Powerful Solutions

7 Ways to Switch America to Renewable Electricity

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Executive Summary

The way electricity is produced and sold in the United States is undergoing an historic change. The changes being debated and enacted across the country are intended to lower electricity prices by encouraging competition among power companies. But what are the implications of electricity deregulation for the environment and public health?

The answer depends on what the rules governing the new electricity market will be. If they ignore threats to the environment and public health, then the overall quality of American life will be diminished by increased pollution, global warming, and other looming problems. But if new market rules are designed to promote cleaner, renewable energy sources such as wind, solar, biomass, and geothermal energy, then we could see lower prices, robust competition, and environmental improvement.

This primer describes seven practical measures to switch America to renewable electricity sources:

- Renewable portfolio standards
- Public benefits funding
- Net metering
- Fair transmission and distribution rules
- Fair pollution rules
- Consumer information
- Putting green customer demand to work

Public Benefits of Renewable Energy Use

Renewable energy can supply a significant portion of the United States' energy needs, creating many public benefits, including environmental improvement, increased fuel diversity and national security, and economic development. These benefits, however, are often not reflected in the prices paid for energy, placing renewable energy at a severe disadvantage when competing against fossil fuels and nuclear power.

Environmental Benefits. Renewable energy provides immediate benefits by avoiding the environmental impacts of fossil fuels. Using fossil fuels to make electricity dirties the nation's air, consumes and pollutes water, hurts plants and animal life, creates toxic wastes, and causes global warming.

Air pollution is an especially serious problem for which electricity generation bears substantial responsibility. One pollutant, fine particles, may be responsible for 64,000 deaths each year—more than the number of people killed in automobile accidents. Other important pollutants include sulfur dioxide, nitrogen oxides, and toxic metals.

Electricity generation is also a leading source of carbon dioxide emissions, the key heat-trapping gas that is causing global warming. Although scientific uncertainties remain about the timing and size of impacts, there is strong evidence that global warming is occurring and that its effects could be severely damaging to both people and wildlife. The warming that is predicted for the next several decades (without action to reduce carbon emissions) could destroy many coastal wetlands, cause more frequent storms and other extreme weather events, put crop production under great stress in some regions, and disrupt public health and ecosystems.

Renewables can also help replace nuclear generation and reduce its safety, environmental and economic risks.

Reducing Pollution Helps the Economy. The pollution and other problems associated with fossil fuels place a burden on the American economy as well as on the environment. The greatest economic impacts take the form of higher health care costs, missed work, and lost lives. According to several studies, such health costs may amount annually to hundreds of billions of dollars. Increasing renewable energy use can help reduce these health costs and also lower the costs to industries and consumers of complying with environmental regulations.

Diversity and Energy Security. By broadening the mix of electricity sources, renewables can make the United States less vulnerable to volatile fuel prices and interruptions to the fuel supply. Renewables like wind and solar that do not depend on fuels are not subject to price fluctuations, such as the huge leaps and falls in oil and gas prices seen in the 1970s and 1980s. And since they are locally produced, they are not as vulnerable to supply interruptions from outside the region or country.

Economic Development. Renewable energy technologies can help create jobs and generate income. A number of state and national studies have found positive net job impacts from increasing renewable energy use. Renewable technologies also have enormous export potential.

Other Nontraditional Benefits. Some renewable technologies can be sited in or near buildings where electricity is used. This practice, known as distributed generation, can avoid costly expenditures on transmission and distribution equipment. Distributed generation can also improve power quality and system reliability.

The Costs and Benefits of Increasing Use of Renewable Energy

Current levels of renewable energy use represent only a tiny fraction of what could be developed. Several major studies show that the United States can meet a large share of its electricity needs from renewable resources at a modest cost, while reducing harmful air emissions, easing pressure on natural gas prices, and greatly diversifying the electricity mix.

Making Renewable Energy the Standard. A 1999 UCS study of federal proposals (*A Powerful Opportunity: Making Renewable Electricity the Standard*) found that achieving a standard of 20 percent (nonhydro) renewables generation by 2020 would freeze electricity-sector carbon dioxide emissions at year 2000 levels. Under business as usual, these emissions would increase by 24 percent. The carbon dioxide reductions would cost $18 per ton. Consumer electricity prices would fall 13 percent between 1997 and 2020, compared to 18 percent under business-as-usual. A typical (500 kilowatt-hours per month) household electricity bill would still be $4.57 per month lower in 2020 than in 1998, compared with a $5.90 per month reduction without the added renewables. The study also showed that the competition from increasing renewable energy use would help restrain natural gas price increases.

Department of Energy Analysis. A 1998 study by the Energy Information Administration (*Annual Energy Outlook 1998*) found that with a standard of 10 percent nonhydro renewables by 2010, electricity prices would be 17 percent lower than in 1996, compared to 20 percent reductions with business as usual. In the renewables scenario, typical households would still see their electricity bills reduced by at least $6.25 month by 2010, compared with $7.74 month with business as usual. When the effect of the added renewables restraining natural gas price increases is counted, along with electricity conservation induced, there would be a net savings of $1.8 billion from the renewables standard in 2010.

Barriers to Renewable Energy

If renewable energy sources are such a good deal for the country, why haven't they been more successful? Four problems are mainly responsible:

- **Commercialization barriers.** Like all emerging technologies, renewables must compete at a disadvantage against the entrenched industries. They lack infrastructure, and their costs are high because of a lack of economies of scale.
- **Distortions in tax and spending policy.** Studies have established that federal and state tax and spending policies tend to favor fossil-fuel technologies over renewables.
- **No value is placed on the public benefits of renewables.** Many of the benefits of renewables, such as reduced pollution and greater energy diversity, are not reflected in market prices, thus

eliminating much of the incentive for consumers to switch to these technologies.

- **Other market barriers.** Lack of information by customers, institutional barriers, the small size and high transaction costs of many renewables, high financing costs, split incentives among those who make energy decisions and those who bear the costs, and high transmission costs can also be barriers to renewables development.

Green Market Limits. Surveys show that many customers are willing to pay more for renewables. But given the barriers to renewables competing fairly in the marketplace, "green markets" are likely to develop slowly. Pilot programs have shown promising results, with some commercial customers choosing renewables, though in smaller numbers than residential customers. Participation levels to date have been far below positive survey responses and customers' switching to "green" suppliers in California is off to a relatively slow start. The most optimistic green marketers expect that 20 percent of residential customers and 10 percent of commercial customers will choose green suppliers within five years of customer choice.

Seven Ways to Switch America to Renewable Electricity

Over the years, state and federal governments have taken a number of policy actions to encourage renewable energy production. In states committed to seeing them through, the policies have been very successful. New policies are needed if renewables are to compete successfully in deregulated electricity generation markets.

We identify seven effective ways to encourage the wider use of renewable energy:

1. Renewables Portfolio Standard. The renewables portfolio standard (RPS) would use market mechanisms to ensure that a growing percentage of electricity is produced from renewable sources. By establishing tradable "renewable energy credits," the RPS would function much like the Clean Air Act emissions allowance trading system. Five states have enacted minimum renewables requirements during restructuring; three others have set pre-restructuring state minimums. Together these bills are likely to preserve 1,650 MW of existing renewables and lead to development of 2,100 MW of new renewables. Connecticut has the highest overall state target; Arizona the highest solar support. Six 1998 federal bills contain RPS provisions.

An RPS can ensure steady, predictable growth of the renewable energy industry. That would enable the industry to obtain lower-cost financing and achieve economies of scale and production that would make the technologies more competitive. The RPS would ensure that the lowest cost renewables are developed by creating competition among renewable developers. The RPS would have low administrative costs, since the market would decide what kinds of renewable energy would be produced.

2. Public Benefits Funding. Another way of encouraging a switch to renewable sources is to fund renewable energy development with a small charge on all electricity sold. Such a charge could fund specific activities to overcome market barriers and help commercialize new technologies. Seven states have adopted renewables funds totaling about $1 billion over ten years. California has the highest level of total funding; Connecticut the highest per customer.

Public benefits funds can be allocated where they are most needed. For example, they can be directed toward technologies that have great long-run potential, like solar photovoltaics, but are not competitive today even with other renewables. They can also be used for other purposes, including funding programs to increase energy efficiency, public benefits research and development and to ensure electricity service to low-income customers. Moreover, public benefits funds, unlike tax credits and other incentives, allow the level of funding to be precisely defined.

3. Net Metering. Net metering is an important way to eliminate penalties for households and small businesses that elect to generate their own power from renewable sources (with, for instance, small wind turbines or rooftop solar systems). It allows customers who produce more electricity than they are using at a given moment to feed the surplus back to the utility and only pay for net electricity used over an entire billing period or year. As of November 1998, at least 21 states required net metering, with utilities in two other states also using net metering.

4. Fair Transmission and Distribution Rules. Some renewables can be sited in or around customer buildings where they can not only replace conventional generation, but help avoid transmission and distribution costs. An important issue is whether these technologies are credited for these savings. In some cases, distributed renewables generation can become cost-effective when these transmission and distribution savings are counted.

New regulations or incentives are needed to encourage distributed generation where it is economic. Options include integrated resource planning for distribution systems and performance-based ratemaking. Massachusetts and Connecticut have required consideration of distributed technologies.

Renewable energy producers, like other generators, need access to the transmission grid and the ability to sell power whenever it is available. New federal rules and regional independent system operators (ISOs) could increase access to customers for renewable generators, and reduce transmission costs for remote facilities. Some proposals for transmission service pricing, however, could unfairly penalize intermittent renewables like wind and solar, by requiring generators to specify sales a day or more in advance and pay penalties for deviating from the amount purchased. Other transmission pricing issues could also affect renewables adversely. An analysis by the Lawrence Berkeley Laboratory shows that charging only for energy transmitted by renewables will produce the least-cost electricity system.

5. Fair Pollution Rules. Under the Clean Air Act, older power plants are allowed to emit more pollutants than newer plants and, therefore, do not have to spend as much money on pollution controls. On average, these rules save older plants nearly one cent per kilowatt hour compared to new plants, giving them an unfair competitive advantage. Northeast states are especially concerned that deregulation could increase electricity imports from these dirtier, less expensive plants in the Midwest, unless older plants are required to clean up to new plant standards.

Several proposals have been made to reduce the disparity in emissions allowed at different plants. Connecticut and Massachusetts directed their environmental regulators to develop emission performance standards for retail supplier portfolios. Another approach is to develop an overall emission cap in the area affected by a specific pollutant, and to allow trading among companies to meet the cap. The US Environmental Protection Agency has proposed a nitrogen oxides trading scheme for Eastern states. Several federal proposals would create caps for multiple pollutants. A third approach would be to tax emissions, a policy that has gained some favor in other countries.

6. Customer Information. To exercise their preference for clean energy sources, customers need reliable information about products they are offered. To address this issue, electricity suppliers can be required to label their products. These disclosure labels for fuel sources and emissions would be analogous to nutrition labels on food. A number of states have required disclosure, and others are considering it. In addition, education programs about environmental impacts and choices available in the marketplace, as well as certification of renewable electricity services by an independent organization, can provide important information.

7. Putting Green Customer Demand to Work. Many surveys have shown that customers are willing to pay more for electricity from clean and renewable sources. At least 40 programs offering customers renewable energy choices were available by mid-1998. Results from initial pilot and marketing experiments are mixed, with low initial participation rates but some signs of long-term promise.

Supportive market rules are important for allowing effective customer choice. Electricity customers who switch suppliers need to receive a shopping credit that includes avoided retail overhead costs, as enacted in Pennsylvania.

Aggregation of small customers can reduce overhead and marketing costs, and facilitate choice of green products. Municipal aggregation, authorized by Massachusetts law, where a city or town votes to purchase electricity for all its residents and businesses, may be especially promising. Government purchases of renewable electricity is another approach to stimulate development.

Conclusion

The deregulation of electricity generation presents both risks and opportunities for renewable energy. The main risk is that renewables will be at a competitive disadvantage against fossil fuels. If this occurs, the result could be even less use of renewable energy for electricity generation than we see today, with corresponding higher levels of pollution, greenhouse gases, and other problems.

However, the new market also creates potential opportunities for renewables *if* appropriate policy steps are taken. This report has described seven practical measures that would greatly increase the contribution of renewable sources to the nation's electricity supply. These measures are complementary and can be enacted together. Policymakers should consider them as an integral part of increasing competition in the electricity industry.

Chapter 1

Introduction

The way electricity is produced and sold in the United States is undergoing an historic change. For a century, electricity has been generated and sold by utilities granted monopolies to supply customers in a given territory. Now, electricity generators are allowed to compete to sell electricity on a wholesale level to any utility anywhere they can transmit their power. In a number of states, electric companies are allowed to compete to sell power to individual retail customers—households or businesses. Whether, how, and when to allow or to require retail competition for electricity customers is being debated in Congress and in every state in the country that has not yet made a decision.[1]

The changes now being debated and enacted across the country are primarily intended to lower electricity prices by increasing competition among electric companies. That is a laudable goal, but what are the implications of electricity deregulation for other things we value, such as the environment and public health?

The answer depends on what the rules governing the new electricity market will be. If they ignore threats to the environment and public health, then electricity prices may well go down in the short term—but the overall quality of American lives will be diminished by increased pollution, global warming, disappearing wildlife, and other looming dangers. Electricity generation is the source of 36% of the carbon dioxide contributing to global warming, to take just one example, and a significant shift toward coal as the main fuel in power plants (a likely result of some deregulation proposals) will only increase those emissions and electricity generation's share of responsibility.

And yet, if those new market rules are designed to promote cleaner, renewable energy sources such as wind, solar, biomass, and geothermal energy—all the while permitting robust competition and lower prices—then we may see significant improvements in all these areas. As several exhaustive studies have established, "renewables" offer a technically sound, economically feasible alternative to more polluting fossil fuels. The once-a-century restructuring of the electricity industry is an opportunity to ensure that the environmental performance of the industry is optimized along with the economic performance.

This primer describes seven simple, practical measures to switch America to clean, renewable electricity sources. They are

- Renewable portfolio standards—a way to use market mechanisms to meet minimum targets for the production of electricity from renewable resources
- Public benefits funds—a way to make sure that public benefits, such as environmental improvement and fuel diversity, provided by renewables and other programs, like energy efficiency and service to low-income customers, are not ignored; and to ensure the that new technologies can be commercialized
- Net metering—a way to avoid penalizing homeowners and small businesses that elect to generate their own power
- Fair transmission and distribution rules—a way to make sure that renewable electricity producers can get their power to markets at a fair price
- Fair pollution rules—a way to make sure that old, dirty power plants have to meet the same pollution rules as new power plants, and to allow renewables credit for cleaning up air pollution

What Is Renewable Energy?

Renewable energy comes from resources that are not depleted when used or that nature can replace when people use them at sustainable levels. Renewable energy sources have been used from ancient times to provide heat (burning wood), grind grains (windmills), and transport goods (sailing ships). New technologies use renewable resources to generate electricity.

Solar energy from the sun can provide direct heat. Or it can be converted to electricity by photovoltaic cells or by using mirrors to concentrate sunlight enough to heat water and drive a steam turbine or an engine.

Biomass energy comes from plants, like trees or crops, that store solar energy through photosynthesis. The stored energy can be released by burning the plant fuel directly in a power plant or by first converting it to a gas or liquid fuel. Sources of biomass include energy crops (plants grown just for fuel), organic wastes such as wood waste or agricultural wastes, and methane gas from landfills.

Wind energy can be converted to electricity by wind turbines, spun by propeller-like blades mounted on towers.

Geothermal energy taps into the heat under the earth's crust to create steam that drives turbines.

Hydroelectric power uses moving water to turn turbines that produce electricity.

For more information on renewable energy technologies, status, potential, costs, markets and environmental characteristics, see Appendix A.

- Consumer information—a way to give consumers the information they need to choose clean electricity sources, if they wish
- Putting green customer demand to work—a way to make sure that competition allows all customers to choose clean energy sources.

The primer also examines the rationale for encouraging renewable energy use, especially in deregulated electricity markets. Chapter 1 examines the public benefits of renewables and the risk that these benefits will be ignored in a restructured electricity industry. Chapter 2 summarizes several studies showing how practical and economical it would be to increase the use of renewables in producing electricity. Chapter 3 describes the barriers that inhibit the success of renewables in current, and perhaps future, electricity markets. Chapter 4 lays out, in depth, the seven ways to switch to renewable electricity. Appendices provide more detail on renewable energy technologies and their status and costs, detailed discussion of implementation issues with the renewables portfolio standards, and descriptions of how states have implemented renewables portfolio standards, public benefit funds, and net metering to date.

Because of the historic restructuring of the electricity industry underway, this primer focuses on changes that it is critical to consider during the restructuring process. However, most of the recommended solutions can also be implemented independently of the restructuring process. They need not wait for deregulation.

The primer does not consider all of the policies needed to deregulate the electricity industry successfully. Electricity deregulation is a very complex topic.[2] The primer focuses only on policies which have critical impacts on the development of renewable energy resources and technologies.

This primer also does not focus, therefore, on energy efficiency technologies, although the public benefits fund mechanism discussed here is a critical part of providing support for ongoing improvements to energy efficiency. Energy efficiency provides most of the same public benefits as renewables and faces most of the same market barriers.[3] Most importantly, energy efficiency improvements are usually the most cost-effective steps that can be taken to reduce the environmental impact of our energy system and to lower long-run costs. As the studies described in Chapter 2 demonstrate, increasing both energy efficiency and renewables is essential for meeting environmental objectives. Preserving the public benefits of utility funding of energy efficiency improvements is a vital part of any restructuring debate.[4]

Following the strategies we recommend will not guarantee that every new power plant will be renewable-based. However, it will set America on a course toward a renewable-based future, one in which the environment and public health, on the one hand, and free-market principles, on the other, are fostered and respected.

Chapter 2

Public Benefits of Renewable Energy Use—Why Switch?

Renewable energy can supply a significant proportion of the United States' energy needs, creating many public benefits for the nation and for states and regions, including environmental improvement, increased fuel diversity and national security, and regional economic development benefits.

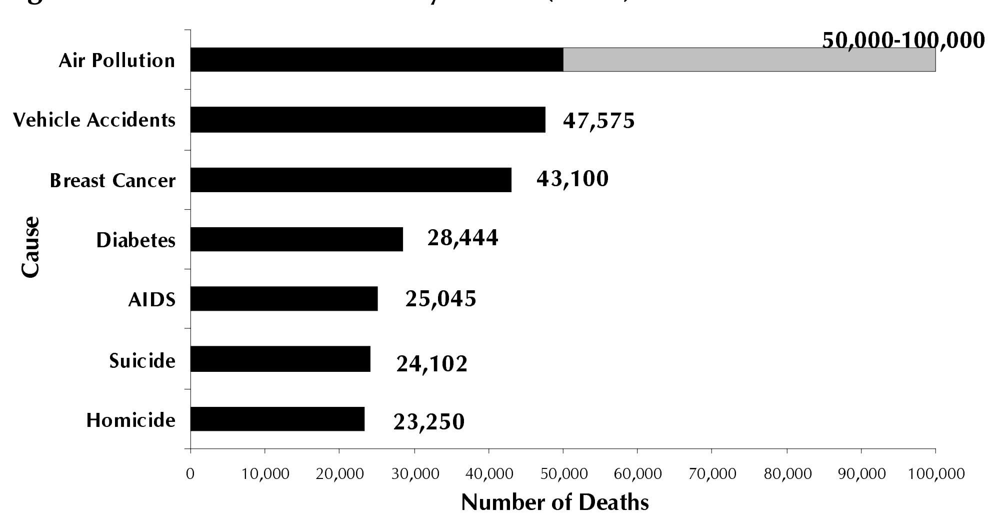
Environmental Benefits

Using fossil fuels—coal, oil and natural gas—to make electricity dirties the nation's air, consumes and pollutes water, hurts plants and animal life, creates toxic wastes, and causes global warming. Using nuclear fuels poses serious safety risks. Renewable energy resources can provide many immediate environmental benefits by avoiding these impacts and risks and can help conserve fossil resources for future generations. Of course, renewable energy also has environmental impacts. For example, biomass plants produce some emissions, and fuel can be harvested at unsustainable rates. Windfarms change the landscape, and some have harmed birds. Hydro projects, if their impacts are not mitigated, can greatly affect wildlife and ecosystems. However, these impacts—which are discussed in Appendix A—are generally much smaller and more localized than those of fossil and nuclear fuels. Care must nevertheless be taken to mitigate them.

Air Pollution. Clean air is essential to life and good health. Air pollution agg–ravates asthma, the num–ber one children's health problem. Air pollution also causes disease and even premature death among vulnerable populations, including children, the elderly, and people with lung disease. A 1996 analysis by the Natural Resources Defense Council of studies by the American Cancer Society and Harvard Medical School suggests that small particles in the air may be responsible for as many as 64,000 deaths each year from heart and lung disease.[5] Figure 1 shows that air pollution is responsible for more deaths than motor vehicle accidents, and ranks higher than many other serious health threats.[6] A few of the most important pollutants are discussed below.[7]

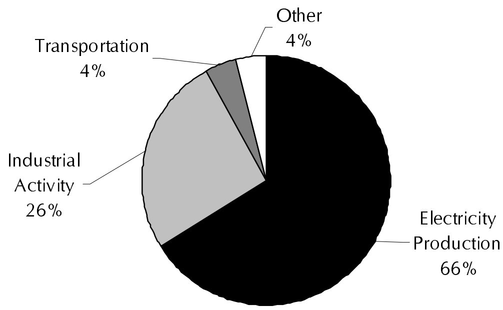
Sulfur oxides. Electricity production, primarily from burning coal, is the source of most emissions of sulfur oxides (SO_x), as figure 2 shows. These chemicals are the main cause of acid rain, which can make lakes and rivers too acidic for plant and animal life. Acid rain also damages crops and buildings. National reductions in sulfur oxides required by the Clean Air

Figure 1. Number of Deaths by Cause (1989)



Source: Curtis Moore, "Dying Needlessly: Sickness and Death Due to Energy-Related Air Pollution", Renewable Energy Policy Project Issue Brief #6, February, 1997. On-line at solstice.crest.org/renewables/repp.

Figure 2. Sources of Sulfur Dioxide



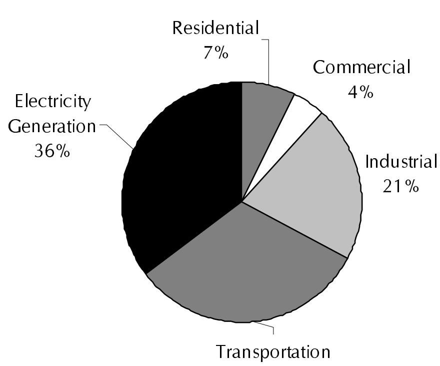
EPA National Air Quality and Emissions Trends Report, 1996.

Act Amendments of 1990 may not be sufficient to end damage from acid rain in the northeastern United States.[8] SO_2 is also a primary source of fine particles in the air.

Nitrogen oxides. Burning fossil fuels either to produce electricity or to power transportation emits nitrogen oxides (NO_x) into the air (see figure 3). In the presence of sunlight, nitrogen oxides combine with other chemicals to form ground-level ozone (smog). Both nitrogen oxides and ozone can irritate the lungs, cause bronchitis and pneumonia, and decrease resistance to respiratory infections. In addition, research shows that ozone may be harmful even at levels allowed by federal air standards. The U.S. Environmental Protection Agency (EPA) has published a new rule reducing nitrogen oxide emissions from 0.12 parts per million to 0.08 parts per million. States have until 2003 to submit plans for meeting the new standard and up to 12 years to achieve it.[9]

Carbon dioxide. Carbon dioxide (CO_2) is the most important of the greenhouse gases, which contribute to global warming by trapping heat in the earth's atmosphere. Electricity generation is, as figure 4 shows, the largest industrial source of carbon dioxide emissions and a close second to the transportation sector.

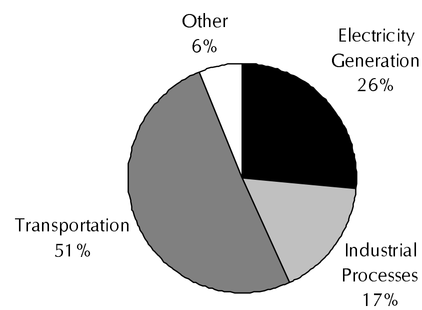
Figure 4. Sources of Carbon Dioxide



EPA National Air Quality and Emissions Trends Report, 1996.

Samples from air bubbles trapped deep in ice from Antarctica show that carbon dioxide and global temperature have been closely linked for 160,000 years (see figure 5). Over the last 150 years, burning fossil fuels has resulted in the highest levels of carbon dioxide ever recorded. In 1995, the Intergovernmental Panel on Climate Change—an authoritative international scientific body—concluded that "the balance of evidence suggests that there is a discernible human influence on global climate."[10] All 10 of the warmest years on record have occurred in the last 15 years. The 1990s have already been warmer than the 1980s—the warmest previous decade on record, according to the Goddard Institute of Space Studies.[11]

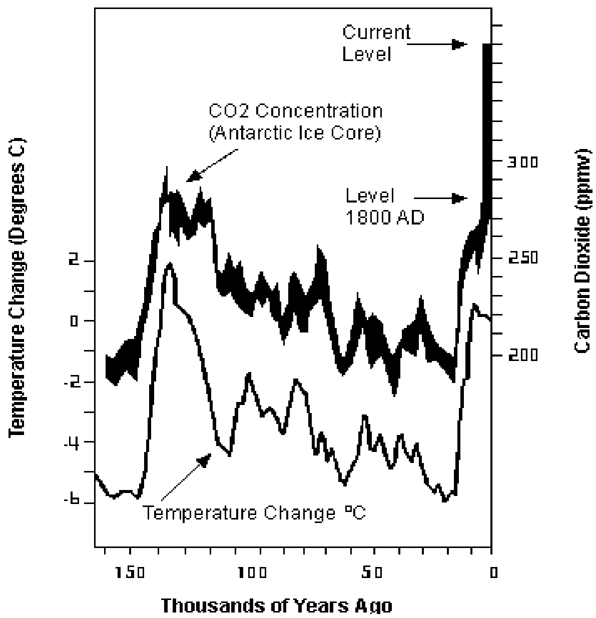
Figure 3. Sources of Nitrogen Oxides



EPA National Air Quality and Emissions Trends Report, 1996.

Without action, carbon dioxide levels would double in the next 50 to 100 years, increasing global temperatures by 1.8 to 6.3 degrees Fahrenheit. The heat trapped in the atmosphere would cause expansion of the ocean's volume as surface water warms and melt some glaciers. A two-foot rise in sea level could flood 5,000 square miles of dry land in the United States, and another 5,000 square miles of coastal wetlands, as figure 6 shows. From 17 to 43 percent of coastal wetland—prime fish and bird habitat—could be lost. Building dikes and barriers could reduce flooding of dry land, but would increase wetland loss. Impacts on

Figure 5. Atmospheric Carbon Dioxide Concentration and Temperature Change



Source: *White House Initiative on Global Climate Change*, October, 1997. On line at www.whitehouse.gov/Initiatives/Climate/greenhouse.html

island nations and low-lying countries, like Egypt and Bangladesh, would be much worse.

Altered weather patterns from changes in climate may result in more extreme weather events. Some areas will suffer more drought and others more flooding, putting crop production under great stress in some regions. The character of our forests could change dramatically. Other expected impacts include an increase in heat-related deaths, increased loss of animal and plant species, and the spread of pests and diseases into new regions with less resistance to them.[12]

In 1997, at a conference in Kyoto, Japan, the developed nations of the world agreed to reduce carbon dioxide emissions. The United States agreed to 7 percent reductions from 1990 levels by the period 2008–2012. Senate ratification of this agreement remains uncertain, however.

Other air pollutants. Burning fossil fuels, especially coal and oil, produces a host of other air pollutants in addition to those discussed above. Among them are

- Carbon monoxide (CO), which can cause headaches and place additional stress on people with heart disease
- Hydrocarbons (HC), which come from unburned fossil fuels and contribute to smog
- Large particles such as dust, soot, smoke, and other suspended matter, which are respiratory irritants
- Small (so-called "fine") particles, which have been linked to chronic bronchitis, aggravated asthma, and premature deaths

Large particles (10 microns in diameter) are regulated by the Clean Air Act. In 1997, the Environmental Protection Agency published a new rule limiting emissions of fine particles (2.5 microns).

A typical 500-megawatt coal plant produces 3.5 billion kilowatt-hours per year—enough to power a city of about 140,000 people.

It burns 1.4 million tons of coal (the equivalent of 40 train cars of coal each day) and uses 2.2 billion gallons of water each year. In an average year, this one plant also generates the following:

- 10,000 tons of sulfur dioxide
- 10,200 tons of nitrogen oxide, equivalent to half a million late-model cars
- 3.7 million tons of carbon dioxide, equivalent to cutting down 100 million trees
- 500 tons of small particles
- 220 tons of hydrocarbons
- 720 tons of carbon monoxide
- 125,000 tons of ash and 193,000 tons of sludge from the smokestack scrubber
- 170 pounds of mercury, 225 pounds of arsenic, 114 pounds of lead, 4 pounds of cadmium, and other toxic heavy metals
- Trace amounts of uranium

States have until 2005 to 2008 to submit plans to the EPA for meeting the standard, and another 12 years to actually comply.[13]

In addition, coal and oil contain air toxics—metals like mercury, arsenic, and lead. Although only trace amounts of these metals are present in coal and oil, they are difficult to catch using pollution-control equipment. Utility coal burning accounts for 40,000 tons of toxic air pollutants per year.[14] For example, coal plants are responsible for over a third of the 150 tons of mercury that are released into the air each year.[15]

Once deposited in nature, toxic metals can accumulate in the fatty tissue of animals and humans. They can cause severe health problems, such as mental retardation, nervous system damage, and developmental disorders. Due to the accumulation of toxic metals in fish—some of it as a result of air pollution—35 states have advisories against eating fish caught in lakes and rivers. Children and pregnant women are the most at risk.[16]

Water, Land, and Thermal Pollution. Energy production and use also have profound impacts on water and land. There are direct impacts, such as oil spills and coal mining, and indirect impacts from air emissions settling out on land and water. Land and water damage can occur throughout the life cycle of fossil fuels, from mining, drilling, and refining, to shipping, use, and disposal.

Coal mining contributes to land and water pollution. New mining practices some–times level mountains. Toxic chemicals brought to the surface during the mining process can leach into water supplies.[17] Railroad and barge trans–portation of coal releases coal dust and is vulnerable to accidents. Finally, after the coal is burned, ash is left as a waste product.

Drilling for oil and natural gas can also pollute the immediate environment. Oil spills kill plants and animals, often leaving waterways and the surrounding shores uninhabitable.

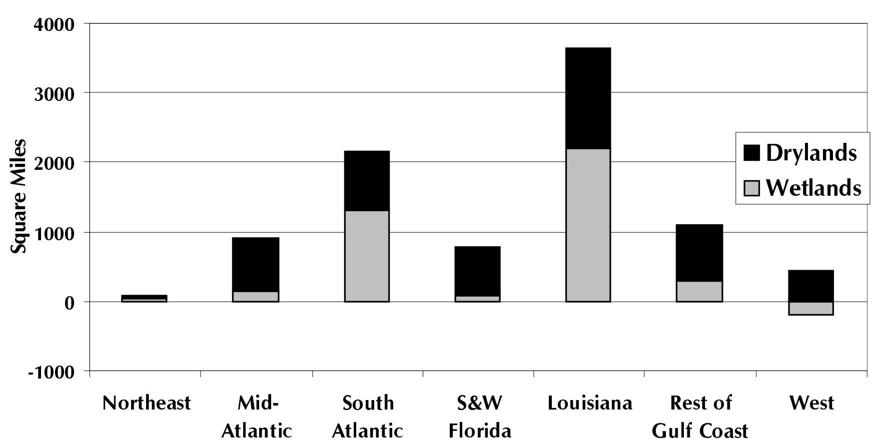
Fossil fuels produce heat energy when burned, some of which is used to generate electricity. Because the process is inefficient, about two-thirds of the heat is released to the atmosphere or to water used as a coolant. Heated water, once returned to rivers or lakes, can upset the aquatic ecosystem. And water intake, outflow, and cooling systems can trap and kill fish and fish larvae.

