The Power of Efficiency

Opportunities to Save Money, Reduce Pollution and Expand the Economy in the Midwest

ENVIRONMENT ILLINOIS
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Environment Illinois Research & Education Center is a 501(c)(3) organization. We are dedicated to protecting Illinois' air, water and open spaces. We investigate problems, craft solutions, educate the public and decision makers, and help Illinois residents make their voices heard in local, state and national debates over the quality of our environment and our lives.

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Frontier Group conducts independent research and policy analysis to support a cleaner, healthier and more democratic society. Our mission is to inject accurate information and compelling ideas into public policy debates at the local, state and federal levels.

MEEA, a 501(c)(3) nonprofit organization, is a collaborative network advancing energy efficiency in the Midwest through programs, policy initiatives, and education. MEEA was created out of the tremendous potential to raise the level of energy efficiency in the Midwest and the need for greater regional coordination among states and the diverse organizations concerned with energy efficiency. Over the past seven years, MEEA has played a critical role in the Midwest by working to educate state policymakers to include energy efficiency in their energy goals and policy decisions. MEEA has created and managed market-based programs which have resulted in placement of more than 15,000 ENERGY STAR® qualified appliances and more than 5 million ENERGY STAR® qualified compact fluorescent lamps in Midwestern homes. MEEA estimates that its programs saved almost 2.5 billion lifetime kWh, eliminating 3.2 million tons of carbon dioxide.

Cover Photos: Upper left: The Aldo Leopold Center in central Wisconsin, an educational facility designed to carry on the legacy of Aldo Leopold and his land ethic, has been certified LEED Platinum by the U.S. Green Building Council in recognition of its high energy-efficiency performance and sustainable construction. The building has zero net global warming emissions, and uses 70 percent less energy overall than required by Wisconsin commercial building energy code. Photo: The Aldo Leopold Foundation; Money: Jake Levin; CFL bulb: Eric Delmar
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Executive Summary

Illinois is sitting on a vast reserve of energy, waiting to be used. However, this energy is not in the form of coal, oil or natural gas. Rather, we are rich in the potential to get more work done with the electricity and natural gas that we already use, through improved energy efficiency.

Energy efficiency measures offer a cost-effective and simple opportunity to solve the state's biggest energy challenges. By reducing demand for electricity and natural gas, energy efficiency measures can prevent the need to build new power plants and ease pressure on limited fuel supplies, bringing a variety of benefits for the economy and for the environment of the Midwest. And at the same time, energy efficiency offers large potential for citizens and businesses to save on energy bills.

Opportunities to improve energy efficiency are everywhere. Homeowners can improve weather sealing and install high-efficiency appliances, saving energy and improving comfort. Businesses and institutions can take advantage of improved lighting systems and high-efficiency ventilation. Manufacturers can improve production through technologies such as efficient motors and precise controls. And with fuel prices on the rise, opportunities for cost-effective energy efficiency improvements are expanding.

While Illinois has taken important steps to improve energy efficiency, much more remains to be done. To take full advantage of all cost-effective opportunities for improved energy efficiency, the state should expand its policy support for efficiency programs.

Opportunities to improve energy efficiency are everywhere.

A variety of readily available technologies and practices can dramatically reduce energy use in homes in Illinois. For example:

- Through home weatherization – including air and duct sealing, insulation and window replacement – Illinois could cut energy use for home heating by 20 percent, saving 64 billion cubic feet of natural gas per year and reducing total natural gas consumption by 7 percent.
- By requiring all new furnaces to meet federal Energy Star® standards (exceeding the efficiency of a typical new furnace by 20 percent) and to include high-efficiency fans, Illinois could save 1,000 gigawatt-hours (GWh) of electricity and 14 billion cubic feet of natural gas in the year 2020 – enough energy to supply more than 100,000 homes.
- Replacing five conventional incandescent light bulbs with compact fluorescent versions in every home could reduce electricity use for residential lighting by 25 percent, saving 1,100 GWh of electricity per year – enough to power 120,000 homes.
- Adopting minimum energy efficiency standards for just three appliances – DVD players, audio equipment, and power supplies (used for laptop computers, cell phones and related electronics) – would save 300 GWh of electricity per year by 2020 – equivalent to the electricity needs of 32,000 homes.
- Putting all these measures together, energy consumption in a typical Illinois home could be reduced by 20 to 40 percent or more, without sacrifice.

- The potential for energy savings doesn't stop here. For example, "zero-energy" designs for new homes could cost-effectively reduce energy use compared to a conventional home by 60 to 90 percent, making up the difference with on-site renewable energy generation.

Many of the same strategies that are available for reducing residential energy use also apply – on a much larger scale – to business, institutions and industry.

- Retrofitting lighting systems in commercial buildings and institutions to reduce electricity use for lighting by 40 percent could save 8,000 GWh of electricity every year in Illinois, or about 5 percent of current statewide electricity consumption.
- The use of efficient motors and precise controls in commercial building systems and manufacturing processes could reduce statewide electricity consumption by as much as 15 to 25 percent.
- Efficient technologies have applications on farms as well. For example, installing variable speed motors in vacuum pump systems at dairy farms can reduce system energy consumption by up to 80 percent.
- Combined heat and power technology, which can generate both electricity and heat in an on-site facility, offers huge opportunities for efficiency gains. For example, the University of Illinois at Chicago installed a CHP system on the East Campus in 1993, reducing energy use by about 15 percent. The greatest potential for expanding the technology in Illinois lies in office buildings, schools and hospitals, which could together support more than 1,400 megawatts (MW) of CHP capacity.

Kenn Kiser

Energy consumption in a typical Illinois home could be reduced by 20 to 40 percent or more, without sacrifice.

Illinois will capture a substantial amount of its energy efficiency resources through legislation that will halt rising demand for electricity by 2015, but many other potential savings measures remain untapped.

- In July 2007, the Illinois General Assembly adopted a bill that will require electric utilities to reduce electricity demand annually by 0.2 percent in 2008, rising to 2 percent per year in 2015 and thereafter. If properly enforced, the bill will stabilize the state's electricity consumption by 2015. Commonwealth Edison estimates that annual electricity savings will exceed 1,000 GWh four years into the program.
- However, Illinois limited the total annual rate impact of the energy efficiency program to a 0.5 percent increase per year, capped at 2 percent. If the rate cap is triggered, the energy savings goals will be scaled back – even if further investment in energy efficiency would yield greater savings for consumers.

Jake Levin

Energy efficiency reduces overall energy system costs – saving everyone money, even people who don't directly install energy efficiency measures.

- While Ameren and Peoples Gas have proposed natural gas energy efficiency programs, Illinois has no statewide energy savings targets focused directly on reducing natural gas consumption.
- Illinois is also one of just a handful of states in the country that does not have a statewide residential building energy code.

By taking greater advantage of energy efficiency, Illinois can save money, reduce pollution, and help to reinvigorate the region's economy.

- Energy efficiency directly translates into lower electricity and gas bills for consumers. For example, if every household in the state replaced five incandescent bulbs with compact fluorescent bulbs, residential electricity use would drop by more than 2 percent, saving consumers $1.7 billion on electricity and maintenance costs over the life of the bulbs.
- Energy efficiency also leads to lower energy prices. For example, if Midwestern states reduced natural gas consumption by 1 percent per year for five years through efficiency measures, wholesale natural gas prices would decline by as much as 13 percent.
- Money saved through efficiency programs can then be spent on other goods and services, creating jobs and stimulating the local economy. For example, in 2005, researchers at the University of Illinois calculated that an energy efficiency package (coupled with other clean energy policies) would create 191,000 new jobs in Illinois by 2020, increase wages by $5.5 billion, and expand economic output by $18 billion.
- Energy efficiency programs, which increase the penetration of efficient technologies and practices into the marketplace, can save electricity at less than half the cost of generating electricity at a power plant and delivering it to consumers over transmission lines. For example, Wisconsin's Focus on Energy Program is currently saving electricity at a cost of about 3 cents per kWh (compared to an average retail cost of electricity in 2005 of 7.5 cents per kWh.) The program also saves natural gas at a cost of 18 cents per therm (compared to a 2005 delivery cost of at least $1 per therm).
- Energy efficiency measures also prevent global warming pollution. For example, if all commercial buildings in Illinois improved the efficiency of their lighting systems by 40 percent, it would reduce pollution at levels comparable to removing about 800,000 cars from the road.

To capture more of its energy efficiency resources, Illinois should:

- Implement and enforce the recently passed energy efficiency resource standard, requiring utilities to reduce electricity consumption before building new power plants.
- Remove the rate cap that arbitrarily limits investment in cost-effective efficiency opportunities.
- Create similar energy efficiency savings targets for natural gas utilities.
- Set strong energy efficiency standards for household and commercial appliances inadequately covered by federal policy.
- Establish a strong residential building energy code and strengthen commercial building codes, ensure the codes are adequately enforced, and update the standards regularly.
- Eliminate obstacles to the use of combined heat and power (CHP), which would dramatically expand opportunities for industrial and commercial energy efficiency.
- Create incentive programs to encourage businesses to go above and beyond minimum standards, and to encourage consumers to adopt new energy-saving technologies.

Introduction: The Energy Crisis

The Midwest is facing an energy crisis.

America's oil production peaked decades ago and is in decline, and domestic natural gas production is nearing its peak now. As a result, we are importing more and more of our energy from abroad, leaving us vulnerable to supply disruptions and sending billions of dollars out of the local economy.

Natural gas has become increasingly expensive as demand inches closer toward available supply – driven in part by the increased use of gas for electricity generation. Gas prices have more than doubled since 2000, increasing the cost of heating our homes and fueling our industries.[1]

We are using more electricity every year, straining our region's energy infrastructure. Overall growth in electricity demand in the Midwest has been on the order of 1.8 to 2.5 percent per year from 1990 to 2005.[2] Only a fraction of the increased demand stems from population growth – people are also using more energy per capita.

Finally, our reliance on polluting energy sources contributes to global warming, unhealthy air quality, and mercury pollution in our lakes and rivers. For example, from 1990 to 2005, global warming pollution from electricity generation increased by 44 percent in Iowa, 48 percent in Wisconsin and 80 percent in Illinois.[3]

Solving this energy crisis will require transforming the way we think about and use energy. For the Midwest to retain our economic security and environmental health, we must build toward a New Energy Future – one based on homegrown, environmentally friendly energy sources and the sensible use of energy throughout the economy.

Solving this energy crisis will require transforming the way we think about and use energy.

Energy efficiency is one of the primary means to achieve a better energy future. The Midwest (and indeed, America as a whole) is rich in the potential to get more work done with the electricity and natural gas that we already use. Tapping into our "strategic reserves" of energy efficiency potential is at least as important as raw stocks of fuel when it comes to meeting our energy needs.

This report presents a review of some of the many available opportunities to improve energy efficiency in Midwest homes and businesses. The breadth of these opportunities should make clear that we already have the technology and the know-how to dramatically reduce our energy consumption. Deploying this know-how can ease pressure on limited fossil fuel supplies, insulate our economy from supply disruptions and price spikes, create jobs and stimulate the economy, and prevent pollution that causes global warming and poor air quality.

The next step is to develop and implement public policies that can put these energy efficiency tools in the hands of individuals and businesses across the Midwest.

Improving the energy efficiency of our economy is the cheapest and fastest way to reduce our dependence on fossil fuels.

Vast "strategic reserves" of energy efficiency exist within Midwestern homes, businesses and industrial facilities. For example, many light fixtures give off excess heat; air fans operate without the benefit of efficient motors; weaknesses in building insulation allow indoor heat to escape. By correcting these problems, we can get the same or better comfort, lighting and production.

Moreover, the technology necessary to accomplish this goal exists today.

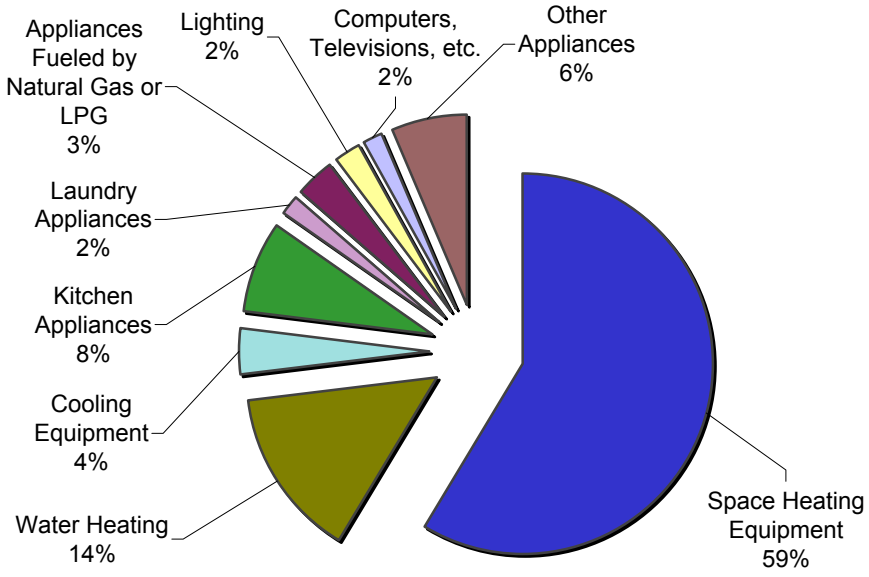
Energy Efficient Homes

Many potential opportunities exist to improve the energy efficiency of our homes. And because homes are responsible for about 31 percent of electricity use and at least one-third of natural gas use in Illinois, Iowa and Wisconsin, achieving improved energy efficiency in homes can make a big difference in overall energy consumption.[4]

Technologies and know-how such as improved weatherization, higher-efficiency furnaces, more efficient air fans, and higher-performance appliances can reduce energy consumption in a typical Midwestern home by 20 to 40 percent or more—without sacrifice.

According to an analysis conducted by the Midwest Energy Efficiency Alliance, the typical state in the Midwest could reduce residential natural gas consumption on the order of 25 percent below projected levels over 20 years through improved insulation, high-performance appliances and other measures.[6] Moreover, the typical Midwestern state could reduce residential electricity consumption by about 10 percent over the same period through measures such as increased lighting efficiency and high-performance appliances.[7]

Figure 1: Breakdown of Energy End-Uses in Midwest Homes[5]



Appliances fueled by natural gas or LPG include: clothes washers, clothes dryers, dishwashers, ovens, ranges, and pool heaters. Other appliances include: pool equipment, waterbed heaters, well water pumps, dehumidifiers and humidifiers, aquariums, answering machines, cordless telephones, rechargeable tools, and automobile engine warmers.

