obtained at the monastery's Web site, <http://www.rc.net/bismarck/shm/bwitness.html>.

and the technology is sufficiently mature that projections can be regarded as fairly reliable. Consistent with studies by the Department of Energy and the Electric Power Research Institute, the Clean Energy Development Plan projects gradual but steady declines in the cost of wind power plants and similar increases in their efficiency and output. Though year-by-year changes are likely to be modest, the cumulative impact over the 20 year period of this study will be substantial. The study's assumptions are summarized in Figure 5.3.

Another characteristic of wind energy is its intermittence. It would be incorrect to represent wind in the PROSYM model as a steady or firm power source, because its fluctuations will affect the type and cost of fuels it displaces, as well as loads placed on bulk transmission systems. This required assumptions about the statistical characteristics of wind plants so they could be simulated correctly.

An individual wind plant was represented in the model as having a certain probability of being either "on" or "off." Because there is some spatial and temporal correlation of winds, however, there is a tendency for several wind plants in the same area to be "on" or "off" at the same time. If they are all modeled independently, the result would be that the wind output would appear too steady throughout the year.

Analysis of wind data from numerous meteorological stations in the Midwest indicated that to avoid this pitfall all wind plants within an area covering roughly 200x200 kilometers should be modeled as a single block. This means, for example, that all of the wind plants located in the western MAPP region (the Dakotas, western Minnesota and Nebraska) are represented by 5 "super-plants", each with an independent probability of being either "on" or "off". The result is approximately the correct statistical behavior of overall wind plant output in the PROSYM model.

**FIGURE 5.3 CURRENT AND PROJECTED WIND ENERGY COSTS AND PERFORMANCE<sup>9</sup>**

	2000	2010	2020
Capital (\$/kW)	1100	810	660
O&M (¢/kWh)	0.8	0.5	0.4
Capacity Factor			
Class 3	24.5 percent	27.4 percent	29.6 percent
Class 4	28.9 percent	32.4 percent	35.0 percent
Class 5	33.0 percent	37.0 percent	39.9 percent

## Electric System Stability and High Wind Penetration

Electrical system operators face the challenge of instantaneously, or nearly instantaneously, matching a constantly fluctuating demand for electricity with supply from a large array of power plants with unique operating characteristics. Electrical system dispatch is complicated when the supply of electricity also fluctuates, as it is caused by the varying output from wind turbines in response to wind speed increases or decreases. This volatility leads to concerns about the stability of the electrical system when wind, or other intermittent resources, provide a significant share of the electricity supply.

The British Wind Energy Association estimates that the fluctuation caused by the introduction of wind to the system is not discernible above normal system fluctuations—until electricity generated from wind turbines reaches approximately 20 percent of the total system supply. Several regions in northern Europe are approaching this figure. According to the European Wind Energy Association, wind energy now accounts for 13 percent of domestic electricity demand in Denmark. The state of Schleswig-Holstein in Germany serves 18 percent of its demand with wind power. Under the Danish national energy plan, new offshore and onshore wind turbines are expected to increase wind generation to the point where it provides more than 50 percent of total electricity consumption before 2030. With this amount of installed capacity, the wind turbines will periodically cover more than 100 percent of Danish electricity demand.

Some renewable electricity technologies are unavoidably intermittent and will need to be supplemented with less intermittent energy supplies. Currently, that means conventional electricity plants, but in the future the electricity supply could be regulated through the use of baseload biomass gasifiers, hydrogen fuel cells, hydrogen pipelines and other storage technologies. In addition, increased energy efficiency helps to lower customer demand, thereby contributing to system stability.

The renewable resources in the Clean Energy Development Plan are not likely to create electrical system stability problems. The intermittent resources (wind and PV) in the plan represent roughly 12 percent of generation in the region in 2020, which is below amounts that have been successfully implemented in Europe.

<sup>9</sup> Source: AWS Scientific, Inc., based on industry and government data. Assumes an average new wind plant size of 50 MW in 2000 and 100 MW in 2010 and 2020. The capacity factor increases reflect projected improvements in technology and increases in tower height from 60 to 80 meters in 2010 and 100 meters in 2020. The capacity factors include expected electrical, mechanical and wake losses. Capital costs do not include transmission interconnection.

## 5.3 BIOMASS ENERGY

### MARKET ASSESSMENT

Like wind energy, biomass experienced a boom in the early 1980s thanks to favorable federal and state policies and incentives put in place in response to the oil crisis. Since then biomass use in the power sector has continued to grow, although much more slowly. As Figure 5.1 indicates, there is currently almost 920 MW of biomass capacity operating in the region (excluding plants using municipal solid waste), with most concentrated in Michigan, Minnesota and Wisconsin. The majority of the plants produce both heat and electricity – CHP facilities. They mainly burn wood residues from pulp and paper production and from logging; they are owned by pulp and paper mills and paperboard manufacturers.

There is enormous potential to expand the use of biomass energy in the Midwest for two basic reasons. First, the biomass resource is very large thanks mainly to the abundance of agricultural land from which both crop residues (left over from farming) and energy crops (grown expressly for energy) can be extracted. Second, the Midwest has a large number of facilities that can be converted, at relatively low cost, to generate electricity from biomass. The two most important near-term opportunities are: (1) the conversion of inefficient steam-only boilers in the pulp and paper sector to efficient CHP; and (2) the co-firing of biomass and coal in existing coal plants.

Increasing the use of biomass in the form of crop residues and energy crops would have substantial economic and environmental benefits. Employment impact studies have demonstrated that biomass facilities create many more jobs than they displace in other sectors, because money flowing into agriculture creates a disproportionately large number of jobs (UCS 1993). Furthermore, biomass is rarely shipped long distances, so money spent on biomass fuel tends to remain in communities near the power plants. At the same time, biomass has a major environmental advantage: when produced in a sustainable manner its combustion generates no net CO<sub>2</sub>. (Other types of air pollution must be controlled just as they are in fossil fuel plants.)

There are, however, significant challenges to be overcome before biomass can supply a much larger share of the region's electricity generation. First, biomass feedstocks (aside from mill and logging residues, which are virtually free) are more expensive than coal, which is their main competitor. Even crop residues, which cost

nothing lying on the ground, become expensive relative to coal when the costs of collecting, transporting and processing them are taken into account.

Second, there is a lack of infrastructure for the production of new biomass feedstocks. Most crop residues are left on the ground, so farmers would have to make significant investments of time and money to collect and deliver them to power customers. They are unlikely to do so without the prospect of a stable and growing market for their product. From the power companies' standpoint, the absence of experienced fuel suppliers creates significant risks for any new biomass power project that might be contemplated. Similar issues confront the use of energy crops.

Third, there is insufficient incentive for owners of existing biomass steam-only plants to convert to efficient CHP. The conversion will, of course, require an investment which must be offset somehow – either by using the power generated to lower the industry's electricity bill or by selling the power to a utility company. Industrial electricity prices and utility buy-back rates are not high enough to make conversion attractive to most plant owners.

### BIOMASS RESOURCES

Biomass energy comes in many different forms, including dedicated energy crops and crop, mill and logging residues. Mill and logging residues are already widely used for energy and other needs in the pulp and paper sector; here, the main opportunity is increased efficiency of energy conversion through modern CHP.

Crop residues (stalks and leaves) are usually left in the field after harvesting. To prevent excessive erosion it is not desirable to remove all such residues, but a portion can be collected and converted to energy. Residues of corn cobs and stalks, as well as straws from cereal grains, are often produced in quantities that far exceed levels necessary for erosion control. Furthermore, they contain few nutrients and, consequently, are of little value as fertilizer.

Research has been conducted for a number of years on a variety of energy crop types. The most promising for the Midwest appears to be switchgrass, a perennial that is native to the Great Plains and is deep-rooted, very persistent and less susceptible to drought than other options. Switchgrass is already used as a cover crop for erodible land not in active cultivation.

## Assumptions for This Study

Estimates of the amount of each type of biomass that would be available at different prices were taken primarily from research by the Oak Ridge National Laboratory (ORNL) (Walsh, et al., 2000). The ORNL model considers environmental constraints, such as limits on agricultural and logging residue removal, as well as economic factors. A summary of the assumptions for each feedstock type is provided below.

**Logging Residues.** No increase in logging is assumed, only the more efficient use of logging residues that are currently being left in the forest or burned off. The ORNL model classifies the total forest inventory by the several wood categories and by volume, haul distances and equipment operability constraints. Environmentally responsible retrieval practices are then applied carefully. For example, this inventory is revised downward to reflect the quantities that can be recovered in each class due to constraints on equipment retrieval efficiencies, road access to a site (e.g., no new roads are built), and impact of site slope on harvesting (e.g., no harvesting on slopes steeper than 20 percent). The estimated delivered price of forest residues includes collection, harvesting, chipping, loading, hauling and unloading costs; a stumpage fee; and a return for profit and risk.

**Mill Residues.** Mill residues are excluded because they are being used almost entirely as fuel or to produce fiber products.

**Crop Residues.** Millions of acres in the Midwest are planted in corn, wheat, grain sorghum, soybeans, hay and other crops. The ORNL analysis of crop residues was limited to the two most important sources of feedstock – corn stover and wheat straw. Although many acres in the Midwest are dedicated to soybean production, soybean residues are not produced in great quantities and tend to deteriorate rapidly in the field, limiting their usefulness as an energy feedstock. Other potential residue sources include barley, oats, rice and rye.

The amount of corn stover and wheat straw theoretically available in each state was estimated by first calculating the total quantities of residues produced, and then calculating the amount that could be collected without harming soil quality and erosion control. The estimated prices of corn stover and wheat straw include the cost of collecting the residues, a premium paid to farmers to encourage participation, and transportation costs. The premium paid to farmers, \$10-15/dry ton, is based on the experience of several companies that purchase corn stover or wheat straw for bedding, insulating materials,

particle board, paper and chemicals. The transportation cost of \$5 - \$10/dry ton covers hauling crop residues a distance up to 50 miles.

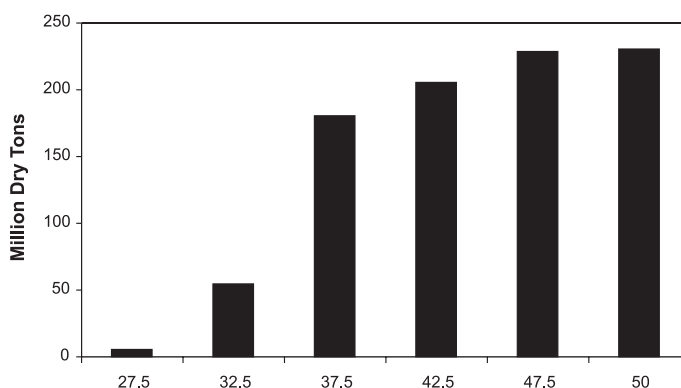
**Energy Crops.** Dedicated energy crops include herbaceous crops such as switchgrass. Currently, dedicated energy crops are not produced in the United States, but could be if they were sold at a price that ensured the producer a sufficient profit. The ORNL POLYSYS model was used to estimate the quantities of energy crops that could potentially be produced at various energy crop prices. POLYSYS is an agricultural sector model that includes all major agricultural crops (wheat, corn, soybeans, cotton, rice, grain sorghum, barley, oats, alfalfa, other hay crops); a livestock sector; and food, feed, industrial, and export demand functions.

Energy crop yields vary within and among states, and are based on field trial data and expert opinion. Energy crop production costs are estimated using the same approach that is used by the USDA to estimate the cost of producing conventional crops. Recommended management practices (planting density, fertilizer and chemical applications, rotation lengths) are assumed. The POLYSYS model estimates the farm-gate price; an average transportation cost of \$8/dry ton (representing a mean haul distance of 50 miles) is added to determine the delivered price.

A special run of the POLYSYS model was performed by ORNL for this study to provide county-level production estimates for prices ranging from \$27.50/dry ton to \$47.50/dry ton. Estimates for the last model year, 2010, were used.

**Summary.** Figure 5.4 shows the projected total amount of biomass from crop residues, energy crops and forest residues that could be available over a range of prices. One dry ton of biomass has an average

FIGURE 5.4 PRICE SUPPLY CURVE FOR BIOMASS FEEDSTOCKS

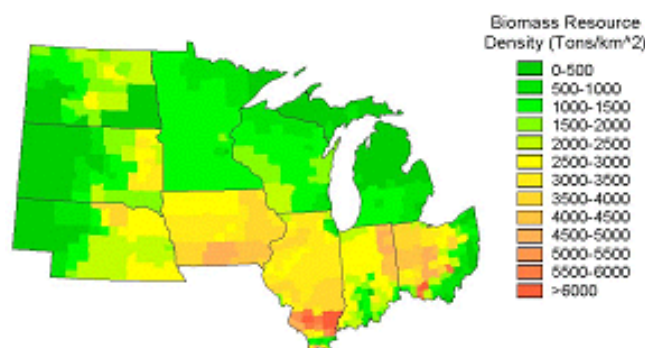




heating value of 17 million British thermal units (BTU). One hundred million dry tons of biomass is sufficient to supply about 23,000 MW of biomass plant capacity at an average heat rate of 10,000 BTU/kWh and average capacity factor of 85 percent.

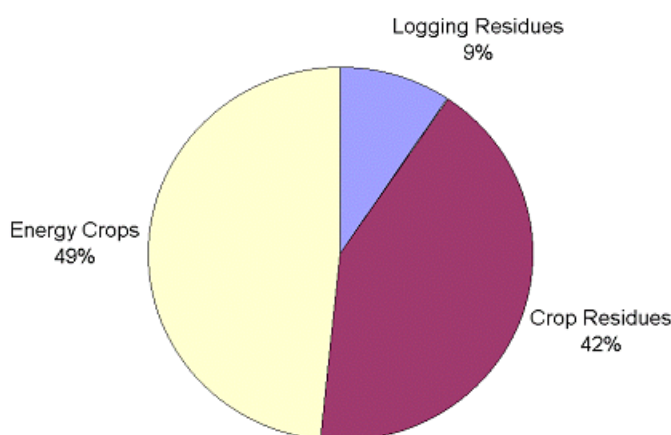
Figure 5.5 shows the distribution of estimated biomass availability by county across the region at a price of \$37.5/dry ton. Reflecting the importance of crop residues and energy crops, the largest resource densities are in the Corn Belt areas of Iowa, Illinois, Indiana and Ohio. The resource distribution at each price point was used to determine the resources available for conversion of coal plants to co-firing, as described in Section 5.3.3.

**FIGURE 5.5 DISTRIBUTION OF BIOMASS RESOURCES AT \$37.5/DRY TON**



Finally, Figure 5.6 shows the approximate breakdown of biomass feedstocks consumed in 2020 in the Clean Energy Development Plan. The energy crop component consists entirely of switchgrass. Logging residues rely upon better use of residues from existing logging operations; no new logging is included in the Clean Energy Development Plan.

**FIGURE 5.6 BREAKDOWN OF BIOMASS RESOURCES IN CLEAN ENERGY DEVELOPMENT PLAN (2020)**



## CO-FIRING BIOMASS WITH COAL

A relatively low-cost, near-term option for converting biomass to energy is to co-fire it with coal in existing power plants. Co-firing means mixing the biomass with the coal to reduce the amount of coal used. Co-firing has been practiced, tested or evaluated for a variety of boiler technologies, including pulverized coal boilers of both wall-fired and tangentially-fired designs, coal-fired cyclone boilers, fluidized-bed boilers, and spreader stokers. Demonstrations and trials have shown that biomass can effectively substitute for 15 percent or more of coal use (DOE 1999b).

Preparation of biomass for co-firing involves well-known and commercial technologies. After “tuning” the boiler’s combustion output, there is little loss in total efficiency. Test results indicate that a 0.5 percent decrease in the boiler’s overall thermal efficiency with 10 percent biomass co-firing is appropriate. Since biomass generally has much less sulfur than coal, there are reductions in SO<sub>2</sub> emissions, and, to a lesser degree NO<sub>x</sub> emissions.<sup>10</sup>

The cost of converting a coal plant to co-firing varies widely depending on the size of the plant, the type of boiler, the available space for storing biomass, and the fuel drying and processing facilities required. For cyclone-type boilers, the cost may be as low as \$50/kW of biomass capacity. Such boilers, however, are not common in the Midwest. Conversion costs tend to be higher for the far more common pulverized coal (PC) boilers. The Department of Energy estimates a median cost of \$180-\$200/kW of biomass capacity. As shown in Figure 5.7, we assume a cost of \$200/kW and a supplemental O&M cost of \$10/kW-yr.

The potential for co-firing in the Midwest is large because of its many coal-fired power plants. Counting only newer and larger coal plants that are likely candidates for co-firing,<sup>11</sup> there are 90 plants with a total capacity of 49,200 MW that could be adapted to

<sup>10</sup> Concerns have been raised that some types of biomass fuel, as well as some types of coal, with a high alkaline content may contaminate the catalyst used in selective catalytic reduction (SCR), a form of NO<sub>x</sub> pollution control that may be required of many coal plants in the future. (David Tillman, Foster Wheeler, personal communication.) This study assumes that alternative catalysts will be developed by the time co-firing is widely deployed. See Section 9.2.7.

<sup>11</sup> Newer and larger coal plants tend to run more often. This means that an investment in co-firing conversion can be recovered more quickly.



**FIGURE 5.7 CHARACTERISTICS OF BIOMASS CO-FIRING RETROFITS**

	Plant Boiler Types	
	Cyclone	PC
Capital (\$/kW)	50	200
Fixed O&M (\$/kW-yr)	2.5	10
Heat Rate Penalty	5 percent	5 percent

co-fire biomass. Assuming an average co-firing fraction of 10 percent, that equates to a potential of 4,920 MW, representing a feedstock demand of roughly 20 million dry tons of biomass per year. As shown in Figure 5.5, the biomass resource in the Midwest is large enough to sustain such a deployment at an average price below \$32.5/ton or \$1.9/MBTU.

It is important, however, to consider how much biomass might be available - and at what price - within a feasible trucking distance of the plants. A GIS was used to assess this question. First, biomass resource density was mapped at each price point from \$27.5 to \$47.5 per dry ton. Then the estimated annual biomass demand from each coal-fired plant in the PROSYM database was overlaid on these maps (assuming it was

converted to 10 percent co-firing and retained its current average capacity factor). Finally, those plants that would be able to obtain sufficient biomass to meet their needs within a 50 mile radius at each price point were modeled. The lowest price at which a plant acquired enough biomass was assumed to be the price of biomass for that plant.

The average biomass price derived by this method in the Clean Energy Development Plan is almost \$31/dry ton (\$1.8/MBTU). For some plants the price is as low as \$27.5/dry ton (\$1.6/MBTU) and for others it is as high as \$52.5/dry ton (\$3.1/MBTU).

Although this scenario assumes 10 percent co-firing at all larger and newer coal plants, it is likely that the co-firing fraction will be higher at some plants than at others, and that some plants will not be converted to co-firing at all. The most favorable locations for co-firing will generally be where the coal price is relatively high and biomass price relatively low. In addition, plants with relatively high capacity factors will be able to recover the capital investment in co-firing more quickly than plants that run less often.

### The Chariton Valley Co-Firing Project

The sponsors of the Chariton Valley (Iowa) Co-Firing Project are aiming to create a new market for a homegrown energy crop: switchgrass (Iowa DNR2000; CVRCD 2000). Switchgrass once grew abundantly in southern Iowa before crops were planted on the land. It is still used as a cover crop for erodible land enrolled in the Conservation Reserve Program because its deep roots and perennial nature hold the soil. Now, a group called Chariton Valley Resource Conservation and Development has persuaded a utility company - Alliant Energy - to test switchgrass as a fuel in the Ottumwa Generating Station in Chillecothe, Iowa. Four thousand tons of switchgrass were harvested in preparation for the test burn, which occurred in fall 2000.

This was not the first time switchgrass or similar biomass was burned with coal in a power plant. In Denmark, three power plants get nearly 10 percent of their fuel from wheat straw, a practice that reduces CO<sub>2</sub> and some pollutant emissions while causing no damage to the plant boiler, according to Danish plant operators. And several coal plants in the United States have burned waste wood.

But this will be one of the first demonstrations of integrating energy crops with co-firing. The objectives of the first test burn were to evaluate switchgrass grinding size, handling and processing, and the impact on the power plant operations and emissions. Fuel delivery and long-term plant performance will be evaluated in two additional co-fire tests scheduled for 2001 and 2002.

The project supporters - who received a grant from the U.S. Department of Agriculture - hope that Alliant Energy will permanently convert this plant to co-firing, thereby helping to maintain switchgrass's important role in controlling erosion and conserving the soil as the Conservation Reserve Program expires.

## COMBINED HEAT AND POWER

The most efficient use of biomass fuel is in CHP applications. New CHP plants can convert biomass to useable forms of energy with almost 90 percent efficiency. Because the pulp and paper industry produces large quantities of biomass waste each year, it has traditionally been the industrial sector with the highest rate of biomass fuel utilization. Installed CHP capacity in the pulp and paper industry comprises roughly a third of the CHP capacity in the region. Most of these plants burn some combination of fossil fuels (generally coal in older CHP plants and gas in the newer ones) and biomass. This study assumes that biomass provides about 60 percent of the fuel consumed at CHP facilities in the pulp and paper industry. Biomass CHP in the pulp and paper industry represents the vast majority of the region's current biomass use for electric generation. Potential exists in the region for both increased usage of biomass CHP, and replacement of existing CHP systems with modern and more efficient systems that can provide additional electric output for onsite usage and/or exports to the grid.

Projections of biomass-based CHP use in the Clean Energy Development Plan are based upon national process steam load and energy projections in the pulp and paper industries. CHP use in manufacturing, where the fuel is mainly natural gas, is discussed in Chapter 6. For the pulp and paper industry, this study assumes that the national mix of 40 percent steam-only and 60 percent CHP holds for each state, and the national mix of 40-60 gas to biomass consumption ratio also applies. The study further assumes that existing steam-only facilities (at an average of 70 percent efficiency) would be switched to CHP at 75 percent efficiency with a 40-60 steam-electric ratio. This analysis assumes that 15 percent of the steam-only plants convert to CHP in this manner by 2010, and double that by 2020. As for facilities that already co-generate electricity, this study assumes that co-generation facilities with 70 percent average efficiency and just 17 percent electric output are replaced by units with 75 percent overall efficiency and 37 percent electric output. Forty percent are assumed to make this conversion by 2010, and twice that by 2020. The projected cost of CHP conversion is shown in Figure 5.8.

The pulp and paper industry is expected to maintain its market share of CHP in the region and to continue to be the largest user of biomass fuels for CHP through 2020. Based on these assumptions, roughly one-fifth of all new CHP added in the region is expected to be biomass-fueled CHP in the pulp and paper industry. This translates into almost 1.67 GW of new biomass-

### District Energy St. Paul

One example of a new combined heat and power project in which biomass would be used is District Energy St. Paul (DESP). DESP recently announced plans to add a new 98 MW (combined thermal and electricity production) wood chip-fired CHP plant to replace its coal and gas boilers, which supply the downtown business district with electricity and heat. When completed in 2002, the upgrade will make DESP the largest biomass-based district energy system in the country. The biomass upgrade will enable DESP to expand its recently added district cooling services and to increase its power sales to XCel Energy (formerly Northern States Power) to 25 MW. The new plant will also enable the city of St. Paul to meet its entire commitment to reduce greenhouse gases under its agreement with the International Council for Local Environmental Initiatives (DESP 1999; DESP 2000). DESP's decision to fuel their new CHP plant with biomass rather than natural gas was likely driven in part by a state mandate that XCel Energy increase its biomass electric output or purchase more electricity generated from biomass. The additional sales to XCel Energy helped DESP finance the biomass conversion and upgrade its system.

fueled CHP capacity being added in the region by 2010 and 3.53 GW by 2020, in addition to the 1.56 GW of currently installed biomass CHP. On an energy basis, biomass CHP generation in the region would total 19.8 TWh by 2010 and 31.2 TWh by 2020.

Gains in new biomass-based CHP capacity outside the pulp and paper industry are expected to be modest by comparison. Recent advances in biomass combustion technologies, however, have made biomass-fueled CHP systems cost-effective for many other industries, as well. New research and development into wood-gasification

FIGURE 5.8 CHARACTERISTICS OF BIOMASS CHP

Heat Rate*	3900 BTU/kWh
Capital	\$860/kW
Fixed O&M	\$3.7/kW-yr
Variable O&M	\$3.7/MWh
Biofuel Fraction	60 percent
Natural Gas Fraction	40 percent

\*Increase over steam-only

technologies and fast-growing energy crops will likely further increase biomass generation efficiency and fuel supply, and cause the rate of growth of new biomass-based CHP systems to continue to increase.

Biomass energy projects have the added economic advantage of creating far more local jobs (particularly in slow-growth rural areas) than other types of energy projects, because biomass fuels are generally produced by local suppliers within a 50 mile radius of the site, while the average distance between production and consumption of fossil fuels is generally much greater. The use of biomass for CHP also can avoid the cost of extending pipelines to serve the plant with natural gas. Another advantage of biomass over gas for CHP is that, when the full fuel cycle is considered, “closed-loop” biomass energy systems (in which the rate of annual biomass fuel production meets or exceeds consumption) produce no net greenhouse gases. As noted above, the Midwest has the technical potential to fuel significantly more biomass-based CHP and reap these economic benefits. But, while increased employment in rural areas, a slower rate of climate change, greater energy self-sufficiency, etc., would undoubtedly yield benefits to the region’s economies, such factors are often difficult to quantify (and are not directly accrued by the CHP developer).

The result is that biomass is often overlooked as a fuel for CHP, except by industries such as pulp and paper that already have access to vast supplies of cheap biomass that would otherwise be wasted. Despite significant advances in the efficiency of new biomass-based CHP systems, expanding the use of biomass for CHP applications to other industries is hampered by the fact that supply infrastructures to guarantee access to sufficient low-cost biomass fuel do not exist in most areas, but economies of scale adequate to lower costs are unlikely to develop without guarantees of sufficient demand. In recent years, recognition of biomass’s full economic and environmental benefits compared with fossil fuel’s has led several states (including Minnesota, Iowa and Wisconsin) to adopt modest quotas or other incentives to promote new biomass generation.

## DEDICATED BIOMASS PLANTS

Today’s biomass-fueled power plants use mature, direct-combustion boiler/steam turbine technology. They tend to be small (the average size is 20 MW) and inefficient (average biomass-to-electricity efficiency is 20 percent), and both factors contribute to a relatively high cost of

delivered electricity of 8-12 ¢/kWh. That explains why most biomass plants use waste feedstocks, which are free or may even earn money for the plant owner by providing a waste-disposal service.

The next generation of stand-alone biomass power plants will be both less expensive and more efficient. One of the most promising near-term technological options is gasification-combined-cycle systems, the biomass equivalent of the natural gas combined-cycle (NGCC). Gasification involves the conversion of biomass in an atmosphere of steam or air to produce a medium- or low-energy-content gas. This biogas powers a combined-cycle power generation plant (combined-cycle means it has both a gas turbine “topping” cycle and a steam turbine “bottoming” cycle, making use of both high- and low-temperature heat generated in combustion).

There are many different gasifier designs. Some of the variables include gasification medium (oxygen or no oxygen), gasifier operating pressure, and gasifier type. Many of the critical technologies were developed through research on coal-based gasification combined-cycle systems, which involve similar principles. Ultimately, biomass gasifiers may provide fuel for fuel cells.

Biomass gasification combined-cycle systems are not yet commercially available, although one small plant is operating in Sweden. The Department of Energy projects that the first generation of biomass gasification combined-cycle systems would have efficiencies of nearly 40 percent, and in co-generation applications they could exceed 80 percent. The cost of the first commercial systems in this country is projected to be in the \$1,800-\$2,000/kW range. With learning, the cost may drop rapidly to reach \$1,400/kW by 2010. (The cost assumptions of our study are shown in Figure 5.9.) Even this capital cost is still high for utility-scale power generation, indicating biomass gasification combined-cycle systems will enter the market more slowly than co-firing or CHP, and will probably require a continuing subsidy.

**FIGURE 5.9 CHARACTERISTICS OF BIOMASS GASIFICATION COMBINED-CYCLE POWER PLANTS**

	2000	2010	2020
Heat Rate (BTU/kWh)	10,000	9,730	8,670
Plant Size (MW)	75	100	110
Capital (\$/kW)	1,939	1,500	1,289
Fixed O&M (\$/kW-yr)	44.5	44.5	44.5
Variable O&M (¢/kWh)	0.5	0.5	0.5

## Environmental Implications of Biomass

The use of biomass for energy can raise significant environmental issues. For example, taking too much agricultural residue off the land can increase erosion and reduce soil quality. Cultivating energy crops on a large scale requires land, as well as energy and other inputs. The combustion of biomass, of course, produces air pollutants such as  $\text{NO}_x$  that must be controlled. There are additional questions concerning how large-scale biomass production might displace or compete with food production, encourage unsustainable forest use, or (in co-firing) provide an incentive to keep dirty and inefficient coal plants in operation.