Economic Benefits of Reducing Environmental Impacts

The many environmental impacts described above result in real costs to society and to individuals. When such costs are not included in energy prices, they are referred to as "externalities." During the 1990s, efforts have been made to calculate the dollar costs of such externalities and, in some cases, to include them in energy planning decisions.[18] In 1998, the Minnesota Supreme Court upheld a state law requiring that utility planning consider externalities.[19]

The largest external costs from pollution are probably human health costs, in the form of health treatment costs, higher health insurance rates, missed work, and lost life. According to an exhaustive survey of health impacts by the Pace University School of Legal Studies and studies by the American Lung Association, the annual US health costs from all air

Figure 6. US Coastal Lands at Risk from a 20-inch Sea-Level Rise in 2020



Source: EPA Air Quality and Emissions Report, 1996.

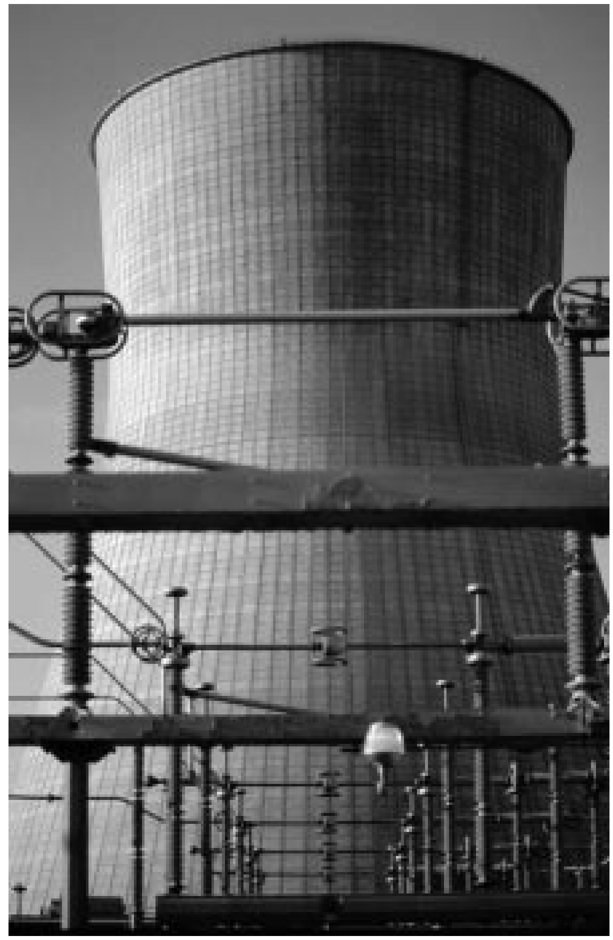
pollutants may be as high as hundreds of billions of dollars.[20] However, unless policies are adopted so that utility rates account for these societal and environmental costs, customers may ignore them when deregulation enables customers to choose their generating sources. Such policies might include pollution taxes or placing total limits on each emission for the geographic area affected by the emission. (See Chapter 4)

Even without considering externalities, both industry and individuals stand to gain from increased reliance on renewable energy. Because renewables produce little or no pollution, they can reduce regional pollution and thereby reduce the costs for neighboring industry to comply with environmental regulations.

The savings are not always obvious. Environmental regulations usually focus on one pollutant at a time, as scientific knowledge about the impacts of the pollutant develops. Then, when government imposes a new regulation, industry may add a series of new pollution controls. Compared with any single pollution-control requirement, replacing the fossil fuel generator with a renewable energy technology may look expensive. But if all potential future controls are considered together, renewable technology can look far more attractive. As of 1998, a host of new environmental regulations were pending:

- The level of ozone (smog) allowed in ambient air is being reduced from 0.18 to 0.08 parts per million.
- Nitrogen oxides have long been regulated under the Clean Air Act. In determining how to allot reductions among industries, state governments are likely to target utilities for major reductions.
- Sulfur dioxide limits will be tightened in the year 2000 when Phase II of the Clean Air Act goes into effect. This will affect every coal-burning power plant in the country.
- Fine particles are being regulated for the first time, with final rules expected by 2005.
- Mercury and other toxic metals have been the subject of substantial research by the Environmental Protection Agency. The EPA has announced it will require coal-fired plants to disclose discharges, and it will use the data to decide on regulations by late 2000.[21]
- Carbon dioxide emissions would need to be reduced to implement the Kyoto agreement on global warming.[22]

Figure 7. Nuclear Power Plant Cooling Tower



Conversion now to renewable technologies would forestall the need for future retrofits to achieve compliance with these regulations.

A 1997 study—*The Hidden Benefits of Climate Policy: Reducing Fossil Fuel Use Saves Lives Now*—illustrates the benefit of multi-emission reductions. Researchers found that measures to reduce global carbon dioxide emissions—including increasing the use of renewables—could save 700,000 lives each year and a cumulative total of 8 million lives worldwide by 2020, in part by such pollutants as fine particles.[23]

Nuclear Risks

Although nuclear power plants avoid many of the air emissions associated with fossil fuel plants, they create unique environmental risks. A combination of human and mechanical error could result in an accident killing several thousand people, injuring several hundred thousand others, contaminating large areas of land, and costing billions of dollars.[24] While the odds of such an accident are low, the Chernobyl accident in 1986 showed that they can occur.

Major nuclear accidents can only result from many failures occurring at about the same time. But in order to maintain safety margins, inspectors and tests must identify equipment problems, and plants must have accurate procedures to minimize worker errors. A 1998 report by the Union of Concerned Scientists found a breakdown in quality assurance during a one-year study of a 10-plant focus group. The plants' internal auditors did not identify in advance any of more than 200 problems reported in 1997. In addition, many problems resulted from worker errors or poor procedures.[25] A 1997 report by the US General Accounting Office criticized the Nuclear Regulatory Commission (NRC) for failing to catch declining performance at some plants.[26] These findings are especially significant at a time when nuclear plants are cutting costs to become more competitive. Cutting costs need not jeopardize nuclear safety, but maintaining safety in this environment requires increased attention.

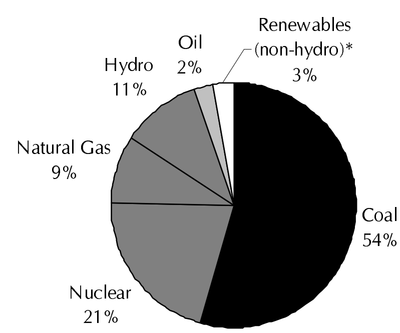
Pressure to cut costs at marginal nuclear plants could reduce the margin of error on safety. For example, the Nuclear Regulatory Commission attributed safety problems at the closed Maine Yankee nuclear plant to "economic pressure to be a low-cost energy producer"—pressure that limited the resources available for repairs.[27]

The erosion of safety measures can be subtle. Staff downsizing programs often target senior employees who receive high compensation. Their departure lowers the corporate experience level and may possibly increase the frequency of human error. Some nuclear utilities reduce costs by scaling back safety monitoring efforts, such as inspecting and testing safety equipment less often and postponing preventive maintenance.

In addition to safety issues, nuclear plants continue to be problematic because of their spent fuel rods and other radioactive waste. By 1995, US nuclear plants had produced almost 32,000 metric tons of high-level radioactive waste.[28] Finding a way to keep this waste out of the environment for the thousands of years it remains radioactive has proven difficult. Problems such as groundwater contamination led to four of the six commercial facilities that store low-level radioactive waste being closed.[29] And, despite years of research, the permanent repository the government hopes to build at Yucca Mountain still has unresolved issues.[30]

But regardless of the environmental issues, it is economics that is most hurting the nuclear industry. In 1998, about 40 percent of the nuclear plants in the United States were producing power at prices above the short-term market rate.[31] A study by the Washington International Energy Group concludes that about 37 percent of the combined nuclear capacity of the United States and Canada could be retired as a result of competition.[32] If fossil fuels are the only replacement option, early nuclear retirements will raise the cost for the country to comply with emission-reduction goals. Most of the planned increases in US natural gas capacity could be needed to replace these retiring nuclear plants, which means that little new capacity would be available to displace coal generation. Even if the nuclear plants were to operate until the end of their license periods, abundant

Figure 8. Sources of US Electricity (1996)



*includes cogeneration

low-emission replacement options would be needed. The availability of significant renewable generation could help to mitigate these nuclear-replacement problems, lowering the costs of regulatory compliance for industry as well as utilities and avoiding the risks inherent in nuclear power generation.

Diversity and Energy Security Benefits

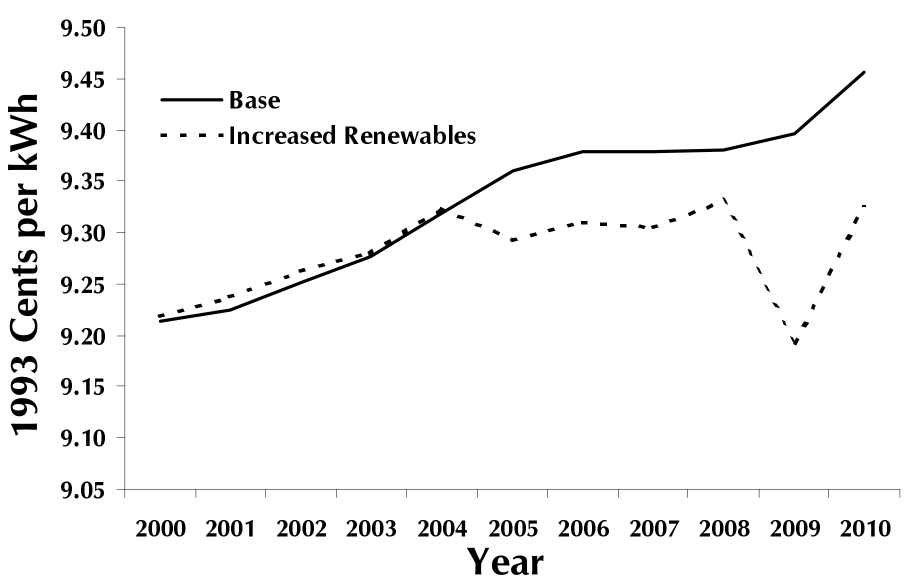
Renewables offer benefits not only because they can reduce pollution, but because they add an economically stable source of energy to the mix of US generation technologies. Depending on only a few energy resources makes the country vulnerable to volatile prices and interruptions to the fuel supply. As figure 8 shows, the United States relies heavily on coal, with nuclear power and natural gas supplying most of the rest.

Natural gas is generally considered the fuel of choice for new power generation, because it is cleaner than coal and sometimes less expensive. But overreliance on natural gas could also create problems. Fossil fuels are susceptible to supply shortages and price spikes.[33]

Since most renewables do not depend on fuel markets, they are not subject to price fluctuations resulting from increased demand, decreased supply, or manipulation of the market. And since fuel supplies are local, renewable resources are not subject to control or supply interruptions from outside the region or country. Some industrial customer trade groups have supported new renewable energy development primarily for their diversity benefits. For example, Associated Industries of Massachusetts, a trade group of manufacturers, testified in support of a utility restructuring settlement including a renewables fund, stating: "Fuel diversity is important to the Commonwealth's future. It would not be advisable to place all our eggs in the natural gas basket."[34]

An additional benefit of increased competition from renewables—and thus reduced demand for fossil fuels—could be lower prices for electricity generated from fossil fuels. Several analyses reviewed in Chapter 2 show that competition from increasing renewables could reduce natural gas prices. A comprehensive modeling project of the New England Governors' Conference found that an aggressive renewables scenario, in which renewables made up half of all new generation, would depress natural gas prices enough to lead to a slight overall reduction in regional electricity prices compared with what prices would be if new generation came primarily from fossil fuels.[35] (See figure 9.)

Figure 9. Average Electricity Prices



Source: Assessing New England's Future, New England Governors' Conference, Inc., 12-11-1996

The nation's fossil fuel dependence also has serious implications for national security, since the United States could again be forced to protect foreign sources of oil to meet our energy needs. During the Persian Gulf War in 1991, US troops were sent in partly to guard against a possible cutoff of the US oil supply. The public continues to pay taxes to support the protection of overseas oil supplies by US armed forces.

Reliance on foreign oil also makes the United States vulnerable to fuel price shocks or shortages if supply is disrupted. In 1997, about a third of US oil came from the Middle East. By

2030, if energy policy does not change, the country may be relying on Middle Eastern, and possibly Central Asian, oil for two-thirds of its supply. Some analysts believe that oil discovery peaked in the early 1960s and that a decline in global oil production, and the beginning of increasingly high prices, will occur within 10 to 12 years.[36]

Some regions, especially New England, still use significant amounts of oil for electricity generation even though nationwide most oil is used for transportation. Electric vehicles, especially if powered from renewable sources, could also play an increasingly important role in reducing oil use and emissions from the transportation sector. And higher oil prices, absent sufficient fuel competition, could lead to higher prices for other fossil fuels.

TABLE 1

Employment in the Renewable Electricity Industry

	Direct Employment	Indirect Employment	Total Employment
Wind (1992)	1,260	4,350	5,610
Biomass (1992)			66,000
Photovoltaics (1994)			15,000
Solar Thermal (1994)	250	250	500
Geothermal (1996)	10,000	20,000	30,000
Total			**116,860**

Economic Development Benefits

Renewable energy technologies can not only keep dollars in this country, but also create significant regional benefits through economic development. Many states are dependent on energy imports. Iowa and Massachusetts, for example, each import about 97 percent of the energy they use.[37] Renewable technologies create jobs using local resources in a new, "green," high-tech industry with enormous export potential. They also expand work indirectly in local support industries, like banks and construction firms. As table 1 shows, during the 1990s, the US renewable electricity industry employed nearly 117,000 people.[38]

Some renewable technologies, like biomass, are relatively labor intensive, which is one of the reasons they are slightly more expensive than their fossil fuel counterparts. For example, growing, harvesting, and transporting biomass fuels all require labor, as does maintaining the equipment. This means that much of the revenue for installing, fueling, and operating renewable power plants remains within the region where the power is used.

Renewables can mean increased revenues for local landowners. A Union of Concerned Scientists (UCS) analysis found that farmers could increase their return on land by 30 to 100 percent from leasing part of it for wind turbines while continuing to farm.[39] Another study found that adding 10,000 MW of wind capacity nationally would generate $17 million per year in land-use easement payments to the owners of the land on which the windfarms are situated, and $89 million per year from maintenance and operations.[40]

Renewables can contribute heavily to local taxes. Wind farms in California pay $10 million to $13 million in property taxes. And manufacturing capital-intensive renewables technologies can also be done domestically. According to the American Wind Energy Association, at least 44 states are involved in manufacturing wind energy system components.[41]

A UCS analysis for Wisconsin found that, over a 30-year period, an 800-megawatt mix of new renewables would create about 22,000 more job-years than new natural gas and coal plants would.[42] A New York State Energy Office study concluded that wind energy would create 27 percent more jobs than coal and 66 percent more than a natural gas plant per kilowatt hour generated.[43] A study of energy efficiency and renewable energy as an economic development strategy in Colorado by Economic Research Associates found an energy bill savings of $1.2 billion for Colorado ratepayers by 2010 with a net gain of 8,400 jobs.[44]

The California Energy Commission estimates that the 600 MW of new renewables that will be built using $162 million in public benefits funding in the state restructuring law will induce

- $700 million in private capital investment

- 10,000 construction jobs, with over $400 million in wages
- 900 ongoing operations and maintenance jobs with $30 million in long-term salaries
- gross state product impacts of $1.5 billion during construction and $130 million in annual ongoing operations45

In addition to creating jobs, renewables can improve the economic competitiveness of a region by enabling it to avoid additional costly environmental controls on other industries, as well as by stabilizing long-term energy prices.

Renewables can also contribute to economic development by providing opportunities to build export industries. In developing countries that do not have electricity grids, pipelines, or other energy infrastructure, renewable energy technologies can be the most cost-effective options for electrifying rural villages. The American Wind Energy Association has estimated that global markets for wind turbines alone will amount to as much as $400 billion between 1998 and 2020.[46]

Other industrial countries are leaping ahead of the United States in renewable energy production, however, because they value the environmental benefits more highly and because they recognize the opportunity to supply export markets. In fact, Japan and various European nations are encouraging the development of renewables by providing greater subsidies than does the United States.[47]

Other Nontraditional Benefits

Because some renewable technologies are small and modular, they can be sited in or near buildings where energy is used. These distributed generation technologies offer some benefits that utilities have usually not considered.

Perhaps most importantly, distributed generation technologies can avoid costly expenditures on transmission and distribution. For example, a utility putting distributed generation in a new neighborhood might be able to use smaller transformers or reduce the size or number of power lines going to the neighborhood. Distributed generation reduces the wear and tear on existing distribution equipment, thereby delaying the need to replace or upgrade the equipment. And distributed generation reduces power losses through the transmission system, so that less electricity needs to be produced in the first place.[48]

A UCS study found that in certain neighborhoods in the Boston area, the value of avoiding transmission and distribution expenditures would more than pay for the extra cost of using such distributed renewables as photovoltaics, solar water heaters, and fuel cells.[49] Many other studies during the 1990s have also pointed to added value from distributed generation.[50]

Distributed generation can also provide "premium power" to customers, improving power quality and system reliability.[51] Companies with critical electricity needs, like hospitals, airports, and computer-dependent firms, pay a premium to ensure reliable power, since the cost of outages can be huge. Generation on site, with small renewable generators, is one way to meet those needs.

Because renewables are typically small, modular, and require short lead times for installation, they can benefit electricity companies' planning. Companies using modular technologies can add capacity in small increments as needed, rather than planning large power plants many years in advance, only to find that they may not be needed when they finally go on line.

Finally, the concept of *value* is changing the perception of renewables, as is consumer choice. Many surveys have shown that customers value the environmental benefits of renewables more than conventional polluting energy sources and prefer electricity companies that supply at least part of their power from renewable energy technologies.[52] Renewables provide options that service-oriented companies can use to improve customer satisfaction. They can improve a company's public image and can create profitable new business opportunities for electricity generation or distribution companies that are customer-oriented.

Chapter 3

Costs and Benefits of Increasing Renewable Energy Use in the United States

Before the 1980s, the only widely used renewable electricity technology was hydropower. Hydropower is still the most significant source of renewable energy, producing 20 percent of the world's electricity and 10 percent of that of the United States. The 1973 oil crisis awoke the country to its vulnerability through dependence on foreign oil. Subsequent changes in federal policy spurred the development of renewable technologies other than hydro.

In 1978, Congress passed the Public Utility Regulatory Policies Act (PURPA), which required utilities to purchase electricity from renewable generators and from cogenerators (which produce combined heat and power, usually using natural gas) when it was less expensive than electric utilities could generate themselves.

Some states, especially California and those in the Northeast, required utilities to sign contracts for renewables whenever electricity from those sources was expected to be cheaper over the long term than electricity from traditional sources. These states saw the largest renewables development under PURPA. However, because oil price projections were high and because utilities were planning expensive nuclear plants, these renewables contracts turned out to be expensive relative to the low fossil fuel prices of the 1990s.

Nevertheless, under PURPA over 12,000 megawatts of nonhydro renewable generation capacity came on line. This development enabled renewable technologies to develop commercially. Wind turbine costs, for example, decreased by more than 80 percent.

Over the last five years, renewable energy growth has been modest, averaging less than 2 percent per year, primarily because of the low cost of fossil fuels.[53] In addition, the uncertainty around the deregulation of the utility industry largely froze investment in renewables, as utilities avoided new long-term investments.

Current levels of renewables development represent only a tiny fraction of what could be developed. Many regions of the world and the United States are rich in renewable resources. Winds in the United States contain energy equivalent to 40 times the amount of energy the nation uses. The total sunlight falling on the country is equivalent to 500 times America's energy demand. And accessible geothermal energy adds up to 15,000 times national demand.[54] Of course, there are limits to how much of this potential can be used, because of competing land uses, competing costs from other energy sources, and limits to the transmission system needed to bring energy to end users.

Below we summarize several studies from the late 1990s that have looked at scenarios involving a greater role for renewable energy technologies. These studies examined a number of policy mechanisms to increase the percentage of renewables in the electricity mix, then considered the costs and benefits of those policies. The results of these studies consistently show that the US can meet a significant share of its electricity needs from renewable resources at a modest cost, while reducing harmful air emissions, easing pressure on natural gas prices, and greatly diversifying the electricity mix.

UCS Renewable Portfolio Standard Analysis

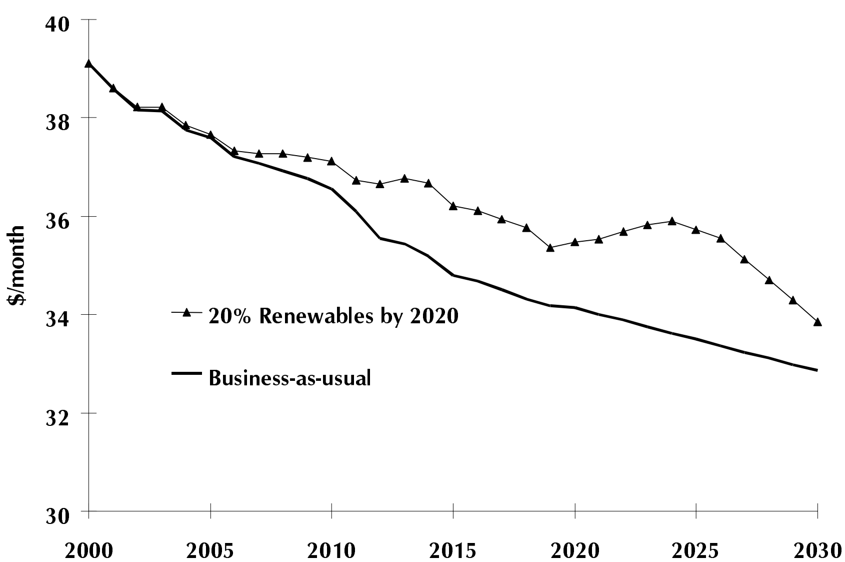
A 1999 study by UCS analyzed the costs and benefits of generating a gradually increasing share of the nation's electricity from wind, biomass, geothermal and solar energy, as proposed in six federal bills.[55] These renewable portfolio standards (RPS) range from 4 percent in 2010 to 20 percent in 2020. The study found that achieving the most aggressive renewables target of 20 percent in 2020 would freeze electricity-sector carbon dioxide emissions at year 2000 levels through 2020 at a modest cost of $18 per ton reduced. By contrast, carbon dioxide emissions are projected to grow 24 percent over the same period under a business-as-usual scenario.

Meeting the 20 percent target would also result in renewable energy development in every region of the country. In particular, the Plains, Western, and Mid-Atlantic states are projected to generate more than 20 percent of their electricity from a diverse mix of renewable technologies. Biomass, wind, and geothermal energy are projected to provide the majority of new renewable generation.

The study also found that the RPS proposals would reduce a portion of the savings consumers are expected to realize from lower electricity prices under a business-as-usual scenario to achieve these benefits. But in every RPS proposal, customers would still be paying less for electricity than they are today. Even under the more aggressive 20 percent RPS, average consumer electricity prices were projected to fall 13 percent between 1997 and 2020, compared with 18 percent without an RPS. This would reduce a typical (500 kilowatt-hours per month) household's expected average electric bill savings of $5.90 per month between 1998 and 2020 under business as usual by $1.33. (figure 10).

The UCS study also showed that increasing renewable energy use would reduce some of the projected growth in natural gas prices for all gas consumers. For example, the 20 percent RPS lowered the projected growth in average natural gas prices by 5 percent in 2020. For the over 50 percent of households that heat with natural gas, gas savings completely offset the slightly higher electricity costs over time. Even with a renewables target of 20 percent, however, total natural gas generation would still nearly quadruple from 1997 levels.

Figure 10. Average Monthly Electricity Bill for a Typical Nonelectric Heating Household



Source: Steven Clemmer, Alan Nogee, and Michael Brower, *A Powerful Opportunity; Making Renewable Electricity the Standard*, Union of Concerned Scientists, January, 1999.

Energy Information Administration RPS Analyses

A 1998 study by the Energy Information Administration (EIA) found that achieving a 10 percent penetration of nonhydro renewables in 2010 would result in a 3 percent higher average electricity price in 2020 compared with a business-as-usual scenario, but the price would still be 17 percent lower than it was in 1996.[56] The study also showed that the RPS would reduce a portion of the average residential household's expected electricity bill savings of about $6.56 per month between 1996 and 2020, due to lower electricity prices under a business-as-usual scenario, by a *maximum* of $2.63 per month in 2020.

However, a close examination of the results revealed major savings for consumers that were not made explicit in the report. First, slightly higher electricity prices under the RPS compared with business-as-usual projections would stimulate investments in energy efficiency, reduce the demand for electricity, and lower consumer electricity bills. Second, by displacing some of the projected growth in natural gas use for electricity generation, the RPS was shown to reduce projected average natural gas prices by 6 percent and lower costs for all gas consumers. Including these effects would reduce the projected peak cost of the RPS from $10.6 billion to $1.8 billion in 2020 and would actually produce a net savings of $1.8 billion in 2010.[57]

The EIA study also found that an

RPS of 10 percent in 2010 would result in a 10 percent drop in projected carbon dioxide emissions and a 8 percent drop in projected nitrogen oxide emissions in 2020 in the electricity sector.

Energy Innovations Study

A 1997 study by UCS and others—*Energy Innovations*—analyzed the impacts of achieving a 10 percent penetration of non-hydro renewable electricity in 2010, as part of a more comprehensive set of policies to achieve a 10 percent reduction in carbon emissions below 1990 levels.[58] Researchers modeled a hybrid renewable portfolio standard/public benefits fund approach, in which funds were raised through a charge of 0.2¢ per kilowatt-hour (¢/kWh) on all electricity sales to "buy down" the projected capital costs of renewable generating technologies to levels competitive with fossil fuels. In addition, no single renewable technology was allowed to capture more than half the market share to spread out the costs among a number of technologies.

The study showed that the RPS reduced carbon emissions 7 percent below projected levels in 2010 at a cost of $26 per ton of carbon dioxide saved.[59] The RPS was also effective in dramatically lowering the cost of renewable technologies, which in turn reduce average electricity prices by more than 2 percent in 2010 and offset much of the higher initial costs. The study also found that combining the RPS with policies to increase energy efficiency would create jobs, produce savings for consumers and the economy, and greatly reduce air pollution.

Department of Energy Five-Laboratory Study

An analysis by a working group of staff from five Department of Energy national laboratories projected that between 40,000 and 80,000 MW of renewable generating capacity could be added to the US electricity mix by 2010 for under $50 per ton of carbon (or about $14 per ton of carbon dioxide).[60] This would increase the market share of renewables by 5 percent to 10 percent of total generation. A $50-per-ton charge is equivalent to adding 0.5 ¢/kWh to the cost of natural gas-generated power and 1.3¢/kWh to coal-generated power.

One conclusion of the DOE laboratories' research is that renewables are necessary for greenhouse gas reductions. "While aggressive energy efficiency and fuel switching can reduce domestic carbon emissions to approximately 1990 levels by 2010, controlling or reducing carbon emissions beyond that date will require greater energy contributions from low-carbon technologies such as renewables."

Chapter 4

Barriers to the Use of Renewable Energy Technologies

Renewable energy technologies have an enormous potential in the United States and that potential can be realized at a reasonable cost. Market research shows that many customers will purchase renewable power even if it costs somewhat more than conventional power.[61] However, both economic theory and experience point to significant market barriers and market failures that will limit the development of renewables unless special policy measures are enacted to encourage that development.[62] These hurdles can be grouped into five categories:

- commercialization barriers faced by new technologies competing with mature technologies
- price distortions from existing subsidies and unequal tax burdens between renewables and other energy sources
- failure of the market to value the public benefits of renewables
- market barriers such as inadequate information, lack of access to capital, "split incentives" between building owners and tenants, and high transaction costs for making small purchases

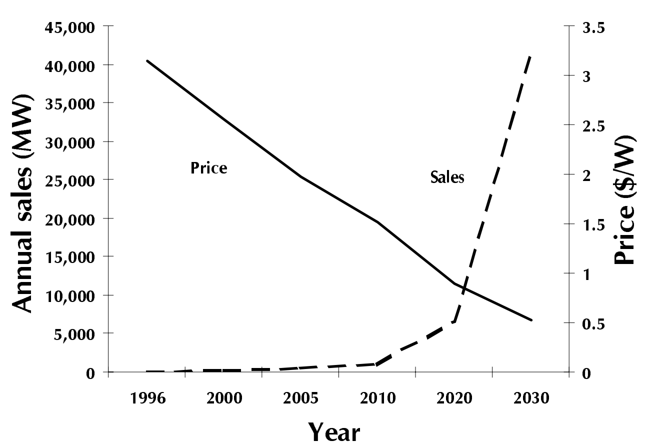
Commercialization Barriers

To compete against mature fossil fuel and nuclear technologies renewables must overcome two major barriers to commercialization: undeveloped infrastructure and lack of economies of scale.

Infrastructure. Developing new renewable resources will require large initial investments to build infrastructure. These investments increase the cost of providing renewable electricity, especially during early years. Examples include

- *Prospecting:* Developers must find publicly acceptable sites with good resources and with access to transmission lines. Potential wind sites can require several years of monitoring to determine whether they are suitable.
- *Permitting*: Permitting issues for conventional energy technologies are generally well understood, and the process and standards for review are well defined. In contrast, renewables often involve new types of issues and ecosystem impacts. And standards are still in the process of development.
- *Marketing*: In the past, individuals had no choices about the sources of their electricity. But electricity deregulation has opened the market so that customers have a variety of choices. Start-up companies must communicate the benefits of renewables to customers in order to persuade them to switch from traditional sources. Public education will be a critical part of a fully functioning market if renewables are to succeed.

Figure 11. Projections of Crystalline Silicon PV Module Sales and Prices



Source: Technology Characterizations, 1997, Residential PV, Table 2.

- *Installation, operation, and maintenance*: Workers must be trained to install, operate, and maintain new technologies, as well as to grow and transport biomass fuels. Some renewables need operating experience in regional climate conditions before performance can be optimized. For example, the optimal spacing of wind turbines is likely to be different on New England ridgelines than on agricultural land in the Midwest.

Economies of Scale. Most renewable energy technologies are manufactured on assembly lines, where mass production can greatly reduce costs. As of the late 1990s, manufacturing costs for photovoltaics had declined 20 to 25 percent for each doubling of production volume, as illustrated in figure 11.[63] The Spire Corporation, which makes assembly lines for manufacturing photovoltaic modules, says that costs for photovoltaic modules can be reduced from about $2.25 per watt to $1.80 per watt merely by scaling up photovoltaic factories so that instead of manufacturing 10 MW of photovoltaics per year, they make 25 MW per year.[64] Economies of scale are also likely to lead to cost reductions for wind, fuel cell, and biomass technologies. Unfortunately, as long as relatively few units are produced, prices will remain high. This leads to low demand, and therefore low production volumes. This chicken-and-egg problem is especially difficult with technologies that have long lives.[65] However, scaling up manufacturing of new technologies too quickly can create its own problems, such as shortages of skilled labor and bottlenecks in parts supplies.

