

Clean Energy Solutions



Energy Efficiency and Renewable Energy in New Jersey

NJPIRG Law and Policy Center
March 2002

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Marianne Zugel
Emily Rusch
Brad Heavner

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ACKNOWLEDGMENTS

The New Jersey PIRG Law and Policy Center gratefully acknowledges Phil Radford (Power Shift), Ron Larson (National Renewable Energy Lab, retired), Karl Gawell (Geothermal Energy Association), John Thorton (National Renewable Energy Lab), Jennifer Lane (Altair Energy, LLC), Dave Rib (KJC Operating Company), and the many other analysts who provided information for this report. Special thanks to Rob Sargent for assistance in the development, drafting, and production of this report. Thanks also to Katherine Morrison, Anna Aurilio, Rebecca Stanfield, and Susan Rakov for editorial assistance. Thanks to Chris Chatto for layout design.

This report was made possible by the generous support of the Educational Foundation of America.

The authors alone bear responsibility for any factual errors. The recommendations are those of the New Jersey PIRG Law and Policy Center. The views expressed in this report are those of the author and do not necessarily reflect the views of our funders.

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NJPIRG
11 N. Willow St.
Trenton, NJ 08608

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EXECUTIVE SUMMARY

As New Jersey's population continues to boom and national energy markets struggle for stability, state officials have the opportunity for a fundamental re-assessment of long-term energy policy. We can now choose alternative fuel sources and new technologies to clean up our future. Ample clean, renewable resources and energy efficiency technologies can provide us with stable, reliable, and cost-effective electricity while reducing pollution.

Traditional Power Production Promotes Global Warming and Damages Public Health

Today's electric power industry is the most polluting industry in the nation. The electric power industry alone is responsible 40% of U.S. carbon dioxide (CO₂) emissions, the primary cause of global warming. Power plants are also the largest industrial source of sulfur dioxide, nitrogen oxides, and mercury, which cause severe public health damage. In New Jersey, power plant pollution cuts short the lives of 1,100 people in the state each year.

Clean Energy Can Grow Rapidly in the Next Decade

Renewables have advanced technologically and commercially to the point where they are now ready for wide-scale development, and there are still many opportunities for efficiency improvements. Huge untapped potential exists at both the state and national levels.

- Renewable energy sources could provide 4% of the total electricity for New Jersey by 2010. Nearly all of this potential remains untapped today, with dirty coal and nuclear power meeting virtually all the state's power needs.
 - Wind power is the renewable technology the state could develop the quickest. 880 peak MW of New Jersey's

4,900 MW potential could come online by 2010.

- Solar power is expanding rapidly. The small current capacity will grow to significant levels over the next ten years and become a major source of electricity thereafter.
- Widespread direct use of geothermal resources can greatly reduce electricity demand.
- By investing in cost-effective energy efficiency measures, New Jersey could reduce anticipated total electricity demand by 15% by 2010.
- By 2010, 125,000 MW of renewable energy capacity could be operational nationally, enough to replace 80 large fossil fuel power plants.
- Policies promoting energy efficiency could cut the nation's electricity demand by 15%, saving 72,000 average MW annually.

Renewable Energy and Energy Efficiency Reduce Pollution

By 2010, New Jersey would reduce annual CO₂ emissions by as much as 31% – 8 million tons – by developing this amount of clean energy rather than continuing on the fossil fuel path. This would also reduce health-damaging pollution by 22%.

Nationally by 2010, energy efficiency and renewable energy development at the levels described above would enable the U.S. to reduce CO₂ emissions by as much as 37% – one billion tons annually – compared to projections for the current path. Health-damaging pollution would be reduced by as much as 43%.

Clean Energy Is the Best Economic Choice

Policies encouraging renewables and energy efficiency would grow the economy more than a business-as-usual scenario.

- Electricity generation from renewable energy involves a higher proportion of its costs for labor as compared to fossil fuel electricity generation, in which much of the cost goes to fuel. Wind and solar photovoltaic operations each provide 40% more jobs per dollar of investment than do coal operations. Meeting stricter energy efficiency goals would also require increases in employment.
- Policies encouraging clean energy would lead to net increases in employment in the U.S. and in each individual state. New Jersey would see a net gain of 20,200 jobs, while the U.S. as a whole would gain more than 700,000 jobs by 2010.
- The best wind, solar, and geothermal projects can produce electricity at a lower cost than fossil fuels when externalized costs of electricity generation are taken into account.
- U.S. utilities have saved between 25,000 MW and 30,000 MW – the equivalent of 100 large power plants – over the past five years through energy efficiency programs, at a cost that is less than that of energy from most new power plants.

Comprehensive Energy Policies Are Needed

In New Jersey, two amendments to established rules are essential to realize the state's clean energy goals:

- Strict enforcement of the state's renewable energy standard, including financial penalties for non-compliance that exceed the savings of companies that do not comply and the power to revoke licenses of those companies that repeatedly fail to fulfill the requirements.
- Appointment of an administrator independent of the electric utilities or their affiliates to manage the funds for utility energy efficiency and renewable energy.

Nationally, the two most important policies for clean energy development in the U.S. are:

- A renewable energy standard requiring all retail electricity suppliers to obtain 10% of their electricity from renewable sources by 2010 and 20% by 2020.
- A utility clean energy fund using a set percentage of revenues to finance programs promoting energy efficiency and renewable energy.

INTRODUCTION

The New Jersey legislature has established key requirements to promote renewable energy sources, but loopholes and delays by past legislatures and administrations threaten to keep New Jersey citizens from realizing a cleaner and more reliable energy future. A requirement to generate 4% of the state's electricity using clean renewables by 2012 was established by the Legislature in 1999. The first incremental goal to reach 0.5% renewables was delayed a year from January 2001 to January 2002. It is widely believed that the requirement was not met even with this delay.

New Jersey has ample renewable energy resources and room for efficiency improvements, and the technology is ready to tap these opportunities. New Jersey needs to enforce and strengthen energy requirements to achieve its clean energy goals.

Due in large part to pollution from our fossil fuel-based power plants, it is already unsafe to breathe the air in New Jersey on one out of three summer days. Virtually the entire state is classified as an "extreme and severe" non-attainment area for national standards for ground-level ozone.¹ The U.S. Environmental Protection Agency has issued mercury advisories for 100% of New Jersey's lakes and rivers.² Potential effects of global warming brought on in part by power plant pollution will exacerbate existing environmental problems and cause serious new problems for the state.

Nuclear power plant pollution is extremely dangerous. The reaction of nuclear fission in power plants produces high-level radioactive waste, arguably the most dangerous substance known. New Jersey's nuclear power plants produce a total of more than 90 metric tons of high-level radioactive waste every year, without any safe disposal method established.³ In addition to the risk of accidents, concerns are growing over potential terrorist attacks.

New Jersey also needs more renewable resources in its energy mix to ensure that electricity remains affordable and reliable. In 2003, electricity price caps will be removed and utilities will be allowed to raise their electricity rates. Volatility in fossil fuel costs will then be passed on to consumers. Dependence on foreign oil is a proven risk, and natural gas proved to be equally risky last year. With 90% of new power plants expected to be fueled by natural gas, concerns of price increases due to supply shortages are legitimate. And nuclear power would not exist today without continual massive subsidies.

As a nation, events of the past year, including market-based energy shortages on the West Coast, the 9/11 terrorist attacks, and war in the Middle East and Central Asia, have led us to the brink of a crucial decision. Do we stay on the same old unreliable, polluting, and insecure path? Or do we shift to a new clean energy path, meeting the nation's ever-growing power needs with sustainable, domestic energy sources that enhance national security and mitigate against further pollution and warming of our atmosphere?

This report shows how we are now able to choose the clean energy path and why it is the better choice both environmentally and economically. We can simultaneously meet our growing electricity needs, reduce pollution contributing to global warming, and grow our economy.

We have the resources here in New Jersey to dramatically reduce our dependence on dangerous, dirty, and unreliable out-of-state fuel sources and to do so even faster than our established timeline. We have worked hard to get as far as we are today toward implementing a smarter, cleaner energy future. Each day that passes without action costs us more. We must demand that the rules we strived to establish are carried out promptly and effectively.

PART I: HEALTH AND ENVIRONMENTAL IMPACTS OF CONVENTIONAL ELECTRICITY PRODUCTION

Conventional electricity production using fossil fuels involves the excavation and combustion of fossil fuels, both of which cause severe environmental and public health damage.

Impacts of Fossil Fuel Burning

In New Jersey, electricity generation is responsible for:

- 7 percent of the state's emissions of carbon dioxide, a principal global warming gas.⁴
- 49 percent of the state's emissions of sulfur dioxide, a precursor of fine particulate matter, acid rain, and regional haze.⁵
- 64 percent of the state's emissions of nitrogen oxide, a precursor of ground-level ozone (smog), particulate matter, acid rain, global warming, nitrogen overloading in waterways and forests, and regional haze.⁶
- 5 percent of the state's emissions of man-made mercury, a toxic metal that bioaccumulates in animals and spreads through the food chain to humans.⁷

Electricity generation in the U.S. is responsible for:

- 40 percent of emissions of carbon dioxide.⁸
- 67 percent of emissions of sulfur dioxide.⁹
- 23 percent of emissions of nitrogen oxide.¹⁰
- 33 percent of emissions of man-made mercury.¹¹

All fossil fuel-burning power plants pollute the air to varying degrees. Coal-fired power plants are by far the dirtiest. Oil-burning power plants emit less pollution than those using coal, but more than natural gas-fired plants. Natural gas produces cleaner emissions than other fossil fuels, but U.S.

power plants burn enough of it to produce hundreds of millions of tons of CO₂ each year.

Although coal is the energy source used to generate 52% of electricity in the U.S., coal-burning power plants account for 87.5% of the CO₂, 95.2% of the SO₂, and 90.9% of the NO_x emitted collectively by all electric power plants.¹³

In New Jersey, coal is used to generate 16% of the electricity produced at utilities, yet coal-fired power plants emit 80% of the total power plant CO₂ emissions in the state, 98% of total power plant SO₂ emissions, and 91% of total power plant NO_x emissions.¹⁴

Figure 1: CO₂ Emission Rates of Power Plants Burning Fossil Fuels¹²

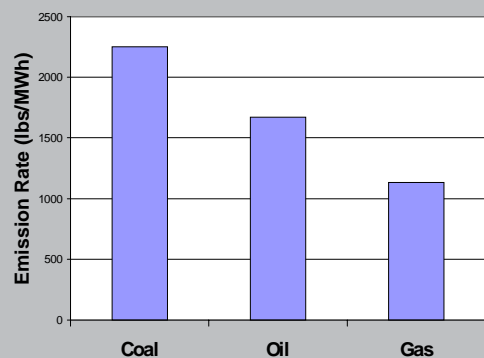
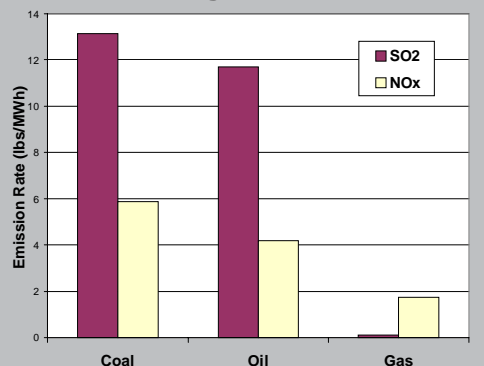


Figure 2: SO₂ and NO_x Emission Rates of Power Plants Burning Fossil Fuels



Global Warming and Carbon Dioxide

Global warming is perhaps the most serious environmental challenge of our time. The world's leading climate scientists, economists, and other experts formed the Intergovernmental Panel on Climate Change (IPCC) in 1988 to verify the recent dramatic increase in the earth's temperature and to identify its causes and consequences. What they have found is alarming.

- The average daytime global surface temperature rose 0.6°C (1.08°F) over the 20th century. The average nighttime minimum surface temperature over land, the more indicative measurement of global temperature change, rose an average of 0.2°C per decade since 1950.¹⁵
- The 1990s were warmer than the 1980s, previously the warmest decade on record. The warmest year on record was 1998.¹⁶

The IPCC predicts that if greenhouse gas emissions are not stabilized, the average global surface temperature will increase by 1.4-5.8°C between 1990 and 2100.¹⁷ This level of increase is put into perspective by the fact that during the last ice age (about 18,000 years ago), the earth's average surface temperature was only 9°C cooler than it is now.¹⁸

The impacts of warmer global temperatures are predicted to include many serious and broad-ranging effects, some of which have already begun:

- Increased frequency and intensity of heat waves, fires, droughts, rainfall, and flooding.
- Rising sea levels that overtake islands and coastal areas.
- Disruption and loss of ecosystems, pushing species to extinction and rendering historically fertile farmland unproductive.
- Increased geographic range and virulence of infectious and tropical diseases.

Although natural variations in the output of the sun can contribute to climate change,

the IPCC has found that natural contributions are minimal compared to the effects of human activities. By burning fossil fuels in our power plants, we are releasing pollution that is altering the atmosphere at a rapid pace. Normally the atmosphere allows excess heat to leave the earth, but air pollution referred to as greenhouse gases, such as CO₂, work like a blanket that traps heat near the earth's surface. As concentrations of greenhouse gases increase, more heat gets trapped and global temperatures rise. Carbon dioxide (CO₂) is by far the most abundant greenhouse gas. The atmospheric concentration of carbon dioxide has increased by 31% since 1750.¹⁹

In its latest update on climate change, the IPCC concluded, "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."²⁰ Fossil fuel burning accounts for three-quarters of the CO₂ emissions associated with human activities. The U.S. electric industry alone, which accounts for 40% of total U.S. CO₂ emissions, emits more CO₂ than the total CO₂ emissions from any other nation.