On balance, however, the environmental benefits of biomass use outweigh these risks when sensitive practices are used. It is important to first consider the activities displaced by biomass production and use, starting with coal mining and the pollution generated by coal plants. A major advantage of biomass - if sustainably produced, as proposed in this study - is that it does not contribute to global warming, since the  $\text{CO}_2$  that is emitted into the atmosphere during combustion is absorbed as plants are grown to replace the biomass consumed.

Right now, agricultural residues are often burned in the open to make way for new plantings, producing far more pollution than would be generated if the residues were collected and consumed in a controlled power plant. Moreover, the removal of residues from the field does not lead to erosion if a sufficient amount is left in place, as our study assumes in its price and supply projections. Lastly, the leading energy crop, switchgrass, has far fewer impacts on land and wildlife than food crops. Unlike food crops, energy crops are not replanted every year, so their roots systems remain in place to hold the soil. In fact, switchgrass is commonly used as a cover crop on erodible or fragile soils enrolled in the Conservation Reserve Program. In the right locations, they can even act as chemical buffers to absorb agricultural runoff before it enters river systems.

Still, it is clear that biomass use must be carefully monitored and regulated to avoid unwanted impacts. For example, co-fired or dedicated biomass power plants should be required to meet the same air pollution regulations as others; potentially contaminated feedstocks (such as municipal wastes) should not be used in biomass power plants; regulations should require that sufficient crop residues be left on the soil to prevent erosion; and the use of forest wood should be strictly controlled to avoid placing a greater burden on forest ecosystems. All of these guidelines were followed in developing estimates of biomass use in the Clean Energy Development Plan.

## 5.4 PHOTOVOLTAICS

### MARKET ASSESSMENT

Photovoltaic systems convert sunlight directly into electricity using semiconductor materials without moving parts. Their remarkable simplicity and flexibility - they can be built in sizes ranging from watts to megawatts - make them suitable for a wide variety of applications, including central-station power plants, substation power plants for distribution support, grid-tied systems for home or business use, and off-grid systems for remote power.

Generally speaking, PV costs remain high compared to conventional alternatives in most applications except off-grid systems. The off-grid market, along with aggressively subsidized markets for grid-connected

systems in Germany and Japan, has driven remarkable growth in PV installations worldwide. Total shipments in 1999 topped 200 MW, a 60 percent increase over the 125 MW shipped in 1997. Growth is likely to continue over the next several years, with annual sales possibly passing the 1000 MW mark before 2010.

Solar power development provides substantial environmental and public health benefits because it creates no air pollution, greenhouse gases, or radioactive and other dangerous wastes. In addition, there are significant economic development opportunities for Midwestern solar companies that manufacture both for domestic use and export to developing countries (see sidebar in Section 5.4.3). Chicago, in particular, is seizing these solar development opportunities by supporting Spire Solar's new solar



panel manufacturing plant on a former “brownfield” site, installing solar panels on the rooftops of nine major museums, and planning to build the largest single photovoltaic assembly (2.5 MW) in the country to provide cleaner and greener power for public use.

Despite PV’s impressive potential and proven track record around the world, it faces major hurdles to penetrating the Midwestern energy market in any significant way. A key problem is the lack of a strong PV industry presence in the region, which can be traced to a preference within the industry to seek “easy pickings” in markets where demand for PV systems already exists (such as the heavily subsidized German and Japanese markets and the well-developed market for remote PV systems in developing countries).

## THE SOLAR RESOURCE

The amount of sunlight available for generating power varies greatly across the region. Figure 5.10a depicts the resource distribution as the capacity factor, or average output divided by peak output, of a typical present-day flat-plate system.<sup>12</sup> On average, the incoming solar radiation (insolation) is highest in Nebraska and decreases gradually toward the north and east. Nebraska and the western Dakotas have a very good solar resource, equal to parts of northern California and eastern Texas. Ohio, Michigan and the other northeastern states receive about 30 percent less radiation.

The total insolation includes two components: direct radiation, which is light received directly from the sun; and indirect or diffuse radiation, which is light reflected or scattered by clouds and dust in the atmosphere. The distinction is important because PV systems with lenses

or mirrors to concentrate sunlight require direct radiation, whereas fixed and tracking flat-plate systems can use both direct and indirect radiation.

An important attribute of the solar resource is that it often is strongly correlated with consumer demand for electricity. In many parts of the Midwest, peak electricity demand is driven by air conditioning on hot summer days, precisely the time when solar radiation is highest. Since peak loads are expensive for power companies to meet, solar PV systems are sometimes attractive even in areas with below-average amounts of sunlight. This concept is expressed as the effective load-carrying capability, or ELCC, which is the average plant output in peak load hours. Analysis shows that in virtually all of the Midwestern states, PV systems have an ELCC exceeding 60 percent (Fig. 5.10b) (Richard Perez, personal communication).

FIGURE 5.10B. COINCIDENCE OF PV OUTPUT WITH UTILITY PEAK LOADS

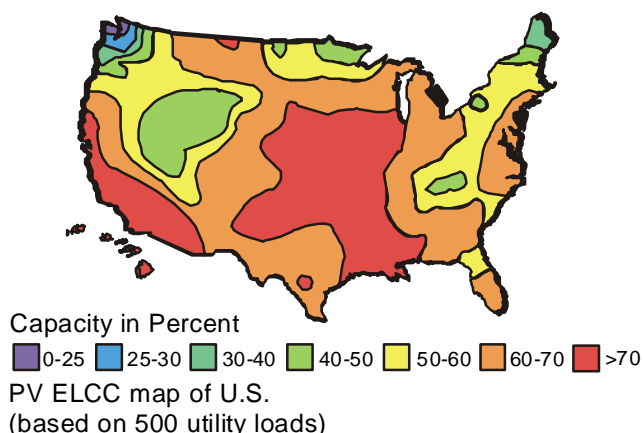
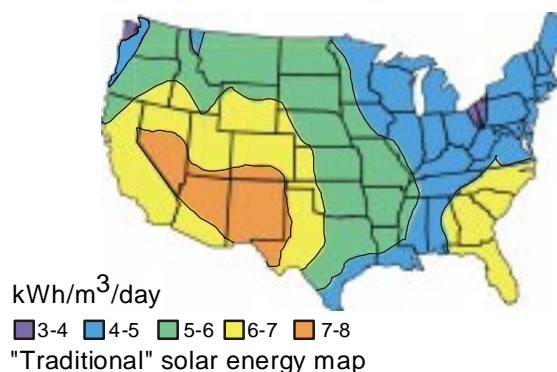
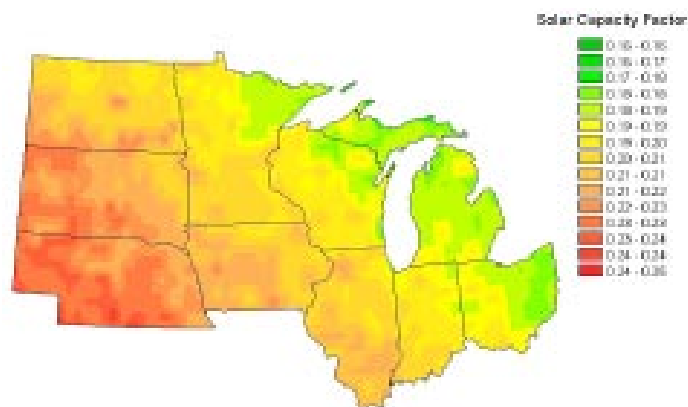


FIGURE 5.10A GEOGRAPHIC DISTRIBUTION OF SOLAR INSOLATION



<sup>12</sup> This resource map was developed by Richard Perez of the Atmospheric Sciences Research Center, State University of New York, Albany, using solar resource data provided by the National Renewable Energy Laboratory.

## PV TECHNOLOGY

PV cells - the most basic component of a PV system - come in many varieties, from flat, thin films made of amorphous (non-crystalline) silicon to pure crystals of silicon or other materials on which direct sunlight is concentrated in intense beams. By and large, the crystalline cells achieve good efficiencies of conversion of light into electricity but are expensive to manufacture. Thin films are less efficient but cheaper to make. As yet, no single technology has proven to be decisively superior to the others. On the contrary, each has found a niche reflecting wide variations in the quality of the resource and the needs of customers.

Individual PV cells are assembled into modules that produce direct current power. Depending on the application, PV modules are either fixed flat plates, tracking flat plates, or concentrating. The fixed flat-plate modules face in one direction all the time, whereas tracking flat plates and concentrating modules are turned to face the sun. The concentrating systems in particular must be finely controlled to maintain an

orientation so sunlight is focused precisely on the comparatively small cells. Again, there is a trade-off between efficiency and cost - more efficient designs tend to cost more.

PV modules are combined with other components, such as power conditioners and inverters, tracking motors and mounting structures, to form a complete PV system. For remote applications, the system is often hooked to a battery to provide continuous power or the ability to produce power over several cloudy days. Here the emphasis is on highly reliable operation with little or no maintenance, which argues for fixed flat-plate systems. Grid-connected systems use the transmission system as a whole for backup. At night and on cloudy days, the consumer draws power from the grid; but when there is plenty of sunlight the consumer draws power from the PV system and may, in fact, become a net power producer. In appropriate locations, larger grid-connected systems may be able to take advantage of the higher efficiencies available with concentrating systems.

### Photovoltaics for Grid-Connected Applications

The biggest near-term market for photovoltaics is in specialized off-grid and remote applications, such as warning signs and battery recharging for communications relays. But several initiatives are helping to expand the use of grid-connected photovoltaics around the Midwest. What follows are snapshots of just a few of them. PV manufacturers BP Solar, First Solar, Spire Solar, Unisolar and Powerlight are actively engaged in these projects.

1. The U.S. Department of Energy's "Million Solar Roofs" program is supporting the use of roof-mounted PV systems (in the 1-5 kW range) around the country. In Wisconsin, for instance, 500 homes will be equipped with rooftop systems by 2005. Several dozen schools equipped with 20-50 kW systems are planned in Ohio, Illinois and Wisconsin.
2. A city-based initiative in Chicago may be reflective of future PV deployment opportunities in the Midwest. The "Brownfields to Bright Fields" project, is a partnership between Spire Solar and the City of Chicago. It features a commitment by the city to purchase PV for local deployment at sites already used for industry ("brownfields"), in exchange for the development of a PV manufacturing capability in the city. The purchase commitment will amount to hundreds of kilowatts per year.
3. BP is deploying PV systems at many of its gas stations around the world, including the Midwest. One of the main benefits of this program is that it may encourage "copy-cat" initiatives by other companies.
4. The city of Toledo, Ohio, working in partnership with First Solar (a relatively new, thin-film PV manufacturer based in Ohio) and Powerlight, is planning several 100 kW PV projects at schools and large commercial buildings.



The challenging interconnection rules imposed by some utility companies date back to the days when there was concern in power engineering circles about whether grid-connected PV systems would adversely affect the quality of power. Experience has demonstrated conclusively, however, that well-designed PV systems can be safely and reliably interconnected with the utility grid.

## PV System Costs

The cost of PV installation mainly depends on the installation's size and the degree to which it uses standard, off-the-shelf components. The technology (thin film versus crystalline) does not appear to be a consistent price differentiation factor. For small, one-of-a-kind grid-connected PV systems (1,000-3,000 W residential), the complete cost ranges between \$9,000/kW and \$11,000/kW. The addition of emergency battery storage may add \$1,000/kW.<sup>13</sup>

For mid-size grid-connected building-integrated PV installations where the roof or walls may be used as structure, the current cost ranges from \$6,000/kW to \$8,000/kW. For bulk orders of small standardized systems, the cost could be as low as \$5,000/kW to \$6,000/kW, based on experience with a program conducted by the Sacramento Municipal Utility District.

The costs of large grid-connected PV systems are not well-known, since most of the ones that have been built are one-of-a-kind prototypes designed with little emphasis on cost efficiency. A reasonable estimate, based on discussions with system manufacturers, indicates that the cost of such systems might range from \$5,000/kW to \$6,000/kW today.

A Road-Map report recently released by the U.S. PV industry provides a view of the future of the industry based on market and cost projections. All major PV manufacturers (Siemens, Astropower and BP Solar) participated in the preparation of this report along with universities (Purdue and MIT), Idaho Power, and Trace Engineering. The Industry Road-Map report establishes a goal of \$3,000/kW (including capitalized operations and maintenance costs) in 2010, and \$1,500/kW in 2020.

## Assumptions for This Study

Because of the relatively low amount of direct, normal solar radiation available in some parts of the Midwest, this study considers only flat-plate systems. Furthermore, in the interest of allowing for the widest possible variety of PV applications, the output of fixed flat-plate systems

suitable for a variety of rooftop mountings were modeled.

Finally, the study considers only grid-connected systems. As noted, off-grid applications are the most promising market in the near term, but to displace substantial amounts of fossil fuel, PV must begin to penetrate the grid-connected market. Initial deployments of grid-connected systems will be of intermediate size (10-100 kW), and designed to provide support to the grid in areas of heavy peak summertime loads. This could include rooftop systems on buildings in cities, as well as systems located near heavily loaded electrical substations. As the market for PV expands and costs decline, residential rooftop PV systems will become more attractive and more important in the energy mix.

Figure 5.11 presents the projected costs of grid-connected PV systems for this study (including the 10 percent investment tax credit available for solar installations). The cost trajectory is consistent with technological assumptions from the 2000 Annual Energy Outlook (DOE 1999) and current business-as-usual industry growth projections. Following EIA's method, a technological optimism factor of 1.12 was applied to the estimated current overnight capital cost of \$4,836/kW, yielding a current cost of \$5,416/kW. Then, cost reductions of 20 percent were assumed for each of the first three doublings of global PV capacity over today's capacity, five percent for the next five doublings, and one percent for all doublings thereafter. Lastly, the analysis assumes that the global installed PV capacity will grow at an average annual rate of 17.5 percent over the next 20 years (in the middle of the range of global business-as-usual growth rates projected in the Road-Map report).

**FIGURE 5.11 CHARACTERISTICS OF GRID-CONNECTED FIXED FLAT-PLATE PV SYSTEMS**

	2000	2010	2020
Capital (\$/kW)	5,416	2,877	2,275
Fixed O&M (\$/kW-yr)	56	23	17

<sup>13</sup> All costs reported here refer to the power output PVUSA test conditions (PTC) rating, which is defined as the AC output at 25 degree celsius ambient temperature. Caution should be used in comparing PV systems costs from other sources, as the cost per kilowatt at standard test conditions (STC), which refers to DC at 20 degrees celsius, will appear lower.

The projected system capacity factors were calculated assuming a typical fixed flat-plate PV system and using gridded solar resource data provided by the National Renewable Energy Laboratory. The average capacity factor for each state was calculated and input into the PROSYM model. No changes in capacity factor are projected over time, as the capacity factor is not driven mainly by changes in the efficiency of cells, but by the solar resource and (for fixed flat-plate systems) the module orientation. With more efficient PV modules, both the peak output and average output per unit area increase, with little change in capacity factor.

## 5.5 SUMMARY OF RENEWABLE ENERGY RESOURCE POTENTIAL

Figure 5.12 presents a summary of the levelized costs of renewable and efficient generation technologies, in ¢/kWh, assumed in this study. These figures include all costs associated with construction, fuel, and operations and maintenance (O&M), based on the information described in the previous sections. The

investment tax credit for solar energy is included, but the production tax credit for wind energy is included only for 2000 because of its uncertain future. Extending this tax credit will make renewable resources more economical for generators. Biomass CHP and co-firing offer the least expensive forms of generation. Wind power costs are lower in areas with greater wind resources, and are expected to decline over time. Photovoltaics are expected to be significantly more expensive than other options currently available, but costs will decline over time.

Figures 5.13 and 5.14 present a summary of the renewable resources included in the Clean Energy Development Plan. Wind turbines present the most significant opportunity for new renewable capacity, particularly in the latter half of the study period. Combined heat and power using biomass offers the second largest potential for new renewables. Biomass gasification and photovoltaics play a much smaller role due to their relatively high costs, but are expected to become more commercially viable in later years.

FIGURE 5.12 LEVELIZED COSTS OF RENEWABLE GENERATION TECHNOLOGIES (¢/KWH) AS MODELED IN THE CLEAN ENERGY DEVELOPMENT PLAN

	2000	2010	2020
<b>Wind*</b>			
Class 5	4.7	3.7	2.8
Class 4	5.4	4.2	3.2
Class 3	6.4	4.9	3.7
<b>Solar PV</b>			
CF 18 percent	48	25	20
CF 23 percent	37	20	15
<b>Biomass**</b>			
Co-Firing	2.5	2.5	2.5
CHP	2.3	2.3	2.3
Gasification CC	6.4	5.6	5.0

Note: All costs are at the busbar and are in constant 1999 dollars.

\*Assumes a production tax credit in 2000 with a levelized value of 1 ¢/kWh. Not included in 2010 and 2020.

\*\*Assumes capacity factor = 85 percent and biofuel price = \$1.9/MBTU for all biomass technologies.

**FIGURE 5.13 SUMMARY OF RENEWABLE RESOURCES INCLUDED IN THE CLEAN ENERGY DEVELOPMENT PLAN (2010)**

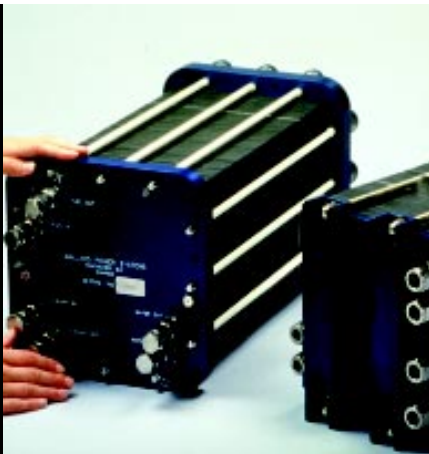
Generator Type	Installed Capacity (MW)	Percent of Total Capacity	Generation (GWh)	Percent of Total Generation
Wind Turbines	6,698	4.2	21,283	3.0
CHP – Biomass	2,949	1.8	23,881	3.4
Biomass Co-Firing	1,850	1.2	9,778	1.4
Photovoltaics	161	0.1	196	0.0
Biomass Gasification	75	0.0	536	0.1
<b>Total</b>	<b>11,733</b>	<b>7.3</b>	<b>55,674</b>	<b>8.0</b>

*Note: This includes all renewables added after 2000. Totals may not add up precisely due to rounding.*

**FIGURE 5.14 SUMMARY OF RENEWABLE RESOURCES INCLUDED IN THE CLEAN ENERGY DEVELOPMENT PLAN (2020)**

Generator Type	Installed Capacity (MW)	Percent of Total Capacity	Generation (GWh)	Percent of Total Generation
Wind Turbines	24,510	13.2	80,795	11.3
CHP – Biomass	6,003	3.2	48,527	6.8
Biomass Co-Firing	4,807	2.6	22,113	3.1
Photovoltaics	482	0.3	571	0.1
Biomass Gasification	575	0.3	4,049	0.6
<b>Total</b>	<b>36,377</b>	<b>19.6</b>	<b>156,055</b>	<b>21.9</b>

*Note: This includes all renewables added after 2000. Totals may not add up precisely due to rounding.*



## 6. EFFICIENT GENERATION TECHNOLOGIES: MAKING THE MOST OF NATURAL GAS

The Clean Energy Development Plan shows that it is possible to greatly reduce the Midwest's use of polluting fossil fuels. Nevertheless, it is unrealistic to expect that they will be replaced entirely by energy efficiency and renewable resources. The Midwest will continue to rely on fossil fuels to supply a large part of its energy demand. Thus, cleaner and more efficient fossil-fuel technologies should be deployed. To minimize carbon dioxide and other pollutant emissions, the new fossil-fuel technologies should use natural gas, which is a cleaner fuel than coal. Although natural gas plants emit less  $\text{SO}_2$ ,  $\text{NO}_x$ , particulates and mercury pollution than coal plants, they also produce considerable  $\text{CO}_2$  emissions that exacerbate climate change. Moreover, it is important that community environmental values be respected in determining where to site these large power plants. Natural gas should be viewed as a transitional fuel from our current energy path to a more sustainable energy future, rather than a long-term solution. The Clean Energy Development Plan focuses on three highly efficient technologies to use natural gas: fuel cells, combined heat and power systems, and district energy systems.

### 6.1 FUEL CELLS

#### Background

As a modular, combustion-free power technology, fuel cells hold great promise for the future. Over the next two decades, they could be applied in cars, basements and central utility generating stations, replacing engines, boilers and turbines, and producing almost no noise or pollution. In the longer term, they could be an essential ingredient in a major transition to a hydrogen-based renewable energy economy.

Less than 30 MW of fuel cells are currently installed nationwide, but as major breakthroughs have recently been achieved, and more seem imminent, research budgets are skyrocketing. Fuel cell companies,

automobile manufacturers and government agencies are expected to spend nearly \$2 billion over the next few years to bring fuel cells to full-scale commercialization (California Air Resources Board July 1998). Driving them are four major attractive features of this technology: (1) generation efficiencies that could exceed 80 percent, higher than combustion technologies can achieve; (2) virtual elimination of most energy-related air pollutants; (3) modularity that will enable fuel cells to serve central, distributed and mobile applications, including the cogeneration of heat and power; and (4) the lack of moving parts, and therefore, nearly silent operation and reduced maintenance (Kartha 1997).

Simply put, fuel cells combine hydrogen (from the fuel source) and oxygen (from the air) in the presence of a catalyst to generate electricity, heat and water. Fuel cells are not new. First developed by Sir William Grove in 1839, they were considered little more than high school physics experiments until the late 1960s, when NASA used them to power the electrical systems of Gemini and Apollo spacecrafts. Steady progress now has brought fuel cells to the verge of commercialization.

Several companies are competing with variants of five basic fuel cell types: phosphoric acid, proton exchange membrane, molten carbonate, solid oxide and alkaline. Because automobile manufacturers expect the first fuel cell-powered cars to be market-ready by 2003-2005, PEMFCs have been attracting considerable press. PEMFCs also are suitable for small-scale distributed applications, such as building co-generation systems for homes and businesses. Higher temperature SOFCs or MCFCs may be more appropriate for larger utility-scale applications, however, because their potential for very high efficiencies (through reuse of high-temperature waste heat) may offset their higher initial cost. Westinghouse, Siemens and others are currently developing and testing hybrid systems that combine a SOFC with a gas turbine bottoming cycle to generate electricity from natural gas at efficiencies higher than 70 percent.

Widespread penetration of fuel cells now awaits major cost reductions resulting from research and development, and accumulated experience in manufacture and use. Today, PAFCs are commercially available at roughly \$3,000/kW, but costs continue to drop across all fuel cell technologies. PEMFC technologies could, if mass

FIGURE 6.1 SELECTED FUEL CELL TYPES

	Proton Exchange Membrane	Phosphoric Acid	Molten Carbonate	Solid Oxide Ceramic
<b>Projected application</b>	Vehicles, mobile applications, residential systems	Medium-sized stationary power	Medium and large stationary power	Stationary power, potentially with hybrid turbine
<b>Development Status</b>	Demonstration units up to 50kW; 250kW within a few years	200kW commercial systems since 1993; one 11MW unit tested	Demonstration units up to 2 MW	Demonstration units up to 100 MW

produced, reach levels as low as \$200/kW once the technology is fully mature. The other major challenge for fuel cells is the supply of hydrogen. Solar and wind systems will likely be the ultimate sources, by converting intermittent electricity into a dispatchable hydrogen resource through electrolysis of water. Fossil fuels, however, are likely to be the more cost-competitive hydrogen sources in the near term.<sup>14</sup>

## Assumptions for This Study

Just as the strategy to create sustainable biomass markets through co-firing relies on the transitional use of coal, a strategy to commercialize fuel cells (for grid electricity) will likely rely on the use of natural gas in the near term. Grid applications for fuel cells, however, will require a significant policy commitment and market push, driven by the goals of technology learning, market development and local pollution reduction.

This analysis assumes that such policies would result in small numbers of fuel cells installed in each Midwestern state. Based on unpublished manufacturer estimates, central station fuel cells would cost \$1,000/kW with a fixed O&M cost of \$15/kW per year, and variable cost of \$0.005/kWh. Insofar as this study does not consider the more promising near-term market for smaller-scale distributed fuel cells, this approach could be viewed as pessimistic.

## 6.2 COMBINED HEAT AND POWER

Combined heat and power (CHP), or co-generation, is a well understood technology with a long history. Because of ongoing technological improvements, CHP has great potential for energy savings, economic benefits and environmental improvement in industrial and community energy systems.

In the absence of CHP, manufacturing firms typically purchase electricity for various uses including motors, lighting and electro-chemical processes; they also purchase fuels for combustion in on-site boilers or furnaces

to generate thermal energy (e.g., steam) for process requirements. The purchased electricity is generated at power plants distant from the industrial site, with an efficiency of 30 to 40 percent, as most of the energy content of the fuel is released as heat into the surrounding environment. Furthermore, energy losses of up to 10 percent occur in transmission and distribution of electricity from the power plants to the industrial site. The on-site thermal energy is produced at efficiencies in the neighborhood of 70 percent. Instead of such separate, and wasteful, generation of electricity and process heat, CHP systems generate electricity onsite and use the otherwise wasted heat to meet thermal requirements. With overall system efficiencies of up to 90 percent, the incremental efficiency of co-generating the electricity can be greater than 80 percent. For example, the McCormick Place Convention Center in Chicago uses a CHP system operated by Trigen Energy to achieve an 81 percent fuel efficiency rate, while reducing pollution from NO<sub>x</sub>, CO<sub>2</sub> and SO<sub>2</sub>. McCormick Place has received an EPA Energy Star award for environmental performance.

The development of new, efficient gas turbine technologies in a wide range of sizes suited to a variety of manufacturing, thermal and electricity needs, has increased the opportunities for industrial CHP at reduced costs. Expenditures for CHP equipment and increased on-site fuel use can be exceeded by reductions in electricity costs. With these advanced combustion turbines (or in the near future with fuel cells) using natural gas or biomass-based fuel inputs, very high efficiencies can be achieved along with low air emissions. Thus, industrial energy use, carbon emissions and pollutant emissions would be dramatically reduced, while continuing to provide a variety of needed energy services.

<sup>14</sup> Today, most hydrogen is produced from natural gas using well-established conventional chemical processes, at a conversion efficiency of roughly 70 percent. Another renewable option is to produce hydrogen from biomass, using an analogous process, but costs are likely to be much higher in the near term.

Estimates of policy-induced CHP in each state were derived from the national analyses in *America's Global Warming Solutions* (WWF and EF 1999). National process steam load and energy projections in the manufacturing industries were adjusted to reflect the mix of industries and their energy use in each state. The analysis of CHP in the paper and pulp industry is discussed in Chapter 5. For the manufacturing industries, this study assumes that on average, a mix of new and existing gas-fired industrial boilers (averaging 70 percent thermal efficiency) would be displaced by on-site gas-fired CHP at 75 percent efficiency (with 37 percent of the output as electricity and 63 percent as thermal). This would reflect a range of sizes, operating conditions, electricity/thermal mix, etc., and a range of costs (e.g., it is more costly to replace an existing boiler than a new one, and smaller units tend to be more costly). This study further assumes that 15 percent of manufacturing steam load would be shifted from boilers to CHP by 2010 and that this figure would double by 2020.

The analysis assumes that electric capacity, generation and fuel inputs in industrial CHP are incremental to meeting the thermal demands, and therefore there is no fuel switching. It also assumes that natural gas is used in the displaced boilers, and that additional natural gas is used to produce the same thermal output plus electricity in the CHP facilities. The net effects are incremental electricity output, natural gas input, emissions, and capital and operating costs – all of which occur onsite. Correspondingly, there will be reduced electricity, fuel inputs, emissions and costs from central station power plants.

### 6.3 DISTRICT ENERGY

District energy systems provide thermal energy via steam or hot water pipelines to multiple customers within a specific geographic area for space heating, water heating, cooling or industrial processes. The district may be as small as several adjacent buildings within a commercial or industrial complex, or as large as a whole city. Frequently, DES co-generate electric power along with thermal energy for use by district energy customers or sale to a local electric utility.

DES have been around as long as there has been electric power generation. During the first half of the 20<sup>th</sup> century, citywide district heating systems were common in many northern U.S. cities. Residents and businesses would be supplied with heat from dedicated thermal plants or waste heat from nearby central station electric power plants. After World War II, low fuel prices made building-scale central heating systems more affordable, and migration to the

suburbs shifted the markets for heating supply. Thus, large urban buildings were increasingly heated individually. Sometimes, the difficulties in siting new power plants in urban areas also were a factor, and that limited the expansion of district energy systems as urban populations grew. The result was a nationwide decline in DES usage, and an overall decrease in energy efficiency in U.S. cities.