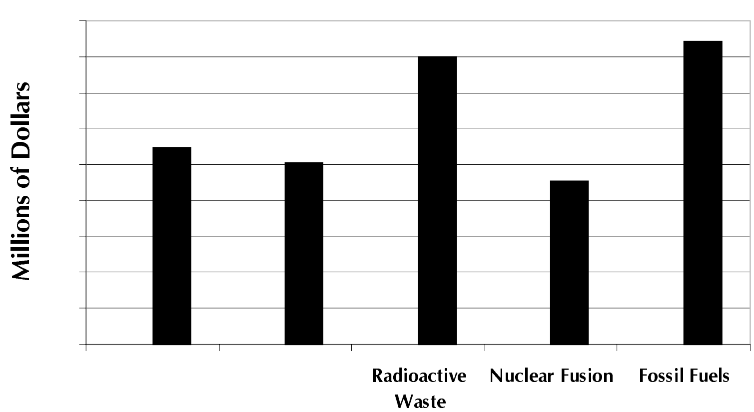
Unequal Government Subsidies and Taxes

Compared with renewables, nuclear and fossil fuel technologies enjoy a considerable advantage in government subsidies for research and development.[66]

- A 1980 Pacific Northwest Laboratory report found that, of $516 billion spent on energy subsidies through 1978, 50 percent had gone to oil, 25 percent to electricity, and 25 percent to nuclear, hydro, gas, and coal.[67]
- A 1992 Energy Information Administration study found that, during fiscal year 1992, direct federal subsidies totaled $8 billion, with renewables (except ethanol for transportation) receiving about one-third as much as coal and less than one-quarter as much as natural gas. Another $3.1 billion in indirect subsidies went to the oil industry.[68]
- For fiscal year 1996, Congress appropriated $422 million for fossil fuels, $227 million for nuclear fusion, $252 million for nuclear fission, $400 million for nuclear waste (only half of which is paid for by nuclear waste fees on generators), but only $273 million for all renewable energy technologies combined[69] (see figure 12).

In addition to receiving subsidies for research and development, conventional generating technologies have a lower tax burden. Fuel expenditures can be deducted from taxable income, but few renewables benefit from this deduction, since most do not use market-supplied fuels. Income and property taxes are higher for renewables, which require large capital investments but have low fuel and operating expenses. A 1996 study by Resources for the Future found that the total tax burden of natural gas facilities is only 0.507¢/kWh (in 1993 dollars), compared with 1.521¢/kWh for biomass generators.[70] Even if the renewable energy production tax credit were counted (no biomass plants had qualified as of 1998), the tax

Figure 12. FY 1996 DOE Energy Budget



Source: "DOE Releases Annual Energy Budget", Public Citizen, March 1996.

burden would be over 50 percent higher than for a natural gas plant.[71] The tax burden for wind energy is approximately as high as for biomass.[72]

A study by the Energy Information Administration found that renewable energy development is further inhibited by a "depletion allowance" for oil, natural gas, and coal suppliers, which resulted in a federal tax revenue loss of $745 million in 1992. The depletion allowance allows companies to deduct the "loss" of fuels that have been mined or drilled.[73] Furthermore, tax law allows fossil fuel producers to write off certain exploration and development costs rather than capitalizing and depreciating them over time. These write-offs, in combination with other incentives, encourage domestic exploration and development. While this has resulted in increased production within the United States and lower oil prices, it may also have both diverted capital from more productive activities, such as energy efficiency investments, as well as constrained the growth of renewable energy.

Market Failure to Value Public Benefits of Renewables

Many of the benefits of renewables described earlier in this primer are public benefits that accrue to everyone—what economists call "public goods." For example, those who choose renewables reduce pollution for everyone and provide an environmental benefit to the public at large. A customer who is willing to pay more for electricity from renewables still has to breathe the same air as the neighbor who might choose not to pay more. Public goods do not motivate everyone who benefits to pay for them, if they can choose to be "free riders" who benefit from the contributions of others.

Employment, fuel diversity, price stability, and other indirect economic benefits of renewables also accrue to society as a whole.[74] For example, for a large industrial customer, it may make more sense to risk moving to another region in response to increases in fuel prices rather than pay more for renewables to stabilize regional prices. While this strategy may benefit the individual firm, it is likely to hurt the region's long-term economic competitiveness. In the same way, firms that can pass on increases in energy costs to customers may also lack an incentive to diversify fuel sources, even though investment in renewables would stabilize prices over the longer term.

Research and development that produces societal benefits, but has little effect on a company's bottom line, will be especially undervalued in restructured markets. Although R&D is likely to continue in a competitive electricity industry, and the desire to provide customer choice is likely to accelerate some innovations, research will probably shift to those areas with the fastest payback and those that allow companies to beat out competitors in the short term. Private funding is likely to dwindle for research with benefits that are primarily public or that do not result in a relatively quick payback, primarily to the funder.

Some research indicates that people will be willing to pay more for public benefits than economic theory would suggest. But investment in technologies where much of the payback does not accrue to the individual making the investment will always be less than the optimal investment for society.[75] Two-thirds of electricity produced is used by commercial and industrial customers. While some of these customers may also pay more for cleaner electricity sources, many will not.[76]

For these reasons, renewables will be unable to compete on a level playing field with conventional generation until new policies are adopted to internalize the public costs of these fossil fuel sources. Emission fees or caps on total pollution, with tradable emission permits, are examples of ways to internalize the costs of pollution, creating a more level arena for renewables. (Such mechanisms are discussed below in Chapter 5.)

Market Barriers

Renewable energy technologies face considerable barriers in market transactions.

Lack of Information. Customers may have insufficient information to make informed choices. Most utilities provide little or no information about their emissions or the fuels they use. Because renewable technologies are relatively new, most customers know little about them. Many customers, for example, may think that solar and wind technologies are unreliable because they are available only when the sun is shining or the wind is blowing. They are unlikely to be aware that these intermittent technologies can be highly reliable when combined with other options.

Institutional Barriers. Commercial and industrial customers are also generally unfamiliar with renewables and have institutional barriers to purchasing renewables. Industrial energy managers are trained only to find low-cost solutions. Industrial environmental managers look for ways to reduce in-house pollution and are unlikely to consider pollution associated with their electricity purchases.

Even local electricity companies may be unfamiliar with renewables. Most utilities have not studied how renewable resources could fit into their systems or what local resources are available. For example, few have investigated how the output of solar and wind technologies matches their system peak load.

Small Size. Renewables projects and companies are generally small. Thus they have fewer resources than large generation companies or integrated utilities. These small companies are less able to communicate directly with large numbers of customers. They will have less clout negotiating favorable terms with larger market players. And they are less able to participate in regulatory or legislative proceedings, or in industry forums defining new electricity market rules.

High Transaction Costs. Small projects have high transaction costs at many stages of the development cycle. For example, it costs more for financial institutions to evaluate the credit-worthiness of many small projects than of one large project. It costs marketers more to negotiate contracts with many small projects, and to market to and sign up residential customers, who are the most likely segment to pay more for renewables.

High Financing Costs. Renewables developers and customers may have difficulty obtaining financing at rates as low as may be available for conventional energy facilities. In addition to having higher transaction costs, financial institutions are generally unfamiliar with the new technologies and likely to perceive them as risky, so that they may lend money at higher rates. High financing costs are especially significant to the competitive position of renewables, since renewables generally require higher initial investments than fossil fuel plants, even though they have lower operating costs. A study by the Lawrence Berkeley Laboratory found that financing costs can greatly affect the price and competitiveness of wind energy, since most of the cost is in capital and little is in operation. The study also found that financing costs for solar panels could result in solar generation prices as low as 15.2¢/kWh for publicly owned utilities and as high as 43.1¢/kWh for a private developer using project financing.[77]

Split Incentives. When renewables are used locally to provide power to individual buildings and businesses through photovoltaics, fuel cells, or small wind turbines, they encounter additional market barriers. Landlords own some of the most cost-effective building sites, but are unlikely to install equipment just so tenants can realize energy savings. And tenants may not have the right to modify the property or the interest in making a long-term investment.

Few utilities consider the full value of distributed generating technologies. A small renewable energy system located in a neighborhood with growing electricity use can help avoid investments to upgrade transmission or distribution lines to the neighborhood. But utility generation planning departments generally consider only the cost of generating electricity with a distributed technology, not the potential savings in transmission and distribution costs. Transmission and distribution planners consider only the costs of alternative transmission and distribution technologies. Because planning is done in separate departments, no one looks at the potential integrated value of a solar module in avoiding all three: generation and transmission and distribution expenditures. Renewable technologies are sometimes cost-effective when this integrated value is considered. In a restructured industry where distribution, transmission, and generation are all in separate companies, planning for distributed generation may be even less likely than previously, unless policymakers provide significant incentives.

Transmission Costs. Renewables may also be charged higher transmission costs than conventional technologies or may be subject to other discriminatory grid policies. For example, a system that requires generators to reserve a block of capacity in advance may force an intermittent generator, like solar or wind, to pay for the maximum output they can generate at any moment. Most of the time, however, an intermittent resource generates at less than its maximum potential capacity. Since a wind farm produces, on average, only about a third of the time, it could have to pay three times more per kilowatt hour transmitted than a conventional plant designed to generate at full capacity all the time.

Another problem is predicting the exact time and quantity of power for delivery, since wind speeds or sunshine can be difficult to predict more than a day or two in advance. The Federal Energy Regulatory Commission recommends a penalty if energy deliveries vary 1.5 percent from scheduled amounts.[78] Remotely located renewable resources may also have to pay heavily in transmission pricing schemes that charge according to distance or in those that charge "pancaked" rates, which depend on the number of utility territories crossed.

Green Market Limits. Given the numerous barriers facing renewables in the competitive market, how big the green electricity market is or could become is uncertain. Some initial signs are encouraging; others are less so. Survey after survey shows strong customer preference for green electricity.[79] Market research also shows distinct market segments of customers interested in buying environmentally preferable products generally. Green markets for other products—including food, paper, cleaners, clothing, computers, furniture, and homes—are also emerging. Of all new products introduced in 1996, 12 percent made environmental marketing claims, according to one market researcher.[80] In some cases, green products have transformed markets; for example, phosphate-containing detergents are no longer available in Europe.

Some electricity choice pilot projects have shown encouraging results. In Massachusetts, for example, 31 percent of residential customers exercising choice in a carefully controlled pilot program picked a product advertised as green.[81] In an Oregon pilot, 15 percent of customers choosing among four options chose a 100 percent renewables product.[82] And some business customers have shown interest in picking green options over the lowest-price options. In Traverse City, Michigan, small commercial customers voluntarily contributed as much money toward a wind turbine as residential customers did.[83] IBM, Coors, and other large industrial customers are participating in a Colorado wind energy program.[84] Toyota has chosen a 100 percent renewables product for its four California offices.[85]

Other signs are less hopeful. Many fewer people actually choose to buy green electricity than say they would if they could. Where utilities have offered "green pricing," no more than 3 percent of all residential customers have participated—in some cases less than 1 percent.[86] One important reason why participation rates have been much lower than survey responses is that people have a strong preference for everyone to contribute to renewables. In an October 1998 poll of Texas Utilities customers, 88 percent said they would be willing to pay more for renewables. However, 79 percent preferred that all utility customers pay at least some of the added costs, whereas only 17 percent wanted to rely only on green-pricing.[87] More importantly, commercial and industrial customers—which use nearly two-thirds of all the electricity that's generated—are more likely to be concerned about price than about the environment.[88]

Newly deregulated markets where customers do not have to choose suppliers may face considerable inertia. Fifteen years after long-distance telephone deregulation, 54 percent of customers have never exercised choice and more than two-thirds are still with AT&T.[89] While environmental factors will induce some customers to switch electricity suppliers, many customers are likely to find the complexity of weighing price and environmental factors more confusing than telephone choices. And, since marketing costs to induce switching are likely to be high, they will probably absorb a substantial part of the green premium customers are willing to pay.

The most optimistic green marketers expect that as many as 20 percent of residential customers and 10 percent of commercial customers will buy green electricity five years after competition has been introduced in a given market.[90] Such results could lead to meaningful new renewable resource development, especially in markets where there are not large amounts of existing renewables that need market support.

However, they would still mean that 80 to 90 percent of customers were not contributing to renewable electricity generation, even though they could be receiving benefits of clean air, fuel diversity, price stability, and increased economic development from renewables. Policy mechanisms are needed to maximize these public benefits, as well as to ensure the development of as robust a green market as possible.

Chapter 5

Renewable Energy Policies—7 Ways to Switch

Existing Policies

Over the years, state and federal governments have taken a number of actions to encourage renewable energy production. Among these were price guarantees, tax incentives, and minimum requirements for renewables. At the federal level, the Public Utility Regulatory Policy Act of 1978 (PURPA) has had the greatest effect in supporting the development of renewable energy. During the late 1990s, as the industry moved toward competition, some legislators have sought to repeal PURPA. Independent energy producers and consumer groups have defended the policy as necessary until the renewables industry is fully competitive. Renewable energy advocates also argue that PURPA should not be repealed until alternative mechanisms are in place to preserve the public benefits of renewables in a deregulated industry.

Federal tax credits for renewable energy technologies have waxed and waned. In the 1980s, investment tax credits for renewables led to some early development. Later, the Energy Policy Act of 1992 (EPAct) extended the investment tax credit for solar and geothermal power, and established a production tax credit of 1.5¢/kWh for wind and for some biomass applications. This credit has been important in sustaining some growth in the wind industry. However, the "closed loop" biomass facilities (see Appendix A for a description) that the legislation supports have remained too expensive to develop, so no facilities have been able to take advantage of the credit. The EPAct production tax credit for wind and biomass expires in July 1999. Efforts are under way to extend the tax credit for wind and to expand the credits to support conventional biomass technologies.

The federal government has also supported research and development for renewables, primarily through federal research laboratories. However, federal spending on R&D for renewable technologies has been far less than for fossil fuel and nuclear technologies, as discussed in Chapter 3.

States have taken a variety of actions to promote renewable energy.[91] Many states have offered tax breaks for renewable energy projects. But these have rarely been effective by themselves since they have usually been set too low to make renewables competitive. Only when combined with other policies have tax breaks succeeded in creating an active renewables market.

The most successful renewables efforts have been in the two states that aggressively implemented PURPA: California and Maine. In the 1980s and early 1990s, California developed almost 6,092 MW of renewables capacity—about 14 percent of the state's generation capacity. Maine developed 855 MW, providing over 35 percent of the state's power plant capacity.[92]

In the 1980s, a number of states adopted integrated resource planning (IRP) policies. IRP regulations require utility companies to consider the mix of demand-side measures (such as investments in energy-efficiency improvements) and supply options that provide electricity at the lowest cost. Some states have considered environmental costs in determining what mix of resources would produce the lowest overall costs to society. Other states, like Wisconsin, passed laws stating a preference for renewable energy sources when cost-effective. IRP frequently led utilities to invest money in energy efficiency programs, because it is often less expensive to reduce energy use by improving the efficiency of appliances, lights, motors, and other end uses than it is to generate the same amount of electricity. But because these policies went into effect during a period when existing electricity capacity exceeded demand, utilities resisted new generation. Consequently, little new capacity—renewable or fossil fuel—was developed. Where new capacity was developed to meet PURPA or IRP regulations, natural gas generators increasingly submitted the low bids and got the contracts. In Texas, however, IRP, together with a process of "deliberative polling" to assess public opinion has led to 43 MW of wind capacity by the end of 1998, with another 75 MW scheduled to come on-line in 1999.[93] Colorado regulators approved an IRP settlement with Public Service of Colorado including 25 MW of wind development.[94]

Some states have required that their regulated utilities build a minimum amount of renewable plant capacity. The largest set-asides have been in the Midwest: Iowa's 1983 law resulted in 105 MW of wind and biomass electricity generation.[95] Minnesota's 1994 settlement with Northern States Power resulted in 425 MW of wind power and 125 MW of biomass. And Wisconsin's 1998 Reliability Act contains a 50 MW renewables requirement. One state utility, Wisconsin Electric, has announced it intends to significantly exceed the requirement.[96]

With increasing wholesale competition, many utilities have actively resisted PURPA, IRP, and set-asides. There is a need for new policies and for reconfiguring older policies to be consistent with restructured electricity markets, if renewables are to compete successfully. Realizing the full potential of renewables to provide public benefits requires either imposing the costs of pollution on those that generate it or providing equivalent support to nonpolluting sources. The remainder of this section describes seven critical ways that can advance renewable energy development in restructured electricity markets.[97]

Renewables Portfolio Standard

The renewables portfolio standard (RPS) is a requirement that a minimum percentage of each electricity generator's or supplier's resource portfolio come from renewable energy. The RPS creates a minimum commitment to a sustainable energy future. It would build on and enhance the investment already made in sustainable energy. And it would ensure that the new electricity markets recognize that clean renewable electricity is worth more than polluting fossil fuel and nuclear electricity. Further, these goals can be accomplished using a market approach that provides the greatest amount of clean power for the lowest price and an ongoing incentive to drive down costs. By using tradable "renewable energy credits" to achieve compliance at the lowest cost, the RPS would function much like the Clean Air Act credit-trading system, which permits lower-cost, market-based compliance with air pollution regulations.

As a minimum national standard, the RPS would not be new or especially notable. US citizens already benefit from similar standards in other sectors of the economy, as table 2 shows. Energy-efficiency standards for buildings, for example, are common in many states and countries. From airlines to cars to drugs, standards ensure public safety, economic health, and environmental protection. Such standards help societies achieve goals or meet needs that might otherwise go begging.

The RPS has garnered significant bipartisan political support. As of December 1998, it has been adopted in five states and is under consideration in a number of others. (See Appendix C for a comparison

TABLE 2

Other Standards Similar to the Renewables Portfolio Standard

Building Energy Efficiency	Many states and over 25 countries require insulation or equivalent measures in all new buildings.
Automobile Fuel Efficiency	Each automaker's fleet of new cars must achieve a certain average fuel economy. Called "CAFE Standards."
Airplane Safety	Uncounted across-the-board rules. A recent rule requires that all passenger aircraft have fire detectors in their cargo holds.
Acid Rain Reduction	All major emitters of sulfur dioxide must own SO_2 allowances equal to their emissions.
Product Safety	Medicines must have child-proof caps. Electronic equipment must meet standards that minimize the chance of electrical shocks or fire.
Food Safety	Standards for packaging, refrigeration, sanitation, labeling, fat content, etc.

of state RPS plans.) In one state, Pennsylvania, individual utility settlements have included minimum renewables requirements for default service—i.e., customers not choosing competitive suppliers. Together with minimum requirements adopted in three states outside of restructuring, these commitments can be expected to preserve approximately 1,500 MW of existing renewables capacity, and lead to the development of 1,700 MW of new renewables (see figure 13).[98]

The RPS has also been included in six separate federal restructuring bills. Appendix C details how states and the U.S. federal government have implemented or proposed to implement the RPS as of December 1998. There is also growing support for implementing a European Union target of doubling the market share of renewables to 12 percent by 2010, with a credit trading system already implemented in the Netherlands.[99]

The RPS has proven politically attractive because if combines the use of a market-based mechanism to solve a "market failure" (i.e., it puts a competition-based price on the "green" in green electricity) with a public policy commitment to a sustainable energy future. State legislators have recognized its economic development and environmental benefits, while a growing number of federal legislators see it as a way and of supporting an emerging domestic industry and decreasing the expense of reducing greenhouse gases.

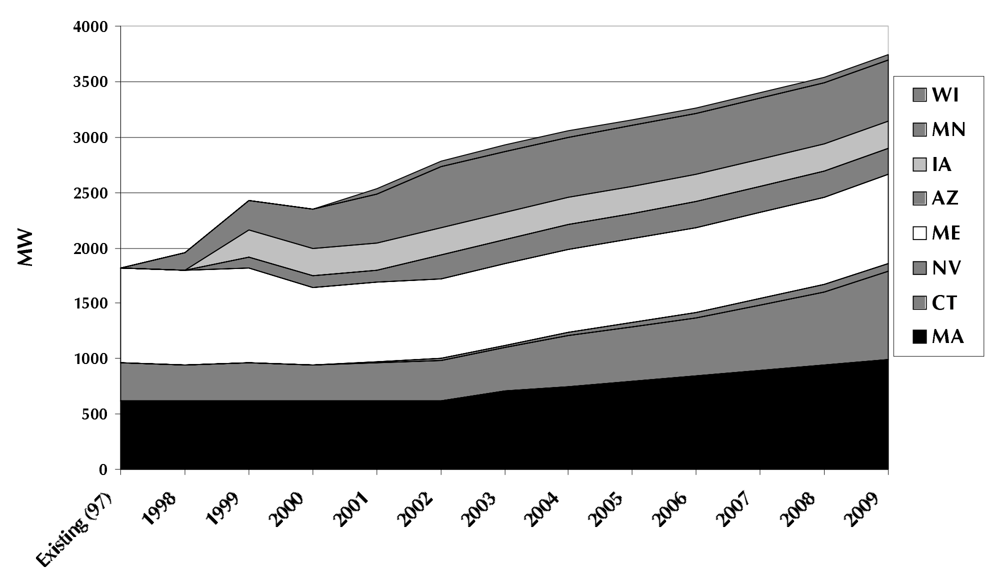
The Elements of the RPS. The renewables portfolio standard includes two elements: a standard that specifies what percent of a utility's electricity must come from renewable resources, and renewable energy credits that the utility acquires as a result of obtaining energy from those renewable sources.

The standard is simple: it requires that a certain percentage of all electricity used in the United States must come from renewable resources. That means every retail provider and generator of power would need to demonstrate once each year that a portion of the power they provided came from renewables. The amounts proposed in state and federal bills vary, but they typically start by preserving existing levels of renewables (around 2–3 percent nationally) and then increase that amount to 4–10 percent by 2010, and in two cases to 20 percent by 2020.

Renewable energy credits (RECs) correct the bias against renewable energy in the electricity market by making sure that renewable generation companies receive payment for the public benefits they produce. The fact that environmental and other benefits are not recognized in the cost of power is the starting point for creating a new commodity that represents those benefits. That commodity is the renewable energy credit.

When a fossil fuel or nuclear power plant operates, it is really creating many products: the electricity itself and all the byproducts, like air and water pollution, hazardous and radioactive waste, the risk of meltdown, and so on. Customers only pay for the electricity. Society pays for the byproducts through a host of unacknowledged costs: health problems, environmental

Figure 13. State Minimum Renewable Energy Requirements



Source: UCS Estimate

degradation, subsidies for oil and gas production, limits on liability for nuclear power plant operators, and many others.

When a renewable power plant runs, like conventional plants it creates electricity, but unlike them it also creates a *reduction* of pollution, waste, and risk. The "byproducts" are cleaner air and water, less waste, reduced fuel imports, and lower risk of catastrophic accidents. When customers buy electricity generated from renewable sources, they pay only for the power and society pays nothing. Renewable energy generators sell *cleaner power*, but are paid only for *power*.

With renewable energy credits, renewables companies will have a new product that represents the *clean*. That is, RECs represent all of the renewable energy benefits that electricity markets ignore, including environmental and energy security benefits. Table 3 outlines the "value" of a renewable energy credit, listing many of the benefits of renewable power that are "free" to society, because nobody is paying for them. But unless someone starts paying for them, many of these generators will go out of business and the benefits will be lost. By turning the value of renewable energy into a commodity traded separately from energy, RECs make that value clearly evident. The renewables premium is no longer hidden in the overall price of a renewable kilowatt hour.

TABLE 3

The "Value" of a Renewable Energy Credit

Consumers typically do not pay for these benefits of renewable energy generation. Renewable energy credits—whose cost all consumers will share—will embody these benefits.

- Less air pollution, water pollution, solid waste, radioactive waste, etc.
- Less exposure to fuel price swings and supply disruptions as a result of multiple fuel sources
- Local economic development
- Technology development benefits, including export potential
- Long-run national energy independence
- Steps toward a sustainable energy system
- A more robust transmission and distribution system as a result of distributed generation

Every unit of renewable energy generated and sold would create one renewable energy credit. A REC could take the form of a piece of paper, like a currency. It would list the number of kilowatt-hours, the year and state of origin, and the type of generation (solar, wind, etc.). Since renewable generation companies produce the power, they would be the original owners of RECs. Electricity providers could purchase these RECs to fulfill their compliance requirements. RECs could also be traded electronically, like stock.

The success of the sulfur dioxide emissions-trading program, instituted by the Clean Air Act, has shown that a systems of allowance and credit trading can be effective, easy to administer, and cheap. The sulfur-trading system works like this: every power generator must meet a certain cap on emissions of sulfur dioxide, a key source of acid rain. To meet the cap, generators can either invest in pollution-control devices (like scrubbers), buy cleaner coal, or buy credits from other generators. If they "overcomply" with the cap—that is, if they stay well under the cap, they can sell their extra credits to generators that would find meeting the cap too expensive.

The RPS applies the same logic to meeting the renewables content standard. A company on the windy Great Plains, for example, may find it easy to overcomply with the minimum renewables content by investing in wind turbines. It can then sell its extra RECs to companies that don't have as strong a renewable resource.

Appendix B provides further details about how an RPS might work, including information about participants, setting the standard, price caps for RECs, as well as how the RPS might interact with current laws and regulations, with public benefits funds, and with "green pricing" measures. Appendix C describes the RPS policies instituted or proposed by state and federal governments as of September 1998.

What the RPS would accomplish. The RPS is designed to ensure the sustained orderly develop–ment of renewable energy technologies.[100] Steady, predictable growth will enable the industry to reduce costs by obtaining lower-cost financing, investing in research and development, and developing infrastructure—from new manufacturing plants to maintenance, repair, and marketing capacity.

The RPS will also reduce renewables prices by using market forces to create competition among renewables developers and providers to meet the standard at the lowest cost. Marketers would have a strong incentive to find the lowest-cost renewables in order to keep their prices down. The RPS will therefore enable those renewables that are most commercially ready—typically wind, biomass, or geothermal technologies—to become an integral part of the electricity market.

And the RPS minimizes administrative judgement in picking winners and losers among renewables developers and technologies. Instead, the market makes those decisions. The policy thus avoids substituting bureaucratic judgement for market discipline and minimizes political influence in determining commercial success or failure.

Public Benefits Funding

Another way of preserving the public benefits of renewable energy is to create a direct funding mechanism for renewables in the restructuring process. Public benefits funding can be provided from fees placed on electricity companies or customers. Such fees are sometimes referred to as "system benefit charges" and are analogous to funding mechanisms created during both long-distance telephone and airline deregulation. A fee on long-distance calls, for example, helps to preserve universal telephone service. A surcharge on all airline tickets helps support airport maintenance and air traffic control. The United Kingdom created a Non-Fossil Fuel Obligation (NFFO) levy to fund renewables when electricity was deregulated there in 1990.[101] Public benefits funding has been proposed to cover not only renewable energy, but energy efficiency programs, research and development, universal service, and other low-income protections.[102]

As of December 1998, seven states have adopted laws or regulations implementing public benefits funding for renewables. (See Appendix D for comparison among states.) Two states, Pennsylvania and New Mexico, have individual utility commitments, with a statewide regulation pending in New Mexico. Collectively, these states have committed approximately $1 billion over the next ten years. Based on extrapolation from California's experience, these funds are likely to leverage around $2 billion in private investment, and lead to the development of over 1,000 MW of new renewables capacity (Note: this figure does not include Connecticut or Massachusetts. For the sake of the analysis, new renewable generation in those states is attributed to their renewables portfolio standards. See previous section).

Such a direct funding mechanism has some unique advantages for preserving the public benefits of renewables. First, funds can be allocated where they are likely to be most effective. For example, they can be directed toward technologies that have great long-run potential, like solar photovoltaics, but that will not be immediately competitive even with other renewables. These technologies will have a difficult time competing for market share even with a Renewables Portfolio Standard. On a state level, funding can be targeted toward resources that provide special benefits to that state. For example, a state with excellent solar resources or with many photovoltaic manufacturing companies could target more of its funding to photovoltaics. A state with wind resources could use the fund for wind resource assessment, collaborative projects to identify and overcome obstacles to siting or permitting, or directly for wind project development.

Second, public benefits funding allows the level of the support for renewables to be precisely defined. Unlike tax credits, which may never be used if not structured appropriately, public benefits funding can assure a minimum level of market activity and renewables development. At the same time, the total cost of the program is limited by the funding levels provided.

Level of the Fund. Ideally, the level of public benefits funding should be set according to the specific objectives of the programs to be funded.

Thus far, states that have passed restructuring measures have generally set funding levels for public benefits programs at about the same level the utilities had provided before restructuring. Some states have reduced funding for energy efficiency somewhat, but increased funding for renewables, on the assumption that the market would stimulate more efficiency investment, especially for commercial and industrial customers.[103]

Restructuring is an opportunity for optimizing the environmental performance of the electricity industry, however, not just an opportunity for preserving funding levels at an arbitrary or historical level. The funding levels adopted in Connecticut and Massachusetts are close to the level UCS had recommended, based on an analysis of commercialization needs for renewable technologies with potential for New England.[104]

Duration of the Fund. Stable, long-term funding levels are especially important for renewables, so that developers can secure long-term financing at favorable rates and manufacturers will consider investing in new plants. The market is likely to continue to ignore the environmental benefits of these technologies until pollution costs are internalized either through emission taxes or fees or through comprehensive pollution caps. Thus indefinite funding periods are warranted. Funding levels should be reviewed periodically based on ongoing evaluations of market barriers to the technologies.

As of September 1998, several states had established public benefits funds for renewables that did not include sunset provisions. Other states, however, set terms of three to five years for both renewables and energy efficiency funds.

Structure of the Charge. Most of the public benefits funds adopted and proposed at the state level charge distribution company customers a fee for each kilowatt-hour of electricity consumed. Such a distribution-related charge is both efficient and fair. The environmental, fuel diversity, and indirect economic benefits of public spending on renewables (and energy efficiency) are related to the energy usage of customers. Customers who use more energy are in effect responsible for causing more emissions, so it is reasonable for them to contribute more to developing and commercializing new clean technologies. Funding to support universal service in electricity and telecommunications has also generally been based on usage. Federal proposals for public benefits funds have also been based on usage, placing the charge on transmission sales, where federal regulators have jurisdiction. Illinois, however, has assessed funding by a flat monthly charge per customer (see Appendix D).

Administering Entity. States have generally chosen either state energy offices or economic development agencies to administer renewables funds. Where state energy agencies have been charged with this duty, they had significant renewable energy development programs prior to restructuring. Designation of economic development agencies to implement the funds reflects an intention to stimulate new renewables business development in those states. Where funds are used primarily for energy efficiency, distribution companies generally retain responsibility—with oversight by the utility commission—for fund administration.

Funding Strategies and Mechanisms. One of the advantages of public benefits funding is the variety and flexibility of options for structuring the funds. Funding can use market mechanisms, such as competitive bidding, or can rely on judgment to determine the most effective applications. Or these approaches can be combined.

One proposed market mechanism is the "auctioned renewables credit."[105] All renewables would bid against each other for financial support from the funding pool per kWh generated, with awards to the low bidders. Like the renewables portfolio standard, this approach would favor those technologies closest to competitiveness. Bidding could also be structured to ensure support for a variety of technologies or to ensure winners within designated technology categories.

California has classified technologies as belonging to one of three tiers based on their competitiveness and has set different levels of support for each tier. The Massachusetts trust fund was authorized by the state legislature to leverage private investment to create a larger pool of capital and to familiarize private investors with renewable energy. Appendix D provides more details about state public benefits funds adopted through 1998.

Many other funding mechanisms are possible. Table 4 illustrates possible applications of public benefit funds for renewables.

TABLE 4.
Possible Applications for Public Benefits Trust Funds

- Aggregate projects that are too small to attract commercial lenders in order to reduce transaction costs
- Provide low-cost financing or financing guarantees where financing is difficult to obtain
- Provide equity financing, grants, production incentives, or buydowns of a portion of a project's cost
- Build infrastructure and reduce development costs, such as siting studies for wind farms
- Develop uniform standards for siting, permitting, and connecting with the electricity grid
- Familiarizing potential customers with the benefits of renewable technologies
- Provide incentives, such as rebates or bill credits, to establish markets for new and unfamiliar products
- Directly fund installation, operation, and maintenance of renewable energy technologies

Funding could also be used to support renewable energy business development directly. (Indirectly, of course, any funding for renewables will provide some company support.) Funding for installation, operation, and maintenance of renewable energy technologies will generally bolster local businesses where the renewable energy is consumed. The Sacramento Municipal Utility District used a request for proposals to encourage establishment of a local facility to manufacture photovoltaic panels. Since the objective of any renewables support should be to create a self-sustaining industry, fund managers may also want to consider involving commercial financing institutions as partners.