Soot and Sulfur Dioxide

Power plants are by far the largest source of sulfur dioxide (SO₂).²¹ More than 12,000 of the nearly 19,000 tons of SO₂ the nation emits annually comes from electric power plants. SO₂ is a large component of fine particulate matter, or "soot."²² Particulate matter is the type of air pollution that is visible in the air – ash, dust, and acid aerosols.

When inhaled, these tiny particles become deeply embedded in the lungs. The particles cannot be expelled by coughing, swallowing, or sneezing. As they sit in lung tissue they cause varying degrees of irritation, which can lead to loss of heart and lung function. Health consequences range from bronchitis and chronic cough to death.²³ Fine particulate matter is of most concern to vulnerable populations, including young chil-

dren, the elderly, and those with asthma or other respiratory diseases. A study conducted by the Harvard School of Public Health estimates that more than 60,000 lives are cut short each year in the U.S. due to fine particulate pollution.²⁴ This pollution causes 1,100 people to lose their lives prematurely each year in New Jersey.²⁵

Particulate air pollution can travel far from its source. The visual effect of particulate air pollution is referred to as haze. Haze has spread so far as to infiltrate some of America's most pristine national parks, blocking vistas and posing health risks for those who use the parks for recreation.

Smog and Nitrogen Oxides

Power plants are the largest industrial source of nitrogen oxide (NOx) pollution, which causes formation of ground-level ozone (also known as smog). Ozone is our nation's most prevalent and well-understood air contaminant. Despite reductions in smog levels since the passage of the Clean Air Act in 1970, today an estimated 117 million people live in areas where the air is unsafe to breathe due to ozone.²⁶ In 1999, the ozone health standard adopted by the EPA in 1997 was exceeded 7,200 times.²⁷

Ozone is an invisible, odorless gas, which is formed when nitrogen oxides mix with volatile organic compounds (reactive man-made chemical air pollutants) in the presence of sunlight. Public health is most at risk during "ozone season," from mid-May to mid-September in most places, when there is plenty of sunlight.

When inhaled, ozone at high concentrations can oxidize or "burn through" lung tissue. Breathing ozone at high concentrations can cause airways to the lungs to become swollen and inflamed. Eventually, this causes scarring and decreases the amount of oxygen that is delivered to the body with each breath. The corrosive effect of exposure to ozone in the respiratory system increases susceptibility to infections. Outdoor exercise

on days when ozone concentrations are high increases the impact on the respiratory system.

As is the case with soot, ozone poses a more serious health threat to vulnerable populations, including children, the elderly, and people with asthma or chronic pulmonary disorders (including chronic bronchitis and emphysema). A number of studies have linked ozone pollution with increased frequency of emergency room visits, including one study of 25 hospitals that found high ozone levels were associated with at least a 21% increase in emergency room visits for people aged 64 and older.²⁸

Ozone has also been linked to increased frequency of asthma attacks. On high-smog days, children with asthma are 40% more likely to suffer asthma attacks compared to days with average pollution levels.²⁹ A 1999 Abt Associates study estimated that more than six million asthma attacks nationwide were triggered by smog during the ozone smog season of 1997.³⁰ Another study found a 26% increase in the number of asthma patients admitted to emergency rooms in New Jersey on summer days when ozone concentrations were high.³¹

New research has also shown that high smog levels can not only exacerbate existing asthma, but can cause the disease as well. A five-year study conducted at the University of Southern California found that active children growing up in high smog areas are more likely to develop asthma than inactive children, while no such relation exists among children living in low smog areas.³²

Acid Rain, Sulfur Dioxide, and Nitrogen Oxides

Sulfur dioxide and nitrogen oxides do their damage not only via airborne ozone and particulates, but also by causing acid rain, which threatens entire forest and aquatic ecosystems. Once emitted into the air, sulfur and nitrogen oxides form sulfates and nitrates respectively, which are the principal com-

ponents that change the pH of rainwater from neutral to dangerously acidic.

Acid in rain, clouds, and fog damages trees in two primary ways:

1. Directly damaging the needles and foliage, making them unusually vulnerable to adverse conditions, including cold temperature.
2. Depleting nutrients from the soils in which the trees grow.

Acid clouds and fog generally have even higher concentrations of damaging sulfates and nitrates than acid rain. Thus, acid deposition is linked to the decline of red spruce growing at high elevations and in coastal areas, both of which are immersed in acid clouds and fog for long time periods.³³

Lake and stream ecosystems are also vulnerable to the effects of acid rain. As the acidity of the lakes and streams increases, the number of species that can live there declines.³⁴

Nitrogen Loading and Nitrogen Oxides

Nitrogen oxide emissions from power plants are a major contributing factor to nitrogen loading in water bodies across the United States. Too much nitrogen causes algae blooms, which deplete the oxygen and kill marine life as they decay. Algae blooms also block sunlight that fish, shellfish, and aquatic vegetation need to survive. Nitrogen oxides released into the air can be carried hundreds of miles by the wind and fall into lakes and rivers.

The effects of nitrogen loading can be devastating for plant and animal life in these water bodies, as well as for people who depend on these waters for tourism, subsistence fishing, commercial fishing, and recreation.

The Toxic Food Chain and Mercury

Mercury is a toxic heavy metal that persists in the environment once it is released. When

ingested in its methylated form, mercury can cause serious neurological damage, particularly to developing fetuses, infants, and children.³⁵ The neurotoxic effects of low-level exposure to methylmercury are similar to the effects of lead toxicity in children, and include delayed development and deficits in cognition, language, motor function, attention, and memory.³⁶ Other studies have linked a history of mercury exposure with neurological problems, heart disease, and Alzheimer's disease in adults.³⁷

Numerous species of fish in thousands of bodies of water across 41 of the 50 states contain such high levels of toxic methylmercury that health agencies have warned against eating them. The number of consumption advisories due to mercury poisoning increased 8% from 1999 to 2000 and 149% from 1993 to 2000.³⁸

People most at risk include women of child-bearing age, pregnant women and their fetuses, nursing mothers and children, and subsistence fishers. Large predator fish such as largemouth bass, walleye, shark, tuna, and swordfish have higher levels of methylmercury in them than smaller species lower in the food web.³⁹ People who frequently and routinely consume fish (i.e., several servings a week), those who eat fish with higher levels of methylmercury, and those who eat a large amount of fish over a short period of time (e.g., anglers on vacation) are more likely to be exposed to higher levels of mercury.⁴⁰

Mercury's primary entrance into the human diet occurs when mercury is emitted into the air and undergoes photochemical oxidation, forming oxidized mercury. Oxidized mercury is water-soluble and is deposited to land, lakes, and streams by rain and snow, where it reacts with bacteria to form methylmercury, the form most toxic to humans.⁴¹ Methylmercury bioaccumulates to the greatest extent in the tissue of fish and other aquatic organisms and persists forever in the environment, magnifying its public health impacts.

Based on national emissions estimates for 1994-95, coal and oil-burning power plants are the largest stationary sources of mercury emissions (32.8%), followed by municipal waste incinerators (18.7%), commercial and industrial boilers powered by coal or oil (17.9%), medical waste incinerators (10.1%), and hazardous waste incinerators (4.4%).⁴²

Other Impacts of Energy Production

The process of excavating fossil fuels is extremely harmful to the environment. Coal and natural gas, the two main fossil fuels used in electricity production, are retrieved by different methods due to their locations in the earth and differing properties.

Coal Excavation

Mining for coal is a dirty, dangerous, and destructive process. It contaminates the land, surface water, groundwater, and air. To get to the coal, enormous chunks of earth are dug up from the surface or displaced by removing mountaintops (surface mining), or are excavated from beneath the ground (underground mining) and discarded into waste piles. Wildlife habitat, agricultural crops, forests, rangeland, and deserts are destroyed and replaced by pits, quarries, and tailing piles. Reclaiming a coal mine (replacing vegetation and restoring the landscape) helps reduce permanent disruption, but in spite of restoration efforts, original ecosystems may be replaced by completely different ecosystems, and hundreds of thousands of acres of mines have been abandoned rather than restored.

Water pollution is an enormous problem of coal mining. Waste piles of excavated dirt deposit toxic heavy metals and sediment that pollute and alter the course of local waterways. More waste from the washing of mined coal is added to these piles that grow on the order of tens of millions of tons per year.⁴³ Underground mining can contaminate and

physically dislocate entire underground reservoirs that serve as drinking water supplies for many Americans.

The Western Pennsylvania Coalition for Abandoned Mine Reclamation calculated the cost of cleaning up pollution from old coal mines in Pennsylvania to be \$15 billion, although they believe it's likely that estimate is low.⁴⁴ The U.S. Bureau of Mines estimates that the U.S. spends over \$1 million each day to treat acidic mine water.⁴⁵ The cost of cleaning up abandoned lands that had been used for mining coal is \$10,000 per acre.⁴⁶

"Clean coal" has been touted as the solution to the horrendous environmental legacy of coal, claiming energy can be harnessed from coal without causing environmental damage. Although clean coal measures involve more responsible management of coal-generated pollution, the actual pollution reduction is marginal and air pollution mitigation strategies ultimately redirect the toxins and emit them into the environment through different routes (like the land or water). "Clean coal" techniques also encourage increased coal use in the long term. The General Accounting Office concluded that federal spending on "clean coal" technology has been a waste of money.⁴⁷ \$2 billion has been spent so far, and current proposals would double that amount.⁴⁸

Natural Gas and Coalbed Methane Excavation

When natural gas is retrieved from reservoirs, the construction of roads and gas pipelines destroys huge amounts of wildlife habitat. Transporting the gas, which is explosive by nature, is increasingly dangerous as the U.S. pipeline infrastructure ages. One quarter of the nation's natural gas pipelines are more than fifty years old.⁴⁹ Over the past decade, the number of serious accidents has steadily increased.⁵⁰

Natural gas is often found in association with oil. The damage occurring from oil drilling and transport is probably the best known

of the environmental impacts of fossil fuel excavation, due to the regularity of oil spills and the duration of their scathing effects. Less known is the fact that leaks commonly go undetected, accounting for hundreds of thousands of gallons of spilled petroleum liquids each year.⁵¹

The most destructive process used to access natural gas from oil-free reservoirs is coalbed methane excavation. Coalbed methane differs from natural gas only slightly in its chemical makeup. Natural gas is mostly methane with some other hydrocarbon gases in its mixture. Coalbed methane is almost always pure methane.

Coalbed methane is found trapped in subsurface coal beds. To release the gas from the porous coal, coal seams are fractured with toxic fluids. Massive volumes of water must be pumped from underground aquifers, which often serve as the only drinking water source for local communities. The water, often containing high levels of sodium, arsenic, and other contaminants, is dumped on the surface and into rivers.

In the San Juan Basin of southwestern Colorado and northern New Mexico, the costly consequences of coalbed methane development are clear. The excavation process, along with the construction of roads and pipelines to transport the gas, has destroyed wildlife habitat and contaminated drinking water. Methane and hydrogen sulfide seeps have forced some families from their homes.⁵² Underground coal fires have caused the ground to collapse in one area, and it is uncertain whether the gas industry can prevent the underground fires from spreading.⁵³

Development in the Powder River Basin in Wyoming is more advanced than the San Juan region. If the gas industry develops the region according to current plans, the estimated cost to the state to address the water loss and contamination will be \$320 million dollars, after accounting for severance tax credits the state will receive from the gas industry.⁵⁴

Nuclear Waste

Nuclear fission, the reaction used to create energy in nuclear power plants, puts our lives at risk from potentially disastrous accidents and creates the most harmful substance known, for which there is no safe disposal process. Direct exposure to irradiated fuel from nuclear reactors delivers a lethal dose of radiation within seconds. According to the Department of Energy, 95% of the radioactive waste in this country (measured by radioactivity) is from commercial nuclear reactors. The storage of this waste poses a threat to water supplies throughout the nation. At the Hanford Nuclear Reservation in Washington, 67 of 177 underground tanks have leaked more than one million gallons of waste, contaminating groundwater and threatening the Columbia River.⁵⁵

Presently more than 42,000 metric tons of spent fuel are in temporary storage in the U.S., with that number increasing by five metric tons every day.⁵⁶ This waste material will remain hazardous for the next 250,000 years.⁵⁷ The potential risk to human health is staggering. The total radioactivity of our spent fuel at this point is 30.6 billion curies. One single curie generates a radiation field intensity at a distance of one foot of about 11 rem per hour; the exposure limit set by federal regulation for an individual is 5 rem per year.⁵⁸ If a person were to stand within a yard from a 10-year old nuclear fuel assembly, within 30 seconds he would significantly increase his risk of genetic damage or cancer and in less than 3 minutes he would receive a lethal dose of radioactivity.⁵⁹

The risks of both catastrophic events and leakage of radioactive material into our environment pose great threats to our public health. Even low-level radiation has been linked to cancer, genetic and chromosomal instabilities, developmental deficiencies in the fetus, hereditary disease, accelerated aging, and loss of immune response competence.

The risk of accidents at reactors is also ever-present. Because many nuclear plants in the U.S. are aging, the risk of accidents is greater now than it ever has been. New Jersey is home to the oldest operating commercial nuclear reactor at Oyster Creek, which opened in 1969. The nuclear plant's permit was recently renewed until 2009, although no plant has ever lasted 40 years.⁶⁰

Further risk may come from transporting high-level nuclear waste. The nuclear industry has been trying for years to establish a single national nuclear waste repository at

Yucca Mountain, Nevada. If such a facility were to be established, the risk of accidents and leakage would be immense. The Nevada Agency for Nuclear Projects recently calculated the risks of transporting nuclear waste using analyses by the Department of Energy and independent consultants. They concluded, "Accidents are inevitable and widespread contamination possible."⁶¹ Shipping routes for this waste would likely include Trenton, Camden, and other populated areas of New Jersey.