Space Heating

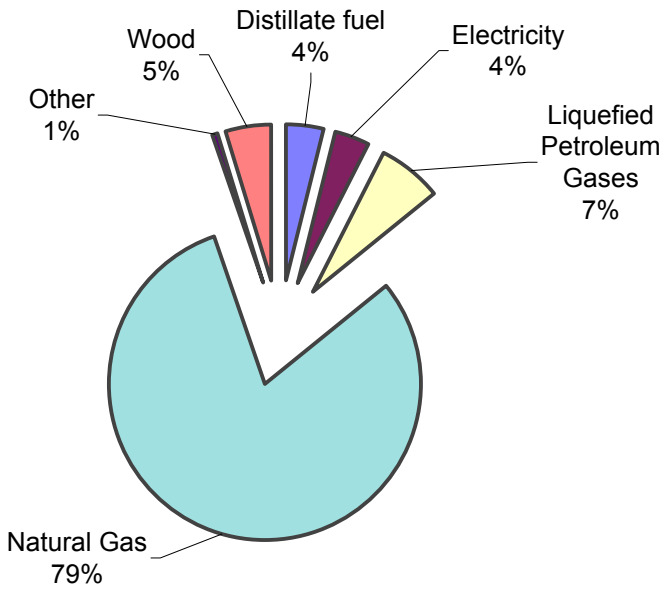
Heating is the largest source of energy consumption in the average home in the Midwest, accounting for nearly 60 percent of total energy use.[8] (See Figure 1.) Most of the energy consumed for heat is in the form of natural gas.[9] (See Figure 2.) Improvements in space heating efficiency hold the largest potential for cost-effective energy savings in the typical home.

Despite dramatic improvements to the energy efficiency of a typical home since the energy crises of the 1970s, most homes – both new and existing – can be heated far more efficiently. For example, the federal government has been providing grants to state agencies that help low-income households improve their energy efficiency through the Weatherization Assistance Program for the past three decades. A recent evaluation of the program in 19 states found that the program reduced natural gas consumption for space heating in affected homes by approximately 32 percent.[11]

There are multiple ways to reduce energy consumption for space heating in Midwest households. Improved insulation, high-efficiency windows and weather-stripping can reduce the amount of heat that escapes from a home during cold weather.

And high-efficiency furnaces and boilers can ensure that less fossil fuel is wasted in the production of heat for homes. New homes can also be built to incorporate strong energy efficiency performance from the start.

Figure 2: Fuel Use for Heating in the Midwest[10]



Weatherization

Improving the thermal efficiency of homes can significantly reduce the use of natural gas for heating. Many homes, especially older ones, have inadequate insulation, leaky seals on windows and doors, or other gaps in the building envelope that allow heat to escape.

Nationally, homes built before 1940 consume more than twice as much energy for space heating when compared to homes built after 1980, even without taking into account that newer homes are also likely larger in size.[12]

More than 70 percent of homes in Illinois, Iowa and Wisconsin were built before 1980, and about one-quarter of homes were built before 1940.[13] Many of these homes have inadequate insulation and weatherization. For example, the Midwest Energy Efficiency Alliance estimates that 5 to 15 percent of customers in the Midwest have un-insulated walls or ceilings, and more than 35 percent of homes in Illinois and Wisconsin have low-efficiency single-paned windows.[14]

The thermal efficiency of these homes can be improved with better insulation, higher performance windows, and other retrofit measures aimed at trapping heat within the home. For example, upgrading insulation in homes with un-insulated attics could reduce residential natural gas consumption across the Midwest by about 2 percent.[15] Moreover, this measure would save energy at about 80 percent less than the retail cost of natural gas.[16]

DOE/NREL, Karen Doherty

Home weatherization measures, like proper insulation, can shave heating fuel use in a typical home by 20 percent.

In a typical home, air sealing, insulation and window replacements can reduce overall heating energy consumption by 20 percent.[17] Achieving a 20 percent average reduction in home heating energy consumption would cut statewide natural gas consumption by 7 percent, saving:[18]

- 64 billion cubic feet of natural gas in Illinois,
- 10 billion cubic feet of natural gas in Iowa, and
- 18 billion cubic feet of natural gas in Wisconsin.

Furnaces and Ducts

Furnaces and ducts provide an additional opportunity to improve the efficiency of space heating in homes.

Older furnaces that rely on a constantly burning pilot light can waste as much as 45 percent of the fuel they use.[19] In contrast, high-efficiency models can improve energy performance by 40 percent or more.[20] Considering that about one-quarter of all homes in the Midwest have furnaces that are 20 years old or older, the opportunity for energy savings is large.[21]

There are differences even among new furnace models. A high efficiency furnace (such as a model meeting Energy Star® standards) uses 20 percent less fuel than basic furnaces built to the minimum federal efficiency standard.[22]

If Illinois required that all new furnaces meet Energy Star® standards, in 2020 the state could save 14 billion cubic feet of natural gas.[23] The same action in Iowa would save 1.3 billion cubic feet of natural gas, and 2.5 billion cubic feet in Wisconsin.[24]

To put this in perspective, this amount of energy could meet the needs of:[25]

- 134,000 Illinois homes;
- 18,000 Iowa homes; and
- 33,000 Wisconsin homes.

The Midwest Energy Efficiency Alliance estimates that across a nine-state region, high-efficiency gas furnaces could reduce residential gas consumption by 5 percent below projected levels over a 20 year period.[26] Moreover, the cost of saved energy would be less than $1 per therm – well below recent residential natural gas prices.[27]

Many home heating systems also include fans, driven by electricity, that circulate warm air from the furnace through ducts. These fans are among the largest users of electricity in a typical U.S. home, consuming about 1,250 kWh of electricity per year, or about 12 percent of home electricity consumption.[28]

Stephen Gibson

A high efficiency furnace uses 20 percent less fuel than basic furnaces built to the minimum federal efficiency standard.

Inefficient fans in older furnaces can be replaced with more efficient models to save electricity. Energy savings on the order of 65 percent are possible, making furnace fan improvements one of the largest available opportunities for energy savings.[29]

By ensuring that all new furnace systems come with high-efficiency fans through a strong minimum efficiency standard, Midwest states could cut projected electricity consumption in 2020 by more than half a percent, saving:[30]

- 1,000 gigawatt-hours (GWh) of electricity in Illinois (enough to power 108,000 homes);
- 250 GWh in Iowa (enough to power nearly 25,000 homes); and
- 500 GWh in Wisconsin (enough to power 58,000 homes) in 2020.

Ductwork that carries warmed air throughout a home offers another opportunity for efficiency improvement. Repairing and sealing the ductwork can reduce heating energy use in a typical home by 15 percent.[31]

Additional savings are possible with improved home heating system controls such as programmable thermostats. These thermostats – which allow residents to match their heating energy use more closely with their actual needs – are very cost-effective. Energy saved through a programmable thermostat is more than 80 percent less expensive than the retail cost of natural gas.[32] Less than half of Midwestern homes use high-efficiency thermostats.[33] Installation of high-performance thermostats across the Midwest could reduce residential natural gas consumption by about 1 percent below projected levels.[34]

Finally, renewable energy technologies like passive solar heating or geothermal heat pumps can add to potential energy savings in the home heating sector. These technologies extract heat from the sun or from the ground to help maintain a comfortable home environment.

New Home Construction

New home construction offers another opportunity to reduce residential energy consumption. By including the most efficient appliances and equipment, implementing quality construction practices, and incorporating high-efficiency design, new homes can be built to use substantially less energy than older homes.

For example, the Alliance to Save Energy estimates that implementing and enforcing the most recent and most effective building energy codes for residential and commercial buildings nationwide could save 0.85 quadrillion BTU (quads) of energy annually by 2020 – or about 2 percent of the total energy consumed in homes and businesses in 2005.[35]

But requiring new residential construction to meet current energy codes is just the tip of the iceberg for the energy savings that can be achieved in new homes. New homes meeting federal Energy Star® energy efficiency standards provide energy savings of at least 15 percent compared with the most recent (and most stringent) residential model building code.[36]

Nationally, 12 percent of new homes in 2006 were built to Energy Star® specifications.[37] Iowa has an exceptionally high participation rate, with 57 percent of new homes built in 2006 meeting the Energy Star® standard. However, Wisconsin (less than 11 percent) and Illinois (less than 3 percent) are lagging behind. By improving the penetration of Energy Star® homes, every Midwest state could reduce electricity and natural gas usage in the residential sector.

Improvements beyond Energy Star® performance are possible. Builders in parts of the country are now constructing "zero-energy homes" in which fossil fuel purchases are virtually eliminated. (See "Zero-Energy Homes" on page 15.)

Water Heating

Water heating accounts for about 14 percent of energy use in a typical Midwestern home (mostly in the form of natural gas).[38]

According to the Midwest Energy Efficiency Alliance, more than two-thirds of water heaters in Midwestern homes are low-efficiency models.[39] Improving the efficiency of home water heaters can lead to significant energy savings.

Several approaches could be used to improve water heater efficiency. By setting the thermal control for the water heater no higher than 120 degrees Fahrenheit, energy savings on the order of 10 percent are possible.[40] For older water heaters with inadequately insulated water storage tanks, adding an insulated cover can result in additional energy savings. Insulating hot water pipes where they may be exposed can further reduce water heating energy use.

New technologies promise more substantial efficiency gains. For example, condensing gas water heaters, similar to the highest efficiency gas furnaces, can heat water at fuel use efficiencies greater than 80 percent (compared to around 60 percent for a standard water heater).[41] Tankless water heaters, which heat water as it is needed, can offer similar performance gains.[42]

In addition, appliances that use less hot water – such as front-loading clothes washers or low-flow shower heads – can help reduce energy use.

Technologies that also use renewable energy to heat water can provide far greater levels of fossil fuel savings. Heat pump water heaters, for example, use less than half as much electricity as traditional electric water heaters.[43] Solar water heating systems, which use roof-mounted solar energy collectors to pre-heat water, can reduce electricity or fossil fuel use for water heating by about two-thirds.[44] Solar water heating systems can yield enough fuel savings to repay the cost of installing the system in about 8 -10 years, and return profit for at least another decade afterward. Through the end of 2008, the federal government also offers a tax credit equal to 30 percent of the cost of installation.[45]

Brad Bennie

Solar water heating systems can reduce electricity or fossil fuel use for water heating by about two-thirds.

Lighting

Lighting accounts for about 9 percent of electricity use in the average Midwest home.[46] However, much of this energy is wasted. For example, conventional incandescent light bulbs waste about 90 percent of the electricity they use, acting as expensive electric heaters. Only 10 percent of the energy drawn by the bulb actually becomes useful light.[47]

By replacing older lighting technologies with newer, more efficient products, significant energy savings can be realized. Some of those technologies, including compact fluorescent lighting and passive solar design, are explored below.

Compact Fluorescent Lighting

Compact fluorescent light bulbs (CFLs) can replace conventional incandescent bulbs for most applications inside the home. CFL bulbs have reached the status of a mainstream technology and can be easily found in stores across the country. The bulbs are easy to install, screwing into the same light sockets as conventional bulbs.

Craig Jewell

If every household in the Midwest installed 5 compact fluorescent light bulbs like these in place of conventional bulbs, we could cut household lighting energy use by one-quarter.

Compact fluorescent light bulbs are vastly more efficient than traditional incandescent bulbs – producing the same amount of light while consuming up to 75 percent less electricity.[48] Moreover, CFLs last up to 10 times as long before burning out.[49]

If every household in the Midwest replaced five incandescent light bulbs with Energy Star® certified CFLs, it would reduce electricity use for home lighting by about 25 percent.[50] (Most households could replace more than five bulbs with efficient models. Some estimates place the potential residential lighting energy savings at more than 50 percent.[51])

The simple step of replacing five incandescent bulbs with CFLs in every home would reduce overall residential electricity use in the Midwest by more than 2 percent, saving: [52]

- 1,140 GWh per year in Illinois (enough to power 120,000 homes);
- 300 GWh per year in Iowa (enough to power about 30,000 homes); and
- 520 GWh per year in Wisconsin (enough to power more than 50,000 homes).

The Midwest Energy Efficiency Alliance estimates that across the nine-state Midwest region, CFLs could reasonably reduce electricity consumption by 5,800 GWh per year, or about 1.6 percent of forecasted electricity consumption in 20 years. Bulbs that are used 2.5 to 6 hours per day save energy at a cost between 1.2 and 2.3 cents per kilowatt-hour – on the order of 75 percent less than retail electricity prices.[53]

Passive Solar and Solar Tubes

Designing or retrofitting buildings to take better advantage of natural sunlight can also be an effective strategy to reduce electricity use for illumination.

Orienting buildings to effectively capture available sunlight using windows and skylights can increase the amount of daylight available inside a home. For interior spaces without access to a window, a rooftop solar collector coupled to interior lights via a solar tube can provide light during daytime hours.

Residential Roofing

Solar tubes act like skylights, transmitting daylight into interior spaces without the need for electricity.

Zero Energy Homes

"Zero-energy" homes are designed to produce about as much energy as they use, requiring very little fossil fuels to function. Zero-energy homes typically combine an array of energy-saving technologies with small-scale renewable energy production. Typically, zero-energy homes use between 60 and 90 percent less energy than a conventional home. Energy saving features can include technologies like:

Net Zero Energy Home Coalition

The Avalon Discovery II home produces as much electricity as it consumes.

- Fluorescent lighting;
- Enhanced insulation, such as foam-wrapped building envelopes;
- Energy-efficient windows;
- Tankless water heaters;
- High-efficiency furnaces and programmable thermostats;
- Cool roof coverings that reflect heat away from the home and reduce cooling needs;
- Tight seals on ducts, windows and doors; and
- Efficient Energy Star®-rated electric appliances.

The balance of the home's energy needs can come from rooftop solar panels, geothermal heat pumps, or other small-scale renewable energy installations.

Near-zero-energy homes are becoming increasingly common and have the potential to dramatically reduce all forms of residential energy consumption. For example:

- In 1999, the U.S. Department of Energy's Building America Program sponsored the construction of Prairie Crossing homes in Grayslake, Illinois. The 315 homes included an advanced insulation system that improve the heating and cooling efficiency of the home by 50 percent compared to a 1993 model home (and roughly double the efficiency of a standard Chicago home).[69]
- Veridian Homes built a prototype near-zero-energy home in the Grandview Commons neighborhood in Madison, Wisconsin in 2005. The home incorporates a variety of advanced features, including high-grade insulation, Low-E insulated windows, a programmable thermostat, a solar hot-water system, 100 percent compact fluorescent lighting, and Energy Star® certified appliances.[70]

Retrofitting an existing home to near-zero energy performance can yield a return on the investment in as little as seven years.[71] Moreover, the added features can significantly increase the resale value of the home.[72]

Appliances

Appliances in Midwestern homes use electricity or natural gas to help with household chores like cooking and laundry, provide entertainment through television and movies, or help to keep computer and cell phone batteries charged and working. The vast majority of these appliances can be made significantly more energy efficient.

The biggest energy-consuming appliances in most homes are refrigerators and freezers, which consume 20 percent of residential electricity.[54] Federal efficiency standards for refrigerators have resulted in vast improvements in energy efficiency over the last three decades. (For example, the average refrigerator sold today uses one-third as much electricity compared to the average unit from 1974, despite an increase in average size and performance.[55])

However, significant improvements in energy efficiency are still possible by replacing older models with new, high-efficiency models. For example, refrigerators meeting Energy Star® standards require about half as much energy as models manufactured before 1993.[56] More than one-third of refrigerators in Midwestern homes and more than half of freezers are greater than 10 years old – representing a significant opportunity for electricity savings.[57]

David Jones

Efficient appliances, like this front-loading washing machine, can do the same jobs with less energy.