State funds must be structured with federal opportunities and regulations in mind. Fund managers must be careful that state funding mechanisms do not prevent projects from also obtaining federal tax credits.[106] And funds must be structured so as not to run afoul of the US Constitution's Commerce Clause, as might happen if funds from a fee placed on electricity were to advantage in-state businesses over out-of-state competition.[107]

Net Metering

Electricity customers seeking to install renewable energy generators, like solar panels or small wind or hydro turbines, at their own buildings often face a daunting array of barriers. Some utilities have imposed expensive requirements for interconnecting with the utility grid, required separate meters for measuring the output of the renewables, and have paid little to buy back any surplus electricity generated in surplus of the customer's needs.

Under these conditions, installed systems would likely be sized not to exceed building electricity use, even when the sun or wind is at its peak. Thus, a building would be unable to use the renewable system for more than a small fraction of its overall electricity use, since there will be many hours when the sun won't be shining or the wind blowing. Fixed interconnection and metering costs would make such small systems expensive and less cost-effective.

One simple policy to overcome these barriers and encourage direct use of renewables is called "net metering" or "net billing." This policy allows customers who produce more electricity than they are using at a given moment to feed the surplus directly into the grid and run their single electricity meter backward. The customer is billed only for the net electricity consumed. In effect, the customer is trading surplus electricity to the utility at the same rate the customer buys electricity from the utility. In some cases, net billing is calculated over an entire year. Customers that produce more power than they consume over the billing period must usually sell the surplus power back to the utility at the wholesale market price.

With net billing, it makes sense to size the renewable system closer to the average use of the building. The overhead expenses of installing, reading, and billing for a separate meter are avoided. The renewable investment becomes much more cost-effective.

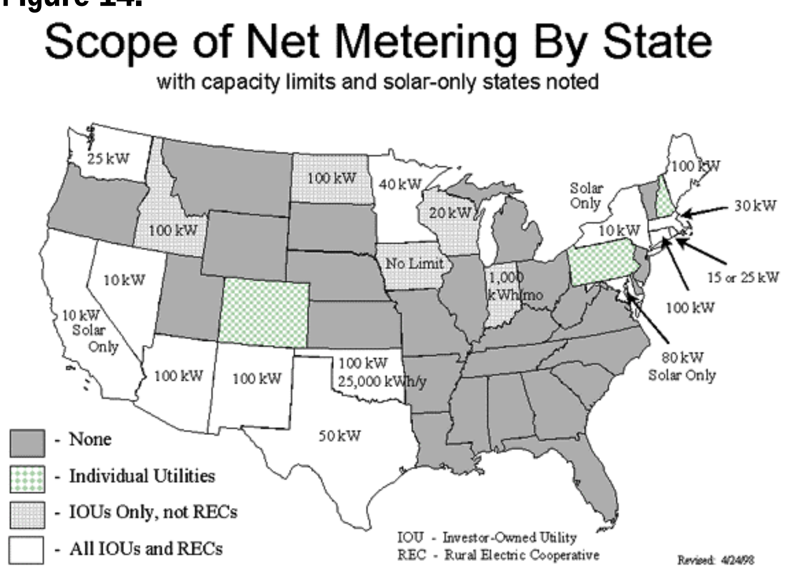
Net metering can mean some revenue loss for the utility. Individual renewables systems are still expensive enough, however, that they are not likely to be used by many customers and are unlikely to have much overall effect on utility revenues. An analysis of net metering in California found that the savings to the utility from avoiding the extra meter reading and billing would be about the same as the revenues lost from net metering.[108] Net billing can provide additional benefits to utilities, by encouraging distributed generation. (See section on Fair transmission and distribution rules.)

Concerns about revenue losses to utilities could be addressed by placing a cap on the number of eligible customers. In California, a limit of 0.1 percent of the peak electricity demand of each utility was deemed eligible for net metering. While this limit is small, it still allows for considerable expansion of the number of customer-owned renewable facilities. California, Maryland, Vermont, New Hampshire, Washington and New York adopted net metering during 1996–1998. Maine, Massachusetts, and Rhode Island reaffirmed their net-metering policies under restructuring regulations. Despite a challenge from its utilities, Maine broadened its net metering policy, moving to yearly averaging for net billing.[109] As of 1998, at least 21 states have allowed net metering by law or regulation. In two other states, utilities have voluntarily implemented net metering programs (See figure 14 and Appendix E).[110]

Many states adopted net metering as part of implementing federal PURPA standards. With repeal of PURPA under consideration at the federal level, inclusion of net metering under state legislation, enacted with or independent of restructuring, could put net metering on a more stable footing.

In October 1998, however, the Mid-American Energy Company, in Iowa, challenged that state's new net metering statute at the Federal Energy Regulatory Commission. The utility argued that net metering constitutes a forced purchase of electricity at a set price, a practice FERC has previously prohibited.[111] Environmental and renewable energy advocacy groups have intervened to defend net metering as sound policy falling squarely within state, rather than federal jurisdiction.

Figure 14.



Source: Yih-huei Wan and H. James Green, NREL , *Current Experience With Net Metering Programs,* WINDPOWER '98*, Bakersfield*, CA, April 27 - May 1.

Fair Transmission and Distribution Rules

Some have argued that a revolution in the way we make and move electricity is developing. New generation technologies—like fuel cells, photovoltaics, wind turbines and natural gas microturbines—are available in small modular units that can be sited in, on, and around buildings where power is used. Many "distributed" technologies also create waste heat that can be easily used on the spot for water and space heating, boosting their efficiency. These distributed technologies already offer an economical alternative to building large central station power plants and new power grids in remote areas that do not have transmission and distribution (T&D) systems. As the prices of the new technologies fall, they may completely reshape existing power networks as well. As discussed in Chapter 1, distributed generation technologies can provide substantial non-traditional benefits to utilities and their customers.[112]

Recognition of the added value that distributed technologies can provide can be critical for new technologies entering the market. UCS's 1995 Renewing Our Neighborhoods study looked at the Boston Edison service territory and compared the cost of upgrading the aging transmission and distribution system in certain neighborhoods with the cost of installing renewable technologies. Even though renewables tend to be higher priced than central station power, UCS found that some renewable technologies may already be cost-effective in areas where particularly expensive transmission and distribution investments can be avoided.[113] Studies in other parts of the country have found similar results.

In a study of potential early markets for solar photovoltaics, the Utility Photovoltaic Group found that the potential US market for photovoltaics at a cost of $3 per watt is as high as 7,630 MW for distributed power applications, compared with 1,130 MW for the potential "green market" at this price.[114] Of course, photovoltaics is not likely to capture most or all of the potential distributed market. It must compete with other distributed technologies which can provide "distribution services." These include distributed electricity storage, such as batteries, and demand-side management technologies, such as energy efficiency investments, which can reduce demand in targeted regions or neighborhoods, extending the usefulness of existing distribution equipment.

Because many renewable energy technologies operate intermittently when the sun is shining or the wind blowing, there are added difficulties in valuing their output fairly. Traditionally, the reliability value of an electricity generator is based on the maximum output that can be turned on, or "dispatched," by the system operator, especially during periods of peak electricity demand. Because individual renewable generators may not be dispatched at will, and cannot be guaranteed to be available during peak times, they have frequently been assumed to have zero reliability value.

There is often, however, a relatively consistent relationship between the output of an intermittent renewable and the level of electricity demand over time. Solar output, for example, tends to be high on mid-afternoon on hot sunny days, which is often when air conditioning use is also high. Utilities have long used statistical methods to allocate costs to classes of customers based on a tendency to use electricity more during high-cost vs. low-cost periods. Similar methods can be used to allocate benefits to intermittent generators based on a tendency to produce electricity during high-value or low-value periods.

Few utilities have closely examined the reliability value of intermittent renewables for their systems. Fewer still have looked at the potential value of renewables in reducing peak demand on their distribution systems. Because the mix of customers and the times they use electricity may vary greatly from one neighborhood to another, the value of intermittent technologies in deferring or avoiding transmission or distribution expenditures may vary greatly from location to location.

In order to realize distributed technology benefits, however, electricity distribution companies must value distributed technologies fairly and be willing to invest in them or encourage their customers to invest in them when they can reduce system costs. Traditional cost-plus regulation has not necessarily encouraged least-cost distribution planning. Also, because methods to value distributed generation in planning distribution systems are new, few utilities have yet adopted them. Utilities are beginning to show greater interest in distributed resources, however.[115]

A restructured industry presents new opportunities and barriers for distributed generation.[116] A more competitive industry is likely lead to specific identification of cost centers and profit opportunities. Location-based transmission or distribution rates, which would be higher where there is congestion, could lead to generation being sited in areas where it has greater value. Independent companies that could profit from providing distributed generation services would have a strong incentive to seek out potential opportunities.

On the other hand, the separation of vertically-integrated utilities into separate functional units or separate companies providing generation, transmission, distribution, and retail marketing services may make it harder to identify the integrated value a distributed technology provides in each of these areas. It is uncertain which market players will have the resources and incentives to make the investments to avoid a combination of generation, transmission, and distribution costs faced by other market players. A transition to location-based distribution pricing, where separate distribution prices would be charged to different neighborhoods based on local costs, would raise significant equity issues. Residents in a neighborhood with aging distribution facilities (who shared the cost, under regulation, of upgrading distribution facilities in other neighborhoods) may well resent seeing distribution price increases designed to induce local distributed generation.

And just as some utilities have avoided investing in new power plants that risked making existing power plants economically obsolete, some companies may resist distributed technologies that could compete with their existing transmission and distribution investments. In many cases, therefore, legislators or regulators may need to establish appropriate rules and incentives.

Many states that have shown some interest in these issues have been preoccupied with overall industry restructuring. There is therefore little experience to draw on at this time.

Connecticut and Massachusetts have addressed distributed technology issues in their restructuring processes. Connecticut's restructuring law requires "demand-side management" expenditures to be considered as alternatives to distribution expenditures. Demand-side management generally refers to technologies to reduce electricity demand, like energy efficiency investments, or to methods that shift demand from one period to another. Distributed generation technologies installed in customer buildings also reduce the system demand for electricity, however, and could be included in regulations developed to implement the Connecticut law.

In Massachusetts, the Department of Telecommunications and Energy has stated that distributed generation will be considered as part of performance-based ratemaking proceedings. This policy, as an alternative to cost-of-service regulation, seeks to induce utilities to reduce costs and improve performance by linking incentives to specific performance measures.

Performance-based ratemaking in Massachusetts and elsewhere has generally been implemented with a price cap. Under a price cap per kilowatt hour, distribution companies have an incentive to sell more kilowatt hours to increase total revenues. Price caps provide disincentives to reduce sales through distributed generation or energy efficiency investments. In contrast, under a revenue cap, total company revenues are fixed, and a company does not lose revenues from distributed technology investments. Prices are adjusted periodically to make up for any unanticipated revenue shortfalls or surpluses. Therefore, a company does not lose revenues or profits if it encourages reduced electricity demand through energy efficiency or distributed generation. Oregon has adopted a revenue cap.[117]

In California, environmental organizations and renewables companies have petitioned the Public Utilities Commission to establish distributed generation regulations. As of November 1998, however, no formal action on the petition had been taken.

One way of ensuring appropriate investment in distributed technologies would be to require regulatory review of transmission and distribution planning decisions. Such planning reviews would be analogous to "Integrated Resource Planning" (IRP) for generation, extended to the distribution planning level. Investments in the distribution system would be reviewed to ensure they have invested in the mix of demand-side and supply side options that provide electricity at the lowest cost.) While there has been a trend to reduce IRP regulatory review in favor of increasing competition in generation, it may be appropriate to retain it for regulated transmission and distribution companies.

Distribution IRP would be somewhat more complex than generation IRP. Generally, however, companies will be planning major transmission or distribution investments in only a few areas at any given time, thus limiting the complexity of the review. One potential model for distribution-level IRP has been developed for the Boston Edison Demand-Side Management Settlement Board.[118]

One way to insert distributed generation into the planning process would be to require distribution companies to competitive bids for distribution services where new investment is required. Distributed technology providers could then compete against traditional equipment upgrades. Another approach would be for the system owner to offer incentives for distributed generation in specific parts of the system that are weak or overtaxed.

One important issue likely to affect utility activities in distributed technology is whether they can own distributed generation.[119] Distribution company ownership of these technologies raises antitrust and anti-competitive concerns. There has been some concern that allowing utility ownership could undermine the development of distributed generation by seeking to be monopoly providers of distributed generation technologies. On the other hand, allowing ownership of distributed generation provides them with an incentive to become active in this area. Massachusetts has explicitly allowed distribution companies to own distributed generation.

Transmission Rules. Renewable energy generators' unique characteristics pose challenges to designing fair transmission rules and prices. Renewables generators must be located where the natural resources are, and sometimes must be transmitted long distances. The intermittent output and low capacity factor of some renewables creates operational issues for the transmission grid (i.e., having backup capacity if the wind suddenly stops blowing) and pricing issues similar to those covered above with distributed generation.

In 1996, the Federal Energy Regulatory Commission (FERC) Order 888 required utilities to make transmission available to all generators and customers.[120] FERC has also encouraged the formation of Independent System Operators (ISOs), groups of multiple stakeholders to control the operation of the transmission network. These developments should increase renewables generators' access to customers. It should also reduce multiple transmission charges, known as "pancaking," when power is transmitted across more than one utility system and each utility exacts a toll.

Transmission service is typically specified as firm or nonfirm, with nonfirm service more interruptible in cases of transmission constraints. FERC did not specify how transmission prices should be set, but proposed that all firm transmission service be based on reservations of transmission capacity made at least one day in advance. Generators would pay for reserved transmission whether or not they used it. They would be subject to penalties if they exceeded or fell short of their reservation by more than 1.5 percent.[121]

This requirement would heavily penalize intermittent generators like wind and solar, where it is hard to predict output accurately a day in advance. If it turns out to be windier than predicted, and not enough transmission capacity is reserved, the wind generator could be unable to sell all the electricity generated. If it were less windy than expected, the generator would be stuck paying for unused transmission. Ideally, generators would be able to resell reserved transmission capacity that they could not use, but this secondary market has not really developed. Renewables generators would have to resell transmission capacity at the last minute, making it unlikely they would get a good price, and transaction costs would be high. Renewables generators could, however, bundle their output together with power sources that can be turned on and off as needed, such as gas turbines. But requiring such bundling would reduce generator and marketer flexibility and might raise total costs.[122]

Generators could also buy non-firm transmission service without a reservation. However, buyers of non-firm service can have their transmission interrupted if the lines get congested. And lenders may charge higher financing costs if renewables generators do not have firm transmission contracts.[123]

The formation of ISOs, with multiple stakeholders, has created pressure for more flexibility and options in transmission service, which may benefit renewables. ISOs that include power exchanges—spot markets for electricity sales—plan to charge spot market prices for transmission that is higher or lower than scheduled amounts, for example. California is currently operating in this manner.

However, as of the end of 1998, most ISOs are still in the process of formation, with their makeup, governance, rules and pricing still under development. The ISOs in formation generally do not include power exchanges.[124]

Some early ISO proposals have some negative implications for renewables. A Southwest proposal would require generators who want nonfirm transmission service to have backup reserve capacity. A New

England ISO proposal would impose "nonusage" charges for both firm and non-firm transmission services.[125]

Another transmission issue affecting renewables is the pricing of "ancillary services" needed to maintain system reliability, such as reserve generating capacity to compensate for plant outages. The wind industry has supported continued cost-based regulation of these services by FERC, although some analysts suggest that market-pricing may provide more flexible services for renewables.[126]

Some ISOs have proposed "postage stamp" rates—one price for transmitting power from anywhere within a region to any other point within the region. Others have proposed "megawatt mile" charges that vary with distance. Congestion charge proposals also vary. The impact of these proposals will vary with specific renewables projects. Generally, transmission costs do not increase linearly with distance, so loading all transmission charges onto a megawatt mile may not treat remote projects fairly. Having many small "postal zones" could have a similar or worse effect, however.

An analysis by the Lawrence Berkeley Laboratory (LBL) shows charging for unused transmission capacity can raise the cost of the entire electricity system. LBL developed a two-tier pricing system, which bases transmission access charges on energy transmitted and congestion charges on capacity reservations. The access charges would be used to cover fixed costs—80 to 90 percent of network costs. LBL shows that this pricing scheme would lead to a least-cost technology mix, as well as reducing the penalty for intermittent renewables, without creating a special condition for them.[127]

Fair Pollution Rules

One of the main goals of utility restructuring is to increase competition in electricity generation. With increasing competition, investment decisions will be guided by market forces. Investors will bear risks they were often insulated from under regulation, such as investing in generation that turns out to be unneeded or uneconomical.[128]

To an extent, investors will bear added environmental risks in a more competitive industry. With evolving environmental regulations, investors in a polluting technology must assume the risk that newly requirements for cleaning up emissions could make their plant less competitive in the future.

There are two major reasons, however, that market forces will still lead to investment decisions that are uneconomic and that harm the environment. First, as discussed in Chapter 1, damage from pollution produces external costs to society at large rather than directly to the investors in the polluting plant or the consumers who buy electricity from the plant. Neither investors nor consumers have the incentive to make decisions that would mean the lowest total costs for everyone, and overall economic efficiency will not be achieved unless policies are implemented to recognize the "externalities."

Second, under current environmental regulations, some plants are allowed to emit more pollutants than other plants. Plants that are allowed to emit more pollutants will have lower costs for pollution controls or for mitigation, so they can operate less expensively than plants facing tougher pollution limits. To the extent that some of these cheaper, dirtier plants are not used to their full capacity before markets open up, they could sell more electricity and increase total pollution.

Under the Clean Air Act of 1970, existing power plants were exempted from meeting emission requirements placed on new power plants. The "grandfathering" exemption was continued in the Clean Air Act Amendments of 1977 and 1990. The main reasons for exempting older plants appear to have been that installing pollution controls would be more expensive for older plants and the belief that existing plants were likely to be retired and replaced by newer, cleaner plants over time.[129]

Instead, most older coal plants have continued to operate. New "life-extension" technologies allowed older fossil plants to continue operating at a lower cost than building new plants. Now fully a quarter of the nation's fleet of fossil and nuclear plants are more than 30 years old, with some coal plants dating back more than 50 years.[130]

The correlation between age and emissions is not perfect—there is, with a number of old plants polluting less than some newer plants. But some older coal plants emit up to five times as much sulfur dioxide (SO_2) as any post-1975 plant, for example. On average, coal plants built before 1976 emitted more than twice as much SO_2 and almost twice as much nitrogen oxides (NO_x) as newer plants in 1996.[131]

The disparity in emissions leads to distortion in the electricity market price. According to an analysis by Synapse Energy Economics, if older plants had to clean up emissions of SO_2 and NO_x to the level typically required of new plants, the average cost of operating and maintaining the existing coal plants would increase by nearly 1 cent per kWh, from 2.1¢ per kWh to almost 3¢ per kWh. The total added costs for emission controls on each plant would by $9.2 billion per year, although market mechanisms such as fuel switching, improving efficiency, or allowance trading could reduce these costs. Total emissions of both NO_x and SO_2 would be reduced by about 75 percent.[132]

Under this scenario, about 6 percent of coal-fired generation would become uneconomical compared with natural gas generation.[133] There would be little effect on CO_2 emissions, because most of the emission reductions would come from pollution controls instead of switching to cleaner fuels. Under a scenario that also includes a tax of $10 per ton of carbon dioxide (CO_2), however, almost a third of current coal generation would be unable to compete with new natural gas plants, unless the coal plants could reduce costs or improve efficiency.[134]

The carbon tax scenario illustrates the benefit of reducing multiple pollutants simultaneously, instead of one after the other. If no consideration is given to carbon reductions along with SO_2 and NO_x reductions, billions of dollars could be invested installing pollution controls on coal plants that could become uneconomical if subsequent reductions in carbon emissions are required. If limits on CO_2 were are put in place along with SO_2 and NO_x reductions, then an integrated emissions reduction strategy could take advantage of opportunities for replacement by cleaner generating sources—achieving total emissions reductions at lower cost.

The 1 cent per kWh disparity in costs between the average operating costs of older coal plants and what it would cost to meet emission standards for new plants underlies the danger that deregulating electricity generation could lead to greater overall emissions. Utilities or customers could seek to buy power from cheaper, dirtier plants within a region or from outside it.

An analysis by the Federal Energy Regulatory Commission concluded that open electricity markets would not significantly increase pollution. FERC therefore declined to require environmental mitigation in its Order 888 opening up wholesale markets. The FERC analysis did find, however, that under some conditions, pollution from midwest plants could increase by more than 30 percent by 2010, an increase greater than all the pollution currently emitted by northeast plants but FERC attributed most of the added emissions to increasing competition and sales that would occur even without Order 888.[135]

FERC's analysis was criticized as underestimating potential pollution increases by environmental groups, northeast environmental regulators and governors, and the US EPA. Perhaps most importantly, even in its worst case, FERC assumed that transmission constraints would greatly limit exports of coal generation from the Midwest. Increasing market activity could lead to investments in improving transmission efficiency or increasing capacity however. A preliminary analysis by Northeast environmental regulators found that net power exports in 1996 from one large Midwest utility exceeded FERC's high-case projection for the entire Midwest for year 2000, and that generation increased at a number of high-polluting Midwest coal plants. [136]

The EPA took important steps in 1997 and 1998 to tighten emission regulations which should reduce emission disparities. They revised standards for ozone and particulates and established NO_x "budgets" for 22 midwestern and eastern states assumed to contribute most to polluting downwind neighbors, requiring all plants to average meeting "new source" standards during the peak ozone season. These measures are not expected to eliminate the disparities and will not take effect until after 2003 for the NO_x budgets, and even later for the new ozone and particulate standards.

Several mechanisms have been proposed to further reduce or eliminate these inequities in allowed pollution levels:

- emission performance standards
- cap and trade regulations
- emission taxes and fees

Emission Performance Standards. There are several variations of proposals to establish comparable emission standards for all electric generators, eliminating the disparities between plants of different ages or in different locations. Uniform standards could be applied to the average of all plants owned or controlled by a company, or to each plant or boiler individually. In certain respects, application to each boiler or plant would be simplest and, importantly, would provide emission reductions to all communities near power plants. But this approach would also be less flexible and more expensive than allowing averaging or trading among plants, and states could probably not be apply their standards to out-of-state plants. Applying standards to individual fossil plants or boilers would also not create incentives for companies to reduce emissions by incorporating more renewables into their mix.

Connecticut and Massachusetts, in their restructuring laws, both adopted emission performance standards for the generation portfolios of retail suppliers serving customers in those states. These laws apply to the overall mix of power plants, including imports from outside the region.

The Massachusetts law requires the Department of Environmental Protection to study emission performance standards for all harmful pollutants, with standards for at least one pollutant to be in place no later than 2003. If another state adopts standards before 2003, Massachusetts may emulate those.

Connecticut required its Department of Environmental Protection to establish standards by the end of 1998 for sulfur dioxide, nitrogen oxides, carbon dioxide, carbon monoxide, and mercury. However, the standards are not to go into effect until three northeast states with a population of at least 27 million people (i.e., Connecticut, Massachusetts, and New York) have adopted the same standards.

A Vermont bill, which has passed the state senate, would establish portfolio requirements for all significant environmental impacts.

Because they are applied to retail supplier portfolios, emission performance standards are similar to renewables portfolio standards. Additional incentives can be created for renewables, and potentially for energy efficiency investments, by allowing suppliers to include those resources in their portfolios as a means of lowering overall portfolio emissions.

Cap and Trade. Emission caps are limits on the total amount of emissions of a particular pollutant in a region or nationally. The Clean Air Act Amendments of 1990 created a national cap for utility sulfur dioxide emissions of 6.3 million tons per year (about half of 1980 levels), covering 110 of the largest sulfur dioxide emitters. In the year 2000, Phase 2 of the amendment will expand the program to hundreds of smaller fossil fuel plants and change the cap to 8.95 millions tons per year. The EPA is also considering another reduction in the cap in the year 2010.[137]

To meet the caps, utilities can trade emission allowances or credits. Allowances are permits that allow an electric generator to release an air pollutant. If a utility overcomplies with emission limits, it will have excess credits that it can sell to other polluters, providing an incentive for companies to reduce emissions below mandated levels.

Currently, a national market for tradable permits is in place for sulfur dioxide emissions. Thirteen states have trading mechanisms for volatile organic compounds or NO_x credits, and the EPA has encouraged the 37 easternmost states (known as the Ozone Transport Assessment Group or OTAG) to establish a cap and trading system for NO_x.

Regional "cap-and-trade" programs could be implemented through the new entities that control utility transmission systems, called independent system operators or ISOs. Richard Cowart, chair of the Vermont Public Service Board, has proposed that any generator that wants to sell power in a region would have to earn or buy enough emission allowances to gain access to the transmission system.[138, 139] Generators with high emissions would have to buy credits from those with lower or no emissions. Those with low emissions would earn credits, gaining access for low or no cost. The ISO would dispatch generators so as to avoid exceeding a regional emissions cap.

Cap-and-trade programs can be very economically efficient. The national SO_2 allowance trading system has been widely credited with producing emissions reductions at a cost far lower than almost anyone anticipated.[140] Cap and trade programs are good solutions when they can be implemented over a geographic area affected by specific emissions. For CO_2, which affects warming over the entire globe, an international cap and trading program is appropriate. But for emissions with localized impacts, such as toxic metals, trading programs could produce heavily impacted local areas. Trading programs cannot be easily applied by a state to out-of-state sources.

Cap-and-trade programs require a fair means for allocating allowances among generators. The national SO_2 trading system has been criticized for awarding allowances based on historical emissions, rewarding high emitters and penalizing low emitters and new market entrants, which receive no allowances and must buy them from the market. Also, apart from a pool of 300,000 bonus allowances created for energy efficiency and renewables, these resources do not create additional credits or allowances for independent developers. Renewables generators receive no direct benefit for their potential emission reductions.[141] The reduction in fossil generation from the added renewables could allow fossil generators to save allowances to pollute more in the future, or even to increase their pollution rate, say, by burning a cheaper, higher sulfur fuel, while still leaving total emissions within the cap.

In early 1998, the EPA proposed NO_x trading in the OTAG region using a "fuel-neutral" approach, in which allowances would be awarded to kilowatt hours generated by any source. While such an approach would earn credits for renewables, it would also reward nuclear generators. Many environmental organizations objected to nuclear generation, with its unique environmental impacts and risks, being allowed to earn the same credits as renewables and being provided with a substantial cash windfall. The EPA subsequently dropped the proposal.

One solution would be to award credits only to fossil generators and to efficiency and renewables. Another might be to award credits to new non-fossil generation, to avoid providing windfalls to existing sources, but stimulate the development of new projects. This approach could, however, lead to a reduction of existing renewables generation. Auctions of allowances or other allocation schemes are other potential approaches.

On the federal level, cap and trade provisions for SO_2, NO_x and CO_2 were included in the restructuring bill filed by Sen. James Jeffords (R-VT). Rep. Frank Pallone (D-NJ) has introduced a bill with caps on SO_2 and NO_x. Rep. Dennis Kucinich (D-OH) would also cap CO_2, mercury, and nuclear waste. A bill sponsored by Rep. Edward Markey (D-MA) would direct the Administration to issue a rule preventing any competitive advantage from grandfathered emission standards. The Administration bill clarifies the existing authority of EPA to create a cap-and-trade program for NO_x.

Emission Taxes or Fees. A third approach to reducing emissions and emission disparities would be to assess a tax or fee per ton of pollutant emitted. Emission taxes are generally the preferred approach of economists and many environmental organizations for internalizing pollution costs efficiently.[142] They allow producers complete flexibility in whether and how to reduce costs. They require producers of the unwanted pollution to consider the risk of increases in pollution taxes if more stringent environmental goals are needed in the future. Conversely, mechanisms that provide special benefits to clean energy producers generally lead those producers to consider the risk that those benefits will be reduced or eliminated in a changing political climate.

One revenue-neutral method proposed for eliminating the disparity between old and new plants would be to assess emissions from existing sources sufficient to compensate owners of new power plants for their higher costs of meeting the more stringent new source standards. This method might not, however, actually lead to desired emission reductions in old sources.[143]

While sometimes favored in other countries, emission fees or taxes have proven difficult to implement in practice in the United States, at least on air emissions.[144] Proposals for pollution taxes have been introduced in state legislatures in Minnesota, Vermont, and Wisconsin.[145]

Customer Information.

In survey after survey, people say they would prefer to receive electricity generated by clean and renewable energy technologies, and are willing to pay more for it (see figure 15).[146] Thus allowing customers to choose their electricity suppliers will provide new opportunities for renewable energy technologies. But for those opportunities to be realized, customers will need reliable information.

A primary barrier for any new technology entering the marketplace is consumers' unfamiliarity with it. Renewables in a competitive market face a triple barrier. First, customers do not know what sources are used today to generate their electricity, and what their environmental impacts are. Second, many customers are unfamiliar with renewable energy technologies, and may have misleading impressions of their performance. Third, customers are unaccustomed to any choice of electricity suppliers, and will be unfamiliar with many of the companies offering new energy choices in the marketplace.

Disclosure Label. Customers are not well-informed about how their electricity is generated. People generally overestimate how much of their electricity comes from renewable sources and underestimate how much comes from polluting fossil fuel and nuclear sources.[147]

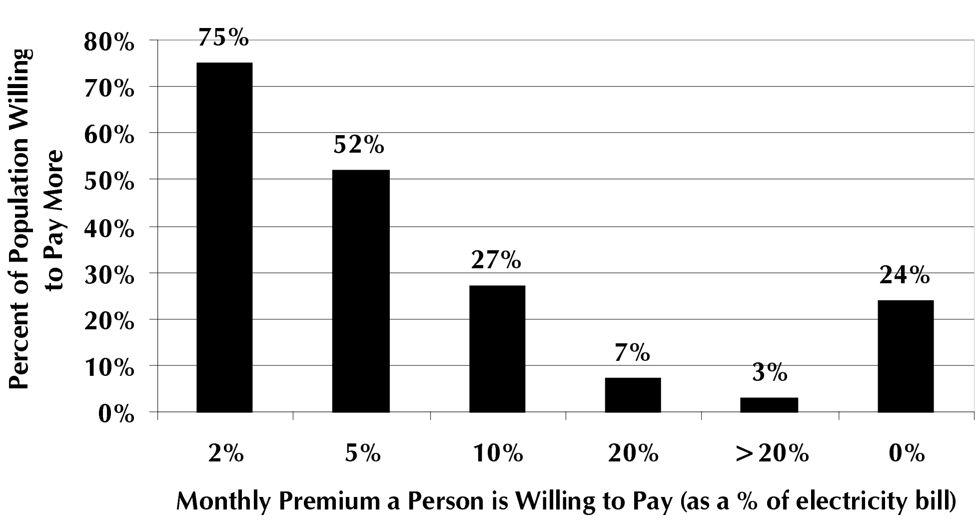
To make sure that customers have the information they need to compare electricity products, the National Association of Regulatory Commissioners and others recommend that electricity suppliers be required to label their products.[148] These "disclosure" labels would be analogous to the label providing uniform information about the nutritional content of food products. Research for the National Council on Competition in the Electricity Industry found that—to make effective choices—consumers want and need labels showing standardized information about price, fuel mix, and emissions, similar to the labels for ingredients in food.[149]

The New Hampshire retail choice pilot program, which did have disclosure requirements, illustrated the importance of providing uniform information on the environmental characteristics of energy choices. Suppliers made a wide variety of confusing environmental claims, some of which were misleading. For example, one company touted electricity from its clean hydropower plant. It did not disclose that the plant was a pumped storage facility, at which coal and nuclear energy are used to pump water into a storage reservoir during the night.[150]

Disclosure labels must be uniform, simple and easy to understand. Figure 16 shows a format for the label developed by the Regulatory Assistance Project, based on considerable research on consumer preferences and the effectiveness of various formats in helping customers pick the products that best reflects their preferences.