PART II: THE RENEWABLE ENERGY AND ENERGY EFFICIENCY SOLUTION

Pollution is not an inevitable result of power production. Our energy future need not incorporate the same massive threats to the environment and public health that we face today. Renewable energy generation has advanced technologically and commercially to the point that it is now ready for wide-scale development, and there are still many opportunities for efficiency improvements. Huge untapped potential exists at both the state and national levels.

Using only renewable resources and energy efficiency, New Jersey could meet all of its predicted growth in electricity demand through 2010 and replace the amount of electricity produced by one coal-fired power plant. Renewable resources would then be generating 4% of the state's electricity. Nationally, renewable energy resources could meet 11% of U.S. electricity demand by 2010.

Renewable Energy and Efficiency Potential in New Jersey

The vast majority of electricity in New Jersey is generated using dangerous and dirty energy sources. Nuclear power provides 74% of the energy used by utilities for electricity generation, and coal (16%) and natural gas (8%) provide nearly all the rest.

Since New Jersey is host to major industrial operations, non-utility electricity generation accounts for nearly one-third of the state's total generation. When looking at total electricity generation in New Jersey, nuclear power provides about half of the energy, fossil fuels contribute 47%, and other sources such as biomass provide the remaining 2%.

For the majority of the past 100 years, New Jersey had no other real alternatives for its

Investing in the development of clean energy sources will grow New Jersey's and the nation's economy more than will further investments in conventional fossil fuels. Today's best renewable energy projects produce power that costs less than fossil fuel-generated electricity, when externalized costs of power production are considered. The cheapest and quickest way to meet urgent power demand is through energy efficiency.

Developing even just the small portion of the total renewable energy and energy efficiency potential outlined below will reduce pollution dramatically by 2010. New Jersey would cut its power plant pollution by as much as 31% compared to projections for the current path by 2010, while the nation as a whole would reduce power plant pollution by 37%.

energy supply. Now, clean and affordable options are finally available. No longer do the people of New Jersey have to trade their health and that of their land, air, and water in order to stay warm in winter and live with the modern conveniences that electricity gives us. By tapping its energy savings and

Figure 3. New Jersey's 1999 Profile of Utility Electricity Sources⁶²

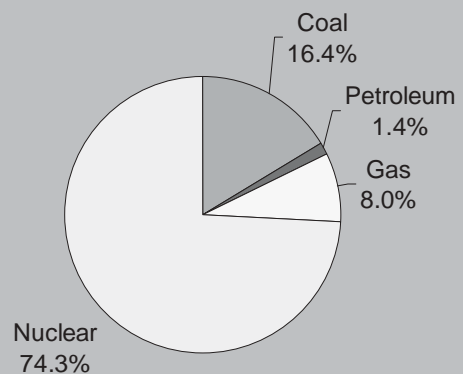
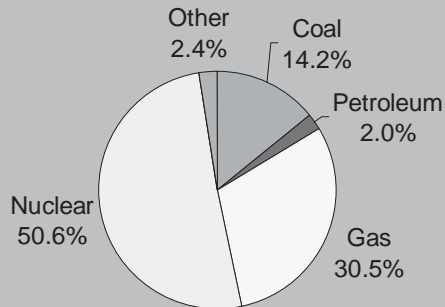


Figure 4. New Jersey's 1999 Profile of Utility and Non-Utility Electricity Sources⁶³



renewable energy potential, the state can now dramatically reduce power plant pollution while cost-effectively meeting its growing electricity demand. By 2010, the state could be generating 4% of its electricity using renewables.

Wind Energy Potential

New Jersey has good wind potential. The Pacific Northwest Laboratory (PNL) estimates the state could generate 13,000 gigawatt-hours per year (GWh/yr) of electricity from wind – 22% of the state's total electricity generation in 1999. The National Renewable Energy Laboratory (NREL) made more conservative estimates, measuring wind potential only in areas that met stricter wind classifications and that were located within ten miles of existing transmission lines. Un-

Table 1. Potential Growth of Wind Power Capacity and Generation⁶⁵

Year	Cumulative Capacity (MW)	Generation (GWh/yr)
2003	140	370
2004	180	480
2005	240	620
2006	300	810
2007	400	1,050
2008	520	1,370
2009	680	1,770
2010	880	2,300

Note on Units

Megawatts (MW) is a unit of measurement indicating how fast a plant can put out energy. This is the standard measure of the generating capacity of a power plant. It is also used to determine if the total generating capacity on the grid is enough to satisfy demand at any one time.

MW denotes peak megawatts, as opposed to average megawatts (MWa). MWa is used to emphasize the intermittency of electricity generation from some sources. Wind power capacity, for instance, is often reported as MWa. 1 MWa is enough to power roughly 1,000 homes.

Megawatt-hours (MWh) is a unit measuring the total amount of energy produced over some time frame. A 50 MW power plant operating at full capacity for one hour produces 50 MWh of electricity. This is the appropriate unit for talking about how much of the state's electricity was produced by various sources in a given time frame. To measure how much such a plant could produce in one year at full capacity, simply multiply the capacity by the number of hours in a year (50 MW x 8,760 hrs/yr = 438,000 MWh/yr). 1,000 MWh equals one gigawatt-hour (GWh).

der these criteria, NREL estimated New Jersey could generate 8,700 GWh of electricity annually, 15% of the total generation in 1999.⁶⁴

Currently none of this important resource is being tapped. However, the New Jersey Board of Public Utilities just finished accepting proposals for clean renewable projects on February 5, 2002. Now is the ideal time to begin aggressive development of the state's wind power resources.

If New Jersey added 140 MW of wind power capacity by 2003, followed by a 30% annual growth rate of cumulative capacity thereafter, total wind power capacity in the state would reach 880 MW by 2010. Wind power would then be generating 2,300 GWh/yr of electricity emission-free.

Other nearby states that have begun tapping their wind resources are adding capac-

ity at even more aggressive rates than this timeline. New wind projects scheduled to come online in 2002 in New York have a collective capacity of 160 MW, and those in West Virginia total 220 MW.⁶⁶

Solar Energy Potential

People often think solar energy can only be harnessed effectively in the Southern and Southwestern states, but solar PV is a valu-

able resource for New Jersey. At this time, the state has barely begun to tap it. Current solar PV capacity in the state stands at 71 kW.⁶⁹ Other states in the Northeast and mid-Atlantic with solar potential similar to New Jersey have already begun to utilize this resource on a much larger scale than New Jersey. Compared to New Jersey, Maine and Maryland have nearly identical solar potential, yet their current solar PV capacities of

Solar Energy

There are two different types of technology for harnessing the sun's energy to generate electricity: solar thermal electric power plants and photovoltaics.

Solar thermal power plants use reflectors to concentrate sunlight on a receiver that uses the sun's heat to drive a turbine and generate electricity. Parabolic troughs, power towers, and dish/engines are the three technologies either in use or in development for solar thermal power plants, differing mainly in the shape and configuration of the reflectors.

Photovoltaics are very different from any other method ever used to generate electricity. All other methods require at least a two-step conversion of energy from its natural state into mechanical power and then to electrical power. Photovoltaic (PV) panels convert sunlight directly into electricity without the use of a generator or any moving parts.

The basic building block of this technology is the photovoltaic cell, which is made of semiconductor materials. Cells can be connected together to form modules, and modules can be connected to form arrays. In this way, PV systems can match power output to power needs. A few PV cells will power a hand-held calculator or wristwatch, while interconnected arrays can provide electricity for a remote village.

PV systems can operate either remotely or in connection with the utility grid. Their reliability even in adverse environments has been proven over decades by their performance powering satellites, which have to operate long term with no maintenance. The Federal Emergency Management Agency now uses solar electricity systems for prevention, response, and recovery in emergency situations. FEMA learned the value of PV for this purpose after Hurricane Andrew, when

some Miami suburbs were without grid power for as much as two weeks. The PV systems that had previously been installed in that region survived and were able to help in the relief efforts.⁶⁷ With PV's long life, minimal operation and maintenance requirements, versatility (remote or grid-connected operation), reliability, and sustainable nature, the U.S. Department of Energy has concluded that, "it is easy to foresee PV's 21st century preeminence."⁶⁸

Solar thermal collectors that use the sun's heat without converting it to electricity can also have an enormous impact on efforts to reduce demand for natural gas and electricity. These collectors are increasingly popular for heating swimming pools. When heating water in a residence, usually they serve as pre-heaters used in conjunction with another heating system, most commonly fueled by natural gas.

326 kW and 221 kW, respectively, overshadow New Jersey's capacity.⁷⁰ New York, considered to have poorer solar resources than New Jersey, has a current solar PV capacity of 1,180 kW.⁷¹ The time is ripe for the state to begin to put its ample solar potential to use.

New Jersey could dramatically increase its current capacity of 71 kW. Within a year, the state could install enough solar PV capacity (250 kW) to match that of Maine. If cumulative installed PV capacity increased from there at the same rate as the 1999-2000 national growth rate (18.5%), PV capacity would reach 1,150 kW by 2010. If, however, the state's total capacity were to grow at the global rate experienced from 1997-2000 (31%) or at the 1999-2000 global rate (37%), New Jersey would have 2,840 kW to 4,250 kW by 2010.⁷²

A more likely progression under favorable policies would see capacity added even faster. In California, where capital cost reduction programs have been in place for several years, capacity has begun to accumulate in larger increments. Alameda County's Santa Rita Jail recently installed a 500 kW PV system. San Francisco is now planning to add 10-12 MW within three years.⁷³

Similar aggregate purchases of PV by New Jersey's state government or municipalities would reduce the overall costs of PV systems and add capacity more quickly. A cooperative like Washington State's Western Sun Coop, which purchases packaged solar electric systems in bulk and sells them to local utilities, would also reduce system costs and encourage faster PV capacity growth.

Geothermal Potential

Although there are no high temperature geothermal resources capable of producing electricity in New Jersey, the state has ample geothermal resources for use of geothermal heat pumps, which reduce demand for electricity. The New Jersey Board of Public Utilities recognized the value of this geothermal resource. In 2000, the U.S. Department of Energy and the New Jersey Board of Public Utilities conducted a comprehensive outreach program to inform school officials about geothermal heat pump technology.⁷⁴ Department of Energy officials are also promoting the use of geothermal heat pumps in state parks such as Monmouth Battlefield State Park, which is currently using geothermal energy in their visitors center. Widespread use of these systems could play a major role in reducing electricity demand in the state.

Geothermal Energy

Geothermal energy is the heat that flows constantly from the center of the earth, where temperatures are believed to reach 4000°C. Certain regions in the subsurface contain pockets where this thermal energy is concentrated. These regions can be tapped with a well to access the steam or hot water. The heat from the steam and hot water is then used to drive turbines that generate electricity.

Although most of the high-temperature geothermal resources capable of producing electricity in the U.S. are found in the western states, mid- and low-temperature resources are more abundant and widespread. Direct use of geothermal energy and geothermal heat pumps transfer heat from the hot water accessed by a well to buildings and districts in order to heat water and air. Use of these resources can significantly reduce electricity demand.

Biomass Energy

Many types of “waste-to-energy” technologies and energy crops used to generate electricity fall under the banner of “biomass.” Some are unacceptably harmful to the environment, while others provide a net benefit to the environment.

Any material that releases air pollutants or toxins into the air upon combustion at a greater rate than the fossil fuel it is replacing should not qualify as a renewable fuel. Included in this group are municipal solid waste (garbage) and construction debris, which can release dangerous toxins from the combustion of plastics and chemicals.

Burning timber wastes and agricultural wastes is also heavily polluting. Agricultural waste can either be turned back into the soil to maintain the long-term vitality of the topsoil or it can be used as biomass fuel for a biogas digester. Biogas digesters utilize bacteria to transform livestock manure and other organic matter into fertilizer and biogas, which consists mainly of methane (the main component in natural gas). Biogas can be used for heating and providing mechanical power and electricity. Normally,

biogas digesters are primarily employed for waste (sewage) treatment and fertilizer production, and biogas-generated electricity is a secondary benefit.

In most cases, landfill gas used as a renewable fuel has a net benefit for the environment. When large amounts of methane are emitted from landfills, operators are required to flare it; when emissions fall below limits requiring flaring, methane and other toxins escape into the atmosphere. Therefore, burning the methane to generate electricity is more desirable.

Various types of energy crops (i.e. willow, sweetgum, sycamore, switchgrass, woody crops) hold the potential for cleaner electricity production compared to traditional fossil fuels, especially coal, but their life-cycle impacts on the environment likely outweigh any benefits. Important considerations include:

- Land use that will be replaced—productive farmland, forests, and ecologically sensitive areas should not be sacrificed for energy crops.

- Effects on nutrient cycling and soil productivity.
- Use of herbicides and fertilizers compared to previous land use.
- Erosion potential and related water quality effects.
- Effects on biodiversity.
- Indirect promotion of unsustainable or ecologically harmful land practices (i.e. genetic engineering and deforestation).
- Effects on local economies.

In general, much research is still needed to determine how the life-cycles of biomass used for electricity production affect pollution emissions and local ecosystems. Until such research is available, individual situations must be evaluated on a case-by-case basis. Until sustainable biomass technologies are developed and proven, the general definition of “renewable energy” should be reserved for wind, geothermal, and solar power. However, this report includes discussions of biomass potential because of its growing popularity.

Biomass Potential

Current biomass capacity in New Jersey is 212 MW.⁷⁵ The Department of Energy estimates that New Jersey could generate 1,400 GWh/yr of electricity using biomass, enough electricity for 142,000 average-sized homes. However, the state will need to assess the various types of biomass included in the DOE estimate to determine the environmental impacts and choose those that provide a net benefit for the state.