Similar gains are possible for other electronic appliances, including media appliances like televisions, stereos, DVD players and computers – which account for about 7 percent of household electricity consumption.[58] For example, many of these appliances continue to consume power even after they are turned off. One study of 10 homes in California found that consumption of standby or "vampire" power accounted for between 5 and 26 percent of the homes' annual electricity use.[59] Replacing existing appliances with those that minimize standby power use could reduce these losses by 68 percent.[60]

Adopting minimum energy efficiency standards for just three appliances, including stereos, CD players and power supplies (used for laptop computers, cell phones and related electronics), would save (in the year 2020):

- 300 GWh in Illinois (equivalent to the electricity needs of 32,000 homes);
- 77 GWh in Iowa (equivalent to the electricity needs of more than 7,000 homes); and
- 135 GWh in Wisconsin (equivalent to the electricity needs of more than 13,000 homes).[61]

Similar improvements could reduce the electricity use of kitchen appliances (now about 10 percent of household electricity use), laundry appliances (7 percent) and other appliances (12 percent).[62]

Air Conditioning

Air conditioning in the Midwest accounts for 4 percent of overall residential energy use. Efficiency improvements are possible that could reduce energy use for cooling,

and the need for cooling in general.

Because of recently adopted energy standards for air conditioners, new models will offer efficiency improvements on the order of 30 percent.[63] However, some manufacturers already produce models that outperform this new standard by 15 percent or more.[64]

The market share of high-efficiency air conditioning systems is low across most of the Midwest – estimated at roughly 24 percent. In Iowa, 74 percent of air conditioners are high-efficiency, due to the effect of utility-run efficiency programs. However, only 10 percent of the market is made up of the most efficient models.[65]

Further savings can be achieved by training contractors to ensure that new air conditioners are properly sized and correctly installed, and by sealing and repairing ductwork.[66]

Additionally, implementing changes in building design and appropriate weatherization can reduce the need for air conditioning. For example, light colored "cool roofs" that reflect sunlight rather than absorb heat can reduce cooling energy use by up to 40 percent.[67] Planting shade trees around a home, or even planting a "green roof" with living plants can have a similar effect.[68]

Energy Efficient Businesses and Industrial Facilities

Business and industry in the Midwest also hold great potential for energy efficiency improvements.

Many of the same strategies that are available for reducing residential energy use also apply – on a much larger scale – to commercial buildings (including office buildings, schools, hospitals, retail stores and related buildings). For example, comprehensive energy efficient retrofits for commercial buildings can achieve energy savings on the order of 11 to 26 percent.[73] To give some idea of the potential, Wal-Mart, the nation's largest private electricity user, recently pledged to reduce energy consumption at its stores by 20 percent and has committed to developing a prototype store that curbs energy consumption by 25 to 30 percent.[74] Because commercial buildings are major consumers of energy (accounting for roughly one-third of electricity consumption and about 20 percent of natural gas consumption in the Midwest), such efficiency measures can make a real difference.[75]

Industrial facilities can take advantage of energy efficiency measures as well, using advanced motors, improvements to manufacturing processes, and technologies to improve thermal efficiency – plus many of the lighting and environmental control measures applicable in homes and businesses. Industrial facilities (accounting for more than one-third of electricity and natural gas consumption in the Midwest) are an important area of focus for energy efficiency promotion.[76]

Flickr:hanneorla

One Dearborn Place, an office building in Chicago, has been certified LEED Silver by the U.S. Green Building Council in recognition of its energy-efficient design.

Children's Hospital of Central California

High-efficiency overhead lighting systems can reduce lighting energy use by up to 70 percent, while improving light quality.

Efficient Lighting

Lighting accounts for more than 40 percent of electricity use in commercial buildings.[77] However, much of this energy is wasted as heat.

By replacing inefficient and over-powered lighting with state-of-the-art lighting systems, overall energy consumption for lighting could be reduced by up to 40 percent.[78]

Achieving this level of savings in commercial buildings would reduce overall electricity consumption:

- by more than 5 percent in Illinois, saving 8,000 GWh per year;
- by about 4 percent in Iowa, saving 1,800 GWh per year; and
- by about 5 percent in Wisconsin, saving 3,600 GWh per year.[79]

Energy savings at this level are equivalent to about 5 percent of current total electricity consumption in Illinois and Wisconsin, and about 4 percent of current total electricity consumption in Iowa.[80]

Overhead Lighting for Offices and Schools

Office buildings and schools are often lit by overhead lighting panels with four fluorescent tubes. Replacing these lights with more efficient sockets and special thin-diameter lamps can reduce lighting energy consumption by about one-third. Further energy savings are possible by reducing the number of lamps in the fixture by one or two, and including special reflectors to optimize the distribution of light from the fixture – leading to energy savings of up to 70 percent.[81] State-of-the-art overhead lighting systems can also improve worker productivity (by providing more consistent light and reduced glare).[82]

LED and Halogen Lights

In locations where incandescent bulbs are used (such as the display window of a storefront), replacement lighting systems are available using efficient halogen spotlights, which consume less than half the energy and lasts twice as long.[83]

For specialized applications, like exit signs, traffic lights, airport runway lights, etc., light emitting diodes offer an energy-saving alternative to incandescent lights. Since an LED directly converts electricity to light, it wastes very little energy as heat. LEDs also produce a narrower beam of light, making them ideal for fixtures where the light needs to be directional. For example, LED traffic lights consume up to 90 percent less energy and last more than 10 times as long as traditional incandescent versions.[84]

Passive Solar

In buildings and manufacturing centers with relatively easy access to the ceiling, solar tubes can be installed, much like in homes, to increase natural sunlight available in the building during daylight hours – providing lighting with no energy

consumption whatsoever. Office buildings can also be strategically designed to increase the amount of daylight available through windows, reducing energy needs for lighting.

Improved Controls

Finally, installing improved controls over lights (such as motion sensors and timed lighting in bathrooms and closets, or building-wide timers to turn off lighting systems after hours) can reduce the use of electricity for lighting.

Heating, Ventilation and Cooling

Maintaining a comfortable environment inside businesses and industrial facilities in the Midwest accounts for about 21 percent of electricity demand in the commercial sector and 9 percent in the industrial sector.[85]

Just as residential furnaces and air conditioners can be made more efficient, so too can heating, ventilation and cooling (HVAC) systems in larger commercial buildings. Opportunities for improvement are available in replacing single-speed drives for fans and pumps with more efficient variable-speed drives; using boilers and chillers with higher thermal efficiency; and using customizable controls to fully optimize the interior climate without wasting energy.

Variable Speed Motors

Many motors driving fans and pumps in a building HVAC system are sized to be large enough to meet the maximum demand for power at any given time. However, they only run at one speed – wasting energy whenever the load on the motor is less than 100 percent. These systems are like "driving a car with the accelerator pushed to the floor while controlling the vehicle's speed with the brake."[86]

Inefficient motors can be replaced with variable speed technology, which uses electronic circuitry to allow the motor to operate efficiently over a wide range of speeds. Variable speed motors are better able to match their output to the actual needs of the HVAC system – reducing electricity consumption by 50 percent or more.[87]

Efficient Boilers, Furnaces and Chillers

Boilers produce steam and hot water to heat buildings or facilitate manufacturing processes. Significant improvements in efficiency – roughly 15 to 19 percent – are possible for oil and natural gas boilers.[88] Moreover, opportunities to integrate boilers and chillers with on-site electricity generation through combined heat and power (CHP) technology offer significant additional potential for efficiency gains. (See "Combined Heat and Power" on page 21.)

Improved Controls

Improving control over building environmental controls can conserve energy. For example, ensuring that air conditioning and fans are turned off when they are unnecessary can save significant amounts of energy at very little cost.

Efficient Industrial Motor Systems

Industrial facilities also rely upon motors to do physical work as part of manufacturing or processing materials. Industrial motors draw huge amounts of electricity, accounting for about 50 percent of consumption in the Midwestern industrial sector and 17 percent overall.[89]

Upgrading motors (and the equipment they drive) to more efficient technology can save significant amounts of energy. The use of high-efficiency motors and better controls in the industrial, electricity

generation and commercial sectors could reduce *total* U.S. electricity demand by as much as 15 to 25 percent.[90]

Motor systems can be made more efficient in a variety of ways, including:

- Maintaining equipment in proper working order and ensuring that it is sized correctly.[91]
- Improving the quality of electricity delivered to the system and increasing the size of wiring to reduce electricity loss.[92]
- Using variable speed motors, which can precisely match their energy use to the needs of the industrial process. Variable speed motors yield the greatest savings when driving pumps or fans, but still provide savings in the range of 15 to 40 percent for applications with more constant speed demands, like moving a conveyor belt.[93]
- Purchasing motors made with high-quality materials, which are more efficient and have longer lifetimes than models built to lower standards. Many types of motors on the market exceed minimum federal efficiency standards, but they make up a relatively small portion of sales. [94]
- Using computerized controls to optimize the efficiency of a manufacturing process.[95]

Tapping into these opportunities can greatly reduce industrial electricity use, while also increasing the reliability and productivity of equipment.

Industrial Process Improvements

Changing a manufacturing or industrial process at a macro-level to improve efficiency can yield huge energy savings, while also saving materials and labor costs. Using a technique called "pinch analysis," engineers can estimate the minimum amount of energy theoretically required at a given facility and make adjustments to processes in order to maximize energy efficiency. Such analyses can reduce energy costs by as much as 40 percent.[96]

Table 1: Commercial and Institutional Buildings with the Greatest Market Potential for CHP[106]

Location	Illinois		Iowa		Wisconsin	
	MW	Percent of Total Potential	MW	Percent of Total Potential	MW	Percent of Total Potential
Office Buildings	494	18%	159	23%	302	21%
Schools	533	19%	153	22%	68	5%
Hospitals	392	14%	87	13%	173	12%
Nursing homes	334	12%	66	10%	267	19%
Hotels	246	9%	37	5%	76	5%
Colleges and Universities	229	8%	68	10%	69	5%
Health Clubs and Spas	133	5%	17	2%	53	4%
Correctional Facilities	88	3%	16	2%	50	4%
Extended Service Restaurants	115	4%	12	2%	44	3%
Total Potential	**2,773**	**100%**	**682**	**100%**	**1,420**	**100%**

For example, carpet manufacturer Bentley Prince Street, based in Los Angeles, California, undertook comprehensive reform of its manufacturing process, switching to a pattern printing technology with superior energy and material requirements. The company has reduced the cost of manufacturing a unit of carpet by 48 percent since 1994, while also reducing its contribution to global warming by more than 75 percent.[97]

In Wisconsin, American Foods Group worked with efficiency experts at the Focus on Energy program to implement 16 different energy-saving projects. The company spent $74,000 to purchase and install more efficient technology and adjust operations to improve efficiency – saving more than $140,000 on energy in the first year alone. In the process, the company identified and is pursuing 11 more projects to further improve production efficiency, with savings estimated at $900,000 per year.[98]

Combined Heat and Power

Industrial facilities, commercial building complexes, and large apartment buildings can save large amounts of energy by using combined heat and power (CHP) technologies. CHP systems consist of an on-site generator which produces electricity for a facility, and equipment that captures the waste heat from electricity generation to warm buildings or power industrial processes. CHP systems can reach 70 to 90 percent thermal efficiency – a huge gain over the 33 percent average efficiency of today's power plants.[99]

Many industrial facilities and institutions like colleges and universities already use CHP. For example, Beloit Memorial Hospital in Beloit, WI installed a CHP system while upgrading its electrical distribution system in the 1990s. The CHP technology allows the hospital to provide its own electricity, and heat for internal hospital systems, at between 1.8 and 2.3 cents per kWh (2002 dollars).[100] The University of Illinois at Chicago installed a CHP plant on the East Campus in 1993, and expanded the system in 2000. The CHP system reduced energy use for electricity and heating on the campus by about 15 percent. Following these successes, the university installed a larger CHP plant on its West Campus, expecting to save $7 million per year on energy as a result.[101]

However, the potential for growth – and thus for greater energy savings – is enormous.

Studies conducted for the U.S. Department of Energy found an industrial market potential of more than 6,000 MW in the East North Central census region (Wisconsin, Illinois, Indiana, Michigan and Ohio), rising to more than 10,000 MW in a future scenario with advances in microturbine technology.[102] Nationally, the study estimated that industrial CHP deployment had reached only one-third of its market potential by 2001, and less than a quarter of its future potential.[103]

Additionally, the studies found that penetration in commercial and institutional buildings was extremely low outside of colleges and universities, and that use of CHP was much lower than in the industrial sector.[104] Nationally, the studies found a technical potential for 77 GW of CHP capacity, with significant potential in the Midwest.[105] Table 1 lists the largest areas of commercial and institutional potential for CHP in Illinois, Wisconsin and Iowa.

At full market penetration, CHP would equal about 10 percent of America's current electric generation capacity, and technological improvements could allow CHP technologies to spread even farther in the years to come.[107] As of January 2006, CHP accounted for 9 percent of all electric generating capacity in Wisconsin, 4.1 percent in Iowa and 2.8 percent in Illinois.[108]

The Next Wave: Green Buildings

Just as is the case with residential buildings, there are a wide variety of technologies available to reduce energy use in businesses and industry. But in some key ways, commercial and industrial buildings may hold greater opportunities for efficiency improvements through the application of professional management and analytical techniques to reduce energy waste that may be hurting a company's bottom line. Many businesses have saved large amounts of energy by undertaking a thorough analysis of how energy is used in their facilities and applying appropriate technologies and practices to minimize energy consumption.

The potential for cutting-edge technology and smart thinking to dramatically reduce energy consumption in buildings and industry is epitomized by the current drive in the American architecture community to encourage "green building" techniques.

Interest in "green buildings" has mushroomed in recent years among companies and government agencies seeking to improve their environmental performance. Green building certification programs such as Leadership in Energy and Environmental Design (LEED) have come to be seen as an important symbol of an organization's environmental commitment. The number of LEED-certified buildings nationwide approximately doubled in 2005 alone.[109]

Now, a group of architects is working to ensure that all new commercial buildings meet exacting energy efficiency criteria. The American Institute of Architects has set a goal of reducing fossil fuel use in the construction and operation of new buildings by 50 percent by 2010, with additional 10 percent reductions in fossil fuel use every five years beyond then.[110] Similar transformative potential may also be possible in industry by reconsidering product design, product flows and industrial facility design in order to reduce the use of feedstocks and minimize energy waste.

The number of LEED-certified buildings doubled in 2005.

Energy Efficient Agriculture

Energy costs account for about 10 percent of the average farmer's budget – much higher than for typical industrial businesses.[111] Since operating margins for farmers (especially small-scale farmers) are typically under 10 percent, improving energy efficiency can be an important way to increase financial success.