Citywide DES are common in several European countries, including Denmark, Finland and the Netherlands. Although they no longer supply whole cities in the United States, some large district energy systems continue to supply thermal energy to customers in downtown areas. According to the U.S. Energy Information Administration, today there are almost 5,800 district energy systems in the United States – supplying thermal energy primarily to military bases, universities, hospitals, downtown office complexes and apartment buildings. Together they serve more than eight percent of commercial floorspace (DOE 1999). Most of the older district energy systems in this country are powered by old coal or oil-burning power plants. In most cases, these plants were originally built to supply electricity to the surrounding region. Back then, they supplied heat to local homes and businesses as a byproduct of their electric generation; today many often generate only steam, or may generate electricity only as the byproduct of their continued district heating service. Many other district energy systems upgraded their systems in the 1980s and 1990s, taking advantage of federal incentives under PURPA. Most of these newer plants are powered by highly efficient combined-cycle natural gas plants.

With the proper incentives, DES could see a major resurgence in this country. Today, low-emitting natural gas combined-cycle plants can be sited in even the smoggiest of urban areas. DES have great potential to reduce energy costs and pollutant emissions by replacing building boiler systems and central station electricity with co-generated heat and power.

One of the most significant areas for new growth potential with DES is in providing cooling services for downtown areas, especially where there is a large amount of commercial floorspace located in a relatively small area. With new high-efficiency absorption chillers driven by the thermal energy of steam or hot water, district cooling systems can enable buildings to reduce air conditioning costs, while helping to increase electric system reliability by reducing peak load. Nationwide, more than \$1.7 billion was invested in DES over the last 10 years, mainly for new cooling systems; at least nine Midwestern municipal DES provide cooling (Thornton 1999).



**FIGURE 6.2 EFFICIENT GENERATION TECHNOLOGIES INCLUDED IN THE CLEAN ENERGY DEVELOPMENT PLAN - 2010**

Generator Type	Installed Capacity (MW)	Percent of Total Capacity	Generation (GWh)	Percent of Total Generation
CHP – Natural Gas	5,650	3.5	45,422	6.5
District Energy Systems	3,223	2.0	25,309	3.6
Fuel Cells	282	0.2	2,267	0.3
<b>Total</b>	<b>9,155</b>	<b>5.8</b>	<b>72,998</b>	<b>10.4</b>

*Note: This includes all renewables added after 2000. Totals may not add up precisely due to rounding.*

Construction costs for DES are on average about one-third higher than those for conventional heating and cooling technologies (DOE 1999). Significant fuel savings over the project's lifetime can offset the higher initial capital costs. In order to guarantee eventual capital recovery, however, DES developers must procure long-term contracts from potential district heating or cooling customers and/or power sales agreements with local utilities. The current restructuring of U.S. electric markets may make it more difficult to obtain long-term contracts for many new projects. Without such guarantees or specific incentives to invest, DES projects in many areas may find it difficult to attract investors. Moreover, DES projects are sometimes hampered by institutional barriers. Successful DES projects require close cooperation of local and state governments, and the community as a whole, to address the legal, financial, siting and logistical issues involved.

This analysis is based on the scenario assumptions for co-generation DES in *America's Global Warming Solutions* (WWF and EF 1999). That study assumed that 18.8 GW of capacity are installed by 2010, which will generate 152 TWh of electricity and nearly 328 trillion BTU of useful thermal energy (about 60 percent electricity and 40 percent thermal energy), for an overall efficiency of almost 74 percent. This study assumes that an additional two GW of capacity are displaced by thermally driven absorption chillers that replace some electric space cooling. As this study is only interested in the electricity production provided by DES, it assumes that building level commercial gas boilers are displaced by DES, with the marginal heat rate of electricity generation taken as the extra fuel needed

for the DES divided by the electricity generated. Here, the marginal heat rate is 4.69 million BTU per MWh, an efficiency of 73 percent, which is far higher than typical existing, or even new, power plants.

The cost of the DES facilities, including the co-generation power plant and thermal energy delivery systems, is \$1,578/kW installed, with O&M at \$1.84 per MWh. Seventy-five percent of the electric capacity provided by the DES is assumed to contribute to reliability, to account for the fact that, notwithstanding the coincidence of heating and cooling demands with system seasonal peaks, the DES electricity is not strictly dispatchable. To obtain the impacts in the states studied in *Repowering the Midwest*, this analysis assumes that: (1) the 152 TWh would be reached by 2020 and half that by 2010; and (2) each state's share of the national total DES would equal the ratio of the state to national space heat plus hot water demand.

## 6.4 SUMMARY OF EFFICIENT GENERATION TECHNOLOGIES POTENTIAL

Figures 6.2 and 6.3 provide a summary of the efficient generation technologies included in the Clean Energy Development Plan. CHP offers the greatest potential, especially by 2020. Fuel cells play a much smaller role due to their relatively high costs, but are expected to become more commercially viable in later years, after the conclusion of the study period.

**FIGURE 6.3 EFFICIENT GENERATION TECHNOLOGIES INCLUDED IN THE CLEAN ENERGY DEVELOPMENT PLAN - 2020**

Generator Type	Installed Capacity (MW)	Percent of Total Capacity	Generation (GWh)	Percent of Total Generation
CHP – Natural Gas	12,230	6.6	98,286	13.8
District Energy Systems	6,446	3.5	50,470	7.1
Fuel Cells	3,257	1.8	25,925	3.6
<b>Total</b>	<b>21,933</b>	<b>11.9</b>	<b>174,681</b>	<b>24.5</b>

*Note: This includes all renewables added after 2000. Totals may not add up precisely due to rounding.*



## 7. BARRIERS TO IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN

### 7.1 BARRIERS TO ENERGY EFFICIENCY

Energy efficiency technologies offer customers a cost-effective means of lowering electric bills. Many efficiency options provide customers with savings as much as two to three times the cost of the measure. A wide variety of efficiency technologies have been commercially available for years, and more are brought into the market each year.

Despite the availability and economic benefits of efficiency, experience demonstrates that efficiency measures will not be realized without significant public policy support. Most customers are unaware of the wide variety of energy efficiency technologies that can lower their electric bills. Some efficient products are more difficult to obtain than conventional products, and they frequently require higher up-front costs in order to achieve robust economic savings. In sum, a number of market barriers inhibit energy efficiency from being adopted by customers and becoming a part of conventional market practices. The most prominent market barriers are summarized below (Geller 1999; Energy Innovations 1997).

1. There is a lack of information and training. Electricity customers often do not know enough about energy efficiency measures as an alternative to electricity consumption, even in those states where customers are provided a “choice” of electricity suppliers. Residential, business and government consumers need more information on the economic, productivity and environmental benefits of efficiency measures.
2. Some energy efficiency measures are produced and distributed on a limited scale and are not readily available to customers, builders, contractors or industries.
3. Residential customers, businesses and industries may lack the up-front capital for an energy efficiency product that can provide large economic savings over time, or may prefer to apply available capital to other investments.

The clean energy options described in the previous chapters are now technologically achievable and economically realistic. They will not, however, reach their full potential without significant public policy support. Coal plants and nuclear energy currently receive substantial financial subsidies and policy benefits. Implementing the Clean Energy Development Plan will require thoughtful and aggressive action beyond current business practices and regulatory policies. Energy efficiency and renewable energy resources are hindered by a variety of “market barriers” that prevent them from competing against coal and nuclear plants on a level playing field. Public policy steps to overcome these market barriers are needed to obtain the benefits of more energy efficiency and wind, biomass and solar power for a more diverse Midwestern electricity market.

Several Midwestern states have recently taken important steps to promote clean energy. Notable examples include the renewable resources and energy efficiency investment funds established in Illinois, the renewable set-aside requirements in Minnesota and Iowa, the green pricing programs in Wisconsin and Michigan, and the net metering provisions established in several Midwestern states.

Much more can be done, however. The Clean Energy Development Plan will not be achieved under current business practices and regulatory policies. Legislators, regulators, utilities, generation companies, producers of efficiency products and electricity consumers will have to make a concerted effort to shift away from current practices that rely heavily upon conventional fuels and less efficient processes.

The barriers to energy efficiency, renewable resources and distributed generation are discussed below. Policy options for overcoming these barriers are presented in Chapters 8 and 9.

4. Obtaining information, making an informed purchase and installing energy efficiency measures may incur high transaction costs of time, money and hassle.
5. Those in a position to implement energy efficiency measures often have different financial interests than the electricity customers who would benefit from the measures. For example, landlords and building owners make capital purchases and maintain buildings, while tenants frequently pay the energy bills. Similarly, at the time of new construction, a builder may have an incentive to minimize short-term costs, while the new owner would benefit from lower electricity bills over the long term.
6. Many buildings are constructed, products purchased and facilities renovated on the basis of minimizing short-term costs, not on minimizing long-term life-cycle costs, including electricity costs.
7. Customers may be skeptical of potential energy efficiency savings or may have doubts about whether an unfamiliar energy efficiency measure will work properly, which leads to risk avoidance.
8. Customers and producers seeking to minimize their own costs often do not account for the societal benefits of energy efficiency – particularly the environmental and economic development benefits.
9. There are institutional and regulatory barriers. Traditional rate-of-return regulation and rate caps reward electric utilities for increased sales. Hence, utilities may oppose otherwise sensible energy efficiency measures.

In economic terms, these barriers represent failures in the electricity market. They prevent producers and consumers from implementing the most cost-effective electricity resources. Consequently, the public policies presented in Chapter 8 are needed to address these market failures and enable energy efficiency resources to achieve their full economic potential.

## 7.2 BARRIERS TO RENEWABLE RESOURCES

As described throughout this report, renewable resources offer a variety of benefits to generation companies, utilities, electricity customers and society in general. They offer fuel diversity, price stability, environmental benefits, improved reliability and economic development

opportunities. Many renewable resources – particularly in the Midwest, with its vast wind potential – are affordable.

Despite all of these benefits, most renewable resources are underutilized. As is the case with energy efficiency, renewable resources face a variety of market barriers and market failures that inhibit their development. These barriers are summarized below (Geller 1999; UCS 1999).

1. There is limited infrastructure as some renewable technologies require equipment, fuels, materials and training that are less readily available than those for conventional electricity technologies. Manufacturers, distributors, installers, operators and others in the production chain are unwilling to develop a market where demand is limited; low demand increases early costs, which in turn slows any increase in demand.
2. Production scales are small. The current demand for renewable technologies is not enough to achieve the economies of scale through mass production that would drive down production costs.
3. Renewable resources tend to have relatively long payback periods because they require relatively high initial investments that are offset over time with low fuel and operating costs. Developers and utilities might be reluctant to accept the financial risks associated with long payback periods. They also might be wary of the costs and operational uncertainties associated with newer, unproven technologies.
4. Developers frequently have difficulty obtaining financial backing for renewable technologies because of the long payback periods. In addition, renewable developers sometimes must pay relatively high interest rates for financing because they incur greater transaction costs, and lenders assume that these unfamiliar technologies are a greater risk.
5. Because of their intermittent nature and remote locations, some renewable resources are subject to inequitable transmission policies. Current transmission pricing practices and developing regional transmission organizations focus primarily on policies that support large conventional generation facilities.

6. Many small renewable technologies, including distributed generation technologies, face a variety of institutional, interconnection and regulatory barriers when attempting to connect to a utility distribution grid. These barriers are discussed in Chapter 9.
7. One of the most important market failures is that the environmental, public health and other external costs of using fossil fuels and nuclear power are not included in the price of electricity, making it difficult for renewables to compete.

Policies to address these barriers to renewable energy development are presented in Chapter 8.

### 7.3 BARRIERS TO DISTRIBUTED GENERATION

Distributed generation resources are small generation facilities that can be deployed at many locations throughout an electric distribution system, often to meet a customer's load.<sup>15</sup> There are a variety of distributed generation technologies. Renewable technologies, such as small wind turbines and photovoltaics, can be used as distributed generation, as can efficient generation technologies, such as fuel cells, combined heat and power, and district energy systems. These will result in environmental benefits in the form of lower air emissions and reduced need for distribution facilities or even central generation facilities. Conventional technologies, such as gasoline and diesel generators, are frequently used as distributed generation. These should not be encouraged as part of the Clean Energy Development Plan, however, because of high air emissions.

Distributed generation technologies tend to face unique institutional, technical and regulatory barriers. Policies should be designed to overcome these barriers and to support those distributed generation facilities that provide environmental benefits (Greene and Hammerschlag 2000). In general, this would include technologies that do not rely upon combustion of fossil fuels – such as fuel cells, wind turbines and PV systems. Distributed generation technologies that use a combined heat and power process also tend to provide environmental benefits because they consume fossil fuels more efficiently than conventional technologies.

Policies to promote distributed generation technologies will play an essential role in the development of renewable resources. Many small renewable technologies currently face a variety of barriers that prevent them from

connecting to a utility distribution grid. According to a recent study by the National Renewable Energy Laboratory, there are three main types of barriers facing distributed generation resources (NREL 5/2000):

1. Technical barriers arise from utility requirements to ensure engineering compatibility of interconnected generators with the grid. The most significant barriers include requirements to install equipment to protect utility property and maintain power quality. There frequently is a lack of clarity and understanding regarding whether and how distributed generation technologies should meet such technical requirements. In addition, technical standards for interconnection vary from state to state and from utility to utility. Even where such standards are reasonable in themselves, their diversity confuses customers and merchants, and hampers manufacturers in designing generators with regional appeal.
2. Business practice barriers are due to: (1) unclear or complex utility contracting practices; (2) utility procedures for approving interconnection; (3) utility application and interconnection fees; (4) insurance requirements; and (5) utility operational requirements. According to an NREL study, the "lack of utility experience in dealing with such issues may be one of the most widespread and significant barriers to distributed generation, particularly for small projects" (NREL 5/2000).
3. Regulatory barriers are created by tariff structures that apply to customers owning distributed generation facilities. For example, backup charges, exit fees and unfavorable buy-back rates make the distributed generation facility less economical. In some cases, utilities offer customers discounted electricity rates in order to prevent the installation of distributed generation facilities.

All of these barriers pose significant, although not insurmountable, challenges. To fully seize the potential for energy efficiency and renewable energy outlined in the Clean Energy Development Plan, the public policies presented in Chapter 8 need to be implemented.

<sup>15</sup> Sometimes the term "distributed resources" is used to include energy efficiency as well as generation facilities. Since energy efficiency is discussed separately, the term "distributed generation" in this section refers only to generation facilities.

# 8. PUBLIC POLICIES TO REMOVE THE BARRIERS TO CLEAN ENERGY



The array of barriers to the robust development of smart and clean energy efficiency and renewable resources creates a compelling basis for aggressive public policies to enable the Midwest to fully tap its clean energy potential. These clean energy efficiency and renewable energy resources are technologically achievable and economically realistic. They will not, however, reach their full potential without significant public policy support.

Coal plants and nuclear energy currently receive enormous financial subsidies and policy benefits. Implementing the Clean Energy Development Plan will require thoughtful and aggressive action beyond business-as-usual practices and current regulatory policies. Energy efficiency and renewable energy resources are also hindered by a variety of market barriers that prevent them from competing against coal and nuclear plants on a level playing field. Public policy steps to overcome these market barriers are needed to obtain the benefits of more energy efficiency and wind, biomass and solar power for a more diversified Midwestern electricity portfolio.

Several Midwestern states have recently taken important steps to promote clean energy, but much more remains to

be done. The key policies and action steps necessary to achieve the fundamental energy policy shifts and reach the goals of the Clean Energy Development Plan are presented below.

## 8.1 POLICIES TO PROMOTE ENERGY EFFICIENCY DEVELOPMENT

Public policies to promote energy efficiency should be designed both, to increase the market penetration of tried-and-true energy efficiency products and measures that produce demonstrable energy and cost savings, and to accelerate the use of new energy efficiency technologies in homes, businesses and public buildings. Market transformation strategies can be designed to overcome barriers in order to make efficiency technologies and practices commonplace and easily accessible to electricity consumers. The most important public policy options for promoting energy efficiency are listed in Figure 8.1 and presented below, in detail.

FIGURE 8.1 POLICIES TO PROMOTE ENERGY EFFICIENCY DEVELOPMENT

<b>Energy Efficiency Investment Fund*</b>	<b>Consistent Pollution Control Laws and Regulations</b>
<b>Independent Third-Party Administrators for Energy Efficiency Investment Funds and Programs*</b>	<ul style="list-style-type: none"><li>• Eliminate “grandfathering” of Old Coal Plants</li><li>• Fair Allocation of Emission Allowances</li><li>• CO<sub>2</sub> Reduction Policies</li></ul>
<b>Improved Efficiency Standards and Building Codes*</b>	<b>Tax Incentives for Energy Efficiency</b>
<b>Implementation of Energy Efficiency Programs by Municipal Aggregators</b>	<b>Wholesale Power Market Demand-Side Bidding</b>
<b>Government Investment in Energy Efficiency</b>	<b>Challenges for Utility-Directed Energy Efficiency Programs</b>

*\*Policy options marked with an asterisk are the leading policies recommended to achieve the Clean Energy Development Plan’s energy efficiency development goals.*

## RECOMMENDED POLICIES

### Energy Efficiency Investment Fund

***Each Midwestern state should establish an Energy Efficiency Investment Fund, or an equivalent mechanism, supported by a non-bypassable charge of 0.3¢ per kWh (less than one-third of 1¢) to support the robust energy efficiency initiatives of the Clean Energy Development Plan. All electricity customers should invest in the Fund, just as various decommissioning charges, franchise fees, utility taxes and other utility charges already apply to all customers on their electric utility bills. All customers will benefit from the cleaner air and improved health resulting from developing energy efficiency opportunities. The Energy Efficiency Investment Fund should be implemented as soon as possible and maintained at this level until at least 2010. At that time, the impacts of energy efficiency investments should be evaluated, and public officials and stakeholders should assess whether to modify the funding levels in order to fully achieve the Clean Energy Development Plan's energy efficiency target for 2020. Furthermore, Congress should enact legislation to provide substantial matching energy efficiency investment funds that can be used by the states to supplement or partially offset their investment funds.***

The concept of investing in energy efficiency is not new. An Energy Efficiency Investment Fund provides a competitively neutral source of funding for energy efficiency initiatives. As of August 2000, 17 states had established programs to promote energy efficiency. Illinois and Wisconsin have recently established new energy efficiency funds. These programs should be expanded significantly throughout the Midwest in order to achieve the full potential for energy efficiency identified in the Clean Energy Development Plan.

The Clean Energy Development Plan includes an annual investment in energy efficiency of roughly \$3.5 billion by 2010. Investing 0.3 ¢/kWh, as proposed, would raise sufficient funds to cover about two-thirds of this investment. The customers participating in the efficiency programs would pay the remaining investments. This opportunity for smart energy efficiency improvements should be seized throughout the Midwest.

The Energy Efficiency Investment Fund approach can be used to: (1) provide financial and technical support for electricity customers to install energy efficiency measures in their homes, businesses, commercial and

public buildings, and manufacturing plants; (2) develop statewide market development programs for new, highly energy-efficient appliances, such as refrigerators and clothes washers, and other technologies such as efficient lighting and motors; (3) design education, training, development and demonstration projects to help overcome specific institutional barriers to energy efficiency; and (4) directly install energy efficiency technologies and measures in targeted high-opportunity locations.

Direct installation programs often are among the most effective uses for energy efficiency investment because the entire market is supported – the manufacturing of energy efficiency products; the distribution and stocking of these products in stores; the training of the architects, engineers and contractors to use modern energy efficient products and technologies; and the education of customers who purchase these energy efficiency products.

### Independent Third-Party Administrators for Energy Efficiency Investment Funds and Programs

***The Energy Efficiency Investment Fund should be managed by an independent and highly capable third-party administrator – a not-for-profit organization or foundation or an appropriate public agency.*** A board including environmental and consumer organization representatives, state energy officials, and energy efficiency industry representatives should oversee the Energy Efficiency Administrator. The overall mission of the Administrator should be to transform the markets for energy efficiency products and services, and to maximize the long-term economic and societal benefits resulting from energy efficiency. The new \$225 million Illinois Clean Energy Community Foundation, with its mission to improve energy efficiency and develop renewable energy resources, among other things, is one model of a third-party Energy Efficiency Administrator.

Third-party administrators avoid the conflicting incentives that utilities and power generators face. Third-party administrators can consider the successful development and implementation of aggressive efficiency programs to be the central mission and overriding business objective. Although some utilities have implemented energy efficiency programs in the past, many utilities and generation companies today are not really supportive of energy efficiency programs, because they have a strong financial incentive to maximize electricity sales at almost all times other than peak. That is why, for example, Wisconsin is transferring



the management of energy efficiency and renewable initiatives from the utilities to public agencies and organizations. The Vermont Public Service Board also recently approved the creation of an Energy Efficiency Utility that would provide uniform energy efficiency programs throughout the state, using a single delivery mechanism.

Energy efficiency administrators should consider competitive bidding systems to identify efficiency initiatives with the greatest potential for achieving electricity savings and transforming the market. Competitive bidding can reduce costs and increase the effectiveness of efficiency initiatives.

The following principles should be considered as part of program design in order to maximize the benefits from increased implementation of energy efficiency:

1. Programs should overcome existing market barriers, both to ensure that energy savings are achieved in the short to medium term, and to promote the transformation of the efficiency market over the long term.
2. Programs should minimize lost opportunities that occur when efficiency measures are not installed when it is most cost-effective to do so (e.g., the construction of a new building or facility, or the purchase of new appliances or equipment).
3. Programs should provide efficiency savings to all customer classes and subclasses. Programs should be designed, however, to especially target residential, small business and public agency customers that generally lack internal energy engineering and technical capabilities, and have not yet been effectively reached by private sector energy services and management companies. Larger commercial and industrial customers typically have their own internal engineering and technical capacity, as well as available financing, or are targeted by specialized energy services companies.
4. Programs should be cost-effective: the program costs should be less than the long-term benefits of the efficiency savings, which include societal benefits, such as reduced environmental impacts, economic development gains and assistance to low-income customers.

## Improved Efficiency Standards and Building Codes

***More stringent energy efficiency standards and building codes should be applied throughout the Midwest.*** Commercial lighting improvements, more energy efficient windows, daylighting, and heating, venting and air conditioning (HVAC) efficiency are some of the most cost-effective opportunities for better environmental performance in the Midwest. Each of the Midwestern states should: (1) evaluate its current efficiency standards and building codes; (2) upgrade outdated codes and standards; and (3) establish monitoring and enforcement practices to ensure that revised standards and codes are implemented. States should coordinate their efforts to provide regional consistency.

Efficiency standards are key for new appliances and other equipment that are used on a mass basis and consume electricity. Ratcheting up the efficiency of refrigerators and air conditioners, for example, can produce huge overall energy savings. Similarly, building code reforms that set minimum efficiency standards for the design and construction of new and renovated buildings target some of the biggest opportunities for energy savings.

Efficiency standards and building codes directly transform the market for energy efficient products, designs and services. Over time, they can permanently remove certain inefficient products and practices from the market. They encourage all manufacturers, designers, architects and builders equally and simultaneously. They also encourage all customers, not just those who are better informed, more motivated or more concerned about energy consumption and environmental impacts. They create a technology “pull” on the market for more efficient products, and they immediately overcome many of the market barriers to energy efficiency.

There are significant opportunities to improve existing efficiency standards and building codes in the Midwest. While the federal government has already established efficiency standards for some appliances and products through the National Appliance Energy Conservation Act of 1987 (NAECA) and the 1992 Energy Policy Act, these standards can often become out-of-date as technologies improve. Similarly, many states have efficiency-related building codes on the books, but most are behind the times. The Energy Policy Act requires all states to adopt at least the “good practice” commercial building code, and to consider upgrading

their residential building code to meet or exceed the “good practice” code.<sup>16</sup> Nevertheless, not all states have complied with the Act’s requirements and suggestions. Furthermore, these codes do not always incorporate the best efficiency practices, and often they are not adequately monitored or enforced.

Efficiency standards and codes are most effective when they cover a broad region, thus applying consistent requirements to manufacturers and easing the education and training of designers, builders and building code officials. That is why it is preferable, and likely to be more cost-effective, for the Midwestern states to coordinate their efforts. Still, individual states can adopt more aggressive standards and codes on their own. California’s groundbreaking 1974 efficiency standards paved the way for other states to adopt similar requirements, and eventually for the existing national standards. In the Midwest, Minnesota has strict energy efficiency standards in its building codes for commercial and multi-family construction.

Efficiency standards and building codes are cost-effective means of achieving energy savings. They increase the economies of scale for producing efficiency measures by making efficient products and designs the normal practice. One study found that, by the year 2015, the U.S. efficiency standards required by NAECA and the Energy Policy Act would reduce U.S. annual energy use by 4.3 percent, save energy consumers approximately \$140 billion (in 1993 present value dollars), and eliminate the need for roughly 80,000 MW of new generation capacity. The benefit-cost ratio of these standards is more than 3:1 – i.e., \$3 of energy savings are produced for every \$1 spent on more efficient measures. The energy savings from the federal efficiency standards are among the highest of any conservation policy pursued in the United States – substantially greater than utility-run energy efficiency programs (ACEEE 1996).

In addition to the success of the federal efficiency standards, states can cost-effectively achieve additional savings by going beyond those standards. A recent study estimated that the 10 Midwestern states can achieve electricity savings of roughly 7,785 MWh by 2010 and 20,499 MWh by 2020 by updating the federal efficiency standards for seven key electricity end-uses: clothes washers; fluorescent ballasts; central air conditioning and heating pumps; water heaters; transformers; commercial air conditioners and heat pumps; and commercial furnaces and boilers. Upgrading these efficiency standards would create a net economic savings of \$3,676

million in 2010 and \$8,029 million in 2020 for the 10 Midwestern states (ASAP 2000).

A 1994 study of efficiency standards in Illinois identified 14 product types that were not already covered by standards, but for which standards are probably justified. The study also concluded that although many individual municipalities in Illinois had adopted building energy codes, the lack of consistency resulted in poor compliance levels (ACEEE 1994).

## **ADDITIONAL POLICIES**

The policies described above are the most important for achieving the Clean Energy Development Plan’s goals. However, the following additional policy options should also be considered.

### **Implementation of Energy Efficiency Programs by Municipal Aggregators**

Municipal aggregators may be well positioned to implement energy efficiency programs. Ohio, for example, has passed legislation that allows municipal governments to act as power supply aggregators. This approach helps ensure that all customers – regardless of size, type or means – will have an aggregator seeking to purchase the best power supply on their behalf.<sup>17</sup>

Municipal aggregators are a natural entity for implementing energy efficiency programs. States could provide them, rather than the local utility, with funds to implement energy efficiency programs. Municipal aggregators will likely take a fundamentally different approach to energy efficiency than utilities – one that is more consistent with an overall goal of lowering electricity costs.

There are other reasons to recommend municipal aggregators. They may have a broad network of local contacts – town halls, schools, churches, hospitals, chambers of commerce and other civic organizations – to assist with marketing and delivery of efficiency programs and with market transformation in general. Municipal aggregators can provide a number of forums, such as town meetings, for residents and customers to

<sup>16</sup> Good practice residential energy code is defined as the 1992 (or more recent) version of the Model Energy Code, and good practice commercial energy code is defined as the ASHRAE 90.1 – 1989 model standard (ACEEE 12/1999).

<sup>17</sup> Municipal aggregation laws usually have an opt-out provision, to ensure that customers who wish to use other power suppliers can do so.

express their views on the types of energy efficiency programs that can best meet their needs. Municipal aggregators have an interest in local economic development and environmental improvement, and they can factor these benefits into their cost-effectiveness assessments. Finally, municipal aggregators are not motivated by the financial impacts on any particular utility, and can therefore offer societally cost-effective fuel-blind and fuel-switching programs.

## **Government Investments**

Federal, state and local government agencies should implement smart and sensible energy efficiency technologies and practices to save electricity. Government as a whole is the largest single consumer of energy and electricity in the nation. Public agencies' investments in energy efficiency can significantly advance the infrastructure for manufacturing, distributing, installing and operating efficiency products. In short, government can help transform the market for efficiency measures and products.

Government investments in energy efficiency can save taxpayers money by reducing energy bills and can produce environmental benefits that are enjoyed by all citizens, but tend to be undervalued in the electricity market. Likewise, efficiency investments can promote job creation and economic development in this sector.

## **Consistent Pollution Control Laws and Regulations**

Environmental regulations perform a vital role in protecting public health and achieving environmental goals. Pollution control regulations applied to the electricity generating sector will tend to support energy efficiency by increasing the costs of conventional generators and placing greater value on cleaner electricity resources.

Environmental regulations must be properly designed and uniformly enforced to ensure that they are applied fairly to all electricity resources. The federal Clean Air Act applies many regulations in a differential manner to coal plants built before 1977 (so-called "old sources") and plants constructed later ("new sources"). The pollution control standards for new sources are much more stringent, and the grandfathering of the highly-polluting older coal plants allows the owners to avoid the costs of installing modern pollution control equipment, thereby providing an unfair competitive advantage over newer fossil fuel plants and cleaner electricity resources such as energy efficiency.