Energy Savings Potential

Energy efficiency measures are the most effective tool for New Jersey to decrease its use of nuclear power and fossil fuels and the pollution that accompanies them. Historically, New Jersey has undertaken significant initiatives to promote energy efficiency. It developed some of the nation's earliest utility energy efficiency programs in 1983 after the accident at Three Mile Island. Investment in these utility programs declined until 1991, when the Board of Public Utilities decided to provide utilities with a profit incentive for successful implementation of energy efficiency programs. Support for these programs continued to gradually increase through 1998.

In 1998, New Jersey spent 1.34% of utility revenues, \$94.5 million, on energy efficiency programs, up from 0.29% in 1993. By 1998, the utilities' investments yielded an annual energy savings equaling 2.63% of electricity sales, or 1,860 GWh.⁷⁶

There are still tremendous opportunities for further energy savings through energy efficiency in New Jersey. Washington State saved more than 9% of its electricity sales through utility energy efficiency programs.⁷⁷ New Jersey could follow its example.

New Jersey was ranked eighth in the nation for total energy savings potential attainable from adopting stricter building codes.⁷⁸

According to the Alliance to Save Energy, a single-family home in New Jersey built in accordance with the 1993 International Code Council's Model Energy Code would experience considerable savings compared to a single-family home built under current building codes. Savings per household resulting from the additional cost of \$2,100 per single-family home to meet the stricter building code include:

- A first year savings in energy costs of \$200, with a positive cash flow in 3.2 years.
- Annual energy savings of 4,570 kWh.
- Annual reduction of 1-1.5 tons of greenhouse gas emissions.⁷⁹

Individual households can also see significant savings in their electricity bills by implementing simple energy efficiency measures. Replacing incandescent light bulbs with compact fluorescent bulbs would save the average household \$35-\$60 annually. Weatherizing a home would reduce the household's energy expenditures by \$200-\$400 annually.⁸⁰

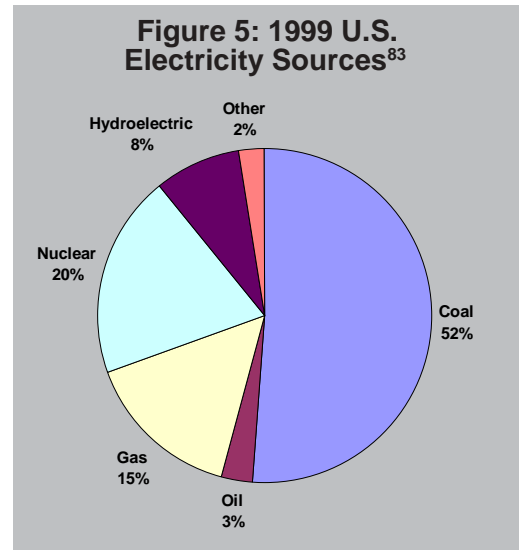
Combining utility energy efficiency programs with other cost-effective programs targeting sectors like the appliance and building industries would yield the best results. The American Council for an Energy-Efficient Economy analyzed the impacts of energy efficiency investments in the mid-Atlantic region (New York, Pennsylvania, and New Jersey) for 1997-2010. They concluded that the region could cut its electricity consumption by 33% in that thirteen-year period.⁸¹ Given that assessment, it is reasonable to call for New Jersey to cut its electricity demand by 15% by 2010 (an eight-year period). By doing so, the generation of 10,200 GWh of electricity would be avoided annually by 2010.⁸²

National Renewable Energy and Efficiency Potential

The nation's enormous renewable energy and energy efficiency potential remains largely undeveloped today. Despite the proven effectiveness and cost savings of energy efficiency and the evolution of affordable, clean technologies to produce electricity, the electric power industry continues to use coal for more than half (52%) of its electricity-generating needs. Other major sources include nuclear power, providing 20%, and gas, providing 15% of electricity. Smaller contributions come from hydropower (8%), oil (3%), and other varied sources including non-hydro renewables (2%). Together fossil fuels make up 70% of the electricity-generating sources in the U.S.

The Energy Information Administration (EIA) predicts fossil fuel contributions will increase to 75% of total sources used to generate electricity by 2010.⁸⁴

The U.S. has another choice. Renewable projects utilizing wind, geothermal, and solar energy are already operating throughout the country, proving the technology is ready to economically harness these resources. In 2000, wind energy contributed 3,000 MW, solar energy 548 MW, and geothermal energy 2,800 MW of power to the nation's energy system.⁸⁵ Together these resources



generate about 32,000 GWh/yr of electricity, enough energy for 3.2 million American homes.

This amount merely scratches the surface of remaining untapped potential. By 2010, the U.S. could be cost-effectively generating 391,000 GWh/yr of emission-free electricity – more than eleven times the current amount of electricity it generates from renewable resources. With the projected electricity demand of 4,140,000 GWh/yr reduced by 15% through energy efficiency measures, non-hydro renewable energy sources could satisfy 11% of the nation's electricity demand by 2010.

Given the potentially catastrophic effects of global warming, it is very much in the best

Table 2: Potential Growth of Clean Energy by 2010⁸⁶

Resource	Capacity (MW)			Generation (GWh/yr)	
	2000	New Development 2002-2010	2010	2010 Production	% of National Total 2010
Wind	2,970	116,300	119,300	313,500	8.7%
Geothermal	2,800	5,600	8,400	70,000	1.9%
Solar PV	194	2,900	3,100	5,400	0.2%
Solar Thermal	354	1,000	1,300	2,400	0.1%
Total	6,318	125,800	132,100	391,300	10.9%
Energy Efficiency				630,000	17.5%

interests of New Jersey citizens to encourage the federal government to facilitate the growth of renewable energy and energy efficiency across the country.

Wind Potential

The U.S. has enough windy spots to cost-effectively install more than a million MWa of wind power capacity, according to the Pacific Northwest Laboratory, a public/private research arm of the U.S. Department of Energy.⁸⁷ This would generate three times the amount of electricity the country used in 2000.⁸⁸

The National Renewable Energy Laboratory made more conservative estimates in 1994, measuring wind-generating capability only in areas that met stricter wind classifications, that avoided environmentally sensitive areas, and that were located within ten miles of existing transmission lines. They estimated that the U.S. could generate 734,000 MWa of electricity from turbines in such locations – nearly twice as much as the U.S. currently uses.⁸⁹

Wind power is the fastest growing energy source worldwide. New wind power capacity grew by 24% annually throughout the 1990s, with a growth rate of 37% in 1999 and 28% in 2000.⁹⁰ Last year, the industry installed enough turbines to generate an average of 798 MW in the U.S.⁹¹ If new installations were to increase by 30% annually hereafter – a rapid but feasible rate – the country could generate more than 7% of its electricity from wind power by 2010, as shown in Table 3. This scenario would tap only 35,000 MWa of the 734,000 MWa potential, but it would displace the need for 80 fossil fuel power plants.

Solar Potential

There is theoretically enough sunlight in a 100-mile square patch of desert in the southwestern U.S. to generate enough electricity for the entire country.⁹² Solar thermal plants could replace 100% of current fossil fuel-

Table 3: Future U.S. Wind Power Generation with 30% Annual Growth

Year	New Installation (MWa)	Total Capacity (MWa)	Total Generation (GWh/yr)
2000		891	7,805
2001	798	1,689	14,796
2002	1,037	2,726	23,883
2003	1,349	4,075	35,697
2004	1,753	5,828	51,055
2005	2,279	8,107	71,021
2006	2,963	11,070	96,976
2007	3,852	14,922	130,718
2008	5,007	19,929	174,582
2009	6,510	26,439	231,605
2010	8,462	34,901	305,736

based electricity production using only 1% of the earth's desert area.⁹³

Although transmission distances may make generating all of our electricity in the deserts unfeasible, much development can take place before this presents a barrier. As a first step, we could easily hope to encourage the construction of 1,000 MW of solar thermal capacity with just five power plants in the Mojave Desert by 2010. As fuel cell technology develops, there will likely be opportunities to produce hydrogen from solar energy in the deserts for shipment elsewhere.

Solar power can generate electricity directly using photovoltaics (PV) as well. PV electricity production is all around us, from satellites to road signs to watches to rooftops. Total U.S. PV capacity of 194 MW is quite small compared to other energy sources, but growth of PV use has been steady and is expected to continue at an increasing rate. Both the domestic and worldwide growth rates for cumulative installed PV capacity have been increasing. The domestic PV capacity growth rate increased to 18.3% in 1999 from an average of 15.6% through most of the 1990s. Worldwide, the cumulative PV capacity growth rate increased from an average of 27% (1993-1999)

Figure 6: Increasing Growth Rate of Worldwide Cumulative PV Capacity

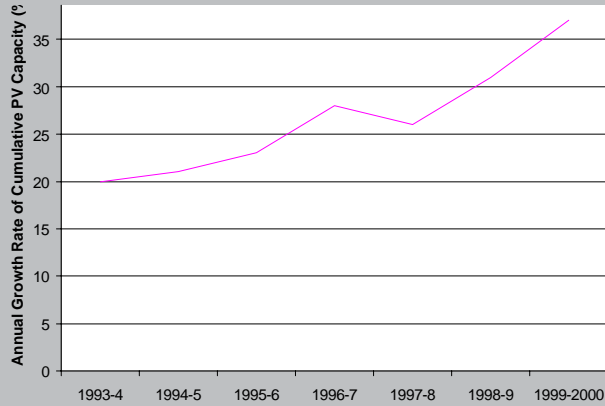
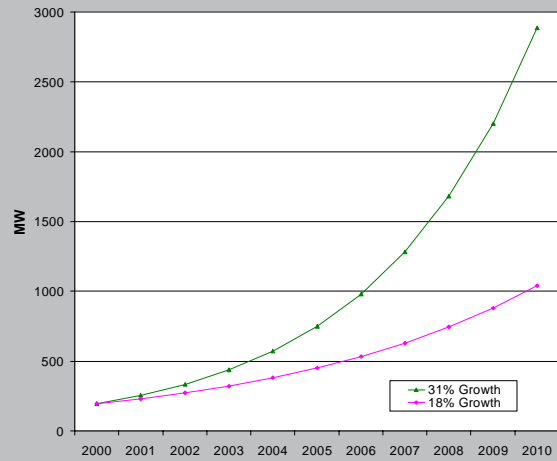


Figure 7: U.S. Solar PV Capacity Growth



to an average of 31% (1997-1999) and peaked at 37% in the last recorded year, 1999.⁹⁴

If the cumulative U.S. PV capacity continues at the current domestic growth rate of 18%, it will increase from its current capacity of 194 MW to 1,000 MW by 2010.⁹⁵ If the U.S. strongly encourages the growth of solar energy, capacity could be added much more quickly. Growing at the 1997-99 worldwide rate of 31% annually, U.S. capacity could reach nearly 3,000 MW by 2010.

Geothermal Potential

The U.S. has tremendous geothermal resources. The DOE estimates high-temperature (electricity-generating quality) geothermal potential in the U.S. to be more than 4,000 quads (quadrillion Btus), more than forty times our current energy use.⁹⁶

The last nationwide assessment of geothermal resources was published in 1978. It estimated a high-temperature potential of approximately 22,000 MW in nine western states from known reserves.⁹⁷ Estimates of undiscovered reserves ranged from 72,000 to 127,000 MW.⁹⁸ Since knowledge about geothermal resources has advanced dramatically since 1978, there is need for reassessment of these resources.

The DOE Office of Power Technologies project entitled “Geopowering the West” has a goal for geothermal energy to provide 10%, or 10,000 MW, of the electricity needs of the Western states by 2020.

The Energy Information Administration estimates the growth rate for geothermal capacity to be 7.2% through 2010.⁹⁹ Given this growth rate, U.S. geothermal capacity would reach over 5,600 MW by 2010, as shown in Table 4.

Table 4: Future Geothermal Generation with 7.2% Annual Growth

Year	New Installation (MW)	Total Capacity (MW)	Total Generation (GWh/yr)
2000		2,800	23,302
2001	202	3,002	24,979
2002	216	3,218	26,778
2003	232	3,450	28,706
2004	248	3,698	30,773
2005	266	3,964	32,988
2006	285	4,249	35,363
2007	306	4,555	37,910
2008	328	4,883	40,639
2009	352	5,235	43,565
2010	377	5,612	46,702

Energy Savings Potential

The U.S. could save energy and significantly reduce pollution by implementing effective policies encouraging energy efficiency. The American Council for an Energy-Efficient Economy (ACEEE) studied the impacts of several “smart energy” policies on U.S. energy consumption, economics, and emissions.¹⁰⁰ Under the “smart energy” policy scenario, the U.S. would reduce its total primary energy consumption¹⁰¹ by nearly 11% by 2010 compared to the business-as-usual, or base-case, scenario lacking new policies. Looking at the electricity production portion of this,¹⁰² annual energy use for electricity would be reduced by 15% in the policy case by the year 2010 as compared to business as usual. A 15% reduction in electricity use in 2010 translates to more than 630,000 GWh/yr saved and 700 million tons of carbon dioxide emissions avoided per year.

The set of policies analyzed in the study includes eight electricity-saving actions:

- Utility energy efficiency program to set aside funds for investment in energy efficiency.
- New and strengthened equipment efficiency standards.
- Tax incentives for energy-efficient homes, commercial buildings, and other products.
- Expanded federal energy efficiency research, development, and deployment programs.
- Promotion of clean, high-efficiency combined heat and power systems.
- Voluntary agreements and incentives to reduce industrial energy use.
- Improvements in efficiency and emissions from existing power plants.
- Greater adoption of current model building energy codes and development and implementation of more advanced codes.

Pollution Reduction Realized with Clean Energy Solutions

Tapping the renewable energy and energy efficiency potential ready for development now in New Jersey and the nation would dramatically reduce power plant air pollution at both the state and national levels. By 2010, New Jersey could reduce its CO₂ emissions by 8 million tons per year by developing clean energy sources instead of increasing fossil fuel use, while the U.S. could reduce CO₂ emissions by 11 billion tons per year.