There are a variety of opportunities to save energy on farms. In the fall of 2004, the Quantum Dairy Farm in Weyauwega, Wisconsin began investigating ways to improve efficiency as part of a large expansion.[112] The principal owner of the farm, Richard Wagner, worked with Wisconsin's Focus on Energy program to identify potential energy saving measures. Focus on Energy recommended installing three scroll compressor units, two refrigeration heat recovery units, a plate heat exchanger, a variable frequency drive vacuum pump, and higher efficiency gas water heaters in place of electric versions.[113]

The plate heat exchanger lowers the temperature of the milk, using well water, before it reaches the storage tank where cooling used to occur. Cows then drink the water while they produce more milk. The heat exchanger reduced electricity use substantially, saving more than $10,000 in annual electricity costs.[114]

Using a variable frequency motor in the vacuum pump system that helps to milk cows and move milk, water and sanitation

agents, also offered significant efficiency improvements. Conventional vacuum pumps are typically sized to be large enough to maintain suction, even when a milking unit accidentally drops off a cow and allows air into the system. The motors driving the pumps always run at full speed, and external controls regulate the vacuum pressure in the system. This setup wastes a great deal of energy.[115]

Replacing a vacuum pump system with a variable frequency motor, which can tailor its operational speed to the moment-to-moment needs of the vacuum system, can cut energy use by 50 to 80 percent.[116] The variable frequency drive installed at Quantum Dairy Farm saves $5,600 worth of electricity annually.[117]

The refrigeration heat recovery systems capture heat from milk refrigerators and harness it for other uses on the farm. The systems save the farm about 2,500 therms of liquid petroleum a year, worth about $3,500.[118]

After installing the improved equipment, Quantum Dairy Farm is saving almost $24,500 on energy costs annually. The savings fully paid back the additional cost of the equipment in about 1.4 years.[119]

Since Wisconsin's Focus on Energy began in 2001, it has worked with about 1,500 dairy farmers to implement energy saving measures. The steps taken by the program annually save 74 million kWh of electricity and 1.4 million therms of natural gas. As a result, participating farms are saving more than $10 million per year on energy costs. [120]

Focus on Energy

Quantum Dairy Farm installed a pump with a variable frequency drive, which saves $5,600 worth of electricity annually.

However, nearly 10,000 eligible farms have not yet worked with Focus on Energy. The potential for improved agricultural energy efficiency in Illinois and Iowa is similarly large. According to the American Council for an Energy-Efficient Economy, farms across the United States have the potential to save hundreds of millions of dollars in natural gas, electricity, and other non-transportation fuel costs.[121]

Moreover, the federal government allocates funding for energy efficiency through the Farm Bill to states that have technical assistance programs and energy experts available to use the money.[122] By increasing efforts at agricultural energy efficiency, Midwestern states could potentially leverage a greater share of Farm Bill energy funding.

How Midwest States Are Capturing (and Missing) Efficiency Resources

Despite the fact that energy efficiency measures are cheaper than increasing supply, they often don't compete on equal footing with measures to increase energy supply. Market barriers (including lack of consumer awareness, the up-front cost of efficient technologies, and split incentives between builders and buyers) often block the full penetration of efficiency measures into the marketplace.

To overcome these market barriers, Midwest states have created a variety of policies and programs that capture energy efficiency opportunities. For example, In July 2007, the Illinois General Assembly passed legislation that could stabilize electricity demand within six years. Iowa requires its investor-owned electric and gas utilities to create and implement energy efficiency plans, and has established strong energy codes for the construction of new homes and commercial buildings. And Wisconsin requires electricity and gas utilities to finance Focus on Energy, a program designed to reduce energy consumption by promoting efficiency and renewable energy.

While Illinois, Iowa and Wisconsin are climbing into the top third of U.S. states in terms of taking advantage of energy efficiency opportunities, no Midwest state is fully capturing its achievable energy efficiency potential. Gaps in efficiency policy fail to overcome key market barriers and thus allow some energy efficiency resources to go untapped.

If Energy Efficiency Makes So Much Sense, Why Aren't We Already Doing It?

There is an old joke in which two economists are walking down the street when one of them spies a $20 bill lying on the ground. He says to his friend, "Hey, there's a $20 bill on the ground!" To which the other economist replies, "That's impossible. If there were a $20 bill on the ground, someone would have already picked it up."

When it comes to energy efficiency in the Midwest, there are $20 bills lying all around us – good opportunities to reduce our environmental impact, curb our dependence on imported energy and boost our economy, all at the same time. Yet most of these opportunities currently go unrealized. Why?

Here are 10 reasons why economically beneficial energy efficiency investments aren't made as often as they should be:

1. Bad incentives – Utilities typically make more money through increasing sales of energy. For example, a 5 percent reduction in energy sales for an electricity generation, transmission and distribution utility could reduce its overall earnings by up to 25 percent. For a utility focused only on electricity distribution, such a reduction in sales could reduce its overall earnings by as much as half.[123] This sends a perverse signal that undercuts energy efficiency.

2. Split incentives – Often, the person who is the most logical candidate to install energy efficiency improvements is least likely to benefit from them. Consider landlords, who maintain buildings but whose tenants generally pay the energy bills. Or builders, who (in the absence of good consumer benchmarks (see #5), face incentives to minimize construction costs rather than make buildings as energy efficient as possible.

3. Missing incentives – Every consumer who saves energy reduces demand, which lowers the cost of energy for everyone. A homeowner who installs efficient lighting or an efficient furnace reduces the need for a new power plant or transmission wire, thus saving other ratepayers money. However, individuals who pursue clean energy

changes are rarely compensated for the benefits they deliver to the rest of society.

4. "Sticker shock" – Consumers often value lower sticker prices for products, appliances and homes, even when they can save money in the long run by purchasing more energy-efficient models. This is particularly true when it is hard to differentiate between the efficiency of two different products (#5) or when it is hard to predict future savings (#6).

5. Lack of knowledge – Even consumers who want to buy more energy efficient products sometimes find it difficult to tell which products are truly energy savers. While the Energy Star® program helps consumers make good choices for appliances and new homes, many products – including existing homes – are not "labeled" for their energy efficiency performance. In addition, consumers might not even be aware of new technologies that can tap renewable energy resources.

6. The "crystal ball" problem – Energy prices are notoriously volatile, making it hard for consumers and businesses to make educated decisions about future investments. Investing in a fuel-efficient vehicle, for example, appears a lot more attractive when gasoline prices are at $3 per gallon than when they are $1.50 a gallon. Yet, there is no guarantee that gasoline prices will remain high over any given period of time, thereby justifying the investment.

7. The "small potatoes" problem – For some businesses, energy costs are such a small part of their overall costs (compared, for example, to labor) that they attract little managerial attention. There may simply be no one whose job it is to look for ways to save energy cost-effectively – even when those opportunities exist. In addition, some businesses may lack access to capital to finance energy efficiency improvements.

8. Bureaucratic inertia – Bureaucracies are often slow to react when conditions in society change. Thinking of efficiency as a resource, rather than simply working to extract and use more fuel resources, is not yet adequately widespread. Old rules often favor supply-side measures. Renewable energy sources such as wind power and solar energy are fundamentally different from the big, central-station power plants that preceded them, and the old rules that applied to those power plants do not always function efficiently.

When it comes to energy efficiency in the Midwest, there are $20 bills lying all around us – good opportunities to reduce our environmental impact, curb our dependence on imported energy and boost our economy, all at the same time.

9. The "chicken and egg" problem – Billions of dollars have been invested over the years in building up the Midwest's energy and transportation infrastructure. These historical investments can make it difficult for new technologies to compete. For example, few people will buy a zero-energy home if builders are not producing them in adequate numbers. But builders won't produce them unless they perceive adequate demand. This "chicken and egg" problem discourages research and investment in technologies that can dramatically change the way we use or produce energy.

10. The "pain in the neck" factor – For some individuals, time is a more precious commodity than money. If installing a solar water heating system or making energy efficiency improvements is too hard or too time-consuming, only the most dedicated consumers will do it.

Public policy can play a critical role in surmounting these barriers. Government can establish mandates for energy efficiency and renewable energy, thus setting a high

"floor" for the penetration of clean energy in the economy. Government can also offer financial incentives, public education programs, energy audits and technical assistance to help individuals and businesses take advantage of their clean energy potential.

Current Efficiency Efforts in Midwest States

To overcome these market barriers, Midwest states have created a variety of policies and programs that capture energy efficiency resources. However, none of these policies fully capture cost-effective and available energy efficiency potential. A variety of gaps limit the ability to take advantage of energy efficiency opportunities.

Illinois

Illinois will capture a substantial amount of its electric energy efficiency resources through legislation that will halt rising demand for electricity by 2015. However, the state has no programs specifically focused on natural gas conservation and it has weak building energy codes to manage energy consumption in new buildings.

New Efficiency Legislation Takes a Large Step Forward

In July 2007, the Illinois General Assembly passed legislation requiring that electric utilities implement energy efficiency measures to reduce electricity demand annually by 0.2 percent in 2008, rising to 2 percent in 2015. If the measure is properly implemented and enforced, this requirement should halt growth in annual electricity consumption in Illinois by 2015.[124]

Before the passage of the new energy efficiency resource standard, Illinois operated an Energy Efficiency Trust Fund, which used money from a public benefits charge paid by electricity customers to promote energy efficiency measures. Separately, the Illinois Clean Energy Community Foundation, an organization created with a one-time payment by Commonwealth Edison, worked to promote energy efficiency and other environmental goals. However, the Energy Efficiency Trust Fund received only $3 million annually, and the Illinois Clean Energy Community Foundation spent about $11 million on energy efficiency on average each year between 2001 and 2006.[125] In 2006, Illinois ranked 25th out of all U.S. states in terms of per-capita spending on electric energy efficiency (excluding load management), and was unranked in terms of spending on gas efficiency, because it did not have a gas efficiency program.[126]

The new energy efficiency requirement will boost Illinois' spending on electric energy efficiency far above existing levels. According to an estimate by Commonwealth Edison, the new standard will save more than 1,000 GWh per year by 2011, with annual spending reaching $258 million by the year 2011. Moreover, the utility forecasts that the cost of saved energy will be only 2.5 cents per kWh – far less than the cost of energy from a new power plant.[127] (See "Energy Efficiency Programs Cost Less Than Building New Power Plants" on page 35.)

However, a Rate Cap Arbitrarily Limits Investment in Cost-Effective Efficiency Opportunities

The new law may not deliver all of these savings, however. The law includes a rate cap that limits investment in energy efficiency. If the implementation of the program increases electricity rates more than 0.5 percent per year, up to 2 percent total, the energy savings goals will be scaled back.

This rate cap arbitrarily limits investment in energy efficiency, even if further effort would yield greater savings for consumers.

Energy efficiency programs – even though they may require a slight increase in the per-kilowatt-hour cost of electricity – lower consumers' overall bills and reduce total future electricity system costs, thus saving everyone money in the long run.

Illinois Has No Statewide Goals for Natural Gas Conservation

Although the legislation passed in 2007 creating an aggressive electric energy efficiency program will go a long way toward saving energy in Illinois, the state still lacks statewide targets for saving natural gas. Although many measures designed to save electricity will also save natural gas, the overlap is not 100 percent. As a result, Illinois is allowing many gas-saving opportunities to pass by.

Ameren Illinois Utilities and Peoples Gas have individually proposed natural gas energy efficiency programs.

In January 2009, Ameren plans to begin offering customers incentives to install efficient appliances, equipment and other energy-saving measures.[128] Within a year, the utility expects to save enough natural gas to meet the needs of about 1,400 single-family homes, with savings growing steadily in future years.[129] And in February 2008, the Illinois Corporation Commission approved a plan by Peoples Gas to establish a $7.5 million per year conservation program, managed by an independent board.[130]

However, these programs are much smaller in scope compared to the state's new electric energy efficiency targets. A consistent, statewide natural gas saving target could coordinate efforts across utilities and more consistently capture opportunities to conserve energy resources.

Illinois Has Weak Building Energy Codes

Illinois is one of just a handful of states in the country that do not have a statewide residential building energy code.[131] More than 60 local jurisdictions, including the state's major population centers, have jumped in to fill the gap and adopted building codes. Approximately 30 communities have adopted the 2000 version of the International Energy Conservation Code (IECC) and 30 others have adopted the 2003 version. (The latest version of the IECC was released in early 2006 as IECC 2006.) Illinois could achieve greater energy savings in new home construction with updated, statewide building energy codes. According to the Pacific Northwest National Laboratory, adopting the IECC 2006 standard for residential buildings would save 3,380 GWh of electricity and 157 trillion BTU of natural gas through 2020.[132] This amount of energy could heat nearly 1.5 million Illinois homes for a year, and provide more than 365,000 Illinois homes with electricity.[133]

The state does have an up-to-date building energy code for commercial buildings. In October 2007, the state adopted the IECC 2006 energy conservation code.[134]

Iowa

Iowa is capturing some energy efficiency opportunities through its strong residential and commercial building energy codes and through energy efficiency programs operated by regulated electric and gas utilities. However, the state could increase the transparency, scope and scale of these programs – and increase emphasis on reducing energy consumption as opposed to merely redistributing electric loads away from peak times – to increase energy savings.

Strong Residential and Commercial Building Energy Codes

Iowa's residential and commercial building codes are equivalent to the 2006 International Energy Conservation Code (IECC)—the strongest model energy

code.[135] While efficiency improvements beyond the 2006 IECC are certainly feasible – (for example, a number of cities on Long Island, New York, have adopted building energy codes equivalent to Energy Star® performance) – this code helps Iowa builders to avoid missing opportunities to build efficient buildings from the start.[136]

Energy Efficiency Spending by Iowa's Electric and Gas Utilities

Iowa's regulated electric and gas utilities are required to file energy efficiency and load management plans with the Iowa Utilities Board under legislation passed in 1990.[137] The Iowa Utilities Board reviews and approves the plans, which were last filed in 2003.[138]

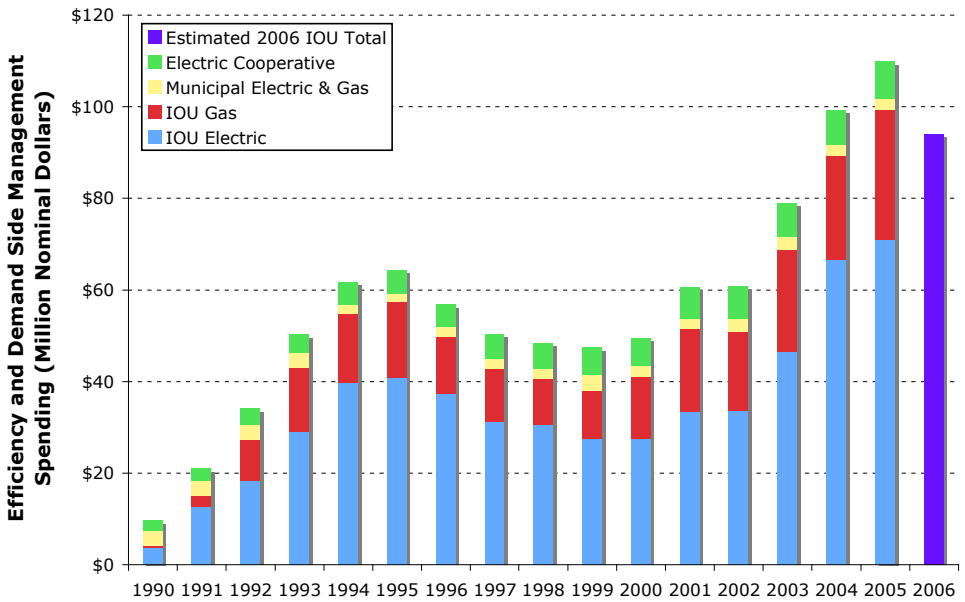
Utilities typically offer financial incentives for energy efficiency or shifting demand away from peak times, including loans and rebates for residential, commercial and agricultural customers to invest in energy efficient appliances and equipment. The Iowa Utilities Board uses four cost-benefit tests to determine the cost-effectiveness of efficiency plans. Programs must be cost-effective from the perspective of participating customers, the utility, the combination of utility and customers, and the impact on utility rates.[139]

Since investor-owned utilities' income is tied to energy sales, utilities have a greater incentive to pursue measures that do not reduce energy consumption (such as load management). Including consideration of lost revenues in the definition of cost-effectiveness limits the ability of Iowa's efficiency programs to reduce overall energy consumption.

