Consumer Guide to Green Energy Choices

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Foreword

This report is dedicated to the proposition that we can each lead the way to a cleaner environment and a better quality of life for us, our children, our grandchildren, and future generations.

Our energy use causes pollution. Fortunately, the following low cost options are available that allow each of us to act directly to reduce this pollution today:

- All of us can increase the efficiency of our energy use by conserving energy and buying more efficient products. Energy efficient products are available at competitive prices in the marketplace, those with the Energy Star label for example.
- Some of us can buy electricity from renewable sources. Renewable electricity is available in areas where utility restructuring has created a competitive retail energy market, or areas where a monopoly utility chooses to provide renewable electricity.
- All of us can buy and retire emission reduction credits to offset the emissions caused by our energy use. Emission reduction credits are available at competitive prices in the marketplace.

This report discusses how to select a combination of these direct emission reduction actions that works for you. By doing just a little of each of these actions, you can show that consumers want reduced environmental emissions, that consumers are willing to pay to reduce emissions, and finally, that emission reductions are available at a lower cost than most people think. In addition to providing direct environmental benefits, taking these actions will help the marketplace, regulators, and legislators do more to reduce pollution. Take these actions and you will be leading the way to a cleaner environment.

If you want see how easy this can be, just visit our web site at *www.cleanerandgreener.org*. Buy as much green energy as you want by making a tax-deductible donation so we can buy and retire emission reduction credits in your name that offset the emissions caused by your energy use.

Pogo had it right, “We have found the enemy and they are us.” As consumers, we have been using our purchasing power to pay others to do most of our polluting for us. It has been easy and effective. Just as easily and just as effectively, as consumers, we can create market demand for pollution reduction by using our purchasing power to pay others to do our pollution *reduction* for us.

Michael Arny
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Executive Summary

Green energy is gaining recognition as we become increasingly aware of the health problems, environmental destruction, and other impacts that result from the pollution caused by our energy use. This growing interest in green energy raises many questions for consumers: *What really* ***is*** *green energy?* ***What kind*** *of green energy should I buy?* ***How much*** *green energy should I buy?* This report was prepared to answer these questions and to help organizations decide what green energy options to recommend to their members. The energy choices consumers make can have a substantial impact on reducing pollution. The use of regulation and legislation to clean up the environment should not be neglected, but expanding the impact of direct actions by consumers will give the environmental improvement stool a third leg to stand on.

The "right" kind of green energy for individual consumers will depend on their values, their willingness to pay for reduced environmental impacts, and their access to reduced-emission options. Given the diversity among both individuals and organizations, it is likely that different individuals and organizations will come to different conclusions about the type of green energy that is right for them. This report accommodates this diversity by examining the issues that underlie green energy choices, developing a framework for making conclusions, and then providing the information needed to make decisions. Organizations can use this information to make green energy recommendations to their members based on the objectives of their organization.

The *Consumer Guide to Green Energy Choices* presents this information in a step-by-step manner. The report:

- First, examines how consumer energy use causes air pollution and other environmental impacts.
- Second, provides some context for evaluating the emissions caused by our energy use, the health effects of air pollution, and how much energy the United States uses per capita relative to other countries.
- Third, identifies green energy types and actions for consumers.
- Fourth, evaluates the environmental benefits of various types of green energy.
- Fifth, presents the costs of various types of green energy.
- Sixth, presents survey results on consumers' willingness to pay for reduced emissions and their views on different emission reduction options.
- Concludes by reviewing the highlights of what issues individuals should consider when deciding what kind of green energy to buy, and what issues organizations should consider when deciding what options to recommend to their members.

Consumers cause air pollution both by the energy they use in their homes and vehicles, and by the energy used to produce and deliver the goods and services they buy. The United States uses 2 to 3 times more energy per capita than highly developed countries like France, Germany, England, and Japan. And although the United States contains less than 5% of the world's population, it generates almost 25% of its air pollution.

In the United States, the conventional production of electricity from power plants causes more air pollution than any other source, and contributes to global warming. In 1997, the burning of fossil fuels accounted for 82% of greenhouse gas emissions[1]. Traditional fossil fuel-based energy generation also emits lead, mercury, sulfur dioxide, particulate matter, carbon monoxide, nitrogen oxides, and volatile organic compounds.

Pollution from fossil-fuel based energy generation is hazardous to public health. Toxic compounds, like mercury and lead, poison organ systems and can lead to brain damage and death. Fish consumption advisories have been imposed in parts of the country where lakes and waterways have been contaminated with mercury from electric power plants. Other pollutants cause respiratory and other health problems, particularly in children and the elderly.

Conventional methods of energy generation are also detrimental to the environment. Climate change on a global scale has been attributed to increased emissions of carbon dioxide (CO_2), a greenhouse gas. A global average temperature rise of 1° to $3.5^\circ C$ could have serious implications. Possible consequences include melting of polar ice caps; an increase in sea level; and increases in precipitation and severe weather events like hurricanes, tornadoes, heat waves, floods, and droughts. Indirect effects include increases in infectious disease, weather-related deaths, and food and water shortages. All these effects put a stress on ecosystems and agriculture, and threaten our planet as a whole.

Other atmospheric effects of air pollution include urban smog and reduced visibility, which are associated with ozone-forming nitrogen oxides and volatile organic compound emissions. Visibility is also affected by emissions of sulfur dioxide and fine particulates. In addition, sulfur dioxide and nitrogen oxides combine with water in the atmosphere to cause acid rain, which is detrimental to forests and other vegetation, soil, lakes, and aquatic life. Acid rain also causes monuments and buildings to deteriorate.

Energy use and the production and delivery of goods and services also degrade the quality of our land and water resources. Although this report focuses on actions that reduce the environmental and human health effects of air pollution caused by our energy use, green energy actions that reduce air pollution will also reduce solid waste and water pollution. Using our energy resources wisely and efficiently can reduce the air, water, and land pollution that typically results from traditional fossil fuel-based energy generation. This pollution, and its associated health and environmental effects, can be reduced by investing in green energy and electricity options.

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[1] Emissions of Greenhouse Gases in the United States 1997, Energy Information Administration, U.S. Department of Energy, DOE/EIA-0573(97), October 1998.

A consensus has not yet been reached on how to define green energy. Some consider all reduced-emission electricity to be green energy, while others include only renewable energy. Some define green energy as all renewable energy except for hydropower and certain forms of biomass power, while others include small existing hydropower in their definition. For the purposes of this report, we used a broad definition of green energy to include all options that reduce the pollution and other environmental impacts caused by a consumer's energy use, as compared to the current generation mix.

***Green energy** is defined as energy that is produced and used in ways that reduce the pollution and other environmental impacts caused by consumer energy use. Green energy includes more efficient energy production and end use, and energy generated from renewables and cleaner fuels.*

As consumers, we have many green energy options available to us that reduce the pollution caused by our energy use. Conserving energy is one way we can reduce our emissions–many of us already turn off lights when not in use and adjust the thermostat a couple degrees up or down depending on the season. But beyond energy conservation, what can we do to reduce our emissions?

Green Energy Strategy #1: Make Our Energy Use More Efficient

Increasing energy efficiency around the house and office is one option that scores high in both availability to consumers and environmental benefits. Buying energy-efficient appliances and light bulbs, switching to natural gas, and installing insulation and programmable thermostats are just a few of the ways consumers can be energy-efficient. When buying new appliances compare Energy Guide labels and look for the Energy Star–a label given by the U.S. EPA and U.S. DOE to products whose energy efficiency rating is best in its category and also exceed the minimum federal standards. To find out how you can further improve the energy efficiency of your home, consider having a home energy audit done.

Energy efficiency reduces the environmental impacts that result from the entire process of producing and delivering energy to consumers, including fuel extraction, combustion, transmission, and distribution (Table 1). Energy efficiency is also a low cost way to reduce emissions. Most efficiency measures more than pay for themselves with the energy savings they provide. Implementing energy efficiency measures has the potential to reduce emissions from household electrical consumption by 30% (Figure 2) and save the average consumer up to $23 per month ($278 per year) on their electricity bills (Figure 1).

Energy efficiency measures have the potential to reduce emissions that result from household electricity use by 30%, with a cost savings of up to $23 per month.

As consumers, we should do as much to increase the efficiency of our energy use as we are comfortable with, but since efficient energy use can only affect a portion of total energy use, we should not stop there.

Table 1 Summary of Environmental Impacts of Options for Reducing the Emissions that Result from an Average Household's Energy Use

Types of Green Energy		**Environmental Impacts Reduced**					
		Air pollution[1]	Electric transmission and distribution	Fuel transmission and distribution or transportation	Electric generating plants	Fuel extraction	Goods and services[2]
Emission Offsets[3]		Yes (100%)	Yes	Yes	Yes	Yes	Yes
Increased Energy Efficiency		Yes (20-30%)	Yes	Yes	Yes	Yes	No
Renewable Generation (wind, solar, etc.)	On-Site	Yes (100%)	Yes	Yes	Yes	Yes	No
	Off-Site	Yes (100%)	No	Yes	Yes	Yes	No
Fuel Switching: Coal to Biomass Fuel Generation		Yes[4] (100%)	No	Maybe[5]	No	Yes	No
Generation Efficiency Improvements		Yes (Varies)	No	No	No	Yes	No
New Generation Technologies (IGCC & IGFC)		Yes (4-28%)	No	No	No	Yes	No
Fuel Switching to Natural Gas Generation		Yes (30-60%)	No	No	No	No	No
Generation End-of-Pipe Actions		Yes (Varies)	No	No	No	No	No

[1] Percentages reflect the average U.S. household's CO_2 emission reduction potential from electricity

[2] Impacts of energy used to produce and deliver the goods and services we buy

[3] Buying and retiring emission reduction credits offsets the emissions caused by household energy use

[4] Impact varies by type of emission and combustion process

[5] Dependent on distance from fuel source – no, if distant source; yes, if nearby source

Green Energy Strategy #2: Buy Cleaner or Renewable Electricity

Buying cleaner or renewable electricity has positive emission reduction benefits, but availability can be restricted by the status of electric industry deregulation. In areas where utilities still have a retail monopoly, green electricity is only available to consumers if the utility chooses to make it available, or if regulations require that it be made available. In this situation, any green electricity services are only available at non-competitive prices set through the regulatory process. Where utility deregulation has created fully competitive retail energy services markets, green electricity can be purchased at prices set by the competitive market. So where the electricity market is competitive, the green electricity is likely to be available at lower prices than where the utility still has a retail monopoly.

An analysis of electricity generation options shows that renewable technologies can economically turn wind, sunlight, and organic matter (biomass) into electricity and other useful forms of energy. 100% reductions of CO_2 emissions (Figure 2) from our electricity consumption are possible using a number of different renewable technologies. Of these, proven renewable energy alternatives such as wind- and solar-fueled generation continue to gain market penetration and enjoy cost decreases over time. Wind power in particular has emerged as an attractive and viable electric generation option for consumers. Buying 100 percent proven available renewable electricity has an incremental cost (as compared to the current generation mix) of about 0.4 to 3 cents per kWh for wind and biomass (fluidized bed combustion) electricity. This means that the average U.S. family could eliminate all the carbon dioxide (CO_2) emissions caused by their household electricity use for less than $3 more per month or around $34 more per year (Figure 1) in a *competitive* market.

In a competitive market, the average U.S. household could eliminate all of their CO_2 emissions from household electricity use for an additional $3 per month.

Several emerging renewable technologies such as biomass feed integrated gasification combined cycle (Biomass-IGCC) can produce electricity at incremental cost savings to consumers. As expected for Illinois, Iowa, Minnesota, and Wisconsin, large scale photovoltaic generation is a more expensive way to produce cleaner electricity at approximately $2000 more per year. However, this technology offers an alternative for isolated consumers located large distances away from the power grid.

Figure 1 shows that on a cost basis, newer emerging generation technologies such as integrated coal gasification combined cycle (IGCC) and integrated gas fuel cells (IGFC) are very cost-effective. However, these two technologies are not widely utilized and offer low emission reduction potentials of 4% and 28%, respectively (Figure 2). Fuel switching to natural gas-fired generation and energy efficiency options provide cost-effective consumer approaches for reducing emissions with emission reduction potentials of 60% and 30%, respectively.

Key to emission reduction technologies in Figures 1 and 2:

IGCC = Integrated Gasification Combined Cycle
N. Gas CC = 215 MW Natural Gas Combined Cycle (stand alone)
Energy Efficiency = Potential for household efficiency measures
IGFC = Integrated Gasification Fuel Cell
Offsets = CO_2 Emission Offsets (voluntary market)
Wind = Average wind turbine
Biomass = Atmospheric Fluidized Bed Wood-fired Biomass
Solar = Fixed Flat Plate Photovoltaic (5 MW) - dispersed connection
4-State Avg Mix = Average electricity generation mix for the states of Illinois, Iowa, Minnesota, and Wisconsin

Figure 1 Average Family's *Incremental* Electricity Cost per Year in Post-Restructuring and Paid-Off Stranded Cost Environment

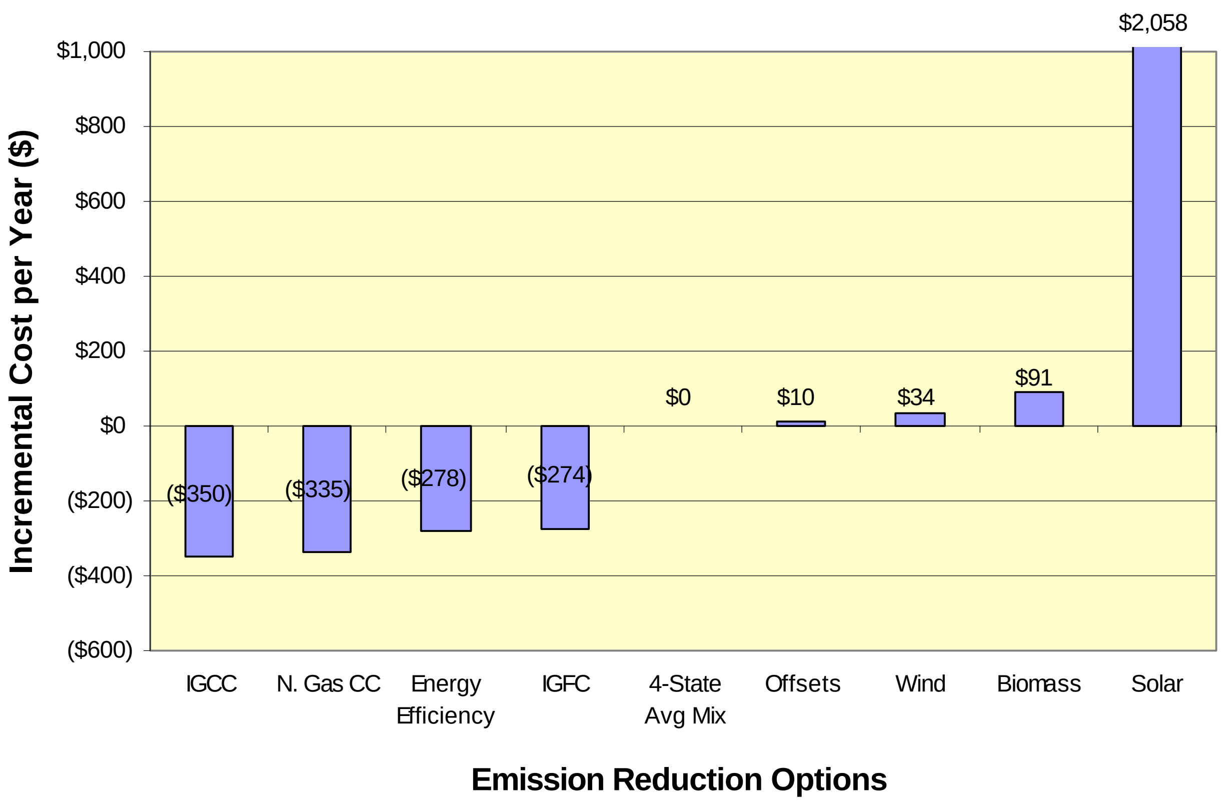
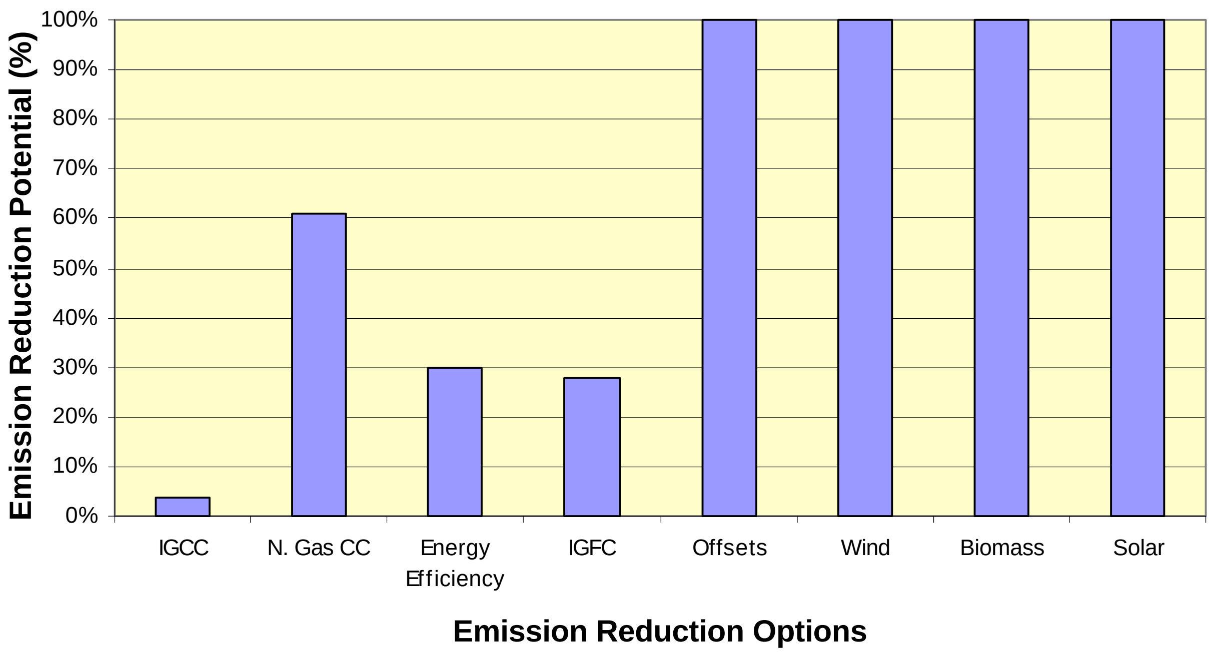


Figure 2 Average Family's *Electricity* CO_2 Emission Reduction Potential per Year in a Post-Restructuring and Paid-Off Stranded Cost Environment



Green Energy Strategy #3: Buy and Retire Emission Reduction Credits

Sources of air pollution that reduce their emissions below their required limit (cap) may receive saleable credits for their reductions. Emission reduction credits reward those who take action to reduce their pollutant emissions and therefore encourage pollution reduction actions. Credits for emission reductions provide an incentive to find the most cost-effective way to reduce emissions, since once an emission reduction credit is earned, it can be sold on the open market. Markets for emission reduction credits or emission allowances can be created by regulation (the sulfur dioxide market for example) or voluntarily (the current market for greenhouse gases).

Emission reduction credits can be used to reduce pollution. Instead of reselling emission reduction credits to sources of air pollution that will use them to compensate for their pollutant emissions, allowances can be retired, *without* emitting any pollution. Once an emission reduction credit is retired, it can no longer be bought, sold, or used to offset pollution. Purchasing and retiring emission reduction allowances reduces the amount of

Traditionally, in areas of tight environmental controls, new sources of air pollution are required to ***offset*** *their new emissions with a reduction in emissions from an existing source. Similarly, consumers can "****offset****" the pollution caused by their energy use by buying and retiring the emission reduction credits created by someone else.*

pollution that is discharged to the atmosphere for regulated markets, and creates future pollution reduction potential for voluntary markets.

The third green energy strategy allows consumers to take advantage of emission reduction credit markets. Buying and retiring emission reduction credits produced by energy efficiency or renewable energy projects allows consumers the chance to:

- Influence public policy decisions to implement market-based pollution reduction strategies
- Give value and financial incentive to the pollution reduction actions made through energy efficiency and renewable energy projects
- Strengthen emission reduction markets
- Reduce the negative environmental impacts that result from the entire process of energy production and distribution, including energy use to produce and deliver the goods and services purchased by consumers

Buying and retiring emission reductions provides many environmental benefits (Table 1). Energy efficiency and renewable energy projects reduce the negative environmental impacts caused by the production and delivery of energy to consumers, as well as provide emission reductions which can be purchased by consumers. Increasing end use energy efficiency provides many environmental benefits as well, but it is difficult for consumers to reduce their indirect emissions caused by the production and delivery of goods and services they buy. Buying emission reduction credits has an added advantage, it allows consumers to offset their net emissions, including those produced by goods and services purchased, by 100 percent (to zero).

Green energy in the form of emission reduction credits can be purchased in the competitive marketplace, so competition will eventually drive the price of emission reductions down to the point where supply and demand are balanced. Buying emission reduction credits lets consumers conveniently offset the emissions, caused by both their direct and indirect energy use, as much as they want at a low competitive market cost. For example, an average U.S. family's CO_2 emissions from their household electricity consumption could be offset for less than $1 per month, or $10 per year (Figure 1). An average U.S. family's total CO_2 emissions, including emissions from transportation and the goods and services purchased, could be offset for less than $5 per month ($56 per year).

To demonstrate the impact that consumers can have on reducing pollution, Leonardo Academy has instituted a program that lets consumers buy green energy in the form of making a donation (all U.S. donations are tax-deductible) to buy and retire emission reduction credits. For pollutants that have established national emission trading systems in place, the Cleaner and Greener[sm] Program buys emission reductions from within that trading system. For example, sulfur dioxide allowance auctions are conducted by the Chicago Board of Trade. For pollutants like carbon dioxide, that do not have established emission trading systems, the Cleaner and Greener[sm] Program buys emission reduction credits that are reported[6] according to the Multiple Pollutant Emission Reduction Reporting System developed by Leonardo Academy with funding from the U.S. EPA. Any emission reduction credits that are purchased are retired. Once retired, they cannot be sold, traded, given away, or otherwise used to offset pollution.

The Cleaner and Greener[sm] Green Energy Program shows that there are low cost pollution reduction options available, encourages increased energy efficiency and renewable energy, and shows that there is public support for taking action to reduce pollution.

The bottom line for consumers is that they can easily take direct action to reduce emissions at a modest cost. Our survey results show that environmentally-oriented consumers are willing to spend $33 more per month to reduce environmental pollution, although consumers also need to feel like they are getting a value for their premium and that the dollars they spend will make a difference.

The demand for cleaner energy sources is already present. What is needed now is more education and access to these cleaner sources. Electricity providers should be able to offer cleaner electricity to consumers for little or no additional cost. The resources are currently available for a supplier to respond to an educated consumer market.

When we incorporate energy conservation and efficiency measures in our own homes we decrease energy consumption. These energy savings increase our disposable income, which leads to growth in employment since most of the income is spent locally on consumption of goods and services instead of flowing out of state to pay for fuel imports. Renewable generation built in-state also has positive economic impacts by eliminating the cost of paying for out of state fuel products. Buying emission offsets helps people and organizations that implement energy efficiency, renewable energy, sequestration, and cleaner generation projects to pursue more and bigger projects. You also help put people to work installing, designing, manufacturing, and developing the equipment needed to carry out these cleaner energy projects.

Consumers can also help the environment by supporting environmentally beneficial regulation and legislation. They can do this by giving with their time and money to organizations that are supporting smart, effective policies for promoting cleaner energy sources. These policies include measures such as renewable portfolio standards, rewarding all pollution reduction actions with allocations, net metering, public benefits funding, and fair rules between all energy sources (even playing field). Our survey results showed high support for many of these policies by environmentally-minded consumers as desirable ways to clean up the pollution our energy use causes. This report provides information which can be used to add support for these policies but was geared towards helping individual consumers take direct actions towards reducing their own air pollution.

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[6] Emission reductions are reported under the Voluntary Reporting Program of the U.S. Department of Energy - Energy Information Administration (1605(b) of the Energy Policy Act).

Regardless of the combination of emission reduction actions you choose, by incorporating just a little of each of the Green Energy Strategies, you can show that consumers want reduced environmental emissions, that consumers are willing to pay to reduce emissions and finally, that emission reductions are available at a lower cost than most people think. Your actions can produce direct environmental benefits–by reducing the demand for emission-producing fossil-fueled electricity generation, you reduce the environmental impacts from energy production and delivery. Your actions also help the marketplace, regulators, and legislators do more to reduce pollution.

So read this report, and choose a mix of increased energy efficiency, renewable electricity, and emission offsets that works for you. If you represent an organization, recommend that each of your members implement a mix that fits your organization's objectives. Start leading the way today to a cleaner environment for you, your children, your grandchildren, and future generations.

Table of Contents

Section 1 Introduction

The Purpose and Structure of this Report

Green energy is gaining recognition as we become increasingly aware of the health problems, environmental destruction, and other impacts that result from the pollution caused by our energy use. This growing interest in green energy raises many questions for consumers: *What really* ***is*** *green energy?* ***What kind*** *of green energy should I buy?* ***How much*** *green energy should I buy?* This report was prepared to answer these questions and to help organizations decide what green energy options to recommend to their members. The energy choices consumers make can have a substantial impact on reducing pollution. The use of regulation and legislation to clean up the environment should not be neglected, but expanding the impact of direct actions by consumers will give the environmental improvement stool a third leg to stand on.

The “right” kind of green energy for individual consumers will depend on their values, their willingness to pay for reduced environmental impacts, and their access to reduced-emission options. Given the diversity among both individuals and organizations, it is likely that different individuals and organizations will come to different conclusions about the type of green energy that is right for them.

This report accommodates this diversity by examining the issues that underlie green energy choices, developing a framework for making conclusions, and then providing the information needed to make decisions. Organizations can use this information to make green energy recommendations to their members based on the objectives of their organization. The *Consumer Guide to Green Energy Choices* presents this information in a step-by-step manner. The report:

(1) Examines how consumer energy use causes air pollution and other environmental impacts.

(2) Provides some context for evaluating the emissions caused by our energy use, the health effects of air pollution, and how much energy the United States uses per capita relative to other countries.

(3) Identifies green energy types and actions for consumers.

(4) Evaluates the environmental benefits of various types of green energy.

(5) Presents the costs of various types of green energy.

(6) Presents survey results on consumers’ willingness to pay for reduced emissions and their views on different emission reduction options.

(7) Concludes by reviewing the highlights of what issues individuals should consider when deciding what kind of green energy to buy, and what issues organizations should consider when deciding what options to recommend to their members.

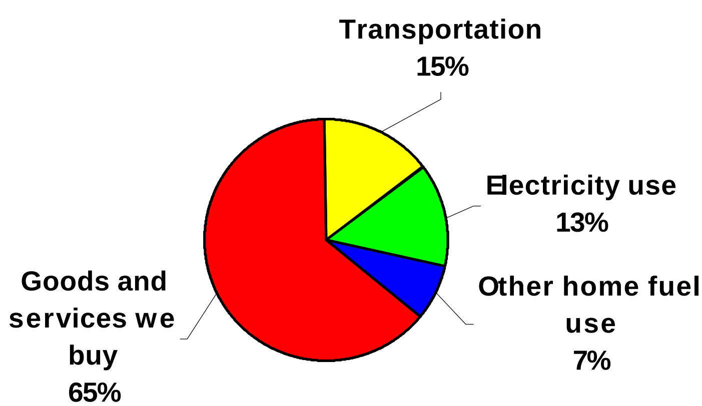
Pollution and Other Environmental Impacts of Consumer Energy Use

How Do We Cause Air Pollution?

We cause air pollution directly through our use of electricity, fuels, and transportation. We also cause air pollution *indirectly*, when we buy goods and services that use energy in their production and delivery. Electricity and home fuel use could be categorized as just another good or service we buy that uses energy in its production and delivery. Either way, we are still responsible for the air pollution caused by both our direct and indirect energy consumption.

In the United States, the conventional production of electricity from power plants causes more air pollution than any other source, and contributes to global warming. In 1997, the burning of fossil fuels–such as coal, oil, and natural gas–accounted for 82% of greenhouse gas emissions.[1] Traditional fossil fuel-based energy generation also emits lead, mercury, sulfur dioxide, particulate matter, carbon monoxide, nitrogen oxides, and volatile organic compounds.