In order to be effective, disclosure rules need to have a practical mechanism for tracking generation sales and purchases. They need not (and physically cannot) track electrons from generators to homes: electrons flowing in the transmission grid cannot be distinguished from one another. But they

Figure 15. People Willing to Pay More for "Green" Electricity



Source: Sustainable Energy Coalition, Washington, DC.

can determine that purchases by customers pay for certain kinds of generators to operate and deliver electricity to the grid. At least two kinds of workable tracking mechanisms have been proposed. One mechanism would use the same data that electric companies use to settle their own financial accounts and could be implemented by the Independent System Operators controlling the transmission grid. Another mechanism would use tags issued to identify the source of generation. The tags could then be traded independently of kilowatt hours (like renewable energy credits). The price of different kinds of tags would be determined by the market value of the generation characteristics (fuel source and emissions) represented by the tags.

The design of potential disclosure mechanisms can have major implications for renewables:

- The rules must allow disclosure of the content of different electricity products, rather than just the overall generation mix of a company, to encourage companies to enter the green market with new products. Annual reporting for overall company generation can then provide useful supplementary information to consumers.
- In order to be effective for intermittent renewables, disclosure should allow averaging of generation over a period of time. A solar generator could then receive credit for surplus sales during peak sunny hours to offset lack of output at night. Similarly, some averaging over monthly, seasonal, or even annual periods, will allow wind and hydro generators to sell more of their generation to green customers. Without such averaging, surplus green generation could have be dumped into the pool during peak generation periods.
- A mechanism to track sales to power pools or exchanges is needed to allow generators and marketers to be credited for the renewables fraction of sales to the power pool and enable them to earn a premium on a greater proportion of their total output and facilitate green marketing.[151] The New York Public Service Commission staff has designed a mechanism for attributing green generation delivered to the pool.
- Marketers prefer that disclosure be prospective, to indicate the content of electricity products customers will receive after they make their purchase decisions, as California has done. New England and Illinois regulators, however, have preferred retrospective disclosure, to ensure greater accuracy and accountability.[152]

The Edison Electric Institute has proposed that suppliers be allowed to disclose average fuel mix of the regional system, rather than their specific purchases and sales.[153] This proposal would limit the tracking needed to disclose the content of products claiming an environmental benefit. However, it would allow companies to "greenwash" especially dirty fuel mixes, by "coloring" them with the regional average mix. Using a regional default label would also prevent one tracking mechanism being used both for emissions disclosure and for verifying compliance with emission portfolio standards.

Many states are considering disclosure requirements at the legislative or regulatory level.[154] California and Maine laws currently require that fuel sources be disclosed on a customer label. Massachusetts, Illinois, and Connecticut require disclosure of fuel mix and air emissions, along with other standardized information.[155] The six New England state utility commissions have tentatively agreed on uniform regulations for the region. The administration's federal restructuring bill includes mandatory disclosure of prices, fuels, and emissions.

Education Programs. Providing information about the content of electricity supplies is a critical first step in informing customers about their choices. But many customers will be unfamiliar with the environmental and health impacts of the fuel sources and emissions identified on a label.

The Oregon voluntary disclosure label includes such information. Consumer research shows that keeping the label uncluttered, however, is important for consumers to use it. One solution, adopted by Massachusetts regulators, is to require that brief summaries of environmental and health impacts be included on the back of the content label.

Environmental organizations are likely to be a source of such information in regions where

Figure 16. Disclosure Label

Electricity Facts

Generation Price

Average price (cents per kWh) for varying levels of use. Prices do not include regulated charges for delivery service.

Average Monthly Use	250 kWh	500 kWh	1000 kWh	2000 kWh
Average Generation Price	5¢	4.5¢	4¢	3.5¢

Your average price will vary according to when and how much electricity you use. See your most recent bill for your monthly use and Terms of Service on your bill for the actual prices.

Contract

See your contractor Terms of Service for more information

■ Minimum Length: 2 Years ■ Price Changes: Fixed over contract period

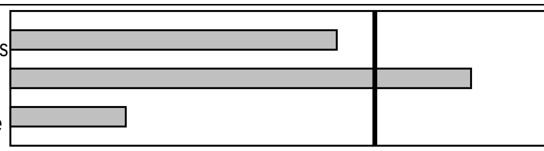
Supply Mix

We used these sources of electricity to supply this product from 6/96 to 5/97

Coal	30%
Natural Gas	20%
Nuclear	15%
Hydro	10%
Solar, Wind, Biomass	20%
Waste Incineration	5%
Total	100%

Air Emissions

Nitrogen oxides (NO_x), sulfur dioxide (SO_2), and carbon dioxide (CO_2) emissions relative to regional average.



Source: Center for Clean Air Policy, Disclosure in the Electricity Marketplace: A Policy Handbook for the States, March 1998.

electricity choice is enacted. These organizations will rarely have the resources, however, to provide the information to all customers seeking to make informed choices.

The Pace University Energy Project is developing a method–ology for ranking the environmental quality of products available in the electricity marketplace on behalf of the "Green Group," a coalition of national environmental organizations that in–cludes the Union of Concerned Scientists. The methodology and results are expected to be published on the PACE web site.[156]

Certification. Another approach to providing important in–formation to customers is certification. A logo provides an easily recognizable symbol to customers that an independent party has determined that certified products are en–vironmentally superior choices.

The nonprofit Center for Resource Solutions offers a "Green-e" logo (figure 19) to products that an annual audit certifies obtain at least half of their generation from renewable resources.[157] The other half must be at least as clean as the system average. Marketers also agree to abide by a code of conduct including requiring disclosure of the fuel sources of all products, and no double-selling of renewables.[158]

As of October 1998, ten retail products and five wholesale products had been certified in the California market.[159] Many of the products initially introduced go beyond the minimum requirement of 50 percent renewables content, with several 100 percent renewables products available. The Green-e certification program was launched in Pennsylvania in June 1998, with four products from two companies certified by September.[160] Marketers and environmental groups in New England are discussing introducing Green-e certification in that region in 1999.

Some environmental groups have criticized most initial green electricity products marketed in California for not prod-ucing incremental environmental improvement.[161] Beginning in the year 2000 in California and Pennsylvania, all Green-e products will have to include an increasing percentage of electricity from new renewable energy projects built after 1997, to ensure that Green-e products lead to development of new renewables. Five of the ten retail products available in California in October 1998 claimed to support new renewables projects. Certified products will also have to meet the new renewables standard one year

Figure 17. Green-e Logo

Source: Center for Resource Solutions

after Green-e is introduced in any new regions beyond California and Pennsylvania.

Other organizations are looking to certify individual generators or to develop broader assessments of the environmental quality of electricity products. Scientific Certification Systems has developed a protocol for certifying generators as having low environmental impacts based on an evaluation of life-cycle impacts, from fuel extraction and processing through waste disposal.[162]

States have also considered certification. California certifies renewable generation facilities, but not products in the market. Early versions of Massachusetts restructuring bills included provisions for state certification of green products. These provisions were abandoned when not supported by marketers or environmental groups, because of the difficulty of coming up with appropriate standards in a legislative context and a preference for private certification efforts. A Delaware coalition has proposed state certification of green products.

Information about Renewables and Customer Choice. Some states have also included provisions in their restructuring laws or in accompanying bills for broader customer education about renewable energy.

The California public benefits fund has $5 million per year allocated to customer education about renewables. The statutes creating the renewables funds in Massachusetts and Connecticut enable the funds to be used, in part, to increase customer knowledge and expertise on renewables.

These state laws also included funding for general customer education on retail choice. These programs have been somewhat controversial to date. Special care must be taken to ensure that such programs are unbiased, timely, and well thought out. California set up an $87 million public education campaign administered by the California Energy Commission, but with a governing board consisting entirely of utilities. The program has been criticized for discouraging customers to leave their existing electricity suppliers. In Massachusetts, a television advertising campaign produced by the state Division of Energy Resources, without participation by stakeholders, began long before suppliers were ready to offer choices to residential customers. The ads, which portrayed consumers celebrating the arrival of choice by conspicuously wasting electricity, were severely criticized by consumer groups. Jurisdictions where restructuring measures have not yet been enacted have the opportunity to consider what educational approaches might prove most effective and least biased. Participation by a broad cross-section of stakeholder groups, including independent generators, marketers, consumers, and environmental organizations, should help make education efforts credible.

Putting Green Customer Demand to Work

The willingness of many electricity customers to pay more for renewable energy supplies can be tapped within any market structure. The term “green-pricing” has been used to describe programs run by regulated utilities that allow customers to contribute to the development of renewable energy projects. “Green marketing” is generally used to describe offerings by competitive suppliers in a retail competition environment.[163]

As of June 1998, there were approximately 40 utility green-pricing programs around the country, using a number of different models. The majority of programs charge a higher price per kilowatt hour to support an increased percentage of renewables or to buy discrete kilowatt-hour blocks of renewables. Other programs have fixed monthly fees, round up customer bills, charge for units of renewable capacity, or offer renewables systems for lease or purchase. Average market penetration for these programs was about one percent, with approximately 45,000 customers participating nationally, expected to lead to new renewables capacity of about 45-50 MW.[164]

Green-pricing results have varied widely, however, ranging as high as three percent. Among the important variables influencing success are specifics of program design, the extent and quality of market research, the credibility of the utility, the simplicity of the program, the tangibility and visibility of the renewables projects, and marketing efforts, particularly with community organization partnerships.[165]

Texas has approved a green pricing rule, setting standards for eligible renewables, green pricing premiums and limits on administrative and marketing costs.[166]

Many environmental groups have actively supported green marketing. The Natural Resources Defense Council, Environmental Defense Fund, Center for Energy Efficient and Renewable Technologies and Union of Concerned Scientists all have web sites encouraging customers to choose renewable options.[167]

Green marketing has begun to develop in California and Pennsylvania. Marketers in California have cited a number of requirements for a successful retail market which are not fully established. Electricity suppliers will need access to information about existing customers and will need to be able to do metering and billing. Standard methods for switching customer accounts easily will also be needed. Marketers have complained that it has been difficult and time-consuming to switch customer accounts in the early stages of the California market.[168]

Most importantly, marketers have had a difficult time competing with artificially low generation prices offered by incumbent utilities. In California, customers who want to switch suppliers receive a credit on the bills from their utilities equal only to the *wholesale* electricity generation rate. They are free to shop for any competitive supplier who can compete against the wholesale generation rate.

But competitive suppliers must not only buy wholesale generation to resell to their customers, they must also incur marketing and overhead costs. Marketing costs to persuade customers to switch suppliers in California have exceeded $100 per customer.[169]

Utilities do not have to advertise to keep most of their existing customers. And their overhead costs—office space, equipment, telephones, customer service, etc.—continue to be paid by all customers, because even those who switch suppliers do not get any credit on their utility bills for these costs.

As a result of these unfavorable conditions, Enron, a large diversified energy company headquartered in Texas, gave up trying to compete in the California residential market only after a few months. There is little competition in California to offer residential customers lower prices than they can get staying with their utility. Ironically, about the only way marketers can compete is to offer a different kind of product—like a green product—but the cost disadvantage faced by marketers has limited competition for green customers as well.

In Massachusetts and Rhode Island, the initial competitive environment has been even worse than in California. All customers who stay with their existing utility are guaranteed a “standard offer” generation price. The standard offer starts at 2.8¢/kWh, and increases over time. But the wholesale market price in New England has been about 3.5 to 4¢/kWh. Utilities that lose money by having to sell generation at standard offer prices which are below-market are allowed to recover those losses with interest after seven years, thus subsidizing the standard offer. Not surprisingly, during the first year competition has been allowed, no companies have stepped forward to try to compete against the residential standard offer. One company, AllEnergy, a subsidiary of New England Electric, is offering a hybrid service, where standard offer customers of any utility an option to “upgrade” their service by buying blocks of renewables generation, but with limited success to date.

A solution adopted in Pennsylvania is to have the credit on utility bills for customers switching suppliers not only reflect the wholesale generation price, but retail costs that the distribution company is no longer incurring on the customer’s behalf. Customers choosing to switch suppliers receive a “shopping credit” intended to cover not only generation costs, but supplier overhead and marketing. The shopping credit varies by company, and is as high as 5.2¢/kWh for customers in the Philadelphia area. As a result, customer response to early offers has been very high. One green marketer recently reported having signed up as many customers in 6-7 weeks in Pennsylvania as they have in 6-7 months in California.[170]

Another partial solution would be to require competitive bidding to serve the standard offer. Marketing and overhead costs to serve the standard offer customers would be low, and companies would be likely to include those costs in their bids.[171] However, this approach would still not create a robust market with many companies competing to provide new products and services to residential customers.

Another approach might be to require utilities to divest of their customers, requiring all customers to choose a competitive supplier. Customers who did not choose would be assigned to a competitive supplier at random.

Aggregation. Customer aggregation is another mechanism for creating a more competitive market in a way that can benefit both the environment and consumers. An aggregator organizes customers into a buying group, thus giving the buying group more bargaining clout and greatly reducing transaction costs for marketers. By combining customers who use electricity at different times of the day and week, and smoothing out sharp peaks or valleys in electricity demand, aggregators can also make it easier and less expensive for marketers to serve groups of customers.[172] Aggregation may be especially important in new markets, where choice is unfamiliar, there is great inertia in the market, and the costs of persuading customers to make any choices can be quite high.

Several different aggregation models are being developed and implemented. In California, state universities have aggregated their demand and negotiated a contract with one supplier. Water agencies throughout the state also formed an aggregation group.[173]

In Colorado, an environmental organization, the Land and Water Fund of the Rockies, is aggregating customers to participate in a wind energy green-pricing program offered by Public Service of Colorado, a regulated utility.[174]

In Massachusetts, large nonprofit electricity users of many kinds, including universities, health facilities, schools, and cultural organizations are being aggregated by the Massachusetts Health and Educational Facilities Authority. The organization, which already had a buying group for natural gas, has expanded to electricity and claims over 500 members with a combined buying power of almost $150 million.[175] Another aggregator, National Energy Choice, is offering an extra 5 percent savings on top of the standard offer discount, plus an additional 5-7 percent savings from energy efficiency improvements, to members of the Massachusetts Municipal Association and two other nonprofit associations.

On an even broader scale, 21 towns on Cape Cod and Martha's Vineyard are aggregating the electricity demand of their more than 150,000 residents, businesses, and town facilities through a municipal franchise model.[176] The towns—which have a combined peak demand of 335 MW—issued a request for proposals in August 1998 through an association known as the Cape Light Compact.[177] A number of other Massachusetts towns and counties are also in various stages of considering municipal aggregation.[178] The Massachusetts Restructuring Law specifically authorizes municipal "opt-out" aggregation. The law allows municipalities to aggregate their customers, by vote of town council or meeting, with contracts subject to approval by the Massachusetts Department of Telecommunications and Energy. Although all residents and businesses of participating towns would be automatically included in the aggregation, any customer can opt out of the aggregation and choose any licensed electricity supplier.

Municipal aggregation could be favorable for renewables in several ways. For one thing, towns may set their own minimum requirements for renewables, energy efficiency services, or other environmental criteria, to reflect the public benefits provided by clean and renewable energy options. And, by pooling large numbers of customers and by making the aggregation process automatic, municipal aggregation can greatly decrease marketing costs and ensure that most of the premium for any green electricity options goes directly to produce more renewable electricity generation. Municipal aggregation could also make it easy for customers to choose a green option merely by checking a box on a bill. Finally, customers may find a green option offered through a municipality more credible than one offered by a private company with which they are not be familiar.

Of course, municipal aggregation will not automatically favor green options. The tendency of many towns is likely to be to seek out the lowest cost electricity sources, irrespective of their environmental profile. Concerned citizens and advocacy groups may need to participate in time-consuming local forums to influence aggregation choices. In addition, towns with contracts for waste disposal with waste-to-energy facilities are likely to feel pressured to include those facilities as green options, despite objections from some environmental groups.

Buyers cooperatives, or co-ops, are another traditional form of aggregation. A Vermont group has put together a plan for a regional consumer controlled coop to reduce prices and develop cleaner energy sources.[179]

Government purchase. A related strategy is using government purchases of green electricity, or direct investment in renewables. The US government is the world's largest energy consumer, with total purchases (electricity plus fuels) of almost $10 billion.[180] State and local governments also consume large amounts of energy. Santa Monica became the first California city to buy from a green marketer to power city facilities.[181] In Nebraska and Colorado, the governors issued Executive Orders for state agencies to look at purchasing green power supplies. In Nebraska, all state facilities to use renewables and energy efficiency where cost-effective.[182]

In 1994, the President issued Executive Order 12902, which set a goal of reducing energy use in federal buildings by 30 percent by 2005 and directing the Department of Energy to develop a Renewable Implementation Plan for increasing the use of renewables by federal buildings and agencies. A number of successful projects have since been developed.[183]

The New England regional office of the U.S. Environmental Protection Agency has made a commitment to purchase at least four percent of its electricity from renewable energy sources.

The Massachusetts restructuring law requires the state to conduct an annual study of the costs and benefits of requiring all state agencies and facilities to purchase a minimum of 10 percent of its electricity from renewable sources.[184]

Chapter 6

Conclusion

The deregulation of the electricity market presents both enormous risks and great opportunities for the development of clean renewable energy sources. The main risk is that renewables will be at a competitive disadvantage against fossil fuels. The failure of the market to value public benefits like environmental protection and fuel diversity, as well as market barriers, will make it hard for relatively new technologies to become commercialized and enter the mainstream marketplace. If this occurs, the result could be even less use of renewable energy for electricity generation than exists today, with corresponding higher levels of pollution, greenhouse gases, and other problems.

However, the new market also creates potential opportunities for renewables *if* appropriate policy steps are taken. This report has described seven practical measures that would greatly increase the contribution of renewable sources to the nation's electricity supply.

At the beginning of the debate over deregulation of electricity generation, renewable energy advocates sometimes debated which of these measures were better or more important than the other. In particular, the relative merits of the renewables portfolio standard and of public benefits funds were hotly debated in California, the first state to implement retail competition.[185] The relative importance of trying to make markets for renewable energy work versus enacting mechanisms that recognize and internalize the public benefits of renewables was also widely discussed in California and elsewhere.

As the debate has matured, more recent restructuring decisions have incorporated multiple public benefits mechanisms and paid closer attention to making the market work more effectively. All of these approaches can be synergistic, rather than competitive.

No matter what industry structures states choose to adopt—retail competition, wholesale competition, regulation with integrated resource planning, public ownership of utilities, electricity cooperatives, or any combination—resource planning decisions and markets can be structured to be fair to clean energy resources, or to discriminate against them. Legislators and regulators who want to minimize the environmental impact of electricity generation while reducing costs will want to ensure that utility customers have the opportunity to make green choices, that they are well-informed about their choices and their consequences, and that green generators have fair access to the grid and to customers. Fair competition also requires fair pollution rules, with comparable emission standards for all power plants.

At the same time, no matter how fair specific market rules are, it is important that public benefits that are not reflected in market prices be recognized and supported through some public mechanism. The two major mechanisms that have been proposed and adopted in various jurisdictions for preserving renewables public benefits—the renewables portfolio standards and public benefits funding—can serve complementary functions. The RPS provides a market-friendly mechanism to ensure the sustained orderly development of renewables close to being market-ready, while maximizing competition. Public benefits funding can help jump-start the renewables market, be targeted to overcome specific market barriers in given regions, and advance research, development and commercialization of technologies which have long-run potential but are not as cost-effective in the short-term.

Various states are currently serving as experimental laboratories for renewable policy, as well as major drivers of renewables development. They will provide important new lessons and models for moving forward. The Massachusetts and Connecticut restructuring laws warrant special attention as models for having adopted the RPS and funding mechanisms together, along with net metering, information disclosure, emissions performance standards, and support for distributed generation. California will continue to be a major bellwether, with a substantial lead in implementing the nation's largest funding program for renewables, along with a number of the other policies discussed in this report. Pennsylvania's market structure may allow the first significant test of the impacts of green marketing. Continued implementation of pre-restructuring renewables requirements in Minnesota, Iowa, Wisconsin and Texas will provide major near-term development experience for the renewables industry.

The majority of states have not yet considered these policies. Congress is being called on to repeal the statute that has provided the most support for renewables to date. If the states enacting policies described in this report are seen as models that can be replicated and improved upon in other states and at the federal level, America may yet switch to cleaner renewable electricity, and realize substantial environmental and economic benefits.

Appendix A

Renewable Energy Technology

Potential, Costs, and Market

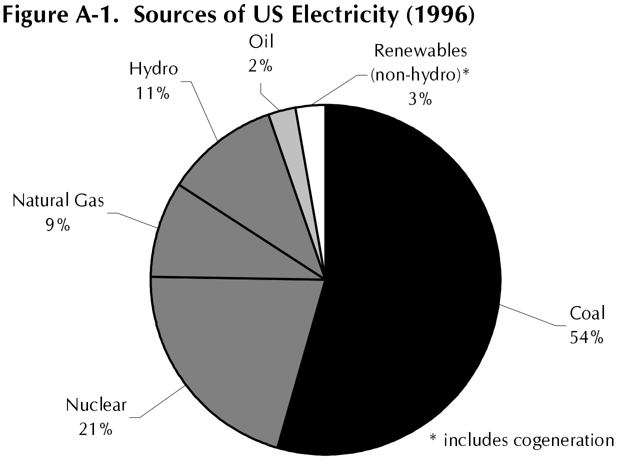
The United States produced about 450 billion kilowatt-hours (kWh) of electricity from renewable energy sources in 1996, about 12 percent of the national total. Hydroelectric generators produced 10 percent of this. Only 2 percent came from other renewable sources powered by biomass, geothermal, wind, or solar energy (figure A-1).*

Solar Energy

Photovoltaics, or solar cells, are the most common solar electric technology. When sunlight hits a semiconductor material, like silicon, it knocks electrons loose from the atoms. These electrons flow in a closed circuit, creating an electrical current. The global photovoltaics industry is growing rapidly, from sales of 23 megawatts (MW) per year in the late 1980s to over 100 MW in 1997. American manufacturers saw annual average growth of 19 percent over the last ten years, with much of their market found abroad. American companies exported $83 million worth of solar panels in 1996.[186] Much of the market is in providing power to people who are "off the grid," or not connected to power lines, especially in developing countries. In the United States, solar cells are increasingly used to power road signs, irrigation pumps, and cellular phone transmitters.

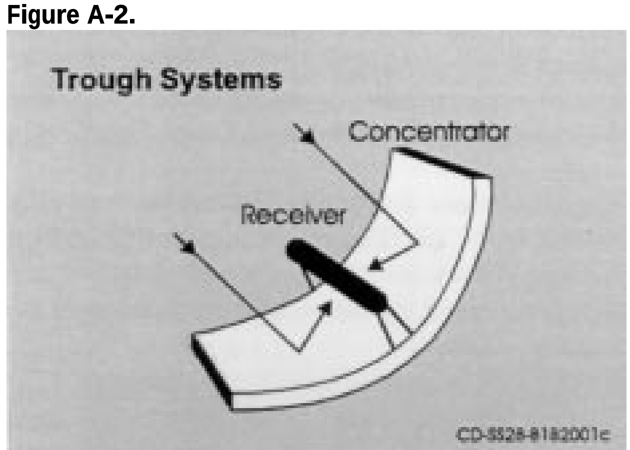
A second type of solar technology uses the sun's energy to heat a fluid. Steam produced using the heated fluid turns a turbine to generate electricity. Such solar thermal electric technology may take any of three configurations: troughs, towers, or dishes.[187] The most common—solar troughs—use curved (parabolic) mirrors in the shape of a trough to heat a fluid in a tube running through the center of the trough (figure A-2). Southern California has 354 MW of solar troughs. Solar towers use mirrors to heat a fluid in a central tower (figure A-3). Two experimental 10 MW "power towers" have been built in

Figure A-1. Sources of US Electricity (1996)



Source: Annual Energy Outlook 1998, Energy Information Agency.

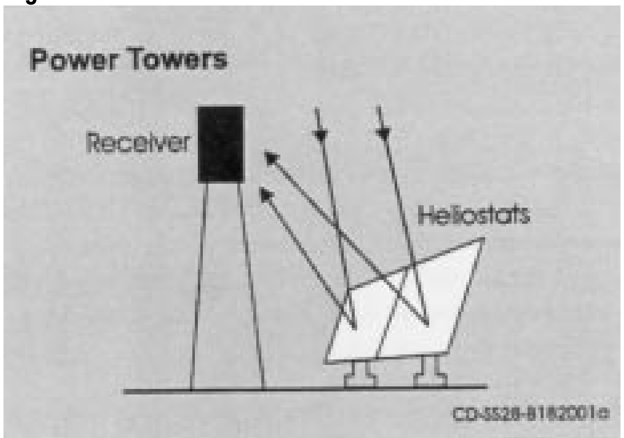
Figure A-2.



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

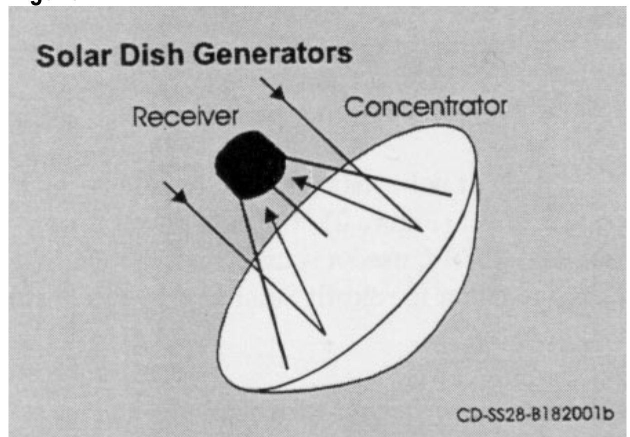
* The capacity of a power plant is typically measured in megawatts (MW), or million watts of generating capacity. Electrical energy is measured in kilowatt hours or megawatt hours (kWh or MWh). A typical

Figure A-3.



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

Figure A-4.



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

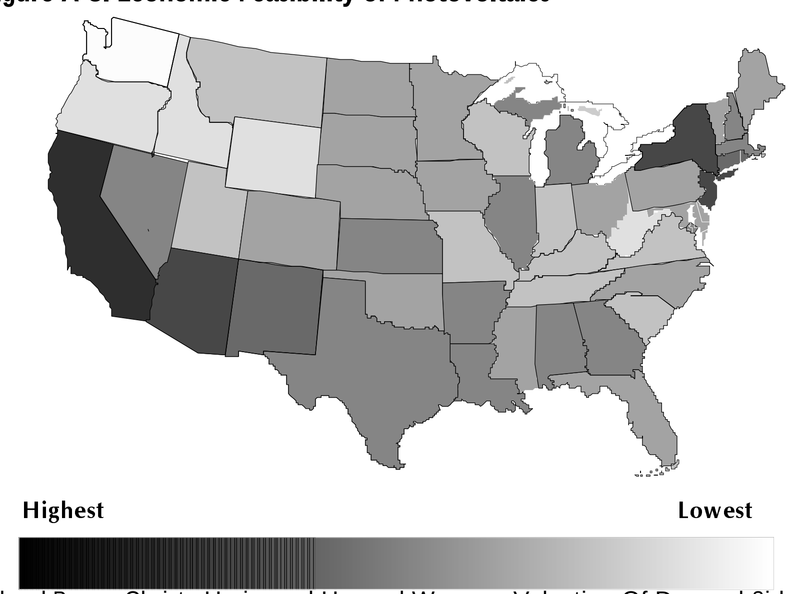
California. Solar One operated from 1982–1988, while Solar Two began operation in 1996. Solar dish technology uses dish-shaped mirrors to focus the sun's heat (figure A-4). A demonstration solar engine was recently installed at the Pentagon.[188]

Potential. Photovoltaic panels installed on less than 1 percent of the US land area could provide all the electricity the country needs, if there were no transmission constraints.[189] Texas alone receives three times the amount of sunlight needed to power the whole country. Of course, different parts of the country receive different amounts of sunlight, but the variations are not as great as one might expect. The sunny southwest gets only about 35 percent more sun than the northeast.[190]

While solar panels work best in the dry and sunny Southwest, they can be of value in less sunny regions, if electricity is expensive and peak electricity demand occurs when the sun is shining brightest, which is often the case in regions with high air-conditioning use. Power from solar panels is currently much more expensive than that from conventional generators. In many places, though, power prices are very high during periods of peak demand, offering an opportunity for solar power. Figure A-5 shows states where photovoltaics have the greatest value.[191]

Because photovoltaics can be easily sited on existing rooftops and other structures, this technology has great potential. A UCS study found that installing photovoltaics on rooftops and south-facing walls could meet as much as 20 percent of the Boston area's electricity needs.[192]

Figure A-5. Economic Feasibility of Photovoltaics



Richard Perez, Christy Herig. and Howard Wenger, Valuation Of Demand-Side Commercial PV Systems in the United States. See also NREL web site at http://www.nrel.gov/ncpv/documents/pv_util.html.

Solar thermal electric technologies are limited in the United States to the Southwest, because they require strong, direct sunlight and few clouds. Despite this constraint, estimates suggest that solar thermal electric stations covering the area of Edwards Air Force Base in California and the White Sands Missile Range in New Mexico could theoretically meet about a quarter of US electricity needs.[193]

Cost. The price of photovoltaics has declined steadily over time. With increased efficiency and mass production, prices could decrease further. The Electric Power Research Institute and the Department of Energy project a drop in total costs for bulk residential customer installations from $6.72/watt in 1997 to $3.05/watt in 2010 and $1.77/watt in 2020. If, as expected, solar module efficiency increases from 14 percent to 20 percent, utility-scale systems could fall to 6.2¢/kWh in 2020 and 5¢/kWh in 2030.[194]

Solar thermal electric technologies are also likely to undergo large price reductions. Projections show a decline in prices for electricity from parabolic troughs from 17.3¢/kWh in 1998 to 6.8¢/kWh in 2030. For hybrid solar dishes, using natural gas to provide supplemental energy, the projected decrease is from 17.9¢/kWh in the year 2000 to 5.2¢/kWh by 2030. Electricity from power towers could reach as low as 4.2¢/kWh in that time frame, dropping from 13.6¢/kWh in 2000.[195]

Market. The market for photovoltaics is limited by high costs relative to other renewable as well as conventional technologies. Even at 1998 prices, however, there are niche markets where these systems can compete. In remote applications, such as off-grid homes, outdoor lighting, communications towers, and water pumping, photovoltaics can be less expensive than building transmission lines to connect with conventional generation. Even in urban areas, photovoltaics may be cost-effective in locations where installation allows expensive transmission and distribution system investments to be deferred or avoided.[196]

The market for photovoltaics is expected to take off when the price of an installed module declines to about $3 per watt. At that price, the total US market for photovoltaics may reach 9,000 MW.[197] Photovoltaic production is expected to grow by 20 percent per year, aiming in part at the 10 million single-family homes located in regions of the United States that have above-average sunshine and suitably tilted roofs with unshaded access to direct sunlight. This market alone has a long-run potential of over 30,000 MW.[198]

Impacts. Solar energy is the most environmentally benign energy source available, since solar technologies produce no air or water pollution, do not deplete natural resources, and do not endanger public health or safety.