Utilities spent increasing amounts on load management and energy efficiency through the middle 1990s, but uncertainty over utility restructuring led to reduced spending in the late 1990s. In 2002, the Iowa Utilities Board directed utilities to prepare new efficiency plans and prioritize efficiency resources. (See Figure 3.)

Iowa's utility efficiency programs now save about 2,000 GWh of electricity per year (equivalent to a reduction in 2005 elec-

Figure 3: Iowa Utility Spending on Efficiency and Load Management Programs Since 1990[140]



tricity consumption of about 4.5 percent), and 7 billion cubic feet of natural gas per year (a reduction in 2005 gas consumption of about 3 percent).[141] In recent years with increased spending levels, investor-owned utilities in Iowa are reducing electricity consumption by about 0.5 percent per year, and shrinking gas consumption by about 0.3 percent per year.[142]

In terms of per-capita spending on electric energy efficiency (excluding load management programs), Iowa ranked 9th out of all U.S. states in 2006.[143] In terms of per-capita spending on gas efficiency programs, Iowa ranked second.[144]

However, in 2006, nearly half of Iowa's spending on electric energy efficiency was directed to load-management as opposed to measures that reduce overall energy consumption.[145] Iowa could increase overall savings by increasing emphasis on reducing consumption in addition to shifting electric loads. Iowa could also increase savings by making efficiency programs mandatory for municipal and cooperative utilities, which now participate only on a voluntary basis.

Iowa could also improve its energy efficiency programs by increasing their transparency. For example, a group independent of the utilities should carry out regular audits of how effectively efficiency money is spent – identifying areas where improvements can be made.

Other Efficiency Initiatives

Iowa also runs several other efficiency initiatives, including the following:

- The Iowa Utilities Board is running a Weatherization Challenge, offering matching grants of up to $500 to local groups planning weatherization projects in their communities.[146]
- Under the terms of an executive order issued in 2005, state agencies operating in publicly owned buildings must reduce their energy use by 15 percent below 2000 levels by 2010.[147]

Wisconsin

Wisconsin is capturing many electric and gas energy efficiency opportunities through its Focus on Energy Program, but other potential savings measures remain untapped.

Focus on Energy

In 1999, the Wisconsin Legislature required investor-owned utilities to pay a portion of their revenues into a public benefits fund for energy efficiency, renewable energy and low income household assistance programs. Legislators gave municipal and cooperative utilities the option of participating in this statewide program, or creating their own "Commitment to Community" programs.[148]

The state restructured the public benefits fund in March 2006 to protect the fund from raiding for other purposes. Currently, investor-owned electric and natural gas investor-owned utilities are required to spend 1.2 percent of their annual revenues on programs to promote energy efficiency and renewable energy – either on their own, or using the statewide Focus on Energy program.[149] Focus on Energy offers technical and financial assistance to residential and commercial energy customers seeking to reduce energy use or develop small-scale renewable energy installations.

In fiscal year 2006, Focus on Energy spent $40 million, about one-third of the public benefit fund dollars collected. The program worked with more than 240,000 participants to save nearly 200 GWh of electricity (about 0.2 percent of annual consumption) and 13 million therms of natural gas (about 0.3 percent of annual consumption, primarily through energy efficiency, but also including renewable energy projects), saving participants more than $30 million per year on energy costs.[150]

In terms of per-capita spending on energy efficiency (excluding load management), Wisconsin ranked 15th out of all U.S. states

in 2006, and first in terms of per-capita spending on natural gas efficiency.[151]

Building Codes and Efficiency in State-Owned Buildings

Wisconsin has an energy code that governs energy efficiency in new residential and commercial buildings, but the code is relatively old. Residential buildings must comply with the 1995 Model Energy Code; only 10 states in the country have weaker codes.[152] Commercial codes are moderately stronger. New buildings must meet the 2000 International Energy Conservation Code, though newer versions of the code are available. A law passed in 2006 requires that the commercial building code be updated to a stronger version and that the code be further updated at least every three years.[153]

Wisconsin also requires that all new state-owned buildings comply with the Leadership in Energy and Environmental Design (LEED) standards and that existing state facilities reduce energy use per square foot by 10 percent by 2008 and 20 percent by 2010.[154]

What Level of Efficiency Savings Is Possible?

While Illinois, Iowa and Wisconsin rank well within the top third of U.S. states in terms of taking advantage of energy efficiency opportunities, no Midwest state is fully capturing its achievable energy efficiency potential.

So, exactly how much energy is it possible to save? There are three different ways to measure energy efficiency potential.

- **Technical Potential** is the sum of all technically possible energy saving measures, regardless of cost. Theoretically, technical potential should approach 100 percent, since there are always more measures that could be considered when money is no object – but most studies consider only a fraction of all energy saving measures to hone in on those most likely to be implemented.
- **Economic Potential** represents the total energy savings that could be achieved using all available energy efficiency measures that meet a cost-effectiveness test. Economic potential can vary greatly, depending on how one defines "cost-effective." More measures become cost-effective the higher the cost of energy becomes. More measures also become cost-effective with a wider consideration of the benefits of energy efficiency (at the narrowest level, a utility can benefit from avoided investments in infrastructure, and at the widest level, society benefits from reduced fuel costs and reduced environmental impact of energy use).
- **Achievable Potential** represents the total energy savings that an analyst believes are practical and achievable with a certain policy measure. Achievable potential estimates are narrower than economic potential, and are subject to additional assumptions about the effectiveness of efforts to increase the market penetration of a set of efficient technologies.

Several studies have quantified the size of the achievable efficiency resource in the Midwest, demonstrating substantial potential.

Midwest States

In 2005, the American Council for an Energy-Efficient Economy (ACEEE) performed an analysis of how energy efficiency measures could help address the natural gas crisis in the Midwest. ACEEE estimated that a "modestly aggressive but pragmatically achievable" energy efficiency

Table 2: Estimated Impact of ACEEE Energy Efficiency Campaign after 5 years (2005-2010)

State	Reduction in Gas Consumption	Reduction in Electricity Consumption
Illinois	4.2%	5.2%
Iowa	4.2%	4.6%
Wisconsin	4.9%	5.5%

campaign could reduce electricity and natural gas consumption by about 5 percent over five years.[155] (See Table 2.)

Illinois

In 2007, William Worek and Steffen Mueller at the University of Illinois at Chicago performed an analysis of Illinois' electric energy efficiency potential.[156] They broke down the state's electricity consumption by end-use, and then applied energy efficiency savings potential estimates from the Department of Energy's *Scenarios for a Clean Energy Future* to determine how much could be saved in each area.[157]

Worek and Mueller found that reaching 75 percent penetration for the energy saving technologies they considered would save Illinois about 28 million MWh in 2020 (or more than 19 percent of projected total electricity consumption in 2020).[158] Moreover, the pair found that achieving this level of energy efficiency would be more cost-effective (from a total resource perspective) than building new power plants to provide the same amount of energy.

Iowa

S.W. Hadley at the Oak Ridge National Laboratory performed a study for the Iowa Energy Center in 2001, estimating potential efficiency gains for a few narrowly defined uses of electricity. He found that minimum efficiency standards could reduce energy use for residential space cooling 20 percent by 2020, and for water heating by 14 percent by 2020.[159] In the commercial sector, modeling the impact of voluntary, market-based policies alone (and not more aggressive requirements), he found the potential for 12 percent energy savings in ventilation and lighting, 7 percent in refrigeration, 6 percent in water heating and 5 percent in space heating, all by 2020.[160]

Wisconsin

In 2005, the Energy Center of Wisconsin evaluated the achievable potential for electric energy efficiency in Wisconsin for the Governor's Task Force on Energy Efficiency and Renewable Energy.[161] The study limited its definition of "cost effective" measures to those that could save energy at costs less than the cost of electricity generation, excluding the cost of electricity transmission and distribution. (Including these additional costs would expand the amount of achievable efficiency potential).

The study found that over five years, an expanded efficiency program could:

- Reduce electric energy consumption by 0.5 to 0.7 percent annually; and
- Reduce natural gas consumption by 0.2 to 0.4 percent annually.[162]

At this level of savings, energy efficiency would defer the need for one electric power plant, save enough power to run 200,000 homes, and save enough natural gas for roughly 50,000 homes.[163]

The study found that the greatest achievable efficiency reservoirs included increased adoption of compact fluorescent bulbs in homes, lighting retrofits in commercial buildings, and improvements to compressed air and pump systems in industrial and commercial buildings.[164]

If the program were run for 10 years rather than five, the program would be more effective. At the 10-year horizon, the study found that an achievable efficiency program would:

- Reduce projected electricity consumption by 6 to 9 percent (7.6 percent); or 0.76 percent per year; and
- Reduce projected natural gas consumption by 3 to 5.2 percent (4.1 percent), or by 0.4 percent per year.[165]

The study concluded, looking at avoided costs of generation alone, that Wisconsin could sustain economically justified energy efficiency spending levels as much as three times higher than in fiscal year 2006, up to $121 million per year.[166]

Studies in Other Parts of the United States

Additional studies of efficiency potential in other parts of the U.S. suggest that even greater savings are possible:

- In 2004, the American Council for an Energy-Efficient Economy (ACEEE) reviewed a set of leading studies of efficiency potential nationwide, finding substantial potential for energy savings. ACEEE found that the median U.S. state could technically reduce electricity consumption by 33 percent and gas consumption by 40 percent.[167] Looking at measures that were both cost-effective and achievable, ACEEE found that the typical state could achieve electric energy savings of 24 percent below forecast levels within 20 years (at a rate of 1.2 percent per year) and gas savings of 9 percent (at a rate of 0.5 percent per year).[168]
- In 2004, Synapse Energy Economics estimated that nationwide, there are enough cost-effective energy efficiency resources to reduce electricity consumption by as much as 35 percent by 2020.[169]
- In 2002, the Southwest Energy Efficiency Project estimated that six states from Arizona to Wyoming could reduce projected electricity demand by 33 percent by the year 2020 (or close to 100,000 GWh/year).[170]

Midwest States Can Do More

The studies discussed above show that Midwest states can do more to improve their energy efficiency. Iowa and Wisconsin are reducing electricity consumption by less than half a percent per year, compared to achievable potentials higher than 1 percent per year. Illinois, while it recently passed a strong electric energy efficiency program, has no programs working to reduce natural gas consumption.

Increasing energy efficiency efforts in the Midwest will yield greater benefits for consumers and the environment.

Improving Efficiency Will Reduce Pollution and Benefit the Economy

By improving energy efficiency programs, Midwest states can save consumers money, create jobs, stimulate the local economy and reduce overall energy prices. In addition, Midwest states can prevent emissions of pollution that causes global warming and threatens our health.

Economic Benefits

Energy efficiency measures save consumers money on their electricity and gas bills, particularly in the long run. Moreover, energy efficiency reduces overall energy system costs – saving everyone money, even people who don't directly install energy efficiency measures. As a result, people and businesses have extra money to spend, which can stimulate the regional economy and create jobs.

Consumer Savings

Energy savings through efficiency directly translate into lower electricity and gas bills. These ongoing savings often far outstrip the increased cost of a higher efficiency light bulb, or a high-performance motor, delivering net savings over time.

For example, a homeowner will find that savings on electricity and replacement bulbs more than justify investing in compact fluorescent light bulbs (CFLs). Purchasing five CFLs requires an extra investment of $15 over the cost of incandescent bulbs. However, over the life of the CFL bulbs, a homeowner will save more than 2,700 kWh of electricity and pay $385 less on energy bills. The bulbs effectively pay for themselves in less than four months, and save the consumer $370 over their useful lifetime.[171]

If every household in Illinois replaced five incandescent bulbs with CFLs, residential electricity use would drop by more than 2 percent, saving consumers more than $100 million per year. Add in savings from reduced need to replace burnt-out bulbs, and savings rise to $200 million per year. Over the life of the bulbs, Illinois homeowners would save more than $1.7 billion.[172]

If the same action were taken in Wisconsin, annual savings would exceed $90 million, and life-cycle savings would approach $800 million. In Iowa, consumers would save more than $50 million per year, and a total of more than $400 million over the life of the bulbs.[173]

Other efficiency measures can have very quick payback times as well. For example, Energy Star® gas furnaces can pay back their additional cost in fuel savings over one to five years depending on equipment type – with savings throughout the remainder of their typical 18-year lifetime returning as profit.[174] Improved furnace fans can save a homeowner in a cooler climate (like the upper Midwest) on the order of 680 kWh per year, paying for themselves in about two years.[175]

Jake Levin

Energy efficiency reduces overall energy system costs – saving everyone money, even people who don't directly install energy efficiency measures.

Efficiency measures have the same effect for industrial, commercial and institutional customers. Low-hanging fruit (such as installing improved controls for building environmental systems) can often yield a return on investment as large as 1,000 percent. For example, Adobe Inc. reprogrammed the central air conditioner and water heater in its headquarters in San Jose, CA, to operate more efficiently and according to the actual needs of the building, yielding over $50,000 a year in energy savings at a one-time cost of $1,000.[176]

More complicated measures, involving structural changes to buildings or equipment, can still yield substantial savings. For example, the CHP system at Beloit Memorial Hospital in Beloit, WI, saves the hospital more than $200,000 on energy costs every year. The project paid for itself in about five years, providing additional revenue to use on other hospital projects.[177]

These savings add up quickly. For example, a policy designed to reduce growth in Iowa's electricity consumption to zero (plus to establish a 20 percent by 2020 renewable electricity standard) would save consumers more than $1 billion dollars over 14 years.[178]

Reduced Energy Prices

In addition to saving consumers money directly, reduced energy demand leads to lower energy prices.

> ***"We can't wait much longer for increased energy efficiency in this country."***[182]
>
> - Peter Molinaro,
> Vice President of Federal and State Affairs,
> Dow Chemical, January 2005

First, energy efficiency programs and renewable energy can reduce peak demand for electricity, reducing the need to use the most expensive sources of electricity (such as a peaking natural gas power plant), and protecting electricity consumers from the impact of fuel price spikes. As a result, these programs can have a stabilizing effect on the overall price of electricity.