Figure 1.1: How Do We Cause Air Pollution? [1,2]



Carbon dioxide is a good indicator of how much fossil fuel is burned and how much of other pollutants we cause to be emitted. Using carbon dioxide as an example, Figure 1.1 presents the distribution of causes of air pollution by an average family in the United States. Since individual electricity use and other home fuel use account for only 13% and 7% of our total emissions, to really clean up the environment, we need solutions that reduce *all* of the emissions we cause.

How Much Air Pollution Do We Cause?

Table 1.1 shows how much air pollution is caused by the average family and individual person (per capita) in the United States each year. The per capita emissions are calculated by dividing the total national emissions of each pollutant by the total population. The average family's share of the national emissions is calculated by multiplying the per capita share by the average family size of 2.6 people per household.

These per capita and per family pollution numbers indicate how much each of us would need to reduce the emissions caused by our energy use to cause a major reduction in national emissions. Since our direct energy use causes only 35 percent of our emissions, while our indirect energy use causes 65 percent of our emissions, to have the greatest effect on reducing the emissions caused by our energy use, we need green energy options that address both direct and indirect energy use .

Table 1.1 Air Pollution Produced by the Average U.S. Family and Per Capita Levels of Direct and Indirect Energy Consumption

Pollutant	Environmental Impacts	Family Yearly Pollution Production		Per Capita Yearly Pollution Production	
Carbon Dioxide (CO_2)	Climate Change	56 tons	112,000 lbs.	22 tons	44,000 lbs
Sulfur Dioxide (SO_2)	Acid Rain and Haze	0.187 tons	374 lbs	0.072 tons	144 lbs
Nitrogen Oxides (NOx)	Acid Rain, Ozone, and Haze	0.229 tons	458 lbs	0.088 tons	176 lbs
Particulate Matter (PM)	Haze	0.032 tons	63 lbs	0.012 tons	24 lbs
Lead (Pb)	Toxics	-	0.075 lbs	-	0.031 lbs
Mercury (Hg)	Toxics and Bio-accumulation	-	0.050 lbs	-	0.019 lbs

Emission Levels Around the World

Although the United States contains less than 5% of the world's population, it generates almost 25% of its air pollution. Most countries that maintain a similar standard of living as the United States use much less energy per capita, and therefore are likely to produce fewer emissions per capita. Tables 1.2 and 1.3 compare the per capita emissions of carbon dioxide for selected developed countries and regions of the world.

There is a lot of room for emission reductions in the United States, without incurring a significant drop in standard of living. Greater investments in energy efficiency provide an avenue for moving in this direction. Increasing energy efficiency often offers the lowest cost option for decreasing our energy needs, and meeting future needs. With energy efficiency, reduction in electricity production does not necessarily mean a reduction in the effective services received. For example, efficient lighting and heating technologies deliver a similar, and often improved level of light and comfort, in addition to cost savings over time.

Table 1.2 Per Capita Emissions of Carbon Dioxide for Selected Developed Countries [3]

Country	Population (millions)	Carbon Dioxide Emissions		Carbon Dioxide Emissions Per Capita	
		(millions of metric tons)	(millions of short tons)	(metric tons per person)	(short tons per person)
Switzerland	7	44	49	**6.1**	**6.7**
France	58	374	412	**6.4**	**7.1**
Sweden	9	59	65	**6.7**	**7.4**
Japan	126	1063	1172	**8.4**	**9.3**
United Kingdom	59	568	626	**9.6**	**10.6**
Germany	82	873	962	**10.6**	**11.7**
Australia	19	290	320	**15.6**	**17.2**
USA	270	5375	5925	**19.9**	**21.9**

Table 1.3 Per Capita Emissions of Carbon Dioxide for Selected Regions of the World [3]

Region	Population (millions)	Carbon Dioxide Emissions		Carbon Dioxide Emissions Per Capita	
		(millions of metric tons)	(millions of short tons)	(metric tons per person)	(short tons per person)
North America	400	6211	6846	**15.5**	**17.1**
South America	408	440	485	**1.1**	**1.2**
Western Europe	474	3557	3921	**7.5**	**8.3**
Eastern Europe and Counties of Former Soviet Union	390	3007	3315	**7.7**	**8.5**
Middle East	152	928	1023	**6.1**	**6.7**
Africa	760	807	890	**1.1**	**1.2**
India	984	851	938	**0.9**	**1.0**
China	1237	2948	3250	**2.4**	**2.6**
World	5940	22132	24396	**3.7**	**4.1**

Effects of the Air Pollution We Cause

The energy choices you make have a direct impact on public health and the environment. Traditional fossil fuel-based sources of electricity deliver detrimental health and environmental consequences. Table 1.4 summarizes some sources and effects of common air pollutants.

Health Effects

Exposure to emissions of lead, mercury, sulfur dioxide, particulate matter, carbon monoxide, and ozone-forming nitrogen oxides and volatile organic compounds are hazardous to public health. Toxic compounds, like mercury and lead, poison organ systems and can lead to brain damage and death. Fish consumption advisories have been imposed in parts of the country where lakes and waterways have been contaminated with mercury from electric power plants. Other pollutants cause respiratory and other health problems, particularly in children and the elderly. One study estimated that each year in the United States, more people die prematurely from heart and lung disease due to particulate air pollution than die in car accidents.[5]

Environmental Effects

Climate change on a global scale has been attributed to increased emissions of carbon dioxide (CO_2), a greenhouse gas. A global average temperature rise of 1° to 3.5°C could have serious implications. Possible consequences include melting of polar ice caps; an increase in sea level; and increases in precipitation and severe weather events like hurricanes, tornadoes, heat waves, floods, and droughts. Indirect effects include increases in infectious disease, weather-related deaths, and food and water shortages. All these effects put a stress on ecosystems and agriculture, and threaten our planet as a whole.

Other atmospheric effects of air pollution include urban smog and reduced visibility, associated with ozone-forming nitrogen oxides and volatile organic compound emissions. Visibility is also affected by emissions of sulfur dioxide and fine particulates. Sulfur dioxide and nitrogen oxides combine with water in the atmosphere to cause acid rain, which is detrimental to forests and other vegetation, soil, lakes, and aquatic life. Acid rain also causes monuments and buildings to deteriorate.

Economic Effects

The effects of air pollution on human health and the environment have economic impacts. According to the Healthy People 2000 report[6], each year in the United States:

- The health costs of human exposure to outdoor air pollutants range from $40 to $50 billion.
- An estimated 50,000 to 120,000 premature deaths are associated with exposure to air pollutants.
- People with asthma experience more than 100 million days of restricted activity, costs for asthma exceed $4 billion, and about 4,000 people die of asthma.

The Environmental Defense Fund (EDF) article,[7] "Why is it Better to Buy Green Electricity?" states that acid rain causes $6 billion a year in damage to crops, forests, lakes, and buildings. The potential economic impact of global warming is estimated to be in the billions of dollars. While green sources of electricity may cost more, they do not incur the external costs of traditional fossil fuel-based generation. The EDF article states that:

> "Increasing reliance on green sources reduces financial risks such as future regulations, taxes on greenhouse gases, and price fluctuations associated with fossil fuels. Green resources increase U.S. energy self sufficiency, and thus economic security, by reducing reliance on fossil fuel imports. They also help reduce current rapid depletion of natural resources.
>
> Green resources are a good source of jobs and income because they rely on local labor, land, and resources. Rural communities would probably benefit the most from renewable energy development, as wind and biomass energy production is likely to take place in rural areas."

Air Pollution Regulation

In the United States, National Ambient Air Quality Standards (NAAQS) regulate six pollutants (criteria pollutants): ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter (PM-10), and lead. These standards are put in place by the U.S. Environmental Protection Agency (US EPA) as a result of the Clean Air Act, and define an acceptable level of pollutant concentration, at or above which, public health is protected. A stricter primary standard aims to protect public health, while a more lax secondary standard is intended to protect public welfare (vegetation, wildlife, etc.).

A geographic area that meets or does better than the primary standard is called an attainment area; areas that do not meet the primary standard are called nonattainment areas. It has been estimated that 90-100 million people in the United States live in nonattainment areas [4, 8], and therefore remain at risk for adverse health consequences. Children, the elderly, and people with asthma are among those who are most susceptible to the health effects of air pollution.

These health and environmental effects demand that action be taken to reduce air pollution. An Environmental Defense Fund article[7] notes that in 1994, electricity generation was responsible for 70% of sulfur dioxide emissions, 33% of nitrogen oxide emissions, 23% of mercury emissions, and 23% of direct emissions of fine airborne particles. Fossil fuel combustion is at least part responsible for the emissions of all of the pollutants listed in Table 2.3. These pollutants, and their associated health and environmental effects, can be reduced by investing in green energy and electricity.

Table 1.4 Sources and Effects of Common Pollutants [4]

Pollutant	Anthropogenic Sources	Human Health Effects	Environmental Effects
Ozone (O_3)	Secondary pollutant formed by chemical reaction of VOCs and NOx in the presence of sunlight.	Breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduces resistance to colds and infections, premature aging of lung tissue.	Damages crops, forests, and other vegetation; damages rubber, fabric, and other materials; smog reduces visibility.
Nitrogen Oxides (NOx)	Burning of gasoline, natural gas, coal, oil. (Cars are a major source of NOx.)	Lung damage, respiratory illnesses, ozone (smog) effects.	Ozone (smog) effects; precursor of acid rain which damages trees, lakes, and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate.
Carbon Monoxide (CO)	Burning of gasoline, natural gas, coal, oil.	Reduces ability of blood to bring oxygen to body cells and tissues.	
Volatile Organic Compounds (VOCs)	Fuel combustion, solvents, paint. (Cars are a major source of VOCs.)	Ozone (smog) effects, cancer, and other serious health problems.	Ozone (smog) effects, vegetation damage.
Particulate Matter	Emitted as particles or formed through chemical reactions; burning of wood, diesel, and other fuels; industrial processes; agriculture (plowing, field burning); unpaved roads.	Eye, nose, and throat irritation; lung damage; bronchitis; cancer; early death.	Source of haze which reduces visibility. Ashes, smoke, soot, and dust can dirty and discolor structures and property, including clothes and furniture.
Sulfur Dioxide (SO_2)	Burning of coal and oil, especially high-sulfur coal; industrial processes (paper manufacturing, metal smelting).	Respiratory illness, breathing problems, may cause permanent damage to lungs.	Precursor of acid rain, which can damage trees, lakes, and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate.
Lead	Combustion of fossil fuels and leaded gasoline; paint; smelters (metal refineries); battery manufacturing.	Brain and nervous system damage (esp. children), digestive and other problems. Some lead-containing chemicals cause cancer in animals.	Harm to wildlife and livestock.
Mercury	Fossil fuel combustion, waste disposal, industrial processes (incineration, smelting, chlor-alkali plants), mining.	Liver, kidney, and brain damage; neurological and developmental damage.	Accumulates in food chain. Harm to wildlife (e.g. fish, loons, and eagles)

Section 1 Sources

[1] Emissions of Greenhouse Gases in the United States 1997, Energy Information Administration Publication, U.S. Department of Energy, DOE/EIA-0573(97), October 1998.

[2] State Energy Data Report 1995, Energy Information Administration Publication, U.S. Department of Energy 1998.

[3] Energy Information Administration, International Energy Database, 1997.

[4] The Plain English Guide to The Clean Air Act, U.S. EPA Office of Air Quality Planning and Standards Publications, EPA-400-K-93-001, April 1993. Retrieved from World Wide Web at *http://www.epa.gov/oar/oaqps/peg_caa/pegcaa11.html* and *http://www.epa.gov/oar/oaqps/peg_caa/pegcaa03.html*

[5] Shprentz, D., Breath-Taking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities, NRDC, May 1996. Taken from "Our Children At Risk", NRDC Online Report, Chapter 4. Retrieved from World Wide Web at *http://www.nrdc.org/nrdcpro/ocar/chap4.html*

[6] Air Pollution and Respiratory Health, Centers for Disease Control and Prevention (CDC) - National Center for Environmental Health (NCEH). Retrieved from World Wide Web at *http://www.cdc.gov/nceh/pubcatns/1994/cdc/brosures/airpollu.htm*

[7] Environmental Defense Fund (EDF) article, "Why is it Better to Buy Green Electricity?" Retrieved from World Wide Web at *http://www.edf.org/programs/energy/green_power/a_better.html*

[8] USA Air Quality Nonattainment Areas, US EPA Office of Air Quality Planning and Standards. Retrieved from World Wide Web at *http://www.epa.gov/airs/nonattn.html*

Section 2 What is Green Energy?

What is Green Energy?

A consensus has not yet been reached on how to define green energy. Some consider all reduced-emission electricity to be green energy, while others include only renewable energy. Some define green energy as all renewable energy except for hydropower and certain forms of biomass power, while others include small existing hydropower in their definition. For the purposes of this report, we used a broad definition of green energy to include all options that reduce the pollution and other environmental impacts caused by a consumer's energy use, as compared to the current generation mix. This definition would include fuel switching from coal to natural gas generation, but not nuclear power because of the added negative environmental impacts.

The objective of green energy is to reduce the pollution and other environmental impacts caused by a consumer's energy use. Green energy options include all the ways that reduce the pollution and other environmental impacts caused by a consumer's energy use. It includes energy produced with increased energy efficiency, renewable energy, and cleaner fuels. The greater the reduction in pollution and other environmental impacts that result from consumer's energy use that a green energy option provides, the greener the energy.

Traditional Sources of Energy and Electricity

Fossil Fuels

Most of a typical U.S. consumer's energy comes from the burning of fossil fuels. Fossil fuels include coal, oil, and natural gas. Fossil fuels cause air pollution when they are burned and also cause indirect environmental effects. These indirect environmental effects include the extraction of fuel from the earth, the construction and maintenance of transportation facilities and pipelines to deliver the fuel to where it is used, and the construction of electric generating plants and electric transmission and distribution lines. Fossil fuels are not renewable – we are currently using them faster than they can be replenished.

Nuclear Power

Nuclear energy currently provides about 20% of the electricity generated in the United States. Nuclear power is created by the splitting (fission) of atomic nuclei, namely uranium or plutonium. This process generates the necessary heat to convert water to steam to drive turbines that generate electricity. Although nuclear power emits little air pollution, the storage of radioactive nuclear waste and chances of nuclear reactor accidents are environmentally dangerous and controversial.

Renewable Sources of Energy and Electricity

In contrast to fossil fuels, renewable energy is often in infinite supply and less polluting. Renewable energy includes solar (photovoltaics), wind, biomass, hydropower, and geothermal. Renewable energy can be used as a form of supplying energy in homes and businesses, and can also be converted directly to electricity.

Currently, most electricity production in the United States comes from coal-fired power plants. In some areas, consumers can impact the amount of air pollution emitted from power plants by choosing to buy electricity generated by renewables or cleaner fossil fuels. Green electric power is being offered in parts of the country where electric utility deregulation has occurred, such as California, Pennsylvania, and Massachusetts. Where electric industry competition does not exist, some utilities offer special “green rates” to their customers for electricity generated from renewables. In this case, these rates are set by regulations rather than competition. Consumers need to make sure any premiums they pay for green electricity are going towards new, not mandated, renewable generation.

Solar

Energy from the sun can be used in several ways. For example, solar energy can be used to heat homes by taking advantage of south-facing windows (solar heating), and can be used to heat water (solar water heating) with flat plate solar collectors. Energy from the sun can also be used to generate electricity. Sunlight can be used to heat water to create steam, which powers a turbine and generates electricity (solar thermal electric power). Photovoltaic (PV) cells, or solar cells (much like those on a solar calculator), convert sunlight directly into electricity. Thousands and thousands of these cells can be joined together to form a photovoltaic system that can be incorporated into an electric utility’s supply network.

Photovoltaic systems are ideal for remote or rural villages, and stand alone sites or residences. In early July 1998, photovoltaics became the fastest-growing energy source, as world-wide production increased 40% in the past year. Converting solar energy into electricity suffers from the constraint that electricity cannot be produced when the sun isn’t shining, like on cloudy days or at night. Photovoltaic energy systems can also be relatively expensive, however, it is expected that prices will continue to drop until photovoltaic is an economical energy source.

Wind

Wind can also be used to generate electricity and is the second-fastest growing energy source. Blades on a wind turbine turn when the wind blows, and drive a generator which produces electricity. Large groups of wind turbines are called wind farms. Wind energy can be used for individual residences and businesses, or can be connected to a utility power grid and transmitted over power lines. In order to generate electricity, wind speeds must be sustained above about 10 mph, although average wind speeds of at least 14 mph are desirable. Since wind speeds are less at ground level than at higher elevations, more wind power can be achieved with taller towers. Wind turbines are usually constructed in the windiest areas, although there are many locations throughout the United States and the rest of the world that are suitable for wind power production. Wind energy is an intermittent source since wind does not blow at consistent speeds and times. For this reason, small wind systems may need to use batteries for backup.

Biomass, Geothermal, and Hydropower

Biomass serves as another renewable energy source. Wood is the most common biomass fuel, but biomass includes many types of organic matter that can be converted into energy, such as plants, agricultural products and by-products (such as corn and sugarcane residue), animal waste, and even garbage. Biomass fuels can be burned to generate heat and electricity directly, converted to gaseous fuel like methane, or converted to liquid fuel such as ethanol and methanol. Agreement has not yet been reached regarding which types of biomass energy should be regarded as renewable or green energy.

Geothermal energy comes directly from the interior of the earth. The heat from hot, molten rock far below the earth's surface can be used to heat large reservoirs of water, or to create steam that can be used to power turbines that generate electricity.

Hydropower accounts for over 90% of all electricity that comes from renewable resources. Electricity can be generated by collecting water in a reservoir, such as behind a dam, and then allowing it to flow past a turbine that is connected to a generator. By comparison, water is cleaner than fossil fuels for electricity generation, however, large dams stop the natural flow of water which can destroy vegetation, aquatic life, and cause other serious ecological damage.

Much more detailed information on renewable energy resources is widely available on the Web. The Energy Efficiency and Renewable Energy Network of the U.S. Department of Energy is one such source (http://www.eren.doe.gov).

Environmental Benefits of Green Energy

Green energy has the potential of significantly reducing the health problems, environmental destruction, greenhouse gas emissions, and other impacts associated with traditional forms of energy. Not only is the fuel itself cleaner and oftentimes renewable, but green energy can reduce the negative environmental impacts that result from the entire process of producing and delivering fuel to customers. These indirect environmental effects include the extraction of fuel from the earth, the construction and maintenance of transportation facilities and pipelines to deliver the fuel to where it is used, the construction of electric generating plants, and the construction of electric transmission and distribution lines. All of these facilities have a negative impact on the environment. How the various types of green energy affect these indirect environmental impacts needs to be considered when evaluating the relative merits of green energy options. A summary of the indirect environmental impacts reduced by different types of green energy is given in Table 2.1.

For example, our use of natural gas causes environmental emissions when we burn it for cooking or heating. Our demand for natural gas requires the construction of pipelines and other infrastructure needed to deliver natural gas to consumers, and the extraction of natural gas from the earth. If we use less natural gas, we decrease these impacts.

When we use electricity, we cause air pollution to be emitted from power plants. As our demand for electricity increases, we also increase: the number of electric distribution and transmission lines; construction of new power plants; the amount of train systems, pipelines, and other infrastructure needed to deliver fuel to power plants; and the need to mine or extract fuels from the earth. When we reduce how much electricity we use, we reduce all of these environmental impacts.

When we buy electricity produced by renewable energy, like wind for example, we reduce the need for fuel extraction from the earth, train systems, pipelines, and other infrastructure. However, power plants in the form of wind generators and electric transmission and distribution lines must still be built to deliver power to customers. Wind generators that are located directly on the consumer's site reduces the amount of transmission and distribution lines needed.

Green Energy Actions for Consumers

As consumers, we have many green energy options available to us that reduce the pollution caused by our energy use. The green energy choices we make can have a big impact on reducing air pollutant emissions. Conserving energy is one way we can reduce our emissions–many of us already turn off lights when not in use and adjust the thermostat a couple degrees up or down depending on the season. But beyond energy conservation, what can we do to reduce our emissions? Consumers can reduce the environmental impacts of their energy use by increasing the efficiency of their energy use, purchasing cleaner or renewable energy and electricity, and buying and retiring emission reduction credits.

Green Household Energy Use

Electricity and other home fuel use is responsible for approximately 20% of the average U.S. household's pollutant emissions. Consumers can reduce the emissions, and therefore the environmental impacts caused by their home energy use by using energy efficiently, and using renewable energy and cleaner fuels.

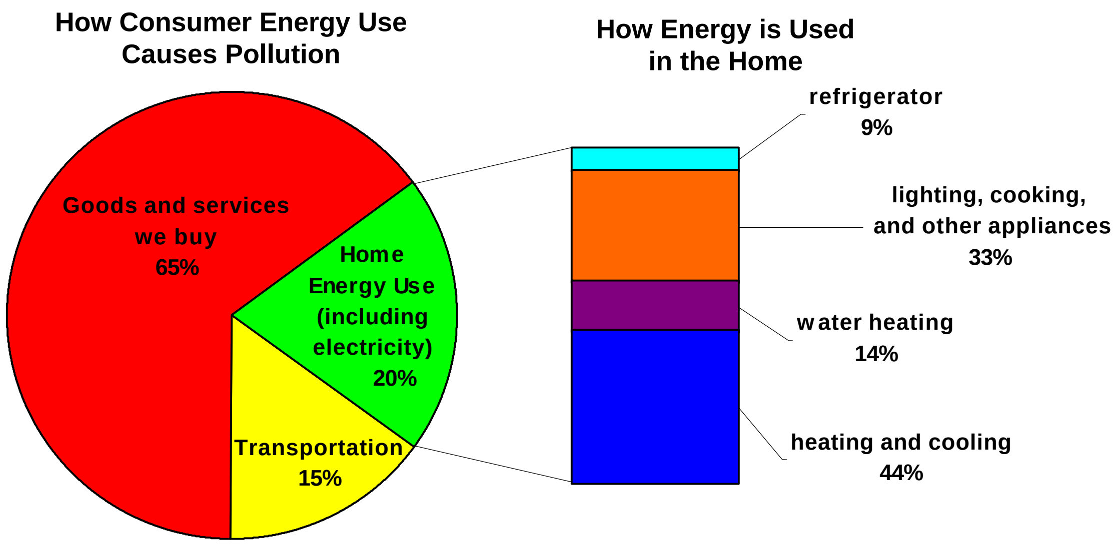
Energy Efficiency

Many low cost energy efficiency measures are available to consumers for decreasing their home energy and electricity use. And while most energy efficiency options may cost a little more at the time of purchase, they save the consumer money over the life of the equipment. Consumers can expect to save between 10% and 50% on utility bills by implementing energy efficiency measures in their homes. In addition, utility companies often offer rebates and other incentives for making homes more energy-efficient.

Buying energy-efficient appliances and light bulbs, switching to natural gas, and installing insulation and programmable thermostats are just a few of the ways consumers can be energy-efficient. When buying new appliances (furnaces, air conditioners, refrigerators, washers, water heaters, clothes driers, etc.) compare Energy Guide labels and look for the Energy Star – a label given by the U.S. EPA and U.S. DOE to products whose energy efficiency rating is best in its category and also exceed the minimum federal standards.

Figure 2.1 shows how energy is used in a typical household.

Figure 2.1 Distribution of Energy Use in a Typical Household



Heating and cooling consumes the most energy (44%) in an average household. Consumers can reduce the energy used for heating and cooling by conserving energy and implementing the following energy efficiency measures:

- ✓ Lower the thermostat in winter; raise it in the summer
- ✓ Use shades and drapes to block sunlight out during hot weather and let sunlight in during cold weather
- ✓ Use ceiling fans in the summer and winter to keep air circulating and mixed
- ✓ Caulk, weatherstrip, and insulate walls, attics, basements, windows, doors, and pipes
- ✓ Clean and service furnace and air conditioner, replace filters as recommended
- ✓ Install a programmable thermostat
- ✓ When replacing windows, buy double- or triple-pane storm windows with solar control or low emissivity (low-E) glass

The water heater and refrigerator account for 14% and 9% of household energy use, respectively. The following practices can help to reduce the energy used by these appliances:

- ✓ Keep hot water heater set between 120 and 140°F
- ✓ Wrap your water heater with an insulating blanket to reduce heat loss
- ✓ Keep the refrigerator set between 36 and 38°F, keep freezer set between 0 and 5°F
- ✓ Check for leaks around refrigerator doors, keep coils clean, defrost freezer to eliminate ice buildup
- ✓ Consider replacing an older inefficient refrigerator with a new one–new refrigerators use up to half the energy of older models
- ✓ Remove old second refrigerator if possible, old appliances are usually inefficient and consume a lot of energy

The remaining portion of home energy (33%) is used for lighting, cooking, and other appliances. Consumers can reduce the energy used for these purposes by implementing the following energy conservation and energy efficiency measures:

- ✓ Turn off lights and appliances when not in use
- ✓ Replace incandescent light bulbs with compact fluorescent
- ✓ Install dimmers and timers on lights
- ✓ Washer: Use cold or warm water for the wash cycle; use hot only for very dirty loads; always use cold water for the rinse cycle; use appropriate water level and amount of detergent
- ✓ Dryer: Clean lint screen after every use, keep vents and ducts clean, hang clothes to dry
- ✓ Use the microwave instead of the stove whenever possible
- ✓ When replacing appliances (furnaces, air conditioners, water heaters, clothes dryers, etc.), buy those that are energy-efficient. When buying new appliances, compare Energy Guide labels, and look for the Energy Star. Energy Star products also save money on utility bills. The energy savings from newer, more efficient appliances can make up for the purchase price of the appliance in just a few years.
- ✓ Appliances that run on natural gas are often more efficient and cause less pollution than those that run on electricity

These are only a few of the low cost ways consumers can make their energy use efficient and decrease pollution from home energy use. To find out how you can further improve the energy efficiency of your home, consider having a home energy audit done. Many tips for making homes energy-efficient are also available on the Web. The following web sites offer helpful information on energy efficiency and renewable energy:

- Energy Efficiency and Renewable Energy Network (EREN) of the U.S. Department of Energy, (http://www.eren.doe.gov)
- Renewable Energy: A Guide to the New World of Energy Choices, available from EREN at http://www.eren.doe.gov/consumerinfo/
- Energy Savers, available from EREN at http://www.eren.doe.gov/consumerinfo/energy_savers

- The Energy Advisor feature of the Home Energy Saver Web Site (http://hes.lbl.gov/hes/vh.html)

  The Energy Advisor is a helpful tool for comparing the utility bills for an average home to an energy-efficient home in your area. The estimate also offers a breakdown of how the energy is used within a home (heating, cooling, appliances, etc.). The site also offers specific recommendations for updating to a more energy-efficient home.

- Energy Star® (http://www.energystar.gov)

  The Energy Star Web Site lists products that have earned the Energy Star Label and features a store locator. The site also offers appliance-buying tips.

Implementing energy efficiency measures in the home has the advantage of saving money on utility bills and can typically reduce air pollutant emissions by 20%. However, since electricity and other home fuel use only account for 20% of a household's total emissions, increased energy efficiency will only counteract a small portion (≈4%) of a consumer's total household air pollution emissions.

Purchasing Cleaner or Renewable Energy and Electricity

Consumers can reduce the emissions that result from their energy use by investing in cleaner or renewable energy and electricity, either on or off their site. On-site renewable energy alternatives for consumers include solar hot water heaters, photovoltaic arrays, and small wind generators.

Energy produced from renewable sources offers many environmental benefits over fossil fuels. When we buy electricity produced by renewable energy, like wind for example, we reduce the emission of air pollutants associated with the burning of fossil fuels. We also reduce the need for fuel extraction from the earth, fuel transportation systems, pipelines, and other infrastructure. However, power plants in the form of wind generators and electric transmission and distribution lines must still be built to deliver power to customers.

Electricity generated by renewables also has positive emission reduction benefits, but availability can be restricted by the status of electric industry deregulation. In areas where utilities still have a retail monopoly, green electricity is only available to consumers if the utility chooses to make it available, or if regulations require that it be made available. In this situation, green electricity services are only available at non-competitive prices set through the regulatory process. Where utility deregulation has created fully competitive retail energy services markets, green electricity can be purchased at prices set by the competitive market, i.e. at lower prices than where the utility still has a retail monopoly. However, in many emerging competitive markets, transition costs will delay this effect for several years.

Wind-generated electricity is the most common renewable resource available. This option is available in many areas at a price a bit above the cost of fossil fuel-generated electricity. Biomass energy is available at moderate costs, and emerging biomass technology can produce electricity at cost savings. Electricity generated by photovoltaics is relatively more expensive, however the use of photovoltaics is increasing as costs continue to decrease.