Pollution Reduction in New Jersey

As of 1999, electricity generation in New Jersey was producing an alarming 20 million tons of carbon dioxide, 48,000 tons of sulfur dioxide, 37,000 tons of nitrous oxides, and 171 pounds of mercury into the air annually, along with deadly particulate pollutants and a host of other toxins.¹⁰³

As outlined above, New Jersey could develop 2,300 GWh/yr of wind energy and save

10,200 GWh/yr through efficiency measures by 2010. By developing these resources, a surplus of emission-free wind power could replace 1,400 GWh/yr of coal-fired electricity generation.

Current emissions could then be reduced by approximately 10% by 2010. Comparing projections of annual power plant pollution in 2010, development of energy efficiency and renewables rather than further development of fossil fuels would reduce pollution by 31%.

By developing clean power solutions rather than meeting the projected electricity demand with gas-fired electricity, New Jersey would reduce air pollution emissions by 8 million tons of CO₂, 10,000 tons each of SO₂ and NO_x, and 36 pounds of mercury by 2010. Under the clean energy development scenario, renewables would be providing 4% of the state's electricity by 2010.

New Jersey has two energy paths to choose between. The amount of power plant pollution New Jersey citizens will have to endure by 2010 will be directly affected by the choice. The state can further develop fossil fuels and increase power plant pollution by nearly 29% from current levels, or develop

Table 5: New Jersey Potential Clean Energy Development by 2010¹⁰⁴

	Capacity (MW)	Electricity Generation (GWh/yr)
1999 Use	16,651	56,995
2010 Projection	19,892	68,089
Additional power needed by 2010	3,241	11,094
Potential Wind Energy Growth by 2010	880	2,300
Potential Energy Efficiency Development by 2010	2,980	10,200
Total Clean Energy Development by 2010	3,860	12,500

Table 6: NJ Power Plant Pollution under Different Scenarios

Year	Scenario	Electricity Generation (GWh/yr) ¹⁰⁵	CO ₂			
			Emissions (thousand tons)	SO ₂ Emissions (tons)	NO _x Emissions (tons)	Mercury Emissions (pounds)
1999		56,995	20,307	48,053	36,589	171
2010	Fossil Fuel Development	68,089	26,100	48,300	40,500	171
2010	Clean Energy Development	57,900	18,120	38,300	30,700	135

Table 7: U.S. Power Plant Emissions Comparison¹⁰⁶

Year	Scenario	Electricity Generated or Saved (GWh/yr)	CO2 Emissions Generated or Avoided (thousand tons)	SO2 Emissions Generated or Avoided (thousand tons)	NOx Emissions Generated or Avoided (thousand tons)	Mercury Emissions Generated or Avoided (pounds)
2000	Current Generation	3,430,700	2,406,780	12,870	6,040	84,850
2010	Projected Generation	4,224,200	2,994,100	14,600	7,300	98,400
2010	Projected Generation with Clean Energy Development:	3,590,600	1,880,100	8,000	4,400	54,300
	Renewables Developable	359,250	404,000	2,400	1,000	16,100
	Energy Savings from Energy Efficiency	630,000	710,000	4,200	1,900	28,000
	Total Clean Energy Development		1,114,000	6,600	2,900	44,100

clean energy sources and reduce power plant pollution by 10%.

Pollution Reduction Nationwide

The U.S. potential growth of wind, geothermal, and solar power outlined above would generate 359,250 GWh/yr of electricity by 2010. This represents 8.4% of U.S. electricity demand projected by the EIA for 2010, not including current renewable energy generation and before any reductions in demand through energy efficiency measures are considered.

If these renewables were to replace coal power plants, CO₂ would be reduced by more than 400 million tons, SO₂ would be reduced by more than 2 million tons, NOx reduced by more than 1 million tons, and power plant

mercury emissions would decrease by nearly 16,000 pounds by 2010.

Energy efficiency measures resulting in a 15% reduction in electricity demand would eliminate the pollution associated with 630,000 GWh/yr of electricity production: 710 million tons of CO₂ emissions, 4 million tons of SO₂ emissions, 1.9 million tons of NOx emissions, and 28,000 pounds of mercury at the rate coal-fired plants emit pollution.

The combined impact of renewable energy and energy efficiency developed to replace coal-fired electricity generation would cut power plant CO₂ emissions by 37%, SO₂ emissions by 45%, NOx emissions by 40%, and mercury emissions by 45% compared to projections for continuing on the current path.

Figure 8: CO₂ Emissions with Renewables and Energy Efficiency Replacing Coal

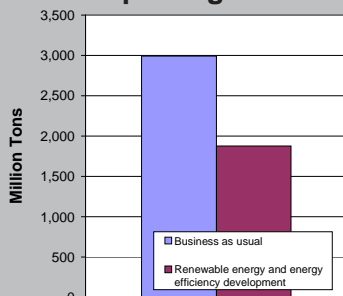


Figure 9: SO₂ Emissions with Renewables and Energy Efficiency Replacing Coal

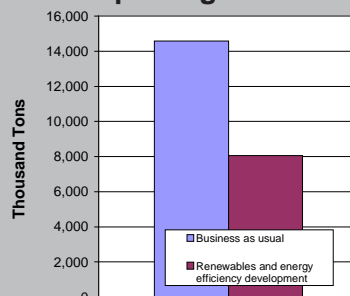
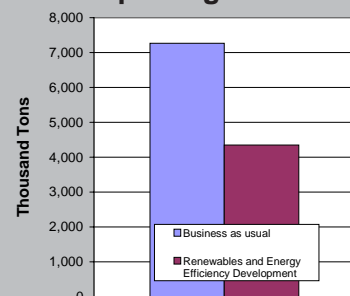


Figure 11: NOx Emissions with Renewables and Energy Efficiency Replacing Coal



Economic Feasibility of Clean Energy Solutions

Not only are clean energy resources abundantly available, they are also economically viable today. Both energy efficiency measures and renewable energy technologies are more cost-effective in the long term than the current fossil fuel-dominated energy system. This was not the case a few decades ago when renewable energy resources were first presented as alternatives to oil and coal. But today any truly sound financial investment in the nation's energy future must involve aggressive and timely development of these resources.

- Energy efficiency measures have been proven on both the local and national levels to be the best response to immediate power needs. They reduce pollution and energy demand at a cost that is less than most new power plants.
- Renewable energy technologies provide stable and declining electricity costs because their “fuel” is free, in contrast to ongoing purchases of fossil fuel at volatile prices. Renewable energy projects have the added economic benefit of creating more jobs than traditional fossil fuel electricity generation since renewable energy costs are more tied to skilled labor than to fuel.
- Clean energy solutions are even more attractive compared to fossil fuels when externalized environmental costs are accounted for.

Clean energy policies resulting in the increased use of both renewable energy and energy efficiency provide the best overall strategy for America's energy future. Several recent studies examining the economic impact of efficiency and renewables stimulus programs found that the nation's economy would experience greater growth with policies encouraging renewables and energy efficiency than under a business-as-usual scenario.

Fossil fuel-generated electricity, on the other hand, is not a good long-term financial investment. Much of its costs are tied to limited fuel resources. Although the upfront capital costs of constructing a new fossil fuel power plant may be less than the upfront costs of a renewable energy power plant, the price of fossil fuel-generated electricity will forever carry a fuel cost. As changes occur in the supply and demand of the limited fuel, the cost will oscillate in response and eventually increase as the resource is depleted.

Fossil fuel-generated electricity also has significant externalized costs. Expenses related to the environmental and public health damages associated with fossil fuel extraction and power plant emissions do not appear on electricity bills, yet they are very real costs to society.

Even though hydropower does not emit air pollutants, dams have major negative environmental impacts. Energy planners are not considering hydropower as a significant source to meet future electricity needs.

Nuclear power, the only other option for electricity generation, is expensive, highly polluting, and unacceptably dangerous.

Energy-Efficient Technologies and their Costs

History has proven that adopting energy efficiency measures is the cheapest, as well as the easiest, quickest, and cleanest way to address urgent power needs. Nationally, energy efficiency programs of the past five years have avoided the need for 25,000-30,000 MW of generating capacity – the equivalent of 100 large power plants. These programs averaged 2.8 ¢/kWh, a cost that is less than that of most new power plants.¹⁰⁷ In addition to cost savings, energy efficiency measures have avoided the logistics and time involved with the siting of 100 large power plants, the acquisition of the rights of way for power lines and gas pipelines, and the emission of 190 million tons of CO₂.¹⁰⁸

California is often considered a leader in energy efficiency efforts. Over the past

twenty years, California has reduced its peak demand by 10,000 MW through utility energy efficiency programs and energy efficiency standards for buildings and appliances, yet there is still potential for increased savings.¹⁰⁹ In the face of its energy crisis last year, a concerted effort resulted in a reduction of electricity demand in the state by 6 percent from the same seven-month time period a year earlier, and a peak reduction of 11 percent over the previous year, with continued growth in the state economy. As a result, California avoided the National Electric Reliability Council's grim prediction of 250 hours of rolling blackouts this past summer that would have cut power to over 2 million households per blackout.¹¹⁰

Several recent studies have shown that the U.S. would continue to save energy and money in the future by implementing more energy efficiency programs and setting stricter efficiency standards.¹¹¹ The ACEEE study that determined the U.S. could reduce its electricity demand by 15% by 2010, for example, also revealed that a net savings of \$152 billion dollars would accompany the energy savings by 2010 under their smart energy policy scenario.¹¹²

A variety of measures fall under the energy efficiency umbrella. Examples of utility energy efficiency measures include replacing older, less-efficient equipment with newer, more-efficient equipment. This equipment can include:

- High-efficiency pumps and motor retrofits for large oil and gas producers and pipelines.
- Redesigned electricity generators with combined heat and power systems that recycle and reuse waste heat, which significantly increases their efficiency.
- Smaller onsite efficient electricity generators (rather than large central power plants) that match the power needs of the district or building and bypass the need for long-distance transmission of electric-

ity where significant losses of energy occur.

Examples of consumer energy efficiency measures include:

- Weatherizing homes.
- Replacing old appliances with newer, more efficient ones.
- Installing electricity, heat, and air-conditioning systems that are responsive to real-time energy demand.

Renewable Energy Technologies and their Costs

Because renewable energy has no fuel costs, its total costs are predictable and stable. Once the plants are built, producers only have to pay the regular operating and maintenance costs to keep the power flowing. The fluctuating fuel costs of fossil fuel-based power plants are not a factor for renewable energy producers.

The fact that more of the costs are upfront rather than spread out in the form of ongoing fuel costs constitutes a challenge in the development of renewable energy projects, since investors need to undertake more financing at the start of the project. However, since this also results in greater certainty of the total costs over the full lifetime of the plants, hesitation over high initial investments can be eased through market certainty. When a state enters into long-term contracts with renewable producers, guaranteeing a stable price for much of the lifetimes of their plants, the initial investment hurdle is greatly reduced.

The combination of advanced technology and market growth in renewable energy industries over the past decades has lowered costs markedly. The average prices of wind and solar energy have plummeted over the last twenty years and are predicted to continue to decline. Geothermal energy costs, which currently range from slightly higher to lower than conventional fossil fuel power, have also declined historically and are pre-

dicted to remain roughly the same over the next ten years.

Wind

The cost of producing electricity from wind energy has declined by more than 80% in the past twenty years, from about 38 cents per kilowatt-hour (¢/kWh) in the early 1980s to a current range of 3 to 8 ¢/kWh (levelized over a plant's lifetime). This does not include the federal wind energy Production Tax Credit which reduced the cost of wind-generated electricity production by about 0.7 ¢/kWh over the lifetime of the plant until the credit expired at the end of 2001.

The cost of electricity from wind plants varies based on their size and the average wind speed. A large plant (50 MW and up) at an excellent site (20 mph average) can deliver power for 3 ¢/kWh . Electricity from a small plant (3 MW) at a moderate site (16 mph) may cost up to 8 ¢/kWh , which is still lower than retail cost in many areas. Analysts believe that wind energy costs could fall to 2.5 ¢/kWh in the near future, making wind power more competitive than most conventional energy sources.¹¹³

Solar

Solar Thermal Power Plants

The first Solar Electricity Generating System (SEGS) plant was installed in California's Mojave Desert in 1984 and generated electricity for 25 ¢/kWh (1999 dollars). The California SEGS plants now have a collective capacity of 354 MW and generate electricity for 8-10 ¢/kWh . A new solar thermal plant with a capacity of 100 MW or more installed today could generate electricity for 7 ¢/kWh .¹¹⁴

Solar energy has the unique advantage of peaking when the electricity grid experiences some of its highest demands – in the heat of summer afternoons. In contrast, when traditional fossil fuel plants attempt to address peak needs, they often must operate for far longer periods than the true peak load period due to long start-up and shut-down pro-

cedures. The wasted fuel and added pollution increases the cost of generating electricity during peak times. For this reason, solar power plants are cost-competitive in the peak power market today.

Photovoltaics

PV can generate electricity for 12-25 ¢/kWh today.¹¹⁵ This is more economical than fossil fuel-generated electricity right now for some situations, such as remote applications in the U.S. and vast areas of the developing world that have no grid/power plant infrastructure in place. However, without subsidies, it is not competitive with the lowest rates from gas and coal-fired power plants today in the grid-connected developed world.