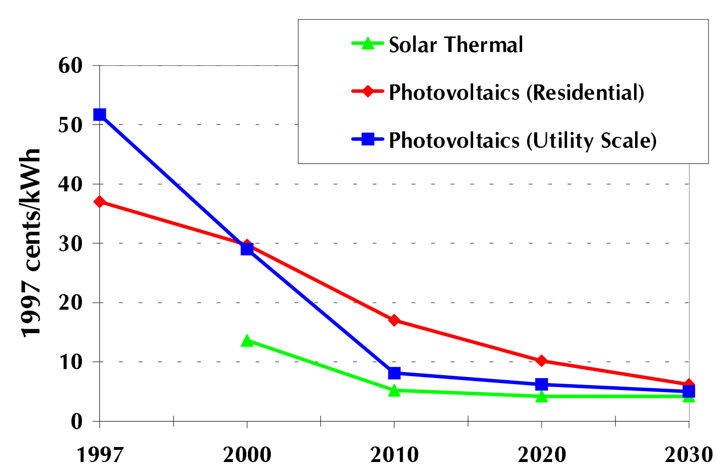
The few environmental impacts are minor or easily controlled. The manufacture of photovoltaic panels, for example, involves the use of toxic materials like cadmium and arsenic. Because this takes place in a closed factory, the toxics can be controlled; pollutants are not released intentionally as they are from a coal-burning power plant. Processes to recycle materials used in thin-film solar panels will need to be developed, but these are unlikely to pose problems.

Land use is an issue for centralized solar thermal power plants. These technologies require about 7.5 acres of mirrors per megawatt, or one square mile for an 85 MW plant. However, as noted earlier, large amounts of electricity could be produced on a small area of desert.

Wind Energy

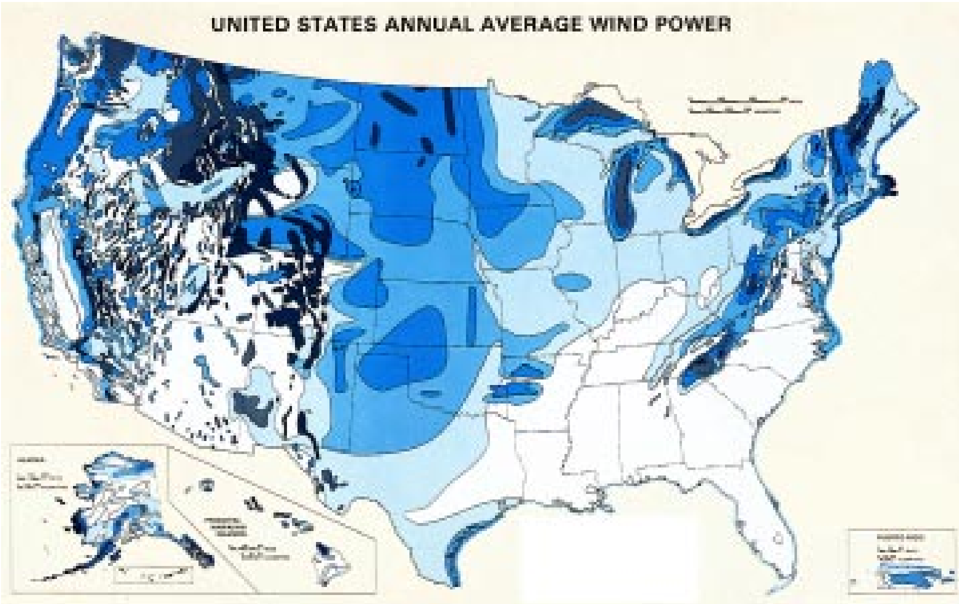
Wind turbines convert the force of moving air into electricity. Like an airplane, the wind turns the blades using lift. Almost all wind turbines have blades

Figure A-6. Solar Cost Projections



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

Figure A-7.



CLASSES OF WIND POWER DENSITY

Wind Power Class		Density at 10m (33ft) W/m²	Speed at 10m(33ft) m/s	mph	Density at 50m (164ft) W/m²	Speed at 50m(164ft) m/s	mph
1		0-100	0-4.4	0-9.8	0-200	0-5.6	0-12.5
2		100-150	4.4-5.1	9.8-11.5	200-300	5.6-6.4	12.5-14.3
3		150-200	5.1-5.6	11.5-12.5	300-400	6.4-7.0	14.3-15.7
4		200-250	5.6-6.0	12.5-13.4	400-500	7.0-7.5	15.7-16.8
5-7		250-1000	6.0-9.4	13.4-21.1	500-2000	7.5-11.9	16.8-26.6

D.L. Elliott and M.N. Schwartz, *Wind Energy Potential in the United States,* DOE, Pacific Northwest Labs, 1991, online at www.nrel.gov/wind/potential.html.

rotating about a horizontal axis. They range in the United States from small 200-watt machines used on sailboats to 750 kW turbines with 46-meter blades mounted on 60-meter tall towers. Some wind turbines of 1 MW and larger are being installed in Europe.[199]

Wind power is the most rapidly growing source of energy in the world, increasing 20 percent per year since 1990.[200] Power producers installed over 1,500 MW of wind turbines around the world in 1997. Germany's installed base rose to 2,080 MW of wind, surpassing the United States as the world leader in wind power generation. In China, India, Denmark, and Spain, wind power is also growing rapidly. Most US wind power development has been in California, but since 1993 new large-scale wind turbines have been installed in Colorado, Iowa, Michigan, Minnesota, Texas, Vermont, and Wyoming.

Potential. A study by the Pacific Northwest Laboratory estimated the total theoretical potential for wind at about 40 times annual US consumption.[201] The study excluded areas where siting wind turbines would be especially difficult, like cities, national parks, and environmentally sensitive areas. About 6 percent of the total land area in the lower 48 states has wind speeds of 13 mph or more and is potentially available for wind turbine installation. Estimates indicate that annual wind power output from these areas could be 4,400 billion kWh—1.5 times total US electricity demand. The study found that 12 states in the middle of the country have most of the wind energy potential, enough to produce nearly four times the amount of electricity consumed by the nation in 1990, if there were no constraints on transmission. North Dakota alone could supply over a third of the nation's power needs.

The study concludes that to provide 20 percent of the nation's electricity, wind development would require only about 0.6 percent of the land of the lower 48 states. Furthermore, since wind turbines must be spaced widely so as not to interfere with each other, less than 5 percent of this land would be occupied by turbines, electrical equipment, and access roads, leaving the rest of the land available to existing land use, such as farming and ranching.

The distance from existing power lines is also a key factor determining the cost-effective potential of wind power, since new long-distance transmission lines can cost as much as $200,000 per mile. In 1995, the Department of Energy assessed the US wind potential based on distance from existing power lines, using a GIS-based method that the Union of Concerned Scientists pioneered in *Powering the Midwest*. The DOE found that 153,000 square miles of land within 5 miles of existing transmission lines had the potential for wind development. That land could accommodate 464,000 average MW—more than the total US generation capacity in 1993. Within 10 miles of power lines, enough wind turbines could be sited to provide more than twice the power needs of the country—as much as 6,430 million MWh.[202]

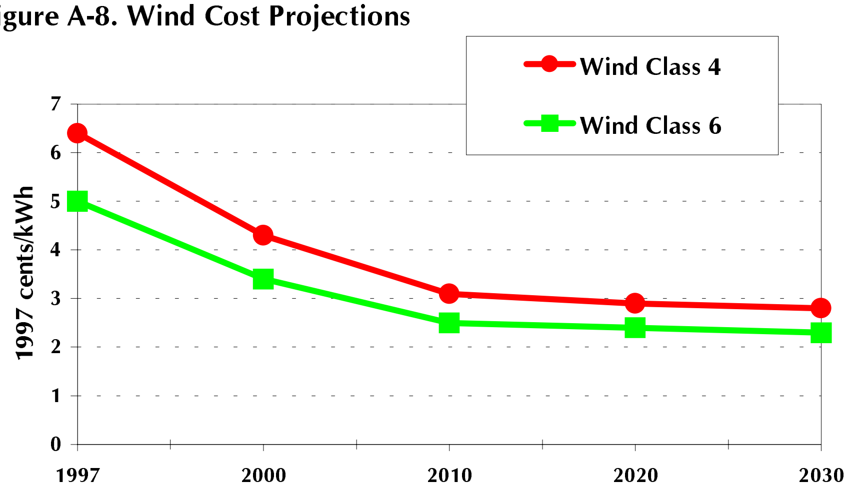
Costs. Wind costs have declined from 25¢/kWh in 1981 to less than 5¢/kWh in 1998. Installation and operations costs are likely to continue falling as performance increases. Improvements in wind technology should enable turbines to take advantage of a wider range of wind speeds, thereby producing power in both slower and faster winds. Construction costs are projected to fall from $1,000/kW in 1998 to $635/kW in 2030, with generation prices falling as low as 2.3 cents per kWh. These improvements will be driven by research and development on aerodynamics and materials, leading to more efficient, lighter weight systems with improved components, placed on taller towers. Manufacturing improvements and increased volume of production will have a strong effect on reducing costs as the market grows.[203]

Markets. Wind competes as a bulk power source and its price is expected to remain higher than the price of natural gas for the near future. Thus changes in the market for wind are likely to depend on how quickly a market develops for environmentally friendlier "green power" and on the extent to which policy supports wind power. Policy decisions about renewal of the 1.5¢/kWh production tax credit, currently set to expire in July 1999, the adoption of renewables portfolio standards, and the extent to which transmission prices penalize intermittent sources like wind will have an enormous impact on wind markets. Market projections for wind range widely. The US Energy Information Administration, forecasting business as usual, projects an increase from 1998 capacity of 1,850 MW to 3,330 MW by 2010. On the other hand, *Energy Innovations*, a study by the Union of Concerned Scientists and others projects market potential at 44,480 MW by 2010, if strong measures are taken to achieve a 10 percent reduction in carbon emissions from 1990 levels by that date.[204]

Impacts. Wind power produces no air or water pollution, involves no toxic or hazardous substances (other than the lubricants commonly found in large machines), and poses no threat to public safety. A serious potential obstacle facing the wind industry, however, is public concern about their impacts on wilderness areas and about the visibility of wind turbines. In forests, wind development may clear some trees and cut new roads. Near populated areas, wind projects may run into opposition from people who regard them as unsightly, or who fear their presence will reduce property values. However, recent studies of the first commercial wind development in New England, as well as a number of studies in Europe, have shown greater public acceptance after construction than before.[205]

One of the most misunderstood aspects of wind power is its use of land. Wind turbines occupy only a small fraction of the land area across which they are sited. The rest can be used for other purposes or left in its natural state. For this reason, wind power development is ideally suited to farming areas. Farmers can plant or

Figure A-8. Wind Cost Projections



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

allow grazing right to the base of turbine towers. In fact, landowners can derive substantial benefits in increased income and land value by leasing land for wind turbines. Consequently, the areas with the greatest potential for wind power development are in the Great Plains, where wind is plentiful and vast stretches of farmland could support hundreds of thousands of wind turbines.

Bird deaths have been a significant problem for wind turbines at only two locations: Altamont Pass in California and Tarifa, Spain. Studies show that bird deaths can be reduced by minimizing perches on and around the wind machines, as by using tubular rather than lattice towers, and new turbines with larger and slower moving blades. Recently, a Danish company announced plans to replace 750 smaller wind turbines at Altamont with only 100 larger new machines.[206] This should greatly reduce the number of injuries there.

Biomass Energy

Biomass energy is energy from plants and organic material. Although the most common form is wood, which can be burned, biomass also includes wastes, like paper, sawdust, and yard clippings; methane, from decomposing trash, sewage, and manure; and crops grown specifically for energy use. For the foreseeable future, biomass energy has the greatest potential of all renewables. Currently in the United States, the combustion of biomass wastes, such as in paper and lumber mills, provides 7,300 MW of power and generates 42 billion kWh of electricity a year, about 1.4 percent of the nation's electricity. Municipal solid waste, considered a renewable source by the US Department of Energy, contributes another 3,000 MW and 20 billion kWh.[207]

Most biomass used for electricity production is simply burned in power plants, much like coal. Most fuel for these plants is produced as waste in other processes, like farming and wood processing. Although this approach is straightforward and familiar, new approaches are needed to take advantage of the full potential for biomass energy.

A process called gasification offers higher efficiency and cleaner power production than simple combustion. A gasification system heats the biomass fuel under pressure until it gives off volatile gases. A high-efficiency gas turbine then burns these gases. While this approach has been proven at a small scale, it is still being tested at a large scale. The US Department of Energy has converted the McNeil Generating Station in Vermont to a 10 MW gasification system using wood waste and is also testing a gasification plant in Hawaii, using sugar cane waste.[208] If successful, these demonstrations could lead to a wider acceptance of utility-scale biomass plants.

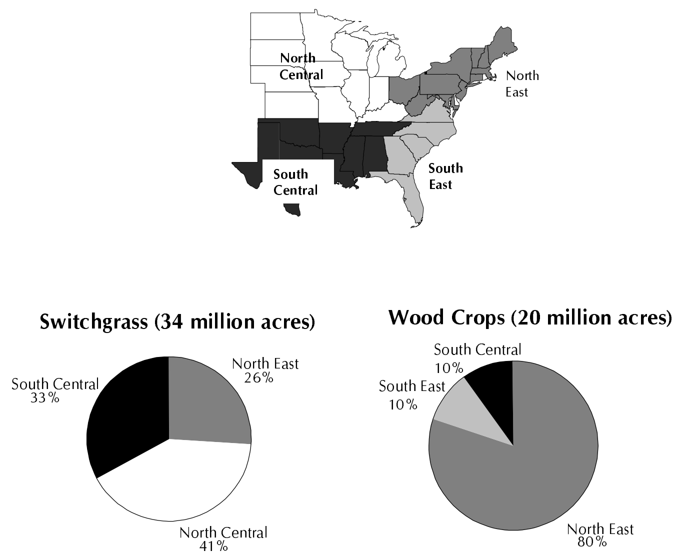
Full development of this technology also requires larger amounts of biomass fuels. Under current economic conditions, waste wood, agriculture residue, and municipal solid waste make the most sense as fuels, since they would otherwise face disposal costs. But expanding biomass generation requires farms and plantations that produce crops solely for energy production. Fast-growing native species like switchgrass, poplar, and willow can grow on land that is idle, subject to erosion, or ill-suited for food crops.

Potential. About 100 million acres of cropland are idle in any given year, some as part of federal conservation programs. Another 150 million acres of pasture, range, and forest has "medium to high" potential for conversion to cropland, according to the US Department of Agriculture. Overall, around 200 million acres of cropland might be suitable and available for energy or "power" crops, without irrigation and without competing with food crops.[209] This land base would be capable of producing one billion tons of biomass every year. Recoverable biomass wastes could contribute 375 million tons annually—during 1997 only half of this was used. In theory, then, biomass could produce over 2 trillion kWh of electricity a year—about 70 percent of US consumption.

On the other hand, some of the biomass resource could be used to make liquid fuels for transportation. If used entirely for transportation, the 1.4 billion-ton total could produce about 150 billion gallons of ethanol or 200 billion gallons of methanol, roughly equivalent to all the fuel currently used in cars and light trucks.

Costs. Biomass is generally cost-effective when residues are available at a low or negative cost. It is also cost-effective when it can serve two purposes at

Figure A-10. Biomass Production Regions



Source: Cost, Noel D. et al. 1990. Forest Biomass Resource of the United States. USDA Forest Service. Aug. 18, 1994. Available on-line at : www.rredc.nrel.gov/biomass/bricmaps.html

once: producing heat as well electricity, or producing electricity in addition to ethanol or animal feed or industrial chemicals. However, power crops are not yet cost-effective, either for farmers to grow or for power producers to use, mainly because subsidies favor food crops and fossil fuels and because the environmental benefits of biomass are not formally valued.

Biomass power is currently produced by small combustion power plants, with an average size of 20 MW. Most of this is operated by the wood industry in combined heat and power applications. These small plants have higher capital costs and lower efficiencies than larger steam plants, resulting in electricity costs in the 8–12¢/kWh range.

The Department of Energy and the Electric Power Research Institute expect the next generation of biomass power plants to substantially reduce these high costs and efficiency disadvantages (see figure A-9). Several processes could result in lower costs:

- cofiring biomass in existing coal-fired power plants
- using high-efficiency gasification with combined cycle gas turbines
- improving efficiency in larger combustion plants, allowing biomass to take advantage of economies of scale

Technologies under development may be competitive in the future The Whole Tree Energy system burns whole trees at once, saving the effort of processing the wood. Integrated gasification fuel cell systems combine biomass gasifiers with new high-efficiency fuel cells. Small modular systems use gasifiers with microturbines, allowing the electrical generator to go the source of biomass, rather than shipping the biomass to the generator.

Markets. The Department of Energy envisions liquid biofuel use growing to over 20 percent of car and light truck use by 2010 and over 50 percent by 2030. The DOE also hopes to raise biomass electric generating capacity to 12,000 MW by the year 2000 and 22,000 MW by 2010. The Electric Power Research Institute believes that as much as 50,000 MW—approximately 8 percent of US generating capacity—could be in place by the year 2010, with twice that amount by 2030.[210]

Researchers at Oak Ridge National Laboratory, the US Department of Agriculture, and the University of Maryland have estimated the economic potential for energy crops like switchgrass, willow, and poplar in a number of states.[211] They found that switchgrass and wood raised on 54 million acres of land and used in biomass gasification/gas turbine systems could produce 630 billion kWh, for about 4.5¢/kWh. This is equal to a fifth of total US electricity production.

Power crop cultivation and energy production might be split among regions as shown in figure A-10. Switchgrass production would be grown in the North Central, South Central, and Northeastern states. The Northeast would lead wood crop production, with 16 million acres of willow trees.[212]

Impacts. Conventional biomass combustion systems produce some air emissions similar to coal-fired power plants, but little sulfur dioxide, carbon dioxide, or toxic metals. The most serious problem is particulate emissions, which must be controlled with special pollution-control devices like electrostatic precipitators. More advanced biomass energy technologies, such as the gasifier/combustion turbine combination, are likely to have emissions comparable to natural gas power plants.

Using biomass as a fuel can greatly reduce emissions of the heat-trapping gases that cause global warming. The carbon dioxide released when biomass is burned is reabsorbed into plants grown to produce more biomass fuels. Thus, in a sustainable fuel cycle, there would be almost no net emissions of carbon dioxide.[213]

Power crops have significant environmental impacts if they are grown in the same unsustainable way that most food crops are grown today, with heavy doses of chemicals and energy. But they can be grown quite differently, so that they improve soil and water quality, reduce erosion, and create animal habitat. Energy crops using fast-growing and hearty native species like switchgrass, willow, and poplar require little if any applications of fertilizers or pesticides. Since trees would grow for several years before being harvested, their roots and leaf litter could help stabilize the soil. Planting varieties that regenerate when cut would minimize the need for disruptive tilling and would be especially beneficial on cropland or rangeland prone to erosion and flooding. Perennial grasses harvested like hay could play a similar role; soil losses with a crop such as switchgrass, for example, would be negligible compared with losses of annual crops such as corn.

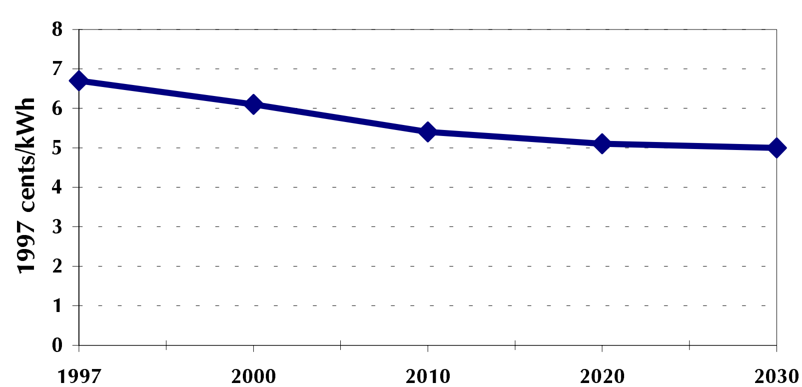
Geothermal Energy

Geothermal energy uses the heat under the earth's crust to produce steam, heat, and power. The US geothermal industry is concentrated in California and Nevada, although the world leader is Iceland, where almost every building is heated by hot springs. With a 3,000 MW capacity, geothermal plants produce about 5 percent of California's electricity. Geothermal plants also produce 460 MW (thermal) of steam and heat for direct use, displacing the use of 1.2 million barrels of oil per year. Worldwide capacity in 1990 was 5,800 MW electric and 11,300 MW thermal.[214]

Geothermal energy in the United States produced about 16 billion kWh of electricity in 1995, making it the third largest renewable energy source, after hydroelectric and biomass generation. Geothermal energy is not replenished, but considering the vast quantity of energy available, it is virtually inexhaustible. The US Geological Survey estimates that the amount of energy from geothermal heat that is accessible amounts to at least 14 times more than all proven and unproven coal reserves in the United States.

Much of this energy, however, is in forms that cannot be captured economically with today's technology. So far, only hydrothermal resources—boiling hot water and steam coming straight out of the ground—have been tapped. Steam reservoirs are the easiest to use for electricity production, but they are rare, and most—like the Geysers in California—have already been exploited. New development is focusing on hot water (150°C or more). Hot water plants have been built in California, Hawaii, and Nevada. The US Geological Survey estimates hot water systems could provide 23,000 MW of power for 30 years at an affordable cost—enough for 23 million people.[215] Hot water and steam are also used directly for industrial

Figure A-9. Biomass Gasification Cost Projection



Office of Utility Technologies, DOE and Electric Power Research Institute, 1997. *Renewable Energy Technology Characterizations*, October, online at www.eren.doe.gov/utilities/techchar.html.

processes, enhanced oil recovery, and district heating. Most new plants are closed loop, returning the steam and hot water to the ground after use. Older plants tend to be open loop, venting the steam to the air after use.

Geothermal heat can also be harnessed using "hot dry rock" technology, which involves drilling deep wells and pumping water down the hole to extract the heat. Since this approach uses hot underground rocks wherever they occur, the potential is enormous, accounting for most of the geothermal resource potential in the United States. While research continues, costs are so far not competitive with traditional resources.

The Department of Energy expects little growth in electrical production from geothermal power plants between now and 2020, as new power plants offset the decline in output from the installation at the Geysers. In an optimistic scenario or with a renewables portfolio standard, geothermal power production could double by 2020.[216]

Impacts. Geothermal plants draw heat from the earth and use it to run steam turbines. Many existing geothermal plants using hot steam directly from the earth and vent it to the air afterwards. These open-loop systems can generate solid wastes as well as noxious fumes. Metals, minerals, and gases are brought to the surface with the geothermal steam. Open-loop systems release carbon dioxide as well, although only about 5 percent of that emitted by a coal- or oil-fired power plant. Open-loop systems can also deplete the water and geothermal resource. Closed-loop systems are almost totally benign, since gases or fluids removed from the well are not exposed to the atmosphere and are usually injected back into the ground after being run through a heat exchanger. Although this technology is more expensive than conventional open-loop systems, in some cases it may reduce scrubber and solid waste disposal costs enough to provide a significant economic advantage.

Hydroelectric Energy

Hydroelectric power uses the energy of moving water to drive water turbines, producing electricity. Large systems rely on dams to block rivers, storing huge amounts of water. The water is passed through the turbines when power is needed. Smaller "run-of-the-river" systems let the water flow through continuously. Most energy production comes from large dams. In the United States, hydropower has grown from 56,000 MW in 1970 to about 80,000 MW today. As a portion of the electricity supply, however, it has fallen to 10 percent, down from 14 percent 20 years ago. Still, US hydropower plants produce the energy equivalent of 500 million barrels of oil per year. In some parts of the country, hydropower is the dominant generator. It provides 63 percent of power used along the west coast and two-thirds of the power in the Pacific Northwest, from 58 hydroelectric dams.

Potential. In theory, there remains great potential for further hydropower development in the United States. The Federal Energy Regulatory Commission has catalogued 7,243 sites, which could provide 147,000 MW of hydropower capacity. As of 1991, less then half of this had been developed, with another 3,300 MW capacity planned or under construction (most of it in expansions or upgrades of existing facilities). Thus, the potential exists for the United States to just about double its current hydropower capacity. The majority of this expansion potential lies in western states, where most previous hydropower development has taken place.[217]

But most of this resource is unlikely to be developed. Environmental laws like the 1968 National Wild and Scenic Rivers Act preclude building dams on stretches of many virgin rivers, eliminating about 40 percent of the potential. An additional 19 percent of potential sites are under a development moratorium until their final status can be decided. According to a 1990 report by national laboratory scientists, only 22,000 MW of the undeveloped hydropower resource is economically viable and of this only 8,000 MW is likely to be developed because of "regulatory complexities and institutional and jurisdictional overlaps" in the hydropower licensing process.[218]

As a result, most of the potential for expanding hydropower involves upgrading existing facilities rather than building new ones. Possibly 6,000 MW in improvements could be made at large dams. The 2,500 small hydro plants currently in operation could also be expanded. These plants account for a tiny fraction of the 70,000 dams that block and divert our rivers. An estimated 4,600 MW of capacity could be added at existing small dams, especially at the more than 3,000 facilities that were abandoned in the 1950s and '60s.[219]

Although it is unlikely, hydropower capacity could be affected if any existing dams were denied licenses when they come up for relicensing. Since hydro facilities have long lives, many dams are quite old. The Grand Coulee dam, for example, has been in operation since 1942. The federal government issues licenses for all dams for a 30- to 50-year period. In 1993, over 200 licenses were due for renewal, amounting to 2,000 MW of capacity. Relicensing will require some dam owners to find ways to reduce environmental impacts.

Costs. As with other renewable technologies, capital costs for hydroelectric plants are high, while operating costs are low, although costs vary widely according to design and location. Large dams in the Pacific Northwest are so inexpensive to operate that commercial electric rates there are as low as 1.5¢/kWh. New large-scale hydro plants can be built for between $500 and $2,500 per kW, while small plants average around $2,000 per kW. Repowering of existing dams is a much cheaper option, usually less than $100 per kW. Operation and maintenance costs are about one-tenth of a cent per kWh.[220]

Impacts. Although hydropower is inexpensive and nonpolluting, the environmental impacts of hydropower can be serious. The most obvious effect is that fish are blocked from moving up and down the river, but there are many more problems. Most problems of hydropower come from large dams with reservoirs. Small run-of-the-river hydro plants produce fewer environmental impacts.

In the Pacific Northwest, large federally-owned dams have blocked the migration of coho, chinook, and sockeye salmon from the ocean to their upstream spawning grounds.[221] Some steps are being taken to help the fish around the dams, such as putting them in barges or building fish ladders, but this has helped only a little. Also, when young fish head downriver to the ocean, they can be chewed up in the turbines of the dam. The salmon population in the Northwest currently seems headed for extinction, falling from a population of 16 million to 300,000.

When land is inundated by the creation of reservoirs, habitat and productive land can be destroyed. This land is often composed of wetlands, which are important wildlife habitats, and low-lying flood plains, often the most fertile cropland in the area. In addition, population density is often higher along rivers, leading to mass dislocation of urban centers.

A related problem has occurred in Canada. The stones and soil in areas now under water contained naturally occurring mercury and other metals. When the land was flooded, the mercury dissolved into the water and was absorbed by fish. The creatures that eat the fish, from bears and eagles to the native Cree people, are suffering from mercury poisoning.

Hydropower affects water quality in other ways as well. Water falling over spillways can force air bubbles into the water, which can be absorbed into fish tissue, ultimately killing the fish. When dams slow rivers, the water can become stratified, with warm water on top and cold water on the bottom. Since the cold water is not exposed to the surface it loses its oxygen so that fish can no longer live in it. And, as illustrated by the Colorado River in the Grand Canyon, fast-moving rivers can fill up with sediment when they are slowed down. During 1997, the Department of Interior flushed huge amounts of water out of dams in an attempt to clear away the sediment.

Another important habitat disruption comes from operating the dam to meet electric demand. Water is stored up behind the dam and released through the turbines when power demand is greatest. This causes water levels to fluctuate widely on both sides of the dam, stranding fish in shallow waters and drying out habitat. There are many competing pressures on dam operators—to produce power, to provide water for recreational use on the reservoir and downstream, to provide drinking and irrigation water, to allow Native Americans to carry out traditional religious practices, and to preserve habitat for fish and plant species. In most cases, nature loses out to boaters and electricity customers.

1

Appendix B

The Renewables Portfolio Standard

Using Markets to Promote Clean Power

With the move toward free markets for electricity, proponents of a sustainable energy future face the risk that unsustainable sources of electricity (primarily fossil fuels and nuclear power) will dominate the market. Today, only 2 percent of US electricity comes from clean, sustainable renewable sources (biomass, geothermal, solar, and wind power), with another 8 percent from hydroelectric power.[222] Although the cost of producing renewable energy has been falling, it has not yet reached the cost of fossil fuel electricity. The combination of market reforms and fossil fuel electricity, could result in a collapse of the existing renewable energy industry, as well as a cutback in investment in research and development on renewable technologies. The short-run economic gains from market reform could block long-run efforts to achieve a sustainable energy future.

To integrate commercially-ready renewables into a competitive market, a number of jurisdictions have, as described in Appendix C, adopted or proposed a renewables portfolio standard (RPS). This simple mechanism would assure that a minimum percentage of all electricity consumed comes from renewable sources.

Who Participates in the RPS and What Do They Do?

The renewables portfolio standard (RPS) is a requirement that a minimum percentage of each electricity generator's or supplier's resource portfolio come from renewable energy. The RPS uses renewable energy credits (RECs)—tradable credits awarded for each unit of renewable energy produced—as a way for companies to meet the minimum standard for renewables easily and efficiently. Without RECs, this standard would be more difficult to meet, since renewable resource generators and retail providers could have to enter into thousands of small power purchase contracts. This process could be relatively time-consuming and expensive. RECs would make compliance simple and transactions more efficient.

Three types of players will be involved in trading renewable energy credits.

- **Energy generation companies**—These are the "power factories," making electricity and selling it at wholesale rates to retailers. When they use renewable sources, they will receive renewable energy credits, which they can sell.
- **Retailers—**These companies sell power to consumers. They will be required to have a certain number of RECs each year. Depending on market rules adopted in different places, one company could be both a retailer and a generation owner.
- **Program administrator—**The administrator, probably a state or federal government agency, will dispense credits to renewable generation companies; ensure that everyone complies with the law and files truthful reports; keep records, and set the price cap, if any.

Other entities could participate as well. Brokers are likely to emerge who buy and sell RECs, offering one-stop shopping for retailers and renewable generation companies. Also, environmental groups or foundations that want to promote renewables could buy RECs and remove them from the market to increase demand, just as they have done with sulfur dioxide credits.

Note that RECs and energy can be traded separately. Buying power from a generator that uses renewable sources is only one way of obtaining RECs. Instead, a retailer may buy power from a generation company that uses only coal and nuclear power or from a spot market (whatever is available at the time), then buy the necessary RECs from a broker. In this way, all retailers can meet their requirements and support renewable energy without having to deal directly with multiple companies. Conversely, a renewable generation company can sell power to a local retailer at the going rate for generic electricity, but sell its credits to a broker to make up for higher production costs. In this way, the renewables company gains income from two sources: the sale of its electricity and the sale of RECs, as shown in Figure B-1.

Renewable energy credits are proof of generation and sale, so to comply with the RPS, all a retail provider has to do is purchase RECs. Figure B-2 is an example of the one-page compliance form a retail provider would have to submit to the program administrator once a year. It simply lists how much power was provided the previous year, how many RECs are needed to comply with the standard, and how many RECs are attached. There are also a couple of lines related to the price cap (discussed below).

In this case, a power retailer who sells 10 million kWh already has half the required RECs at the time of the reporting and buys the other half from the program administrator at the level of the price cap, here set at 2.5¢ per kilowatt-hour (¢/kWh).

Price Caps. One criticism that has been made of the renewables portfolio standard is that the cost of the requirement is not known in advance. If a direct subsidy to producers or a cash incentive to customers is used to promote renewables, it can be budgeted in advance, down to the penny. However, in such cases, a bureaucrat rather than market forces would make the decision about who to support and how much to pay them. Though the decisions may be wise, they may not be economically "optimal" and may be unwieldy to implement.