Second, both energy efficiency and renewable energy reduce the demand for natural gas and ease the upward pressure on natural gas prices, saving gas consumers money which can then be reinvested in other parts of the economy, rather than spent on high-priced fuel imported from out of state.

Reduced natural gas prices are especially important for industries like Dow Chemical that require natural gas as a raw material to manufacture products.

Recent studies estimate that for every 1 percent reduction in national natural gas demand, natural gas prices fall by 0.8 percent to 2 percent below forecast levels.[179] Modeling the impacts of a hypothetical national renewable energy standard and energy efficiency effort in effect starting in 2003, the Lawrence Berkeley National Laboratory found natural gas bill savings with an estimated net present value as high as $73 billion through 2020.[180]

The Midwest Natural Gas Initiative, coordinated by the Midwest Energy Efficiency Alliance (MEEA), has a goal of decreasing natural gas consumption by 1 percent per year for five years in eight Midwestern states. According to an analysis by the American Council for an Energy-Efficient Economy, doing so will decrease wholesale natural gas prices by as much as 13 percent.[181]

Job Creation and Economic Stimulus

Money saved by consumers through efficiency programs can then be spent for

other goods and services, creating jobs and stimulating the local economy.

A variety of studies have attempted to quantify these impacts. For example:

- In 2001, researchers at the University of Illinois's Regional Economics Application Laboratory determined that a regional plan to boost energy efficiency would create 43,000 jobs in Illinois and increase the gross state product by $4.6 billion by 2020; plus 6,800 jobs and a gross state product increase of $300 million in Iowa; and 7,400 jobs and a gross state product increase of 2.7 billion in Wisconsin by 2020.[183]
- In 2005, researchers at the University of Illinois calculated that a set of policies designed to reduce electricity consumption in Illinois by about 16 percent in 2020 (plus expand renewable energy generation, CHP, and gasified coal) would create 191,000 new jobs in Illinois by 2020, plus increasing the income of Illinois residents by $5.5 billion and total economic output by $18 billion.[184] Three-quarters of the jobs stem from energy efficiency expenditures and savings.
- In January 2005, the American Council for an Energy-Efficient Economy estimated that the Midwest Natural Gas Initiative (a five-year regional energy efficiency program) would create more than 13,000 jobs in Illinois and more than 7,000 jobs in Wisconsin.[185]
- A 2003 study by the Tellus Institute for the World Wildlife Fund found that a suite of national-level clean energy policies would reduce electricity demand by 25 percent below projections and produce net energy savings of $100 billion annually by 2020.[186]

Efficiency programs can create productivity benefits as well, especially in the industrial sector. Investments that increase industrial energy efficiency can improve product quality, lower capital and operating costs, and increase employee productivity.[187] By increasing reliability and preventing power outages, efficiency programs can also create value for the economy. One recent study estimated the cost of power outages to U.S. businesses alone at between $104 billion and $164 billion per year.[188]

Energy Efficiency Programs Cost Less than Building New Power Plants

Energy efficiency measures cost much less than generating and delivering electricity or natural gas, especially given the dramatic increase in the cost of building new power plants that has occurred over the last year or so. Puget Sound Energy, in its 2007 Integrated Resource Plan, estimated that the cost of natural gas combined cycle plants had increased by 44 percent and the cost of natural gas to fuel those plants had increased by about 85 percent.[189] Similar cost increases have been documented for new coal and nuclear power plants in the United States and around the world.[190] Generation costs at new power plants now likely exceed 5 or 6 cents per kWh – with additional costs for transmission and distribution of the electricity, plus the environmental impact of fossil fuel combustion.

In contrast, energy efficiency measures reduce the need to build new power plants – and do so at much less cost. For example, Wisconsin's Focus on Energy Program is currently saving electricity at a cost of about 3 cents per kWh – compared to an average retail cost of electricity in 2005 of 7.5 cents per kWh.[191] On the natural gas front, Focus on Energy yields savings at about 18 cents per therm, while in 2005, delivery of natural gas cost at least $1 per therm.[192]

Estimates of energy efficiency potential in the Midwest also predict that efficiency programs achieve savings at less than half

the cost of generating electricity. For example, William Worek and Steffen Mueller at the University of Illinois at Chicago estimated that Illinois could reduce electricity consumption 19 percent by 2020 at a costs of saved energy from 1.6 to 4.8 cents per kWh.[193]

Other studies also find that energy savings can often be had at little cost:

- The Energy Efficiency Resource Task Force of Michigan's 21st Century Energy Plan estimates that over 8,000 GWh/year of energy savings in Michigan over the next 10 years can be achieved at a lifetime cost of only 2.57 cents per kWh.[194] In comparison, the cost of generating and delivering electricity in Michigan is about 6 cents per kWh.[195]
- In 2002, energy efficiency programs supported by public benefit funds in New England produced energy savings at an average lifetime cost of 2.4 cents per kWh.[196] In comparison, utilities in New England pay on the order of 9 cents per kWh to generate and distribute electricity, while customers themselves pay on the order of 10-11 cents per kWh for electricity service.[197]
- A study of potential efficiency measures in the Mountain West identified energy efficiency measures across all sectors of the economy that could result in electricity savings at an average cost of 2 cents per kWh (2000 dollars). The study concluded that the benefits of the efficiency measures exceeded their costs by more than 400 percent.[198]
- Commonwealth Edison forecasts that the cost of saved energy under the recently passed Illinois energy efficiency resource standard will be only 2.5 cents per kWh in 2011.[199]

Moreover, efficiency measures can be as simple and fast as replacing a light bulb – producing measurable impacts in very little time.

Environmental Benefits

In addition to consumer savings, reduced energy prices, job creation and increased economic productivity, energy efficiency can reduce global warming pollution and help create a cleaner, healthier future for the Midwest.

Reduced Global Warming Pollution

Energy efficiency measures are a critical tool to reduce global warming pollution in the Midwest.

On average, each megawatt-hour of electricity generated produces about 1,145 pounds of carbon dioxide in Illinois, 1,925 pounds in Wisconsin, and 2,007 pounds in Iowa.[200]

However, energy efficiency measures prevent the need to operate power plants, reducing global warming pollution. For example, researchers at the University of Illinois predict that reducing forecast electricity consumption by 16 percent in Illinois by 2020 would reduce carbon dioxide emissions by 33 million tons per year in 2020.[201]

Energy efficiency can make substantial cuts in global warming pollution possible. For example:

- If every household replaced five conventional bulbs with compact fluorescent lights, the annual global warming pollution prevented would be the equivalent of removing almost 90,000 cars from the road in Wisconsin, removing 50,000 cars from the road in Iowa, and 110,000 cars from the road in Illinois.[202]
- If all commercial buildings improved lighting efficiency by 40 percent, it would prevent global warming pollution at levels comparable to removing more than 300,000 cars from the road in Iowa, more than 600,000 cars in Wisconsin, and about 800,000 in Illinois.[203]

Reduced Soot, Smog and Mercury Pollution

Coal and natural gas-fired power plants emit air pollution, including soot-forming sulfur dioxide, smog-forming nitrogen oxides, and neurotoxic mercury.

Sulfur dioxide emissions from coal-fired power plants form fine soot particles in the atmosphere. When inhaled, these particles become lodged deep in the lungs where they cause a variety of health problems, including asthma, bronchitis, lung cancer and heart attacks.[204] Soot pollution from power plants is responsible for significant harm to public health in the Midwest. For example, soot in Illinois cuts short the lives of more than 1,000 people, and causes more than 30,000 asthma attacks annually.[205]

Fossil-fueled power plants also emit nitrogen dioxide, one of the primary ingredients in smog. Smog makes lung tissues more sensitive to allergens and less able to ward off infections.[206] It scars airway tissues.[207] Children exposed to smog develop lungs with less flexibility and capacity than normal. During high smog days, otherwise healthy people who exercise can't breathe normally.[208] Over time, smog exposure can lead to asthma, bronchitis, emphysema and other respiratory problems.[209]

Mercury emissions from coal-fired power plants and other industrial sources are making the fish in our lakes, rivers and streams unsafe to eat. Burning coal releases mercury into the air that eventually contaminates rivers and lakes, where bacteria convert it to a highly toxic form that bioaccumulates in fish. Mercury is a neurotoxin that is particularly damaging to the developing brain. In early 2004, EPA scientists estimated that women of childbearing age in the U.S. have levels of mercury in their blood that are sufficiently high to put one in six babies born each year at risk of learning disabilities, developmental delays and problems with fine motor coordination, among other problems.[210]

Kenn Kiser

Energy efficiency is an effective tool to prevent emissions of global warming pollution and health-threatening soot, smog and mercury pollution.

Health problems imposed by soot, smog and mercury have serious economic consequences for the Midwest. Beyond the loss of priceless years of healthy life, an unhealthy workforce is less productive.

Energy efficiency measures can help reduce power plant air pollution. By reducing electricity consumption, efficiency can reduce the time existing power plants operate and prevent the need for the construction of new plants. This can result in significant air pollution benefits. For example, researchers at the University of Illinois predict that reducing forecast electricity consumption by 16 percent in Illinois by 2020 would reduce soot-forming emissions by 150,000 tons per year, smog-forming emissions by 80,000 tons per year, and mercury emissions by 1,200 pounds per year in 2020.[211]

Additionally, Harvard researchers estimate that by simply retrofitting existing homes with improved insulation, reduced pollution would prevent 240 premature deaths, 6,500 asthma attacks, and 110,000 restricted activity days per year across the United States. Health care savings alone could total $1.3 billion per year.[212]

Policy Tools to Promote Efficiency

Despite the many benefits of energy efficiency, technologies and practices that waste energy are still commonplace in the Midwest. A variety of market barriers increase the difficulty of spreading the best approaches widely across homes, businesses and institutions.

A variety of effective public policy approaches can remove these market barriers and ensure that the Midwest takes advantage of its vast energy efficiency resources.

Midwestern states should strengthen their energy efficiency policies, with a goal of reducing overall energy use by 10 percent from today's levels by 2025. Specific recommendations for Illinois, Iowa and Wisconsin follow.

Illinois

To capture more of its energy efficiency resources, Illinois should:

- **Implement and enforce the recently passed energy efficiency resource standard**. This bill will require utilities to significantly reduce electricity consumption before building new power plants, and will greatly enhance Illinois' electric energy efficiency performance.
- **Remove the rate cap that arbitrarily limits investment in cost-effective efficiency opportunities.**
- **Create an analogous energy efficiency resource standard for natural gas utilities.** Illinois should create an analogous program to require natural gas suppliers to deploy energy efficiency measures, with an ambitious target of reducing natural gas consumption by 1 percent per year vs. projected levels, or more.
- **Eliminate obstacles to the use of combined heat and power (CHP).** States should ensure that their utility policies encourage the deployment of CHP, which would dramatically expand opportunities for industrial and commercial energy efficiency. States should allow:
  - Fair interconnection standards for connecting to CHP systems to utility distribution systems;
  - Favorable utility rate structures for CHP customers;
  - Reasonable exit fees when switching from utility electric service to a CHP system; and
  - Fair tax treatment for CHP equipment.
- **Set strong energy efficiency standards for household and commercial appliances.** Midwest states can and should enact energy efficiency standards for residential and commercial appliances where the federal government has failed to do so. States may also petition the federal government for a waiver to implement stronger energy efficiency standards for appliances subject to federal regulation. At least 10 residential and commercial appliances – ranging from commercial boilers to DVD players – are potential targets for immediate adoption of efficiency standards.[213]
- **Strengthen residential and commercial building energy codes and ensure that they are adequately enforced.** Building codes are a crucial leverage point in reducing energy consumption. State building codes regulate the construction of residential and commercial buildings and generally include

standards to ensure minimum levels of energy efficiency. Illinois should require new homes to be built to federal Energy Star® standards, and establish energy codes for new commercial construction that reduce energy consumption 25 percent beyond the 2006 International Energy Conservation Code. Illinois should have the authority to update the code once every three years at minimum. The state should also supply adequate funding and staff to enforce the building codes.

- **Create incentive programs for further progress.** Further progress can be made by encouraging businesses to go above and beyond minimum requirements, or to encourage consumers to adopt new technology. For example, the state could reward builders for constructing near-zero energy homes or commercial centers, or reward utilities that exceed energy efficiency targets. Additionally, the state could offer tax breaks or other financial incentives to encourage the installation of energy-saving technologies such as solar water heating systems.

Iowa

To capture more of its energy efficiency resources, Iowa should:

- **Increase energy efficiency savings targets.** Policy makers should set more ambitious mandatory targets for electricity and natural gas savings for investor-owned utilities, aiming to reduce electricity consumption by 2 percent and gas consumption by 1 percent per year, or more.
- **Require the participation of municipal and cooperatively-owned utilities.** Instead of asking smaller utilities to participate on a voluntary basis, Iowa should require participation. The state should also set ambitious but achievable savings targets comparable to those for investor-owned utilities.
- **Bolster transparency and accountability of utility-run energy efficiency programs.** The Iowa Utilities Board should require an annual audit of spending and effectiveness for utility-run efficiency programs, carried out by an independent organization. Increased transparency can help identify areas where program management can be improved.
- **Eliminate obstacles to the use of combined heat and power (CHP).** States should ensure that their utility policies encourage the deployment of CHP, which would dramatically expand opportunities for industrial and commercial energy efficiency. States should allow:
  - Fair interconnection standards for connecting to CHP systems to utility distribution systems;
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Midwestern states should set ambitious targets for electricity and natural gas savings.

Wisconsin

To capture more of its energy efficiency resources, Wisconsin should:

- **Increase energy efficiency savings targets.** Wisconsin should require its electric and gas utilities to increase their investment in energy efficiency programs. The state should translate its current public benefits fund spending requirements into specific targets for annual electricity and natural gas savings. These targets should aim to reduce annual electricity consumption by 2 percent and natural gas consumption by 1 percent per year, or more. The state should set parallel targets for both investor-owned and municipal and cooperative utilities.
- **Eliminate obstacles to the use of combined heat and power (CHP).** States should ensure that their utility policies encourage the deployment of CHP, which would dramatically expand opportunities for industrial and commercial energy efficiency. States should allow:
  - Fair interconnection standards for connecting to CHP systems to utility distribution systems;
  - Favorable utility rate structures for CHP customers;
  - Reasonable exit fees when switching from utility electric service to a CHP system; and
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Notes

1. Martin Kushler, Dan York and Patti Witte, American Council for an Energy-Efficient Economy, *Examining the Potential for Energy Efficiency to Help Address the Natural Gas Crisis in the Midwest,* ACEEE Report U051, 2005.

2. Energy Information Administration, U.S. Department of Energy, *Electric Power Annual 2005*, Retail Sales of Electricity by State by Sector by Provider (EIA-861), October 2006.

3. Energy Information Administration, U.S. Department of Energy, *Electric Power Annual 2005*, State Data Tables: 1990-2005 U.S. Electric Power Industry Estimated Emissions by State (EIA-767 and EIA-906), October 2006.