Another option is buying electricity generated with lower environmental emissions. For example, since natural gas burns much more cleanly than coal, changing the fuel burned to generate electricity from coal to natural gas will decrease emissions by about two thirds. However, fuel costs would increase because natural gas is more expensive than coal.

Combining a cleaner fuel with a more efficient generation design, like natural gas combined cycle[1], can also reduce emissions. This very clean and efficient type of generation reduces carbon dioxide (CO_2) emissions approximately 60% over the average emission rate for electric generation, and provides a cost savings to the consumer. This significant reduction in emissions from electric generation is achieved utilizing a mature and widely used generation technology. In fact, the majority of the new generation capacity currently being planned or built in the United States is natural gas combined cycle because it is a reliable technology that has relatively low capital investment and environmental emissions compared to coal-fired generation. However, the cost of natural gas-fired combined cycle generation is more sensitive to fuel costs than typical coal-fired generation. Broad implementation of natural gas combined cycle generation could have an uncertain effect on natural gas prices and the consequent competitiveness of this generation option. Planners question natural gas suppliers who assert that natural gas reserves are not a problem.

Green Transportation

To use energy efficiently and reduce air pollutant emissions in the transportation sector, consumers should use mass transit, car pool, telecommute, and bike and walk as much as possible. When consumers do drive, they can make sure that tires are properly inflated, and air and oil filters are clean. Cars that are properly tuned up use less gasoline. When the time comes to buy a new vehicle, look for smaller, more fuel-efficient vehicles that get good gas mileage.

In the future, electricity, fuel cells, and liquid fuels derived from biomass may power more of our cars. Vehicles that use renewable fuels are already available. According to “Fuel-Cycle Fossil Energy Use and Greenhouse Gas Emissions of Fuel Ethanol Produced from U.S. Midwest Corn” by Argonne National Laboratory in 1997, using E85 fuel reduces CO_2 emissions by 41.1% over conventional gasoline. Flexible fuel vehicles that can operate on E85 are readily available to consumers in the form of Ford’s Taurus sedan and Ranger pickup, Mazda’s B3000 pickup, and a variety of Chrysler and Plymouth minivans all priced identically to their standard gasoline counterparts.

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[1] Combined Cycle is an efficient electric generating technology which makes use of the otherwise lost waste heat exiting from gas (combustion) turbines. The hot exhaust gas from the turbine is converted to steam and used to power a steam turbine to produce additional electricity.

Green Goods and Services

To reduce emissions that result from the production and delivery of goods and services we buy, we can purchase goods and services that are produced and delivered in cleaner ways. For example, commodities that are grown or produced locally can reduce emissions that result from shipping. Consumers can also look for reusable and recyclable products, avoid excess packaging, and buy from companies that have good environmental track records.

Emission Offsets

Sources of air pollution that reduce their emissions below their required limit (cap) may receive saleable credits for their reductions. These reductions are measured and recorded in an appropriate way so that the resulting credits can be bought, sold, and traded. Emission reduction credits reward those who take action to reduce their pollutant emissions and therefore encourage pollution reduction actions. Credits for emission reductions provide an incentive to find the most cost-effective way to reduce emissions, since once an emission reduction credit is earned, it can be sold on the open market.

Emission reduction credits can also be used to reduce pollution even further. Instead of reselling emission reduction credits to sources of air pollution that will use them to compensate for their pollutant emissions, credits and allowances can be retired, *without* emitting any pollution. Once an emission reduction credit is retired, it can no longer be bought, sold, or used to offset pollution. Purchasing and retiring emission reduction credits and allowances reduces the amount of pollution that is discharged to the atmosphere for regulated markets, and creates future pollution reduction potential for voluntary markets.

Consumers can purchase emission reduction credits and emission allowances in the marketplace, and retire them to cancel out (offset) part or all of the emissions caused by their energy use. This is a low cost and convenient approach, and allows consumers to offset their net emissions, including those produced by goods and services purchased, by 100 percent (to zero).

This gives people the option of reducing the environmental impacts of their energy use directly, or they can buy and retire emission reductions in the form of emission reduction credits created from someone else implementing efficiency or renewable energy projects. The same overall environmental benefits are achieved either way.

What is a Good Way to Evaluate Green Energy Options?

Based on Figure 1.1, using green electricity will only reduce the total amount of air pollution caused by our energy use by 13%. To reduce all of the emissions caused by our energy use, we must also account for the emissions that result from transportation, home fuels, and the production and delivery of goods and services we buy.

We can take action to reduce emissions that result from our energy use in all of the sectors. For example, increasing our reliance on mass transit and buying cleaner, more efficient vehicles can reduce air pollution emissions in the transportation sector. Making our energy use and homes more energy-efficient, for example replacing less efficient appliances (water heaters, furnaces, stoves, clothes dryers, etc.) with those that are more efficient and run on natural gas, can reduce overall emissions from home energy use.

To reduce emissions from the goods and services sector, we can purchase goods and services that are produced and delivered in cleaner ways. We can also buy emission reduction credits from energy efficiency and renewable energy projects to offset part or all of the emissions caused by our energy use. This amounts to paying someone else to reduce *their* emissions to compensate for the emissions that result from our energy use.

We all use energy in many direct and indirect ways. The direct ways we use energy include heating and cooling, appliances and lights, and transportation. We use energy indirectly by purchasing goods and services that use energy in their production and delivery. We must consider the entire picture when we make energy choices. A good way to evaluate green energy is to look at how each green energy option reduces the total environmental impact caused by both our direct and indirect energy use.

Table 2.1 The Green-O-Meter: A Summary of the Environmental Benefits of Different Types of Green Energy

Types of Green Energy	How much of each consumer's per capita share of national air pollution can be reduced	Reduced air pollution from electric generation	Reduced solid waste disposal	Reduced need for fuel extraction	Reduced need for fuel transmission and distribution or transportation facilities	Reduced need for electric transmission and distribution facilities	Reduced need for electric generating plants	Reduced air pollution from our home fuel use	Reduced air pollution from our cars and trucks	Reduced environmental impacts of energy used to produce and deliver the goods and services we buy
Emission offsets (buying and retiring emission reduction credits)	up to 100%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Increasing efficiency of our own energy use	up to 10%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	yes	No
On-site renewable energy	up to 13%	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Off-site renewable energy	up to 13%	Yes	Yes	Yes	Yes	No	Yes	No	No	No
End use fuel switching to a cleaner fuel (replace coal-fired electricity generation with natural gas)	up to 8%	Yes	Yes	No	No	Yes	Yes	No	No	No
Change fuel used to generate electricity from coal to biomass fuels	up to 13%	Yes[1]	Yes	Yes	Maybe[2]	No	No	Maybe[2]	No	No
Existing generation efficiency improvements	up to 1%	Yes	Yes[3]	Yes	Yes	No	No	No	No	No
New high efficiency natural gas-fueled electric generation (combined cycle)	up to 9%	Yes	Yes	Yes	Yes	No	No	No	No	No
Change fuel used to generate electricity from coal or oil to natural gas	up to 8%	Yes	Yes	No	No	No	No	No	No	No

1. Impact varies by type of emission and combustion process.
2. No, if fuel used is from distant source; yes, if fuel used is from a nearby source.
3. Impacts vary by existence and level of fuel reductions.

Section 3 Analysis of Energy Efficiency Options for Green Energy

Introduction

Energy efficiency is a very important part of the energy puzzle. This is because a significant portion of future electricity needs for most of the United States could be met more cheaply by investing in energy efficiency than by building and operating new electric generating plants. Inclusion of end use energy efficiency programs in a utility's resource mix also reduces overall risk to the organization by diversifying their energy portfolio (Hewett, 1998). Not only are investments in energy efficiency often the lowest cost option, but these investments have been shown to provide other positive economic benefits on a statewide level. These benefits include increased employment and income benefits for residents, businesses, and farmers. Energy efficiency is also a low cost way to reduce the emissions of greenhouse gases and other pollutants.

A number of state and national studies have shown that cost-effective investments in energy efficiency measures can significantly reduce emissions and stimulate economic growth (e.g. Sanghi, 1992; Krier et al., 1993; Laitner, 1994 and 1991; Geller, 1992; and Weisbrod, 1995). A Wisconsin Study (Clemmer, Olson, and Arny, 1998) on the economic and greenhouse gas emission impacts of electric energy efficiency investments showed that implementing cost-effective measures (mostly energy efficiency) in Wisconsin would by 2010:

- Reduce emissions in Wisconsin
    - Reduce greenhouse gas emissions by 12.5 million tons (7% of expected total)
    - Reduce nitrogen oxide (NOx) emissions by 19,000 tons (7% of expected utility emissions in 2010)
    - Reduce sulfur dioxide (SO_2) emissions by 29,000 tons (11% of expected utility emissions in 2010)
    - Reduce particulate (PM10) emissions by 1,600 tons (11% of expected utility emissions in 2010). Note: PM2.5 is 40-50% from SO_2 emissions and 15% from NOx emissions, so above reductions would significantly reduce PM2.5
    - Reduce mercury (Hg) emissions by 300 pounds (11% of expected utility emissions in 2010)
    - Reduce ash production by 220,000 tons (12% of expected utility emissions in 2010)
- Create 8,500 new jobs
- Increase disposable income by $490 million
- Increase gross state product by $41 million
- Reduce projected statewide electricity use in Wisconsin by more than 9 million megawatt hours in 2010. This is equivalent to displacing the electricity generated from five 265 megawatt power plants or consumed annually by more than one million households.
- Reduce the need for electric generation capacity additions by more than 1300 megawatts
- Decrease energy and operating expenditures by $4.44 billion between 1997 and 2010. Given the investment of $1.75 billion needed to install the more efficient technologies for consumers and businesses during the same period, this amounts to a total net savings of $2.69 billion or a benefit-cost ratio of 2.7.

Some states have competitive electricity markets, while other states are still in the planning stages or have no plans to deregulate in the near future. In this uncertain environment, many electric utilities have favored taking more short-term planning views. Many energy-efficient programs and measures require capital expenditures up-front but reduce overall costs over the long-term. This initial investment in an uncertain long-term utility environment is one possible explanation for the declining investments in recent years of utility-sponsored demand-side management (DSM) programs which have been occurring in recent years.

This report shows that cost-effective energy efficiency investments make sense for consumers in both regulated and competitive utility environments. Energy efficiency investments can produce overall cost savings when combined with other low to medium cost emission reduction measures, such as cleaner energy generation.

This section of the analysis looked at many end use energy efficiency technologies, as well as the cost-effectiveness of individual end use efficiency measures under different scenarios. The study identified the energy efficiency and fuel switching measures with the lowest net life cycle cost per ton of carbon dioxide (CO_2) reduced from a consumer perspective. This was accomplished by modeling individual reduction measures in the residential, industrial, commercial and institutional, and agriculture sectors. Alternate model scenarios were developed based on different levels of estimated emission costs for nitrogen oxides (NOx) and mercury which may be levied against energy producers in the future. This was done to study the effect which increased emission costs on energy providers have upon the cost-effectiveness of energy efficiency measures.

The analysis was carried out to the incremental cost and savings level. The costs and emission reduction results for energy efficiency measures are equally applicable in both regulated and competitive utility structures. Only the environment for promoting and implementing the cost-effective efficiency measures changes between the different utility structures.

Methodology

The energy efficiency and fuel switching measures used in this report were selected using the analysis of measures in the Wisconsin Greenhouse Gas Emission Reduction Cost Study, (WDNR 1998). (See Appendix A for a detailed description of the study methodology and a list of the specific measures ranked by their net cost of reducing greenhouse gas emissions.) The WDNR study analyzed hundreds of specific energy efficiency and fuel switching measures for different market segments and end uses within the residential, commercial, industrial, and agriculture sectors based on data from Wisconsin's Demand-Side Options Database (WDOD). The WDOD information was developed collectively by Wisconsin's utilities for use in the state's integrated resource planning process (ECW, 1994).

This report relied on the model used for the WDNR 1998 study. The WDNR 1998 study calculated costs and emission savings using a generation (avoided-cost) basis. Our study modified the model to calculate costs and emissions from an end user (consumer) perspective. We also developed alternate model scenarios based on different levels of estimated emission costs for NOx and mercury which may be levied against energy producers in the future.

Individual emission reduction measures were evaluated and compared based on their relative costs for reducing greenhouse gas emissions. To calculate the emission reduction cost, the net cost of the emission reduction measure was divided by the number of tons reduced. The net cost of the emission reduction measure is the cost of the measure minus the dollar value of all of the other benefits delivered. This approach is useful for comparing the cost per unit of emission reduction of individual greenhouse gas emission reduction measures.

All of the emission reduction measures were ranked based on the calculated consumer cost per ton for each measure. The net cost of each emission reduction option was calculated in the following manner. First the cost of each option was calculated on a per unit basis. Then the benefits of each option were subtracted from the option costs to calculate the net cost on a per unit basis. The benefits include: the contribution the option makes toward meeting the peak load (capacity value), the value of any reduction in emissions other than greenhouse gases, and for energy efficiency measures, the value of avoided electricity generation. Subtracting the capacity value of a measure, in terms of the cost of equivalent combustion turbine capacity, gives a normalized energy-only cost for each option.

The net greenhouse gas emission reduction for each option was determined incrementally versus the base situation. For end use measures this was determined by multiplying the energy savings by the utility system average emission factor projected for Wisconsin in 2010.

Several types of industrial process improvements and residential and commercial whole building increased energy efficiency and fuel switching measures, such as integrated heating, cooling, lighting, and building shell improvements were not considered. These areas have been shown to provide additional opportunities for increased energy efficiency and fuel switching in other studies.

The ongoing development of technical innovation and commercialization of new energy efficiency and fuel switching measures was not assumed. This analysis is limited to the best available measures between 1992 and 1995, when the WDNR 1998 analysis was carried out and when the WDOD data base was developed. New and improved technologies that are more efficient than those available between 1992 and 1995 continue to be developed and commercialized.

Results

The results show that many low cost emission reduction measures are available to end use consumers for decreasing greenhouse gases and other pollution from electric generation. Tables 3.1 through 3.4 show the most cost-effective end use efficiency measures from a consumer perspective within each sector. Appendix A shows a more detailed ranking of the individual efficiency measures by their cost-effectiveness at reducing greenhouse gases. Increased efficiency of energy use is a low cost way to reduce emissions from electric generation from both an end user (consumer) perspective and a generation (avoided-cost) perspective. The total overall impact of energy efficiency measures depends on the total population of units eligible for replacement and the existing saturation levels of the individual efficient measures within the population. The total impact also depends on factors such as overlap between different measures and the percentages of the population with access to natural gas and other fuels.

Table 3.1 Most Cost-effective End Use Efficiency Measures from a Consumer Perspective in the Residential Sector

End Use	Base Technology	End Use Efficiency Option
Clothes Drying	Electric Dryer: Typical New	Gas Dryer: '94 Minimum Efficiency Standard
Clothes Drying	Electric Dryer: Typical New	High Spin Washer (850 rpm)
Freezing	Average Efficiency Freezer	Efficient Upright Freezer
Freezing	Average Efficiency Freezer	Efficient Chest Freezer (15ft^3)
Lighting	40-Watt Fluor. with Old Core & Coil Ballast	34-Watt Fluorescent with Electronic Ballast
Lighting	70-Watt Standard Incandescent Lamp	18-Watt Compact Fluorescent Lamp
Refrigeration	Average Efficiency Refrigerator	Best Current Refrigerator-18ft^3-Top Freezer
Refrigeration	Average Efficiency Refrigerator	Golden Carrot Refrigerator 22ft^3
Refrigeration	Refrigerator: Secondary Avg. Efficiency	Remove Refrigerator
Refrigeration	Refrigerator: Autodefrost Avg. Efficiency	Adaptive Defrost-18 ft^3 (no CFCs)
Outdoor Lighting	Standard Outdoor 150W Incandescent Flood Lamp	70 W High Pressure Sodium Lamp with 17W Ballast
Space Cooling	Central Air Conditioning	Efficient Heat Pump
Space Cooling	Central Air Conditioning	Efficient Ground Source Heat Pump
Space Cooling	Central Air Conditioning	Whole-House Fan
Space Cooling	Standard Room Air Conditioner	Efficient Room Air Conditioner
Space Heating	Heat Pump (Typical New)	Dual Fuel Heating (Add Gas Furnace)
Space Heating	Electric Furnace with Standard Thermostat	Programmable Thermostat
Space Heating	Heat Pump (Typical New)	Gas Furnace (Typical New)
Space Heating	Electric Furnace with Standard Thermostat	Gas Furnace (Typical New)
Space Heating	Standard Gas Furnace	Gas Absorption (GAX) Heat Pump
Space Heating	Electric Furnace with Standard Thermostat	Efficient Heat Pump
Space Heating	Electric Furnace with Standard Thermostat	Efficient Open Loop Ground Source Heat Pump
Water Heating	Electric Water Heater	Gas Water Heater

Table 3.2 Most Cost-effective End Use Efficiency Measures from a Consumer Perspective in the Commercial and Institutional Sector

End Use	Base Technology	End Use Efficiency Option
Air Conditioning	All Electronic Cooling Systems	Temperature Set-Up (Unoccupied hours)
Air Conditioning	Standard Efficiency Central Chiller	High Efficiency Central Chiller
Air Conditioning	Conventional Cooling Base	Add Desiccant Dehumidifier (Gas-fired)
Build Envelope	Base Building Envelope	Efficient Building Envelope*
Cooking	All Electric Cooking Equipment	Gas Cooking Equipment
Cooking	Standard Electric Resistance Ovens	Convection Ovens
Lighting	Standard 40W Fluorescent	34W High Efficiency Fluor. with Reflectors
Lighting	Nine 150W Incandescent Spots and Floods	One 175W Metal Halide & One 35W Ballast
Lighting	75W Standard Incandescent Bulb	18W Screw-In Fluorescent
Lighting	Four 8-foot 75W Fluorescent Lamps and Two Standard Ballasts	Two 8-foot 60W High Efficiency Fluorescent and One High Efficiency Ballast & Reflector
Lighting	Four 4-foot Standard 40W Fluorescent Base	Four 4-foot 34W High Efficiency Fluorescent Lamps and Ballast with Reflectors
Lighting	All Lighting Types	Occupancy Sensors
Refrigeration	All Grocery and Warehouse Refrigeration	High Efficiency Compressor
Refrigeration	All Grocery and Warehouse Refrigeration	Floating Head Pressure Controls
Refrigeration	All Grocery and Warehouse Refrigeration	Mechanical Subcooling
Refrigeration	All Grocery and Warehouse Refrigeration	Microprocessor-based Controls
Refrigeration	All Grocery and Warehouse Refrigeration	Ambient Subcooling
Space Heating	All Electronically Heated Floorspace	Temperature Set-back (Unoccupied hours)
Space Heating	Standard Electric Space Heating Systems	High Efficiency Gas Furnace
Space Heating	Large Centralized Heating Systems	Install Air-to-Air Heat Exchanger
Space Heating	All Electronically Space Heated Floorspace	Reduce Ventilation Intake
Space Heating	All Space Heating Systems	Tune-up/Improved Maintenance
Ventilation	Cental Chiller and DX System Floorspace	Reduce Fan Power
Ventilation	Standard Efficiency Motor	High Efficiency Motors
Ventilation	All Ventilation Systems	Timers for Fans (Unoccupied air shut-down)
Water Heating	All Electric Water Heaters	Air-Source Heat Pump Water Heater

*Efficient Building Envelope includes increased roof and wall insulation, double glaze on all windows and doors, and installing reflective film on all glazing.

Table 3.3 Most Cost-effective End Use Efficiency Measures from a Consumer Perspective in the Industrial Sector

End Use	Base Technology	End Use Efficiency Option
Air Conditioning	125 Ton Electric Chiller	Gas Engine Chiller (125 Ton)
Compressed Air	Standard Efficient Motor	Pneumatic Motor Replacement
Compressed Air	Standard Efficient Motor	High Efficiency Nozzles
Compressed Air	Standard Efficient Motor	Low Load Unloading Mechanism
Drying Fans	Standard Efficiency Drying Fan Motor	Dryer Control System (Humidity & Dry Rate)
General Mechanical	Conventional Agitators	Hydrofoil Agitators
General Mechanical	Standard Wastewater Diffuser Aeration	Micro-Bubble Aeration (Submerged Jet)
General Mechanical	Conventional Paint Booth Air Guns	Air-Airless Spray Guns
Hydraulics	200 Horsepower Motor	Downsize Motor to 60 Horsepower
Lighting	75W Incandescent Screw-in Bulbs	18W Compact Fluorescents Screw-in Bulbs
Lighting	All Exterior Lighting	Install Photo Cells
Materials Handling	Pneumatic Conveyors	Replace Pneumatic w/ Mechanical Conveyor
Motors	Standard Motors, All Horsepower	Downsize Motors
Motors	Standard Motors, All Horsepower	High Efficiency Motors
Motors	Standard Motors, All Horsepower	Voltage Control Soft Starts
Process Cooling	60 Horsepower Cooling Base	Replace Dampers with Fan Controls
Pumping	75 Horsepower Pumping Base	Install Low Flow Nozzles
Refrigeration	142 kW Refrigeration System	Cold Start Controls / Energy Management System
Refrigeration	142 kW Refrigeration System	Improved Refrigeration Doors
Refrigeration	142 kW Refrigeration System	Improve Building Envelope (Insulation)
Refrigeration	142 kW Refrigeration System	Install Control System
Refrigeration	142 kW Refrigeration System	High Efficiency Compressor
Space Heating	Electric Resistance Heat	Electric Heat to Gas Heat
Space Heating	Electric Resistance Heat	Improved Radiant Heater

Table 3.4 Most Cost-effective End Use Efficiency Measures from a Consumer Perspective in the Agricultural Sector

End Use	Base Technology	End Use Efficiency Option
Lighting	250-Watt Brooder Lamp	175-Watt Infrared Heat Lamp
Lighting	100W Standard Incandescent Lamps	30W Compact Fluorescent Lamps
Lighting	175W Mercury Vapor Lamps	100W High Pressure Sodium Lamp
Other/General	Engine Heater without Timer	Engine Heater with Timer
Stock Watering	Standard Electric Heated Waterer	Efficient Waterer
Stock Watering	Standard Electric Heated Waterer	Energy-Free Waterer
Water Heating	80-Gallon Electric Water Heater	High Eff. 80-Gallon Electric Water Heater
Water Heating	80-Gallon Electric Water Heater	Desuperheater (Heat Recovery Water Heater)

Tables 3.5 and 3.6 show that placing emission costs on energy providers increases the cost-effectiveness of energy efficiency measures. There were $2.3 per ton in additional savings for each $850 per ton in NOx emission costs and $0.3 per ton for a $100 SO_2 emission cost placed on energy providers across all sectors. A $30,000 cost per ton cost for mercury emissions did not have an impact on the effectiveness of the efficiency measures. This could be due to how small the emission factors are for mercury emissions as compared to NOx and SO_2 emission factors.

Table 3.5 Residential Sector Energy Efficiency End Use Average Cost Summary

Emission Costs** (Real 1993 $/ton)	Total average cost from measures* up to $0 per ton — Consumer Costs: with emissions ($/ton)	without emissions ($/ton)	Total net real CO_2-equivalent savings per unit (tons) per year from measures up to $0 per ton
Zero NOx and Hg Costs	($96.6)	($96.2)	220.8
Hg = $30,000	($96.6)	($96.2)	220.8
NOx = $850	($98.9)	($96.2)	220.8
NOx = $1,700	($101.2)	($96.2)	234.4
NOx = $3,400	($105.8)	($96.2)	245.3
NOx = $1,700 & Hg = $30,000	($101.2)	($96.2)	234.4

* Based on consumer costs with a $0 per ton emissions cutoff for zero NOx and Hg cost scenario.

** SO_2 =$100 per ton for all scenarios, possible future emission cost rates were used for NOx and Hg. At the time of analysis in early 1998, SO_2 = $100 per ton. The current price is closer to $200 per ton which would increase the cost savings from energy efficiency measures.

Tables 3.5 and 3.6 also show that placing emission costs on energy providers also increases the number of 'no regrets' efficiency measures and thereby increases the total emissions savings in the 'no regrets' category. Total net real CO_2-equivalent savings per unit (tons) from measures up to $0 per ton increased from approximately 221 tons to 245 tons for residential options with the addition of $3,400 per ton emission costs to energy providers (Table 3.5). The industrial, commercial and institutional, and agricultural sector efficiency measures also showed the same effect (Table 3.6). The increased emissions savings levels would be much more substantial if measured over the entire population of replacement units in the population.

Table 3.6 Industrial, Commercial and Institutional, and Agricultural Sector Energy Efficiency End Use Average Cost Summary

Emission Costs** (Real 1993 $/ton)	Total average cost from measures* up to $0 per ton — Consumer Costs: with emissions ($/ton)	Total average cost from measures* up to $0 per ton — Consumer Costs: without emissions ($/ton)	Total net real CO_2-equivalent savings per unit (tons) per year from measures up to $0 per ton
Zero NOx and Hg Costs	($54.2)	($53.9)	608.8
Hg = $30,000	($54.2)	($53.9)	608.8
NOx = $850	($56.5)	($53.9)	612.5
NOx = $1,700	($58.8)	($53.9)	613.6
NOx = $3,400	($63.4)	($53.9)	618.3
NOx = $1,700 & Hg = $30,000	($58.8)	($53.9)	613.6

*Based on consumer costs with a $0 per ton emissions cutoff for zero NOx and Hg cost scenario.

**SO_2 = $100 per ton for all scenarios, possible future emission cost rates were used for NOx and Hg. At the time of analysis in early 1998, SO_2 = $100 per ton. The current price is closer to $200 per ton which would increase the cost savings from energy efficiency measures.

Conclusions on Energy Efficiency

1. Many low cost emission reduction measures are available to end use consumers for decreasing greenhouse gas pollution and other pollution from electric generation.
2. Increased efficiency of energy use is a low cost way to reduce emissions from electric generation from both an end user (consumer) perspective and a generation (avoided-cost) perspective.
3. Because emissions are linked by their sources, using an integrated analysis of all the affected pollutants is the key to finding low cost strategies for reducing emissions.
4. Placing emission costs on energy providers increases the cost-effectiveness of energy efficiency measures. (There were approximately $3 per ton in additional savings for each $850 in NOx emission costs placed on energy providers.)
5. Placing emission costs on energy providers also increases the number of ‘no regrets’ efficiency measures and thereby increases the total emissions savings in the ‘no regrets’ category.
6. Required reductions of NOx and particulates will reduce the net cost of greenhouse gas reductions if states build energy efficiency into NOx and particulate emission reduction regulations (an option for states that the EPA is planning to include in the Model NOx rules currently being promulgated).
7. Using energy efficiency to reduce emissions can increase employment and economic activity.

References for Analysis of Energy Efficiency Options

Clemmer, S., Olson, S. and Arny, M. (1998) The Economic and Greenhouse Emission Impacts of Electric Energy Efficiency Investments. USDOE EFP Report, February 1998.

Energy Center of Wisconsin 1994. Wisconsin Demand-Side Options Database (WDOD).

Energy Information Administration (EIA), *State Energy Price and Expenditure Report 1995*, DOE/EIA-0376(95), August 1998.

Geller, Howard, John DeCicco and Skip Laitner. 1992. Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies. American Council for an Energy-Efficient Economy.

Hewett, Martha, (1998). Achieving Energy Efficiency in a Restructured Electric Utility Industry, Minnesotans for an Energy Efficient Economy, July 1998.

Krier, Betty, Ian Goodman and Peter Kelly-Detwiler. 1993. Employment Impacts of Electricity Efficiency in Florida. Prepared for the Florida State Energy Office.

Laitner, Skip, Ian Goodman and Betty Krier. 1994. DSM as an Economic Development Strategy. The Electricity Journal 7, No. 4 (May): 62-69.

Laitner, Skip. 1991. The employment impacts of Wisconsin utility DSM programs. Testimony submitted to the Public Service Commission of Wisconsin for Advance Plan 6, Docket 05-EP-6.

Sanghi, Ajay K. 1992. Economic Impacts of Electricity Supply Options. Submitted for Publication in the Incorporation of Social Costs of Energy in Resource Acquisition Decisions Conference in Racine, Wisconsin.

Weisbrod, Glen et. al. 1995. The Economic Impact of Energy Efficiency Programs and Renewable Energy Power for Iowa. Prepared for the Iowa Department of Natural Resources.