An important consideration in cost comparisons of traditional power plants and PV is that when a PV system is installed in a home or business, there are no mark-up costs to middlemen and no distribution costs. Therefore, the comparisons must take place at the retail cost of electricity rather than the wholesale cost of the fuel or the power plant generating cost. The average U.S. residential retail cost of electricity is 8.5 ¢/kWh , though it can cost over 14 ¢/kWh in some states.¹¹⁶ In 1996, the cost of installing a PV system represented either no net cost or profit over remaining completely dependent on grid-connected power in only five states. Just three years later, this was true in fifteen states.¹¹⁷ Residential rates, along with tax credits and/or capital cost reduction policies, were the most influential factors rendering PV cost-effective in these states.

Economies of Scale

Although technological breakthroughs may lower PV prices significantly, the biggest price reductions are expected from economies of scale due to increased PV panel manufacturing volume.

The current cost of PV modules is quoted at about \$3.50-\$3.75 per watt wholesale and \$6-\$7 per watt for an installed system.¹¹⁸ This is a dramatic reduction in cost from \$20 per watt ten years ago and a hundred-fold drop

Table 8: Experience Curve for PV Module Price

Doubling	Installed MW	Wholesale Price per Watt	Installed System Price per Watt
0	1,034	\$3.50	\$6.50
1	2,068	\$2.87	\$5.33
2	4,136	\$2.35	\$4.37
3	8,272	\$1.93	\$3.58
4	16,544	\$1.58	\$2.93
5	33,088	\$1.30	\$2.40
6	66,176	\$1.06	\$1.97
7	132,352	\$0.87	\$1.62
8	264,704	\$0.72	\$1.32
9	529,408	\$0.59	\$1.08
10	1,058,816	\$0.48	\$0.89

in cost since 1972.¹¹⁹ The cost will continue to decline as PV manufacturers reach economies of scale. Since nearly all of the costs for PV-generated electricity lie in the equipment, the more equipment manufactured on a mass scale, the cheaper the electricity becomes.

The relationship between increased volume and decreased price is called the experience curve. For PV, it is estimated to be 82%. That is, for every doubling of cumulative production volume, the price of PV is expected to decline by 18%.¹²⁰

In 1999, total worldwide installed PV capacity was 1,034 MW.¹²¹ The next four doublings of this amount will each reduce the price of installed systems by about one dollar per watt.

To compete on equal footing with traditional power sources in a short-term economic view, PV prices will need to be around \$1/watt for an installed system.¹²² According to this experience curve, that price will be reached once total PV installations surpass 500,000 MW.

The PV industry clearly has a fair distance to go, but it is steadily progressing toward its goal. PV module shipments in the U.S. and worldwide have steadily increased over

Figure 11: Annual PV Manufacturing Volume¹²⁴

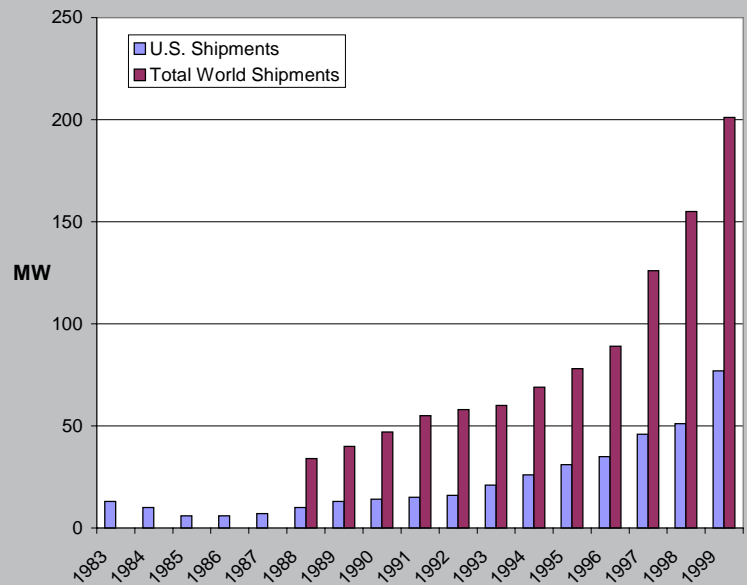
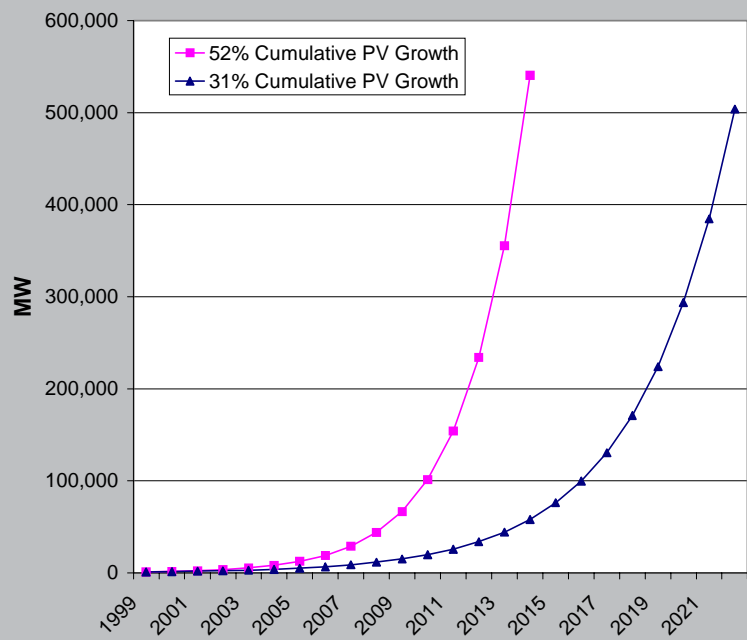


Figure 12: PV Market Growth Rates¹²⁵



the past twenty years. Furthermore, the rate by which shipments have increased has risen.

From 1989-99, the growth rate of worldwide PV module shipments averaged 18%. For the same time period, the U.S. growth rate was 21%. Recently the growth rate has

been much higher. The average growth rate in 1997-99 in the U.S. and worldwide was 31%. In 1999, the U.S. growth rate of PV module shipments was 52%, the highest ever, while the worldwide growth rate of shipments remained at a healthy 30%.¹²³

If the growth rate in PV manufacturing activity continues at the 52% level it reached in the U.S. in the past year, cumulative worldwide PV capacity will have reached 500,000 MW by 2013. If growth in manufacturing only grows at the 1997-99 average rate of 31%, the industry will have reached this milestone in 2022.

Geothermal

Geothermal energy provides the U.S. with 2,700 MW of generating capacity. Currently geothermal fields are generating electricity for 1.5-8 ¢/kWh.¹²⁶

The Geysers in California are a good example of how renewable energy, with the bulk of its costs upfront, can provide electricity at stable and declining costs. The plants were built in the 1960s and are still operating today with much of the original infrastructure, including the wells. Since the capital costs of the original construction have been paid off and the resource continues to fuel the plant at no cost, the only expenses are ongoing operation and maintenance costs. They are now producing electricity for 3 ¢/kWh.¹²⁷

Biomass

A power plant burning 100% biomass can produce electricity for about 9 ¢/kWh, though advances in technology are expected to bring the cost down to 5 ¢/kWh in the future.¹²⁸

Economic Development Benefits of Clean Energy

The 1997 Kyoto protocol, an international treaty to reduce global-warming greenhouse gases, prompted analyses of the feasibility and impacts of carbon reduction strategies in the U.S. Given that power plants account

for 40% of U.S. carbon dioxide emissions, power plants were featured prominently in these strategies. Each of these reports produced concurring results:

- A 1997 study by five national laboratories concluded that a vigorous national commitment to developing and deploying energy-efficient, low-carbon, and renewable technologies can reduce pollution, reduce energy consumption, and produce energy savings that equal or exceed the costs of the endeavor.¹²⁹
- Another 1997 study by five environmental and public policy organizations found that policies encouraging energy efficiency, renewable energy, and other advanced clean technologies would result in lower energy consumption, lower CO₂ emissions, billions of dollars in consumer energy bill savings, and a net employment boost of nearly 800,000 jobs in the U.S. by 2010.¹³⁰
- In 1998, the U.S. Environmental Protection Agency analyzed policy and program scenarios with help from the Lawrence Berkeley National Laboratory. The analysis identified a relationship between carbon emissions mitigation (through development of energy-efficient, low-carbon, and renewable technologies) and economic activity. In their model, carbon mitigation resulted in increased gross domestic product and economic savings by 2010 larger than the business-as-usual projections.¹³¹
- In 2000, the Interlaboratory Working Group on Energy-Efficient and Clean Energy Technologies examined the potential for public policies and programs to address current energy-related challenges. Their study concluded that public policies promoting energy efficiency and clean energy production can significantly reduce power plant air pollution with economic benefits that are comparable to overall program implementation costs.¹³²

All of these studies address the problem of pollution with a comprehensive and long-term approach, and all of these studies disprove the long-held misconception that we must choose between cleaner energy production and economic growth. Their solutions are similar in that each multifaceted scenario involves using energy more efficiently and diversifying our energy mix by adding clean renewable technologies to our portfolio.

Conventional Sources of Electricity Generation and their Costs

Coal, natural gas, and nuclear power serve as the major sources for America's electricity generation. Current trends are pointing us in the direction of increased dependence on these unsustainable resources. A closer look into the life-cycles of each of these resources reveals why they are unsustainable and more costly than clean energy solutions in the long term.

Fossil Fuels

Fossil fuels are a limited resource. Clearly we cannot continue to rely on them forever. Some people fear that we will run out and have no place to go, while others feel that we will keep finding new deposits and do not need to worry about it. Both of these views miss the point. We should be concerned about the limited nature of fossil fuels because of escalating environmental costs, volatile fuel costs and supply instabilities, and because deepening our dependence on them is money and effort poorly spent when we will unavoidably need to transition to renewable fuels.

Natural Gas

Natural gas is currently the world's favored fossil fuel because it is the cleanest burning fossil fuel. Energy companies have responded to concerns about the health and global warming effects of burning coal by proposing that nearly all future electricity-generating power plants be fueled by natural gas.

Because its emissions are cleaner and because we are not yet geared up to rely completely on sustainable fuels, gas is extremely valuable and should be treated as a precious, limited, transitional resource to aid us as we shift our reliance onto sustainable energy sources. Instead it is being regarded as an unlimited commodity whose availability will be appropriately managed by market forces alone.

Market forces would eventually treat natural gas as a limited resource, but this would happen very slowly and only after wasting unnecessary amounts. Most energy experts agree that the average price of natural gas will gradually rise over the coming years and decades. Even the unflinchingly optimistic Energy Information Administration (EIA) predicts that natural gas prices will rise between 1.2% and 2.8% per year in constant dollars through 2020.¹³³ Energy experts of all backgrounds agree that energy production will shift from natural gas and other fossil fuels to renewable technologies as the price of fossil fuels goes up and the price of renewables declines. To make this shift before supplies are squandered too extensively and to correct for historical manipulations of the market favoring fossil fuels, renewable energy development should be encouraged now.

Natural gas prices are also subject to dramatic volatility, as was clearly seen in the "energy crisis" in California over the past year. According to the Department of Energy, the cost of generating electricity using natural gas was 3.7 ¢/kWh in 2000, but the cost reached as high as 43 ¢/kWh in February 2001 in California.¹³⁴

The price of fossil fuel-generated electricity is dominated by the ongoing cost of the fuel. Several factors directly affect the cost of fossil fuels:

- Supply and demand.
- Accessibility of reserves.
- Infrastructure requirements for transportation and distribution.

Supply and Demand

The U.S. does not have enough domestic reserves of natural gas to satisfy our growing demand. The U.S. Geological Survey estimates that the U.S. has 1,049 trillion cubic feet of gas remaining, of which only 16% are proved reserves. If demand were to grow by 2.3% through 2020 as predicted by the Department of Energy and stay constant thereafter, and imports from foreign nations remain around 16% of demand, this amount of gas only constitutes a 38-year supply.

Since 1986 the U.S. has not produced enough natural gas to meet its demand, and the gap continues to widen.¹³⁵

Accessibility

Many of the new gas wells needed in the next twenty years will be tapping reserves that are more difficult to reach than those we have already tapped. As the EIA has stated in explanation of its forecast of increasing natural gas prices, “increases reflect the rising demand projected for natural gas and its expected impact on the natural progression of the discovery process from larger and more profitable fields to smaller, less economical ones.”¹³⁶

Energy companies have had to drill a vastly

increasing number of wells each year to provide a marginally increasing supply of gas. If they are to increase production dramatically over the next twenty years as projected, they will have to increase drilling far beyond current and previous rates. Due to declining well productivity, meeting those projections may not even be possible.

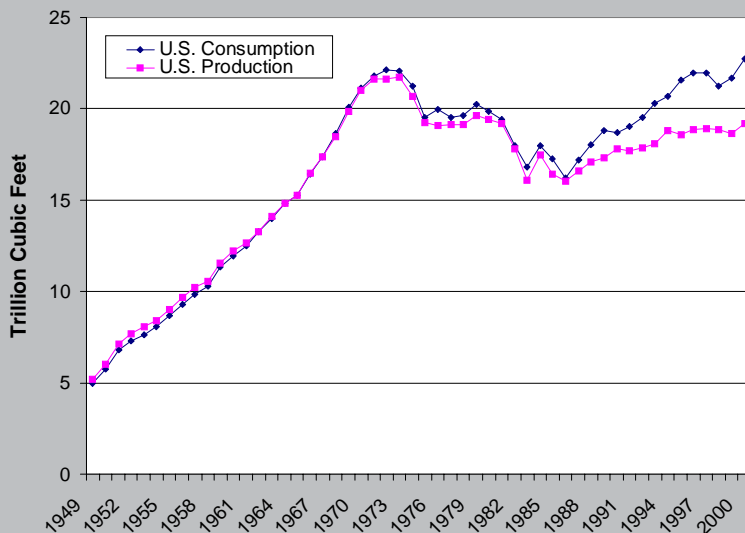
Well Productivity

The productivity of gas wells peaked in 1973 and has steadily declined since then. The 124,000 wells in the U.S. in 1973 produced an average of 182 million cubic feet (MMcf) of natural gas. This productivity fell sharply in the following years, then continued on a gradual decline. From 1984-2000, the average annual gas production per well declined by 21 percent. In 1999, the country had two and a half times as many wells as in 1973, but each well was producing less than a third as much gas – 307,000 wells produced an average of 55 MMcf/yr each.