Two steps are necessary to ensure that the pollution control laws treat energy efficiency resources fairly. First, the grandfathering provisions in the Clean Air Act should be eliminated. Second, cap-and-trade systems should be designed to ensure that energy efficiency resources obtain a fair amount of free emission allowances. For example, states that establish NO<sub>x</sub> allowance trading schemes in response to the EPA's SIP Rule should require that qualified efficiency resources are provided with NO<sub>x</sub> allowances on the same basis as existing coal plants. This also is important for renewable resources and is discussed in Section 8.2.2

Furthermore, as presented in Section 8.4, environmental policies that are explicitly designed to reduce CO<sub>2</sub> emissions will provide substantial support for energy efficiency, which is the most cost-effective means to achieve this goal.

## **Tax Incentives**

Tax credits can be provided to individuals and businesses that purchase and install qualifying, innovative energy efficiency measures. The goal is to reduce the financial barriers that many customers face when purchasing energy efficiency equipment, and to stimulate the development of certain advanced technologies that have not yet reached commercialization. Tax credits could come from both federal and state governments.

It is important that tax incentives be designed to achieve the greatest impact on the efficiency market. The following key principles should be considered in designing tax incentives (ACEEE 7/1999):

1. Seek to stimulate commercialization of advanced technologies that have not yet been established in the marketplace.
2. Establish performance criteria for manufacturers to meet, and pay the incentives as qualifying products are sold.
3. Pay incentives large enough to influence business and residential consumers' decision-making, and to cover a sizable fraction of the incremental, up-front cost of the energy efficiency product.
4. Apply tax incentives to only those technologies where the initial investment is a major barrier.

5. Be flexible with respect to what entity receives the tax credits: in some cases it may be most effective to provide the incentives to manufacturers, while in others it may make more sense to target technology users.
6. Complement other policy initiatives, such as the Energy Star labeling programs and other market transformation efforts.
7. Select priorities based on potential impact, cost-effectiveness, private sector interest and support, and likelihood of success.
8. Allow adequate time for qualifying technologies to become commercialized.

### **Wholesale Power Market Demand-Side Bidding**

In regions where the electric industry has been restructured and there is a wholesale electricity spot market, demand-side bidding could be implemented to allow customers to be paid the market clearing price for curtailing their load. Demand-side bidding offers many benefits to the electricity system as a whole, including increased reliability, less price volatility and reduced market power problems. Demand-side bidding provides many benefits over traditional utility-based interruptible programs because it offers payments to customers based on market prices, and is far more flexible in terms of which customers can participate and when.

### **Challenges for Utility-Directed Energy Efficiency Programs**

*Repowering the Midwest* recommends using new, independent third-party Energy Efficiency Administrators to design and implement state programs to improve energy efficiency for the reasons presented in Section 8.1.1. In the past, many electric utilities implemented energy efficiency programs. Utilities were a logical choice because they have an existing delivery mechanism, their customers could benefit from reduced electricity costs, they have the necessary infrastructure for raising capital, and these actions could be encouraged through state utility regulatory processes.

As the electricity services market becomes more regional and competitive, however, many utilities have

been reluctant to implement energy efficiency programs in their local service territories because the energy savings can lead to lower sales and revenues. Throughout the United States, utility investments in energy efficiency and load management have declined from a peak of \$2.7 billion in 1993 to \$1.6 billion in 1998 (ACEEE 2000); for energy efficiency, as opposed to peak-shaving load management, they are probably even lower today. Distribution-only utilities face many of the same financial impacts from energy efficiency actions as vertically integrated utilities, and most do not see improved energy efficiency on the customer-side of the meter as a preferred business strategy, except in limited cases (e.g., where there are transmission or distribution constraints) for responding to the new market structure.

The Midwestern states are at a transitional time when it comes to implementing changes in their historic utility regulatory systems. Two states – Illinois and Ohio – have enacted comprehensive restructuring legislation. Two other states – Michigan and Wisconsin – have passed significant legislation that has restructured the prior system in major ways. On the other hand, other Midwestern states have generally maintained their longstanding utility regulatory systems and have not enacted significant deregulation laws. Moreover, even the traditional utility regulatory system differed significantly from state-to-state on the ratemaking treatment related to energy efficiency programs.

At this time, utility-directed energy efficiency programs may make sense in limited circumstances or in particular states, but the independent third-party Energy Efficiency Administrator is the preferred approach to best achieve the potential of the Clean Energy Development Plan.

## **8.2 POLICIES TO PROMOTE RENEWABLE ENERGY RESOURCE DEVELOPMENT**

Policies to encourage renewable resources should acknowledge and help overcome the market barriers discussed above. It is important to recognize that renewable energy technologies tend to follow a product cycle – typical of all new technologies – that has five stages of development: (1) basic science and research; (2) bench-scale testing; (3) prototype development; (4) initial commercial availability; and (e) competitive, mature product (Jefferiss and Haddad 1999). Some of the renewable technologies proposed in the Clean Energy Development Plan have already reached the initial

commercial availability stage, while others are still in the developmental stages. Public policies should recognize that various renewable technologies might be at different stages of development, and should explicitly seek to advance these technologies through the product cycle.

One key strategy for advancing the commercial availability of renewable technologies is through “sustained orderly development.” This explicitly recognizes that in order to become mature, competitive products, renewable technologies must be manufactured and deployed at a high enough rate to achieve economies of scale and lower production costs. Sustained orderly development is a technique for jumpstarting the renewable energy industry by promoting enough resource development to achieve high manufacturing rates and enable the technologies to become commercially viable.

The most important public policy options for promoting renewable energy resources are listed in Figure 8.2 and presented below, in detail.

## RECOMMENDED POLICIES

### Renewables Portfolio Standard

*Each Midwestern state should promptly establish a Renewables Portfolio Standard (RPS) that requires all retail electricity suppliers to include a specified percentage of renewable resources in their generation mix.* The RPS percentage requirement should increase steadily each year to reach eight percent by 2010 and 20 percent by 2020. In states

that have adopted electric industry restructuring legislation, the RPS should apply to all customers, including “standard offer” or “default” customers served by electric distribution companies. RPS standards should be applied to each product provided by a retail electricity seller, as opposed to being applied to the company’s overall sales on average. This ensures that the RPS will be applied for the benefit of all customers. **Ideally, a national RPS would be enacted, in addition to a regional RPS policy for the Midwest as a whole.**

A RPS is one of the most important policies for promoting renewable resources. It is market-based, and relies upon competing generating companies to develop the technologies necessary to achieve the targeted level of renewable resources. As of August 2000, minimum renewable energy requirements have been adopted in Connecticut, Iowa, Maine, Massachusetts, Minnesota, Nevada, New Jersey, Pennsylvania, Texas, Arizona, New Mexico and Wisconsin (UCS 2000). A RPS also has been proposed in at least six federal electricity restructuring bills.

The RPS percentage standard should be met by only new renewable energy generation so that it will support the development and commercialization of new resources and technologies. Otherwise, generators would simply repackage existing wind and solar power, and no net environmental and economic development benefits would be obtained. The RPS should not be applied to hydropower and other technologies that are already mature and cost-effective.

FIGURE 8.2 POLICIES TO PROMOTE RENEWABLE ENERGY RESOURCES DEVELOPMENT

<b>Renewables Portfolio Standard*</b> <b>Renewable Energy Investment Fund*</b> <b>Independent Third-Party Administrator for Renewable Energy Investment Funds and Programs*</b> <b>Fair Transmission Access and RTO Policies*</b> <b>Federal Production Tax Credit for Renewables*</b> <b>Additional Tax Incentives</b>	<b>Policies to Support Green Power Marketing</b> <ul style="list-style-type: none"> <li>• Environmental Disclosure Requirements</li> <li>• Systems to Account for Generation Attributes</li> <li>• Certification Standards</li> </ul> <b>Consistent Pollution Control Laws and Regulations</b> <ul style="list-style-type: none"> <li>• Eliminate grandfathering of Old Coal Plants</li> <li>• Fair Allocation of Emission Allowances</li> </ul> <b>CO<sub>2</sub> Reduction Policies</b> <b>Government Purchases of Renewables</b> <b>Elimination of Fossil Fuel and Nuclear Subsidies</b>
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*\*Policy options marked with an asterisk are the leading policies recommended to achieve the Clean Energy Development Plan’s renewable energy resources development goals.*



Policymakers should consider including a renewable credit trading system in the RPS that is designed to assure improvements to local air quality through renewables development in all states. Qualifying renewable energy generators in the Midwest would produce credits that could be sold to all retail electricity suppliers in the region. Tradable credits would make the renewables market significantly more flexible and fluid, and would enable all states to take advantage of the most cost-effective renewable resources available in the region. They also ease administration of an RPS by providing a concrete and verifiable system for reporting how much renewable generation was purchased by each retail supplier.

## Renewable Energy Investment Fund

***Each Midwestern state should establish a Renewable Energy Investment Fund, or an equivalent mechanism, supported by a non-bypassable charge of 0.1¢ per kWh*** (one-tenth of 1¢) to support the robust development of wind power, biomass energy and solar power. All electricity customers should invest in this Fund because, just as with the Energy Efficiency Investment Fund, various decommissioning charges, franchise fees, utility taxes and other utility charges already apply to all customers on local electric utility bills. All customers will benefit from the cleaner air and improved health resulting from developing renewable energy resources. The Renewable Energy Investment Fund complements the Renewables Portfolio Standard, which largely supports technologies that are already close to commercial viability. The Investment Fund also will advance technologies that are still in the developmental stages. The Renewable Energy Investment Fund should be implemented as soon as possible and maintained at this level until at least 2010. At that time, the impacts of the renewables investments should be evaluated, and public officials and stakeholders should assess whether to modify the funding levels in order to achieve the Clean Energy Development Plan's renewable energy resources target for 2020. Furthermore, **Congress also should enact legislation to provide substantial matching renewable energy investment funds that can be used by the states to supplement or partially offset their investment funds.**

The Renewable Energy Investment Fund should focus on development and demonstration projects that:

1. Support technologies that are not immediately competitive (even with an RPS) but offer great long-

term potential, such as solar photovoltaics, fuel cells and small wind turbines.

2. Leverage private investment and familiarize private investors with the potential for renewable energy.
3. Support training, education, development and demonstration projects to help overcome specific institutional barriers to renewable resources.
4. Target those technologies that offer special economic or environmental benefits for a particular state.

The investment of 0.1¢/kWh would raise about \$730 million per year throughout the Midwest. This opportunity for renewable energy investment and development should be seized throughout the Midwest.

## Independent Third-Party Administrators for Renewable Energy Investment Funds and Programs

***The Renewable Energy Investment Fund should be managed by an independent and highly capable third-party administrator – a not-for-profit organization or foundation or an appropriate public agency***—that should be overseen by a board including environmental and consumer organization representatives, state energy officials and renewable energy industry representatives. Competitive bidding processes, such as “reverse auctions,” should be emphasized to most effectively deploy these renewable energy investment and development funds. Funding should generally focus on production incentives which are typically more efficient than investment incentives, because they encourage least-cost electricity production, not just capital investment. Financial incentives should take into account the above-market costs of the renewable technologies on a life-cycle basis. The rationale for the creation of independent third-party administrators for the Renewable Energy Investment Funds' programs is largely the same as presented above for the Energy Efficiency Investment Funds.

## Fair Transmission Access and RTO Policies

***Transmission pricing policies and power pooling practices should treat renewable energy resources fairly.*** They must account for the intermittent nature of wind and solar power operations, and their generally smaller scales and remote locations. Transmission policy reform is necessary to

ensure that renewable energy generators have full and fair access to the grid. Some of the most important transmission reform steps are:

1. The regional transmission Independent System Operators (ISO) and Regional Transmission Organizations (RTO) should have governance structures that reasonably include representation of both environmental advocacy organizations and renewable energy generators. They should not be dominated by transmission owners or owners of conventional generation technologies.
2. Pancaked transmission rates – the practice of layering on new transmission charges in each utility or control area that power is delivered through – should be eliminated wherever possible and minimized elsewhere.
3. Postage stamp rates – where one price is applied to transmit power anywhere within a region – should be encouraged.
4. Real-time balancing markets should be established to allow generators to buy or sell firm transmission capacity that deviates from the amount reserved in advance.
5. Spot-market bidding systems should not penalize renewable energy producers that have intermittent and unpredictable generation patterns.
6. Transmission congestion management systems should not impose penalties on, or deny benefits to, remote, intermittent renewable generators.
7. Ancillary services for renewables generators' purchases and sales should be priced fairly.
8. Public and private stakeholders should consider establishing renewable power exchanges in order to facilitate the scheduling and transmission of renewable generation.
9. Net metering and fairer interconnection policies should be implemented as explained in Section 8.3.

## Federal Production Tax Credit

***The federal production tax credit (PTC) for renewable energy should be extended.*** The PTC is currently scheduled to expire at the end of 2001, but it is justified by sound policy and should be extended in order to

facilitate the robust development of renewable energy resources. The PTC currently covers wind and closed-loop biomass, but should be expanded to cover solar power as well. This tax incentive has been a powerful force in achieving the wind energy development seen in the Midwest to date, and can help renewable energy overcome existing market barriers.

## ADDITIONAL POLICIES

The policies described above are the most important for achieving the Clean Energy Development Plan's goals. The additional policy options described below should also be considered.

## Additional Tax Incentives

Federal and state governments should provide targeted tax incentives to support the development of renewable generators. In addition to the important extension of the federal PTC for renewables identified above, the following additional focused options should be considered:

1. Investment tax credits can provide the owner or developer of a renewable generator with a tax reduction based on some portion of the initial capital investment of the facility.
2. State and local sales tax reductions can be offered to the owners of renewable generators. The per-kWh sales tax is high for owners of renewable generators relative to owners of conventional generators, because fossil fuel inputs are exempt from sales taxes. A sales tax reduction for renewables helps offset this imbalance.
3. Property tax reductions can be offered to the owners of renewable generators. Because of their relatively high initial capital costs as opposed to very low fuel costs – \$0 for wind and solar – renewable generation owners may sometimes pay relatively higher property taxes than owners of coal, gas and nuclear generation. A property tax adjustment for renewables can offset this imbalance.
4. Accelerated tax depreciation schedules can be used to provide tax benefits in the early years of a new renewable generator. The federal government already provides renewables with a five-year accelerated depreciation schedule. States can provide the same opportunity.

A few considerations are important when evaluating the opportunities for tax incentives. Production tax credits are sometimes favored over investment tax credits because they provide incentives for efficient construction and operation of the facility. Any tax reduction is only valuable to the extent that the renewable resource owner is subject to tax liability. Stability in the amount and duration of the tax incentive is very important for renewable project developers and financiers. Nonprofit and governmental agencies (e.g., cooperatives and municipal utilities) are not subject to taxes, and thus alternative support mechanisms should be considered.

## Policies to Support Green Power Marketing

Some electricity customers have demonstrated a willingness to pay a premium for renewable resources, and some generation companies have offered such “green power” products as a way to differentiate themselves from competitors. Some regulatory policies are necessary to better enable customers to make an informed choice among green power products and ensure that the market works properly.

First, all retail electricity suppliers should provide consistent and comprehensive environmental data that informs all customers of the mix of the generation resources being offered and their environmental characteristics. Environmental disclosure removes informational market barriers. It enables consumers who wish to choose among competing electricity suppliers based on environmental characteristics to make an informed choice based on consistent data. Furthermore, state environmental disclosure laws prevent inaccurate or misleading claims by suppliers about how “green” their power is. Illinois has adopted a comprehensive disclosure law and set of administrative regulations that have been in operation for two years and can serve as a model for other Midwestern states.

Second, standards should be established to track and account for generation attributes (e.g., fuel type, air emissions, other environmental impacts) to ensure that green power marketers actually produce the promised green power and that the same renewable energy is not sold more than once.

Third, standards should be established to identify and certify generation that qualifies as green power. This will help to assure customers that the power they are purchasing will actually result in environmental improvements and reduce potential consumer confusion in determining what is green power and what is not.

Green power purchasing by individual residential and business consumers is important, but cannot alone substitute for the broader public policy and market development measures presented in this chapter. Utilities’ green pricing programs do laudably spur renewables development, but they are not consistent with the widely-accepted “polluter pays principle” because they impose a cost on some customers but not others – even though all customers benefit from clean energy development and all equally bear the burdens of higher pollution and social costs from fossil fuel and nuclear plants.

## Consistent Pollution Control Laws and Regulations

As discussed in Section 8.1, environmental regulations perform a vital role in protecting public health and achieving environmental quality goals such as clean air and water. Pollution control regulations applied to the electricity generating sector will tend to support renewable energy development by increasing the costs of conventional generators and placing greater value on cleaner electricity resources.

Two policy changes in the pollution control laws should be made. First, the “grandfathering” provisions in the Clean Air Act should be eliminated. These provisions support and, in effect, subsidize continued pollution from old, inefficient coal plants, create market distortions and thus reduce the potential for renewable energy resources development.

Second, SO<sub>2</sub> and NO<sub>x</sub> cap-and-trade programs should be changed because they tend to attribute insufficient value to efficiency and renewable resources by primarily (or only) encompassing fossil fuel resources. The SO<sub>2</sub> allowance allocation scheme provides most of the initial allowances to existing fossil-fueled plants.<sup>18</sup> Most of the proposed NO<sub>x</sub> cap-and-trade systems tend to heavily favor existing fossil fuel sources in the initial allocation of NO<sub>x</sub> allowances.<sup>19</sup>

<sup>18</sup> The 1990 Clean Air Act Amendments included a reserve of allowances for energy efficiency and renewable resources, but the conditions placed on the reserve were such that they were underutilized.

<sup>19</sup> In the federal Ozone Transport Commission’s NO<sub>x</sub> Budget program, some states allocate all of the free NO<sub>x</sub> allowances to existing fossil-fueled plants. In the EPA’s NO<sub>x</sub> Budget Trading Program, the EPA recommended setting aside some NO<sub>x</sub> allowances for new sources, renewable resources and energy efficiency. However, new source set-aside allowances will ultimately be decided at the state level, and only a few states have proposed set-asides for renewables and efficiency (Synapse 1999).

When allowances are allocated primarily to existing power plants, opportunities to promote cleaner resources for meeting national air quality standards are bypassed. In addition, existing generation sources are provided with an inequitable competitive advantage in the electricity marketplace. The sum of the reduction in compliance costs from allocation of both SO<sub>2</sub> and NO<sub>x</sub> allowances to existing sources could be as much as \$3.5/MWh (Synapse 1999). This is approximately 10 percent of the cost of generating electricity, and will likely be an important factor in the operating economics of some generation units. This advantage to existing fossil fuel generators will be even larger if a similar cap-and-trade system is adopted for CO<sub>2</sub> emissions.

An emission performance standard (EPS) should be explored to replace existing regulations for NO<sub>x</sub> and SO<sub>2</sub>. The EPS would apply equally to existing and new generation plants. This standard would be determined in such a way as to achieve the desired environmental objective (e.g., New Source Review requirements and the EPA NO<sub>x</sub> SIP Rule). It would determine caps on NO<sub>x</sub> and SO<sub>2</sub> emissions, and allowances would be based on those caps. The emission performance standard should be output-based (i.e., lb/MWh), in order to encourage efficient approaches to reducing emissions.

NO<sub>x</sub> and SO<sub>2</sub> emission allowances would be allocated to new natural gas plants, energy efficiency and renewable energy generators, as well as to existing plants.<sup>20</sup> Nuclear generators should not be allowed to receive any emission allowances, because nuclear plants produce large amounts of other pollutants (e.g., high-level and low-level radioactive nuclear wastes, air pollution from uranium processing, water pollution from thermal discharges) that impose significant environmental and public health costs on the public that are not covered in the Clean Air Act's emissions cap-and-trade programs. Similarly, hydro power plants should not be allowed to receive any emission allowances because they can also impose significant environmental quality costs.

## Government Purchases

Federal, state and local government agencies can help drive and develop the clean energy market by purchasing renewable energy as part of their overall power procurement. Government is the largest single consumer of energy and electricity in the nation. Green energy procurement policies can help to: (1) jumpstart and develop the infrastructure necessary to support new renewable energy technologies; (2) overcome financial agencies' concerns about risk and uncertainty of future demand for renewables; and (3) promote economies of

scale for the production of renewables technology that may also achieve local economic development benefits.

The City of Chicago has taken a national leadership role by spurring solar energy use and business development. The City's guaranteed purchase of solar photovoltaic panels – to be used on public schools, museums and public buildings – helped attract Spire Solar to build a new manufacturing plant on a brownfield area on the West Side of Chicago that will provide new jobs in the community.

The City of Chicago's green power purchase initiative, starting in 2001, for the city, certain suburbs and other local public agencies, will likely spur broader development of renewable energy in Illinois and the Midwest. The city's request for proposals, issued in 2000, calls for a total of 400 MW of electricity, including at least 80 MW of green power defined as "new" renewable energy resources. At least one-half of the green power is likely to be supplied by wind power. The city's RFP also includes preferences for green power to be developed in Illinois and for air pollution reduction measures.

Government procurement practices are important, but should not stand alone; rather, they should be part of a broader strategy to help commercialize renewables by building upon other public policies, market development and business network efforts.

## Elimination of Fossil-Fuel and Nuclear Subsidies

Fossil fuel and nuclear generation currently enjoy massive federal and state government subsidies in the form of tax breaks, research and development, and protection from nuclear accident liability. In recent years, renewable technologies have also received much more modest public support through research and development funding and production tax credits. The overwhelming amount of government subsidies, however, has flowed to conventional generation technologies:

1. A recent study concluded that the federal government subsidies from 1943 through 1999 to nuclear, wind, photovoltaic and solar thermal electric generation technologies totalled \$151 billion (in 1999 dollars). A staggering 96 percent of these subsidies (\$145 billion) went to nuclear generation

<sup>20</sup> In this approach, there would be no need to create a "set-aside" for efficiency or renewable resources, because they would simply be allocated a share of emission allowances in proportion to the amount of electricity they produce or save. In the past, "set-asides" have tended to be unduly restrictive (Synapse 1999).

technologies, while only four percent (\$5 billion) went to renewable technologies (REPP 7/2000).

2. The Department of Energy budgets have consistently favored coal and nuclear generation. For example, in fiscal year 1996, the DOE budget included a total of \$1,300 million for nuclear technologies, radioactive waste and fossil fuels, but only \$273 million for all renewable energy technologies combined (UCS 1999).
3. Renewable technologies have a higher tax burden than conventional generation technologies because they do not have fuel expenses to deduct, they cannot benefit from “depletion allowances” that allow companies to deduct the loss of fuels that have been mined or drilled, and they tend to pay higher property and income taxes (UCS 1999).

The amounts and allocations of these government subsidies do not reflect sound public policy and should be changed. Fossil fuel and nuclear generation produce environmental and public health harms. Their subsidies should be phased out and eliminated, both for sound public policy reasons and to create a more level playing field in the emerging competitive electricity services market.

### 8.3. POLICIES TO PROMOTE CLEAN DISTRIBUTED GENERATION DEVELOPMENT

Clean distributed generation resources – such as fuel cells, small wind turbines and solar panels – can be deployed at many locations throughout an electric distribution system. They can enhance generation reliability by providing power when and where most needed, as well as in remote locations where it is costly and/or difficult to run power lines. They can also enhance distribution reliability by providing grid support to relieve

stress on aging electricity delivery systems especially in urban and suburban areas, such as Chicago, that have recently been plagued by recurring power outages. In some cases, distributed resources may avoid the need for transmission line extensions as sprawl pushes development beyond existing suburban areas. Policies should be designed to support clean distributed generation technologies, including small turbines, solar photovoltaic panels and fuel cells. There is a distinct difference between desired policy support for these clean technologies, as opposed to diesel generators and other dirty distributed generation that may also provide power to enhance reliability in specific locations, but at the cost of excessive air pollution.

The most important public policy options for promoting clean distributed generation are listed in Figure 8.3 and presented in detail below.

#### RECOMMENDED POLICIES

Regulatory policies to promote distributed generation should effectively target those most likely to take action – for example, customers or utilities. The policies discussed below are designed to encourage electricity customers to install and operate distributed generation whenever and wherever they will cost-effectively improve the reliability of the customer’s service or reduce the customer’s overall electricity costs.

#### Net Metering

***Net metering for clean distributed generation technologies should be enacted and implemented in all Midwestern states.*** Federal legislation to adopt net metering nationally would be appropriate as well.

Net metering allows customers who own clean renewable generators to sell their excess power – beyond what they

FIGURE 8.3 POLICIES TO PROMOTE CLEAN DISTRIBUTED GENERATION DEVELOPMENT

<b>Net Metering*</b>	<b>Reduce Ratemaking Barriers to Clean Distributed Generation</b>
<b>Uniform Safety and Power Quality Standards*</b>	<b>Define Conditions for Customer’s Right to Interconnect</b>
<b>Standardization Interconnection and Business Terms*</b>	<b>Focused Exploration of Niche Applications</b>
<b>Apply Clean Air Laws and Regulations to Small (Dirty) Distributed Generators*</b>	<b>T&amp;D Planning and Upgrade Policies</b>

\*Policy options marked with an asterisk are the leading policies recommended to achieve the Clean Energy Development Plan’s clean distributed generation development goals.



use at their homes and businesses – back to the grid. Customers should be paid the retail rate for this excess generation. Thus, the net metering customer is paid the same rate for power generated and sold to the utility as the rate that the customer pays to buy power from the utility to be used at the home or business. The fairness of this approach is obvious. Especially when wind power or solar power is provided to the grid at peak demand times, there is a strong argument for payment at a higher market rate, rather than the retail rate.

To date, 30 states have adopted net metering policies in some form. Ohio and Iowa have among the most effective net metering policies in place today. In Iowa, the net metering limit is based on the size of the customer's electrical demand, rather than on some arbitrary level. This means that large customers can install large, more cost-effective clean generation units, but customers cannot sell large quantities of power offsite. About 3.7 MW of renewables are now operating under net metering arrangements in Iowa, probably the largest amount in any state.

## **Uniform Safety and Power Quality Standards**

***Uniform safety and power quality standards should be developed throughout the Midwest*** in order to facilitate the process for customers and developers to reasonably, economically and safely interconnect to the electricity distribution system. Consistent standards for interconnection of clean distributed generation to meet safety, power quality and reliability requirements would reduce technical barriers and costs and address utility safety concerns. Fortunately, a number of nationally recognized standards for safety and performance have been adopted that could be used in the Midwest for distributed energy interconnection. For example, standards developed by the Institute of Electrical and Electronic Engineers (IEEE929) and Underwriters Laboratories (UL 1741) ensure safe photovoltaic interconnection that protects the consumer, the utility and its lineworkers. Similarly, where necessary, distributed generation equipment could be tested and certified to ensure that it meets interconnection and other operational standards. The combination of interconnection standards and pre-certification requirements should eliminate utilities' concerns about the impacts of distributed generation on their systems, and it should simplify the connection process for owners of distributed generation. Overall, interconnection standards should achieve the goals identified by the American Solar Energy Society: safety and reliability, simplicity, fairness, standardization and cost-effectiveness.

## **Standardized Interconnection and Business Terms**

***Utilities and state utility regulatory commissions across the Midwest should work cooperatively to establish standard business and interconnection terms and conditions*** that will help overcome existing institutional barriers to clean distributed generation technologies. Many distributed generation developers have found that utilities have inefficient business practices for the connection of clean distributed generation resources, and utilities' interconnection terms and conditions can create barriers in the form of delays, inequitable fees and unnecessary impediments. Standard protocols could address issues such as insurance requirements, indemnification clauses, power purchase contracts and siting provisions.

Utilities should also waive their interconnection charges for small wind power, solar photovoltaic panels and fuel cell installations because of the reliability and environmental benefits associated with these clean technologies. State utility regulatory commissions should require these steps if not undertaken voluntarily by the utilities.

## **Apply Clean Air Laws and Regulations to Small (Dirty) Distributed Generators**

***Federal and state environmental officials should apply clean air standards to small distributed generation sources so that clean power technologies are promoted and highly polluting diesel generators are discouraged.*** Congress should eliminate the exemption from federal Clean Air Act standards for small generation sources in light of the new realities of the electric power market. In today's circumstances, this exemption undermines the national air quality improvement goals, and it provides polluting diesel generators with an unfair competitive advantage. Diesel generators, for example, produce up to 30 times as much NO<sub>x</sub> and particulate pollution as new combined-cycle natural gas plants and microturbines, but these generators are often the first choice for standby and peak power, particularly in areas where grid reliability is a concern. In addition to truly clean wind turbines, solar photovoltaic panels and fuel cells, there also are new relatively clean microturbines and other small generator technologies on the market that can achieve the benefits of distributed power resources without sacrificing environmental quality.