Wisconsin Associated Utilities (WAU), 1994, Statewide Technical and Economic Potential, Advance Plan 7 Technical Support Document D12.

Wisconsin Associated Utilities (WAU), 1994, Power Supply, Advance Plan 7 Technical Support Document D24.

Wisconsin Department of Natural Resources. 1998. Wisconsin Greenhouse Gas Emission Reduction Cost Study, Report 3, Emission Reduction Cost Analysis.

Section 4 Analysis of Generation Options for Green Electricity

To determine what it should cost the consumer to purchase less-polluting electricity, it is first necessary to understand how electric utilities might produce cleaner electricity and how they might market it to their customers. Currently, generation units are run on an economic dispatch system with low-cost, large, coal-fired units used to meet the bulk of the continuous electricity demand (baseload). The utility anticipates that somewhat frequently and for extended periods of time it will have to generate even more electricity above the baseload. For this purpose, somewhat smaller units with operational flexibility, usually natural gas-fired combined cycle or combustion turbines, are run in an intermittent manner to meet the additional load. These units are used because they require less capital investment and can be built more quickly and in smaller increments than baseload generation. As the use of electricity increases during peak periods, utilities can build these units in small increments until the overall demand grows enough to justify building another large base unit.

Electric utilities have two basic options for providing cleaner electricity. Utilities can modify the current equipment or operations in their existing power plants, or utilities can install new cleaner generation units. The lowest-cost option for modifying current equipment or operations is usually to upgrade equipment and increase maintenance to provide a boost in generation efficiency. However, gains are usually modest in the range of 5% and have a limited potential for emission reductions.

To make substantive reductions, the utility usually installs pollution control equipment which cleans the combustion gases before they are exhausted to the atmosphere. The installation and operation of such equipment is usually a costly proposition and presents a new variable into the operation of a generation facility. Therefore, such action is usually only undertaken in response to a regulatory requirement to reduce air emission of a specific pollutant. The estimated cost of installing pollution control equipment on existing power plants is shown in Table 4.1 for several major pollutants.

Table 4.1 Estimated Cost of Installing Pollution Control Equipment on Existing Units

Pollutant	$/ton	$/kWh
[1]Carbon dioxide (CO_2)	$181	0.201
[2]Sulfur dioxide (SO_2)	$100 to $5,000	0.0007 to 0.035
[3]Nitrogen oxides (NOx)	$800 to $2,000	0.003 to 0.007
[4]Mercury (Hg)	$30,000	0.000006
Total	not additive	0.2047 to 0.2430

Notes on Table 4.1:
1) Scrubbing CO_2 emissions from boiler exhaust gases (CCAP, 1995).
2) Cost of fuel switching to low sulfur coal/SO_2 market. The coal fuel cost is very competitive and therefore the upper bounds of cost is felt to be reflected by the SO_2 trading market (WDNR, 1999).
3) Range represents reduction range of 50 - 80% (Staudt, 1998).
4) Case estimate of reduction for a Wisconsin power plant (WDNR, 1998).

The second option that utilities have is the installation of new cleaner generation units. Oftentimes, the cost of reducing one pollutant's emissions from an existing plant is considerably more than the incremental cost of installing the same equipment as part of a new generation unit. However, because utilities would have to invest a large amount of capital in building new generation to capture the reduced incremental cost of pollution control equipment, it is not in their best interest to make the long-term investment for the minimal gain. In fact, since utilities have recaptured the majority of their investment in the older plants, they are more willing to absorb the higher cost of retrofitting pollution control equipment than building whole new generation sites. This is seen as the most cost-effective means to reducing emissions of specific pollutants.

However, as emission restrictions are being considered for CO_2 and Hg, as well as tighter controls on SO_2, NOx and particulates, the utilities are taking a more integrated approach to meeting limitations. As seen in Table 4.1, the total cost to control these pollutants on an individual basis is $0.20 per kilowatt-hour, which is over two times the average cost of electricity of $0.086 to consumers in the four-state study area of Illinois, Iowa, Minnesota, and Wisconsin (Table 4.3). On this basis, replacing old generation units with new less polluting technologies becomes a viable option for utilities.

Many utilities see an opportunity in the electric market to charge higher prices for cleaner electricity and therefore capture an immediate return on new generation while decreasing their long-term liability from high emitting facilities. A utility or energy provider, in either the regulated or deregulated market, can theoretically market their cleaner generation resources by (1) implementing these options to reduce their entire electric system average emission rate, or (2) market individual generation units or a package of cleaner resources.

The latter option is the most likely scenario under both a regulated and deregulated utility system and allows utilities to pursue a higher rate to pay for implementing individual projects for cleaner generation. Even before deregulation is implemented, utilities are currently building renewable resources, such as wind and solar units, and then marketing this electricity to customers for an additional fee over their base electric rate.

However, in some cases utilities may also offer existing but "cleaner than the system average" generation resources to customers for an additional cost. For example, a utility may offer electricity from their natural gas combined cycle units, which by themselves are generally cleaner and more efficient, for an increased price per kilowatt-hour. In effect, this does not change the overall amount of emissions from electric generation but still gains additional revenue for the existing generation system. Theoretically, as cleaner capacity is sold, the additional revenue can be used to implement additional clean generation capacity. Over time this would allow utilities to remove the more polluting units from service, and thereby result in overall lower emissions.

We used three different approaches to estimate the potential incremental cost that consumers should pay for cleaner electricity options. First, we performed an incremental emissions and cost analysis of new installations of specific generation technologies versus the average characteristics of electricity in the four-state study area of Illinois, Iowa, Minnesota, and Wisconsin. Second, we reviewed the cost of current renewable energy projects in the Midwest. Third, we gathered information on current green electricity pricing programs in the four-state study area as of March of 1999.

Emissions and Cost Analysis of Specific Generation Technologies

To determine the potential consumer price of "green" or less polluting electricity, the cost and emissions were determined for various types of generation technologies. This information was then compared to the average electricity mix for each of the four states to provide a relative measure of the cost-effectiveness of these generation technologies to reduce air emissions.

This analysis utilized cost and emission information for different generation technologies shown in Appendix B, Table B.1 as compiled by Wisconsin electric utilities for the state's public planning process (WAU, 1998). The cost of generating electricity for these units was determined using the Electric Power Research Institute's busbar cost methodology as outlined in their Technical Assessment Guide (EPRI, 1994). The cost was then adjusted to account for business overhead to yield the estimated consumer's cost of electricity.

Table 4.2 shows the resulting estimates of generation cost and consumer price for electricity generated by each technology along with its emission rate for identified pollutants. These results were then compared to the average characteristics of electricity sold in Iowa, Illinois, Minnesota, and Wisconsin (Table 4.3) to determine the incremental customer cost and emission reduction potential for each type of generation technology.

The results of this analysis varied according to the electricity provided in each state. To summarize these characteristics, the average CO_2 emission rate does not vary considerably between the four states with an average 2.23 lbs per kWh. However, there is considerably more difference in the price of electricity between the states. The average electricity prices are much higher in Illinois for residential and industrial customers as compared to the prices in the other three states. The average Illinois residential electricity price ($ 0.103/kWh) is over 30% higher than the Wisconsin price ($0.069/kWh). On average, this costs Illinois residents $250 more per year in electricity costs than Wisconsin residents.

Table 4.2 Cost and Emissions of Potential New Generation Units

Generation Unit	Cost of Generation ($/kWh)	Cost of Generation and Overhead ($/kWh)	Consumer Cost of Delivered Electricity ($/kWh)	Emission Rate per kWh-delivered (lbs/kWh)				
				CO_2	SOx	NOx	Hg	Part
Coal Fluidized Bed Combustion	$0.0352	$0.0390	$0.0410	2.79	0.002024	0.0018	5.6E-07	0.00240
Integrated Gasification Combined Cycle	$0.0388	$0.0430	$0.0453	2.15	0.000439	0.0010	4.6E-07	0.00008
Integrated Gasification Fuel Cell	$0.0464	$0.0515	$0.0542	1.61	0.000022	0.0000	3.5E-07	0.00022
Atmospheric Fluidized Bed Combustion	$0.0404	$0.0448	$0.0471	2.54	0.000967	0.0011	5.2E-07	0.00016
154 MW Combined Cycle - single unit	$0.0447	$0.0496	$0.0522	0.92	0.000056	0.0002	0.0E+00	0.00003
215 MW Combined Cycle - single unit	$0.0404	$0.0448	$0.0471	0.87	0.000053	0.0001	0.0E+00	0.00007
215 MW Combined Cycle - 1st of multiple unit	$0.0413	$0.0458	$0.0482	0.87	0.000053	0.0001	0.0E+00	0.00007
215 MW Combined Cycle - nth of multiple unit	$0.0378	$0.0419	$0.0442	0.87	0.000053	0.0001	0.0E+00	0.00007
Molten Carbonate Fuel Cell	$0.0666	$0.0739	$0.0777	1.02	0.000032	0.0000	0.0E+00	0.00000
75 MW Combustion Turbine - single unit	$0.0487	$0.0540	$0.0568	1.29	0.000078	0.0003	0.0E+00	0.00004
83 MW Combustion Turbine - single unit	$0.0533	$0.0591	$0.0622	1.79	0.000076	0.0011	0.0E+00	0.00000
154 MW Combustion Turbine - single unit	$0.0475	$0.0526	$0.0554	1.31	0.000080	0.0003	0.0E+00	0.00011
154 MW Combustion Turbine - 1st of multiple unit	$0.0478	$0.0530	$0.0558	1.31	0.000080	0.0003	0.0E+00	0.00011
154 MW Combustino Turbine - nth of multiple unit	$0.0458	$0.0508	$0.0535	1.31	0.000080	0.0003	0.0E+00	0.00011
Atmospheric Fluidized Bed Combustion - Biomass	$0.0828	$0.0918	$0.0966	0.00	0.000140	0.0037	0.0E+00	----
Spreader Stoker Biomass (7.2)	$0.0954	$0.1058	$0.1113	0.00	0.000111	0.0017	0.0E+00	----
Spreader Stoker Biomass (57)	$0.0658	$0.0729	$0.0768	0.00	0.000111	0.0017	0.0E+00	----
Whole Tree Biomass	$0.0489	$0.0542	$0.0570	0.00	0.000088	0.0014	0.0E+00	----
Integrated Gasification Combined Cycle - Biomass	$0.0656	$0.0727	$0.0766	0.00	0.000078	0.0012	0.0E+00	----
Wind Tubine	$0.0771	$0.0854	$0.0899	0.00	0.000000	0.0000	0.0E+00	0.0E+00
5 MW Flat Plate Photovoltaic	$0.2978	$0.3302	$0.3475	0.00	0.000000	0.0000	0.0E+00	0.0E+00
0.5 MW Flat Plate Photovoltaic	$0.4080	$0.4524	$0.4762	0.00	0.000000	0.0000	0.0E+00	0.0E+00
5 MW Fixed Flat Plate Photovoltaic - dispersed connection	$0.2858	$0.3169	$0.3250	0.00	0.000000	0.0000	0.0E+00	0.0E+00
0.5 MW Fixed Flat Plate Photovoltaic - dispersed connection	$0.3960	$0.4391	$0.4504	0.00	0.000000	0.0000	0.0E+00	0.0E+00

Note: Table 4.2 cost estimates and emission reduction potential are based on the four-state average characteristics of electricity. See the previous page for number sources and Appendix B for background cost and emission information for different generation technologies and a full evaluation for each technology for each state.
NOx emission rates for biomass generation are based on new installation requirements.

Table 4.3 Characteristics of Electric Consumption for the Residential and Industrial Sectors

Parameter	Illinois	Iowa	Minnesota	Wisconsin	4-State Weighted Average
Average CO_2 Emission Rate (lbs/kWh)	2.17	2.29	2.32	2.23	2.23
Residential					
Average Electricity Price ($/kWh)	$0.103	$0.082	$0.071	$0.069	$0.086
Number of Residential Households	4,604,056	1,190,005	1,888,279	2,182,879	9,865,219 (Total)
Average Monthly Consumption (kWh)	679	808	757	713	717
Average Monthly Consumer Cost ($)	$70	$66	$54	$49	$62
Average Yearly Consumer Cost ($)	$843	$791	$647	$589	$743
Industrial					
Average Electricity Price ($/kWh)	$0.052	$0.039	$0.043	$0.037	$0.051
Number of Industrial Customers	5,047	3,964	9,913	5,087	24,001 (Total)
Average Monthly Consumption (kWh) per customer	694,307	310,694	226,420	391,046	373,358

Source: State Energy Data Report 1996, Consumption Estimates, US DOE / EIA Publication, February 1999.

Results

To rate the generation technologies, results are presented in terms of the cost of reducing carbon dioxide emissions. This was done because CO_2 emissions provide a relatively strong measure for the reduction of other pollutants of consideration. Also, to simplify the results, the main body of cost estimates and emission reduction potential is illustrated based on the four-state average characteristics of electricity. However, to provide a measure of variability, the CO_2 reduction found for the list of generation technologies is shown in Table 4.4. The full evaluation for each technology in each state is included in Appendix B.

Table 4.4 CO_2 Percent Reduction Comparison

	WI	IL	IA	MN	AVG
Price ($/kWh) =	$0.069	$0.103	$0.082	$0.071	$0.086
lbs CO2/kWh =	2.23	2.17	2.29	2.32	2.23
tons CO2/kWh =	0.001115	0.001085	0.001145	0.00116	0.001115
Technology	**Percent CO_2 Reduction (%)**				
Atmospheric Fluidized Bed Biomass	100%	100%	100%	100%	100%
Spreader Stoker Biomass (7.2 MW)	100%	100%	100%	100%	100%
Spreader Stoker Biomass (57 MW)	100%	100%	100%	100%	100%
Whole Tree Biomass	100%	100%	100%	100%	100%
Integrated Gasification Combined Cycle Biomass	100%	100%	100%	100%	100%
Wind Turbine	100%	100%	100%	100%	100%
Fixed Flat Plate Photovoltaic (PV) (5 MW)	100%	100%	100%	100%	100%
Fixed Flat Plate PV (0.5 MW)	100%	100%	100%	100%	100%
Fixed Flat Plate PV (5 MW), dispersed connection	100%	100%	100%	100%	100%
Fixed Flat Plate PV (0.5 MW), dispersed connection	100%	100%	100%	100%	100%
215 MW Combined Cycle (CC) - stand alone	61%	60%	62%	63%	61%
215 MW CC - unit 1	61%	60%	62%	63%	61%
215 MW CC - unit n	61%	60%	62%	63%	61%
154 MW CC - stand alone	59%	58%	60%	60%	59%
Molten Carbonate Fuel Cell	54%	53%	56%	56%	54%
75 MW Combustion Turbine (CT) - stand alone	42%	40%	43%	44%	42%
154 MW CT - stand alone	41%	40%	43%	44%	41%
154 MW CT - unit 1	41%	40%	43%	44%	41%
154 MW CT - unit n	41%	40%	43%	44%	41%
Integrated Coal Gasification Fuel Cell (IGFC)	28%	26%	30%	31%	28%
83 MW CT - stand alone	20%	17%	22%	23%	20%
Integrated Coal Gasification Combined Cycle (IGCC)	4%	1%	6%	7%	4%
Atmospheric Fluidized Bed (AFB) Combustion	-14%	-17%	-11%	-10%	-14%
Coal Fluidized Bed Combustion (CFBC)	-25%	-29%	-22%	-20%	-25%

As seen in Table 4.4, the carbon dioxide emission reductions for each technology are within a few percentage points of the four state average. However, it should noted that the cost of these reductions by the same technology will vary accordingly to the average cost of electricity in each state. In essence, the higher the electricity price, the lower the cost or greater the savings associated with the CO_2 reduction.

Within the context of this analysis, the results lead to several interesting insights. First, the use of natural gas combined cycle reduces CO_2 emissions approximately 60% over the average emission rate for a net cost savings to the consumer. This is significant as it is achieved by utilizing a fully mature and widely implemented generation technology. In fact, the majority of the new generation capacity currently being planned or built in the United States is natural gas combined cycle because it is a reliable technology that has relative low capital investment and environmental liabilities compared to coal fired generation. However, the cost of combined cycle generation is more sensitive to fuel costs than typical coal fired generation, and may therefore have limited capability to meet a wide market demand for low cost cleaner electricity.

The analysis also showed that 100% reduction of CO_2 emissions was possible using a number of different renewable technologies. Of these, the results for the two most common proven renewable energy alternatives, wind- and solar-fueled generation, are shown in Table 4.5. As expected for Illinois, Iowa, Minnesota, and Wisconsin, large scale photovoltaic generation is an expensive way to produce cleaner electricity. Alternatively, for an approximate added cost of $2.58 per month, wind power is an attractive and viable electric generation option for consumers.

The estimated cost of providing 100% reduction electricity (for CO_2) could potentially be achieved with a *cost savings to the consumer* by utilizing biomass feed integrated gasification combined cycle (Biomass-IGCC) technology. This is an emerging technology which is typically considered in technical evaluations of new generation alternatives, but is as yet unproven in the field. Therefore, electric suppliers are less apt to utilize this technology without special considerations. This represents a case where educated consumers who request cleaner electricity at lower costs could potentially force the electric supplier to implement these newer and cleaner technologies.

Table 4.5 The Cost of Cleaner Electricity for the Residential Sector (Four-State Average)

Technology	% CO_2 Reduction	Incremental consumer cost of cleaner electricity ($/kWh)	($/ton)	($/month)	($/year)
215 MW Combined Cycle (CC) - unit n	61%	($0.0422)	($61.50)	($30.26)	($363)
Integrated Coal Gasification CC	4%	($0.0411)	($999.72)	($29.46)	($354)
215 MW CC - stand alone	61%	($0.0392)	($57.15)	($28.14)	($338)
215 MW CC - unit 1	61%	($0.0382)	($55.59)	($27.38)	($329)
154 MW CC - stand alone	59%	($0.0342)	($51.64)	($24.51)	($294)
154 MW Combustion Turbine (CT) -unit n	41%	($0.0328)	($70.58)	($23.56)	($283)
Integrated Coal Gasification Fuel Cell	28%	($0.0321)	($103.63)	($23.05)	($277)
154 MW CT - stand alone	41%	($0.0310)	($66.50)	($22.21)	($267)
154 MW CT - unit 1	41%	($0.0305)	($65.53)	($21.89)	($263)
75 MW CT - stand alone	42%	($0.0295)	($62.35)	($21.18)	($254)
Whole Tree Biomass	100%	($0.0293)	($25.99)	($21.03)	($252)
83 MW CT - stand alone	20%	($0.0241)	($109.11)	($17.30)	($208)
Integrated Biomass Gasification CC	100%	($0.0098)	($8.46)	($7.01)	($84)
Spreader Stoker Biomass (57 MW)	100%	($0.0096)	($8.28)	($6.86)	($82)
Molten Carbonate Fuel Cell	54%	($0.0086)	($13.64)	($6.17)	($74)
Wind Turbine	100%	$0.0036	$3.53	$2.58	$31
Atmospheric Fluidized Bed Biomass	100%	$0.0103	$9.50	$7.35	$88
Spreader Stoker Biomass (7.2 MW)	100%	$0.0250	$22.73	$17.93	$215
Fixed Flat Plate Photovoltaic (5 MW), dispersed connection	100%	$0.2386	$214.34	$171.17	$2,054
Fixed Flat Plate Photovoltaic (5 MW)	100%	$0.2612	$234.56	$187.34	$2,248
Fixed Flat Plate Photovoltaic (0.5 MW), dispersed connection	100%	$0.3640	$326.78	$261.09	$3,133
Fixed Flat Plate Photovoltaic (0.5 MW)	100%	$0.3899	$349.95	$279.63	$3,356
Atmospheric Fluidized Bed Combustion	-14%	-------------- No CO_2 Reduction --------------			
Coal Fluidized Bed Combustion	-25%	-------------- No CO_2 Reduction --------------			

Notes on Table 4.5: Table 4.5 is based on a weighted average of 8607 kWh usage per year per household. Parentheses indicate cost savings. Negative percentages indicate CO_2 increase.

Transmission Constraints

Electric transmission lines provide the capacity for transmitting electricity from one area to another. Transmission lines are one of the burdens imposed on the environment by electricity use. Where transmission capacity becomes inadequate at times of high transmission system loading, and not all transactions can take place that are desired, the transmission system is said to be constrained. Transmission system constraints prevent some purchases and sales of electricity from occurring, and thus limit the amount of electricity that can be transferred from one area to another. The two reasons for electric power transfers are (1) to provide backup for reliability purposes, and (2) to acquire power from lower cost generation. There are a number of transmission constraints in the Midwest that affect the four-state area of Iowa, Minnesota, Illinois, and Wisconsin.

Lower cost electric generation capacity is frequently located to the north and west of Minnesota, and therefore the flow of electricity is typically from northwest to southeast. This relatively low cost electric generation includes hydroelectric generation in Canada and generation near the coal mines to the west. As a result, transfers of electricity from Minnesota to eastern Wisconsin and Illinois are common. This electricity has two primary paths. It can flow into Wisconsin and south to Chicago, or it can flow south through Minnesota and Iowa and then east through Illinois to Chicago. Transfers are also common from states to the south into the Iowa, Minnesota, Illinois, Wisconsin area.

One transmission constraint is the limitation on the transmissions system's capacity to transfer electricity from states to the south of the area into Iowa, Minnesota, Illinois, and Wisconsin. With all the transmission lines functioning normally, the amount of electricity that can be transferred is limited. If one of the major transmission lines from states to the south of the four-state area goes out, the amount of electricity that can be transferred into the area is reduced to a lower level.

Another transmission constraint is the capacity of the transmissions from Minnesota into western Wisconsin. With all the transmission lines functioning normally, the amount of electricity that can be transferred from Minnesota into western Wisconsin is limited. If one of the major transmission lines from Minnesota to Wisconsin or Iowa goes out, the amount of electricity that can be transferred between Minnesota into western and eastern Wisconsin is reduced to a lower level. The transmission constraints between Minnesota and western Wisconsin are made worse by the fact that most of the generation used to serve Northern States Power Utility's customers in western Wisconsin is located in Minnesota. This constraint is also affected by other transactions on the electric system. For example, electricity is being sold from Minnesota's Twin Cities area to Chicago or St. Louis. This reduces the capacity to transmit electricity from Minnesota to Wisconsin. Sales of power from Illinois into Wisconsin also reduce the amount of electricity that can be transferred from Minnesota into western Wisconsin.

A third transmission constraint is the transmission system capacity between Wisconsin and Illinois. With all the transmission lines functioning normally the amount of electricity that can be transferred from Illinois into southern Wisconsin is limited. If one of the major transmission lines between Wisconsin and Illinois goes out, the ability to transfer electricity between these two states is reduced.

This constraint is also affected by other transactions on the electric system. For example, more electric power is being transferred from Minnesota's Twin Cities area to western Wisconsin or to St. Louis This reduces the capacity to transmit electricity from Illinois into southern Wisconsin.

There are also transmission constraints between Illinois and the states to the east and southeast, as well as between Illinois and states to the southwest.

Transmission constraints are a result of the combined effects of all the characteristics of the interconnected electric system. These characteristics include:

- Size and geographic distribution of the electricity consumption
- Size, location, and operating costs of electric generating plants
- Size and location of electric transmission lines and their interconnections

Transmission constraints are not inherently good or bad, they just affect the cost of alternative options for achieving society's objectives for the electric system. The typical objectives used in electricity system regulation are (1) to provide electricity at moderate costs, (2) to provide the desired level of reliability of electric service, and (3) to moderate the environmental impacts of providing these services. The lowest cost option for maintaining reliable electric service given a particular transmission constraint could be increasing the capacity of a transmission system constraint with a transmission improvement or the addition of generating capacity at a particular location. Or the lowest cost option could be electric demand reduction created by allowing electricity users to sell demand reductions in electricity capacity markets. These same options could also be low cost options for maintaining moderate electric costs for energy users.

Potential Effects of Transmission Constraints on Local Costs of Reduced-Emission Electricity in the Midwest

Reducing future needs for increased transmission capacity avoids the costs and environmental impacts associated with the increased transmission capacity. Actions that reduce this need are valuable, and should be rewarded. For example, constrained transmission lines increase the value of energy efficiency and renewable energy projects located in the region that is prevented from making purchases. The increased value of local energy efficiency and renewable energy stems from the higher costs of electric energy and capacity due to the constraint. However, the owners and implementors of energy efficiency and renewable energy projects are not able to capture the increased value of their projects.

Current electricity pricing systems sell electricity to most customers at an average energy-based rate (cents per kWh). This does not give most customers access to separate demand and energy pricing or access to the metering, from the supplier of their choice, that is needed to capture the benefits of this kind of pricing. Therefore, most electricity users are not allowed to receive the full economic value of their local increased energy efficiency, load management, or renewable energy actions. This approach of fencing out most electricity users from the market for reductions in electricity use and electricity demand at peak times results in fictitious needs for generation capacity and electric transmission capacity that increase the costs for all electricity users.

There are reliability problems in Wisconsin due to this problem. When average electricity pricing is imposed on customers, high peak demand problems can ensue. This predicament is similar to the old system of water rates in Denver Colorado: with no water meters in place, consumers tended to use excessive amounts of water when billed a fixed amount that did not correlate to their actual use. If Wisconsin industry, businesses, and consumers want to avoid paying for unnecessary generation capacity additions and unnecessary transmission capacity additions, all consumers should be given the option of separate demand and energy charges, the best approximation of real-time pricing that could easily be provided, and the option of acquiring the metering they want to use to capture these benefits from the metering supplier of their choice.

Transmission constraints between states will affect local costs of reduced-emission electricity in the four-state study region. Minnesota and Iowa consumers will enjoy lower costs for renewables because they are closer to areas with greater wind resource potential. Large-scale wind generation projects have already been completed in these two states, with many projects in the planning and construction phases. Transmission constraints will encourage an increase in local reduced-emission projects in each of the four states.

Wind resource is not as great in Wisconsin as in Iowa and Minnesota, but it may still be less expensive given transmission constraints to develop wind projects locally. Illinois has few areas capable of supporting economical wind projects. Electricity generators in Illinois will have to rely on fuel switching or biomass generation options for local reduced-emission electricity. Illinois could also afford to import reduced-emission electricity from out of state given the high cost of its in-state generation compared to Wisconsin and Iowa.

Where transmission constraints exist or arise, regulators will ultimately have to select a system for allocating the available capacity among those that want to use the facilities. One option is to use bidding to allocate use of the constrained transmission to the highest economic purpose. Another option is to allocate the use of the constrained transmission to the electricity generated with the lowest level of environmental emissions.

Market Status of Potential Reduced-Emission Generation Technology Options

A short list of generation options that have a potential for emission reductions for a relatively high cost-effectiveness, and which are likely to be available to consumers, is given in Table 4.6. These units are used to represent the potential of generation technologies to reduce emissions in the combined approach comparison in Section 6 of this report.

Table 4.6 Proven and Likely Emerging Generation Technologies in the Emission Reduction Market

Generation Technology	Market Status
Natural Gas Combustion Turbine - 154 MW	Proven: Mature
Natural Gas Combined Cycle - 215 MW	Proven: Mature
Wind Turbine	Proven: Available
Fluidized Bed Combustion - Wood Fired (Biomass)	Proven: Available
Solar - 5 MW dispersed connection	Proven: Available
Integrated Coal Gasification Combined Cycle	Likely Emerging
Integrated Coal Gasification Fuel Cell	Likely Emerging

Natural gas combustion turbines and combined cycles currently account for the majority of new capacity installation, and therefore represent a mature market for cost, engineering, and installation capability. The next level of technologies including wind, biomass fluidized bed combustion, and solar are considered proven and readily available on the market. But they do not represent the typical baseload capacity installation, and therefore do not have a mature market cost and infrastructure. Lastly, IGCC and IGFC are developing technologies which are highly likely to become commercially viable. These technologies have been listed using coal as the fuel of choice because of its potential for widespread market application.

Current Cost Data on Existing and Proposed Upper Midwest Renewable Energy Projects

Wind Energy Costs

Though performance data is somewhat difficult to ascertain, it is more readily available than cost information. Developers, manufacturers, and utilities alike restrict the release of cost data for competitive reasons. Even though utilities frequently must disclose details of their contracts to regulators, the information is declared proprietary and the regulatory staff is forbidden from disclosing that information to the public. Sketchy estimates of costs may be made from publicly available information, however, the likelihood of such information being accurate is slim.