The natural gas industry has evidence that the rate per well of natural gas production will continue to decline. William Wise, Chairman and CEO of the world’s largest natural gas company, El Paso Corp., recently stated plainly that gas production in North America is flat despite a recent surge in drilling. Receipts from his company’s expansive pipeline systems have stayed roughly constant for the past three years. “Our field services are in all of the basins where all of the drilling in the United States is taking place and we are not seeing a production response. We’re just kind of trading water, holding our own,” Wise told an annual energy conference in March 2001. Decline rates – the reduction in well output over the previous year – have increased from 17% per year in 1970 to nearly 50% today. “What not everybody realizes is the same thing is happening in Canada,” Wise said. Decline rates there went from 20% per year in 1990 to 40% per year in 1998.¹³⁷

If the productivity per well stays constant at the current rate of 55 MMcf/yr, 529,000 production wells will be needed to meet the

Figure 13: U.S. Natural Gas Consumption vs. Production



U.S. projected demand of 29.1 tcf of gas in 2020. This is 72% more than the 307,000 wells in operation in 1999. With the generous assumption that all current wells will still be producing gas in twenty years, the U.S. would need an additional 221,600 producing wells. Since only one out of two wells drilled actually produces gas, 443,200 wells would need to be drilled, an average of 23,300 per year. This is just slightly more than the number of wells that were actually drilled in 2000.¹³⁸

However, since the productivity per well has declined continually since 1973, it would be more realistic to assume that the productivity rate will continue to decline. Between 1984 and 2000, productivity declined by 21%. If productivity declines another 20% over the next twenty years, 707,800 new wells will need to be drilled, an average of 37,000 per year. Since drilling will be significantly less than that in the next few years as the industry gradually expands, drilling in the latter part of the twenty-year period will need to be well over 40,000 wells per year, a truly unprecedented amount.

Imports

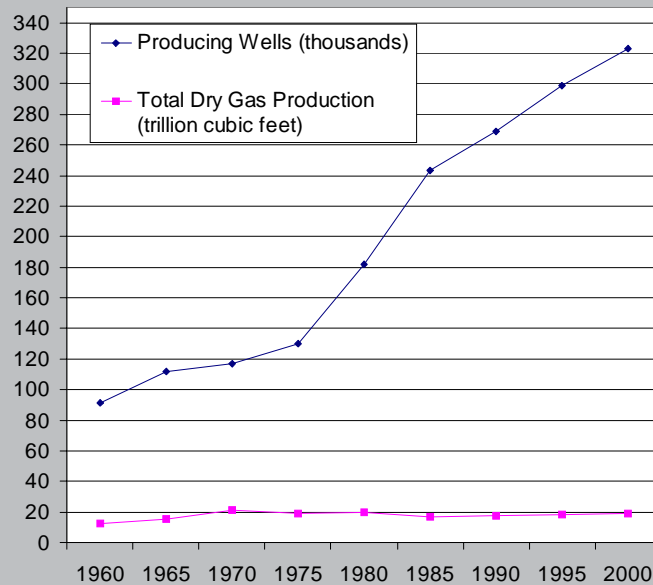
Since domestic supplies are limited, if we continue to increase our dependence on natural gas, we will have to turn to expensive overseas shipments.

Gas imported from Canada can be shipped by pipeline, but as Canada experiences declining production rates like the U.S., we will be forced to look to other continents for imports. To import natural gas from overseas, the gas must first be turned into a liquid by cooling it to -256 degrees Fahrenheit. It is then shipped in tankers, turned back into a gas at receiving facilities, and sent by pipeline to its final destination. The process will certainly increase natural gas prices.

Infrastructure

The U.S. gas pipeline and electricity power line network is in desperate need of attention. In most parts of the country, the network is operating at its upper limits. New

Figure 14: U.S. Production Wells vs. Total Dry Gas Production



infrastructure needed to feed the multitudes of new gas plants planned for the U.S. will affect the cost of natural gas.

Vice President Cheney has called for the construction of more than one power plant per week for the next twenty years, with most of them fueled by natural gas. He recently stated that the Bush energy plan would require 38,000 miles of new gas pipelines.¹³⁹ At a rough estimate of \$700,000 to build a mile-long stretch of pipeline in an unpopulated area and \$2 million per mile in populated areas, this one piece of the Vice President's plan would cost \$27-76 billion.¹⁴⁰ Along with the cost of finding and extracting natural gas, this will be a tremendous investment for a relatively short-term solution.

At an average power plant lifetime of forty years, domestic production of natural gas will peak well before those plants are used for their full lifetimes. In recent years, "stranded costs" from bad investments in nuclear power plants have been an issue. Twenty-five years from now, we may face stranded costs from gas-fired power plants that are no longer economically viable due to limited resources.

Coal

Coal is used for electricity generation in the U.S. more than any other resource for two basic reasons: it is a domestic resource and, by ignoring the externalized costs, coal appears to be the cheapest of all energy resources.

As downstream effects of burning coal are being recognized, studies have begun to reveal the truer costs of coal-burning power plants. Without externalized costs included, coal-fired electricity generation costs about 2.3 ¢/kWh.¹⁴¹ When external costs are accounted for, the cost rises to more than 8 ¢/kWh.¹⁴² This is more expensive than many emission-free renewable energy projects.

Fossil Fuel/Renewable Energy Cost Comparison

When the true costs of the life-cycles of “cheap” fossil fuels are revealed, renewable technologies often prove to be less expensive. In 1994, the U.S. Office of Technology Assessment reviewed previous studies of the environmental costs of electricity production. The studies mostly measure the costs of compliance with air quality regulations, transportation costs associated with energy production, land use impacts, and some public health costs. Only one study, a more recent analysis by the European Union and the U.S. Department of Energy published in 2001, attempted a comprehensive set of costs

including the costs of climate change, human death and illness from disease and accidents, reduced production of crops and fisheries, degraded structures, lost recreational and tourism opportunities, degraded visibility, loss of habitat and biodiversity, and use of land, water, and minerals. The other studies each contain some subset of these impacts.

Coal has the greatest external costs. Natural gas, though its air emissions are cleaner than coal, also has significant external costs due to its environmental impacts. Once some external costs are included in the generation costs, renewable energy sources are far more competitive, with costs of some renewables less than that of fossil fuels.

Nuclear Power

Nuclear power is not the answer to cleaning up our electric power industry-related pollution. It is not cheap and it is not safe.

Nuclear power would not exist in this country today were it not for enormous subsidies paid for by taxpayers and ratepayers. Taxpayer-financed federal R&D money alone has totaled \$66 billion.¹⁴⁶ On top of that, the nuclear industry has received a special taxpayer-backed insurance policy known as the Price Anderson Act, taxpayer-funded cleanup of uranium enrichment sites, the costly privatization of the previously government-owned Uranium Enrichment Corpora-

Table 9: Studies of External Costs of Electricity Generation (¢/kWh)¹⁴³

Study	Combined Cycle		Solar PV	Wind	Geothermal	Biomass
	Coal	Natural Gas				
1990 Pace University	3.91-9.58	1.5	0.0-0.5	0.0-0.1		0.0-0.9
1991 Tellus Institute	6.03-13.45	2.27				
1989 PLC Consulting	4.7-8.4	2.8				
1999 Fraunhofer Institute			0.4	0.009		
1986 Bonneville Power					0.0-0.029	
1982 NRDC	4.05-6.75			0.0-0.27		
2001 U.S. DOE/European Union	5.8	1.8	0.6	0.15		1.1
Average	6.6	2.1	0.4	0.09	0.01	0.8

Table 10: Electricity Generating Costs with Some External Costs (¢/kWh)¹⁴⁴

	Coal	Natural Gas	Solar PV	Wind	Geothermal	Biomass
Basic Generating Cost	2.3	3.9	18.5	5.5	4.8	9
External Costs	6.6	2.1	0.4	0.09	0.01	0.8
2001 Cost	8.9	6	18.9	5.6	4.8	9.8

2001 costs for renewables in this table are the national average of today's range of costs for each resource. Solar PV costs must be compared to retail electricity costs, which range from 5-14.8 ¢/kWh for residential rates.¹⁴⁵

tion, and unjustifiably high electricity rates from state regulators. Add to this the enormous bailouts in state deregulation plans that began a few years ago and will continue in the coming years. “Stranded costs” in just

eleven key states may total more than \$132 billion.¹⁴⁷ New Jersey’s deregulation allowed a \$9 billion dollar bailout for the utilities, over \$4 billion of which will go to cover bad investments in nuclear power.

Job Gains from Clean Energy Solutions

A clean energy strategy involving renewable energy projects and energy efficiency measures would provide a net increase in jobs for Americans. Both renewable energy and energy efficiency projects would employ people for manufacturing, installing, and servicing equipment.

While much of the generating costs of electricity production from fossil fuels goes to fuel, electricity generation from renewable energy involves a higher proportion of its costs for skilled labor. A recent report by the Renewable Energy Policy Project estimated labor requirements for coal, wind, solar PV, and biomass co-firing. According to REPP, wind and solar PV would provide 40% more jobs per dollar of cost (including capital, construction, and generating costs), compared to coal employment.¹⁴⁸ A 37.5 MW wind project would require 9,500 hours of labor per megawatt of power installed and operating for one year. This translates to 4 person-years per megawatt, assuming a 10-year operation period. The operations involved in producing electricity from a 2 kW solar PV system would require 35.5 person-years per megawatt of power output.

The California Energy Commission (CEC) conducted its own analysis of job impacts associated with different electricity generat-

ing technologies. Unlike the REPP analysis, the CEC separated temporary construction jobs from long-term operating employment.

The CEC analysis also found that renewable energy technologies employ far more people than natural gas power plants. Comparing jobs created by a new 300 MW power plant operating for 30 years, renewable energy technologies create at least five times as many jobs as new combined cycle plants (for solar PV) and as much as 25 times as many jobs (for geothermal).

Net Job Gains in New Jersey

New Jersey would experience a net job gain with renewables and energy efficiency development even after considering the employment losses in the conventional fossil fuel industry.

A study conducted by the Tellus Institute found that implementing climate protection policies would result in net job gains across the country. The suite of policies in the climate protection scenario included a renewable portfolio standard and caps on CO₂, SO₂, and NOx emissions to directly address the electricity sector, along with policies addressing the construction, industry, and transportation sectors. Under this climate protection policy scenario, the study estimated New Jersey would see a net job gain of 20,200 jobs.¹⁵⁰

Table 11: Job Impacts of Electricity Generating Technologies¹⁴⁹

Resource	Construction Employment (jobs/MW)	Operating Employment (jobs/MW)	Jobs Created per 300 MW Plant	Factor Increase in Jobs over Natural Gas Plants
Natural Gas Plants	0.60	0.04	630	1
Wind	2.57	0.29	3,381	5.4
Solar PV	7.14	0.12	3,222	5.1
Solar Thermal	5.71	0.22	3,693	5.9
Geothermal	4.00	1.67	16,230	25.8

Net Job Gains Nationwide

The National Center for Photovoltaics estimates that the PV industry alone currently employs some 20,000 American workers in high-value, high-tech jobs. By 2020, the industry expects the workforce to reach 150,000. Several years beyond 2020, the PV industry estimates it will double this employment level, with jobs at the same level currently supported by General Motors or the U.S. steel industry.¹⁵¹

Even considering the job losses that would occur in the fossil fuel energy industry, the Tellus Institute study mentioned above found that a net gain of more than 700,000 jobs in the U.S. would be created by 2010 under their climate protection scenario.¹⁵² Although the number of jobs gained varies from state to state, all states would see a net gain in the number of jobs, even those that produce significant amounts of fossil fuels, like Texas.

POLICY RECOMMENDATIONS

A comprehensive energy plan on a local, state, or national level must address four major priorities:

1. Energy conservation and efficiency.
2. Promotion of clean, renewable energy sources.
3. Termination of wasteful subsidies for fuels and technologies that are neither clean nor sustainable.
4. Promotion of more local control and democratic governance over energy.

State Policy Recommendations

With energy policies that address these four areas, New Jersey can begin cost-effectively phasing out coal power plants, replacing them with cleaner and more sustainable resources, and reducing overall demand through energy efficiency strategies. The benefits of such a transition include a dramatic reduction in pollution, a more reliable energy system, and a stronger, more stable economy for the state.

1) Policies Promoting Energy Conservation and Efficiency

Utility Energy Efficiency Program

The utility energy efficiency program (often referred to as a public or systems benefits charge) establishes a uniform charge issued by the electric utilities to all customers. The revenues received are set aside for a wide range of energy efficiency and renewable energy programs. This has proven to be very successful, saving money, reducing electric demand, and reducing pollution.

One critical amendment is needed for the program. The New Jersey Board of Public Utilities needs to assign an independent administrator to control the allocation of the program funds instead of allowing the utili-

ties to perform this function. The independent administrator should ensure the funds are spent effectively, using less money on education programs and more money on programs that demonstrate reductions in consumption.

Cool Advantage and Warm Advantage Program

This program currently offers rebates for residential energy efficient equipment, but it is not offered by all utilities. All utilities statewide should offer this program.

State Agency Requirement for Energy Efficiency Investment

State-owned buildings should be constructed or retrofitted with high efficiency lighting, heating, venting, air conditioning, and appliances in order to reduce energy consumption and to provide leadership for the state in the area of energy efficiency.