4. The residential sector accounts for 31 percent of electricity use in Illinois, Iowa and Wisconsin; and 45 percent of natural gas use in Illinois; 32 percent in Iowa and 35 percent in Wisconsin. Energy Information Administration, U.S. Department of Energy, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, 1 June 2007.

5. All estimates of residential energy consumption in this report refer to energy consumed on site and excludes energy losses during the generation and transmission of electricity. Energy Information Administration, U.S. Department of Energy, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004.

6. Midwest Energy Efficiency Alliance, *Midwest Residential Market Assessment and DSM Potential Study*, March 2006.

7. Ibid.

8. Energy Information Administration, U.S. Department of Energy, *2001 Residential Energy Consumption Survey Consumption and Expenditures Fuel Tables*, April 2004.

9. Ibid.

10. Ibid.

11. Martin Schweitzer, Oak Ridge National Laboratory, *Estimating the National Effects of the U.S. Department of Energy's Weatherization Assistance Program with State-Level Data: A Metaevaluation Using Studies from 1993 to 2005*, September 2005.

12. Energy Information Administration, U.S. Department of Energy, *2001 Residential Energy Consumption Survey, Table CE2-6u: Space-Heating Energy Consumption and Expenditures by Square Feet and Usage Indicators,* April 2004.

13. Illinois: Nearly one-third of homes were built before 1940, and nearly 80 percent before 1980. Iowa: Nearly one-quarter before 1940, nearly 80 percent before 1980. Wisconsin: Nearly one-quarter before 1940, more than 70 percent before 1980. U.S. Census Bureau, *Census 2000: Summary File 3, DP-4. Profile of Selected Housing Characteristics*, 2000.

14. See Note 6.

15. Ibid.

16. Cost of measure: $0.25 per therm. See Note 6. Residential retail natural gas prices in 2006 were about $1.25 per therm.

17. Jennifer Thorne, American Council for an Energy-Efficient Economy, *Residential Retrofits: Directions in Market Transformation*, December 2003.

18. Based on applying 20 percent savings to estimated fuel use for home heating (derived from regional residential heating end-use consumption percentage estimates contained in Note 8), and total residential gas consumption estimates: Energy Information Administration, U.S. Department of Energy, *State Energy Consumption, Price, and Expenditure Estimates (SEDS)*, 1 June 2007.

19. American Council for an Energy-Efficient Economy, *Consumer Guide to Home Energy Savings: Condensed Online Version, Heating Systems: Furnaces and Boilers*, September 2005.

20. Based on American Council for an Energy-Efficient Economy, *Consumer Guide to Home Energy Savings: Condensed Online Version*, downloaded from www.aceee.org/consumerguide/mostenef.htm, 22 May 2006.

21. Based on U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey*, Table HC3-1a, Space Heating by Midwest Census Region, April 2004.

22. See Note 20.

23. Steven Nadel et al., American Council for an Energy-Efficient Economy and Appliance Standards Awareness Project, *Leading the Way: Continued Opportunities for New Appliance and Equipment Efficiency Standards*, March 2006.

24. Ibid.

25. Annual natural gas needs of a household in each state estimated by dividing the 2006 residential consumption of natural gas in each state by the number of residential customers. See U.S. Department of Energy, Energy Information Administration, *Natural Gas Consumption by End Use* and *Number of Natural Gas Consumers*, updated 30 January 2008.

26. See Note 6.

27. The highest efficiency furnaces offer the most cost-effective natural gas savings, at costs of saved energy less than $0.60 per therm: Cost of saved energy: See Note 6. In comparison, residential natural gas prices in 2006 ranged around $1.20 per therm.

28. See Note 23.

29. Ibid.

30. See Note 23. Projected electricity consumption in 2020: 2005 total electricity consumption from Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007, projected to 2020 using growth rate for the East North Central census region (Illinois and Wisconsin) and for the West North Central census region (Iowa) in Energy Information Administration, U.S. Department of Energy, *Annual Electricity Outlook 2007 with Projections to 2030*, DOE/EIA-0383, February 2007. Savings translated into number of homes using 2006 residential electricity consumption divided by number of customers, per U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006*, 26 October 2007.

31. See Note 17.

32. The cost of saved energy through a programmable thermostat is about $0.17 per therm, compared to a retail price of natural gas on the order of $1.20 per therm: See Note 6.

33. See Note 6.

34. Ibid.

35. Total number from Joe Loper, et al., Alliance to Save Energy, *Building on Success: Policies to Reduce Energy Waste in Buildings*, July 2005; comparison based on U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 2005*, 27 January 2006. Comparison based on primary energy consumption, including electricity line losses.

36. U.S. Environmental Protection Agency and U.S. Department of Energy, *What Are Energy Star® Qualified New Homes?,* downloaded from www.energystar.gov/index.cfm?c=new_homes.hm_earn_star, 2 October 2006.

37. Energy Star®, *Energy Star® Qualified New Homes Market Indices for States,* downloaded from www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex, 1 August 2007.

38. Natural gas is the most frequently used fuel for water heating in Midwestern homes (accounting for more than 80 percent of water heating energy), followed by electricity and liquefied petroleum gas. See Note 5.

39. Low-efficiency units account for 66 to 87 percent of the market. See Note 6.

40. U.S. Environmental Protection Agency, *Save Energy this Winter with Energy Star®*, downloaded from www.energystar.gov/index.cfm?c=heat_cool.pr_winter on 2 August 2007.

41. American Council for an Energy-Efficient Economy, *Comments on Energy Star® Residential Water Heaters: Draft Criteria Analysis*, letter to Richard H. Karney, Manager, Energy Star® Program, U.S. Environmental Protection Agency, 13 July 2007, available at www.energystar.gov.

42. Ibid.

43. American Council for an Energy-Efficient Economy, *Consumers Guide to Home Energy Savings: Condensed Online Edition: Water Heating*, updated September 2006.

44. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Solar Hot Water and Space Heating & Cooling*, downloaded from www.eere.energy.gov/RE/solar_hotwater.html, 8 September 2005.

45. Solar Depot, *Residential Systems: Solar Hot Water*, downloaded from solardepot.com/r_solar_hot_water.htm, 5 March 2007; Les Nelson, President, Western Renewables Group, personal correspondence, 25 January 2007; Sue Kateley, California Solar Energy Industries Association, personal correspondence, 6 March 2007.

46. See Note 5.

47. U.S. Environmental Protection Agency, Region 1, *EPA Encourages New Englanders to Warm Up to Energy Efficient Light Bulbs*, (press release) 23 January 2004.

48. U.S. Environmental Protection Agency, Energy Star® Program, *Compact Fluorescent Light Bulbs*, downloaded from www.energystar.gov/index.cfm?c=cfls.pr_cfls on 8 August 2007.

49. Ibid.

50. U.S. Environmental Protection Agency, Energy Star® Program, *Life-Cycle Cost Estimate for Energy Star® Qualified Compact Fluorescent Lamps*, (spreadsheet), downloaded from www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CFLs_Consumer.xls on 8 August 2007. Assumptions include replacing five 60 watt incandescent bulbs operated on average 3 hours per day with equivalent 15 Watt CFL bulbs with 12,000 hour lifetimes. 25 percent: estimated electricity savings compared to estimated total home energy use for lighting (9 percent of electricity consumption (See Note 5) applied to 2005 electricity consumption (See Note 2)).

51. Howard Geller, American Council for an Energy-Efficient Economy, *Compact Fluorescent Lighting*, downloaded from www.aceee.org/press/op-eds/op-ed1.htm, 10 October 2006.

52. See Note 50. Individual home savings expanded to statewide estimates using the number of households: Illinois: Illinois Department of Commerce and Economic Opportunity, *Illinois Census Profile System*, accessed at www2.illinoisbiz.biz/censusprofile/default.asp on 14 August 2007; Iowa: Iowa State Data Center, *Housing Units and Households in Iowa: 1980–2005*, downloaded from data.iowadatacenter.org/datatables/State/sthhhuestimates19802005.pdf on 14 August 2007; Wisconsin: State of Wisconsin, "Wisconsin Households and Families," *Wisconsin Blue Book 2003-2004*, page 137. 2 percent: compared estimated savings from CFL installation to residential electricity consumption in 2005 (See Note 2). Savings translated into number of homes using 2006 residential electricity consumption divided by number of customers, per U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006*, 26 October 2007.

53. See Note 6.

54. See Note 5.

55. Commission on Engineering and Technical Systems, National Research Council, *Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000,* National Academies Press, 2001.

56. U.S. Environmental Protection Agency, *Refrigerators and Freezers: Energy Star®*, downloaded from www.energystar.gov/index.cfm?c=refrig.pr_refrigerators on 3 August 2007.

57. U.S. Department of Energy, Energy Information Administration, *2001 Residential Energy Consumption Survey, Table HC5-10a, Appliances by Midwest Census Region*, April 2004.

58. See Note 5.

59. J. P. Ross, Alan Meier, *Whole-House Measurements of Standby Power Consumption*, 2000.

60. Ibid.

61. See Note 23. Savings translated into number of homes using 2006 residential electricity consumption divided by number of

customers by state, per U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006*, 26 October 2007.

62. See Note 5.

63. Residential savings: See Note 20; Commercial savings: *Greenbiz.com*, "U.S. Manufacturers Reach Landmark Agreement on Air Conditioner Efficiency Standards," 15 November 2004.

64. Duro-Last Roofing, Inc., *Energy Efficient Roof: Delivered by Reflective Roofing*, downloaded from www.duro-last.com/coolzone/energy-efficient-roof.asp on 14 August 2007.

65. See Note 6.

66. See Note 17.

67. Lawrence Berkeley National Laboratory, *Heat Island Group: Cool Roofs*, 2 October 2006, downloaded from eetd.lbl.gov/HeatIsland/CoolRoofs/.

68. Shade Trees, see e.g.: National Renewable Energy Laboratory, U.S. Department of Energy, *Landscaping for Energy Efficiency*, DOE/GO-10095-046, FS 220, April 1995; Green Roofing, see e.g.: Amanda Paulson, "Plants, Grass on the Rooftop? No Longer an Oddity," *Christian Science Monitor*, 10 July 2006.

69. Building America Program, U.S. Department of Energy, *Prairie Crossing Homes* – Building America *Houses that Use Half as Much Energy,* 1999.

70. [No Author Listed], "Raising the Energy Bar: Wisconsin Home Hits Net Zero Energy Usage," *Roofing, Siding and Insulation Magazine (RSI)*, 1 September 2005.

71. Norma and Alan Williamson, "The Near-Zero-Energy Home Makeover," *Solar Today*, November/December 2006.

72. Ibid.

73. Jennifer Thorne Amman and Eric Mendelsohn, American Council for an Energy-Efficient Economy, *Comprehensive Commercial Retrofit Programs: A Review of Activity and Opportunities*, April 2005.

74. Alliance to Save Energy, *Alliance to Save Energy Recognizes Nation's Largest Private Electricity User – Wal-Mart Stores, Inc. – For Commitment to Energy Efficiency* (press release), 6 September 2006.

75. One third, highest rate of growth: Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007; Natural gas: See Note 4.

76. See Note 4.

77. Energy Information Administration, U.S. Department of Energy, *Commercial Buildings Energy Consumption Survey*, Table 1: Sum of Major Fuel Consumption by End Use 1995, data for Midwest Region, downloaded from www.eia.doe.gov/emeu/cbecs/detailed_tables_1995.html#ce on 6 July 2007; Steven Nadel, American Council for an Energy-Efficient Economy, *Saving Lighting Energy in Commercial Buildings*, downloaded from www.aceee.org/press/op-eds/op-ed5.htm, 3 October 2006.

78. Ibid, Steven Nadel.

79. Assuming that commercial lighting electricity use is about 40 percent of total electricity use and savings of 40 percent are achieved, per: Ibid, Steven Nadel.

80. U.S. Department of Energy, Energy Information Administration, *State Electricity Profiles*, November 2007.

81. See Note 77, Steven Nadel.

82. Ibid.

83. Ibid.

84. General Electric, "Kentucky Finishes Statewide LED Traffic Signal Retrofit," (press release), undated, downloaded from www.geconsumerproducts.com/pressroom/press_releases/lighting/gelcore/kentuckytrafficsignals.htm on 7 August 2007.

85. Commercial: See Note 77, Energy Information Administration; Industrial: Energy Information Administration, U.S. Department of Energy, *Manufacturing Energy Consumption Survey*, data for Midwest Region, 8 March 2005.

86. American Council for an Energy-Efficient Economy, *Energy-Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities, 2nd Edition*, 2002.

87. Alliant Energy, *Variable Frequency Drives*, downloaded from www.alliantenergy.com/docs/groups/public/documents/pub/p012399.hcsp on 7 August 2007.

88. R. Neal Elliott, Therese Langer, Steven Nadel, American Council for an Energy-Efficient Economy, *Reducing Oil Use through Energy Efficiency: Opportunities Beyond Cars and Light Trucks*, January 2006.

89. Energy Information Administration, U.S. Department of Energy, *Manufacturing Energy Consumption Survey*, data for Midwest Region, 8 March 2005.

90. See Note 86.

91. Ibid.

92. Ibid.

93. 15 to 40 percent: Ibid.

94. Ibid.

95. Ibid.

96. Electric Power Research Institute, "Save Industrial Customers Millions by Optimizing Energy and Water Use," *Value & Vision*, November 1999.

97. Travis Madsen and Bernadette Del Chiaro, Environment California Research & Policy Center, *Greening the Bottom Line: California Companies Save Money By Reducing Global Warming Pollution,* August 2006.

98. Wisconsin Focus on Energy, *American Foods Group Finds Over $1,000,000 in Low-Hanging Fruit* (factsheet), 2007, 1.

99. 70 to 90 percent from U.S. Combined Heat and Power Association, *CHP Basics*, downloaded from uschpa.admgt.com/CHPbasics.htm, 25 May 2006; 33 percent from U.S. Department of Energy and U.S. Environmental Protection Agency, *Carbon Dioxide Emissions from the Generation of Electric Power in the United States*, July 2000.

100. Gas Technology Institute for Midwest CHP Application Center, *Beloit Memorial Hospital Case Study for CHP Applications*, May 2002.

101. Gas Technology Institute for Midwest CHP Application Center, *University of Illinois at Chicago East Campus (Including White Paper of West Campus Facility): Case Study MAC #2001-001*, August 2001.

102. Resource Dynamics Corporation, *Cooling, Heating, and Power for Industry: A Market Assessment*, prepared for the U.S. Department of Energy and Oak Ridge National Laboratory, August 2003.

103. Ibid.

104. Commercial and institutional: ONSITE SYCOM Energy Corporation, *The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector*, prepared for the U.S. Department of Energy, January 2000.

105. Ibid.

106. Ibid.

107. 10 percent based on comparison of potential levels discussed with U.S. Department of Energy, Energy Information Administration, *Electric Power Annual with Data for 2004*, November 2005.

108. Midwest CHP Application Center, *State and Regional Baseline CHP Information*, downloaded from www.chpcentermw.org/07-00_region.html on 8 August 2007.

109. U.S. Environmental Protection Agency, *Sector Strategies Performance Report 2006*, March 2006.

110. American Institute of Architects, *Sustainability at the AIA*, downloaded from www.aia.org/sustainability, 6 October 2006.