Developers must account for all fixed, variable, and operating costs of a project in their negotiations with utilities. They must include the costs of equipment, installation, interconnections, feeder lines, sub-stations (perhaps), permitting costs, taxes, wind rights royalties, etc. The allocation of many of those costs between the developer and the utility varies between projects, making inter-project comparisons very difficult. Furthermore, the developer must make accurate estimates of the projected electricity production, which, as indicated above, is subject to numerous variables. Wind energy projects are eligible for a tax credit from the federal government for the first ten years of a project, which is adjusted annually for inflation.

The cumulative costs and benefits must be spread over the power purchase contract period to derive a negotiated payment per unit of electricity produced (cents/kWh). However, even that value can vary throughout the contract – a power purchase agreement can be "front-loaded," providing the developer greater cash flow during the early years of a project during the finance period, and dropping to a lower payment later which is still projected to cover the operation and maintenance costs. However, in order to adequately compare power purchase contracts with differing payment schedules, the power purchase prices are expressed as "levelized", a single rate that is equivalent to the total to be paid under the contract over the life of the contract, expressed in inflation-adjusted dollars per kilowatt-hour.

Given the uncertainty and proprietary nature of power purchase contracts, this summary is substantially based on inferred information and conjecture. Prices listed do not include the cost of transmission upgrades which may have been (or be) necessary for the utility to undertake, and they assume that the project is eligible for the federal investment tax credit.

Last year (January 1998), Electrical World investigated the current costs of wind energy. According to their sources; Enron Wind Corporation’s contract with Northern States Power (NSP) for the Phase II project has a levelized price of 3.5 cents/kWh [1]. They quote Enron Wind CEO Ken Karas as saying that "Enron Wind has been underbid by rivals quoting prices as low as 3 cents/kWh."

NSP is subject to a mandate requiring it to add 425 MW of windpower by 2002, of which 135 MW has been constructed and another 130 MW is under development and should be operational before July 1999. None of the windpower acquired to date has been marketed outside NSP's service territory. The Minnesota Public Utilities Commission (MN PUC) also voted in January of 1999 to require NSP to proceed with an additional 400 MW of windpower generation over the next 10-15 years as a cost-effective alternative to fossil fuel electric generation. In its filing to the MN PUC, the MN SEED Coalition and Izaak Walton League argued that windpower is the least-cost option. According to the League's estimates, windpower would be 32% less expensive than natural gas combined cycle generation with the Production Tax Credit (PTC) and 7% cheaper without the PTC. Indeed, the League estimates that new windpower projects will cost about 2.8 cents/kWh (with the PTC).

The most thorough analysis of wind energy costs has recently been conducted by the Izaak Walton League (IWL) in their evaluation of NSP's "Application for Resource Plan Approval, 1998-2012" [2]. Though much of the data in IWL's critique remains proprietary, they project that the levelized price for wind-energy conversion will be $28.00 per megawatt-hour (MWh) in the 2001-2003 time frame (2.8 cents/kWh). They also contend that this price is comparable with the NSP Phase II project. The reason for the difference between this estimate and the price quoted in the Electrical World report has not been determined.

NSP contracted with Kenetech, Inc. for a 25 MW wind power plant in 1993 to be installed southeast of Lake Benton along the Buffalo Ridge (NSP Phase I). The project was brought on line in May of 1994. According to firms which bid against Kenetech, the levelized price for electricity from that project was about 5 cents/kWh [3].

Northern States Power is authorized by the MN PUC to negotiate private contracts for wind energy projects under 12 MW. However, the basis for those negotiations is the most recent bid price for wind energy received by NSP. If the estimate for NSP's Phase II (and perhaps Phase III) are accurate at about 3.5 cents/kWh, and since the smaller projects avoid the administrative costs of bidding projects and reduce interconnection costs, industry sources project that the medium-sized project contracts are in the range of 4.2 cents/kWh.

In all of NSP's projects to date, they have provided the wind rights and the interconnection substation, which are estimated to be worth 0.5 cents/kWh levelized. Furthermore, the 1.5 cent/kWh production tax incentive, though appreciated to compensate for inflation, is only available for the first ten years of the project's operation. The levelized value of the incentive, therefore, is estimated to be about 1.1 cents/kWh.

Based on this sketchy information, a summary of power production costs for NSP projects is given in Table 4.7.

Table 4.7 NSP Wind Energy Contract Prices (estimated cents/kWh)

Project Phase	*Base Price*	*NSP Infrastructure Value*	*Production Tax Credit*	*Levelized Power Production Cost*
I	5.0	0.5	1.1	6.6
II	3.5	0.5	1.1	5.1
III	3.3	0.5	1.1	4.9
Medium	4.2	0.0	1.1	5.3

Construction of three wind turbines was completed in December 1998 near Chandler, Minnesota. The three wind turbines generate 2 MW of electricity and are said to be the tallest turbines in the nation reaching more than 206 feet in the air. Approximately one-third of the wind power will go to Cooperative Power (part of Great River Energy), a generation and transmission cooperative based in Eden Prairie, MN. They will offer wind power to customers at a $2 premium per 100-kWh block with the help of the state production incentive. To date, 13 of Coop Power member cooperatives including Dakota Electric offer the Wellspring product to their customers. Dairyland Power Cooperative and United Power Association (also part of Great River Energy) will each purchase one-third of the remaining balance [7].

For the recently announced Moorhead Public Service Project, the 400 charter members in the Capture The Wind™ program will pay just a half-penny more per kWh for the renewable energy or approximately $4 more each month. The one-third of customer electricity that now comes from coal will be replaced by wind, while the remaining two thirds will remain hydropower. There are currently more than 100 customers on a waiting list to join the program when slots become available [8].

There are at least three projects going up in Iowa. Project costs there will range from 4 cents at the largest projects to 6 cents/kWh at smaller projects. Two of those projects, a 42 MW project and a 10 MW project, will produce power for the Alliant system in response to an existing renewable capacity set-aside requirement on Iowa investor-owned utilities (IOU's). These projects are planned to be placed into service by July 1999.

Iowa municipal utilities in Cedar Falls, Westfield, Ellsworth, Fonda, Esterville, Montezuma, and Algona have invested in a 2.3 MW windfarm near Algona. The cost of the power should be 3 to 3.5 cents per kilowatt-hour or 2.2 cents for the first ten years if the federal Renewable Energy Production Incentive is received.

As long as the federal production tax credit remains in effect, Wisconsin wind generation should range from slightly above 6 to 8 cents/kWh, depending on the size of the project, the strength of the wind resource at hub height, and the owner of the project. Municipal utilities would be the lowest-cost producers of wind, as documented through the Traverse City and Moorhead (MN) installations.

Investor-owned utilities (IOU) are taxable entities; project costs would be higher for them than for municipal utilities, even though IOU's are more likely to build larger projects. Installations owned by independent power producers will be more expensive still, due to more stringent rate of return requirements imposed by investors.

The two-turbine De Pere project is not a reliable indicator of typical project costs. The costs of a five-year study (the Turbine Verification Program involving EPRI and U.S. DOE) is rolled into the stated project costs, inflating the per kilowatt/hour cost of energy substantially.

MG&E's 11.2 MW wind farm in Kewaunee County, when constructed, will be a much more reliable indicator of windpower costs, at least for projects in that size range. MG&E has not yet settled on a premium size. Based on program offerings to MG&E residential customers, the premium will be in the neighborhood of $5 per 80 kWh/month.

Wisconsin Electric will be constructing two turbines this year. Power from these turbines will be marketed to Energy for Tomorrow subscribers.

The wind resource in Iowa and Minnesota is significantly more robust than that in Wisconsin, resulting in higher capacity factors and lower production costs. That difference can translate into as much as 3 cents per kilowatt-hour.

Dairyland Power Cooperative is offering wind power from a single turbine on the Buffalo Ridge in southwest Minnesota to its customers (Wisconsin accounts for half of its load) at a premium of $3/100 kWh/month. This turbine is one of three to be constructed by an independent power producer for two Upper Midwest cooperatives, Dairyland and United Power Cooperative as part of Coop Power's Wellspring project. The turbines were placed in service at the end of 1998. Because the project's size is under 2 MW, it qualifies for a 1.5 cents/kWh tax credit recently enacted in Minnesota. While this provision stays on the Minnesota books, the cost of wind generation in that state will range from as low as 3.0 cents/kWh (at large installations for NSP) to about 5.5 cents kWh (at smaller installations owned by independent power producers).

Upon expiration of the federal production tax credit, the cost of windpower built by for-profit entities is likely to rise by about 1.5 cents. Congress still has time before June 30, 1999, to reauthorize the credit for an additional five years, or extend the existing window of eligibility for another year.

Photovoltaic Costs

Photovoltaics (PV) have been cost-effective from the early 1960's. Of course, "cost-effective" relates photovoltaic costs to the alternative energy sources to meet the same load. In the 1960's, photovoltaics were the cheapest electricity source available for satellite applications, even though they cost $50 per kilowatt hour. In the 1970's, they became the least-cost electricity source for remote telecommunication applications. In the 1980's, many people installed photovoltaics in remote residences, as it was cheaper than running electric power from the utility. In the 1990's, photovoltaics became the energy source of choice for some remote village applications and stand alone residences. In early July 1998, photovoltaics became the fastest-growing energy source, as worldwide production increased 40% in the past year, albeit from a relatively small baseline production (wind power, the second-fastest growing energy source at 25% per year, added twice the current total installed photovoltaic capacity worldwide in just the past year) [4].

Regardless of the recent robust growth and growing market penetration of photovoltaics, the costs have yet to approach utility wholesale or even retail rates. In the 1980's, levelized photovoltaic electricity costs ranged from 35 cents/kWh to 50 cents/kWh. More recently, typical costs range from 17 cents/kWh to 20 cents/kWh [5]. These costs are projected to continue to decrease through 2010 to nearly 5 cents/kWh (constant dollars) [ibid]. A major reason for the optimistic projections is a recent commitment by President Clinton to support the "Million Solar Roofs Initiative," in which the U.S. Department of Energy would like to stimulate one million new installations of photovoltaic systems, solar water heaters, and transpired solar collectors before 2010. Though photovoltaics are not the least cost of the eligible energy technologies, they are expected to capture a major share of the new installations due to their appropriateness for a very large variety of electricity applications.

Manufacturing costs are expected to drive down total system costs, primarily due to increased manufacturing capacity and increased efficiency system components. According to DOE [ibid.], manufacturing costs have decreased from an average of $4.20/peak watt of capacity in 1992 to less than $3.00/peak watt in 1997. Once mounting, packaging, and marketing costs are included, the cost of a PV module can cost as low as $5.67/peak watt for a 75 watt panel [6]. Additional system components, such as mounting hardware, a controller, batteries, or an inverter, increase the total installed cost. Specialty applications can be substantially more expensive. For instance, a charging system for a recreational vehicle costs about $7.80/peak watt, while a portable panel to charge a computer runs about $29/peak watt. Typical stand alone residential systems for virtually all domestic electric loads may cost between $4,000 and $12,000 installed, depending upon size, application and location.

Unlike wind, the solar resource is considerably less variable throughout the region. Therefore solar costs should not vary much from one state to the next. Only one utility in the Great Lakes region, Detroit Edison, offers a solar Green Power option to its customers. The premium amounts to about 56 cents per kWh. As exorbitant as that price may seem, it would climb even higher if federal cost-sharing programs were allowed to lapse (a distinct possibility in the current political climate).

Though near-term costs of solar electricity (produced from photovoltaic cells) are well above those of other renewable technologies, it is quite possible that utilities in Wisconsin will offer in the near future PV power at considerably lower prices (15 cents to 30 cents per kWh). That possibility hinges on several conditions materializing, the most important of which would be the continuation and expansion of federal cost-sharing initiatives.

Right now PV costs between $7 to $8 a watt, or $7,000 - $8,000/kW. Cost-sharing through the Utility Photovoltaic Group (UPVG) Team-Up program has reduced acquisition cost to about $5/watt for individual utilities. If utilities were to combine their acquisition efforts, installed costs would likely drop further. Larry Krom is investigating the availability of UPVG Team-Up credits with the Energy Center and a consortium of utilities (MG&E, Wisconsin Electric, and Wisconsin Public Service).

When combined with battery storage, PV can provide a capacity value (30 - 35%) in excess of twice its capacity factor (15%).

PV has the potential to provide both utilities and their commercial customers with reliability benefits that could reduce the investment payback down to 10 years or less, depending on the availability of low-interest financing. These benefits can and should shave the price of solar electricity marketed to utility customers.

Biomass-Wood Costs

Among wood-fired generation options, co-firing at existing utility fossil units shapes up to be the lowest-cost application for wood. Co-firing costs should not vary significantly from one state to the next.

Wisconsin Electric is actively investigating the installation of a wood-fired boiler at its Valley Cogeneration Plant. One of Wisconsin Electric's sources of power for its Energy for Tomorrow program is a Duluth plant that has a co-firing system. It seems reasonable to use the power production costs there, in the vicinity of 3.3 cents/kWh, as a benchmark for the Valley project, should it go forward.

Wood fuel (and paper sludge) can also be fed into stand-alone nonutility-owned generators or cogeneration systems producing electricity and steam. Stand-alone wood generation is a more expensive option than co-firing. The cost of a 10 MW system is likely to be in the range of 7 cents/kWh, higher for smaller units. The capital cost of a nonutility system is somewhere in the range of $1,700/kW, while the cost of fuel, depending on the availability, would run about $1.00/ MMBTU.

Other Costs: Landfill Gas, Farm Digesters, and Hydro

As compared with other renewable fuels, generating electricity from landfill sources of methane is an inexpensive option. Dane County began producing electricity from a 1 MW generator installed at its Rodefeld landfill last fall, receiving about 2.8 cents/kWh. However, Dane County is of the view that MG&E's current buyback rate does not provide enough economic incentive to continue production beyond another year. It recently submitted a proposal to sell this power to Wisconsin Electric's Energy for Tomorrow program at slightly above 3 cents/kWh. At that rate, Dane County has indicated that it would operate its methane recovery system as long as supplies from the Rodefeld landfill last.

Efforts have begun to site a demonstration of a new animal waste-to-methane energy conversion system, including a 0.5 MW generator, at a large Wisconsin farm. The company seeking to market this system, called Anergen, envisions selling the power from this energy system at 6.5 cents/kWh.

Many hydro generators are facing a costly relicensing process; it may not make sense for some of them to continue production at their existing facilities unless capacity is increased and output is sold into a green power program. For these kinds of units, power generation costs will range from 3 to 5 cents/kWh.

Current Green Electricity Pricing Programs in Four-State Study Area (March 1999)

Minnesota and Wisconsin have many green electricity program offerings in their states as summarized in Table 4.8. Iowa and Illinois currently have no green pricing programs available to residential customers. Iowa has significant mandated wind resources available or in development. In Iowa, MidAmerican has no plans for offering a green pricing program. Their position is that the Alternate Energy Production law of 1990 encourages renewable energy at a rate that should be shared by all customers. Alliant Energy is exploring the development of a green pricing program in 1999 using mandated wind energy. There are several other Iowa Municipal utilities and electric coops offering their own wind energy generation to all customers as a part of their mix. Illinois currently has very little in-state renewable generation available to offer residential customers. Figure 4.1 summarizes the annual cost premiums for green electricity programs in Minnesota and Wisconsin.

Table 4.8 Costs of Current Green Electricity Pricing Programs in Four-State Study Area

Utility Name	**Program Name**	**Energy Type**	**Size** (MW)	**Program Offer**	**Premium** (cents/kWh)
Moorhead Public Service	Capture the Wind Project	Wind & hydro	0.8	$5/1000 kWh	0.5
Dakota Electric Association	Wellspring Renewable Energy	Wind	0.7	$2/100 kWh	2.0
Cooperative Power Assoc.	Wellspring Renewable Energy	Wind	0.7	$2/100 kWh	2.0
Wisconsin Electric Power	Energy for Tomorrow	Hydro, wind & biomass	7.5	30% Premium	2.0
United Power Association	Wellspring	Wind	1.0	$3 / 100 kWh	3.0
Dairyland Power	Evergreen Program	Wind	1.8	$3 / 100 kWh	3.0
Madison Gas and Electric	Wind Power Program	Wind	11.2	$5 / 80 to 120 kWh	4.2 - 6.3
Northern States Power Company	EnergyWise Solar Advantage	Rooftop PV	0.034	$50 / month	6 - 7

Wisconsin and Minnesota Programs

Cooperative Power Associations' Wellspring Renewable Energy Program

- Cooperative Power (part of Great River Energy), is a generation and transmission cooperative based in Eden Prairie, MN. They offer one-third of the wind power capacity from the Chandler wind turbines to customers at $2 per 100 kWh block with the help of the state production incentive. To date, 13 of CPA's member cooperatives offer the Wellspring product to their customers. Dairyland Power Cooperative and United Power Association will purchase the balance.
- Cost: Approximately $15 more per month to offset 100% of customers' electricity with wind power.

Dairyland Power's Evergreen Program

- Offers wind power in 100 kWh blocks at a $3 per month premium (all 1,800 blocks have been sold) in MN and WI markets.
- Cost: Approximately $22 more per month to offset 100% of customers' electricity with wind power.

Dakota Electric Association Wellspring Program

- Offered through Cooperative Powers' program to Dakota Electric customers in MN. Originally priced at $4 per 100 kWh block of wind energy, the price is expected to be only a little over $2 more per 100 kWh block because of new state incentives and increased efficiency in wind turbines.
- Cost: Approximately $15 more per month to offset 100% of customers' electricity with wind power.

Madison Gas and Electric Wind Power Program

- Will offer wind power to Wisconsin customers in at least 80 kWh blocks at a $5 per month premium from mixture of 3MW mandated and 8.2MW voluntary wind power. (Block size could increase to as much as 120 kWh for the same $5 price with good construction weather and federal production tax credits).
- Cost: Approximately $45 more per month to offset 100% of customers' electricity with wind power. Cost could decline to as low as $30 more per month.

Moorhead Public Service Capture the Wind Project

- 400 charter members will pay a half-penny more per kWh for renewable energy. (The one-third of customer electricity that now comes from coal will be replaced by wind, while the remaining two thirds will remain hydropower.)
- Cost: Approximately $3.80 more per month to offset one-third of customers' electricity with wind power with the other two-thirds remaining as hydropower.

Northern States Power Company EnergyWise Solar Advantage Program

- This program installs 2 kW residential PVs on Minnesota customers' rooftops. NSP pays for and installs the systems with help from the U.S. Department of Energy and the Utility PhotoVoltaic Group.
- Cost: Program participants pay an additional $50 on each month's utility bill for five years and receive the power generated by the unit at no cost.

United Power Association (UPA)

- UPA (part of Great River Energy) is a generation and transmission cooperative based in Elk River, MN. UPA offers wind power in 100-kWh blocks at a $3 per month premium to its 12 member distribution cooperatives for sale to their customers. Two-thirds of their total wind offering is from the Chandler wind turbines. The remaining one-third of their wind offering comes from existing (mandated) wind power purchased from NSP.
- Cost = Approximately $23 more per month to offset 100% of customers' electricity with wind power.

Wisconsin Electric Power's Energy for Tomorrow Program

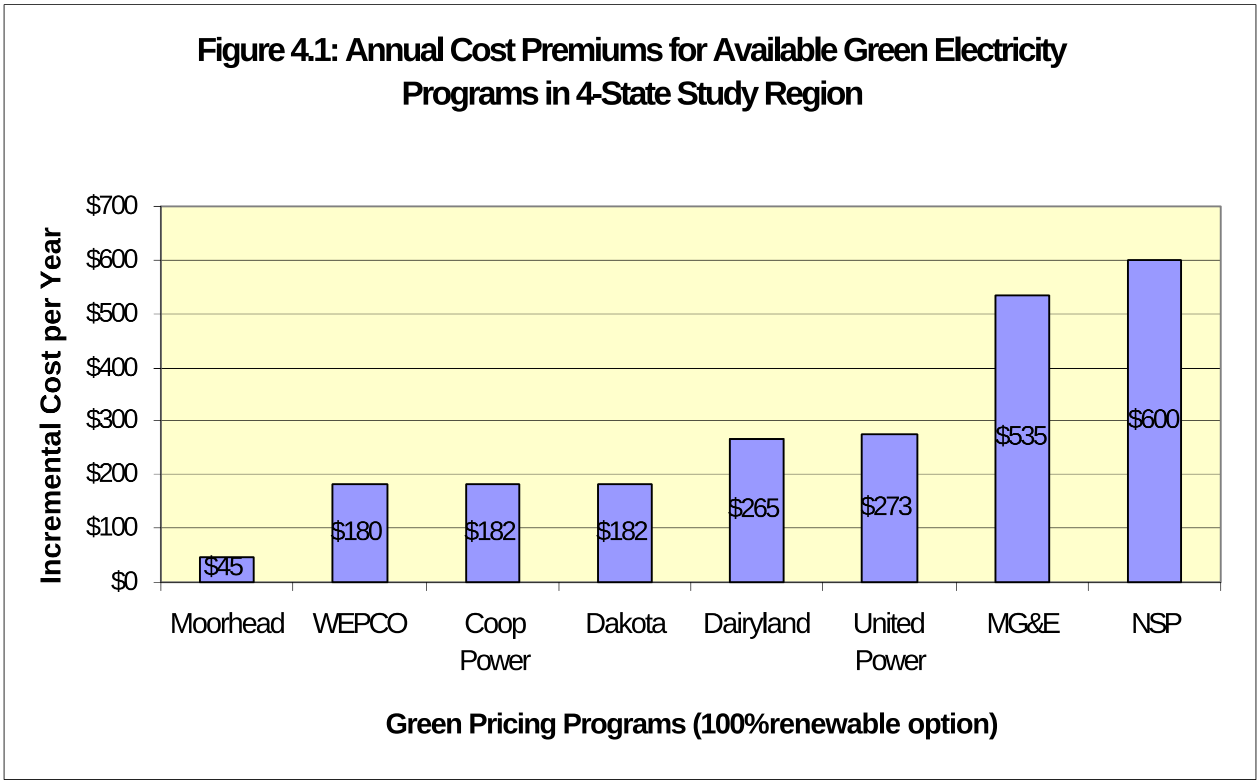
- Offers renewable power at a 30% premium over its regular rate. 8,500 subscribers can purchase one-quarter, one-half, or all of their power as renewable. (Currently hydropower energy and biomass, with significant new in-state wind power generation to contribute to the program by the summer of 1999)
- Cost: Approximately $15 more per month to offset 100% of customers' electricity with renewable power.

Wisconsin Public Power

- Planning to offer renewable power to customers based on 2 - 5 MW of new renewable generating capacity.

Wisconsin Public Service

- Customers can contribute towards the Solar Wise for Schools Program which installs PV's on the roofs of school buildings.



Note: Costs in Figure 4.1 based on different mixes of renewable products and costs within each green pricing program combined with the Table 4.3 residential electric consumption characteristics for the four-state area. Moorhead (66% hydro and 33% wind) and WEPCO (hydro, wind, and biomass mix) programs are mainly hydro power. Dakota, Coop Power, Dairyland, United Power and MG&E programs are 100% wind, and NSP's program is 100% solar.

References for Analysis of Generation Options for Green Electricity

Center for Clean Air Policy, 1995, *Wisconsin's Strategy, Phase Two: Cleaning the Air, Protecting the Environment, Sustaining the Economy***.**

Wisconsin Department of Natural Resource, 1999, *personal communication,* Allen Hubbard, Bureau of Air Management.

Staudt, James E., Ph.D., 1998, *NESCAUM's Status Report on NOx Post-RACT Control Technologies and Cost-effectiveness,* 1998 DOE Conference on Selective Catalytic and Non Catalytic Reduction for NOx Control, Pittsburgh, PA, 1998.

References for Emissions and Cost Analysis of Specific Generation Technologies

Electric Power Research Institute (EPRI), 1994, *Technical Assessment Guide*, Volume II

Energy Information Administration (EIA), *State Energy Price and Expenditure Report 1995,* DOE/EIA-0376(95), August 1998.

Wisconsin Associated Utilities (WAU), 1998, *Advance Plan 8*, Wisconsin Public Service Commission, Madison Wisconsin 1998.

References for Cost Data on Midwest Renewable Energy Projects

[1] "Wind Power: Will it Prevail?" by Lisa Cohn, Electrical World, January 1998.
[2] Initial Comments of the Izaak Walton League of America, in the matter of the 'Application of Northern States Power Company for Resource Plan Approval, MPUC Docket No.EOO2/RP-93-32", July 6, 1998.
[3] Wind manufacturer confidential discussion with J. Dunlop, September 1997.
[4] Untitled Report, by Christopher Flavin, to be printed in "The Nucleus," September 1998.
[5] "PV: The Power of Choice, National PV Program Plan for 1996-2000," U.S. Department of Energy, 1996.
[6] "Real Goods Catalog, " Real Goods Trading, Ukiah, CA, Summer 1998.
[7] Conversation with Tim Seck of Great River Energy, March 1999.
[8] Moorhead Public Service Press Release, July 29, 1998.

Section 5 Analysis of Emission Reduction Credits as a Green Energy Option

The Market for Sulfur Dioxide

The Acid Rain Program of the 1990 Clean Air Act places a limit (a cap) on the amount of sulfur dioxide (SO_2) that can be emitted annually. Sources of air pollution were allocated allowances, or "rights to pollute", based on their historic level of SO_2 emissions. Each allowance permits one ton of SO_2 to be released into the air. For each ton of SO_2 discharged, one allowance is expended, and can not be used again. At the end of each year, polluting sources must hold enough allowances to cover their SO_2 emissions for that year. Any remaining allowances can be sold, traded, or banked for future use. If a source of air pollution does not have enough allowances to cover its SO_2 emissions, it can buy allowances on the open market. Allowances are a valuable and tradable commodity.

The cap-and-trade approach to sulfur dioxide pollution reduction has been very successful, both economically and environmentally. During the regulatory process that led to the sulfur dioxide emissions cap, the original estimated cost of reducing emissions of sulfur dioxide was $1500/ton. However, the market-based sulfur dioxide program offers financial incentive to find the most cost-effective solution to reducing sulfur dioxide. The result – the current cost of eliminating sulfur dioxide emissions averages about $150/ton to $200/ton. (Meanwhile, the environmental damage produced by one ton of sulfur dioxide is estimated to be near $4000). Attainment of sulfur dioxide limits has also occurred more quickly than expected.

Offsets

Geographical regions that are not in compliance with an air quality standard are classified as nonattainment areas. Construction of new sources of air pollution or expansion of existing sources in these areas would be prevented since it would exacerbate already high levels of pollution. Offsets were originally designed to allow growth and development in these areas without increasing pollution levels. An offset program allows emission trading between a new or modified source of air pollution and an existing source. New sources are required to *more than* offset its emissions with reductions by the existing source. In this way, net emissions actually decrease.

Emission Reduction and Trading

Sources of air pollution that wish to reduce their emissions have many options available to them. These options include installing more advanced pollution control technology, switching to cleaner fuels, improving energy efficiency, and increasing renewable energy usage. Sources that decrease their emissions by implementing such measures create "emission reductions." Emission reductions from energy efficiency and renewable energy produce health and environmental benefits by reducing sulfur dioxide, carbon dioxide, nitrogen oxides, lead, mercury, and particulate matter emissions.

Sources of air pollution that reduce their emissions may receive credit for their reductions. For many pollutants, sources must reduce their emissions below their required limit (cap) in order to earn saleable credits. Emission reduction credits reward those who take action to reduce their pollutant emissions and therefore encourage pollution reduction actions. Credits for emission reductions provide an incentive to find the most cost-effective way to reduce emissions, since once an emission reduction credit is created, it can be sold on the open market. Markets for emission reduction credits or emission allowances can be created by regulation (the sulfur dioxide market for example) or voluntarily (the current market for greenhouse gases).

Markets for Pollution Reduction

Currently, there is a well-established sulfur dioxide (SO_2) emission reduction market in the U.S. and the beginnings of established reduction markets for CO_2, NOx, and volatile organic compounds (VOCs) in parts of the U.S. and Canada. Emission reduction markets are also possible for other pollutants such as mercury, lead, and particulates; the only components required to establish a market are a buyer and a seller. Emission reduction credit markets that are shaped by regulation have the advantage of being very concrete, but have the disadvantage of leaving out important emission reduction actions.

For example, the sulfur dioxide emission allowance market is well-established and very concrete, but the regulators who set it up failed to include rewards for the emission reduction benefits of energy efficiency and renewable energy projects implemented by non-emitters. Allowances have only been allocated to affected utility units (mostly fossil fuel-fired power plants) for these emission reduction actions, although very few have taken advantage of these credits because of limited access and a burdensome credit collection system for energy efficiency and renewable reduction actions. There is no reason that access to the SO_2 reduction market could not be expanded in the future to include credits for energy efficiency and renewable energy emission reduction actions by non-emitters. The credit collection system for SO_2 reduction credits in this area could also be made less of a burden.