One way to retain the simplicity of using renewable energy credits, while limiting the cost of the RPS program is to set a price cap. If REC prices get too high, as a result of low supply or high demand, the program administrator can offer "proxy credits" for sale at a fixed price. The price would be set slightly above the expected price of RECs. Look again at Part 3 of the Sample Compliance Sheet in Figure B-1. The power retailer can comply with the RPS simply by writing a check to the program administrator for the required number of RECs multiplied by the posted price cap. With a single transaction and a single payment, the retail provider has complied with the RPS. Of course, if RECs are cheaper on the open market, a retailer will save money by buying RECs.

The money collected by the program administrator would not simply disappear into the bureaucracy. Rather, the program administrator would spend the money on RECs in the market, seeking the lowest price and buying RECs until the fund is exhausted. In the example shown in Figure B-1, the administrator would use the $6,250 received from Green Power Inc. to buy RECs. If RECs were selling for 3¢ apiece, the administrator would buy 208,333 RECs, representing 208,333 kilowatt-hours of renewable energy production, instead of the 250,000 kilowatt-hours for which Green Power was responsible. This would save Green Power $1,250 in compliance costs, while supporting renewables to the greatest possible extent.

With a price cap, power retailers are protected against unanticipated shortages in the REC market, while generators (and their financial backers) are assured of a thriving market for RECs. To date, however, no state that has adopted the RPS has felt the need to adopt a price cap. Regulators have not judged the added costs for purchasing renewable energy to be burdensome enough to require one.

Figure B-1: Two Sources of Income for Renewable Generators

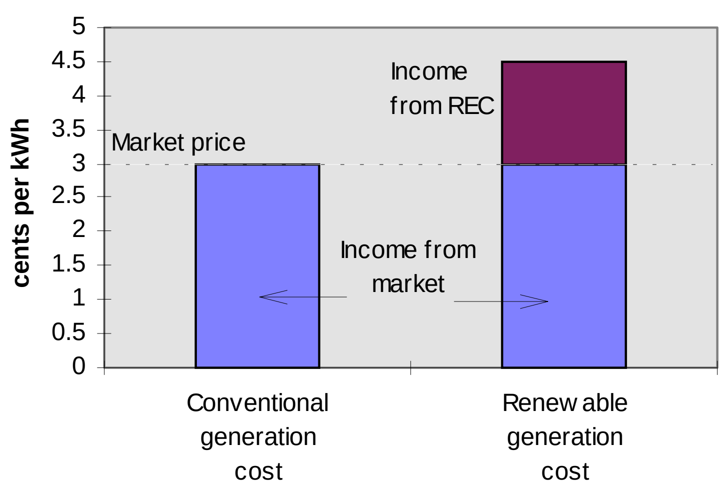


Figure B-2: Sample Compliance Sheet

Renewables Portfolio Standard Compliance Form

Company Name and Address: Green Power Inc., Sheboygan, Wisconsin

* *

Part One: Total REC Requirement

Total kWh sold in 1999:		10,000,000 kWh
x RPS requirement percentag		5%
equals Total Requirement for RECs		500,000 kWh

* *

Part Two: RECs Purchased

Total Requirement for RECs (from above)		500,000 kWh
less RECs attached to this form		250,000 kWh
equals Remaining Requirement	=	250,000 kWh

(If Remaining Requirement is equal to or less than zero, stop here.)

* *

Part Three: Price Cap Purchases

Remaining Requirement (from above):		250,000 kWh
x price cap ($0.025/kWh)	x	$0.025/kWh
equals Total remittance to the REC Purchase Fund	=	$ 6250

(Please attach check payable to REC Purchase Fund to this form.)

From Good Idea to Good Policy: Filling in the Details of the RPS

The renewable portfolio standard has the potential to move the United States along a path to sustainable energy, but only if the state and national governments make a commitment to it. This section examines some of the practical issues that could move the RPS from a good idea to good policy.

Choosing the Right Percentage for the RPS. The portfolio standard should be set at a level that can create a viable, predictable and safe market for a still young renewable energy industry. What is that level? At a minimum, it would maintain the current level of renewable generation we have now and lead to slow but steady growth over time. Retaining the level of existing generation does not necessarily mean retaining the same generators, since low-cost new generation should be able to compete against and displace high-cost existing generation. The RPS should also grow slowly over time, to allow the market for renewables to develop. Finally, the level should reflect societal values and goals for environmental protection, economic independence, and sustainability.

A study by the Union of Concerned Scientists and others, *Energy Innovations*, found that by following an "innovation path" of energy efficiency and low-polluting technologies, the United States could reduce greenhouse-gas emissions to 10 percent below 1990 levels by 2010, while reducing air pollution, saving money, and promoting economic development.[223] Under that scenario, renewable electricity would make up 14 percent of the US power supply by 2010. But even a 10 percent standard by 2010 would assure sufficient development of renewables to contribute substantially to that goal, while allowing market forces to increase renewables penetration further if they are the low-cost compliance option. (For details about state and federal standards enacted or proposed as of September 1998, see Appendix C.)

Costs of an RPS Program. Costs associated with renewable portfolio standards fall into four categories: the cost to consumers, the public costs of administering the program, the cost of the renewable energy credits, and the costs to private firms of carrying out the program.

Costs for public administration of the program would stem from handling claims for RECs from generators and retailers; overseeing, reviewing, and enforcing the program; and administering the price cap fund. These costs could be covered by fees collected for processing REC claim forms or by the general funds of the agency charged with administering the program. The process could be largely computerized, as the Environmental Protection Agency's sulfur dioxide allowance trading program is, thereby reducing management costs considerably. The combination of participant fees, computerization, straightforward forms and accounting, and stiff penalties to deter false claims means this program should not be costly to administer.

Prices for RECs will be a function of supply and demand. The portfolio standard will set the demand for RECs, a demand that will increase slightly each year. Power producers will determine the supply of RECs. Producers and retailers, through negotiation, will set the price.

Finally, the administrative cost to companies for trading RECs and complying with the standard should be small. Retailers will have numerous options for trading or may simply rely on brokers. The primary cost of an RPS program is the cost of the RECs, which directly supports renewables generation; low administrative cost is one of the distinguishing benefits of market-based regulation.

Regional Issues. If RECs are traded nationwide, some critics have argued that regions with a substantial base of renewables already in place, such as California, would be the sole or primary beneficiary of the RPS. This needn't be the case. A federal RPS can be designed to promote regional or state development of renewables. Current federal bills allow states to tailor the RPS to fit their needs.

For example, a sunny state like Nevada could require that 1 percent out of a 5 percent national REC requirement come from Nevada-based solar generators. Or it could require retailers to obtain 1 percent of their power from in-state solar plants, on top of the federal standard. And, to keep costs down, a state or region could set its own price cap.

Due to interstate commerce rules, state-level RPS laws probably cannot now require in-state siting of renewable generators. Such a law would arguably restrict interstate commerce. However, a federal law that allows for state-specific siting could overrule interstate commerce considerations.[224]

With or without a local standard, states could promote renewables development by providing tax incentives or development grants to energy developers. Public universities could provide research to identify renewable resources within a state. These complementary inducements would attract renewables developers to any state inclined to pursue them.

States also have the option of allowing the standard to be met entirely through nationally tradable RECs. This option permits states with less attractive renewable resources to contribute to meeting the national standard at the lowest possible cost.

Automatic Sunset and Ongoing Adjustments. In the transition to a fully competitive retail electricity market, some policymakers are worried about how long they should support renewables, energy efficiency, and low-income issues. They worry that these issues won't just go away in a competitive market, but that political support for ongoing funding may. Thus, many policy measures include sunset provisions or at least sunset reviews. California's $540 million "transition fund" for renewables ends after only four years, implying that renewables must be fully competitive by then.

Because of the way in which the RPS is designed, policymakers needn't worry about picking an end date for it. A goal of an RPS is to drive down the cost of the renewable energy through competition. If an RPS is successful and renewables become competitive with conventional generators, the value of the RECs will be driven down to almost nothing. In other words, a renewable power producer that can be profitable selling its power at market rates will be able to sell its RECs for less than any other generator on the market. Eventually, the RECs will be worthless, and the RPS will be obsolete.

If the renewables standard remains at the same level, the RPS requirement is likely to become increasingly irrelevant as prices for renewable energy decline. But the RPS approach also allows regulators to continue raising the standard so as to develop more renewables. Just as the Clean Air Act tightened emission standards over time, so too can an RPS require more clean energy production over time. If a 5 percent standard is met ahead of schedule and under cost, regulators can increase it to 6 or 7 percent, creating continual improvements. Renewables will always provide public goods that future legislators may want to continue to credit.

The RPS and Resource Diversity. By developing a market for nonfossil fuel and nonnuclear electricity, the RPS would take an important step toward diversifying the nation's energy supplies. Further increasing the variety among renewable energy sources would also provide diversity benefits. The RPS is designed to promote the technologies that are closest to being market-ready, such as wind, landfill gas, and in some areas, geothermal. But if other types of renewables—such as biomass and solar—are also developed, the stability of the entire US energy program will increase.

The RPS could be designed to explicitly promote different technology types. Arizona's standard, for example, focuses exclusively on solar energy, while Nevada's requires that half of new production to be from solar technologies. In California, RPS proponents recommended that part of the overall RPS percentage be set aside for biomass power, to support the large and troubled biomass industry in that state.

An alternative mechanism would be to set a limit on the use of any one or two technologies to meet the standard. Thus, a supplier could be limited to meeting the standard with no more than 60 percent of credits from any one technology, or 90 percent from any two technologies. This mechanism would preserve diversity without requiring government officials to pick technology winners.

A related issue is the conflict between existing and new renewable power plants. Some existing power plants may have already recovered their capital costs and need less support, while others may need to pass their costs along to the consumer. In most cases, new renewable plants will have difficulty competing with older plants. One proposed federal bill (Bumpers-Gorton) would use adjust the RECs to favor new renewables: it proposes giving energy from new renewables two credits, that from existing renewables one credit, and energy from large hydro dams a half credit.

Another solution (adopted in Connecticut and Massachusetts and proposed in Vermont) is to create separate portfolio standards for different tiers or classes of renewables. New renewables are assigned a separate minimum, growing standard. This mechanism allows new renewables to receive a price premium different from that needed to preserve existing renewables. New renewables are also allowed to compete to displace the class of existing renewables, ensuring that existing renewables continue to be supported only as long as their operating costs are less than the cost of building and operating new renewables.

Linking the RPS with the Public Benefits Trust Fund. The RPS is designed to bring a minimum percentage of renewables into the market at the lowest cost to society. The least-cost renewables will be the winners. But emerging technologies like photovoltaics and fuel cells—which cost more now but may have important future benefits—would not be viable in the near-term based solely on the value of renewable energy credits. A public benefits trust fund, created by a small charge on each kilowatt-hour of electricity, could support the research, development, and commercialization of innovative renewable technologies. It could also help to overcome specific market barriers, provide financing for renewables projects, and build renewable industry infrastructure. Connecticut and Massachusetts have adopted both portfolio standards and renewable energy trust funds.

The Relationship Between the RPS and "Green Marketing" of Electricity. A federal or state RPS is not incompatible with green marketing. It is a supply-side requirement—it doesn't specify how the power is sold, only that retailers must include it in their product mix. In a competitive market, retailers will sell renewable energy for whatever the market will allow, and many are likely to try to charge a premium for it as an "environmentally friendly" product. Since the RPS is a minimum standard, strong consumer demand could result in more power being produced than the RPS requires.[225] If demand is weak due to high prices, the RPS would ensure that the public desire for a clean environment is being addressed, at least at a minimum level.

The RPS is likely to affect the content of products offered as "green." If every power product has a minimum 10 percent renewable content, then green marketers will have to go beyond the minimum to attract a premium from environmentally-concerned consumers.

To Whom Should the Standard Apply: Retailers or Generators? Some of the legislative proposals require that retailers comply with the RPS, while others put the standard on electricity generators. It seems to make more sense to have retailers meet the RPS requirement, using RECs created by generation companies.

Power retailers will operate as intermediates between generation companies on one side and retail customers on the other, essentially assembling a "portfolio" for their customers. It would be a natural function of their business to incorporate renewable resources and RECs into their portfolios. They will be in the best position to decide whether they should buy RECs, buy power and RECs, or invest in their own renewable resource facilities and create RECs.

Generation companies will have a very different role. Their job will be to provide power to the wholesale market. In some cases, this could involve collecting a number of different power plants into a single product, but in many cases it wouldn't. Generators may or may not have regular contact with other generation companies, so may have limited ability to incorporate REC trading into their everyday operations.

Financial Effects on Renewable Resource Generators. The RPS does not pick winners and losers, and it does not guarantee an income for a power producer. It does guarantee that a share of the power market will come from renewable energy, but requires individual companies to fight for a piece of that share. Renewable energy companies will survive and thrive according to their ability to compete.

This competition, like competition in the broader market for electricity, will drive down costs and increase innovation. It will cause some generation companies, if they don't innovate to lower their costs, to go out of business. Likewise, low-cost generators that are already competitive could earn additional revenues from an RPS program. This is not necessarily a bad outcome for a number of reasons. First, it would reward the most cost-effective generators and provide them with incentives to expand low-cost output or build new plants. Second, it would provide an incentive to high-cost generators to work hard to lower their costs. And third, it would compensate these renewable generators for the environmental benefits their power provides. As with other industries, those that find ways to lower costs profit more and offer a cost target for others to pursue.

The RPS in Regulated Markets. The portfolio standard will work well in competitive markets, but it can be used to lower the cost of renewables in regulated utility markets as well. Without retail competition, an RPS is similar to a "set-aside," which a number of state legislatures and utility commissions have implemented. But instead of each company, or specific companies, complying with the standard, the suppliers can collaborate by means of tradable renewable energy credits. For example, one company may have superb wind or geothermal resources that others lack. By developing that resource and selling credits to other companies so that they can meet their share of the standard, the industry as a whole can meet the goal at the lowest cost to state consumers.

By having an RPS up and running under the current regulated system, utilities and regulators will be ready to implement renewable credit trading if competitive markets take over.

The RPS and Current Laws and Regulations. Because the RPS is not a subsidy program, it would not necessarily come into conflict with government tax credits or production credits for renewable generation. For example, a company producing renewable energy credits could still receive Renewable Energy Production Incentives authorized by the Energy Policy Act of 1992. The RPS also would not directly affect existing contracts formed under the Public Utilities Regulatory Policy Act (PURPA). It is possible that the RPS could cause generators or utilities to mutually end or change existing contracts, if the opportunity for added revenue from selling renewable energy credits (perhaps under a new long-term contract for credits) is more attractive than maintaining the existing power contract.

Unless specified otherwise, the Internal Revenue Service is likely to declare RECs to be taxable income for the renewable generators. Taxing RECs will reduce their value to the generators and produce additional tax revenues for the government. It would be preferable to declare RECs nontaxable. Alternatively, an offsetting tax cut could be implemented.

Choosing a Program Administrator. Candidates for administering a federal RPS include the Department of Energy, the Federal Energy Regulatory Commission, and the Environmental Protection Agency. Their state-level counterparts would be the state energy office, utility commission, and department of natural resources. One argument in favor of the DOE is that it does not have an adversarial relationship with potential RPS participants. FERC has extensive knowledge of the wholesale electricity industry. The EPA might also be an appropriate place to manage the program. First, the EPA has experience managing the acclaimed sulfur dioxide trading program. The RPS would be a similar but simpler undertaking, since there would be no emissions monitoring. Second, RECs represent the “clean” in clean power (among other attributes), so a case can be made for an environment-oriented agency to administer the program.

States have made differing choices. Massachusetts chose the state Division of Energy Resources (the governor’s policy office) to administer the program. Connecticut chose the Department of Public Utility Control. See Appendix C for more details about state RPS programs.

Whoever is chosen, the approach should be nonadversarial, problem-solving, promarket, and goal oriented. That is, the program administrator should set performance goals and seek to live up to them. Some of the administrative functions—such as REC purchases from the price cap fund or site audits—could, under appropriate circumstances, be contracted out to private firms.

Alternatives to the Price Cap Mechanism. By offering “proxy” credits at a price slightly above where RECs are expected to sell, as described above, the program administrator would limit the total cost of an RPS. As competitive forces drive down the price of RECs, the likelihood that retailers would ever pay this maximum decreases. The price cap option retains the cost-reducing power of market incentives while protecting buyers from unexpected upswings in REC prices.

The price cap is unlikely to become the “going price” for all RECs. First, retail providers have numerous options for acquiring RECs, so they will actively seek out lower-cost credits. Second, there are too many generators to coordinate a “REC cartel” and game the market. With dozens (perhaps growing to hundreds) of renewable resource generators spread all over the country, individual generators could easily lower their prices slightly and obtain the most secure contracts for RECs and power. Third, if renewable generation exceeds demand for RECs, some generators will not be able to sell the RECs they created, thus driving down prices. Finally, as a result of market-based innovation, the price for sulfur dioxide credits in the EPA’s acid rain reduction program has never risen to the "penalty" price cap; the RPS aims to stir the same market forces.

An alternative to the price cap would be to allow retail providers to petition the program administrator to reduce their REC targets or extend compliance dates. This approach has three weaknesses. First, it would require a bureaucratic investigation and decision, a process likely to be costly and time consuming. Second, the process would introduce uncertainty into REC markets. Renewable energy sellers (and investors) would not know how much of a market exists. Should they or should they not invest in a new plant? If they do, and then enough retail providers manage to postpone compliance, the generator could go bankrupt for lack of a REC market. Third, such an option would give retailers an incentive to resist compliance and violate the spirit of the law. It is far simpler to set a reasonable price cap and let the market decide which is the least-cost provider.

Penalties for Noncompliance. If a generator attempts to falsely certify RECs, a penalty could range from simply denying the request to imposing a fine to excluding the generator from certifying any RECs for a given period of time (thus missing out on credit payments). Penalties should be severe enough to deter submission of false claims. If a retail provider fails to comply—unlikely, given the price cap mechanism—the program administrator could impose a significantly higher penalty per required REC.

Self-Generators and Hybrid Fossil Fuel/Renewable Generators. Some companies have their own electricity generators that do not provide power to the larger electricity grid. Most self-generators use polluting, nonsustainable fuels, just like conventional generators. They should be required to participate in the RPS program just like any retailer of power. To ease administration and compliance, companies with small generators, perhaps 1 MW or less, might be exempted from participation.

Some power generation companies use both renewable power and conventional power in hybrid power plants. For example, solar thermal power plants in California use gas-fired turbines to provide power when needed. Renewable energy credits would only result from the renewable energy portion of a hybrid technology. Maine has chosen this approach for fossil fuel hybrids in draft RPS regulations.

Issues Relating to Energy Use across National Boundaries. The RPS is analogous to any other product safety or performance standard. For example, no matter where an airplane is manufactured, if it is used in the United States, it must meet US safety and performance standards. The RPS covers all power whose end use occurs in the United States, regardless of where the power or the power sales originate. Since all countries are treated equally under the RPS, it is unlikely to conflict with NAFTA or GATT trade rules.

Both Mexico and Canada have renewable energy generators that could qualify for RECs. Mexico has a 100 MW geothermal facility that has historically sold power into the US market, while Canada has some wind facilities and some small-scale hydropower. If these companies are supplying power to the United States, they should be allowed to apply for and receive RECs from the program administrator. Similarly, retailers located in Canada or Mexico who sell power in the United States would need to acquire credits for the US portion of their sales.

Appendix C

The Renewables Portfolio Standard

Implementation Status as of November 1998

Status

As of December 1998, renewables portfolio standards had been adopted in Arizona, Connecticut, Maine, Massachusetts, and Nevada, passed by the Vermont senate, and filed in bills in Nebraska, New Jersey, New Mexico, Delaware, Kansas and Wisconsin (see table C-1).[226] In Pennsylvania, some individual utility settlements have been adopted which provide for a minimum renewables requirement for a default provider to serve up to 20 percent of non-switching customers.[227] A number of federal restructuring bills also have RPS provisions, including those proposed by Representative Daniel Schaefer (R-Colorado), Representative Edward Markey (D-Massachusetts), Senator Dale Bumpers (D-Arkansas), Senator James Jeffords (D-Vermont), and the Clinton Administration (see table C-2).

Implementation Issues

Renewables portfolio standards can be implemented in a variety of ways, as discussed below. No two states adopting renewables portfolio standards (RPS) have chosen the same approach to date.

Credit Trading. As originally proposed by the American Wind Energy Association, the RPS would allow companies to meet their obligation by generating or purchasing renewable energy, or by buying tradable credits from other suppliers. Credits would be created as renewable power is created, with one credit representing one unit of electricity. Renewable energy generation companies would sell credits to retailers who need them to meet the RPS standard. This approach is based on the credit-trading program for sulfur dioxide emissions instituted by the Clean Air Act: utilities that can make low-cost reductions of sulfur dioxide can sell excess credits to utilities facing higher compliance costs, resulting in an economically optimal result. Appendix B discusses in detail how an RPS credit trading system would work and the advantages of this approach.

All federal bills introduced to date have included renewables credit trading. The National Association of Regulatory Utility Commissions has passed a resolution endorsing credit trading for implementing any minimum renewable energy requirements. So far, however, no states adopting an RPS have required credit trading. The Connecticut restructuring law allows the Department of Public Utilities Control to implement credit trading. Arizona and Nevada are considering tradable credits. The Massachusetts law requires the Division of Energy Resources to study credit trading and report to the legislature, which would need to adopt new legislation to implement credit trading. The Maine Public Utilities Commission tentatively decided against credit trading in its draft RPS regulations, stating that it is inconsistent with the intention of New England state commissions to track kilowatt-hour sales in order to inform customers of each utility's fuel mix and emissions.[228] However, if the national system to verify sulfur dioxide emission reductions—which uses credits to determine compliance with regulations—does not conflict with the proposed disclosure mechanism, it is unclear why a credit system to verify compliance with an RPS would either.

Cost Caps. One potential disadvantage of renewables portfolio standards is that the cost of the policy is not defined. Appendix B describes a cost cap mechanism that can address this issue where it may be a concern. To date, however, no state adopting a portfolio standard has enacted a cost cap, although individual utility settlements in Pennsylvania include caps. Originally, the RPS passed by the Massachusetts House of Representatives included a cap, but the Senate and conference committee discarded it. At the federal level, the administration's restructuring bill includes an RPS with a cost cap, which sets a 1.5 cent per kWh maximum price for renewable energy credits.

Level of the Standard. Determining the level of the standard may be the most difficult decision in RPS implementation. In Maine, the legislature set the requirement at 30 percent of retail sales. Because Maine had the highest level of renewables generation in the country (approximately 50 percent of generation) in 1995, its RPS was intended to ensure that a large portion of existing renewables generation continues to operate after restructuring. It could also lead to development of new renewables if sales increase over time.

Connecticut and Massachusetts adopted separate standards for existing renewables and for new renewables. The Connecticut law clearly requires existing renewable technologies, labeled Class II technologies, to maintain their current 5.5 percent of sales and to increase to 7 percent of sales by 2009. Class I technologies—which are new, emerging technologies—must increase yearly to 6 percent of sales by 2009. Class I technologies can also displace existing Class II renewables if they are more cost-effective.

The Massachusetts law is somewhat ambiguous about the level of existing renewables included in the RPS. The law directs the Division of Energy Resources to set a standard for renewables, with *new* renewables (built after 1997) increasing to “an additional” 1 percent by 2003, 4 percent of sales by 2009 and 1 percent per year thereafter. Some Massachusetts stakeholders have interpreted the requirement to apply *only* to new renewables. Others believe that the phrase “an additional” means that the state must protect the existing level of renewables and ensure that new renewables add to that level, requiring in effect a two-tier standard.

The Vermont Senate has passed a two-tier RPS that would preserve existing sales of 15 percent renewables and add 4 percent from new renewables by 2007.

The advantage of a two-tier proposal is that it assures the continued development of new projects and technologies. Without such a requirement, the entire RPS in Connecticut, Massachusetts, or Vermont could be met by existing renewables in Maine or Canada, without stimulating any new renewables development. In addition, the two tiers mean that the incremental cost of meeting the standard in each tier can be different. If the cost of continuing to operate existing renewables is much lower than the cost of developing new renewables, the credit price for existing renewables will also be much lower, thereby reducing the cost of the RPS to customers.

The level of the RPS passed in Connecticut and Massachusetts, and proposed in Vermont, is approximately the level that the Union of Concerned Scientists had recommended, based on the availability and cost of renewables in the region and on an analysis of the regional contribution to goals for sustained orderly development nationwide.[229] UCS estimated that the RPS should increase gradually to 1 to 2 percent of electricity revenues by the end of the 10-year period. A preliminary estimate by the Massachusetts Division of Energy Resources was also about 2 percent in 2009.

The renewables portfolio standards passed in Arizona and Nevada focus on developing new renewables. Nevada would increase new renewables generation to 1 percent of sales by 2009. The Arizona Corporation Commission originally approved a solar portfolio standard of 0.5 percent of sales by 1999 and 1 percent of sales by 2002. This proposed Arizona standard would have increased rates by 0.6 percent to 1.7 percent by 2010, according to the state energy office.[230] The requirement was subsequently modified to 0.2 percent by 1999 and 1 percent by 2003, remaining in place until 2012.

Pennsylvania utility settlements start with the default provider supplying 2 percent renewables, increasing at 0.5 percent per year, with a cost cap.

The federal bills would all begin at approximately the level of existing renewables generation—about 2.5 percent of generation—and increase over time. They would reach at least 4 percent of sales by 2010 in the Schaefer bill, 10 percent of sales by 2010 in the Markey and Jeffords bills, and 20 percent of sales by 2020 in the Jeffords proposal. The national Sustainable Energy Coalition has recommended that the level be set at 10 percent of sales by 2010, based on general considerations of sustained orderly development, environmental protection, fuel diversity, and national security. Over 200 environmental, consumer, and business organizations have endorsed a platform including this goal.[231]

In-State vs. Out-of-State Generation. Nevada and Arizona have required that the RPS be met using generation located in the state. The New England states allow the requirement to be met with any generation sold to customers in the state, whether generated in state or not. A standard in which all generators can compete to meet the RPS, irrespective of location, may be more likely to withstand potential challenges to the Commerce Clause of the US Constitution.[232]

Eligible Resources and Technologies. States have adopted very different RPS eligibility requirements, depending on resource availability and costs. Arizona, for example, has required that its standard be met exclusively by solar technologies. At least half of Nevada's requirement must be met by solar.

Each New England state has adopted slightly different eligibility requirements. Maine allows the RPS to be met using hydroelectric generation from plants smaller than 100 MW, as well municipal solid waste (MSW) facilities, and cogeneration plants under 100 MW, even if fueled by natural gas. Massachusetts and Connecticut allow MSW and hydroelectric plants to meet the requirement for existing renewable technologies, but not the requirement for new technologies. All three New England states allow fuel cells to qualify as new renewables, even if natural gas is used as the fuel.[233] Some environmental groups had urged fuel cells to qualify as a low-emission bridge to a renewable hydrogen fuel technology. Connecticut is also home to a major fuel-cell manufacturer.

Most federal proposals exclude hydropower. The proposal by Senator Bumpers includes hydropower, but grants large hydro plants only half the credit granted to other existing renewables. New renewables would earn double credit under the Bumpers bill.

Appendix D

Public Benefits Funding

Implementation Status as of November 1998

Status

As of December 1998, Arizona, California, Connecticut, Illinois, Massachusetts, Montana, New Mexico, New York, Rhode Island and some Pennsylvania utilities have set specific funding levels for either renewables or for a range of purposes that include renewables (see table D-1). California and Rhode Island have begun disbursing funds to renewables developers. On the federal level, bills by Representative Edward Markey (D-Massachusetts), Senator James Jeffords (D-Vermont), and the Clinton Administration have included public benefits funding for renewables.

Implementation Issues

There are many methods of raising and spending public benefit funds. The funding variations reviewed here are those that had been proposed and adopted in various jurisdictions as of September 1998.

Level of the Fund. Thus far, in most states postrestructuring funding levels for public benefits programs have approximated the level of funding provided by regulated utilities prior to restructuring. Some states, such as Massachusetts and Rhode Island, have reduced funding for energy efficiency somewhat, but increased funding for renewables, on the assumption that the market would stimulate more efficiency investment, especially for commercial and industrial customers.[234] Illinois instituted modest funding for efficiency and for renewables in restructuring legislation, despite no previous utility spending in these areas.

Most states have implemented uniform, statewide public benefits funding in legislation and regulation. In New York, however, where the Public Service Commission approved individual utility restructuring settlements, public benefits funding levels have also been set company by company to approximate prerestructuring levels.

Connecticut's restructuring legislation significantly increased public benefits funding from earlier levels. Energy efficiency funding was restored to peak historical levels of 0.3 cents per kWh (3 mills/kWh), reversing cuts that had been made over several years prior to restructuring. In addition, Connecticut adopted funding for renewable energy of 0.5 mills/kWh for the first two years of restructuring, followed by two years at 0.75 mills/kWh and 1 mill/kWh thereafter. The Union of Concerned Scientists had proposed a minimum level of funding of 1 mill/kWh in New England, based on analysis of a regional contribution to a national scenario for sustained orderly development of renewables.[235]

Arizona has established a system benefit charge to fund a solar hot water heater rebate program, with $200,000 in 1999, increasing by $200,000 annually to $1 million in 2003. The state's SBC also includes energy efficiency, nuclear fuel disposal, and public benefit R&D, in addition to the low income, environment, renewables, and nuclear power plant decommissioning.

New Mexico has established a charge equal to 0.5 percent of each customer's bill, approximately the same percentage of revenues as in Massachusetts and Connecticut. Funding would go half to solar and half to a bidding process for other renewables.

Duration of the Fund. States have varied greatly in the duration established for public benefits funding. California and Rhode Islands, the first two states to restructure, approved public benefits funding for four years. New York set funding levels for only three years. Massachusetts and Connecticut established efficiency funding levels for five years, but indefinite funding for renewables. Illinois approved a ten-year funding plan.

Structure of the Charge. Most of the public benefits funds adopted and proposed at the state level charge distribution company customers a fee for each kilowatt-hour of electricity consumed. Illinois structured its public benefit funding on a flat charge per class of customer. Residential electricity customers pay 2.5 cents per month; nonresidential customers using less than 10 MW pay 25 cents per month, and customers using over 10 MW pay $17.75. Because the Illinois charge is so small, the state's flat charge per residential customer approximates what a charge based on usage would cost. However, large commercial and industrial customers pay significantly less than they would if charged per kWh.

Administering Entity. States have generally chosen either state energy offices or economic development agencies to administer renewables funds. California and New York have designated state energy agencies—the California Energy Commission and the New York State Energy Research and Development Agency—to administer their renewables funding, because both of these agencies had significant renewable energy development programs prior to restructuring. The Connecticut, Illinois, and Massachusetts restructuring bills designated quasipublic economic development agencies to implement their funds, reflecting a desire to stimulate new renewables business development. Boards with stakeholder representation will provide input and oversight to fund managers. In Rhode Island, a collaborative stakeholder process, with oversight by the Public Utilities Commission, guides both renewables and energy-efficiency spending. In most other states, distribution companies—with oversight by the utility commission—retain responsibility for administering energy-efficiency spending.

Funding Strategies and Mechanisms. A number of different funding strategies have been proposed and implemented to date. California's strategy is the most developed, with different mechanisms created to support different states of renewables development. California's restructuring law (AB 1890) established $540 million in funding for existing, new, and emerging renewables in the state over a four-year period. Following the recommendations of the California Energy Commission, with stakeholder input, SB 90 adopted specific allocation and distribution mechanisms. Existing technologies are eligible for $243 million, with monthly generation payments. Based on their competitiveness, technologies are classified in three tiers, with different maximum support payments for each tier. New renewables projects are eligible for $162 million awarded by an auction for price supports. Awards have been made to a total of 600 MW of new wind, geothermal, biomass, landfill gas and small hydro, at an average level of 1.2 cents per kWh.