## ADDITIONAL POLICIES

The policies described above are the most important for achieving the Clean Energy Development Plan's goals. The following additional policy options should also be considered:

### Reduce Ratemaking Barriers to Clean Distributed Generation

Some utilities have inflexible standby charges and backup rates that are designed for relatively large, independent generation plants, and they can create significant barriers for intermittent clean distributed generation. These types of ratemaking practices should be redesigned to encourage the development of renewable, efficient distributed generation.

### Define the Conditions for a Customer's Right to Interconnect

Clean distributed generation developers and customers could be provided a "right to interconnect" to a utility's distribution grid, as long as they comply with interconnection standards, standard business terms and conditions, and regulatory principles. Utility regulators could clearly define the conditions necessary for a customer's or developer's right to interconnect, in order to streamline the interconnection process and minimize the need for dispute resolution or regulatory appeal processes.

### Focused Exploration of Niche Applications

There are many niche locations – such as second-home development in remote rural areas and residential construction in ex-urban areas – where installing clean distributed generation may be preferable to interconnection with the existing electricity grid or transmission and distribution upgrades. Diesel generators also can be hybridized with wind, solar or PV to reduce emissions from existing installations. These applications should be explored through a combination of educating developers and active collaborations involving state utility regulatory commissions, utilities and public and private stakeholders.

### Transmission and Distribution Planning and Upgrade Policies

Electric utilities (either vertically-integrated or distribution-only) should be required by state utility regulatory commissions to conduct periodic planning studies to

assess the potential for deploying clean distributed generation to improve reliability or reduce transmission and distribution (T&D) costs. At a minimum, utilities should be required to explore and determine clean distributed resource options before seeking to undertake major T&D upgrades or line extensions. Clean distributed generation should be provided with "extra credit" in such determinations because of the positive environmental and social values.

## 8.4 CO<sub>2</sub> REDUCTION POLICIES

Legislators, regulators and public stakeholders seeking to reduce CO<sub>2</sub> pollution from coal and natural gas plants should also look beyond these clean energy proposals. Aggressive energy efficiency and renewable energy resources development can, indeed, play an important role in offsetting increased CO<sub>2</sub> pollution. However, coal plants produce the largest share of the Midwest's air pollution, and achieving significant CO<sub>2</sub> reductions will require reducing pollution from these plants.

Furthermore, over the next 20 to 30 years, many nuclear units in the Midwest and the United States are expected to retire. If this nuclear generation is simply replaced with natural gas combined-cycle generation, there will be significant increases in CO<sub>2</sub> emissions from the electric industry (Woolf and Biewald 1998). Aggressive policies designed to replace this retired nuclear generation with zero carbon resources may help keep CO<sub>2</sub> emissions from growing significantly, but they will be unlikely to achieve significant CO<sub>2</sub> reductions from the electric industry.

The best way to be sure of achieving reductions in CO<sub>2</sub> emissions from the electric industry is through policies explicitly designed to do so. State and federal policymakers should consider three basic approaches to achieve CO<sub>2</sub> reductions, described below.

### Multi-Pollutant Regulation

Environmental regulations have traditionally treated each pollutant separately. Pollution regulations for SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub>, particulates and mercury should be strong, but also fully integrated in order to allow plant owners to pursue less costly compliance strategies, including repowering with natural gas or retirement of older coal plants. Treating pollutants separately has encouraged power plant owners to install pollution-specific control technologies (e.g., scrubbers for SO<sub>2</sub> and SCR for NO<sub>x</sub>) in order to comply with each new regulation. Because previously installed control technologies are a sunk cost,

they are not considered in the economic analysis as to whether to install another control technology for a newly regulated pollutant. But, if plant owners considered the costs of controlling all pollutants to be regulated in the near future, then they might adopt different control strategies. They might decide to repower a coal plant or to simply retire it. This approach is preferable from an economic and environmental perspective, and it would also help increase interest in renewable resources that produce few, or no, air emissions. The EPA has investigated opportunities to integrate the regulation of four key air pollutants – SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub> and mercury – and found that “having advanced knowledge of potential requirements for all four pollutants could allow industry to pursue different and less costly compliance strategies than they would if the pollutants were addressed one-by-one” (GAO 2000).

### **CO<sub>2</sub> Cap-and-Trade Policies**

CO<sub>2</sub> pollution from fossil-fueled power plants should be subject to a cap-and-trade system similar to that currently used for SO<sub>2</sub> emissions. An overall emissions cap would be set for the desired level of CO<sub>2</sub> emissions, and allowances within that cap could be traded between generators. Allowances also should be allocated to energy efficiency and renewable resources, on the same basis used for allocation to fossil-fired facilities. (Nuclear and hydro power plants, however, would not be allocated CO<sub>2</sub> allowances, because of the environmental and other costs they impose on society.)

### **Early Retirement of Older, Highly Polluting Coal Plants**

In the absence of other CO<sub>2</sub> pollution reduction policies, legislatures, regulators and other public stakeholders should establish policies to encourage or require the retirement of older, less-efficient coal plants that produce high amounts of pollution. This could be achieved through voluntary negotiations, explicit requirements and other mechanisms. This would be the most direct approach for reducing CO<sub>2</sub> emissions, and it would also help achieve ambient air quality standards and address concerns about harmful local health impacts from air pollution.



## 9. OVERCOMING SPECIFIC BARRIERS TO DEVELOPING EACH OF THE RENEWABLE ENERGY TECHNOLOGIES

The policy actions recommended in Chapters 7 and 8 will play a pivotal role in developing renewable energy resources and efficient generation in the regional electricity services market. However, the different renewables technologies often face different market, institutional and technical barriers. It is important to recognize the distinct barriers faced by wind power, biomass co-firing, biomass CHP, photovoltaics and fuel cells, and to implement specific action steps to help overcome them. This chapter provides resources and ideas for clean energy stakeholders to draw upon to overcome specific barriers to renewables development.

### 9.1 WIND POWER

#### INTRODUCTION

Wind power technological developments have rapidly driven down costs and, over time, the current price differential should be reduced through targeted public policies, further technological improvements and increased production that will help to achieve economies of scale. There are, however, several specific barriers to wind power development that should be addressed in the near-term to accelerate the clean energy development process and obtain the environmental, reliability and economic development benefits sooner in the Midwest.

#### TRANSMISSION AND DISTRIBUTION

##### Issue

**Infrastructure.** The windiest areas in the Midwest and Great Plains are generally far from the electricity load centers in the major industrialized cities in the eastern part of the region. Consequently, significant new wind development will often require transmission upgrades and access in order to maximize the ability to deliver this power supply to where the market demand is located.

#### Solutions

**Transmission Policies.** The transmission access and pricing and Regional Transmission Organization policies described in Chapter 8 are essential for wind power development in the Midwest. Wind power must have reasonably-priced, available transmission access.

**Engineering Study.** Midwestern state energy offices and economic development agencies, in conjunction with the U.S. Department of Energy, environmental organizations and utilities, should arrange to conduct a comprehensive engineering study of the technical potential to improve and expand the availability of existing transmission corridors that are key for wind power market development. The study should investigate both physical upgrades to the transmission lines and equipment, and the use of advanced data metering, communications and computing technology that can improve operational performance.

**Wind-only Transmission.** The analysis of transmission upgrades and improvements should also examine potential ways of achieving new “wind-only” access that would facilitate wind power development that has strong public support, as opposed to providing more available transmission capacity that would allow increased utilization of highly polluting coal plants. For example, public and environmental organization support could potentially be obtained for increased transmission capacity to link wind power development in the Dakotas to the potential “green power” consumer demand in the major metropolitan areas to the east, but that support would evaporate if the added transmission became a conduit for increased generation from Basin Electric’s very dirty lignite coal plants in the Dakotas.

**Task Force.** Midwestern state energy offices, in conjunction with the U.S. Department of Energy, should convene a task force including key public officials, economic development agencies, environmental organizations and utilities, to develop policies and

programs to: (1) better achieve the potential of distributed wind development; and (2) adjust the dispatch of WAPA hydro and existing coal to accommodate wind power development in the Great Plains.

## PUBLIC ATTITUDES

### Issues

**Decisionmakers.** Many key public officials and policy “influentials” are uninformed about the current state of wind power technologies and development and the relatively high level of consumer support for clean energy.

**Communities.** Some individuals and communities are opposing the construction of new power lines or wind farm development because of fears that wind development may impair open spaces and lower property values. (By contrast, many farm families view wind power development as a new “cash crop” to support farming or ranching activities and forestall further suburban encroachment.)

**Utilities.** Utilities may resist investment or long-term strategic decisions while state and federal restructuring action hangs in the balance.

### Solutions

**Public Forums.** Renewables companies, environmental advocates and foundations can sponsor forums and briefing sessions for public officials, policy “influentials” and community groups to learn more about wind power development opportunities.

**Economic Development Studies.** Midwestern state energy offices and economic development agencies, in conjunction with the U.S. Department of Energy, can fund studies on the economic development benefits, especially in rural communities, of wind power development.

**Outreach.** Midwestern state energy offices and economic development agencies, in conjunction with the U.S. Department of Energy, can fund outreach work involving local communities, environmental organizations and the wind power industry to develop codes of conduct, model siting procedures and other guidelines for wind development.

**Polling.** State regulators can direct utilities to arrange for a deliberative polling process to determine public and consumer support for clean energy development.<sup>21</sup>

## INDIAN COUNTRY

### Issues

In addition to the barriers described above, Native American tribes seeking to develop their wind resources face additional barriers.

**Ownership.** Tribal councils often prefer to develop their own projects, rather than sign long-term contracts with outside developers. This enables them to retain control and to keep the project’s employment and economic benefits within tribal communities. However, because the federal government holds Native American land in trust, some lenders may fear that they would not be able to recoup their investment in case of financial failure. Moreover, some tribal projects may be perceived to lack stability because councils generally sit for only two years.

**Financial Incentives.** Because tribes do not pay federal taxes, they cannot claim the benefits of the PTC, which provides a guaranteed tax credit for 10 years after construction begins. The Renewable Energy Production Incentive (REPI) offers equivalent payments to tax-exempt entities, but its dependence on annual appropriations, which frequently fall short of demand, makes REPI less effective in attracting financing. Tribes must compete for REPI funds with the municipal utilities and other entities that have worked to establish this financial incentive and obtain the necessary appropriations.

### Solutions

**Jurisdiction.** Tribal councils could turn their wind power development activities over to their business arms in order to stabilize and de-politicize the process. To further insulate wind power from political turnover, tribes could also consider chartering intertribal wind ventures.

<sup>21</sup> Deliberative polling in Texas gathered randomly-selected residential consumers and recorded their energy preferences before and after they spent a weekend hearing presentations from, and then questioning, a diverse panel of energy experts. The polls reveal that although most people do not understand how the electric system works in detail, most do support and express willingness to pay for clean energy after learning more about the issues. Texas policymakers have pointed to these deliberative polls as the key event that made clear to them broad public support for clean energy development.



**REPI Modifications.** Congress could lengthen the appropriation period for REPI, explicitly authorize payments to tribes and substantially increase the funding allocated to the program.

**Partnerships.** Tribes could consider innovative mechanisms to facilitate participation by outside entities in wind projects on tribal land. These may include limited waivers of sovereign immunity, the use of leasehold mortgages to create security interests on tribal land, and conducting business through entities that do not share in tribal immunity.

## POWER PURCHASE CONTRACTS

### Issues

**Existing “Full Requirements” Contracts.** Some municipal utilities and rural electric co-ops located near good wind power sites are bound to wholesale suppliers by “full requirements” contracts, which prevent them from purchasing or developing additional generation resources.

**Financing.** Financial institutions generally prefer to see long-term power-purchase contracts before lending money for wind development, but retail customers in the emerging competitive market generally sign short-term contracts.

### Solutions

**Studies.** State legislatures, with assistance from the National Council of State Legislatures, can assess the potential for wind development by municipal utilities, especially the barrier to wind development represented by “full requirements” contracts. In states where this analysis reveals both reasonable wind development potential and a clear barrier, state legislatures could authorize a neutral mediator (e.g., a judge or conflict resolution commission) to oversee the negotiated modification of “full requirements” contracts to “partial requirements” contracts.

**Federal Purchasing.** In order to help facilitate financing, the federal government can aggregate electricity demand at its Midwestern facilities, and sign long-term power-purchase contracts with wind power developers. State governments also can make similar commitments.

**Insurance.** Federal and state governments could collaborate with the private insurance industry on the “Green Power Insurance Initiative” developed by the

U.S. Department of Energy. This proposed initiative would offer “price insurance” to green power marketers, lowering the risk to them of falling prices. Its advocates estimate that this insurance approach would potentially result in 1,000 MW of new renewable energy development. As proposed, a joint federal-state investment of \$5-10 million would establish the program, and an additional \$40-45 million from federal and state sources would backstop private insurers’ capital commitment to the program; any portion not paid out in claims would be refunded to the federal and state treasuries (Means 1999).

## 9.2 BIOMASS CO-FIRING

### INTRODUCTION

Biomass co-firing has strong technological and economic potential. The policies presented in Chapter 8 can advance biomass power development, but there are several specific barriers that should be addressed as well.

### INCLUDING BIOMASS ENERGY IN RENEWABLE ENERGY POLICIES

#### Issues

**Defining “Environmentally Acceptable.”** It is important to distinguish environmentally acceptable biomass co-firing from that which raises significant environmental concerns – e.g., including “energy crops” such as switchgrass and agricultural wastes, but excluding timber cutting and incineration of construction and demolition wastes. Many key legislators, other public officials and environmental organizations have carefully examined the eligibility of biomass energy for state renewable energy investment funds and other renewables policies because of concerns that:

1. Incinerators and other plants might co-fire potentially dirty fuels, especially construction and demolition waste, threatening to degrade local air quality.
2. Co-firing with biomass could increase the use of coal at older coal plants that are exempt from the most stringent portions of the Clean Air Act and even extend the operating life of the older coal plants.
3. Using wood biomass for co-firing could accelerate potentially destructive logging activities in public and

private forestlands, as well as encourage other unsustainable agricultural and forestry practices.

**Price.** Biomass fuels may not be available at a price acceptable to utilities. Most utilities report they would buy biomass if it cost the same as or less than coal on an energy basis. Biomass fuel suppliers may not enter the co-firing market at these prices, for two reasons. First, co-firing is sometimes a relatively low-value market for biomass. Second, the price offered by utilities often is lower than the cost of collecting, processing and transporting the biomass (including avoided waste disposal costs). Of course, the price and availability of biomass varies by location, and some coal plants may have access to large amounts of lowcost biomass just as coal supplies may be distant. In addition, the federal PTC includes only closed-loop biomass.

## Solutions

***Inclusion of Environmentally Acceptable Biomass in Renewable Energy Investment Funds.*** State legislatures can include carefully defined, environmentally acceptable biomass in legislation establishing investment funds for renewable energy. For example, the Illinois Renewable Energy Resources Trust Fund legislation provides funding for “dedicated crops grown for energy production and organic waste biomass,” and it specifically excludes “energy from the incineration, burning or heating of waste wood, tires, garbage” and other types of potentially hazardous biomass. Minnesota legislation provides separate renewables development mandates for wind power and biomass energy, respectively. Any of these policies and incentives should only apply to the generation from the biomass portion of a co-fired power plant. This policy support is needed in light of the current price increment for biomass fuels.

***Tax Credits.*** Congress could consider amending Section 45 of the Energy Policy Act of 1992 so that environmentally acceptable biomass co-firing qualifies to receive the PTC now available for wind and closed-loop biomass development. The credit would help plant owners offset any cost difference between biomass and coal. This credit should apply only to the generation from the biomass portion of the co-fired power plant.

***Biomass Summit.*** A series of meetings can be convened among renewable energy advocates, environmental organizations, agricultural groups, federal and state energy and environmental officials, utilities and the biomass industry. These “summit meetings” could provide an opportunity to: (1) balance the positive

and negative impacts of biomass development against the impacts of other energy sources; (2) consider the role of biomass in a coherent energy and economic development strategy; and (3) develop a consensus position on environmentally acceptable biomass fuels and practices. The scope of the summit could include various biomass energy applications, and, particularly, address the questions raised by co-firing. Moreover, the EPA could conduct a series of stakeholder meetings to assess how biomass co-firing interacts with New Source Review requirements for power plants. That might eventually lead to guidelines for how this important Clean Air Act protection applies to biomass co-firing.

## PREDOMINANCE OF PULVERIZED COAL BOILERS

### Issue

Most Midwestern coal plants burn pulverized coal, as indicated in Figure 9.1. Co-firing pulverized coal (PC) boilers tends to be more difficult, and consequently more expensive, than co-firing in other boiler types. First, since PC boilers burn fuel crushed to a powder-like consistency, co-firing requires more elaborate measures for processing and handling biomass. Second, the high alkali content of some biomass fuels, particularly the potassium and sodium in herbaceous crops and agricultural residues, can cause problematic ash build-up and slagging. Retrofitting a PC facility to co-fire may cost \$200/kW.

Cyclone boilers, the second most common Midwestern configuration, accept larger fuel particles than PC boilers. They also allow some ash slagging and, indeed, require it for proper operation, suiting them for high-alkali biomass fuels. Retrofitting a cyclone boiler to co-fire may cost \$50/kW. Stoker and fluidized bed boilers, the least common Midwestern plant type, allow the largest fuel particles, due to the combustion process and fuel residence time. They are, however, susceptible to slagging problems.

While co-firing with PC boilers costs more than co-firing with cyclone boilers, they both represent a relatively low-cost opportunity for producing electricity from biomass. The co-firing capacity projected in the Clean Energy Development Plan incorporates the price differential between different boiler types.

FIGURE 9.1 COAL-FIRED BOILERS >25 MW AT MIDWESTERN UTILITIES BY TYPE

Boiler Type	Number (percent of total)	Particle size	Vulnerability to slagging
Pulverized Coal	278 (64)	Under ¼ inch	Yes
Cyclone	41 (9)	Under ½ inch	No
Fluidized Bed	0 (0)	Larger	Yes
Stoker	3 (1)	Larger	Yes
Unknown	112 (26)	n.a.	n.a.
<b>Total</b>	<b>434 (100)</b>	<b>n.a.</b>	<b>n.a.</b>

Note: "Unknown" boilers either were listed as "other," or no information was provided.

## Solutions

**Identifying High-Value Opportunities.** The Department of Energy's Regional Biomass Energy Program and EPRI (formerly the Electric Power Research Institute) should identify all opportunities to co-fire biomass fuels in coal plants with cyclone, fluidized bed and stoker boilers.

**Identifying High-Value Biomass Resources.** The Regional Biomass Energy Program, state energy offices and appropriate federal laboratories should compile a database of low-cost, low-ash and low-alkali biomass fuels, and distribute it to owners of coal plants with PC boilers.

## CONTAMINATION OF SELECTIVE CATALYTIC CONVERTERS

### Issue

In the near future, many coal plants may use selective catalytic reduction (SCR) to comply with new, more stringent limits on NO<sub>x</sub> emissions. Some analysts have expressed concerns that the alkali content of biomass fuels may contaminate the catalyst used in SCR technologies. Some types of coal, such as that from the Powder River Basin, also have a high alkali content that might cause contamination of the SCR catalyst.

Although there is some anecdotal evidence of this problem, it has not been firmly established. The National Energy Technology Laboratory is researching this issue. This may prove to be a problem in the short-term, but it is expected to be resolved five to 10 years from now. Regardless of whether this issue also proves to be a technical barrier to biomass co-firing, it may be a "perception" barrier. In the absence of further research and targeted education, coal plant owners may become wary of modifications to co-fire biomass if there is a perception that this will threaten SCR operation.

## Solutions

**Contamination Indicators.** The National Energy Technology Laboratory, assisted by other appropriate federal laboratories, should develop "SCR contamination indicators" to classify biomass fuels by their reactive alkali content. These indicators will assist coal plant operators in identifying biomass fuels with low potential to contaminate SCR equipment. The labs should also investigate the impact of such factors on fuel availability and cost.

**New Catalyst Development.** The Department of Energy and the Environmental Protection Agency should encourage research and demonstration of SCR catalysts that are less susceptible to contamination by reactive alkalis in biomass and other fuels.

## COAL FLY ASH DEFINITION

### Issue

Coal plants sell fly ash to producers of cement and concrete for use as a raw material. These high-value transactions significantly reduce net operating costs. Many analysts believe (pending definitive tests) that co-firing biomass at rates up to five percent of heat content has minimal impact on ash characteristics due to biomass' comparatively low ash content. However, the American Society for Testing and Materials (ASTM), which sets standards for coal ash used in concrete, requires that ash be generated from unadulterated coal.

Some coal plant owners also may be concerned that even if ASTM were to accept co-fired ash, the cement and concrete industries might perceive it as inferior. This constitutes a further barrier to co-firing.

## Solution

**Stakeholder Group.** A multi-stakeholder partnership should ensure that the concrete and cement industries have good, credible information on the effects of biomass ash in their products. The partnership might include: the American Coal Ash Association; federal and state agencies interested in biomass; national laboratories such as Sandia, the National Renewable Energy Laboratory and the National Energy Technology Laboratory; EPRI; and the University of North Dakota's Energy and Environmental Research Center. If this partnership deems current information insufficient, the Department of Energy should commission further research as necessary, through its fossil fuel and other programs. The goal would be to develop acceptable standards for coal ash that do not unnecessarily discriminate against biomass.

## 9.3 BIOMASS COMBINED HEAT AND POWER

### INTRODUCTION

Two types of biomass combined heat and power (CHP) co-generation systems have particularly high potential for the Midwest over the next decade.

### Small Gasifiers

Small gasifiers are typically linked to generating equipment ranging from 10 kW to 5 MW. They are suitable for community, district energy, institutional, commercial and light industrial thermal loads, and power generators on both sides of the customer meter. The Department of Energy's Small Modular Biopower program is developing prototypes, and advanced testing is expected to begin soon. Worldwide, a number of developers are focused on small gasifiers, and the primary goal is to produce biogas clean enough to power internal combustion engines, diesel engines and gas turbines.

### District Energy Systems (DES)

DES are the most fully mature biomass CHP technology (see the "District Energy St. Paul" project described in Chapter 5). District energy systems in the United States provide more than one quad of end-use energy, but renewable energy fuels only one percent of these systems. Thus, there is a huge opportunity for increased use of renewables in these systems.

The highest priority is to create financial incentives to counter the short financial time horizons for utility investments in biomass CHP.

### SHORT FINANCIAL TIME HORIZONS

#### Issue

Typically, utilities and other private entities look to a relatively short (two- to four-year) payback on investments in electricity, heating and cooling systems. For several reasons, biomass CHP systems require a greater capital investment than equivalent fossil fuel systems:

1. They include fuel storage and mechanical fuel handling facilities beyond the simple pipeline connection required by gas-fired systems.
2. The dust surrounding these facilities may necessitate more frequent maintenance.
3. Efficient biomass CHP projects typically require unique boilers.
4. Biomass CHP systems may be as much as 10 percent less efficient than equivalent fossil fuel systems (i.e., 35 percent for fossil fuels versus 25 percent for biomass).

For these reasons, biomass CHP systems generally present a longer payback horizon. Public agencies, universities and other not-for-profit institutions may tolerate longer time horizons for returns on their investments, and may be more inclined to invest in ways that benefit local communities and the environment. Campus heating systems relying on water or steam heat are ideal for biomass CHP.

#### Solutions

##### ***Financial Incentives for Biomass CHP Systems.***

Congress and state legislatures can create policies for accelerated depreciation for CHP systems to reduce tax burdens in the short-term, and therefore make the short-term economics more attractive to financiers. Policymakers might reasonably apply this measure to other clean energy technologies as well.

Congress and state legislatures could create an investment tax credit for biomass CHP systems. At least one of the proposed federal electricity restructuring bills included an eight percent investment

tax credit for CHP systems with minimum total efficiencies between 60 percent and 70 percent, depending on the system's size. For biomass systems to qualify, the minimum efficiencies in the proposal would have to be lower, since they provide additional climate change and economic benefits. Again, policymakers might reasonably apply this measure to other clean energy technologies as well.

Municipal governments with existing CHP systems, or planning to build CHP systems, could identify opportunities to finance biomass CHP systems through the municipal bond market, and, for smaller projects, through municipal leasing companies.

#### ***Creation of Biomass CHP Systems in Universities.***

State energy offices could offer funding support to universities to develop preliminary feasibility studies. Managers of state renewable energy investment funds can target university biomass CHP as a prime project opportunity.

The International District Energy Association could hold its annual College and University Conference in the Midwest, and feature biomass CHP sessions on policy and technical issues for university officials.

### **LIMITED EXPERIENCE WITH BIOMASS FUELS AND BIOMASS CHP SYSTEMS**

#### **Issue**

Important potential stakeholders in CHP systems lack experience with biomass fuels. Most notably, most farmers and other potential suppliers have no experience with growing, processing, storing and transporting crops suitable for combustion. In addition, power engineers have little real-world experience with burning biomass in gasifiers. (In fact, these obstacles have stymied a promising biomass gasifier project in Granite Falls, Minn.) Where biomass competes against natural gas for CHP applications, inconveniences based on inexperience are enough to discourage early adoption.

Furthermore, there is no well-established, well-distributed base of professional engineers, architects and planners who understand biomass CHP. Professional degree programs generally do not include information on biomass combustion, and fuel storage and handling for district energy systems. As a result, project initiators often rely on local professionals with limited knowledge, who inadvertently "reinvent the wheel," driving up costs or creating sub-optimal projects.

#### **Solutions**

***Crop Development.*** U.S. Department of Agriculture (USDA) extension offices in the Midwest, in cooperation with farmer cooperatives, can help to develop dedicated energy crops, such switchgrass, that are geared to the Midwest applications.

***Information.*** The DOE and the USDA can collect information on regional experience in handling, storing, and combusting a wide variety of agricultural crop residues. Regional outreach that expands the availability of that information should occur in cooperation with Midwestern biomass institutions.

***Regional Center.*** Midwestern universities, community colleges and tribal institutions could form a regional consortium to build regional biomass expertise. The consortium could found a center to house—physically or on-line—the clearinghouse of information on Midwest biomass feedstock experience described above. In addition, it could coordinate the development of undergraduate programs to train engineers in biomass applications and develop professional training modules for farmers and others potentially interested in raising or handling energy crops. It can also expand to cover policy mechanisms and regulatory approaches to biomass projects.

### **SMALL GASIFIERS**

#### **Issue**

Small gasifiers are not yet market-ready, but they should be in five years and supportive policies are essential. As described above with regard to biomass co-firing, policy mechanisms such as renewable energy investment funds may not yet include thermal applications such as biomass CHP. Distributed energy policies – especially interconnection rules and net metering practices – can also have very significant impacts on small, modular biomass gasifiers.

#### **Solutions**

***Identifying Sites.*** The Great Lakes Regional Biomass Program and the Department of Energy's Small Modular Biopower (SMB) Program can locate attractive sites for small biomass systems and identify ways to establish demonstration projects at these sites. Depending upon the site, host institutions such as municipal governments, universities, hospitals and industrial facilities could participate in developing project plans.



**Easy Interconnection.** For small biomass systems that can be sited on the customer side, state legislators and public utility commissions can adopt fairer and more accessible interconnection standards and net metering policies (see Chapter 8 policies above) for which biomass is eligible.

## 9.4 SOLAR PHOTOVOLTAICS

### INTRODUCTION

Solar photovoltaic (PV) opportunities can be divided into off-grid and grid-tied markets. The former presents the most promising opportunity for PV in the short-term. The latter offers the most potential in terms of volume thereafter.

### Off-Grid Markets

**Water Pumping for Livestock.** PV systems averaging 350 W can supply water to livestock, thereby preventing surface water pollution, protecting livestock from infestation by water parasites and supporting greater livestock growth. The total market in the Midwest ranges from 26 MW (at 100 W/farm) to 92 MW (350 W/farm) if all 264,000 farms with livestock installed a PV system. Nebraska holds the biggest prize—it harbors about 25 percent of all livestock in the Midwest and 11 percent of all farms. Iowa and Wisconsin each hold 15 percent of all livestock farms (USDA, 1999).

**Cathodic Protection for Gas Pipelines.** PV systems without batteries can be used to apply a voltage to metal gas pipelines to prevent corrosion. Systems range from 20 W to 10 kW, depending on site-specific factors including pipe diameter and soil type. Systems for transmission pipelines tend to be larger than those for distribution pipelines. The Midwest is the major hub of natural gas transmission in the United States. The Great Lakes region receives the largest volume of natural gas for any region in the United States (DOE 1999). Iowa, Nebraska and the Dakotas have important gas transmission pipelines, and Nebraska may soon have more transmission due to its proximity to the gas-rich Powder River Basin of Wyoming. The best markets involve new pipelines, although PV can replace diesel generators on existing lines.