On the other hand, the markets for pollutants that are not yet regulated are voluntary and therefore less concrete. Voluntary markets have the advantage of being flexible and not influenced by regulatory rules, so the emission reduction credit market is able to simply reflect an approach and criteria selected by the buyers and sellers of emission reduction credits. For example, the currently voluntary market for carbon dioxide (CO_2) reductions is shaped by what the participants think is important and what they anticipate will be included in eventual CO_2 emission reduction regulations.

Emission Trading for Consumers

Traditionally, in areas of tight environmental controls, new sources of air pollution are required to offset their new emissions with a reduction in emissions of an existing source. Similarly, consumers can "offset" the pollution caused by their energy use by buying and retiring the emission reduction credits created by someone else.

In this way, the market for emission reduction credits can be used to further reduce pollution. Instead of reselling emission reduction credits to sources of air pollution that will use them to compensate for their pollutant emissions, allowances can be retired, *without* emitting any pollution. Once an emission reduction credit is retired, it can no longer be bought, sold, or used to offset pollution. Purchasing and retiring emission reduction allowances reduces the amount of pollution that is discharged to the atmosphere for regulated markets, and creates future pollution reduction potential for voluntary markets.

Energy efficiency and renewable energy projects reduce the negative environmental impacts caused by the production and delivery of energy to consumers, as well as provide emission reductions which can be purchased by consumers. Buying and retiring emission reduction credits produced by energy efficiency or renewable energy projects provides many environmental benefits and allows consumers the chance to:

- Influence public policy decisions to implement market-based pollution reduction strategies
- Give value and financial incentive to the pollution reduction actions made through energy efficiency and renewable energy projects
- Strengthen emission reduction markets
- Reduce the negative environmental impacts produced by energy production and distribution including the production and delivery of goods and services purchased by consumers

Increasing consumer energy efficiency provides many environmental benefits, but it is difficult for consumers to reduce the emissions caused by the production and delivery of goods and services they buy. Buying emission reductions has an added advantage, it allows consumers to *offset* their net emissions, including indirect emissions from goods and services purchased, by 100 percent (to zero).

Green energy in the form of emission reductions can be purchased in the competitive marketplace, so competition will eventually drive the price of emission reductions down to the point where supply and demand are balanced. Buying emission reduction credits lets consumers conveniently offset the emissions, caused by both their direct and indirect energy use, as much as they want at a low competitive market cost. For example, an average U.S. family's CO_2 emissions from their household electricity consumption could be offset for less than $1 per month (about $10 per year). An average U.S. family's *total* CO_2 emissions, including emissions that result from the production and delivery of goods and services purchased, can be offset for less than $5 per month (about $56 per year).

Emission trading can be used to reduce pollution. Instead of reselling emission reduction credits or allowances to sources of air pollution that will use them to compensate for their pollutant emissions, allowances can be retired, *without* emitting any pollution. Once an allowance is retired, it can no longer be bought, sold, or used to offset pollution. Purchasing and retiring emission reduction allowances reduces the amount of pollution that is discharged to the atmosphere.

Consumers can take advantage of this concept and offset the emissions caused by their energy use by participating in emissions trading, i.e., buying and retiring emission reduction credits. This amounts to paying someone else to reduce the consumer's emissions, with the agreement that the consumer will own the resulting emission reduction credits. In this way we, as consumers, have a low cost way to compensate for the pollution that results from our energy use. Purchasing emission reduction credits also strengthens the emission reduction market and gives companies and individuals an added incentive to reduce their pollution.

Buying Green Energy through the Cleaner and Greener^{sm} Program

To demonstrate the impact that consumers can have on reducing pollution, Leonardo Academy has instituted a program that lets consumers buy green energy in the form of making a donation (all U.S. donations are tax-deductible) to buy and retire emission reduction credits. Consumers everywhere can buy Green Energy through the Cleaner and Greener^{sm} web site at http://www.cleanerandgreener.org

For pollutants that have established national emission trading systems in place, the Cleaner and Greener^{sm} Program buys emission allowances and offsets from within that trading system. For example, sulfur dioxide allowance auctions are conducted by the Chicago Board of Trade. For pollutants like carbon dioxide, that do not have established emission trading systems, the Cleaner and Greener^{sm} Program buys emission reduction credits that are reported[2] according to the Multiple Pollutant Emission Reduction Reporting System developed by Leonardo Academy with funding from the U.S. EPA. Any emission reduction credits or emission offsets that are purchased are retired. Once retired, they cannot be sold, traded, given away, or otherwise used to offset pollution. The purchase, transfer of ownership, and retirement of emission reduction credits are recorded in the U.S. DOE / EIA's 1605(b) electronic database and will be summarized on the Cleaner and Greener^{sm} Web Site.

The Cleaner and Greener^{sm} Green Energy Program shows that there are low cost pollution reduction options available, encourages increased energy efficiency and renewable energy, and shows that there is public support for taking action to reduce pollution.

[2] Emission reductions are reported under the Voluntary Reporting Program of the Department of Energy - Energy Information Administration (1605(b) of the Energy Policy Act).

Emission Reduction Credit Costs

The good thing about emission reduction credits (offsets) is that they let those who can reduce emissions at the lowest cost do the reductions, so that the overall cost of emission reductions is reduced. Table 5.1 shows the estimated cost of offsetting emissions caused by one family at projected future costs of efficiency-based reductions. Emission reduction credits could be purchased on a trading market at relatively low costs. One person could offset their own emissions for approximately $190 per year or $16 per month. Of this total, $150 per year or $12.50 per month would go towards offsetting emissions of nitrogen oxides (NOx).

These offset cost figures assume a separate trading market for each emission type so therefore overestimate the total cost. If an integrated trading market which includes energy efficiency is created, the total costs would decrease because many of the allocations rewarded for energy efficiency and renewable projects reduce multiple emission types. If you wished to offset your carbon dioxide emissions only, it would cost $1.83 per month, less than $5 for the average family.

Table 5.1 Estimated Cost of Offsetting All of Your Emissions at Projected Future Costs of Efficiency-Based Reductions

Pollution Type	Estimated Market Cost of Emission Reductions ($/ton)	Estimated Annual Per Family Cost ($)	Estimated Annual Per Capita Cost ($)	Estimated Monthly Per Capita Cost ($)
Climate Change (CO_2)	$1	$56.00	$22.00	$1.83
Acid Rain (SO_2)	$200	$37.40	$14.40	$1.20
Ozone-Causing (NOx)	$1,700	$389.30	$149.60	$12.47
Particulate (PM10)	$200	$6.30	$2.40	$0.20
Toxic Lead (Pb)	$30,000	$1.13	$0.47	$0.04
Toxic Mercury (Hg)	$30,000	$0.75	$0.28	$0.02
Total Cost	NA	$490.88	$189.15	$15.76

Notes on Table 5.1: The estimated costs of offsetting emissions are based on the U.S. average per capita and family emissions per year from Table 1.1. The estimated value of emission reductions from energy efficiency and renewable energy assumes these actions are given credit in future emission reduction regulatory programs. Estimates are based on emission reduction prices in situations where there is not a fully competitive market for emission reductions that includes full participation of energy efficiency-based reductions. If a fully competitive market for emission reductions that includes full participation of energy efficiency-based reductions is created, this additional supply of low cost emission reductions will clearly affect the market price.

CO_2: Based on some early transactions in Oregon and estimates of future market prices
SO_2: When SO_2 emissions reductions regulations were proposed, estimates of reduction cost in the range of $1000 to $1500 per ton were commonly made. In the last 3 years emission allowances have been in the $50 to $200 per ton range. Prices are currently closer to the $200 per ton range. As phase two of the SO_2 reduction regulations take effect in early 2000's the prices for SO_2 allowances may rise.
NOx: Current regulatory proceeding estimates of reduction costs for generation based reduction measures.
PM10: The SO_2 market price is used since particulates are partly composed of SO_2.
Hg: Current regulatory proceeding estimates of reduction costs for generation based reduction measures.
Pb: Estimated to be equal to or less than mercury costs because of the lower volatility of lead.

Section 6 Combined Analysis of Energy Efficiency, Generation Technology, and Emission Reduction Credits as Green Energy Options

Sections 3, 4, and 5 describe the analysis of energy efficiency, generation, and emission reduction credit options for reducing environmental emissions. This section brings the analysis of these options together so that the relative costs and benefits of the full range of options can be compared.

Since each action can have different effects on different types of emissions, the cost per ton of emission reduction for several pollutants are shown in table 6.1, 6.2, and 6.3. Carbon dioxide (CO_2) reduction costs (Table 6.1) provide a good indication of the reduction costs of other emissions because CO_2 emission reductions are a good measure of the amount of fossil fuel use reduction provided, and most other types of emissions are reduced by decreases in fossil fuel use.

Tables 6.1, 6.2, and 6.3 show that for each of the pollutants, several options provide cost savings on a dollars per ton basis. New generation technologies, energy efficiency, and natural gas-fired generation options all provide emission reduction at cost savings for CO_2, SO_2, NOx.

Table 6.1 Energy Efficiency and Generation Option Costs for Reducing Emissions (Ranked by Dollars per ton of CO_2 Reduced*)

Energy Efficiency and Generation Options	CO_2 Reduction Cost ($/ton)
Integrated Coal Gasification Combined Cycle	($991)
Integrated Coal Gasification Fuel Cell	($103)
Average of Residential Sector Cost-Effective Energy Efficiency Options	($97)
Natural Gas Combustion Turbine - 154 MW	($67)
Residential Sector Example: Replace Residential Electric Furnace with a New Standard Gas Furnace	($61)
Natural Gas Combined Cycle - 215 MW	($57)
Average of Commercial, Industrial, and Agricultural Sector Cost-Effective Energy Efficiency Options	($54)
Industrial Sector Example: Replace Industrial Incandescent Lamps with Compact Flourescent Lamps	($43)
Wind Turbine	$4
Fluidized Bed Combustion - Wood Fired (Biomass)	$10
Installation of Generation Pollution Control Equipment	$181
Solar - 5 MW dispersed connection	$214

Note: For Tables 6.1, 6.2, and 6.3, the costs of energy-efficient end use measures were compared to standard new equipment. Generation options were measured against the current average electric generation characteristics in the four-state study area.

Table 6.2 Energy Efficiency and Generation Option Costs for Reducing Emissions (Ranked by Dollars Per Ton of SO_2 Reduced)

Energy Efficiency and Generation Options	SO_2 Reduction Cost ($/ton)
Average of Residential Sector Cost-Effective Energy Efficiency Options*	($101,809)
Average of Commercial, Industrial, and Agricultural Sector Cost-Effective Energy Efficiency Options	($14,750)
Industrial Sector Example: Replace Industrial Incandescent Lamps with Compact Flourescent Lamps	($12,044)
Residential Sector Example: Replace Residential Electric Furnace with a New Standard Gas Furnace	($11,185)
Integrated Coal Gasification Combined Cycle	($6,008)
Natural Gas Combined Cycle - 215 MW	($5,577)
Integrated Coal Gasification Fuel Cell	($4,550)
Natural Gas Combustion Turbine - 154 MW	($4,400)
Wind Turbine	$562
Fluidized Bed Combustion - Wood Fired (Biomass)	$1,529
Installation of Generation Pollution Control Equipment	$100 - $5,000
Solar - 5 MW dispersed connection	$34,141

*Note: It takes over 6000 end use energy efficiency replacement units to reduce one ton of SO_2 emissions. This amount of measures adds up to a large savings per ton (see Table 6.4).

Table 6.3 Energy Efficiency and Generation Option Costs for Reducing Emissions (Ranked by Dollars per ton of NOx Reduced)

Energy Efficiency and Generation Options	NOx Reduction Cost ($/ton)
Average of Residential Sector Cost-Effective Energy Efficiency Options	($41,842)
Residential Sector Example: Replace Residential Electric Furnace with a New Standard Gas Furnace	($26,341)
Average of Commercial, Industrial, and Agricultural Sector Cost-Effective Energy Efficiency Options	($20,245)
Industrial Sector Example: Replace Industrial Incandescent Lamps with Compact Flourescent Lamps	($15,925)
Integrated Coal Gasification Combined Cycle	($13,544)
Natural Gas Combined Cycle - 215 MW	($11,268)
Integrated Coal Gasification Fuel Cell	($9,085)
Natural Gas Combustion Turbine - 154 MW	($9,095)
Wind Turbine	$1,125
Installation of Generation Pollution Control Equipment	$800 - $2,000
Fluidized Bed Combustion - Wood Fired (Biomass)	$6,499
Solar - 5 MW dispersed connection	$68,282

The average residential sector and the other sector options shown in Table 6.4 include many different types of cost-effective energy efficiency measures including the two specific efficiency measures shown. As Table 6.4 shows, it takes a lot more cost-effective energy efficiency measures to reduce a ton of SO_2 or NOx than it takes to reduce a ton of CO_2. Replacing a residential electric furnace with a new standard gas furnace is one of the best energy efficiency options available since it will save over five tons of CO_2 per year, while it will only save 0.3 tons of SO_2 and 0.012 tons of NOx. However, our own energy use for the most part results in less SO_2 or NOx emissions than CO_2 emissions (See Table 6.5). Another way to look at this is that if enough cost-effective efficient units are installed to reduce a ton of NOx, it will produce very large cost savings as shown in Table 6.3.

Table 6.4 Required Levels of Unit Replacements to Reduce One Ton of Emissions for Each Pollutant for Cost-Effective Energy Efficiency End Use Option Measures

Cost-Effective Energy Efficiency End Use Option Measures	# of Replacement Units Required to Reduce One Ton of Emissions for Each Pollutant		
	CO_2	SO_2	NOx
Average of Residential Sector Options	5.2	6,392	1,937
Average of Commercial, Industrial, and Agricultural Sector Options	3.7	1,012	1,352
Replace Residential Electric Furnace with a New Standard Gas Furnace	0.2	35	83
Replace Industrial Incandescent Lamps with Compact Flourescent Lamps	4.4	1,232	1,629

Table 6.5 shows the net real emissions savings for each pollutant from the installation of cost-effective energy efficiency measures. This is another way of looking at the results in Table 6.4. As shown for each option, energy-efficient measures result in the reduction of multiple types of emissions. Emissions of lead, mercury, and particulates are also reduced through the installation of energy efficiency measures.

Table 6.5 Net Real Emissions Savings for Cost-Effective Energy Efficiency End Use Option Measures (Tons)

Cost-Effective Energy Efficiency End Use Option Measures	Emissions savings per unit per year (tons)		
	CO_2	SO_2	NOx
Average of Residential Sector Options	1.46	0.0059	0.0038
Average of Commercial, Industrial, and Agricultural Sector Options	1.94	0.0072	0.0052
Replace Residential Electric Furnace with a New Standard Gas Furnace	5.17	0.0282	0.0120
Replace Industrial Incandescent Lamps with Compact Flourescent Lamps	0.23	0.0008	0.0006

Reducing the Emissions Caused by Our Energy Use

To compare the cost to a consumer of choosing various emission reduction options, we calculated the cost of reducing a consumer's per capita share of U.S. emissions to zero. This approach includes a consumer's average direct and indirect contribution to emissions. When examining green energy options it is important to remember that there are a variety of ways of reducing emissions that deliver net emission reductions.

It is perhaps useful to look at deciding how to reduce the emissions caused by our energy use as we do most decisions we make as consumers. We, as consumers, decide either to make the goods and services we consume or pay someone else to produce them for us. Consumers consciously, or unconsciously, consider the time, money, and effort involved with the broad range of options that exists between the two extremes before making a decision. In the end, most of us choose to pay someone else to produce the goods and services we consume.

Let's consider clothing as an example. One option is to buy our clothes at a store. Another option is to purchase the fabric, sewing supplies, and other needed materials, and make the clothes ourselves. Alternatively, we could grow cotton, process it, weave it into cloth, design our own patterns, and sew the clothes. Most of us prefer to forgo the production and buy our clothes from a store. Another example is food. We can grow all of our food ourselves; we can specialize in one type of food and set up a trading system with other growers of other food types; we can buy our food at the grocery store and finish preparation at home; or we can go to a restaurant. All these approaches lead to the same outcome - we have food to eat, yet most consumers choose to purchase food from grocery stores or markets.

Just like clothing and food, consumers have a range of choices for reducing the emissions caused by household energy use as well.

We can reduce our own direct energy use by conserving energy, implementing energy-efficient measures, and installing our own renewable generation. For example, replacing less efficient appliances (furnaces, air conditioners, water heaters, stoves, clothes dryers, etc.) with those that are more efficient and/or run on natural gas can reduce overall emissions from home energy usage. Increasing our reliance on mass transit and buying cleaner, more efficient vehicles can reduce air pollution emissions in the transportation sector. To reduce emissions from the goods and services sector, we can purchase goods and services that are produced and delivered in cleaner ways. For example, commodities that are produced locally can reduce emissions that result from shipping.

We all should conserve energy and implement energy-efficient measures to the degree that we are comfortable. But for most of us, the energy efficiency improvements we can make and the energy-saving lifestyle choices that we are comfortable with only partly negate our per capita emissions. No matter how energy-efficient most households become, some energy consumption will still occur. Even if we reduced the direct energy use in our homes to zero, the emissions caused by the production and delivery of the goods and services we purchase (which accounts for about 65% of total household emissions) still remain. The remainder of the emission reduction could be accomplished through additional low cost options such as purchasing from cleaner generation sources or buying emission offsets.

In some states, consumers can pay someone else to provide them with cleaner "green" energy by buying renewable or cleaner fossil fueled generation from energy providers. Green electric power is being offered in parts of the country where electric utility deregulation has occurred, such as California, Pennsylvania, and Massachusetts. Where electric industry competition does not exist, some utilities offer special "green rates" to their customers for electricity generated from renewables. In this case, these rates are set by regulations rather than competition. Consumers also need to make sure any premiums they pay for green electricity are going towards new, not mandated, renewable generation.

Buying green electricity is a step in the right direction, but it is currently only available in a few states. In addition, green electricity can only reduce the emissions from our electricity use, which is responsible for about 13% of a household's total emissions. There *is* an option that is available to consumers everywhere, regardless of the status of electric utility industry deregulation, and it gives consumers the opportunity to compensate for 100% of the emissions caused by their household's energy use. Consumers can cancel out (offset) the emissions caused by their energy use by participating in emissions trading, i.e., buying *and retiring* emission reduction credits.

Consumers can also reduce their per capita share of emissions by paying someone else to change how they use energy so that emissions are reduced, with agreement that the consumer will own the resulting emission reductions. This can be done through emissions trading and offsets. This amounts to paying someone else to reduce their emissions to compensate for the emissions that result from our energy use. Buying reductions that result from someone else's actions change how that person uses energy so that emissions are reduced. This will create demand for further emission reductions.

The important point is that there are many ways for consumers to reduce their per capita share of emissions, whether through energy efficiency, buying cleaner or renewable energy and electricity, or purchasing emission offsets.

Summary of Consumer Costs and Impacts of Emission Reduction Options

Energy Efficiency End Use and Generation Options

Tables 6.7 through 6.9 show the average costs for a family to reduce their monthly and yearly emissions of CO_2, SO_2, and NOx. The costs for the different emission types are not additive and are meant to be viewed as stand-alone costs. This is because installing energy-efficient equipment or buying renewable and cleaner generation can reduce emissions of CO_2, SO_2, and NOx, as well as other pollutant types, with each single consumer action. Many of these actions save money for consumers over the long run and can be done at very low costs.

Table 6.7 Family's Cost of Using Cost-Effective Energy Efficiency End Use and Generation Options to Reduce CO_2 Emissions Resulting from Household Electricity Use

Energy Efficiency and Generation Options	Family's Monthly CO_2 Reduction (tons)	CO_2 Reduction Cost ($/ton)	Family's Added Monthly Cost ($)	Family's Added Yearly Cost ($)
Integrated Coal Gasification Combined Cycle	0.03	($991.42)	($29)	($350)
Natural Gas Combined Cycle - 215 MW	0.49	($57.15)	($28)	($335)
Residential Sector Energy Efficiency Options	0.24	($96.60)	($23)	($278)
Integrated Coal Gasification Fuel Cell	0.22	($102.53)	($23)	($274)
Natural Gas Combustion Turbine - 154 MW	0.33	($66.50)	($22)	($263)
Wind Turbine	0.80	$3.53	$3	$34
Fluidized Bed Combustion - Wood Fired (Biomass)	0.80	$9.50	$8	$91
Solar - 5 MW dispersed connection	0.80	$214.34	$171	$2,056

Note: Based on four-state average monthly consumption of 717 kWh per month per family and CO_2 Reduction Cost ($/ton) from Table 6.1. The total emission reduction potential = 0.80 tons per month.

Table 6.8 Family's Cost of Using Cost-Effective Energy Efficiency End Use and Generation Options to Reduce SO_2 Emissions Resulting from Household Electricity Use

Energy Efficiency and Generation Options	Family's Monthly SO_2 Reduction (Tons)	SO_2 Reduction Cost ($/ton)	Family's Added Monthly Cost ($)	Family's Added Yearly Cost ($)
Residential Sector Energy Efficiency Options	0.00151	($98,348)	($149)	($1,782)
Integrated Coal Gasification Combined Cycle	0.00486	($6,008)	($29)	($350)
Natural Gas Combined Cycle - 215 MW	0.00500	($5,577)	($28)	($335)
Integrated Coal Gasification Fuel Cell	0.00501	($4,550)	($23)	($274)
Natural Gas Combustion Turbine - 154 MW	0.00499	($4,400)	($22)	($263)
Wind Turbine	0.00502	$562	$3	$34
Fluidized Bed Combustion - Wood Fired (Biomass)	0.00502	$1,529	$8	$92
Solar - 5 MW dispersed connection	0.00502	$34,141	$171	$2,057

Table 6.9 Family's Cost of Using Cost-Effective Energy Efficiency End Use and Generation Options to Reduce NOx Emissions Resulting from Household Electricity Use

Energy Efficiency and Generation Options	Family's Monthly NOx Reduction (Tons)	NOx Reduction Cost ($/ton)	Family's Added Monthly Cost ($)	Family's Added Yearly Cost ($)
Residential Sector Energy Efficiency Options	0.00075	($41,842)	($32)	($378)
Integrated Coal Gasification Combined Cycle	0.00216	($13,544)	($29)	($351)
Natural Gas Combined Cycle - 215 MW	0.00247	($11,268)	($28)	($334)
Integrated Coal Gasification Fuel Cell	0.00251	($9,085)	($23)	($274)
Natural Gas Combustion Turbine - 154 MW	0.00241	($9,095)	($22)	($263)
Wind Turbine	0.00251	$1,125	$3	$34
Fluidized Bed Combustion - Wood Fired (Biomass)	0.00251	$6,499	$16	$196
Solar - 5 MW dispersed connection	0.00251	$68,282	$171	$2,057

Emission Reduction Credits or Offsets

Emission reduction credits or emission offsets are reductions in emissions that result from some action like increased energy efficiency, and are measured and recorded in an appropriate way so that they can be bought, sold, and traded. This gives people the option of reducing emissions from their energy use directly, or they can buy emission reductions from someone else in the form of emission reduction credits. The same overall emission reductions are achieved either way.

For the purpose of comparing the direct generation and energy efficiency options described in this section, Table 5.1 from the previous chapter is repeated here. Table 6.10 shows the estimated cost of offsetting emissions caused by one family at projected future costs of efficiency-based reductions. Emission reduction credits could be purchased on a trading market at relatively low costs. One person could offset their own emissions for approximately $190 per year or $16 per month. Of this total, $150 per year or $12.50 per month would go towards offsetting NOx emissions.

These offset cost figures assume a separate trading market for each emission type so therefore overestimate the total cost. If an integrated trading market which includes energy efficiency is created, the total costs would decrease because many of the allocations rewarded for energy efficiency and renewable projects reduce multiple emissions from the list. If you wished to offset your carbon dioxide emissions only, it would cost $1.83 per month, or less than $5 per month for the average family.

Table 6.10 Estimated Cost of Offsetting All of Your Emissions at Projected Future Costs of Efficiency-Based Reductions

Pollution Type	Estimated Market Cost of Emission Reductions ($/ton)	Estimated Annual Per Family Cost ($)	Estimated Annual Per Capita Cost ($)	Estimated Monthly Per Capita Cost ($)
Climate Change (CO_2)	$1	$56.00	$22.00	$1.83
Acid Rain (SO_2)	$200	$37.40	$14.40	$1.20
Ozone-Causing (NOx)	$1,700	$389.30	$149.60	$12.47
Particulate (PM10)	$200	$6.30	$2.40	$0.20
Toxic Lead (Pb)	$30,000	$1.13	$0.47	$0.04
Toxic Mercury (Hg)	$30,000	$0.75	$0.28	$0.02
Total Cost	NA	$490.88	$189.15	$15.76

For notes on Table 6.10, refer to Table 5.1.

Cost Summary of Emission Reduction Options

Figure 6.1 shows the average family's CO_2 emission reduction options and costs for household electricity consumption in a post restructuring and paid off stranded cost environment. Figure 6.1 shows that energy efficiency is a low cost way to reduce emissions, and most low cost efficiency measures rapidly more than pay for themselves through the energy savings they provide. Implementing energy efficiency measures has the potential to save the average consumer up to $23 per month ($278 per year) on their electricity bills.

Consumers can offset their emissions by buying and retiring emission reductions produced by someone else's energy efficiency or renewable energy projects. Green energy in the form of emission reduction credits can be purchased in the competitive marketplace so competition will drive the price down to the point where supply and demand are balanced. Buying emissions reduction credits lets consumers conveniently reduce the emissions, caused by both their direct and indirect energy use, as much as they want at a low competitive market cost. For example, an average US family's CO_2 emissions from their household electricity consumption could be offset for less than $1 per month or only $10 per year (Figure 6.1). 100 percent of an average US family's CO_2 emissions, including emissions from transportation and the goods and services we buy, can be offset for less than $5 per month or $56 per year (Figure 6.2).

Figure 6.1 Average Family's CO_2 Emission Reduction Options and Costs for Household Electricity Consumption in a Post-Restructuring and Paid-Off Stranded Cost Environment

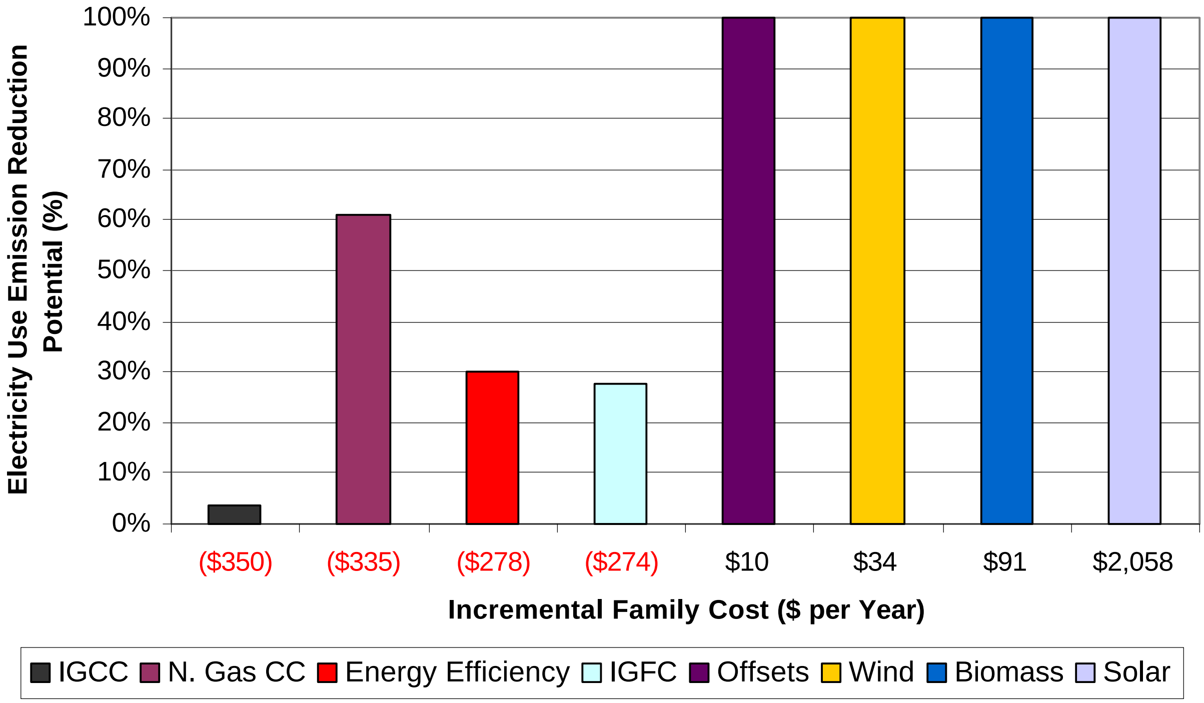


Figure 6.1and 6.2 notes: Costs are compared to the four-state average generation mix. Also, costs do not reflect transition to competitive market costs such as required consumer responsibility for stranded costs. The figure also assumes consumer access to one emission reduction source option only for any of the options instead of a mix of the different options. See Figure 1 in the Executive Summary for a description of emission reduction technologies.