For emerging technologies (photovoltaics, small wind turbines, solar thermal and fuel cells), $54 million is being used to reduce the price of new installations. Decreasing incentives are provided each year over five years, in the maximum incentive per watt of system output and the maximum incentive as a percentage of the total system cost.

A customer credit account of $75.6 million pays an incentive of 1.5 cents per kWh to customers choosing to buy power from in-state renewables. Finally, $5.4 million was allocated to a consumer education account, for which expenditures are still in the planning stage.[236]

In Rhode Island, a $20 million annual energy efficiency and renewables fund is expected to spend about $2 million on renewables in 1998. A renewable energy collaborative first sponsored studies of the market potential of specific technologies in Rhode Island and Massachusetts. Rhode Island made initial project awards in June 1998. One helped a solar company to buy down the cost of installing photovoltaics at 500 homes, schools, and nonprofit organizations. The other enables a wind energy developer to investigate coastal wind sites. Money for permitting and project development has also been allocated, pending completion of the feasibility study.

The New York State Energy Research and Development Authority has published a notice announcing it will co-fund one or two wind developments of at least 4 MW for up to $6 million.[237]

The Massachusetts Renewable Energy Trust Fund was established to support renewable energy for electricity customers and the development of Massachusetts renewable energy businesses. The fund will collect approximately $200 million over five years, and $20–25 million each year thereafter. For the first five years, about $10 million each year is dedicated to retiring waste-to-energy plants or installing pollution controls on them.

The restructuring law authorized a broad range of funding mechanisms to support renewables product and market development, pilot and demonstration activities, production incentives, training and public information, research and development, and investment to support renewables projects, enterprises and institutions. The Massachusetts law seeks to leverage private investment to create a larger pool of capital and to familiarize private investors with renewable energy.

A lawsuit challenging the constitutionality of the Massachusetts fund has been filed alleging that it is an unconstitutional discriminatory tax, since funding is provided by investor-owned utility customers but not by municipally-owned utilities, which are not subject to the electricity restructuring law. Until the lawsuit has been resolved, the fund is unlikely to support projects. Nevertheless, the Massachusetts Technology Collaborative, a quasipublic agency designated by the legislature to manage the fund, has assumed that the lawsuit will be resolved and has hired consultants, Bain & Co. and Arthur D. Little, to develop a business plan.[238]

At the national level, Richard Cowart, chair of the Vermont Public Service Board, proposed a National System Benefits Trust that would provide matching funds to states to support energy efficiency, low-income energy assistance, and research and development on renewables.[239] This approach is parallel to the Universal Service Support in the telecommunications industry and the Airport and Airway Trust Fund, which provides for public safety in air transit. Federal bills introduced by Representative Peter DeFazio, Representative Kucinich, Senator James Jeffords, and the Clinton Administration include such a provision.

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[21] George Lobsenz, "EPA Orders Utilities to Assess, Disclose Mercury Emissions," *Energy Daily*, November 18, 1998.

[22] See the US Environmental Protection Agency web site at www.epa.gov.

[23] These results are based on a hypothetical "climate policy" scenario that assumes carbon dioxide emissions would be reduced 15 percent below 1990 levels in developed countries and 10 percent below 1990 levels in developing countries. See *The Hidden Benefits of Climate Policy: Reducing Fossil Fuel Use Saves Lives Now,* Resources for the Future, 1997.

[24] Reactor Safety Study—An Assessment of Accident Risks in U.S. Commercial Power Plants, U.S. Nuclear Regulatory Commission WASH-1400 (NUREG 75/014), Washington, D.C., October 1975, Cited in The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study, Union of Concerned Scientists, Cambridge, MA, Aug. 1977.

[25] David Lochbaum, *The Good, the Bad, and the Ugly: A Report on Safety in America's Nuclear Power Industry,* Union of Concerned Scientists, June 1998, on line at www.ucsusa.org.

[26] US General Accounting Office, *Nuclear Regulation: Preventing Problem Plants Requires More Effective NRC Action,* RCED-97-145, May, 1997.

[27] US Nuclear Regulatory Commission, *Independent Safety Assessment Report for Maine Yankee Atomic Power Company*, 1996.

[28] US Department of Energy, *Integrated Data Base Report—1995: US Spent Nuclear Fuel and Radioactive Waste Inventories, Projections and Characteristics,* DOE/RW-0006, Rev. 12, December 1996.

[29] US Environmental Protection Agency, *Low Level Radioactive Waste,* p. 3, on line at www.epa.gov./radiation/radwaste/llw.htm.

[30] US Environmental Protection Agency, "Setting Environmental Standards for Yucca Mountain," fact sheet, on line at www.epa.gov/radiation/yucca/factrev.htm.

[31] Jim Riccio, *Questioning the Authority*, Public Citizen, April, 1998. On-line at www.citizen.org

[32] Washington International Energy Group, *Need for Natural Gas Increases With More Nuclear Shutdowns, Washington International Energy Group*, May 1998, on line at http://www.wieg.com/nu/narchive.htm#Nuclear Industry/Regulation.

[33] For example, in the winter of 1995–96, natural gas prices rose to $31 per million Btu, an increase of about 15 times above normal prices. Strategic Energy Ltd., "Weathering the Winter Without Interruptions," *Energy Watch*, March 11, 1996, on line at www.sel.com/ew031196.html. See also John Herbert, James Thompson, and James Todaro, "Recent Trends in Natural Gas Spot Prices," *Natural Gas Monthly*, December 1997.

[34] Comments of Associated Industries of Massachusetts, to the Massachusetts Department of Public Utilities, 96-100, April 24, 1996, p. 12.

[35] New England Governors' Conference, *Assessing New England's Energy Future,* A Report of the Regional Energy Assessment Project (REAP), December 11, 1996, p. V-6.

[36] Colin Campbell and Jean Laherrere, "The End of Cheap Oil," *Scientific American*, March 1998, pp. 78-83.

[37] US Department of Energy, *Dollars from Sense: The Economic Benefits of Renewable Energy,* 1998, on line at http://www.eren.doe.gov/utilities/pdfs/dollars.pdf. Includes many excellent examples of renewables/economic development synergy.

[38] The US geothermal industry as a whole employs about 40,000. According to the National Corn Growers Association the corn-to-ethanol industry employs about 55,000 people (5,800 direct and 48,900 indirect).

[39] Michael Brower, Michael Tennis, Eric Denzler and M. Kaplan, *Powering the Midwest: Renewable Electricity for the Economy and the Environment*, Union of Concerned Scientists, 1993

[40] Jamie Chapman, OEM Development Corp. and Steven Wiese, Planergy, Inc., *Expanding Wind Power: Can Americans Afford it?,* Renewable Energy Policy Project Research Report No. 6, October 1998. Available on-line at http://www.repp.org/index_ar.html

[41]*The Effect of Wind Energy Development On State and Local Economies*, National Wind Coordinating Committee, Wind

Energy Series No. 5, January 1997.

[42] Brower et al., *Powering the Midwest*, Union of Concerned Scientists, 1993, pp. 107–108. The study assumed 400 MW of wind, 110 MW conventional biomass, and 300 MW advanced biomass. Energy-employment studies are necessarily resource- and region-specific.

[43]A.K. Sanghi., *Economic Impacts of Electricity Supply Options*, New York State Energy Office, July 1992.

[44] Skip Laitner and Marshall Goldberg, *Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy,* April 1996. on line at http://solstice.crest.org/renewables/era/index.html. Similar conclusions were found for the US and for nine other states studied.

[45] Jan Smutney-Jones and John Stewart, San Jose Mercury News, November 22, 1998,

[46] American Wind Energy Association, *Wind Energy and Climate Change: A Proposal for a Strategic Initiative*, October 1997, on line at www.igc.org/awea/pol/ccwp.html.

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[48] T.E. Hoff, H.J. Wenger, and B.K. Farmer, "The Value of Deferring Electric Utility Capacity Investments with Distributed Generation," *Energy Policy*, March 1996. H.J. Wenger, T.E. Hoff, and B.K. Farmer, *Measuring the Value of Distributed Photovoltaic Generation: Final Results of the Kerman Grid-Support Project,* First World Conference on Photovoltaic Energy Conversion, Waikoloa, Hawaii, December 1994.

[49] Michael Tennis, Alan Nogee, Paul Jefferiss, and Ben Paulos, *Renewing Our Neighborhoods: Opportunities for Distributed Renewable Energy Technologies in the Boston Edison Service Area*, Union of Concerned Scientists, August 1995.

[50] Utility Photovoltaic Group, *Utility Planning for PV Systems*, Part 3, June 1994, p. 29.

[51] T. Hoff, H.J. Wenger, and B.K. Farmer, *The Value of Grid-Support Photovoltaics in Providing Distribution System Voltage Suppor*t, presented at the Solar 94 Conference, American Solar Energy Society, San Jose, Calif., June 1994.

[52] Barbara Farhar, *Trends in Public Perceptions and Preferences on Energy and Environmental Policy*, National Renewable Energy Laboratory Report TP-461-4857, February 1993. See also *Energy and Environment: The Public View*, Renewable Energy Policy Project Issue Brief, November 1996, on line at www.repp.org.

[53] US Energy Information Administration, *Renewable Energy Annual 1997*, Volume I, October 1997, DOE/EIA-0603(97).

[54] Michael Brower, *Cool Energy: Renewable Solutions to Environmental Problems,* MIT Press, 1992.

[55] Steven Clemmer, Alan Nogee and Michael C. Brower, *A Powerful Opportunity: Making Renewable Electricity the Standard*, Union of Concerned Scientists, November 1998.

[56] Energy Information Administration, Office of Integrated Analysis and Forecasting, *Analysis of S. 687, the Electric System Public Benefits Protection Act of 1997*, prepared for Senator James M. Jeffords, February 1998, SR/OIAF/98-01. EIA also modeled two RPSs gradually increasing over time to 5 percent and 10 percent of total US electricity generation in 2020 for *Annual Energy Outlook—1998: With Projections to 2020*, December 1997, DOE/EIA-0383(98), on line at http://www.eia.doe.gov/oiaf/aeo98/homepage.html..

[57] Consumers gas savings and the impact on electricity sales from higher electricity prices under the RPS were calculated by UCS based on the detailed results of EIA's analysis, generated by the National Energy Modeling System and provided to us by EIA staff.

[58] Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Tellus Institute, and Union of Concerned Scientists, *Energy Innovations: A Prosperous Path to a Clean Environment*, Washington, DC: Alliance to Save Energy, 1997.

[59] The cost per ton of carbon dioxide saved comes from an update to *Energy Innovations* called *Policies and Measures to Reduce CO2 in the United States: An Analysis of Options Through 2010*, by the Tellus Institute and the World Wildlife Fund, 1998.

[60] Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies, *Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2010 and Beyond*, Oak Ridge, Lawrence Berkeley, Argonne, Pacific Northwest, National Renewable Energy Laboratory, 1997, on line at www.ornl.gov/ORNL/Energy_Eff/CON444.

[61]Barbara Farhar and Ashley Houston, *Willingness to Pay for Electricity from Renewable Energy*, National Renewable Energy Laboratory, 1996, on line at www.eren.doe.gov/greenpower/willing.html.
See also Kari J. Smith, *Customer-Driven Markets for Renewably Generated Electricity,* California Regulatory Research Project, 1-96, 1996.

[62] See David Moskovitz, *Renewable Energy: Barriers and Opportunities, Walls and Bridges,* World Resources Institute, July 1992.

[63] Utility Photovoltaic Group, *The Utility Experience Base with PV Systems*, Part 2, June 1994, p. 21.

[64] Paul Maycock, "Spire PV Module Manufacturing Cost at $1.78/Watt," *PV News*, Jan. 1998, p. 3

[65] For example, suppose a wind turbine installed today looks more expensive than a natural gas plant for the first five years, but is projected to be less expensive than the gas plant as fuel prices rise over the 20- to 30-year life of the wind turbine. Suppose also that wind turbines are projected to be much cheaper five years from now than they are today, based on increasing wind production volumes. In this case, a developer might select the gas plant, which is cheap in the short-run, and wait for the less expensive wind turbines to emerge later. But if all developers wait, the production volumes would not be achieved and the wind costs would never come down.

[66] For an analysis of subsidies to oil, principally in the transportation sector, see Roland Hwang, *Money Down the Pipeline: Uncovering the Hidden Subsidies to the Oil Industry,* Union of Concerned Scientists, September 1995.

[67] Fred J. Sissine, *Renewable Energy: A New National Commitment?* Science Policy Research Division, Congressional Research Service, Library of Congress, updated August 26, 1994. Figures are in 1992 dollars.

[68] *Ibid.*

[69] Public Citizen, "DOE Releases FY 1997 Budget," March 19, 1996.

[70] Dallas Burtraw, *Renewable Energy Tax Issues,* Resources for the Future, US Department of Energy, Office of Utility Technologies Analysis Workshop, July 23, 1996.

[71] Note that this credit is available only through July 1999, and only for closed-loop facilities, none of which are currently under construction or planned. Efforts are under way to try to extend and expand the tax credits.

[72] Dallas Burtraw, US Department of Energy Office of Utility Technologies Workshop, Washington D.C., July 23, 1996. See also Alec F. Jenkins, California Energy Commission, Sacramento, California, Richard A. Chapman, Consulting Engineer, San Jose, California, Hugh E. Reilly, Sandia National Laboratories, Albuquerque, New Mexico, *Tax Barriers to Four Renewable Electric Generation Technologies*, http://www.energy.ca.gov/development/tax_neutrality_study and

Stanton Hadley, Lawrence Hill, and Robert Perlack, *Report on the Study of the Tax and Rate Treatment of Renewable Energy Projects*, Oak Ridge National Laboratory, ORNL-6772, December 1993. This study found net tax penalties for utility-owned solar and hydro, but net incentives for utility-owned wind and biomass energy crops, thanks to production tax credits that expire in 1999. For nonutility generators, which are responsible for most renewables development, all renewables have net tax penalties compared with conventional sources, even with production tax credits.

[73] US Energy Information Administration, *Federal Energy Subsidies Direct and Indirect Interventions in Energy Markets,* DOE/EIA-EMEU/92-02, on line at www.eia.doe.gov/bookshelf/multi.html.

[74] Nancy Rader and Richard Norgaard, "Efficiency and Sustainability in Restructured Electric Utility Markets: The Renewables Portfolio Standard," *Electricity Journal*, July 1996.

[75] Ryan Wiser and Steven Pickle, *Green Marketing, Renewables, and Free Riders: Increasing Customer Demand for a Public Good*, Lawrence Berkeley National Laboratory, LBNL-40632, September 1997.

[76] For a good case study in small business purchases of renewable energy, see Edward Holt, *Green Power for Business: Good News from Traverse City*, Renewable Energy Policy Project, Washington, D.C., July 1997. Available on-line at http://www.repp.org/index_ar.html

[77] Evan Jones and Joseph Eto, *Financing End-Use Solar Technologies in a Restructured Electricity Industry: Comparing the Cost of Public Policies,* LBNL-40218, UC-1321, September 1997. Also Ryan Wiser and Edward Kahn, *Alternative Windpower Ownership Structures: Financing Terms and Project Costs,* Lawrence Berkeley Lab, LBNL-38921, May 1996. Both on line at eande.lbl.gov.

[78] Kevin Porter, "Open Access Transmission and Renewable Energy Technologies," Topical Issues Brief, National Renewable Energy Lab, NREL/SP-460-21427, September 1996. See also Steven Stoft, Carrie Webber and Ryan Wiser, *Transmission Pricing and Renewables: Issues, Options and Recommendations*, Lawrence Berkeley National Lab, LBNL-39845, May 1997.

[79] Farhar, ibid. For up-to-date information on green markets, also see the Green Power Network web site: http://www.eren.doe.gov/greenpower/

[80] Marketing Intelligence Service, Naples, NY, cited in Land and Water Fund of the Rockies and Community Office for Resource Efficiency, *Promoting Renewable Energy in a Market Environment: A Community-Based Approach for Aggregating Green Demand*, May 1997, p. 9

[81] Steven Rothstein and Jeffrey Fang, Green Marketing in the Massachusetts Electric Company Retail Competition Pilot Program, National Renewable Energy Laboratory, NREL/TP-260-23507, October 1997. The pilot program was only conducted in four towns, one of which was a very liberal college town. Participants in the pilot were self-selected. Consequently, many of those choosing to participate did so because of interest in the green products.

[82] Barrett Stambler and Andrea Kelly, "The Portfolio Approach to Green Power," Third National Green Power Conference, Sacramento, CA, June 25-26, 1998. http://www.eren.doe.gov/greenpower/3gp_conf.html. see also Blair G. Swezey, Ashley H. Houston and Kevin L. Porter, "Green Power Takes Off With Choice in Electricity," *Public Utilities Fortnightly*, August 1998. http://www.eren.doe.gov/greenpower/pufweb.html#6fn.

[83] Edward Holt, Green Power for Business: Good News from Traverse City, Renewable Energy Policy Project Research Report No. 1, July 1997.

[84] Rudd Mayer, "The Value of Marketing Partnerships," Third National Green Power Conference, Sacramento, CA, June 25, 1998 http://www.eren.doe.gov/greenpower/3gp_conf.html

[85]Jim Cooke, Toyota Motor Sales USA, "Toyota's Green Power Commitment," Third National Green Power Conference, Sacramento, CA, June 25, 1998 http://www.eren.doe.gov/greenpower/3gp_conf.html

[86]For surveys of green pricing program results and design issues, see Edward Holt, *Green Pricing Resource Guide*, The Regulatory Assistance Project, Gardiner, ME, February 1997. www.rapmaine.org. See also Edward Holt, "Green Power: Where We've Been, Where We're Going," Third National Green Power Conference, Sacramento, CA, June 25, 1998 and Terry Peterson, "Green-Pricing Scorecard," Third National Green Power Marketing Conference, Sacramento, CA, June 25-26, 1998. http://www.eren.doe.gov/greenpower/3gp_conf.html.

[87] Tom Rose, TU electric, "TU Electric Deliberative Poll Summary Results: Residential Participants", October 23, 1988.

[88] In the Massachusetts pilot program described above, where 31 percent of participating residential customers chose green options, only 3 percent of commercial customers did. Ibid.

[89] Yankee Group market research cited in Marci Bailey, "Dialing a better deal," *Boston Globe*, Sept. 15, 1997, p. B4.

[90] Ryan Wiser and Steven Pickle, Selling Green Power in California: Product, Industry, and Market Trends, Lawrence Berkeley National Laboratory, LBNL-41807, May 1998.

[91] For a comprehensive guide to existing state financial incentives and regulatory policies on renewables, see the North Carolina Solar Center, Database of State Incentives for Renewable Energy, Interstate Renewable Energy Council, New York, January 1998, on line at www-solar.mck.ncsu.edu/dsire.htm.

[92] See Jan Hamrin and Nancy Rader, *Investing in the Future, A Regulator's Guide to Renewables,* The National Association of Regulatory Utility Commissioners, Washington, D.C., February 1993 for a thorough description of pre-restructuring status of renewables development and policies. Among the most important policies for aggressively implementing PURPA were providing standard long-term contracts, basing the long-run contract price on the cost of avoiding new utility power plants, allowing front-loaded payments, or setting special rates for renewable electricity.

[93] Mark Crawford, "Tax Credit Expiration Threatens Gusting Wind Power Industry, *Energy Daily*, November 2, 1998, p. 1.

[94] State Renewable Energy News, NARUC Subcommittee on Renewable Energy, Fall 1998. Order (Docket No. 97A-297E) available on-line at: http://www.sni.net/~pucsmith/new.htm

[95] The Iowa mandate is for 105 MW of *average* production, not peak production. An intermittent resource like wind power has a low "capacity factor," which means it would

require more than 105 MW of peak or "nameplate" capacity to meet the Iowa law. For example, if a wind power plant produces full power 33 percent of the time, it would require 315 MW of peak capacity to produce 105 MW of average capacity. Biomass power plants can produce power at full output more often—typically around 75 percent of the time. So a biomass plant could produce 105 average MW with a 140 MW plant.

[96] *State Renewable Energy News*, NARUC Subcommittee on Renewable Energy, Fall 1998.

[97] For a detailed analysis of how these and other policies affect the potential for wind energy especially, see also Nancy Rader and Ryan Wiser, *Strategies for Supporting Wind Energy: A Review and Analysis of State Policy Options*, Prepared for the National Wind Coordinating Committee, 1998 release pending.

[98] Because most of the minimum requirements are based on electricity sales, the renewables capacity is estimated based on an assumed mix of resources. Actual capacity will differ based on which technologies win the competition to fill the Renewables Portfolio Standards. The Maine renewables estimate drops in the year 2000 because the RPS which takes effect that year is equal to 30% of sales, whereas existing renewables in Maine are 45-50% of sales. The Massachusetts estimate assumes that an ambiguity in the restructuring law is resolved to require preserving the existing level of renewables, as well as requiring development of new renewables.

[99] Janice Massy and Lyn Harrison, "Fixed Quotas Most Favored Option: European Union takes first step for Directive on renewables," *Windpower Monthly*, Denmark, April 1998. P. 22. Abstracts available on-line at http://www.wpm.co.nz/.

[100] UCS Senior Scientist Donald Aitken popularized the concept of sustained orderly development in "Sustained Orderly Development of the Solar Electric Technologies," *Solar Today*, May/June 1992.

[101] Regulatory Assistance Project, Making Room for Renewables, Issues letter, July 1996, on line at www.rapmaine.org/issue.html. A Non-Fossil Fuel Obligation (NFFO) levy of up to one percent of revenues goes into a pool, which the system administrator distributes to the winning bids, using a request-for-proposals (RFP) process. The administrator establishes the amount of power to be acquired and the RFP criteria. The NFFO levy was designed to enable enough new renewables to be developed to supply 3 percent of system capacity by the year 2000, as well as to preserve at least 20 percent of generation from all nonfossil fuel sources, including nuclear.

[102] An overview of the public benefits at risk in utility restructuring—and mechanisms to protect them—can be found in Nancy Brockway and Michael Sherman, *Stranded Benefits in Electric Utilities Restructuring*, The National Council on Competition and the Electric Industry, National Conference of State Legislatures, October 1996, on line at www.ncsl.org/public/catalog/envicat.htm#electric.

[103] Massachusetts previously allowed utility funding of renewables, but did not require it. The Department of Public Utilities had approved Massachusetts Electric recovery of incremental costs from a "Green RFP."

[104] Alan Nogee, "Renewables in Utility Restructuring: New England's Fair Share," DOE Office of Utility Technologies Worshop, June 23, 1996.

[105] Dan Kirshner, B. Barkovich K. Treleven and R. Walther, "A Cost Effective Renewables Policy Can Advance the Transition to Competition," *The Electricity Journal*, October 1997.

[106] Ryan Wiser, "Evaluating the Impacts of State Renewables Policies on Federal Tax Credit Programs," Prepared for California Energy Commission Renewables Program Committee, December 1996.

[107] Kirsten Engel, "The California Electrical Industry Restructuring Law as Applied to the Renewable Energy Industry: An Analysis of Commerce Clause Issues," Memorandum for the American Wind Energy Association, February 21, 1997.

[108] Howard Wenger, California Net Metering Program Impact: Net Present Value Economic Analysis, (unpublished paper), January 8, 1995. Available from the Renewable Energy Policy Project.

[109] Public Utilities Commission Rulemaking Docket No. 97-794, March 10, 1998. On-line at http://solstice.crest.org/renewables/wlord/.

[110] For more information, see Yih-huei Wan and H. James Green, NREL , Current Experience With Net Metering Programs, WINDPOWER '98, Bakersfield, CA, April 27 - May 1, on-line at http://www.eren.doe.gov/greenpower/netmetering/current_nm.html, and Thomas J. Starrs, *Net Metering: New Opportunities for Home Power*, Issues Brief, Renewable Energy Policy Project, September 1996 on-line at http://www.repp.org/index_ar.html. States with net metering policies are included in the DSIRE database at www.dsire.org.

[111] MidAmerican Energy Company, Federal Energy Regulatory Commission Docket No. EL99-3-000. Filings available on-line at http://rimsweb1.ferc.fed.us/rims/

[112] See EPRI, PG&E, and NREL. An Introduction to the Distributed Utility Valuation Project, Monograph, 1993;

Coles, R.L., et al. *Analysis of PV benefit Case Studies: Results and Method Used*, NREL Draft Report, May 1995.

[113] Union of Concerned Scientists, 1995. *Renewing Our Neighborhoods: Opportunities for Distributed Renewable Energy Technologies in the Boston Edison Service Territory*, August., 1995

[114] *Opportunities in Photovoltaic Commercialization: Report of the UPVG's Phase I Efforts, Part 4*, Commercialization Strategies Work Group, Utility Photovoltaic Group, Washington, DC, June 1994, p. 38

[115] See, for example, Taylor Moore, "Emerging Markets for Distributed Resources," *EPRI Journal*, March/April 1998, cover story, p. 8.

[116] For a thorough treatment of distributed generation legal and regulatory issues, see John Nimmons, Thomas Starrs, Ren Orans, Joel Swisher and Joel Singer, *Legal, Regulatory & Institutional Issues Facing Distributed Resources Development*, Prepared for the National Renewable Energy Laboratory, Central & Southwest Services, Inc., Cinergy Corp., Florida Power Corp., San Diego Gas & Electric, National Renewable Energy Laboratory NREL/SR-460-21791

[117] Oregon Public Utilities Commission, PacifiCorp-Distribution Only AFOR, Order No. 98-191, May 5, 1998. Available on-line at www.puc.state.or.us/orders/98orders/98-191.htm.

[118] Henry Yoshimura, Robert Graham, and Christopher Hebert, La Capra Associates, *An Incentive Regulatory Framework to Encourage Cost-effective Investment In Transmission and Distribution System Resources in a Restructured Electric Utility Industry in Massachusetts*, Boston Edison Demand-Side Management Settlement Board, September 28, 1995. Summary and order information available on-line at http://www.magnet.state.ma.us/doer/utility/orderreg.htm.

[119] Nimmons et. al., *ibid.*

[120] Federal Energy Regulatory Commission, Open Access

Rule, Order 888, April 27, 1996. Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities (RM95-8-000).

[121] Federal Energy Regulatory Commission, *Capacity Reservation Open Access Transmission Tariffs*, Notice of Proposed Rulemaking, FERC Docket No. RM96-11-000, April 24, 1996.

[122] For more detail about the effects of transmission issues on renewables, see Kevin Porter, National Renewable Energy Laboratory, "What is Happening with Independent System Operators?" Presented to Windpower '98, American Wind Energy Association, Bakersfield, CA, April 30, 1998. Available on-line at http://www.nrel.gov/analysis/emaa/isos.pdf; Steven Stoft, Carrie Webber, and Ryan Wiser, *Transmission Pricing and Renewables: Issues, Options and Recommendations*, Lawrence Berkeley National Lab, Berkeley, Calif., May 1997.Available on-line at http://eetd.lbl.gov/EA/EMP/emppubs.html; Kevin Porter, "Open Access Transmission and Renewable Energy Technologies." National Renewable

Energy Laboratory Topical Issues Brief NREL/SP-460-21427. September 1996 Available on-line at http://www.nrel.gov/research/ceaa/emaa/open_access/index.html; Steven Stoft, Carrie Webber, and Ryan Wiser, *Transmission Pricing and Renewables: Issues, Options and Recommendations*, Lawrence Berkeley National Lab, Berkeley, Calif., May 1997.Available on-line at http://eetd.lbl.gov/EA/EMP/emppubs.html.

[123] Soft et. al., *ibid.*

[124] Porter, Windpower '98, *ibid.*

[125] Porter, Windpower '98., *ibid.*

[126] Porter, Windpower '98, *ibid*

[127] Soft et al, *ibid.*

[128]In some jurisdictions, regulators have employed a traditional standard which only allowed utilities to recover and earn a return on investments which are "used and useful." They have required utility investors to bear or to share the costs of unneeded or uneconomical investments. The Federal Energy Regulatory Commission, and many states, have allowed utilities to recover and earn a return on bad investments, however, as long as they were prudent, i.e., reasonable at the time they were made, irrespective of how they may have turned out.

[129] For extensive analysis and discussion of this issue, see Bruce Biewald, David White and Tim Woolf, Synapse Energy Economics, and Frank Ackerman and William Moomaw, Global Development and Environmental Institute, *Grandfathering and Environmental Comparability: An Economic Analysis of Air Emission Regulations and Electricity Market Distortions*, Prepared for the National Association of Regulatory Utility Commissioners, July 11, 1988. Available on-line at www.naruc.org.

[130] Energy Information Administration, 1995. Annual Electric Generator Data, EIA-860 Data File.

[131] Biewald et. al., ibid., pp 22-24.

[132] Id., p. 29

[133] *ibid.* These results vary widely in different regions, however. The percent of coal capacity at risk for retirement is less than 4% in most regions, but 18% in the in the Mid-America Interconnected Network (most of IL, eastern WI; 19% in the mid-Atlantic; and 60% in the northeast.

[134] An Oak Ridge National Laboratory study also found that coal plant retirements in the Midwest would not be induced until carbon taxes reached $50 per metric tonne of carbon ($13.67/metric ton CO2). Stanton Hadley, *The Impact of Carbon Taxes or Allowances on the electric Generation Market in the Ohio and ECAR Region*, ORNL/CON-463, July 1998.

[135] Federal Energy Regulatory Commission, Open Access Rule, Order 888, April 1996. 27. Federal Energy Regulatory Commission, Final Environmental Impact Statement - Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities (RM95-8-000) and Recovery of Stranded Costs by Public Utilities and Transmitting Utilities (RM94-7-001). FERC/EIS-0096, April 1996, Tales 5-1 and 5-4 (indicating that coal-fired generation could increase by 31 percent between 1993 and 2010, from 1,639 to 2,152 billion kWh, even assuming no change in total power-plant capacity).

[136] *Air Pollution Impacts of Increased Deregulation in the Electric Power Industry: An Initial Analysis*, Northeast States for Coordinated Air Use Management (NESCAUM), January 15, 1998. On-line at http://www.nescaum.org/pdf/dereg.pdf

[137] Dallas Burtraw, 1998. *Cost Savings, Market Performance, and Economic Benefits of the U.S. Acid Rain Program*, Resources for the Future, Discussion Paper 98-28, April.

[138] *Utility Environment Report*, 1996b. "Vermont Official Proposes Regional ISOs as Emission 'Cap-and-Trade' Overseers," March 15, Pg. 1.

[139] Richard H. Cowart, Chair, Vermont Public Service Board, 1997. Statement Before the Committee On Energy and Natural Resources, United States Senate, March 20, Washington D.C., online at http://www.senate.gov/~energy/comp3a.htm.

[140] Douglas R. Bohi and Dallas Burtraw, Resources for the Future,. *SO 2 Allowance Trading: How Experience and Expectations Measure Up*, Discussion Paper 97-24, February, 1997.

[141] In theory, allowance prices should be reflected in the market price of generation, allowing cleaner generation to receive a higher market price. The extent to which this will occur in practice is uncertain, due to market imperfections.

[142] See for example*, Citizens Guide to Environmental Tax Shifting* - Friends of the Earth, June 1998*. Price It Right: Energy Pricing and Fundamental Tax Reform* - Alliance to Save Energy, January 1998 Available on-line, along with many other green tax resources, at http://www.me3.org/projects/greentax/. Also David Roodman, *Getting the Signal Right: Tax Reform to Protect the Environment and the Economy*. Worldwatch Paper 134 Washington, DC: Worldwatch Institute, 1997. Available to purchase on-line at http://www.worldwatch.org/titles/titlesp.html .Robert Repetto et al. *Green Fees: How a Tax Shift Can Work for the Environment and the Economy*, Washington, DC: World Resources Institute, 1992. Available to purchase at http://www.wri.org/cat-econ.html#gfees.

[143] Biewald et al., ibid, p. 48.

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