111. American Council for an Energy-Efficient Economy, *Agricultural Energy Infrastructure: Leveraging the 2002 Farm Bill and Steps for the Future*, Report Number IE072, July 2007.

112. Focus on Energy, *Case Study: Quantum Dairy Takes the Modernization Leap*, 2005, accessed at www.focusonenergy.com/data/common/dmsFiles/W_RB_MKCS_QuantumDairyCaseStudy.pdf.

113. Ibid.

114. Ibid.

115. The Center for Ecological Technology, *Variable Frequency Drives*, accessed at www.cetonline.org/FarmBusiness/vfds.php on 8 August 2007.

116. Ibid.

117. See Note 112.

118. Ibid.

119. Ibid.

120. See Note 111.

121. Neal Elliott, American Council for an Energy-Efficient Economy, *Characterization of the Potential for Energy Efficiency in Agriculture*, Presented at the 2005 Midwest Energy Solutions Conference, October 2005.

122. See Note 111.

123. Wayne Shirley, Regulatory Assistance Project, *Barriers to Energy Efficiency* (presentation), undated, downloaded from www.raponline.org/Slides/MACRUCEnergyEfficiencyBarriersWS.pdf on 8 February 2008.

124. Environmental Law and Policy Center, *Illinois General Assembly Passes Renewable Energy and Energy Efficiency Standard* (press release), 27 July 2007.

125. $3 million: Illinois Department of Commerce and Economic Opportunity, *Energy Efficiency Trust Fund Program Report, January 2005 through December 2005*; $11 million: Illinois Clean Energy Community Foundation, *Milestone Report 2004*; and Illinois Clean Energy Community Foundation, *Summary of Foundation Grants Through July 2006*, July 2006.

126. Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Figure 1 – 2006 Per Capita Budgets, by State (Electric Programs)*, downloaded from www.cee1.org/ee-pe/budgets-main.php3 on 17 August 2007.

127. 2.5 cents per kWh: Commonwealth Edison, *Summary of Proposed Illinois Rate Relief and Competitive Market Settlement Terms*, obtained from Sharon Hillman, Vice President of Marketing and Environmental Programs, via personal correspondence, 29 August 2007.

128. Staff Writer, "Ameren Illinois Utilities File Energy Efficiency Plan with ICC," *Energy Business Review*, 13 February 2008.

129. Ibid.

130. Stephanie Huls, "Chicago Consumers Hit With New People Gas Increase Based on Expected Use," *Midwest Business.com*, 19 February 2008.

131. Building Codes Assistance Project, *Code Status*, downloaded from www.bcap-energy.org/code_status.php, 18 August 2006.

132. R.G. Lucas, Pacific Northwest National Laboratory, *Assessment of Impacts from Adopting the 2006 International Energy Conservation Code for Residential Buildings in Illinois*, PNNL-16266, January 2007.

133. Assuming Illinois residential electricity consumption of 9,238 kWh per year and natural gas consumption of 108 million BTU per year. See U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2006*, 26 October 2007; and U.S. Department of Energy, Energy Information Administration, *Natural Gas Consumption by End Use* and *Number of Natural Gas Consumers*, updated 30 January 2008.

134. Illinois Department of Commerce and Economic Opportunity, *Illinois Energy Conservation Code for Commercial Buildings*, downloaded from www.commerce.state.il.us/dceo/Bureaus/Energy_Recycling/IECC.htm on 18 January 2008.

135. Database of State Incentives for Renewables and Efficiency, *Iowa Building Energy Codes*, downloaded from dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=IA10R&state=IA&CurrentPageID=1&RE=0&EE=1, 8 August 2007.

136. Energy Star building codes: Richard Faesy, Vermont Energy Investment Corporation, *Ratcheting Residential Energy Codes up to Energy Star®: The Long Island Example as a Model of What Can Be Achieved,* 2 March 2007.

137. Iowa Code Section 476.6(19)"a"

138. Iowa Utilities Board, *Overview of Energy Efficiency Plans and Programs in Iowa*, downloaded from www.state.ia.us/government/com/util/energy/energy_efficiency.html on 17 August 2007.

139. Ibid.

140. Data through 2005: Iowa Utilities Board, *Iowa Utility Energy Efficiency – Information presented by the Iowa Utilities Board to the Iowa House and Senate Commerce Subcommittees*, undated, downloaded from www.state.ia.us/government/com/util/

energy on 17 August 2007; 2006 estimate from: Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Table 1 – 2006 Budgets by State*, downloaded from www.cee1.org/ee-pe/06_elec-gas.pdf on 17 August 2007.

141. Savings: John Norris, Iowa Utilities Board, *Energy Efficiency and Iowa Utilities,* Presentation to the Energy Policy Advisory Forum, convened by Governor-Elect Chet Culver, 4 January 2007; Electricity consumption: Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007; Gas consumption: Energy Information Administration, U.S. Department of Energy, *Natural Gas Navigator: Consumption by End Use*, downloaded from tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_SIA_a.htm on 17 August 2007.

142. See Note 140.

143. See Note 126.

144. Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Figure 1 – 2006 Per Capita Budgets, by State (Gas Programs)*, downloaded from www.cee1.org/ee-pe/budgets-main.php3 on 17 August 2007.

145. Consortium on Energy Efficiency, *U.S. Energy-Efficiency Budgets: Table 3 – 2006 Electric Budgets by State*, downloaded from www.cee1.org/ee-pe/06_elec-gas.pdf on 17 August 2007.

146. Iowa Utilities Board, *Iowa Weatherization Challenge*, downloaded from www.state.ia.us/government/com/util/energy/iwc/IWC_overview.html on 17 August 2007.

147. Governor Thomas Vilsack, *Executive Order Number 21*, 22 April 2005.

148. State of Wisconsin, *Wisconsin Public Benefits Program Annual Report, July 1, 2005 to June 30, 2006*, available at www.focusonenergy.com.

149. Database of State Incentives for Renewables and Efficiency, *Wisconsin: Focus on Efficiency Program*, downloaded from dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WI15R&state=WI&CurrentPageID=1&RE=0&EE=1, 8 August 2007.

150. See Note 148.

151. See Notes 126 and 144.

152. See Note 131.

153. 2005-2006 Wisconsin Legislative Session, *2005 Senate Bill 459*.

154. Database of State Incentives for Renewables and Efficiency, *Wisconsin: Energy Efficiency and Green Building Standards for State Buildings*, downloaded from dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WI14R&state=WI&CurrentPageID=1&RE=0&EE=1, 8 August 2007.

155. See Note 1.

156. William Worek and Steffen Mueller, *Clean Energy in Illinois – A Solid Foundation… Time to Build,* Presented at: Fueling Change with Renewable Energy – International Symposium, Urbana-Champaign, 26-27 April 2007.

157. U.S. Department of Energy, Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, ORNL/CON-476 and LBNL-44029, November 2000.

158. See Note 156.

159. S.W. Hadley, Oak Ridge National Laboratory for the Iowa Energy Center, *The Potential for Energy Efficiency in the State of Iowa*, June 2001.

160. Ibid.

161. Energy Center of Wisconsin for the Governor's Taskforce on Energy Efficiency and Renewables, *Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006-2015,* November 2005.

162. Ibid.

163. Ibid.

164. Ibid.

165. Ibid.

166. Ibid.

167. Steven Nadel, Anna Shipley, and R. Neal Elliot, American Council for an Energy-Efficient Economy, *The Technical,*

Economic, and Achievable Potential for Energy Efficiency in the U.S.—A Meta-Analysis of Recent Studies, From the Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy-Efficient Economy, 2004.

168. Ibid.

169. Bruce Biewald, David White, et al., Synapse Energy Economics, *A Responsible Electricity Future: An Efficient, Cleaner and Balanced Scenario for the U.S. Electricity System*, 11 June 2004.

170. Howard Geller et al, Southwest Energy Efficiency Project, *The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest*, November 2002.

171. See Note 50.

172. See Note 52.

173. Ibid.

174. See Note 23.

175. Ibid.

176. See Note 97.

177. See Note 100.

178. Environment Iowa Research & Policy Center, *Redirecting Iowa's Energy: The Economic and Consumer Benefits of Clean Energy Policies*, December 2006.

179. Ryan Wiser, Mark Bolinger and Matt St. Clair, U.S. Department of Energy, Lawrence Berkeley National Laboratory, *Easing the Natural Gas Crisis: Reducing Natural Gas Prices through Increased Deployment of Renewable Energy and Energy Efficiency*, LBNL-56756, January 2005.

180. Ibid.

181. R. Neal Elliot and Ann Monis Shipley, American Council for an Energy-Efficient Economy, *Impacts of Energy Efficiency and Renewable Energy On Natural Gas Markets: Updated and Expanded Analysis,* 2005.

182. Justin Blum, "Energy Department Slow to Mandate Efficiency," *Washington Post*, 22 January 2005.

183. Regional Economics Application Laboratory for the Environmental Law & Policy Center, *Job Jolt: The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland*, 2001.

184. Energy Resources Center, University of Illinois at Chicago, *The Economic and Environmental Impacts of Clean Energy Development in Illinois*, June 2005.

185. See Note 1.

186. Alison Bailie, et al., Tellus Institute & the Center for Energy and Climate Solutions for the World Wildlife Fund, *The Path to Carbon Dioxide-Free Power: Switching to Clean Energy in the Utility Sector*, April 2003.

187. United States Congress, Office of Technology Assessment, *Industrial Energy Efficiency*, September 1993, page 65; For a more complete discussion on this point, see: Skip Laitner, Economic Research Associates, *Energy Efficiency as a Productivity Strategy for the United States*, Alexandria, VA, June 1995; and Joseph J. Romm, *Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution*, Kodansha American, Ltd., 1994.

188. Consortium for Electric Infrastructure to Support a Digital Society, *The Cost of Power Disturbances to Industrial and Digital Economy Companies*, June 2001.

189. Puget Sound Energy, *Least Cost Plan 2007*, downloaded from www.pse.com/energyEnvironment/pse2007irpView.aspx, 24 July 2007.

190. Matthew L. Wald, "Costs Surge for Building Power Plants," *New York Times*, 10 July 2007.

191. Focus on Energy performance: State of Wisconsin, *Wisconsin Public Benefits Program Annual Report, July 1, 2005 to June 30, 2006*, available at www.focusonenergy.com; Retail electricity price: Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007.

192. Focus on Energy performance: Ibid; Natural gas price cited is the city-gate price: Energy Information Administration, U.S. Department of Energy, *Natural Gas Navigator: Natural Gas Prices,* downloaded from tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_SWI_a.htm on 18 August 2007.

193. See Note 156.

194. Michigan Public Service Commission, 21st Century Energy Plan, *Resource Assessment for Energy Efficiency*, 15 November 2006.

195. Ibid.

196. Richard Sedano, Regulatory Assistance Project, *Economic, Environment and Security Effects of Energy Efficiency and Renewable Energy: A Report for EPA and the New England Governors' Conference*, Northeast Energy Efficiency Partnerships (NEEP) Policy Conference, 24 May 2005.

197. Utility Costs: Optimal Energy, Inc. for Northeast Energy Efficiency Partnerships, *Economically Achievable Energy Efficiency Potential in New England*, May 2005. Customer costs: Energy Information Administration, U.S. Department of Energy, *Monthly Electric Utility Database, Form EIA-826*, 2004; Values were calculated by summing electric utility revenue and sales, then determining revenue per kWh.

198. See Note 170.

199. See Note 127.

200. Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007.

201. See Note 184.

202. See Note 52, using electric sector carbon emission intensities from: Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007; and assuming that a typical passenger car emits 11,470 pounds of carbon dioxide per year, built into the EPA spreadsheet cited in Note 50.

203. Translating electricity savings into global warming pollution equivalents using state electricity sector global warming emission intensities per: Energy Information Administration, U.S. Department of Energy, *State Electricity Profiles 2005 Edition*, DOE/EIA-0348, March 2007; and assuming carbon dioxide emissions for an average passenger car of 11,470 pounds per year, per Note 50.

204. C. Pope et al., "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution," *Journal of the American Medical Association,* 287: 1132-1141, 2002; A. Peters et al., "Increased Particulate Air Pollution and the Triggering of Myocardial Infarction," *Circulation,* 103: 2810-2815, 2001; J. Samet et al., The United States Health Effects Institute, *The National Morbidity, Mortality, and Air Pollution Study, Part II: Morbidity and Mortality from Air Pollution in the United States,* Research Report Number 94, June 2000; Joel Schwartz, "Particulate Air Pollution and Chronic Respiratory Disease," *Environmental Research* 62: 7-13, 1993; D. Abbey et al., "Long-term Ambient Concentrations of Total Suspended Particles, Ozone, and Sulfur Dioxide and Respiratory Symptoms in a Nonsmoking Population," *Archives of Environmental Health* 48: 33-46, 1993; Joel Schwartz et al., "Particulate Air Pollution and Hospital Emergency Room Visits for Asthma in Seattle," *American Review of Respiratory Disease* 147: 826-831, 1993; J. Schwartz et al., "Acute Effects of Summer Air Pollution on Respiratory Symptom Reporting in Children," *American Journal of Respiratory Critical Care Medicine* 150: 1234-1242, 1994.

205. Abt Associates, *Power Plant Emissions: Particulate Matter-Related Health Damages and the Benefits of Alternative Emission Reduction Scenarios,* June 2004.

206. M. Gilmour et al., "Ozone-Enhanced Pulmonary Infection with *Streptococcus Zooepidemicus* in Mice: The Role of Alveolar Macrophage Function and Capsular Virulence Factors," *American Review of Respiratory Disease* 147: 753-760; I. Mudway and F. Kelley, "Ozone and the Lung: A Sensitive Issue," *Molecular Aspects of Medicine* 21: 1-48, 2000.

207. M. Lippman, "Health Effects of Ozone: A Critical Review," *Journal of the Air Pollution Control Association* 39: 672-695, 1989; I. Mudway and F. Kelley, "Ozone and the Lung: A Sensitive Issue," *Molecular Aspects of Medicine* 21: 1-48, 2000.

208. W. McDonnell et al., "Pulmonary Effects of Ozone Exposure During Exercise: Dose-Response Characteristics," *Journal of Applied Physiology* 5: 1345-1352, 1983.

209. R. McConnell et al., "Asthma in Exercising Children Exposed to Ozone: A Cohort Study," *The Lancet* 359: 386-391, 2002

210. Kathryn R. Mahaffey, Robert P. Clickner, and Catherine C. Bodurow, "Blood Organic Mercury and Dietary Mercury Intake: National Health and Nutrition Examination Survey, 1999 and 2000," *Environmental Health Perspectives* 112 (5), 562-570, April 2004; Kathryn R. Mahaffey, U.S. EPA, Methylmercury: Epidemiology Update, presentation before the Fish Forum, San Diego, January 2004.

211. See Note 184.

212. Jonathan Levy et al., "The Public Health Benefits of Insulation Retrofits in Existing Housing in the United States," *Environmental Health: A Global Access Science Source* 2:4, 11 April 2003.

213. See Note 23.

214. Ibid.

215. Ibid.