Figure 6.1 shows that 100 percent reductions of CO_2 emissions from our electricity consumption are possible using a number of different renewable technologies. Wind power in particular has emerged as an attractive and viable electric generation option for consumers. Buying 100 percent proven available renewable electricity has an incremental cost of 0.4 to 3 cents per kWh for wind and biomass (fluidized bed combustion) electricity over the current generation mix in the four-state study area. This means that the average U.S. family could reduce all of their household electricity emissions for as little as $3 more per month or around $34 per year in a competitive market.

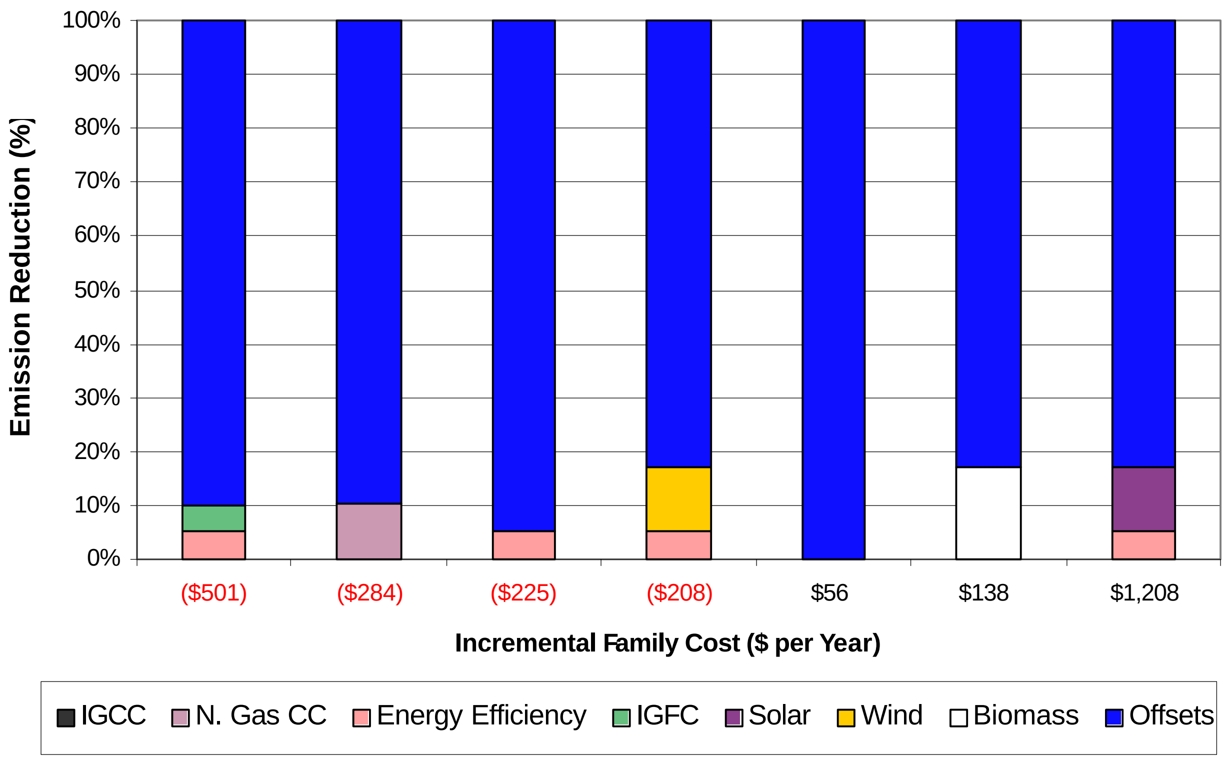
Several emerging renewable technologies such as biomass feed integrated gasification combined cycle (Biomass-IGCC) can produce electricity at incremental cost savings to consumers. As expected for Illinois, Iowa, Minnesota, and Wisconsin, large scale photovoltaic generation is a more expensive way to produce cleaner electricity at approximately $2000 more per year. But this technology offers an alternative for isolated consumers located large distances from the power grid. Purchasing electricity produced from fuel switching generation technologies provides another good option for emission reductions. Fuel switching to the use of cleaner fueled generation such as natural gas combined cycle by generation sources reduces CO_2 emissions approximately 60% over the average emission rate for a net cost savings to the consumer.

On a cost basis alone, Figure 6.1 shows that new emerging generation technologies such as integrated coal gasification combined cycle and integrated gas fuel cells are very cost-effective. These two technologies though, are not widely practiced and offer low emission reduction potentials of 4% and 28%. Fuel switching to natural gas fired generation and energy efficiency options also provide cost-effective approaches for reducing emissions for consumers with greater emission reduction potential (60% and 30%). Emission offsets offer a very low cost option for emission reductions with 100% emission reduction potential. After offsets, renewable options such as wind, biomass, and solar provide more costly emission reduction options, although on a monthly basis, wind and biomass are quite inexpensive and also provide 100% reductions of the emissions resulting from our electricity use.

Figure 6.2 shows a variety of CO_2 emission reduction mixed options under a competitive electricity environment. In a competitive environment, consumers could purchase a variety of CO_2 emission reduction generation options from the supplier of their choice. In a regulated environment, there are still many cleaner generation packages available through utility green energy programs. Several utilities in the four-state study area offer, or are planning to offer, green energy to their consumers for a premium of $5 to $45 more a month for 100 percent renewable energy. As a consumer, you need to consider whether the premiums charged for green electricity from these programs are the result of new projects, and not existing, mandated renewable projects. Otherwise, premiums are being used to pay for actions which would have occurred regardless of your participation.

Although consumers may pay a premium for cleaner electricity and emission offsets, when combined with energy conservation and energy efficiency measures, we can still reduce our share of emissions at cost savings, since the savings from energy conservation and energy efficiency *more than* make up for the cost of participating in valid green energy programs and emission offsets.

Figure 6.2 Average Family's Total CO_2 Emission Reduction Mixed Options and Costs in a Post-Restructuring and Paid-Off Stranded Cost Environment



Section 7 Green Energy Survey Results

The Green Energy Survey was done as part of the overall Green Energy Project work to help individuals make green energy choices, and to help organizations decide what green energy options to recommend to their members. The survey was conducted to capture, and better understand, the views of consumers on green energy and other selected environmental issues.

The Green Energy Survey addresses consumers' views on:
- Level of concern regarding different types of pollution
- How different pollution impacts motivate them to take action
- Willingness to pay for reduced pollution
- Different emission reduction approaches

Survey Part 1: How the Survey Was Conducted and Background Response Data

Leonardo Academy posted the survey on their web site and notified environmental, health, energy, consumer, and sporting organizations in the four-state area of Iowa, Illinois, Minnesota, and Wisconsin through email messages to the organizational contacts. The survey was therefore biased towards these groups. We asked these contacts to encourage their members to visit our web site and fill out the Green Energy Survey and provided them with a message for their members. We also sent survey forms to members of Renew Wisconsin and Iowa Renew directly without return postage. We received responses from 239 individuals including 60 responses from Renew Wisconsin members and 46 responses from Iowa Renew members (Table 7.3). We received a total of 126 responses from within the four-state study region (Table 7.1) and 113 responses from outside this region including 34 responses from outside the U.S. (Table 7.2).

Table 7.1 United States Survey Responses by State

State	Count	State	Count	State	Count
Wisconsin	68	Oregon	3	Georgia	1
Iowa	45	Pennsylvania	3	Indiana	1
Washington	12	Washington DC	3	Michigan	1
California	11	Florida	2	Missouri	1
Minnesota	8	Kansas	2	Montana	1
New York	6	Kentucky	2	Oklahoma	1
Colorado	5	Maryland	2	Texas	1
Illinois	5	Massachusetts	2	Utah	1
North Carolina	4	New Hampshire	2	Vermont	1
Virginia	4	New Mexico	2	Wyoming	1
Ohio	3	Connecticut	1		

Table 7.2 Survey Responses by Country

Country	Count	Country	Count
USA	205	Belgium	2
Australia	7	The Netherlands	2
United Kingdom	5	Colombia	1
Canada	4	Germany	1
New Zealand	4	Portugal	1
Thailand	3	South Korea	1
Austria	2	Sweden	1

We also asked respondents to state their affiliation with any national, local , or regional environmental, health, energy, consumer, and sporting organizations (Tables 7.3 and 7.4).

Table 7.3 Survey Responses by Local or Regional Organization

Regional/Local Organization	Members	Regional/Local Organization	Members
Renew Wisconsin	60	Iowa Natural Heritage Foundation	4
Iowa-Renew	46	Clean Water Action Alliance-Minnesota office	3
Midwest Renewable Energy Association	29	Indian Creek Nature Center	3
Wisconsin Environmental Decade	13	Energy and Environmental Professionals	2
Citizens Utility Board	7	Heartland	2
Sierra Club - local chapter involvement	6	Iowa Citizen Action Network / Iowa SEED	2
Wisconsin Citizens for a better Environment	5	Iowa Environmental Council	2
Nature Conservancy - local chapter involvement	5	Lakeshore Peacemakers	2
Audubon - local chapter involvement	4	Other Organizations (one member only)	131
Ice Age Park and Trail Foundation	4		

Table 7.4 Survey Responses by National and International Organization

National and International Organizations	Members	National and International Organizations	Members
Nature Conservancy	45	U.S. - Rails to Trails	5
Sierra Club	41	International Solar Energy Society	4
World Wildlife Fund	23	Planned Parenthood	4
Union of Concerned Scientists	21	U.S. - Trout Unlimited	4
Natural Resource Defense Council	21	U.S. Public Research Interest Group	4
Audubon	17	U.S. - Wind Energy Association	4
GreenPeace International	17	U.S. - Nat'l Assn. of Environ. Professionals	3
Environmental Defense Fund	17	U.S. - Public Citizen	3
Wilderness Society	15	U.S. - Seed Savers	3
U.S. National Wildlife Federation	15	Thai Environment and Natural Resource Club	3
American Solar Energy Society	13	UK - Friends of the Earth	3
American Assoc. of Retired Persons	8	U.S. - Izaak Walton League of America	3
Defenders of Wildlife	7	Zero Population Growth	3
U.S.-National Parks & Conservation Assoc.	7	Other Organizations (two members)	11
Cousteau Society	6	Other Organizations (one member)	124
U.S. - League of Conservation Voters	5		

As shown in Table 7.5, the educational level of our survey response was very high. Over 92% of our respondents had at least a college level of education or higher, and over 45% had obtained a masters degree level of education or higher.

Table 7.5 Survey Responses by Education Level

Education	Count
College	112
Masters Degree	80
PHD	22
High School	16
MD	5
Less Than High School	3
DVM	1

A majority (65%) of our survey response was from men, as shown in Table 7.6. Table 7.7 shows how spread out our survey participation was by occupation, with over 90 responses from different fields. The highest concentration of survey responses were from engineers, teachers and professors, and students.

Table 7.6 Survey Responses by Sex

Sex	Count
Male	150
Female	85

Table 7.7 Survey Responses by Occupation

Occupation	Count
Engineer	23
Teacher/Professor	22
Student	21
Retired	20
Environmental Field	19
87 Other Fields	133

The mean age of the survey responses was 42 years old; the youngest respondent was 14 years old, and the oldest was 86 years old. The average number of children for our respondents was 1.2 children with a mode of zero children. The average age for children of respondents was 22 years old.

Table 7.8 Background Information on Age and Children of Survey Respondents

Category	Mean	Std. Dev.	Mode	Median	Minimum	Maximum
Age	42.48	14.77	35	41	14	86
Number of Children	1.16	1.37	0	1	0	5 or more*
Children Ages	22.1	13.05	1		0.2	57

*Note: 5 or more was scored as 5 children.

Survey Part 2: What Types of Environmental Pollution Concern You the Most?

Respondents were asked to rate each of the following list from 1 to 5 according to their level of concern about each type of pollution (1 = not concerned and 5 = very concerned). Pollution types are listed from highest to lowest concern rating from survey respondents.

A. Climate Change (Carbon) Pollution - linked to global warming and increased frequency of extreme weather like heat waves and violent storms.
B. Ozone-Causing Pollution - which can increase the incidence and severity of respiratory problems like asthma.
C. Particulate Pollution - which can increase the incidence and severity of respiratory problems like asthma.
D. Lead Pollution
E. Mercury Pollution - which can lead to health problems for pregnant women and their unborn children particularly from consumption of contaminated fish.

Table 7.9 Common Statistics on Concern for Different Types of Environmental Pollution

Pollution Type	Mean	Std. Dev.	Mode	Median	Minimum	Maximum
Climate Change Pollution	4.10	1.32	5	5	1	5
Ozone Causing Pollution	3.93	1.21	5	4	1	5
Particulate Pollution	3.81	1.17	4	4	1	5
Lead Pollution	3.53	1.23	4	4	1	5
Mercury Pollution	3.50	1.29	4	4	1	5

Note: 1 = not concerned and 5 = very concerned.

Respondents had high levels of concern for all five pollutant types with all means equal to 3.5 or greater on a scale of 1 to 5 (Table 7.9). All of the modes and medians were at high levels of concern of either 4 or 5. From the means, respondents were more concerned with climate change, ozone-causing, and particulate pollution than they were with either lead or mercury pollution. Table 7.10 shows the t-tests on the means to determine if differences between the mean scores for levels of concern were significant.

Table 7.10 T-tests for Selected Means on Concern for Different Types of Pollution

Pollution Type	Mean	T-test Results
Climate Change Pollution	4.10	Significant difference between climate change pollution and particulate, lead or mercury pollution
Ozone Causing Pollution	3.93	Significant difference between ozone causing pollution and lead or mercury pollution
Particulate Pollution	3.81	Significant difference between particulate pollution and lead or mercury pollution
Lead Pollution	3.53	
Mercury Pollution	3.50	

Note: 1=not concerned, 5=very concerned. Two sample t-test assuming equal variances with level of significance=0.05.

From our t-test results we can conclude that:

- Respondents are significantly more concerned with climate change pollution than with particulate, lead, or mercury pollution but statistically have the same level of concern with climate change pollution as with ozone-causing pollution.
- Respondents are significantly more concerned with ozone-causing pollution than with lead or mercury pollution but have the same level of concern for particulate pollution.
- Respondents are significantly more concerned with particulate pollution than with lead or mercury pollution.
- Respondents are equally but less concerned with lead and mercury pollution than the other pollutant types.

Survey Part 3: Which Impacts of Environmental Pollution Motivate You the Most to Take Action?

Respondents were asked to rate each of the following list of effects of pollution from 1 to 5 depending on how strongly each made them feel like they would want to do something to reduce pollution (1 = not very strongly and 5 = very strongly). Statements are listed from highest to lowest rating from survey respondents.

A. Pollution makes the world less livable for future generations
B. Pollution makes the world less livable for our children and our grandchildren
C. Pollution causes harm to wildlife
D. Pollution causes health problems for children
E. Pollution causes health problems for pregnant women and their unborn and nursing children
F. Pollution makes it more difficult to grow enough food to feed all the people in the world
G. Pollution makes fish from some lakes unsafe to eat
H. Pollution causes health problems for older people
I. Pollution causes increased incidence of skin cancer
J. Pollution increases incidence of asthma
K. Pollution causes extreme weather including unusually hot summers, and more violent storms like tornadoes and hurricanes

Table 7.11 Common Statistics on Rating Which Impacts of Environmental Pollution Motivate You to Take Action to Reduce Pollution

Impact Statement	Mean	Std. Dev.	Mode	Median	Min	Max
World less livable for future generations	4.36	1.12	5	4	1	5
World less livable for our children and our grandchildren	4.30	1.15	5	5	1	5
Pollution causes harm to wildlife	4.11	1.11	5	4	1	5
Health problems for children	4.00	1.16	5	4	1	5
Health problems for pregnant women, unborn and nursing children	3.95	1.20	5	4	1	5
More difficult to grow enough food to feed all people in world	3.82	1.28	5	5	1	5
Makes fish from some lakes unsafe to eat	3.74	1.18	4	4	1	5
Health problems for older people	3.68	1.18	4	4	1	5
Increased incidence of skin cancer	3.67	1.24	4	4	1	5
Increased incidence of asthma	3.57	1.23	4	4	1	5
Extreme weather	3.55	1.36	5	4	1	5

Note: 1 = not very strongly and 5 = very strongly.

Respondents felt high levels of motivation to reduce pollution from all of the impact statements with all of the means equaling 3.5 of greater on a scale of 1 to 5 (Table 7.11). Respondents felt the greatest motivation to reduce pollution because it makes the world less livable for future generations and less livable for our children and our grandchildren. The least motivation was gained from the effect of pollution causing extreme weather.

Table 7.12 T-tests for Selected Means on Rating Which Impacts of Environmental Pollution Motivate You to Take Action to Reduce Pollution

Impact Statement		Mean	T-test Results
A	World less livable for future generations	4.36	Significant difference between making world less livable for future generations and less livable for our children and our grandchildren and all other statements except for between Statements B & C
B	World less livable for our children and our grandchildren	4.30	
C	Pollution causes harm to wildlife	4.11	Significant difference between pollution causing harm to wildlife and Statements F, G, H, I, J, & K
D	Health problems for children	4.00	Significant difference between health problems for children and Statements G, H, I, J, & K
E	Health problems pregnant women and their unborn and nursing children	3.95	Significant difference between health problems for pregnant women and Statements H, I, J, & K
F	More difficult to grow enough food to feed all people in world	3.82	Significant difference between not enough food to feed all people in world and Statement K
G	Makes fish from some lakes unsafe to eat	3.74	
H	Health problems for older people	3.68	
I	Increased incidence of skin cancer	3.67	
J	Increased incidence of asthma	3.57	
K	Extreme weather	3.55	

Note: 1=not very strongly and 5=very strongly. Two sample t-test assuming equal variances with level of significance = 0.05.

From our t-test results we can conclude that:

- Pollution making the world less livable for future generations and pollution making the world less livable for our children and our grandchildren made respondents feel significantly more motivated to reduce pollution than any of the other impact statements (except for statements of world less livable for our children and our grandchildren and harmful to wildlife).
- Pollution causing harm to wildlife made respondents feel significantly more motivated to reduce pollution than:
  - Pollution making it more difficult to grow enough food to feed all the people in the world
  - Pollution making fish from some lakes unsafe to eat
  - Pollution causing health problems for older people
  - Pollution causing increased incidence of skin cancer
  - Pollution increasing the incidence of asthma
  - Pollution causing extreme weather including unusually hot summers, and more violent storms like tornadoes and hurricanes
- Pollution causing health problems for children made respondents feel significantly more motivated to reduce pollution than:
  - Pollution making fish from some lakes unsafe to eat
  - Pollution causing health problems for older people
  - Pollution causing increased incidence of skin cancer

- ‣ Pollution increasing the incidence of asthma
  - ‣ Pollution causing extreme weather including unusually hot summers, and more violent storms like tornadoes and hurricanes
- Pollution causes health problems for pregnant women and their unborn and nursing children made respondents feel significantly more motivated to reduce pollution than :
  - ‣ Pollution causing health problems for older people
  - ‣ Pollution causing increased incidence of skin cancer
  - ‣ Pollution increasing the incidence of asthma
  - ‣ Pollution causing extreme weather including unusually hot summers, and more violent storms like tornadoes and hurricanes
- Pollution making it more difficult to grow enough food to feed all the people in the world made respondents feel significantly more motivated to reduce pollution than pollution causing extreme weather including unusually hot summers, and more violent storms like tornadoes and hurricanes

Survey Part 4: Willingness to Pay to Clean Up the Environmental Pollution We Cause

The survey included the following paragraphs to find out what respondents' bottom line was for reducing the emissions caused by their energy use. The results are given in Table 7.13.

> "Our energy use causes pollution directly when we burn fuels like natural gas, fuel oil, coal, and gasoline and indirectly when we buy things that burn fuels in their production, transportation and delivery. One obvious example of our energy use is electricity, which is most commonly produced by burning fuels. There are many different ways we can help reduce the pollution caused by our energy use."
>
> "I would be willing to spend [$0, $1, $2, $3, $4, $5, $6, $7, $8, $9, $10, $15, $20, $25, $50, $75, $100, More than $100] more per month to clean up (reduce, offset, or eliminate) the pollution caused by my direct and indirect energy use."

Table 7.13 Common Statistics on Willingness to Pay for Reduced Emission Energy

	Mean	Std. Dev.	Mode	Median	Minimum	Maximum
What is your bottom line?	$33	$33	$10	$20	$0	$101*

*Note: More than $100 was tabulated as $101.

Survey Part 5: Views on Best Ways to Clean Up the Pollution Our Energy Use Causes

What are the best approaches to reduce the pollution caused by our energy use? Respondents were asked to rate each of the following list from 1 to 5 according to their view on each approach (1= not desirable and 5 = very desirable). Approaches are listed in order of highest to lowest rating.

A. Individual actions to reduce pollution by increasing the efficiency of our direct energy use. We can do this by buying more efficient appliances and equipment for our homes. *(Energy Efficiency by Individuals)*
B. Change how electric and gas utilities are regulated so that energy efficiency and cleaner sources of electricity like renewable energy can compete on a level playing field with other energy supply options. *(Even Playing Field)*
C. Change environmental regulations so that pollution reducing actions which increase energy efficiency or the use of renewable energy are rewarded as well as the pollution reductions from polluters cleaning up their operations. *(Reward all Pollution Reduction Actions)*
D. Individual actions to reduce pollution by using our buying power to encourage companies to reduce the pollution caused by their energy use. We can do this by buying products and services from companies, which cause less pollution than their competitors. *(Buy Green Products and Services)*
E. Change regulations so that electric utilities must provide electricity produced from a mixture of sources including required amounts of renewable energy, cleaner fuels, and increased energy efficiency as well as conventional generation. *(Minimum Clean Electricity Portfolio Standard)*
F. Tighten environmental regulations so that less pollution is allowed. *(Tighten Pollution Regulations)*
G. Individual actions to reduce the net pollution caused by our direct and indirect energy use by buying emission reductions (offsets) from people and companies that implement increased energy efficiency and other measures to reduce the emissions they cause. *(Buy Emission Offsets)*

Table 7.14 Common Statistics on Views on Best Ways to Clean Up the Pollution Our Energy Use Causes

Action Type	Mean	Std. Dev.	Mode	Median	Minimum	Maximum
Energy Efficiency by Individuals	4.45	0.96	5	5	1	5
Even Playing Field	4.42	1.10	5	5	1	5
Reward all Pollution Reduction Actions	4.37	1.10	5	5	1	5
Buy Green Products and Services	4.26	1.08	5	5	1	5
Min. Clean Electricity Portfolio Standard	4.14	1.20	5	5	1	5
Tighten Pollution Regulations	4.06	1.19	5	4	1	5
Buy Emission Offsets	3.44	1.26	3	4	1	5

Note: 1= not desirable and 5 = very desirable.

From Table 7.14, we can conclude that respondents viewed all of the listed approaches to reduce the pollution caused by their energy use as better than neutral responses on a scale of 1 to 5. Buying emission offsets had a mean of 3.4, and all of the other approaches had means greater than four and modes equal to five. Energy efficiency actions by individuals was rated as the best approach for reducing pollution followed by requiring an even playing field for all energy sources, rewarding all pollution reduction actions, and buying green products and services. The lower ranking of buying emission offsets may be due to unfamiliarity with the concept since this is a relatively new approach to pollution reduction, and several responses had questions marks next to this question.

Table 7.15 T-tests for Selected Means on Views on Best Ways to Clean Up the Pollution Our Energy Use Causes

Action Type	Mean	T-test Results
Energy Efficiency by Individuals	4.45	Significant difference between energy efficiency by individuals and minimum portfolio standard or tighter pollution regulations
Even Playing Field	4.42	Significant difference between even playing field and minimum portfolio standard or tighter pollution regulations
Reward all Pollution Reduction Actions	4.37	Significant difference between rewarding all pollution reduction actions and minimum portfolio standard or tighter pollution regulations
Buy Green Products and Services	4.26	
Min. Clean Electricity Portfolio Standard	4.14	
Tighten Pollution Regulations	4.06	
Buy Emission Offsets	3.44	Significant difference between buying offsets and the other six approaches for cleaning up pollution

Note: 1=not desirable, 5=very desirable. Two sample t-test assuming equal variances with level of significance = 0.05.

From our t-test results we can conclude that respondents believe that:

- Energy efficiency actions by individuals are a significantly more desirable approach for cleaning up the pollution from our energy use than requiring a minimum portfolio standard or enacting tighter pollution regulations.
- Requiring an even playing field for all energy sources is a significantly more desirable approach for cleaning up the pollution from our energy use than requiring a minimum portfolio standard or enacting tighter pollution regulations.
- Rewarding all pollution reduction actions is a significantly more desirable approach for cleaning up the pollution from our energy use than requiring a minimum portfolio standard or enacting tighter pollution regulations.
- Buying emission offsets is rates significantly lower than the other approaches for cleaning up the pollution from our energy use than any of the other approaches. It was rated significantly higher than the neutral score of 2.5.

Correlation Tests Between Background Information and Responses to Sections 2 through 5

Correlations were run between answers to questions on age, number of children, education level, and sex (male or female) and the answers to Sections 2 through 5. There were no correlations found between number of children, education level, and sex to the responses to Sections 2 through 5. The highest correlation (r-value = +0.16) was between number of children of respondent versus the response to how much the impacts of environmental pollution on health problems for children motivate action to reduce pollution. Most r-values were less than + or - 0.10 for these correlations.

There were small correlations between the age of respondent versus the response to how much the impacts of environmental pollution on incidence of asthma (r-value = +0.30) and health problems for older people (r-value = +0.22) motivate action to reduce pollution. There were also small correlations between the age of respondent versus the response to responses to minimum clean electricity portfolio standard (r-value = +0.26) and even playing field for all energy supply options (r-value = +0.20) as best approaches to clean up pollution from our energy use.

From these tests we can conclude that the age, number of children, education level, and sex of the respondents had little to no impact on their views on:

- The level of concern about different pollution types
- Which impacts of environmental pollution motivate them the most to take action to reduce pollution
- Willingness to pay to clean up the pollution they cause
- Best ways to clean up the pollution their energy use causes

Discussion of Results

The responses to each section of the survey had relatively high mean scores across the board. This could reflect a built-in bias to the survey sample since we were targeting environmental, health, energy, consumer, and sporting organizational members as our target group. Therefore it was not surprising to see high mean scores to the survey questions. We also had the survey posted on our Cleaner and Greener[sm] web site. We expect that most consumers who happen across our web site would have a higher interest in environmental concerns than the average population. The results of this survey should therefore not be generalized to reflect the views of the general population but should be viewed in the context of the survey sample group.

Since one of the goals of this project was to help individuals and organizations make green energy choices, we were looking for significant differences between the options from each section within the survey in order to better advise organizations on their member's preferences regarding reduced-emission energy versus the environmental and economical costs of different options for cleaner electricity. We were able to see significant differences in responses to questions on views on different types of pollution and views on best ways to clean up this pollution. These results should be helpful for organizations trying to develop their positions on green energy policies and choices.

There was very little correlation between the age, number of children, education level, and sex of the respondents and their environmental views. Since these characteristics show no influence on respondent's views on reduced-emission electricity, organizations can develop policies and recommendations regarding green energy which should be supported by a broad spectrum of their member base.

Section 2 of the survey looked at respondents level of concern about five different types of pollution. A higher level of concern was reported for climate change pollution, ozone causing pollution and particulate pollution than for the lead and mercury pollution.

The US EPA has already issued rules requiring major reduction in NOx emissions in 22 states and the District of Columbia by 2003 and announced that it will set emission reduction requirements for small particulates (PM2.5) in 2007. The survey results appear to bode well for support for action to reduce climate change pollution because climate change pollution was ranked to be of greater concern that these two other pollutants that have already been acted on by the US EPA.