**Control Valves for Irrigation Systems.** This application is not yet available commercially, but can become a sizable market for an early entrant. PV can power control valves that regulate the flow of irrigation water. PV systems for this application can range from 100 to 250

W. As an indication of market size, 35,432 farms covering 9.3 million acres in the Midwest used irrigation systems in 1992 (USDA 1994). Midwestern farms spent \$125 million on energy for irrigation pumping in 1994. Nebraska has 74 percent of all irrigated acreage in the Midwest, and spent \$105 million on energy for irrigation in 1994.

**Rural Residential Off-Grid Use.** The increasing amount of summer second-home development in outlying rural areas that are beyond the existing grid, as well as upgrades to existing more primitive cabins, can be an attractive market opportunity for solar PV.

### Grid-Tied Markets

For grid-tied PV, both the Midwest/Great Lakes and Great Plains areas hold promise, albeit for different reasons.

**Midwest/Great Lakes.** In Illinois, Michigan, and northern Ohio, electricity prices are high, and interruptions in both the summer (through peak demand and transmission constraints) and winter (through ice storms and downed power lines) are common (DOE 1999). One study found that the price of a two-axis tracking PV system would be economical for businesses in northern Illinois, northern Ohio, and southern Michigan at approximately \$3/Watt, given grid capacity needs. This does not include the substantial value of providing back-up power for several hours for local area networks and other critical systems (Perez, Wenger and Herig 1998).

**Great Plains.** Sparse populations and high distribution costs per customer may make PV attractive to rural electric cooperatives (RECs) in Nebraska, the Dakotas, and Iowa. One study estimates that the REC market for PV hybrids (which include PV, a generator and batteries) can grow to between 500 and 950 MW nationwide if the PV component of the hybrid system drops to \$3/Watt, or half of the current low-bound cost cited in the study (Hoff and Cheney 1998). Since RECs serve many parts of the Midwest, they may represent the key rural prize for PV once PV has saturated closer to economic, off-grid markets.

The highest priorities among the issues and solutions discussed are the need for a Market Development Fund and for state media campaigns to raise awareness of PV.

## LACK OF MARKET DEVELOPMENT

### Issue

Despite the possibility of plentiful, economic applications for PV in the remote power market, there exists no significant PV industry presence able to (1) market PV to farmers and those who sell farming equipment (e.g., cooperatives and agricultural tool vendors); and (2) distribute and service PV systems before and after a purchase.

Two new PV manufacturing plants are underway—one in Chicago (Spire Solar) and one in Perrysburg, Ohio (First Solar)—and the regional marketing infrastructure may grow in response. The Chicago plant, however, is initially supported on pre-commitments from Commonwealth Edison and the City of Chicago to purchase PV. And while the demand for PV from the Perrysburg plant does not include early purchasing commitments, it is essential to note that 75 percent of all PV manufactured in the United States supplies the booming overseas market, particularly Europe and Japan. So it is not automatic that a local manufacturing presence will induce a vital local marketing presence.

This situation, particularly in the immediately attractive off-grid market, points to two factors:

1. **Markets.** Cost-effective markets appear to exist. Expanded PV markets will reduce PV costs and likely develop a strong regional industry presence.
2. **Capital.** The PV industry lacks the capital and, consequently, the risk-taking entrepreneurship to pursue “loss leaders” requiring up-front marketing. Instead, the industry prefers to channel resources to subsidized markets abroad (e.g., Germany); subsidized markets in the United States (e.g., government markets, green power markets and mandated markets, such as the new solar renewable portfolio standard in Arizona); and existing, economic markets (e.g., telecommunications).

This has significant implications for renewable energy policy in the region. In the case of PV, consumer incentives such as cheap financing or direct subsidies are undermined by a weak regional industry presence. Based on interviews with the PV industry, the most important government incentive to immediately attract industry to the region would be a solar renewable portfolio standard.

Without appropriate market conditioning, incentives short of a RPS or a generous subsidy will merely result in an under-subscribed incentives program. For example, the state of Nebraska has offered to purchase half of all bank loans to in-state buyers of renewable energy and energy efficiency technologies, including solar. Of the \$51 million in state money lent under the program for 15,000 individual loans, none has gone to solar purchases. In Iowa, a similar program is also severely under-subscribed—the \$300,000 program has helped to finance only three small residential PV systems. Again, the lack of suppliers, as well as difficult interconnection rules, has stymied potential consumers.

### Solutions

**Supply-Push.** The gap between newly found applications and industry commitment to a region must be bridged with public investments based on public benefits. Specifically, state governments should offer cost-sharing support with the PV industry for a Market Development Fund (MDF). This could be one use of Renewable Energy Investment Funds (see Chapter 8). The appropriate Fund Administrator can select a solar industry association, an industry consortium or individual firms, based on transparent criteria such as their record of customer satisfaction, applicable standards for PV, competitive success and willingness to share some of the costs of the effort. The MDF could perform several essential market-building tasks:

1. The MDF could market PV products to relevant customer segments. In the case of livestock water pumping, national PV firms interested in establishing a Midwestern presence can work with water conservation districts interested in clean rivers and streams, agricultural extension agents interested in healthier livestock, and farmers interested in avoiding water pollution fines and in raising healthier cattle.
2. The MDF could market PV products to appropriate vendors. Once customers show an interest in a PV product, PV firms, in conjunction with interested rural parties, can approach vendors who already serve the relevant consumer segment. Encouraging existing vendors to include PVs in their sales offerings would give customers easy access to the technology from known and trusted sources. In the case of livestock water pumping, vendors may include rural electric cooperatives, farmer cooperatives that provide other farm inputs such

as fertilizer, distributors of agricultural tools and machinery (e.g., Country General in Nebraska), well drilling companies and home improvement stores.

3. The MDF could assure customers that PV products are reliable. These conditions can be imposed on participants from the PV industry. However, the public agent participating in this process can inform potential vendors of PV standards, as well as the performance of different balance-of-system components (e.g., motor, inverter for AC motor), and enable the vendors to make choices with customer satisfaction a prime driver.

**Demand-Pull.** Demand for PV can be developed through government procurement and economic incentives:

1. As states remove commercial and technical barriers to PV adoption, local and state governments can play an important role in jump-starting PV sales by committing to new installations for parks and buildings – off-grid applications for which PV is well suited, and applications which enhance power quality and reliability. Government commitments, such as the City of Chicago's to buy PVs over several years, can provide an incentive for industry involvement and, if publicized, demonstrate the feasibility of PV. It is important that these markets co-exist with genuine efforts targeting private markets offering the most promise for PV, so that regional sales are not limited to government procurement efforts, but instead truly spur private market sales as well.
2. As rural customers become more aware of solar products and have better access to them, and as grid-connected customers in states with higher electricity prices find it easier to use PV for summer peak use, economic incentives can accelerate the market penetration. Incentives can supply an effective “hook” in initial marketing efforts. And by funding only PV systems certified for safety and quality, incentives can reinforce quality-assurance provisions in other PV programs.

Consumer incentives – preferably a combination of low-cost financing, writedowns and tax incentives – are essential to attract customer attention. Established financial institutions (e.g., Fannie Mae, Farmers Home Administration) can offer affordable financing packages, and state renewable energy investment and development programs can buy

down interest costs. Producer incentives (e.g., tax incentives for unit sales) for the initial years of a buydown program could provide a clear way to attract industry attention.

Relevant agencies and firms must publicize economic incentives and, preferably, plug them into marketing efforts to create a turnkey system for purchasing and financing PV.

## LACK OF PUBLIC AWARENESS

### Issue

Many Americans have seen or heard about solar power, but very few know about solar products, let alone how to select, buy, finance and install them. Part of the responsibility in making solar purchases easy rests with the PV industry. To succeed, PV firms should offer a turnkey system including finance, installation and service. Unfortunately, much of the PV industry generally lacks the capacity to fund broad educational campaigns targeting consumers and professionals such as homebuilders, building inspectors and consumer finance institutions.

### Solutions

**State Media Campaigns.** State energy offices, the renewable energy industry, renewable energy advocates and environmental advocates can sponsor media campaigns to promote public awareness about renewables. The campaign should be targeted to financiers, buildings professionals, commercial and residential customers and include the following information:

1. The environmental and economic benefits of PV and renewables.
2. The technical feasibility of PV and renewables.
3. Funds and incentives that are available to consumers.
4. Firms that sell PV and renewables.

**Educate Financiers.** The Department of Energy could fund the PV industry to develop PV education programs for real estate and finance-related fields who advise and provide financing for homebuyers.

**Educate Building Professionals.** The Department of Energy and state energy offices could provide cost-

sharing support to the PV industry and environmental advocates to work with architect/design, construction and engineering professional societies and commercial real estate management firms to provide both broad and technical educational materials to these professionals on the smart and sensible deployment of PVs.

## **POOR INTEGRATION INTO ENVIRONMENTAL POLICY**

### **Issue**

Despite the environmental benefits of PV, environmental regulations offer little support to market development. Although some work has been done to explore ways to integrate renewables in pollution credit-trading programs, PV systems are unlikely to benefit because of their small size and distributed nature.

### **Solution**

**Diesel Replacement Program.** PV, among other clean distributed energy resources, can be promoted as an alternative to diesel generators for small loads through replacement programs. PV “uninterruptible power supply” systems with batteries offer several hours of power for residences and small commercial establishments throughout the year. And in the summer, grid-connected PV offers reasonable security against power outages, while running as a small power plant from which the owner can sell excess power back to the grid. Vehicle trade-in programs, in which state environmental agencies offer to buy back old cars and retire them, offer a useful model. Midwestern states such as Illinois, which uses almost 28,000 diesel generators for stand-by power, can benefit from such programs.

The program can offer a capped amount of funding per customer who wants to buy PV, small wind, renewable energy hybrids, biodiesel or fuel cells fueled by renewables. The program can target areas that are in nonattainment with EPA criteria pollutant standards. The model for this program (though it does not include renewables) is the state of California’s “Carl Moyer Program,” which provides diesel engine owners with the added financing required to either upgrade or replace their equipment. The state has found that the program is a cost-effective tool to reduce nitrogen oxides and plans to continue the program as an important part of its state implementation plan for NO<sub>x</sub>.

## **INTERCONNECTION CHALLENGES**

### **Issue**

As discussed in Chapter 8, interconnection challenges for distributed renewable resources are significant. Currently, all Midwestern states except Michigan, Nebraska and South Dakota have net metering measures, although most net metering rules do not grant the generator retail rates (Spratley, 2000).

### **Solution**

It is essential to adopt the net metering and distributed generation policies relating to interconnection standards and practices and transmission pricing and access as discussed in Chapter 8. Development efforts for grid-tied PV should focus on adequate implementation by individual distribution utilities, once these statewide policies are established. These efforts can be more effective if PV advocates develop alliances with other industries, including the fuel cell and microturbine industries.

## **9.5 FUEL CELLS**

### **INTRODUCTION**

In its early stages, three major factors will drive fuel cell development: reliability, demand for distributed power and co-generation opportunities.

### **Reliability and Power Quality**

Unfortunately, there have been a large number of major power outages in recent years in major cities, and one impact of the restructuring of the electric sector is the threat of the increased number and severity of power outages. At the same time, high-tech firms are proliferating in the American economy, as are firms dependent on computer systems; both groups require constant power free from fluctuations. Businesses and institutions that cannot readily tolerate outages (e.g., hospitals, credit card processors and hotels) or unstable voltage (e.g., semiconductor plants and database-dependent firms) may also turn to fuel cells for added reliability.

### **Distributed Power**

Fuel cells form part of a larger trend toward small generating units installed directly where customers need power. EPRI suggests that there may be installation of 20 GW of distributed generation in the

United States, and a potential U.S. market of 25 million households over the next decade (EPRI 7/1999).

## Co-generation Opportunities

Short-term market opportunities for fuel cells depend on exploiting their waste heat – for example in industrial processes, space heating or cooling. A recent Arthur D. Little, Inc. analysis suggests that while fuel cells will require prices of \$1,500 to \$1,300/kW to compete in distributed power applications, they will enter the market for commercial co-generation applications at \$2,000 to \$1,500/kW (ADL 1998).

The highest priorities for fuel cell development are the need for: (1) operating experience through demonstration projects to address lack of familiarity with the technology; and (2) innovative finance programs to address the higher front-end cost of fuel cells.

## LACK OF FAMILIARITY AMONG POTENTIAL USERS

### Issue

Fuel cells are unfamiliar to most potential users and also to firms potentially able to distribute or service them, such as propane dealers and air conditioning service firms.

### Solutions

**Operating Experience.** To accumulate field knowledge of fuel cells, and thereby raise the comfort level of potential users, the Department of Energy, EPA and state agencies can collaborate with industrial and municipal users to encourage fuel cell demonstrations at appropriate sites, especially those with a source of hydrogen-rich gas (e.g., landfills, breweries and wastewater treatment plants), or a need for heat (e.g., schools, hospitals and fast food restaurants) or high-quality power (e.g., airports, high-tech factories or computer data banks). Results from these demonstration projects should then be publicized to potential customers, investors and equipment vendors.

**Professional Skills.** To increase knowledge of fuel cells among small businesses potentially able to distribute and service them:

1. State and county governments could support the development of fuel cell training courses at community and technical colleges.

2. State energy offices could join with industry in supporting a fuel cell training initiative including the preparation of training videos and outreach to the propane, air conditioning and other appropriate industries.
3. State energy offices could work with RECs to identify cost-effective uses of fuel cells to avoid or defer constructing or upgrading high cost distribution systems.

### Cost

### Issue

Fuel cells cost too much for most customers. ONSI's PC25, the only commercial fuel cell now available on a large scale, generates power at a little over 12¢/kWh (ADL 1998). The unit costs about \$4,000/kW, compared to microturbines at \$1,000/kW (and projected to cost \$300/kW in mass production) and to combined-cycle gas turbines at \$550 to \$650/kW.

### Solutions

The fuel cell industry will lower costs by reducing the number of parts and streamlining manufacturing processes, reducing reliance on noble metal catalysts, and lowering unit costs by scaling up production. In the short term, public policy can play an auxiliary role in helping firms build markets by decreasing costs to the end-user elsewhere in the fuel cell industry.

**Innovative finance programs.** Renewable Energy Investment Funds (see Chapter 8) could support the following programs:

1. Funds could be provided as business development loans to small firms looking to sell or service fuel cells using renewable fuels.
2. Funds could be deployed to provide loan guarantees to reimburse financial institutions in full or in part if a business or homeowner defaults on a loan used to buy a fuel cell using renewable fuels. This would encourage financial institutions to lend at reasonable rates.

**Favorable insurance treatment.** In the aftermath of Hurricane Andrew, up to 30 percent of the insurance losses paid were for business interruptions due to power loss. State insurance regulators could

encourage insurance firms to reward fuel cell owners through lower premiums for property and business interruption insurance.

**Third-party ownership.** This would effectively raise allowable costs by extending acceptable payback periods and leveraging O&M resources. Energy service companies will naturally tend to consider fuel cells as costs drop. In addition, state public utility commissions should consider the advantages and disadvantages of allowing distribution utilities to own fuel cells, particularly where such units would defer distribution upgrades or construction, or provide line support.

## TECHNICAL BARRIERS

### Issue

Fuel cells must become more robust to succeed on the basis of reliability. Fuel impurities can easily “poison” the stack, a particular problem for renewable biofuels. The PC25 can run eight years between overhauls, but other units may last only three years. There have been reports that smaller units require an overhaul after only 5,000 hours.

### Solution

**Performance Guarantees.** As in the case of cost barriers, the fuel cell industry will resolve technical problems on its own. As firms improve their products, however, performance guarantees could lower perceived risk.

## CODES, STANDARDS AND DEFINITIONS

### Issue

Fuel cells suffer from many of the same obstacles facing photovoltaics, small wind turbines and other distributed generation resources discussed in Chapter 8.

### Solutions

In addition to the policies described in Chapter 8, the following solutions would facilitate interconnection, raise consumer confidence and help create an integrated national market for fuel cells.

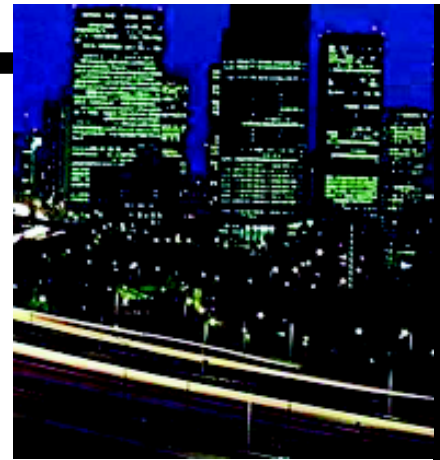
**Codes and Standards.** State policymakers can support existing industry efforts to develop consistent and easily understandable codes and standards for fuel cells.

**Interconnection Protocols.** The following policies would also help address the specific interconnection issues faced by fuel cells:

1. States could include fuel cells in net metering provisions. The provisions might allow higher buyback rates and size limits for fuel cells using renewable fuels.
2. State environmental agencies and zoning authorities could develop fast-track siting procedures for small fuel cells based on measured performance of given models in the field.
3. State utility commissions could exempt some or all fuel cells from paying all or part of the exit fees. Fuel cells qualifying for exemptions might include those using renewable fuels, those meeting high efficiency goals or those below a certain size. Commissioners also might set a cumulative system cap for exempt units at a level equivalent to expected new load growth.



# CONCLUSION



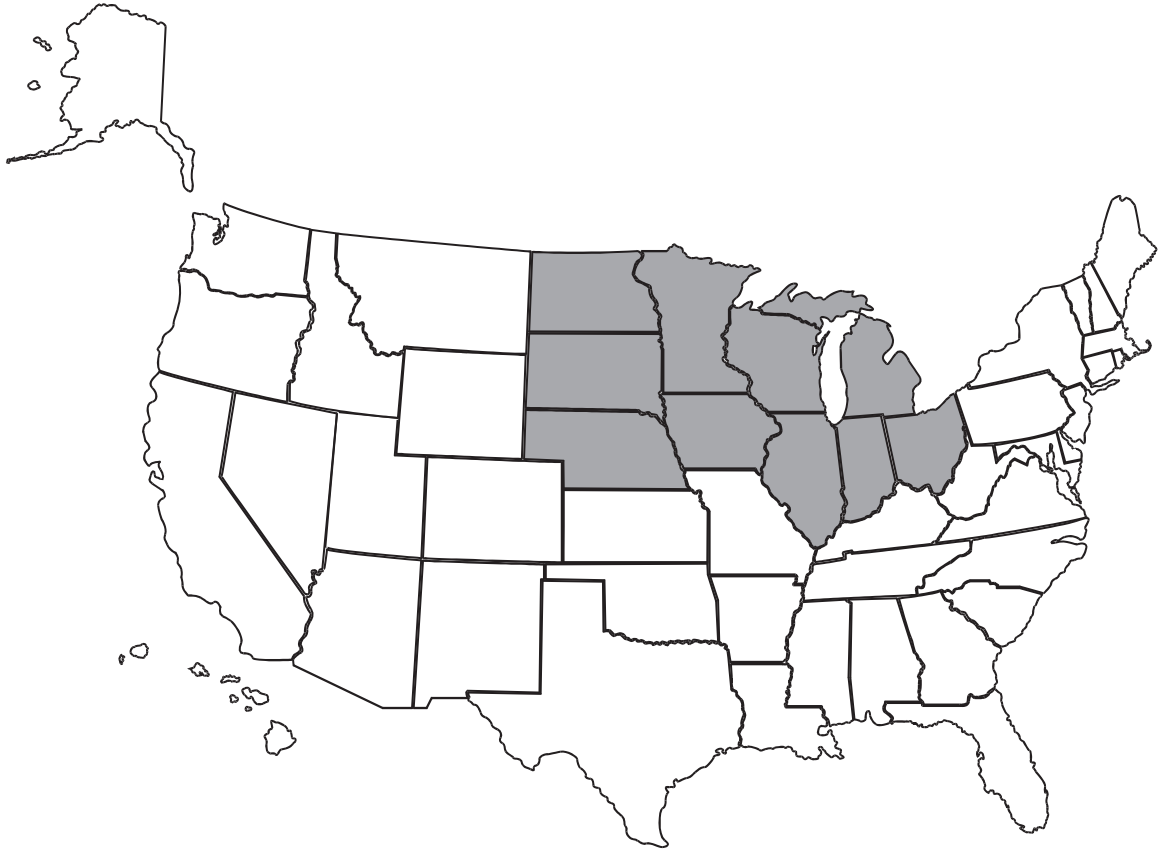
The Midwest Clean Energy Development Plan is visionary, and it is practical and achievable. It will require a dedicated and concerted effort by governors, legislators, regulators, the electric power industry, consumers and citizens to replace current, outdated power plants and practices with modern clean technologies and policy innovations. It will require specific steps to adopt and aggressively implement the recommended new strategies, policies, and practices. The Midwestern public is ready to seize the opportunities to robustly develop our clean energy efficiency and renewable energy resources that will lead to better environmental quality and public health, improved electric system reliability and regional economic development gains.

One or two states alone cannot achieve the full benefits of the Midwest Clean Energy Development Plan. The electricity services market is regional, and successful energy strategies and policies for the Midwest require regional solutions and cooperation across state lines. The Clean Energy Development Plan is a smart policy and technical strategy for the Midwest that can also serve as a model for the rest of the nation. As federal policymakers consider more aggressive clean energy development policies and practices to secure national environmental benefits, balanced fuel portfolios and economic growth, we can and should lead the way here in the Midwest – the nation’s heartland.



# APPENDIX 1. STATE SUMMARIES

ON FOLLOWING PAGES





# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Illinois needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying a power supply that has relied on old, highly polluting coal and nuclear plants, Illinois will reduce pollution, improve electricity reliability, create new "green" manufacturing and installation jobs, and provide renewable energy "cash crops" for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

Illinois should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

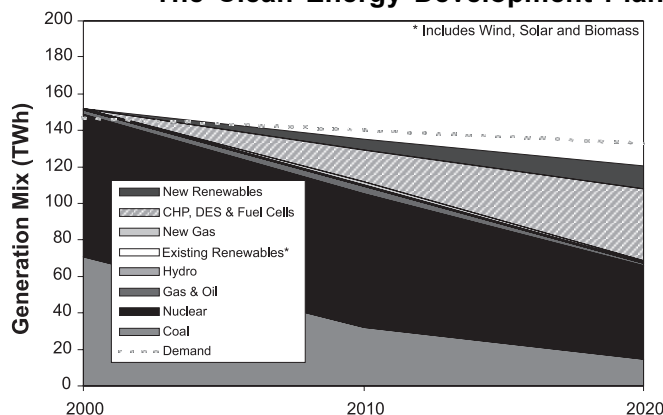
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.

4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Illinois means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.

## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN ILLINOIS WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 87 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 82 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 71 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind and biomass power "cash crops" for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER ILLINOIS!

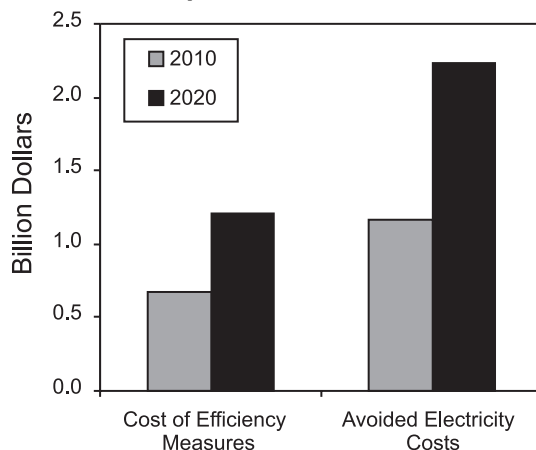
For more information and resources to develop Illinois' clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Illinois has tremendous opportunities to invest in energy efficiency technologies that will reduce pollution, save money and create jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$1 billion by 2020.
2. Saves 50,761 GWh of electricity – equal to about 18 large power plants – by 2020.
3. Reduces electricity demand by 16 percent in 2010 and 28 percent by 2020.
4. Costs less – at an average investment of 2.4¢/kWh – than generating, transmitting and distributing electricity from power plants.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Illinois has strong opportunities to develop wind, biomass and solar power, which provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Furthermore, Illinois can develop new efficient CHP using natural gas. Together, the opportunities shown in Figure 3 can provide 10 percent of Illinois' generation capacity by 2010 and 22 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In Illinois, it would increase overall electricity costs by about 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the market and regulatory barriers that energy efficiency and renewable resources face. Illinois has already adopted some policies to promote clean power options, but more must be done to succeed. The key policies for achieving the Clean Energy Development Plan are to:

1. Increase the Illinois Energy Efficiency Investment Fund by investing 0.3¢/kWh.
2. Evaluate and update Illinois' efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
3. Establish an Illinois Renewables Portfolio Standard that requires all retail electricity suppliers to provide eight percent of their power from renewable resources by 2010 and 20 percent by 2020.
4. Increase the Illinois Renewable Energy Investment Fund investment to 0.1¢/kWh.
5. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
6. Remove barriers to clean distributed generation by: (1) expanding Commonwealth Edison's net metering program to be offered statewide by all utilities; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	423	1,519
CHP – Biomass	488	992
Biomass - Co-Firing	496	650
Photovoltaics	80	200
Biomass Gasification	0	0
Eff. Natural Gas Gen.*	2,162	4,997
<b>Total</b>	<b>3,649</b>	<b>8,358</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.





# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Indiana needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying a power supply that has relied on old, highly polluting coal and nuclear plants, Indiana will reduce pollution, improve electricity reliability, create new "green" manufacturing and installation jobs, and provide renewable energy "cash crops" for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

Indiana should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

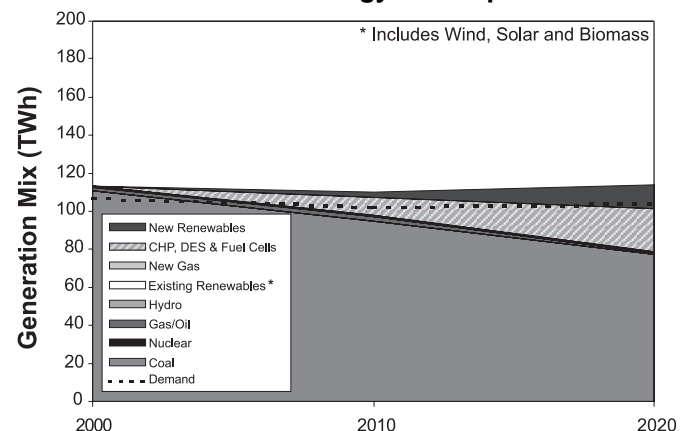
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.

5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Indiana means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



*The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.*

## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN INDIANA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 50 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 69 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 39 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind and biomass power "cash crops" for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER INDIANA!

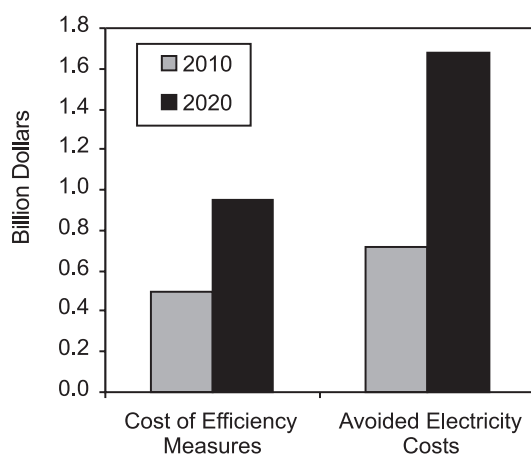
For more information and resources to develop Indiana's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Indiana has tremendous opportunities to invest in energy efficiency technologies that will reduce pollution, save money and create jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$731 million by 2020.
2. Saves 41,752 GWh of electricity – equal to about 15 large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 29 percent by 2020.
4. Costs less – at an average cost of 2.4¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Indiana has the opportunity to develop wind, biomass and solar power, which provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Furthermore, Indiana can develop new efficient generators, such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could provide eight percent of Indiana's generation capacity by 2010 and 23 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In Indiana, it would increase overall electricity costs by about 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. To achieve the Clean Energy Development Plan in Indiana, the key policy actions are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Indiana Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update Indiana's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish an Indiana Renewables Portfolio Standard that requires all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies, with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
7. Remove barriers to clean distributed generation by: (1) expanding Indianapolis Power and Light's net metering policy to include wind and to be offered by utilities statewide; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	148	544
CHP – Biomass	209	432
Biomass - Co-Firing	139	1,255
Photovoltaics	14	47
Biomass Gasification	0	0
Eff. Natural Gas Gen.*	1,173	2,800
<b>Total</b>	<b>1,683</b>	<b>5,078</b>
*Includes CHP (natural gas), district energy systems, and fuel cells.		





# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Iowa needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying its power supply, Iowa will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

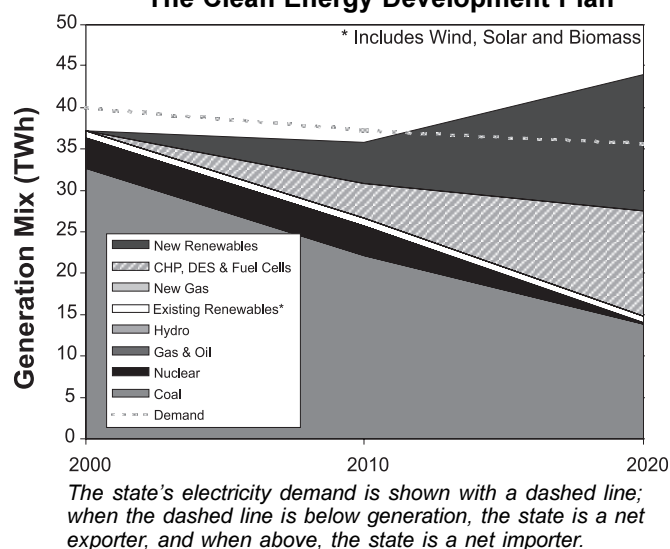
Iowa should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies, and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region’s electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region’s electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region’s electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Iowa means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN IOWA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 61 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 65 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 56 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind power “cash crops” for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

**Harnessing clean energy improves the environment and spurs economic growth.**

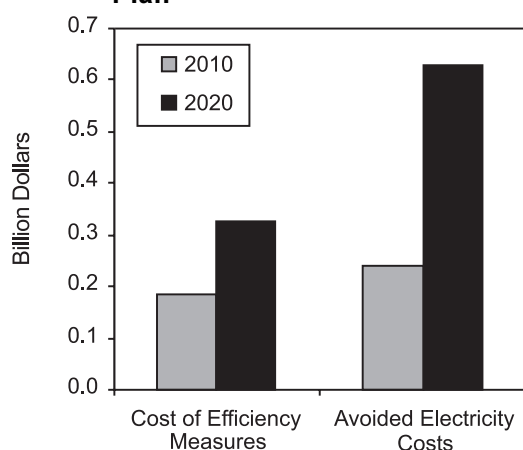
## HELP REPOWER IOWA!

For more information and resources to develop Iowa's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

### REAPING ENERGY EFFICIENCY OPPORTUNITIES

Iowa has an opportunity to use energy in smarter, more efficient ways, thereby reducing pollution, saving money and creating jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$304 million by 2020.
2. Saves 13,895 GWh of electricity – equal to about five large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.5¢/kWh – than generating, transmitting and distributing electricity.

### DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Iowa has a tremendous opportunity to harness abundant renewable resources – especially wind – that provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Iowa can also develop efficient generators, such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could supply 22 percent of Iowa's generation capacity by 2010 and 48 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In Iowa, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

### 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable

resources face. Iowa has already adopted some policies to promote clean power options, but more must be done to succeed. The key policy actions for achieving the Clean Energy Development Plan are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update Iowa's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Increase Iowa's Renewables Portfolio Standard, so that the percentage requirement reaches eight percent by 2010 and 20 percent by 2020. Policymakers in Iowa may wish to adopt an RPS requirement that is higher than those in neighboring states, due to Iowa's abundance of wind resources. If the Iowa RPS requirement were to be set at 10 percent for new renewables by 2010 (instead of eight percent), the costs of the Clean Energy Development Plan in 2010 would increase from \$40 million to \$48 million.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly, and account for their intermittent nature, remote locations, or smaller scale.
7. Remove the barriers to clean distributed generation by: (1) establishing standard business and interconnection terms; (2) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (3) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	1,021	3,817
CHP – Biomass	107	222
Biomass - Co-Firing	325	325
Photovoltaics	5	19
Biomass Gasification	0	100
Eff. Natural Gas Gen.*	526	1,588
<b>Total</b>	<b>1,984</b>	<b>6,071</b>
*Includes CHP (natural gas), district energy systems, and fuel cells.		



# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Michigan needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying a power supply that has relied on old, highly polluting coal and nuclear plants, Michigan will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

Michigan should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region’s electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

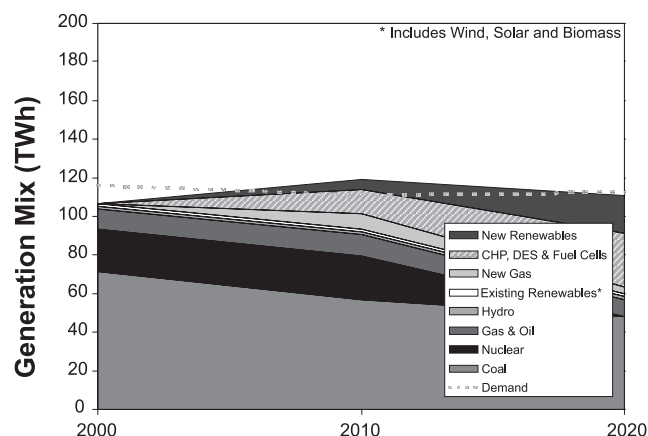
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region’s electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region’s electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.

5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Michigan means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



*The state’s electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.*

## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN MICHIGAN WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 41 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 77 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 47 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind and biomass power “cash crops” for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER MICHIGAN!

For more information and resources to develop Michigan's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

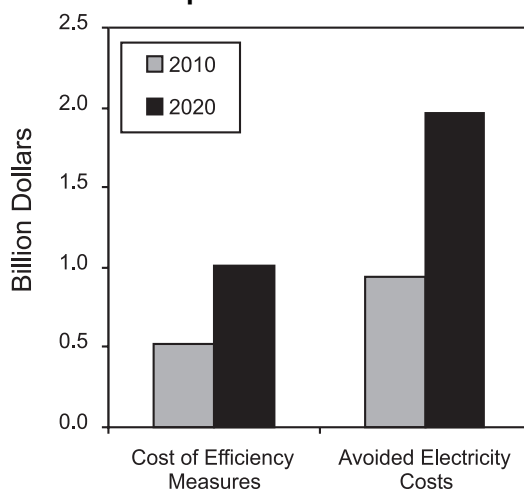
Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Michigan has tremendous opportunities to invest in energy efficiency technologies that will reduce pollution, save

money and create jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$968 million by 2020.
2. Saves 45,246 GWh of electricity – equal to about 16 large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 29 percent by 2020.
4. Costs less – at an average cost of 2.2¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Michigan has strong opportunities to develop wind, biomass and solar power, which provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Furthermore, Michigan can develop new efficient generation, such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could supply nine percent of Michigan's generation capacity by 2010 and 29 percent by 2020.

The Clean Energy Development Plan can be realized at a modest cost, as energy efficiency savings offset the cost of new generation. In Michigan, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. The most important policy actions for achieving the Clean Energy Development Plan in Michigan are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and modernize Michigan's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish a Michigan Renewables Portfolio Standard requiring all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies, with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
7. Remove the barriers to clean distributed generation by: (1) applying net metering policies to all wind and photovoltaics; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	304	2,552
CHP – Biomass	338	702
Biomass - Co-Firing	94	521
Photovoltaics	15	52
Biomass Gasification	0	100
Eff. Natural Gas Gen.*	1,504	3,510
<b>Total</b>	<b>2,255</b>	<b>7,437</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.





# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Minnesota needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying its power supply, Minnesota will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

Minnesota should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

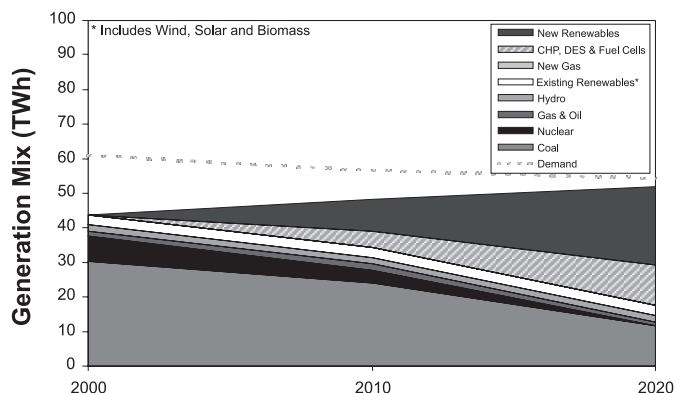
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.

5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Minnesota means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



*The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.*

## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN MINNESOTA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 71 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 71 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 67 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind power “cash crops” for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER MINNESOTA!

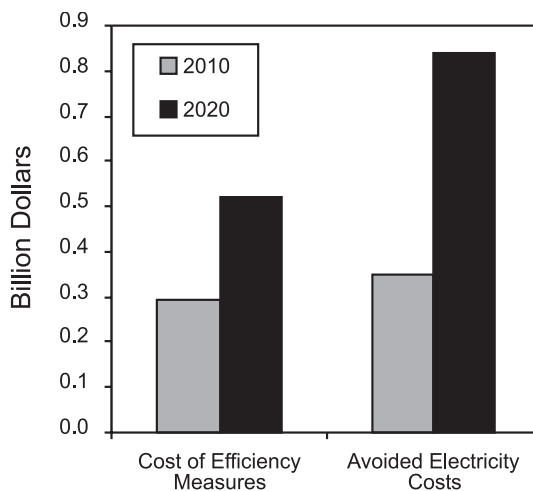
For more information and resources to develop Minnesota's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601; tel: 312-673-6500.

Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Minnesota has an opportunity to use energy in smarter, more efficient ways, thereby reducing pollution, saving money and creating jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$321 million by 2020.
2. Saves 21,152 GWh of electricity – equal to about seven large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.6¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Minnesota has the opportunity to harness abundant renewable resources – especially wind – that provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Minnesota can also develop efficient generators, such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could supply 24 percent of Minnesota's generation capacity by 2010 and 48 percent by 2020.

The Clean Energy Development Plan can be realized at a modest cost, as energy efficiency savings offset the cost of new generation. In Minnesota, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. Minnesota has already adopted some policies to promote clean power options, but more must be done to succeed. The key policies for achieving the Clean Energy Development Plan are to:

1. Increase Minnesota's Energy Efficiency Investment Fund by investing 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update Minnesota's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Increase Minnesota's Renewables Portfolio Standard, so that the percentage requirement reaches eight percent by 2010 and 20 percent by 2020. Policymakers in Minnesota may wish to adopt an RPS requirement that is higher than those in neighboring states, due to Minnesota's abundance of wind resources. If the Minnesota RPS requirement were to be set at 11.5 percent for new renewables by 2010 (instead of eight percent), the costs of the Clean Energy Development Plan in 2010 would increase from \$61 million to roughly \$83 million.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies, with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly, and account for their intermittent nature, remote locations, or smaller scale.
7. Remove barriers to clean distributed generation by: (1) establishing standard business and interconnection terms; (2) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (3) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	1,586	4,474
CHP – Biomass	412	729
Biomass - Co-Firing	15	282
Photovoltaics	8	29
Biomass Gasification	75	175
Eff. Natural Gas Gen.*	603	1,471
<b>Total</b>	<b>2,699</b>	<b>7,160</b>
*Includes CHP (natural gas), district energy systems, and fuel cells.		





## REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

### THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Nebraska needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying its power supply, Nebraska will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

### THE CLEAN ENERGY DEVELOPMENT PLAN

Nebraska should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region’s electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

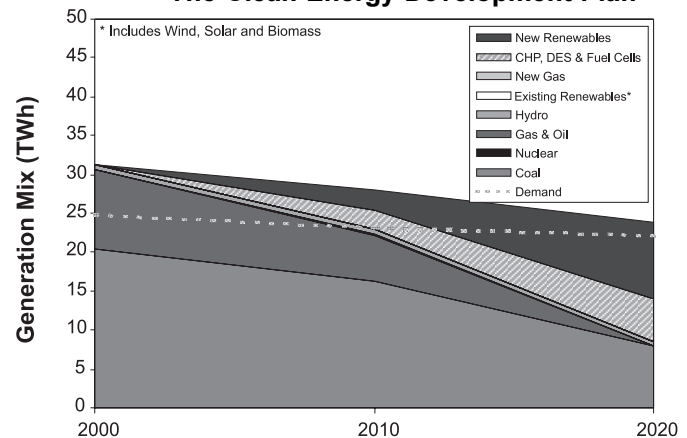
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region’s electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region’s electricity generation by 2010 and 25 percent by 2020.

4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Nebraska means:

1. Energy efficiency measures reduce electricity demand, and therefore generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



The state’s electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.

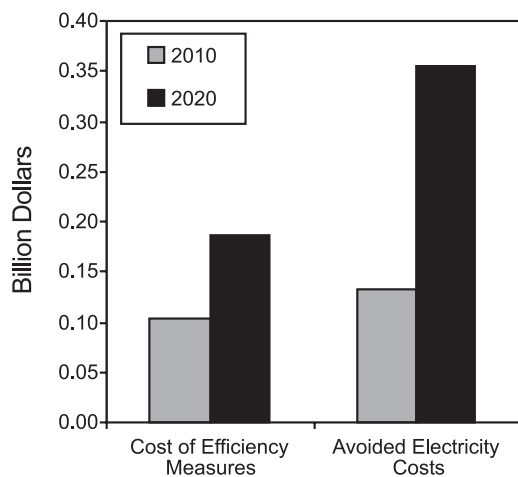
### IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN NEBRASKA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 63 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 60 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 61 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind power “cash crops” for farmers and clean energy exports, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Nebraska has an opportunity to use energy in smarter, more efficient ways, thereby reducing pollution, saving money and creating jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$169 million by 2020.
2. Saves 8,628 GWh of electricity – equal to about three large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.2¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Nebraska has a tremendous opportunity to harness its abundant wind resources, which offer environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Nebraska can also develop efficient generators, such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could supply 21 percent of Nebraska's generation capacity by 2010 and 47 percent by 2020.

The Clean Energy Development Plan can be realized at a modest cost, as energy efficiency savings offset the cost of new generation. In Nebraska, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. The key policy actions for achieving the Clean Energy Development Plan in Nebraska are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update Nebraska's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish a Nebraska Renewables Portfolio Standard requiring all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly, and account for their intermittent nature, remote locations, or smaller scale.
7. Remove the barriers to clean distributed generation by: (1) applying net metering policies to all wind and photovoltaics; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	850	2,446
CHP – Biomass	19	48
Biomass - Co-Firing	72	208
Photovoltaics	4	12
Biomass Gasification	0	0
Eff. Natural Gas Gen.*	303	710
<b>Total</b>	<b>1,248</b>	<b>3,424</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.



## REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

### THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

North Dakota needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying its power supply, North Dakota will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

### THE CLEAN ENERGY DEVELOPMENT PLAN

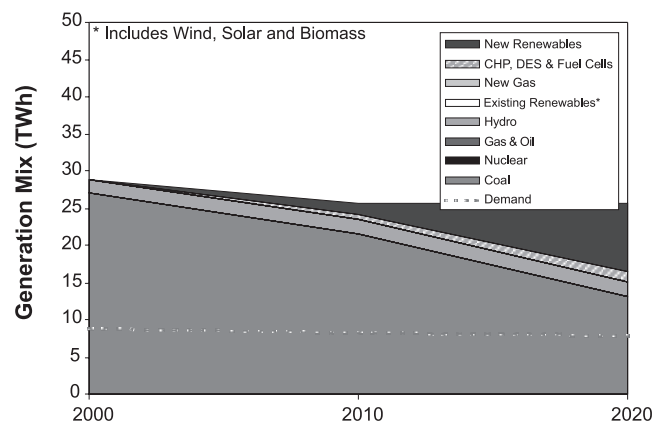
North Dakota should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in North Dakota means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.

### IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN NORTH DAKOTA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 53 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 53 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 48 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind power “cash crops” for farmers and clean energy exports, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

### REAPING ENERGY EFFICIENCY OPPORTUNITIES

North Dakota has an opportunity to use energy in smarter, more efficient ways, thereby reducing pollution, saving money and creating jobs. This will produce the benefits summarized on the following page.

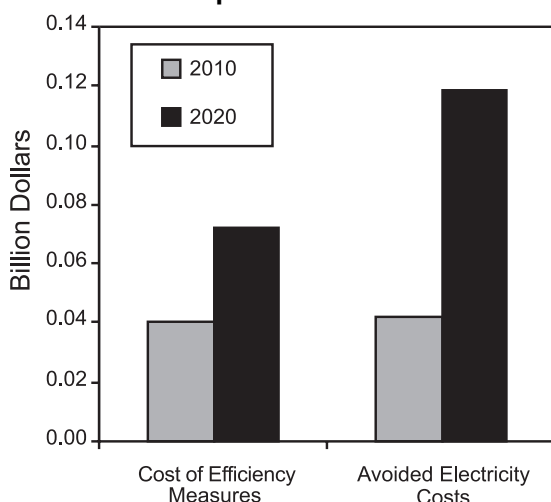
**Harnessing clean energy improves the environment and spurs economic growth.**

## HELP REPOWER NORTH DAKOTA!

For more information and resources to develop North Dakota's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

1. Reduces net electricity costs by \$46 million by 2020.
2. Saves 3,064 GWh of electricity – equal to about one large power plant – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.4¢/kWh – than generating, transmitting and distributing electricity.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

North Dakota has a tremendous opportunity to harness its abundant wind resources, which offer environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. North Dakota can also develop efficient generators, such as CHP and district energy systems. Together, the opportunities shown in Figure 3 could supply 14 percent of North Dakota's generation capacity by 2010 and 35 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In North Dakota, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and

renewable resources face. The key policy actions for achieving the Clean Energy Development Plan in North Dakota are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update North Dakota's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish a North Dakota Renewables Portfolio Standard requiring all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
7. Remove the barriers to clean distributed generation by: (1) applying net metering policies to all wind and photovoltaics; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	750	2,550
CHP – Biomass	0	4
Biomass - Co-Firing	0	0
Photovoltaics	1	4
Biomass Gasification	0	0
Eff. Natural Gas Gen.*	79	180
<b>Total</b>	<b>830</b>	<b>2,738</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.





# REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

## THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Ohio needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying a power supply that has relied on old, highly polluting coal and nuclear plants, Ohio will reduce pollution, improve electricity reliability, create new "green" manufacturing and installation jobs, and provide renewable energy "cash crops" for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

## THE CLEAN ENERGY DEVELOPMENT PLAN

Ohio should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

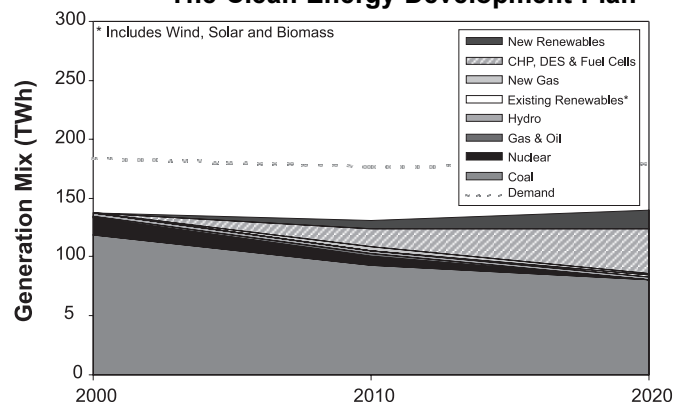
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.

4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Ohio means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.

## IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN OHIO WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 47 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 69 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 43 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind and biomass power "cash crops" for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER OHIO!

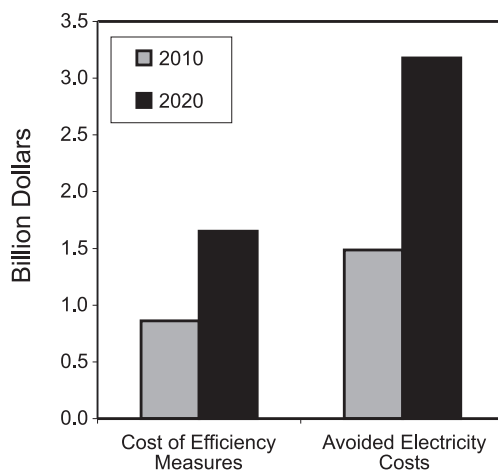
For more information and resources to develop Ohio's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Ohio has tremendous opportunities to invest in energy efficiency measures that will reduce pollution, save money and create jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$1,527 million by 2020.
2. Saves 72,417 GWh of electricity – equal to about 25 large power plants – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 29 percent by 2020.
4. Costs less – at an average cost of 2.4¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Ohio has strong opportunities to develop wind, biomass and solar power, which provide environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. Furthermore, Ohio can develop new efficient natural gas generation, such as CHP. Together, the opportunities shown in Figure 3 could supply 11 percent of Ohio's generation capacity by 2010 and 24 percent by 2020.

The Clean Energy Development Plan can be realized at a modest cost, as energy efficiency savings offset the cost of new generation. In Ohio, it would increase overall electricity costs by only about 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. Ohio has already adopted some important policies to promote clean power options, but more must be done to succeed. The key policy actions to achieve the Clean Energy Development Plan are to:

1. Increase Ohio's Energy Efficiency Investment Fund investment to 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by a third-party administrator overseen by an independent board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update Ohio's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish an Ohio Renewables Portfolio Standard that requires all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
6. Remove barriers to clean distributed generation by: (1) establishing standard business and interconnection terms; (2) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (3) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	264	920
CHP – Biomass	460	977
Biomass - Co-Firing	443	1,179
Photovoltaics	23	81
Biomass Gasification	0	100
Eff. Natural Gas Gen.*	1,982	4,710
<b>Total</b>	<b>3,172</b>	<b>7,967</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.





## REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

### THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

South Dakota needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying its power supply, South Dakota will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

### THE CLEAN ENERGY DEVELOPMENT PLAN

South Dakota should seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region's electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

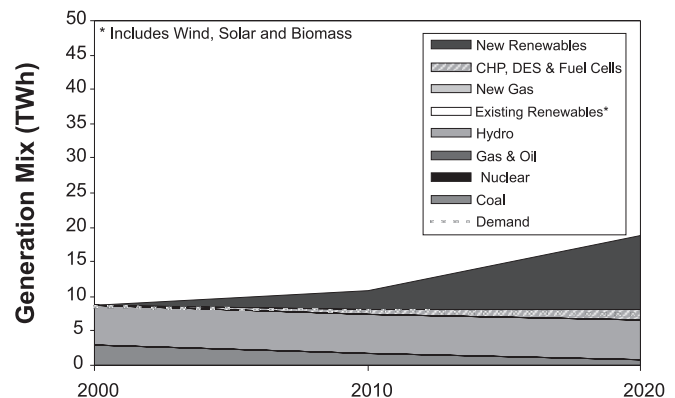
1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region's electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region's electricity generation by 2010 and 25 percent by 2020.
4. Retires selected older, less efficient and highly polluting coal plants.

5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in South Dakota means:

1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



The state's electricity demand is shown with a dashed line; when the dashed line is below generation, the state is a net exporter, and when above, the state is a net importer.

### IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN SOUTH DAKOTA WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 50 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 75 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 38 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind power “cash crops” for farmers and clean energy exports, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

**Harnessing clean energy improves the environment and spurs economic growth.**

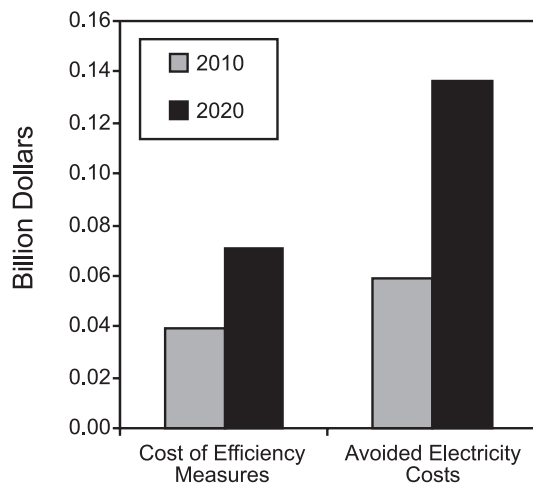
## HELP REPOWER SOUTH DAKOTA!

For more information and resources to develop South Dakota's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

### REAPING ENERGY EFFICIENCY OPPORTUNITIES

South Dakota has an opportunity to use energy in smarter, more efficient ways, thereby reducing pollution, saving money and creating jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$66 million by 2020.
2. Saves 2,917 GWh of electricity – equal to about one large power plant – by 2020.
3. Reduces electricity demand 17 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.5¢/kWh – than generating, transmitting and distributing electricity.

### DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

South Dakota also has a tremendous opportunity to harness its abundant wind resources, which offer environmental benefits, improved reliability, and economic development in the growing renewable energy business sector. South Dakota can also develop efficient generators, such as CHP and district energy systems, using natural gas. Together, these opportunities, shown in Figure 3, could supply 28 percent of South Dakota's generation capacity by 2010 and 53 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In South Dakota, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

### 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. The key policy actions for achieving the Clean Energy Development Plan in South Dakota are to:

1. Establish an Energy Efficiency Investment Fund to support energy efficiency initiatives with a non-bypassable charge of 0.3¢/kWh.
2. Manage the Energy Efficiency Investment Fund by an independent third-party administrator overseen by a board composed of regulators, state energy offices, and consumer, efficiency and environmental advocates.
3. Evaluate and update South Dakota's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
4. Establish a South Dakota Renewables Portfolio Standard requiring all retail electricity sellers to provide eight percent of their electricity from renewable resources by 2010 and 20 percent by 2020.
5. Establish a Renewable Energy Investment Fund to support emerging renewable technologies with a non-bypassable charge of at least 0.1¢/kWh.
6. Ensure transmission pricing policies and power pooling practices that treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
7. Remove the barriers to clean distributed generation by: (1) applying net metering policies to all wind and photovoltaics; (2) establishing standard business and interconnection terms; (3) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (4) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	940	2,900
CHP – Biomass	0	5
Biomass - Co-Firing	47	47
Photovoltaics	1	4
Biomass Gasification	0	0
Eff. Natural Gas Gen.*	89	200
<b>Total</b>	<b>1,077</b>	<b>3,156</b>
*Includes CHP (natural gas), district energy systems, and fuel cells.		



## REPOWERING THE MIDWEST: THE CLEAN ENERGY DEVELOPMENT PLAN FOR THE HEARTLAND

### THE 21<sup>ST</sup> CENTURY OPPORTUNITIES FOR CLEAN ENERGY

Wisconsin needs a strategic clean energy development plan that implements smart policies and practices to capture readily achievable environmental, public health and economic development benefits. This sustainable development strategy is good for the environment and the economy. The Clean Energy Development Plan proposes policies to implement underutilized energy efficiency technologies and to aggressively develop renewable energy resources. By diversifying a power supply that has relied on old, highly polluting coal and nuclear plants, Wisconsin will reduce pollution, improve electricity reliability, create new “green” manufacturing and installation jobs, and provide renewable energy “cash crops” for farmers. The Clean Energy Development Plan provides the strategies to achieve these goals.

### THE CLEAN ENERGY DEVELOPMENT PLAN

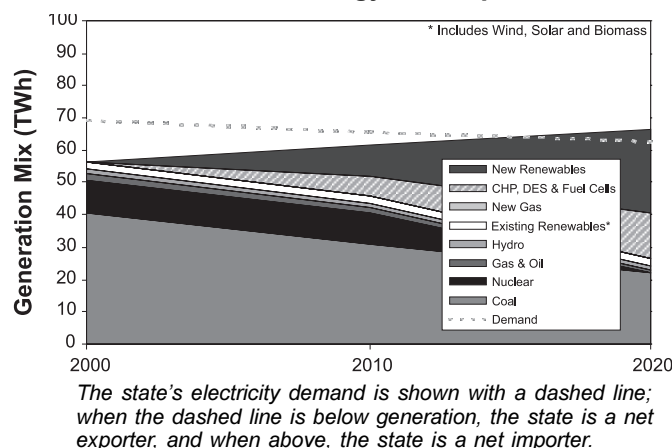
Wisconsin can seize the opportunity to develop its clean energy resources: modern energy efficiency technologies and wind, biomass and solar power. The Clean Energy Development Plan achieves large environmental, public health and economic development benefits with only modest increases in cost. Moreover, investing in energy efficiency and renewable energy will diversify the region’s electricity portfolio, thereby improving reliability. The Clean Energy Development Plan:

1. Aggressively implements the newest, as well as tried-and-true, energy efficiency technologies.
2. Develops and implements renewable energy technologies – wind, biomass and solar power – so that they provide eight percent of the region’s electricity generation by 2010 and 22 percent by 2020.
3. Develops and implements efficient natural gas uses in appropriate locations, especially combined heat and power (CHP), district energy systems and fuel cells, so that they provide 10 percent of the region’s electricity generation by 2010 and 25 percent by 2020.

4. Retires selected older, less efficient and highly polluting coal plants.
5. Applies sustainable development strategies to aggressively link environmental improvement policies to economic development.