The low rating for concern for mercury pollution was somewhat surprising given that both Minnesota and Wisconsin have lakes with advisories on eating fish from the lakes due to mercury contamination. This may indicate that further education on the risks of consuming mercury contaminated food are needed.

From our results of Section 3 of the survey, we can see that environmental consumers have a high level of concern for how pollution will make the world less livable for future generations including our children and grandchildren. Organizations should define positions and messages to their members which take these concerns into consideration. Consumers were less concerned about how pollution causes extreme weather. This would make sense with a majority of the responses coming from residents of U.S. Midwestern states. Residents of areas more recently affected by increases in extreme weather such as Florida or California may have had higher concern levels for this question. Organizations in the four-state region would not have as much impact if they design their message by only taking into consideration their members' concerns for pollution's impact on extreme weather.

Over the last twenty years, there have been numerous surveys done on willingness to pay for cleaner electricity. Further research has shown that willingness to pay usually does not transcend into being the most important factor when actual green electricity programs are offered. Although 56 - 86% of respondents to recent national surveys said they would pay a premium for environmental protection or renewable electricity, less than 10% of customers have signed up to participate (usually only 1 - 2%) when green-pricing programs have actually been initiated (Farhar, 1996). This could be due to existing barriers to renewables for competing fairly in the marketplace. Other factors involved with the program offerings were important for customers, such as flexibility for participation, and whether premiums were going towards new, not mandated cleaner electricity and not for existing green electricity. Several respondents to our survey indicated that their answer would depend on if the premium were applied to all customers and not just voluntary.

We added a willingness to pay question to our survey to try and reflect the views of specific organization's members. Our survey results showed a high level of willingness to pay premiums for reduced-emission electricity. The mean response was $33 more per month. This is somewhat higher than most other surveys done on both national and local levels and could reflect the bias of our sampling group. The majority of respondents in a number of recent surveys are willing to pay $6 to $25 more per month (Holt, 1997). A 1996 local-area survey of Central Power and Light customers in Corpus Christi, Texas discovered that residential customers were willing to pay an additional $5.60 per month on average for renewable electricity (Farhar, 1996). Customers are willing to pay more for cleaner electricity but given other factors in place, utility green electricity programs are likely to develop slowly.

The results of Section 5 of the survey indicate that a broad range of emission reduction approaches are supported by the respondents. For those promoting consumer actions to increase energy efficiency in general, the survey provides an indication of support for this approach. For regulators working on restructuring the electric utility industry, the survey shows that there is support for leveling the playing field so that energy efficiency and renewable energy can compete with other sources of energy. For regulators working on implementing emission reductions strategies like the NOx SIP call, it shows there is support for using the distribution of emission allowances to reward energy efficiency and renewable energy.

References for Section 7

Holt, E.A. (1997). Green Pricing Resource Guide, Regulatory Assistance Project. February 1997.

Farhar, B.C. (1996), Energy and the Environment: The Public View. Renewable Energy Policy Projects Issue Brief No. 3. October 1996.

Section 8 Conclusions

Consumers have many easy, low cost options for reducing their share of the nation's air pollution. Direct actions by consumers provide the direct benefits of pollution reduction and the indirect benefits of showing policymakers that consumers want reduced pollution and are willing to pay for it. A balanced mix of emission reduction measures is the best approach for consumers for reducing their entire household's emission responsibilities. Energy conservation, energy efficiency, and fuel switching measures combined with purchases of renewable generation and emission offsets is a sound strategy for consumers. This strategy can substantially reduce household emissions from electricity and home fuel use at a low cost or cost savings to the consumer. Actual consumer costs will depend on the chosen mix of emission reduction options. In the post-restructuring market, after transition costs have been accounted for, emission reduction costs will be even lower.

As consumers, we also have many options for reducing the emissions caused by personal transportation and the production and delivery of goods and services we buy. Increasing our reliance on mass transit, telecommuting, using bicycles or walking for shorter distances, and buying cleaner, more efficient vehicles all reduce air pollution emissions in the transportation sector. Purchasing goods and services that are produced and delivered in cleaner ways can reduce emissions as well. For example, commodities that are grown or produced locally can reduce emissions that result from shipping. Consumers can also look for reusable and recyclable products, avoid excess packaging, and buy from companies that have good environmental track records. To counteract (offset) any remaining emissions caused by our energy use, we can also buy emission reduction credits on the market. This action amounts to paying someone else to reduce *their* emissions to compensate for the emissions that result from *our* energy use.

As shown, there are many easy-to-implement emission reduction options for consumers. Consumers only need the education and access required to incorporate these choices into their daily routines.

Energy Conservation

Consumers can start to reduce their energy costs and reduce pollution by conserving energy at home and in the workplace. Energy conservation measures provide the same environmental benefits as energy efficiency at cost savings. Heating and cooling are estimated to account for 44% of household energy use. Water heating and refrigeration account for another 14% and 9% respectively. Consumers can easily implement the following conservation measures throughout the house.

- Lower the thermostat in winter; raise it in the summer
- Use shades and drapes to block sunlight out during hot weather and let it in during cold weather
- Use ceiling fans in the summer and winter to keep air circulating and mixed
- Turn off lights and appliances when not in use
- Clean and service furnace and air conditioner, replace filters as needed
- Keep hot water heater set between 120 and 140 degrees; wrap your water heater with an insulating blanket to reduce heat loss

- Caulk, weatherstrip, and insulate walls, attics, basements, windows, doors, and pipes
- Check for leaks around refrigerator doors, keep coils clean, and defrost freezer to eliminate ice buildup
- Use the microwave instead of the stove whenever possible
- Washer: Use cold or warm water for the wash cycle; use hot only for very dirty loads; always use cold water for the rinse cycle; set water level accordingly
- Dryer: clean lint screen often, keep vents and ducts clean, and hang clothes to dry when possible

Conserving energy is just one way we can reduce our emissions. Many of us already turn off lights when not in use and adjust the thermostat a couple degrees up or down depending on the season. As consumers, we have many green energy options available beyond energy conservation that reduce the pollution caused by our energy use.

Green Energy Strategy #1: Make Our Energy Use More Efficient

Increasing energy efficiency around the house and office is one strategy that scores high in both availability to consumers and environmental benefits. Using energy efficiency to reduce emissions can also increase employment and economic activity in a consumer's state and region. We can start by installing compact fluorescent light bulbs, dimmers and timers on lights, and a programmable thermostat. Replacing less efficient appliances (water heaters, air conditioners, furnaces, stoves, clothes dryers, etc.) with those that are more efficient or run on natural gas are also great choices for reducing the overall emissions from our electricity and home energy use. When buying new appliances compare Energy Guide labels and look for the Energy Star. The Energy Star label is given by the U.S. EPA and U.S. DOE to products whose energy efficiency rating is best in its category and also exceed the minimum federal standards.

As Table 8.1 shows, energy efficiency options reduce the negative environmental impacts caused by the production and delivery (electric and natural gas transmission and distribution, as well as fuel extraction) of energy to consumers, as well as reducing the pollution from the use of the fuel itself. Energy efficiency is also a low cost way to reduce emissions. Most efficiency measures more than pay for themselves with the energy savings they provide. Implementing energy efficiency measures has the potential to reduce emissions from household electricity consumption by 30% and save the average consumer up to $23 per month ($278 per year) on their electricity bills (Figure 8.1).

As consumers, we should do as much to increase the efficiency of our use of energy as we are comfortable with, but since efficient energy use can only affect a portion of total energy use, we should not stop there.

Table 8.1 Summary of Environmental Impacts of Options for Reducing the Emissions that Result from an Average Household's Energy Use

Types of Green Energy		**Environmental Impacts Reduced**					
		Air pollution[1]	Electric transmission and distribution	Fuel transmission and distribution or transportation	Electric generating plants	Fuel extraction	Goods and services[2]
Emission Offsets[3]		Yes (100%)	Yes	Yes	Yes	Yes	Yes
Increased Energy Efficiency		Yes (20-30%)	Yes	Yes	Yes	Yes	No
Renewable Generation (wind, solar, etc.)	On-Site	Yes (100%)	Yes	Yes	Yes	Yes	No
	Off-Site	Yes (100%)	No	Yes	Yes	Yes	No
Fuel Switching: Coal to Biomass Fuel Generation		Yes[4] (100%)	No	Maybe[5]	No	Yes	No
Generation Efficiency Improvements		Yes (Varies)	No	No	No	Yes	No
New Generation Technologies (IGCC & IGFC)		Yes (4-28%)	No	No	No	Yes	No
Fuel Switching to Natural Gas Generation		Yes (30-60%)	No	No	No	No	No
Generation End-of-Pipe Actions		Yes (Varies)	No	No	No	No	No

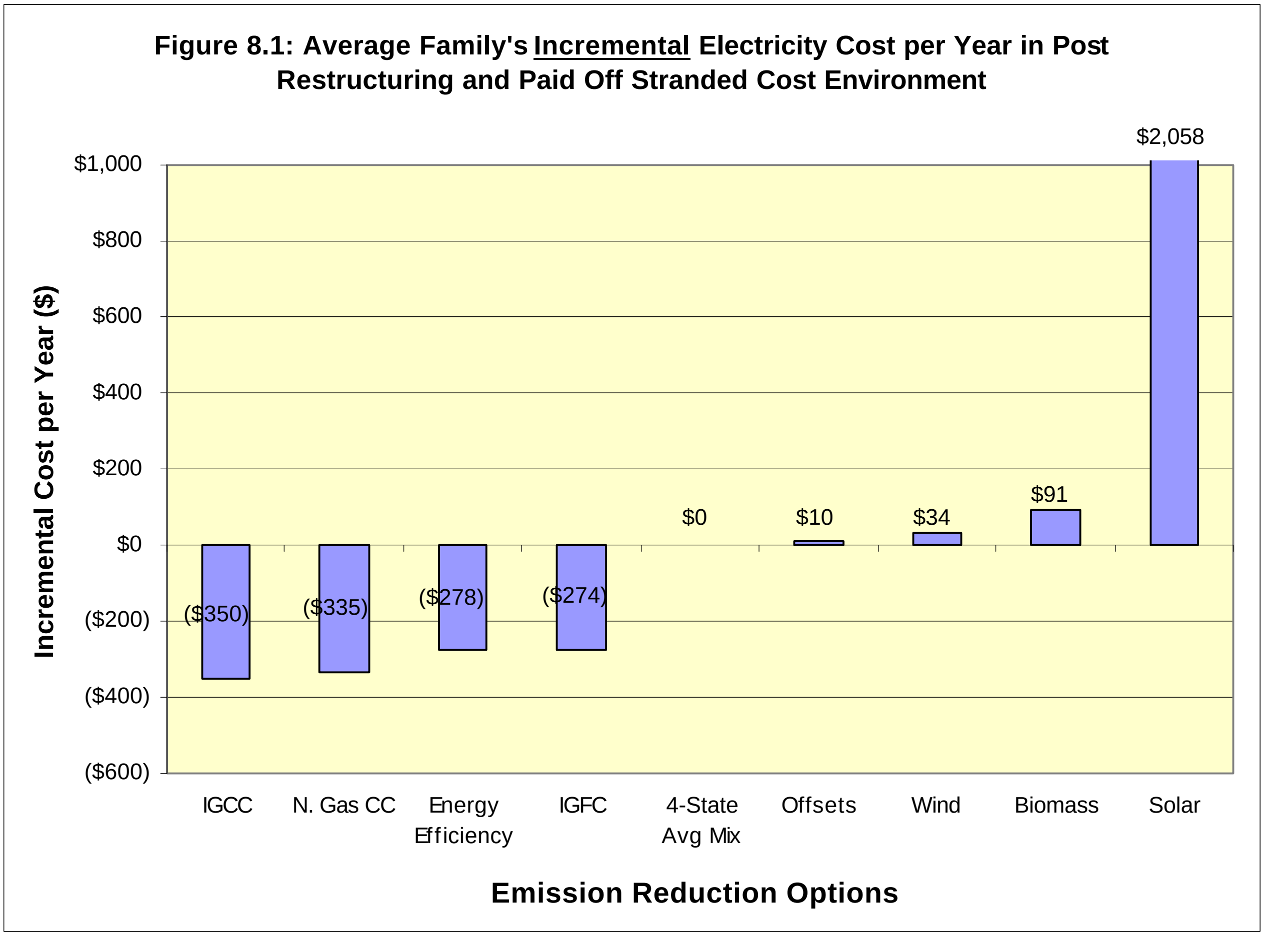
[1] Percentages reflect the average U.S. household's CO_2 emission reduction potential from electricity

[2] Impacts of energy used to produce and deliver the goods and services we buy

[3] Buying and retiring emission reduction credits offsets the emissions caused by household energy use.

[4] Impact varies by type of emission and combustion process

[5] Dependent on distance from fuel source – no, if distant source; yes, if nearby source

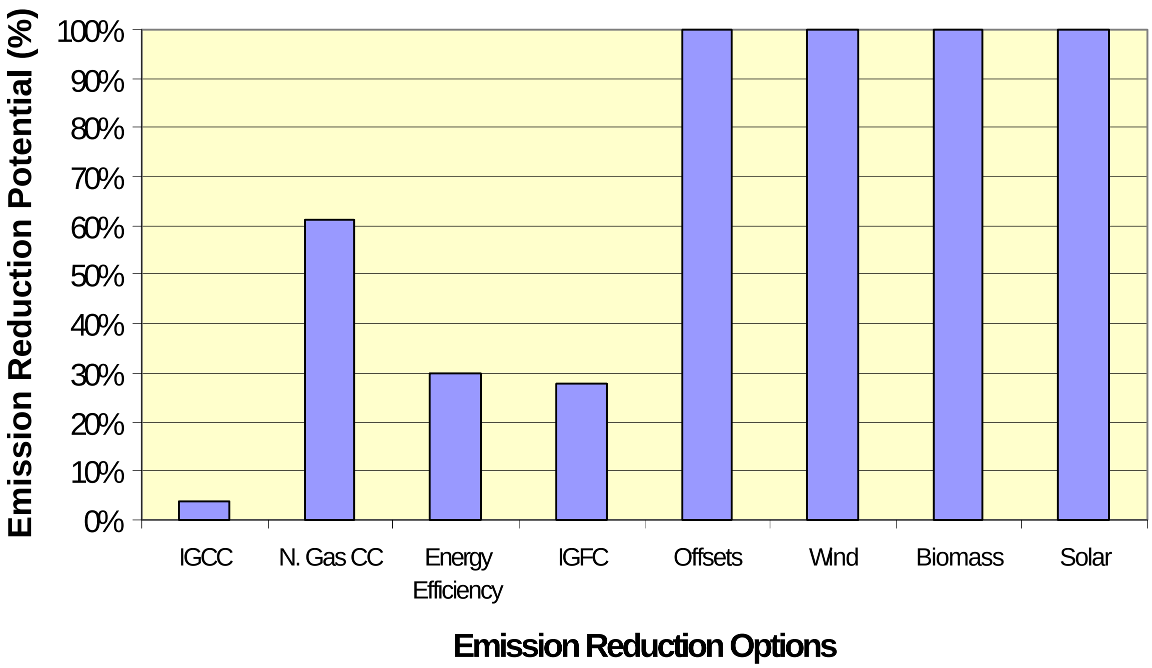


Green Energy Strategy #2: Buy Cleaner or Renewable Electricity

This option has positive emission reduction benefits, but availability can be restricted by the status of electric industry deregulation. In areas where utilities still have a retail monopoly, green electricity is only available to consumers if the utility chooses to make it available, or if regulations require that it be made available. In this situation, any green electricity services are only available at non-competitive prices set through the regulatory process. Where utility deregulation has created fully competitive retail energy services markets, green electricity can be purchased at prices set by the competitive market. So where the electricity market is competitive, green electricity is likely to be available at lower prices than where the utility still has a retail monopoly.

Renewable technologies can economically turn wind, sunlight, and organic matter (biomass) into electricity and other useful forms of energy. 100% reductions of CO_2 emissions (Figure 8.2) from our electricity consumption are possible using a number of different renewable technologies. Of these, proven renewable energy alternatives such as wind and solar-fueled generation continue to gain market penetration and enjoy cost decreases over time. Wind power in particular has emerged as an attractive and viable electric generation option for consumers. Buying 100 percent proven available renewable electricity has an incremental cost of 0.4 to 3 cents per kWh for wind and biomass (fluidized bed combustion) electricity over the current generation mix in the four-state study area. This means that the average U.S. family could reduce all of their household electricity emissions for as little as $3 more per month or around $34 more per year (Figure 8.1) in a competitive market.

Figure 8.2: Average Family's Electricity CO2 Emission Reduction Potential per Year in a Post Restructuring and Paid Off Stranded Cost Environment



Several emerging renewable technologies such as biomass feed integrated gasification combined cycle (Biomass-IGCC) can produce electricity at incremental cost savings to consumers. As expected for Illinois, Iowa, Minnesota, and Wisconsin, large scale photovoltaic generation is a more expensive way to produce cleaner electricity at approximately $2000 more per year. But this technology offers an alternative for isolated consumers located large distances from the power grid.

Purchasing electricity produced from fuel switching generation technologies provides another good opportunity for emission reductions. Fuel switching to the use of cleaner fueled generation, such as natural gas combined cycle, reduces CO_2 emissions approximately 60% over the average emission rate for a net cost savings to the consumer. On a cost basis alone, Figure 8.1 shows that new generation technologies such as integrated coal gasification combined cycle and integrated gas combustion turbines are also very cost-effective. Although these two technologies are not widely practiced and offer low emission reduction potentials of 4% and 28% (Figure 8.2).

Green Energy Strategy #3: Buy and Retire Emission Reduction Credits

Sources of air pollution that reduce their emissions below their required limit (cap) may receive saleable credits for their reductions. Emission reduction credits reward those who take action to reduce their pollutant emissions and therefore encourage pollution reduction actions. Credits for emission reductions provide an incentive to find the most cost-effective way to reduce emissions, since once an emission reduction credit is earned, it can be sold on the open market. Markets for emission reduction credits or emission allowances can be created by regulation (the sulfur dioxide market for example) or voluntarily (the current market for greenhouse gases).

Emission reduction credits can be used to reduce pollution even further. Instead of reselling emission reduction credits to sources of air pollution that will use them to compensate for their pollutant emissions, allowances can be retired, *without* emitting any pollution. Once an emission reduction credit is retired, it can no longer be bought, sold, or used to offset pollution. Purchasing and retiring emission reduction allowances reduces the amount of pollution that is discharged to the atmosphere for regulated markets, and creates future pollution reduction potential for voluntary markets.

The third green energy strategy allows consumers to take advantage of emission reduction credit markets. Buying and retiring emission reduction credits produced by energy efficiency or renewable energy projects allows consumers the chance to:

- Influence public policy decisions to implement market-based pollution reduction strategies
- Give value and financial incentive to the pollution reduction actions made through energy efficiency and renewable energy projects
- Strengthen emission reduction markets
- Reduce the negative environmental impacts that result from the entire process of energy production and distribution, including the energy used to produce and deliver the goods and services purchased by consumers

Buying emission reductions produced by someone else is similar to most consumer purchases. As consumers, we decide either to make the goods and services we consume, or pay someone else to produce them for us. More often that not, consumers choose to buy most of the goods and services they want, rather than produce them.

Buying and retiring emission reductions provides many environmental benefits (Table 8.1). Energy efficiency and renewable energy projects reduce the negative environmental impacts caused by the production and delivery of energy to consumers, as well as provide emission reductions which can be purchased by consumers. Increasing consumer energy efficiency provides many environmental benefits as well, but it is difficult for consumers to reduce the emissions caused by the production and delivery of goods and services they buy. Buying emission reduction credits has an added advantage, it allows consumers to offset their net emissions, including those produced by goods and services purchased, by 100 percent (to zero).

Green energy in the form of emission reduction credits can be purchased in the competitive marketplace, so competition will eventually drive the price of emission reductions down to the point where supply and demand are balanced. Buying emission reduction credits lets consumers conveniently offset the emissions, caused by both their direct and indirect energy use, as much as they want at a low competitive market cost. For example, an average U.S. family's CO_2 emissions from their household electricity consumption could be offset for less than $1 per month, or $10 per year (Figure 8.1). An average U.S. family's total CO_2 emissions, including emissions from transportation and the goods and services purchased, can be offset for less than $5 per month or $56 per year.

Consumer Cost Comparison of Green Energy Options

To put things in real consumer cost comparison terms, Figure 8.3 shows average family electricity costs per year using different emission reduction options. Figure 8.3 uses the incremental costs in Figure 8.1 combined with the four-state residential electric consumption information in Table 8.2. Using the four-state average electricity price of $0.086 per kWh for the cost comparisons makes the emission reduction options more attractive in Wisconsin and Minnesota than they actually are on a cost basis and has the opposite effect for Illinois.

Table 8.2 Characteristics of Residential Electric Consumption in the Four-State Study Area

Parameter	Illinois	Iowa	Minnesota	Wisconsin	4-State Weighted Average
Average CO2 Emission Rate (lbs/kWh)	2.17	2.29	2.32	2.23	2.23
Average Electricity Price ($/kWh)	$0.103	$0.082	$0.071	$0.069	$0.086
Average Monthly Consumption (kWh)	679	808	757	713	717
Average Yearly Consumer Cost ($)	$843	$791	$647	$589	$743

Source: State Energy Data Report 1996, Consumption Estimates, US DOE / EIA Publication, February 1999.

In a competitive electricity environment, consumers could purchase a variety of CO_2 emission reduction generation options from the supplier of their choice. In a regulated environment, there are still many cleaner generation packages available through utility green energy programs. Several utilities in the four-state study area offer, or are planning to offer, green energy to their consumers for a premium of $5 to $45 more a month for 100 percent renewable energy. As a consumer, you need to consider whether the premiums charged for green electricity from these programs are the result of new projects, and not existing, mandated renewable projects. Otherwise, premiums are being used to pay for actions which would have occurred regardless of your participation.

Although consumers may pay premiums for cleaner electricity and emission offsets, when combined with energy conservation and energy efficiency measures, consumers can still reduce their share of emissions at cost savings, since the savings from energy conservation and energy efficiency *more* *than* make up for the cost of participating in valid green energy programs and emission offsets. For example, a typical consumer could read this report and choose to implement the following three emission reduction actions:

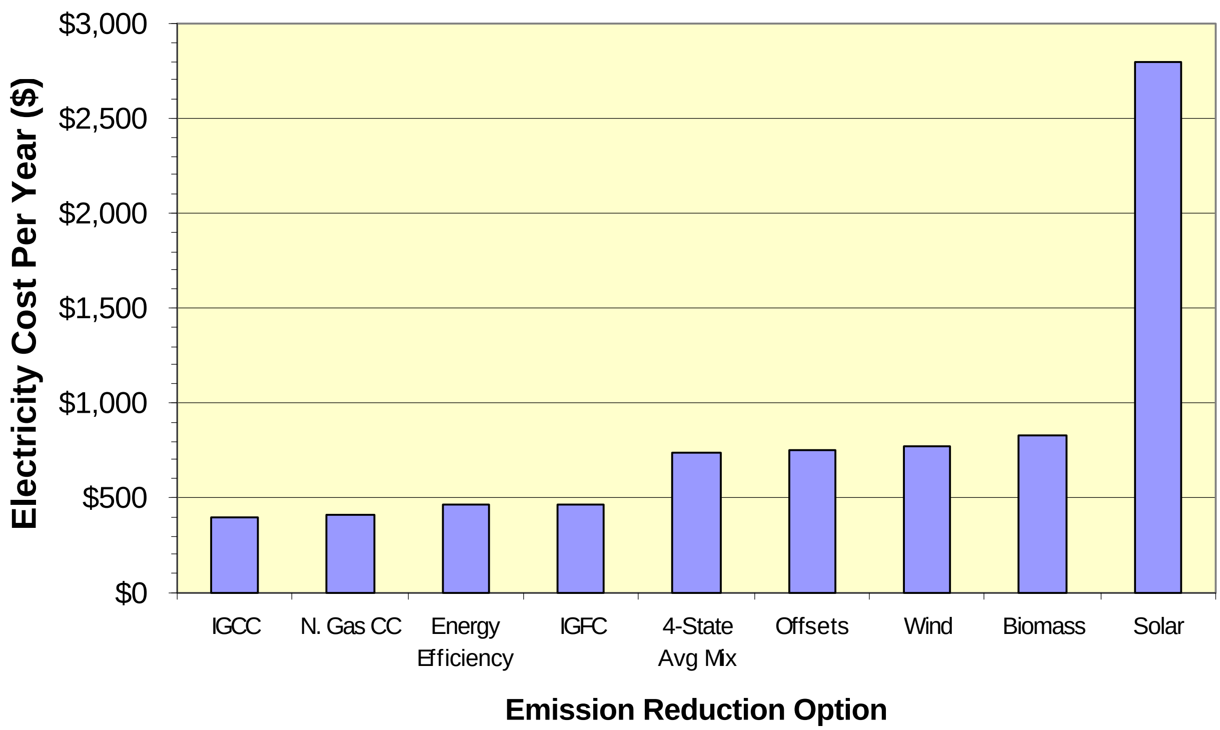
(1) When purchasing new equipment and appliances, the consumer chooses to buy those that are energy-efficient (Energy Star-rated models for example)
(2) The consumer buys the cleanest electricity she can
(3) The consumer offsets the CO_2 emissions caused by her direct and indirect energy use

The cost of these three actions is as follows:

(1) Increased initial cost of 10-30%, with net cost savings over the life of the equipment/appliance
(2) \$3 to \$7 per month (assuming an electricity bill of 717 kWh per month and an incremental renewable electricity cost of 0.4 to 1.0 cents per kWh for wind or biomass energy over the average cost of the four-state study area's current generation mix).
(3) \$5 per month for CO_2 emissions (and it is tax-deductible)

Net cost: Less than \$12 per month with overall cost savings after initial 10 to 30% investment premiums in energy-efficient equipment.

Figure 8.3: Average Family's Electricity Cost per Year in a Post-Restructuring and Paid-Off Stranded Cost Environment



Many surveys have shown that most consumers support emission reductions and are willing to pay a small premium for cleaner generation sources. In fact, a survey conducted for this study showed that environmentally-minded consumers were willing to pay $33 more on average for reduced-emission electricity. This is coupled with the fact that there are already many low cost reduced-emission technologies currently available across the country. Consumers just need to feel like they are getting a value for their premium and that the dollars they spend will make a difference.

The demand for cleaner energy sources is already present. What is needed now is more education and access to these cleaner sources. Electricity providers should be able to offer cleaner electricity to consumers for little or no additional cost. The resources are currently available for a supplier to respond to an educated consumer market.

The bottom line for consumers that they can easily take direct action to reduce emissions at a modest cost. This report presents numerous green energy choices and discusses how to select and buy a combination of emission reduction actions that works for you. Regardless of the combination of emission reduction actions you choose, by incorporating just a little of each of the Green Energy Strategies, you can show that consumers want reduced environmental emissions, that consumers are willing to pay to reduce emissions and finally, that emission reductions are available at a lower cost than most people think. Your actions can produce direct environmental benefits–by reducing the demand for emission-producing fossil-fueled electricity generation, you reduce the environmental impacts from energy production and delivery. Your actions also help the marketplace, regulators, and legislators do more to reduce pollution.

When we incorporate energy conservation and efficiency measures in our own homes we decrease energy consumption. These energy savings increase our disposable income, which leads to growth in employment since most of the income is spent locally on consumption of goods and services instead of flowing out of state to pay for fuel imports. Renewable generation built in-state also has positive economic impacts by eliminating the cost of paying for out of state fuel products.

Buying emission offsets helps people and organizations that implement energy efficiency, renewable energy, sequestration, and cleaner generation projects to pursue more and bigger projects. You also help put people to work installing, designing, manufacturing, and developing the equipment needed to carry out these cleaner energy projects.

Consumers can also help the environment by supporting environmentally beneficial regulation and legislation. They can do this by giving their time and money to organizations that are supporting smart, effective policies for promoting cleaner energy sources. These policies include measures such as renewable portfolio standards, rewarding all pollution reduction actions with allocations, net metering, public benefits funding, and fair rules between all energy sources (even playing field). Our survey results showed high support for many of these policies by environmentally-minded consumers as desirable ways to clean up the pollution our energy use causes. This report provides information which can be used to add support for these policies but was geared towards helping individual consumers take direct actions towards reducing their own air pollution.

So having read this report, choose a mix of increased energy efficiency, cleaner or renewable electricity, and emission offsets that works for you. If you represent an organization, recommend that each of your members implement a mix that fits your organization's objectives. Start leading the way today to a cleaner environment for you, your children, your grandchildren, and future generations.