As Figure 1 shows, implementing the Clean Energy Development Plan in Wisconsin means:

**Figure 1. Sources of Electricity Generation:  
The Clean Energy Development Plan**



1. Energy efficiency measures reduce electricity demand, and therefore the need for generation.
2. Generation from renewable resources and efficient natural gas increases.
3. Generation from older, less efficient and highly polluting coal plants decreases.

### IMPLEMENTING THE CLEAN ENERGY DEVELOPMENT PLAN IN WISCONSIN WILL ALSO PRODUCE:

1. Dramatic improvements in environmental quality by 2020, compared to business-as-usual practices, by reducing: sulfur dioxide (SO<sub>2</sub>) pollution, which causes acid rain, by 55 percent; nitrogen oxides (NO<sub>x</sub>) pollution, which causes smog, by 72 percent; and carbon dioxide (CO<sub>2</sub>) pollution, which causes global warming, by 53 percent.
2. Improved electricity reliability thanks to a diversified power portfolio.
3. Economic development and job growth through wind and biomass power “cash crops” for farmers, increased business for energy efficiency and renewable energy manufacturers, and new skilled jobs in installation and maintenance of this equipment.

# HELP REPOWER WISCONSIN!

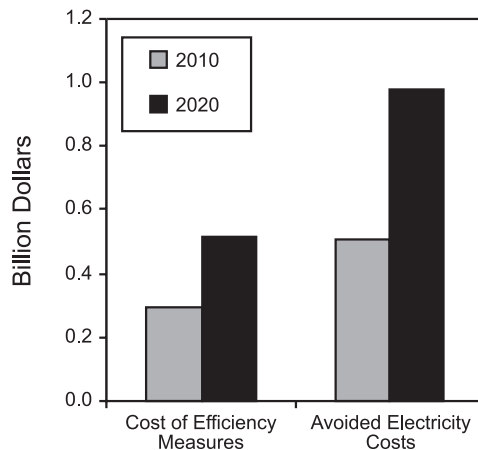
For more information and resources to develop Wisconsin's clean energy options, visit [www.repowermidwest.org](http://www.repowermidwest.org) or contact Environmental Law & Policy Center of the Midwest, 35 East Wacker Drive, Suite 1300, Chicago, IL 60601, tel: 312-673-6500.

Harnessing clean energy improves the environment and spurs economic growth.

## REAPING ENERGY EFFICIENCY OPPORTUNITIES

Wisconsin has tremendous opportunities to invest in energy efficiency technologies that will reduce pollution, save money and create jobs. This will produce the benefits summarized below.

**Figure 2. Benefits from Energy Efficiency Investments: The Clean Energy Development Plan**



1. Reduces net electricity costs by \$468 million by 2020.
2. Saves 23,895 GWh of electricity – equal to about eight large power plants – by 2020.
3. Reduces electricity demand 16 percent by 2010 and 28 percent by 2020.
4. Costs less – at an average cost of 2.2¢/kWh – than generating, transmitting and distributing electricity.

## DEPLOYING RENEWABLE RESOURCES AND EFFICIENT GENERATION

Wisconsin has the opportunity to develop wind, solar and biomass power, which offer environmental benefits, improved reliability, and economic development in the growing renewable energy sector. Furthermore, Wisconsin has great potential to develop new efficient generators such as CHP, using natural gas. Together, the opportunities shown in Figure 3 could provide 17 percent of Wisconsin's generation capacity by 2010 and 41 percent by 2020.

The Clean Energy Development Plan's benefits can be achieved at a modest cost, as energy efficiency savings offset the cost of new generation. In

Wisconsin, it would increase overall electricity costs by only 1.5 percent in 2010 and 3.4 percent in 2020.

## 21<sup>ST</sup> CENTURY POLICIES FOR MODERN TECHNOLOGIES

Smart policies can overcome the many market and regulatory barriers that energy efficiency and renewable resources face. Wisconsin has already adopted some policies to promote clean power options, but more must be done to succeed. The key policy actions to achieve the Clean Power Plan are to:

1. Increase Wisconsin's Energy Efficiency Investment Fund investment to 0.3¢/kWh.
2. Evaluate and update Wisconsin's efficiency standards and building codes. Establish or reinforce monitoring and enforcement practices.
3. Modify Wisconsin's existing Renewables Portfolio Standard so that the percentage requirement reaches eight percent by 2010 and 20 percent by 2020.
4. Ensure that transmission pricing policies and power pooling practices treat renewable resources fairly and account for their intermittent nature, remote locations, or smaller scale.
5. Remove barriers to clean distributed generation by: (1) establishing uniform business and interconnection terms; and (2) establishing uniform safety and power quality standards to facilitate safe and economic interconnection to the electricity system; and (3) applying clean air standards to small distributed generation sources, thereby promoting clean power technologies and discouraging highly polluting diesel generators.

**Figure 3: New Generation Resources in the Clean Energy Development Plan**

Generator Type	2010 New Capacity (MW)	2020 Cumulative New Capacity (MW)
Wind Turbines	412	2,788
CHP – Biomass	916	1,892
Biomass - Co-Firing	219	340
Photovoltaics	9	33
Biomass Gasification	0	100
Eff. Natural Gas Gen.*	734	1767
<b>Total</b>	<b>2,290</b>	<b>6,920</b>

\*Includes CHP (natural gas), district energy systems, and fuel cells.

## APPENDIX 2. EXISTING STATE ENERGY EFFICIENCY AND RENEWABLE PROGRAMS

### ILLINOIS

***Illinois Clean Energy Development Fund.*** The Illinois Clean Energy Community Foundation was created as a result of a settlement of contested issues between Commonwealth Edison and environmental organizations and was enacted by the Illinois General Assembly in 1999. The Foundation has \$225 million of assets available to further its mission of improving energy efficiency and developing renewable energy resources, as well as certain other specified environmental measures.

***City of Chicago Clean Energy Development Fund.*** The City of Chicago Environmental Fund was created as a result of the settlement of the city's claims against Commonwealth Edison relating to the franchise agreement. This Fund has \$25 million per year for each of four years; about half of this is devoted to energy efficiency and half to renewables.

***Energy Efficiency Investment Fund.*** The Illinois Energy Efficiency Trust Fund was enacted by the Illinois General Assembly and is supported by utility and energy supplier payments that provide \$3 million per year for each of 10 years. The Illinois Department of Commerce and Community Affairs manages this Fund.

***Renewable Energy Investment Fund.*** The Illinois Renewable Energy Resources Fund was enacted by the Illinois General Assembly. It has \$5 million per year for each of 10 years for renewable energy development projects, and it is supported by: (1) residential and small commercial customers' payment of a flat fee of \$0.50 per month; and (2) large commercial customers – that have a peak electric demand greater than 10 MW and used more than four million therms of gas in the previous calendar year – payment of a flat fee of \$37.50 per month. The Illinois Department of Commerce and Community Affairs manages this Fund.

***Commonwealth Edison Renewable Energy Fund.*** Commonwealth Edison's Renewables Program, also resulting from the settlement of the City of Chicago's claims against Edison relating to the franchise agreement, has \$3 million per year for each of four years, principally for solar photovoltaics development.

***Environmental Disclosure.*** Retail suppliers of electricity must disclose their fuel mix in the form of a multi-color pie chart and table and provide pollution information data on air emissions – carbon dioxide, nitrogen oxides and sulfur dioxide – and both high-level and low-level radioactive nuclear wastes. The environmental disclosure must be provided as a separate insert in customers' electricity bills each quarter.

***Net Metering.*** Commonwealth Edison – wind and solar systems of less than 40 kW are eligible to a limit of 0.1 percent of total peak demand. Excess generation is purchased at the avoided cost.

***State Grants.*** Grants of \$60,000 to \$1 million are available for capital projects of any renewable energy technology. Funding is not available for residential projects.

***Tax Relief.*** Property tax assessment – solar energy systems are assessed at a value not greater than conventional energy systems.

### INDIANA

***Energy Efficiency Programs Run by Utilities.*** Utilities are required to consider energy efficiency programs in the context of integrated resource planning. Some electric utilities implement demand-side management programs.

***State Renewable Grants.*** Commercial/Industrial – 80 percent of renewable project costs up to \$10,000. Industrial/Government/Utilities – \$20,000 for biomass and alternative fuels. Commercial/Government/Nonprofit – small-scale grants for projects with high degrees of public visibility that demonstrate a novel technology or novel application of an available technology.

***Net Metering.*** Indianapolis Power and Light offers a net metering program for PV systems, available for generators producing less than 1,000 kWh per month. No statewide limit exists on the amount of electricity that may be produced. Excess generation is granted to the utilities. For larger producers, two meters are installed.

***Tax Relief.*** One hundred percent of residential renewable installations are exempt from property tax for the lifetime of the installation. Exemption is for the renewable device and related equipment.

***Green Pricing.*** Indianapolis Power and Light offers customers a Green Power Option.



## IOWA

### ***Energy Efficiency Programs Run by Utilities.***

Regulated electric utilities are required to file energy efficiency plans with the Iowa Utilities Board. Programs must be available for all consumer classes. These programs are funded by a surcharge on all utilities, including municipal utilities and electric cooperatives.

***Renewables Portfolio Standard.*** Investor-owned utilities in the state must purchase a combined total of 105 MW of electricity from renewable or small-scale hydro plants.

### ***State Grants & Loans***

1. The Iowa Energy Center sponsors a competitive grants program for renewables and energy efficiency.
2. Residential, commercial and industrial sectors are eligible for zero percent interest loans for up to half of the project cost, up to a maximum of \$250,000. In 1996, \$1.8 million per year was appropriated for the three-year period 1997-1999.
3. Renewable Fuel Fund – There is funding of up to \$900,000. Approximately 20 percent of the money awarded to a project is in the form of a grant and the remaining 80 percent in the form of a low-interest loan.

***Net Metering.*** All customer classes are eligible for net metering for renewable generation. Applicability is limited to 1,000 kWh/month. Excess generation is purchased at avoided cost.

***Tax Relief.*** Property tax assessment – wind energy conversion equipment is to be assessed at zero percent of its cost for the first year. For the second through sixth years, value is increased by five percentage points per year. For the seventh and succeeding years the assessment is at 30 percent of its cost. Sales tax exemption – 100 percent of wind energy equipment is exempted.

## MICHIGAN

***Energy Efficiency Programs Run by Utilities (Discontinued).*** The Michigan Public Service Commission eliminated all requirements for utility energy efficiency programs in 1995 and 1996, in response to utility requests to abandon these programs in anticipation of electricity restructuring.

## Green Pricing

1. Under the Green Rate offered by Traverse City Light and Power, customers who receive all of their power from a 600 kW wind turbine pay a premium of 1.58¢ per kilowatt hour. Residential customers must make a three-year commitment and commercial customers must make a 10-year commitment.
2. Detroit Edison's SolarCurrents program allows customers to purchase 100 Watt shares in the utility's two grid-connected photovoltaic systems. The monthly premium for a share is \$6.70.

## MINNESOTA

***Energy Efficiency Programs Run by Utilities.*** Each public utility must spend 1.5 percent of its gross operating revenues from service provided in the state on energy conservation improvements. For a utility that furnishes electric service and operates a nuclear generating plant within the state, two percent of its gross operating revenues from in-state service must be spent.

***Renewables Set Aside.*** XCel Energy (formerly Northern States Power) – was required to build or contract out 224 MW of wind power by December 31, 1998. An additional 200 MW are required by December 31, 2002. XCel Energy also was required to build or purchase 50 MW of farm grown closed-loop biomass by December 31, 1998 and an additional 75 MW by December 31, 2002.

### ***State Grants & Loans***

1. State Grants provide 1.5¢ per kilowatt hour payment for electricity generated from new wind projects less than 2 MW in capacity. Available up to a statewide ceiling of 7.5 MW. The ceiling will be raised to 100 MW by 2005. The credit is available for a period of 10 years after installation for all projects under the ceiling installed by Jan. 1, 2005.
2. The Rural Finance Authority will provide up to \$100,000 (45 percent) of loan principal to farmers for improvements or additions to wind facilities. Rates on these loans average four percent. The loans are funded through a revolving account.

***Construction Requirements.*** New state government building projects must incorporate active and passive solar energy and other alternative energy sources where feasible. Energy efficiency programs also are mandated in selected state buildings.



**Net Metering.** Renewable technologies and co-generators of less than 40 kW are eligible for net metering; there is no limit to statewide capacity. Excess generation is purchased at the average retail rate.

#### **Tax Relief**

1. Corporate Depreciation – follows the federal modified accelerated cost recovery schedule for renewables.
2. Property tax exemption – wind systems less than two MW are exempt; those larger than two MW have nine percent of their value subject to local taxes; and those larger than 12 MW will have 30 percent of their value subject to property taxes. PV systems also are eligible.
3. The total cost of solar and wind devices is exempt from sales tax.

#### **Green Pricing**

1. The Solar Advantage program, offered by XCel Energy (formerly Northern States Power) installs two-kW photovoltaic systems on participating customers' rooftops. Customers with the installations use power and sell excess generation to XCel Energy at the retail rate. Customers pay a monthly premium of \$50 with a minimum commitment term of five years, after which customers have the option of purchasing the installation or continuing the agreement.
2. Wellspring, offered by Cooperative Power Association – Customers can purchase 100 kWh block of wind-generated electricity for a \$2 monthly premium. Customers must commit to a term of 12 months.

## **Nebraska**

#### **Energy Efficiency Investment Funds**

1. The Dollar and Energy Savings Loan Program provides low-interest loans to homeowners, businesses, government, and farmers and ranchers to make energy efficiency improvements.
2. The Energy Efficient Mortgages program provides mortgage discounts of up to one percent for newly constructed homes and .25 percent on existing homes.

3. Rebuild Nebraska assists communities and building owners with improving the energy efficiency of their commercial and multi-family residential buildings.

**Loans.** Loans are available at zero percent interest for up to half of a renewable energy project's cost. To date, more than 15,000 loans have been granted, totaling more than \$100 million.

## **NORTH DAKOTA**

**Net Metering.** Net metering is available for renewables and co-generators of 100 kW or less. There is no statewide limit to net metered capacity. Utilities must purchase excess generation at their avoided cost.

**Tax Relief.** Tax payers can deduct five percent of the cost of equipment and installation of renewable energy installation from their personal taxes for a period of three years. Renewable energy devices are eligible for property tax exemption of 100 percent of the value for five years after installation.

## **OHIO**

**Energy Efficiency Investment Fund.** Beginning in July, 2001, \$100 million will be collected over 10 years to establish a revolving loan fund for energy efficiency and small-scale renewables.

**Environmental Disclosure.** Retail suppliers of electricity must disclose their fuel mix and environmental characteristics in a pie chart showing fuel mix of the competitive supplier and the region, bar graphs showing air emissions and a statement on radioactive waste. Generic descriptions of environmental characteristics (i.e. "air emissions and solid waste," "wildlife impacts," "radioactive waste," etc.) are included for each possible generation type.

**Net Metering.** Net metering is available for solar, wind, biomass, landfill gas, hydro, microturbines and fuel cells. There is no cap on system size, but the total capacity is limited to one percent of each utility's peak demand. Single meter tracking is used, and excess generation is purchased at the unbundled generation rate and credited to the following month's bill.

**Green Pricing.** Bowling Green's municipal utility program ranks seventh in the nation for customer participation and offers customers low-impact, "run of the river" hydropower from the Ohio River. Customers pay .0135¢/kWh for 100 percent

renewable electricity; .0104¢/kWh for 75 percent; .0069¢/kWh for 50 percent; and, .0035¢/kWh for 25 percent. Green power offerings may be expanded to include wind and solar power.

## **SOUTH DAKOTA**

**Tax Relief.** One hundred percent of residential installations and 50 percent of commercial installations are exempt from property tax. Exemption is available for three years after installation. Exemption is not available for installations producing energy for resale.

**Green Pricing.** The East River Electric Power Cooperative is making wind-generated electricity available to rate payers in 100 kWh blocks at a premium of \$3.50. A one-MW installation will be constructed in early 2001. Customers will not be charged until the facility goes online.

## **WISCONSIN**

**Energy Efficiency and Renewable Energy Investment Funds.** A transition plan is underway to transfer the management of energy efficiency and renewable energy initiatives from the utilities to state government. By 2003 the state government will administer and disburse, on an annual basis, between \$70 and \$80 million of ratepayer funding dedicated to clean energy programs.

**Renewables Portfolio Standard.** Beginning in 2001 and continuing for 10 years, electricity providers must increase the percentage contribution of renewable power sources relative to total electricity sales. The increase amounts to 1.7 percent of total electricity sales, which by 2011 translates to an increase in renewable electricity of nearly one billion kWh annually.

**State Grants.** Up to \$15,000 in state grants is available for technical assistance. Funding for 10 to 20 percent of renewable installations is available up to \$75,000. Half of the funding is withheld until project completion.

**Net Metering.** Net metering is available for all generator types less than 20 kW. Customers using renewables are paid the retail rate for their excess generation; customers using non-renewables are paid avoided costs.

**Tax Relief.** One hundred percent of renewable installations are exempt from property taxes.

### **Green Pricing Programs.**

1. Energy for Tomorrow, offered by Wisconsin Electric, provides three levels of renewable fuel mix (currently hydro, wood waste and landfill gas; wind is planned). Customers can choose fuel mixes of 25 percent, 50 percent or 100 percent renewables and pay a monthly premium of \$3, \$6 or \$12, respectively.
2. Under the SolarWise program, offered by Wisconsin Public Service, contributions from customers in amounts of \$1, \$2 and \$4 support the installation of 12-kW grid-connected installations on school buildings. The SolarWise curriculum was developed, in part, through a grant from the Wisconsin Environmental Education Board
3. Wind Power Green Pricing, offered by Madison Gas & Electric, allows residential and business customers to purchase 100-kWh blocks for a monthly premium of \$4 to \$5 per block. MGE plans to construct and operate an 11.25 MW wind farm. The wind installation will consist of 15 – 750 kW turbines.

## APPENDIX 3. MODELING ASSUMPTIONS

### THE PROSYM MODEL

The electric power system in the Midwest was simulated using the PROSYM model. PROSYM is a chronological model that represents the operation of the roughly 2,000 individual generating units in the Midwest to serve customer electricity demand on an hourly basis. As a general matter, the units with lower operating costs have priority in the dispatch over higher cost units, so that the total cost of operating the system is minimized. The model also recognizes generator operating constraints such as minimum downtime and maximum ramp rates, as well as transmission constraints between each of the 10 individual “transmission areas” in the study region.

We selected the years 2010 and 2020 in which to perform simulations to provide a snapshot of the ways that the electric industry in the Midwest could evolve over time. We simulated 2010 and 2020 in both a business-as-usual case and a Clean Energy Development Plan. We also performed a simulation of 2000 as a benchmark of our assumptions.

The PROSYM model was used to analyze three NERC electricity regions: the East Central Area Reliability Coordination Agreement (ECAR), the Mid-American Interconnected Network (MAIN) and the Mid-Continent Area Power Pool (MAPP). These three regions include the 10 Midwestern states addressed in this study, as well as Kentucky, Missouri, Pennsylvania and West Virginia.

### THE BUSINESS-AS-USUAL CASE

The business-as-usual case input assumptions were developed based primarily upon EIA’s AEO 2000 in order to represent a “business-as-usual” future. For example, the business-as-usual case PROSYM inputs were set to match AEO 2000 projections of fossil fuel prices and electricity demand. The business-as-usual case, however, differs from AEO 2000 in several respects:

1. AEO 2000 does not include NO<sub>x</sub> emission controls to comply with the EPA SIP Call. The business-as-usual case includes these controls, primarily SCR on newer plants (post-1960) and combustion controls on all plants, applied to individual generators in the portion of the study region east of the Mississippi River.
2. AEO 2000 assumes that the operating lives of some nuclear generating units in the region are extended

beyond their current operating licenses. In the business-as-usual case we assume that these units – amounting to nearly 4,095 MW of capacity in 2010 and an additional 11,020 MW in 2020 – are retired at the expiration of their current operating licenses.

3. AEO 2000 has new renewable resources added, but apparently does not recognize certain recent state policies. In the business-as-usual case, additional renewable generation beyond that forecast in AEO 2000 was added to reflect the commitment in Minnesota to develop 400 MW of wind generation by 2012 and the funding for renewables in Illinois and Iowa.

It should be noted that under the business-as-usual case only a very small amount of existing coal generation is retired (1,700 MW by 2010). This is roughly consistent with AEO 2000, and appears to be consistent with the way coal plant owners will view the economics of retirement under business-as-usual conditions. That is, in the absence of explicit policies to the contrary (such as a carbon emissions cap or a targeted requirement for retirement/repowering), the existing fleet of coal plants will continue to operate (Synapse 6/1998). Indeed, consistent with AEO 2000, the coal units in the business-as-usual case operate at high-capacity factors over time, increasing from 63 percent in 2000 to 68 percent in 2010 and to 71 percent by 2020.

In the business-as-usual case, new generating resources must be added in order to meet growing demand and to replace retiring nuclear generation. In the business-as-usual case new gas-fired generators were added in order to meet a 12 percent reserve margin target in each “transmission area.” It was assumed that 50 percent of this new capacity would be combustion turbine and 50 percent would be combined-cycle capacity. The resulting set of business-as-usual case capacity additions is broadly consistent with AEO 2000 and with the mix of new projects currently proposed and under construction in the Midwest, as indicated in Figure A.1.

FIGURE A.1 COMPARISON OF PROSYM AND AEO 2000 GENERATION FUEL MIX  
Percentage of Total Generation in 2000

Fuel Type	PROSYM	AEO 2000
Coal	74	78
Natural Gas/Oil	2	3
Nuclear	20	17
Renewable	3	3

## THE CLEAN ENERGY DEVELOPMENT PLAN

The Clean Energy Development Plan includes four major changes from the business-as-usual case: (1) aggressive energy efficiency measures are implemented; (2) additional renewable and efficient generation resources are installed; (3) fewer new natural gas facilities are installed as a result of lower electricity demand and increased renewable resources; and (4) some older coal plants are retired early.

The energy efficiency measures, renewable technologies and efficient generators assumed in the Clean Energy Development Plan are described in Chapters 4, 5 and 6. The new natural gas units installed under the Clean Energy Development Plan to maintain a 12 percent reserve margin are consistent with the approach used in the business-as-usual case. However, in some control areas the reserve margins exceed 12 percent without installing any new natural gas facilities, because of the lower load and increased renewable resources. In these areas there will be some additional costs associated with having reserve margins higher than necessary, but there may also be additional benefits associated with higher reliability. We did not account for such benefits in our study. In the Clean Energy Development Plan we assumed that all new natural gas units are combustion turbine facilities because many of the new clean power options will meet the region's baseload needs.

The additional coal plant retirements were assumed to be the result of some form of CO<sub>2</sub> reduction policy. As described in Chapter 8, there are a variety of CO<sub>2</sub> reduction policies that could influence the retirement of older, less efficient, high-pollutant coal units. In the Clean Energy Development Plan we assumed that by 2010 all coal plants that were installed before 1960 (i.e., more than 50 years old) are retired. This represents roughly 19 percent of the existing coal fleet or 22 GW. There are no additional coal retirements between 2010 and 2020.

Our model calculated all of the going-forward costs associated with the production of electricity from 2000 through 2020. These going-forward costs include the costs to build new power plants; the fuel and O&M costs associated with running those plants; the costs of installing emission control costs and purchasing emission allowances; and the costs of any transmission and distribution upgrades that are necessary. The going-forward costs also include the costs of implementing efficiency initiatives, including administration costs, utility

costs and customer costs. The difference in going-forward costs between the business-as-usual case and the Clean Energy Development Plan indicated the additional costs (or savings) associated with the Clean Energy Development Plan.

Going-forward costs do not represent the total cost of providing electricity. The total cost also includes "embedded" costs that are necessary to recover past expenditures. The price of electricity was based on total costs, in order to allow utilities to recover both embedded costs and going-forward costs.

We estimated the impact on total electricity system costs of the Clean Energy Development Plan by making a simplifying assumption about embedded costs. We began by estimating embedded costs in 2000 as the difference between 2000 total costs and 2000 going-forward costs. We then assumed that embedded costs will decline slightly from 2000 through 2020. Embedded costs were the same in the business-as-usual case and the Clean Power Case, by definition. Finally, we added the estimated embedded costs to the going forward costs from our model to determine total costs in 2010 and 2020. The percentage difference in total costs between the business-as-usual case and the Clean Energy Development Plan indicated the impact on total costs of the Clean Energy Development Plan.

The total costs included expenditures to reflect distribution system upgrades that will be necessary to meet load growth over the next 20 years. We assumed that distribution upgrades will cost \$500/kW (\$64/kW-yr) to cover the additional peak load over the study period. This is roughly half of the amount that U.S. electric utilities spent on transmission and distribution upgrades in the 10 years from 1979 through 1998.<sup>22</sup> These distribution upgrade costs were included in both the business-as-usual case and the Clean Energy Development Plan. In the Clean Energy Development Plan, however, we assumed that total distribution costs were reduced by 20 percent as a result of the energy efficiency investments. This is likely to be an underestimate of the distribution costs avoided by energy efficiency measures. Distributed generation technologies might result in additional avoided distribution costs.

<sup>22</sup> Distribution costs were roughly 75 percent of transmission and distribution costs over this period. We chose a lower distribution cost in order to be conservative.

## APPENDIX 4.

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- Kim Christiansen, North Dakota Division of Community Services.
- George Crocker, North American Water Office.
- Hans Detweiler, Environmental Law and Policy Center.
- Jeff Genzer, Duncan, Weinberg, Genzer & Pembroke, P.C.
- Bob Gough, Intertribal Council on Utility Policy.
- Bill Grant, Izaak Walton League.
- Jay Haley, EAPC Architects and Engineers, Grand Forks.
- Paul Helgeson, Public Service Commission of Wisconsin.
- Greg Jaunich, Northern Alternative Energy.
- Jack Kiers, Pipestone County Commissioner.
- Ward Lenz, Iowa Department of Natural Resources.
- LuAnn Napton, South Dakota Resources Coalition.
- Jim Nicols, Lake Benton Director of Economic Development.
- Michael Noble, Minnesotans for an Energy-Efficient Economy.
- Heather Rhoads, Global Energy Concepts, L.L.C.
- Lola Schoenrich, Minnesota Project.
- Chris Schoenherr, Wisconsin Electric.
- Mark Trechock, Dakota Resources Council.
- Michael Vickerman, RENEW Wisconsin.
- Steve Wegman, South Dakota Governor's Office.

## **INTERVIEWS – BIOMASS CO-FIRING**

- Joseph Battista, Co-firing Alternatives.
- Marty Braster, Chariton Valley Resource Conservation and Development.
- Kevin Comer, Antares Group, Inc.
- Genevieve Damico, U.S. Environmental Protection Agency, Region 5.
- Phillip Goldberg, U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory.
- Gene Heupel, XCel Energy (formerly Northern States Power) Company.

- William Hohenstein, U.S. Environmental Protection Agency, Office of Policy.
- Evan Hughes, Electric Power Research Institute.
- Felton Finney, Electric Power Research Institute.
- Patty Hus, Northern Indiana Public Service Company.
- Jonathan Kirschner, United BioEnergy Commercialization Association.
- Joseph Miakisz, M. J. Bradley & Associates.
- David Solomon, U.S. Environmental Protection Agency, Office of Air Quality, Planning, and Standards.
- David Tillman, Foster Wheeler Development Corporation.
- Gary Walling, Alliant Energy.
- Meredith Wingate, Center for Resource Solutions.

## **INTERVIEWS – BIOMASS CHP**

- Dr. Richard Bain, National Renewable Energy Laboratory.
- Jeffrey Fehrs, P.E., biomass energy consultant.
- Bob De Geus, Vermont Department of Public Service.
- Fred Kuzel, Great Lakes Regional Biomass Program.
- Dr. Thomas Mancini, Sandia National Laboratories.
- Scudder Parker, Vermont Department of Public Service.
- Anders Rydaker, District Energy St. Paul.

## **INTERVIEWS – PHOTOVOLTAICS**

- Marc Fioravanti, Utility Photovoltaic Group.
- Jeff Graef, Nebraska Energy Office.
- Phil Key, Kyocera Solar.
- Keith Kutz, Iowa Energy Center.
- Chris Larsen, North Carolina Solar Center.
- Warren Lauzon, Northern Arizona Wind and Sun, Inc.
- Bill Roush, Heartland Solar Energy Industries Association.
- Roland Skinner, Northwest Rural Public Power District.
- William Spratley, Spratley and Associates.

## **INTERVIEWS – FUEL CELLS**

- John Cervený, Plug Power.
- Mark Cherniak, Pacific Energy Conservation, Inc./Trexler Associates.
- Bill Cratty, Surepower.
- Bernie Geyer, Fuel Cells 2000.
- Joe Mahler, Fuel Cell Energy.
- Alan Nogee, Union of Concerned Scientists.
- Todd Otis, Minnesotans for an Energy-Efficient Economy.
- Glen Rambach, Desert Research Institute.
- Rhett Ross, U.S. Fuel Cell Council.
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