Statewide Adoption of the International Energy Efficiency Code

Energy codes provide builders with minimum standards for energy efficiency in buildings. An absence of minimum standards discourages builders from incorporating energy efficiency measures. Unfortunately, construction in New Jersey still follows an outdated building code. Significant energy savings would be realized by adopting more aggressive codes like the International Energy Efficiency Code (IEEC).

State Standards for Energy Efficiency of Appliances and Products

The state can save consumers money, boost the economy, and save energy by adopting energy efficiency standards for commonly used appliances and electrical products.

State Tax Incentives

Taxation has long been a proven method for encouraging or discouraging targeted busi-

ness practices. Tax incentives should be set for energy efficiency measures to encourage individuals and businesses to incorporate energy efficiency improvements and technologies.

2) Policies Promoting Clean, Renewable Energy

The state's *Renewable Energy Standard*, also known as the *Renewable Portfolio Standard (RPS)* and arguably the most important renewable energy-promoting policy, has two serious flaws. As it is written now, all retail electricity suppliers are to include an increasing percentage of clean renewable resources (wind, solar, fuel cells, ocean energy, landfill methane, and other biomass) in their generation mix according to the following schedule: 0.5% by January 1, 2002, 0.75% by 2003, 1.0% by 2006, then increasing by 0.5% each year until it reaches 4% in 2012. Two facets of the rule need amending to ensure the goals of the Renewable Energy Standard are met:

- Its penalties for non-attainment are weak. If a company cannot demonstrate that it has met the annual requirement for renewable resources for the year, automatic fines should be imposed. Multiple infractions should result in a revocation of the company's license.
- The New Jersey RPS includes an additional 2.5% requirement for alternative energy sources – above the 4% clean renewable requirement – but municipal solid waste (MSW) incineration can be used to fulfill this portion of the requirements. Municipal waste incineration is highly polluting and cannot be considered a clean, renewable energy source. It is already used on scale wide enough to satisfy the 2.5% requirement for the foreseeable future. This seriously diminishes one key objective of the renewable energy standard – pollution reduction. Municipal solid waste incineration should

not qualify as an energy source to meet these requirements.

State Agency Requirement for Renewable Energy Purchases

The state could have a significant effect on the renewable energy industry by requiring its agencies to purchase 20% of their power from clean renewable sources. This would provide a dependable market for local renewable energy companies as well as reducing pollution and helping to stabilize utility prices.

3) Policies Ending Wasteful Subsidies for Fuels and Technologies that Are Neither Clean Nor Sustainable

New Jersey should not subsidize fossil fuel production or nuclear power, both of which cost us dearly in environmental and public health consequences. Subsidies to polluting energy sources are a waste of money that leave the renewable energy infrastructure unbuilt.

4) Policies Promoting More Local Control and Democratic Governance over Energy

In a democratic society, public preferences must be represented during the process of energy policy development. To ensure that the voices of New Jersey citizens are heard the state should:

- Include public participation in energy policy decisions.
- Support efforts for the public to buy electricity through their local governments.
- Support Citizen Utility Boards to give the public greater representation in the regulatory process.
- Guarantee that communities are notified of policy decisions that could affect their future.

Federal Policy Recommendations

A clean energy policy on the national level must include policies that address the same major areas. The two most important policies needed on a federal level to achieve the goal of a clean and sustainable energy future for America are a renewable energy standard and a utility energy efficiency and renewable energy development program (Public Benefits Fund).

Renewable Energy Standard

A renewable energy standard, as described above in the state policy recommendation section, should also be implemented on the federal level. The potential power output of wind, solar, and geothermal resources in the U.S. is many times greater than our total electricity consumption. A national renewable standard requiring all retail electricity suppliers to generate or obtain 10% of their power from renewable resources by 2010 and 20% by 2020 would benefit the country's economy and environment.

Utility Energy Efficiency and Renewable Energy Development Program

As described under the state policy recommendation section, the revenues received from the uniform utility charge are set aside for a wide range of energy efficiency and renewable energy programs. On the federal level, however, revenues collected would be distributed by matching funds collected by individual state utility energy efficiency and renewable energy development programs.

In addition to these priorities, other federal measures should be continued or created to ensure a viable national energy policy.

Incentives for Energy-Efficient Products, Buildings, and Power Systems

Efficient use of energy is critical to a sustainable energy system. Multiple incentives targeted at different consumers and uses should:

- Provide consumers with energy efficiency incentives such as rebates for energy-efficient home appliances and construction.
- Provide incentives to industrial users of power to become more energy-efficient.
- Require real-time pricing structures for large industrial power users.
- Provide incentives to power plants that adopt combined heat and power systems to use waste heat and increase efficiency.

Efficiency Standards and Building Codes

Efficiency standards and building construction codes need to be updated in order to take advantage of technology advancements. Aggressive but achievable standards should be established for the construction industry and for appliances, transformers, industrial motors, air conditioners, lighting, and other products that consume significant amounts of electricity.

Renewable Energy Production Incentive

This program provides financial incentive payments for electricity produced and sold by new qualifying renewable energy generation facilities. Qualifying facilities are eligible for annual incentive payments of 1.7 ¢/kWh for the first ten-year period of their operation. Qualifying facilities must use solar, wind, geothermal, or biomass generation technologies.¹⁵³ This program ended on December 31, 2001 and has not been renewed.

Wind energy projects have proven to be very successful, and energy suppliers are just beginning to understand how to integrate wind power into their energy mix. Several large Washington State wind projects backed by the Bonneville Power Administration and the largest wind energy project to date in Colorado, however, are currently on hold awaiting the decision on the extension of this program. Although wind is currently the least expensive renewable energy source, incentive is needed to pave the way for its rapid and widespread utilization.

Interconnection Standards and Net Metering Regulations

Renewable energy sources have a new capability that no traditional energy source to date ever had. Not only can they operate like traditional power plants, dispatching their power through the infrastructure of power lines, but they can also generate electricity onsite. Onsite electricity generation saves energy and money in several ways: 1) It can match the power needs of the onsite home, building, or district accurately; 2) It eliminates the losses of energy that occur in long-distance transmission; and 3) Excess power generated at onsite locations can be sent to the grid for distribution elsewhere, reducing the number of new central power plants needed. However, current interconnection penalties and barriers limit our ability to effectively harness electricity generated from these sources. Setting uniform and consumer-friendly interconnection standards would address the inconsistencies that now exist. Net metering standards, as described in the state policy section above, should be set with

a 1 MW cap to encourage onsite clean electricity generation.

Expansion of Federal Energy Efficiency and Renewable Energy Research and Development Funding

Energy efficiency offers the fastest, cleanest, cheapest solution to the nation's power needs, and renewable energy technologies are essential for the U.S. to develop and maintain a sustainable energy system. Congress should increase funding for research and development of these technologies.

Carbon Tax

Currently, the costs of environmental and public health damage caused by CO₂ emissions from fossil fuel combustion are not accounted for by the electricity generation industry. A carbon tax would assign responsibility of these costs to the appropriate sources, instead of passing them on to other sectors of society.

Retirement Plan for Grandfathered Coal Plants

The Clean Air Act of 1970, as amended in 1977 and 1990, exempts coal-burning power plants from new source standards, allowing them to emit four to ten times the amount of pollution that new plants may emit under the Clean Air Act. These grandfathered coal power plants should be required to meet the same air pollution standards as new power plants. Otherwise these plants should be retired and replaced by renewable energy technologies, low-carbon technologies, or energy efficiency.

NOTES

1. U.S. Environmental Protection Agency (EPA), *Global Warming State Impacts: New Jersey*, downloaded from www.epa.gov/globalwarming/impacts/stateimp/newjersey/index.html, 11 October 2001.
2. U.S. EPA, *National Listing of Fish And Wildlife Advisories* (EPA-823-F-01-010), April 2001.
3. Nuclear Information Resource Service, *High-level Radioactive Waste Fact Sheet*, downloaded from www.nirs.org/factsheets/hlwfscst.htm, 29 January 2002.
4. U.S. EPA, State Energy CO₂ Inventories, downloaded from yosemite.epa.gov/globalwarming/ghg.nsf/emissions/state, 21 January 2002.
5. U.S. EPA, AIRData – NET SIC Report, downloaded from <http://www.epa.gov/air/data/netsic.html>, 20 December 2001.
6. Ibid.
7. U.S. EPA, AIRData – NTI MACT Report, downloaded from <http://www.epa.gov/air/data/ntimact.html>, 20 December 2001.
8. U.S. Department of Energy, Energy Information Administration (EIA), *Emissions of Greenhouse Gases in the United States 2000*, EIA/DOE 0573 (2000), November 2000.
9. U.S. EPA, *National Pollutant Emission Estimates for 1999*, 13 June 2001.
10. Ibid.
11. U.S. EPA, *Utility Air Toxics Report to Congress* (fact sheet), 24 February 1998. Although electric power plants emit many other pollutants, this report will limit discussions to these major contaminants.
12. U.S. EPA, *The Emissions and Generation Resource Integrated Database 2000, (Egrid 2000)*, Version 2.0, September 2001. All pollution emission figures in this report not otherwise accounted for are from Egrid.
13. Egrid calculation using U.S. data for 1999.
14. Egrid calculation using New Jersey data for 1999.
15. Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report: Climate Change 2001*, January 2001.
16. Ibid.; Goddard Institute of Space Studies.
17. Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report: Climate Change 2001*, January 2001.
18. Clean Air Network, *Poisoned Power: How America's Outdated Electric Plants Harm Our Health and Environment*, September 1997.
19. Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report: Climate Change 2001*, January 2001.
20. Ibid.
21. U.S. EPA, Office of Air Quality and Standards, *National Air Quality Trends Report*, 1999, Table A8, downloaded from <http://www.epa.gov/oar/aqtrnd99/>, 2 October 2001.
22. Natural Resources Defense Council, *Breathtaking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities*, May 1996.
23. See Dockery et al., "An Association Between Air Pollution and Mortality in Six U.S. Cities," *New England Journal of Medicine* 329(24), 1993, 1753-9.
24. Ibid.; Natural Resources Defense Council, *Breathtaking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities*, May 1996.
25. Clean Air Task Force, *Death, Disease & Dirty Power: Mortality and Health Damage Due to Air Pollution from Power Plants*, October 2000.
26. American Lung Association, *Lungs at Risk*, December 1997.
27. Clean Air Network, U.S. Public Interest Research Group, *Danger in the Air*, January 2000. Based on data from state air pollution officials.
28. R.J. Defino et al., "Effects of Air Pollution on Emergency Room Visits for Respiratory Illnesses in Montreal, Quebec," *American Journal of Respiratory and Critical Care Medicine* (155), 1997, 568-576.
29. American Lung Association, *American Journal of Respiratory and Critical Care Medicine*, February 2000.
30. Abt Associates, *Clear the Air, Out of Breath: Health Effects from Ozone in the Eastern United States*, October 1999.
31. C.P. Weisel, R.P. Cody, and P.J. Levy, "Relationship between Summertime Ambient Ozone Levels and Emergency Department Visits for Asthma in Central New Jersey," *Environmental Health Perspectives* (103), 1995, 97-102.
32. Rob McConnell et al., "Asthma in Exercising Children Exposed to Ozone: A Cohort Study," *The Lancet*, 2 February 2002.
33. A.H. Johnson et al., "Synthesis and Conclusions from Epidemiological and Mechanistic Studies of Red Spruce in Decline," *Ecology and Decline of Red Spruce in the Eastern United States* (C. Eater and M.B. Adams, eds.), 1992.

34. The U.S. National Acid Precipitation Assessment Program, *1990 Integrated Assessment Report 48*, 1991.
35. U.S. EPA, *Mercury Study Report to Congress*, 1997.
36. Ibid.
37. National Academy of Sciences, National Research Council, *Toxicological Effects of Methylmercury*, 2000; B. Weiss, "Long Ago and Far Away: A Retrospective on the Implications of Minamata," *Neurotoxicology* 17(1), 1996, 257-264; C.C.W. Leong, N.L. Syed, and F.L. Lorscheider, "Retrograde Degeneration of Neurite Membrane Structural Integrity of Nerve Growth Cones Following *In Vitro* Exposure to Mercury," *NeuroReport* 12(4), 2001, 733-737.
38. U.S. EPA, *Update: National Listing of Fish and Wildlife Advisories* (EPA-823-F-01-010), April 2001.
39. U.S. EPA, *Mercury Study Report to Congress*, 1997.
40. Ibid.
41. Ibid.
42. Ibid.
43. W. Rossman, Western Pennsylvania Coalition for Abandoned Mine Reclamation, E. Wytovich, Eastern Pennsylvania Coalition for Abandoned Mine Reclamation, and J.M. Seif, Department of Environmental Protection, *Abandoned Mines – Pennsylvania's Single Biggest Water Pollution Problem*, 21 January 1997.
44. Ibid.
45. T.D. Pearse Resource Consulting, *Mining and the Environment*, March 1996, 14.
46. The Ohio Department of Natural Resources, *Geofacts #15: Coal Mining and Reclamation*, July 1997.
47. U.S. General Accounting Office (GAO), *Clean Coal Technology* (RCED-00-86R), March 2000; GAO, *Fossil Fuels: Outlook for Utilities' Potential Use of Clean Coal Technologies* (RCED-90-165), May 1990; GAO, *Fossil Fuels: Status of DOE-Funded Clean Coal Technology Projects as of March 15, 1989* (RCED-89-166FS), June 1989; Friends of the Earth, Taxpayers for Common Sense, U.S. PIRG, *Green Scissors 2001: Cutting Wasteful and Environmentally Harmful Spending*, January 2001; The Economist, *The Leaky Bucket*, 12 April 2001.
48. Friends of the Earth et al., *Running on Empty: How Environmentally Harmful Energy Subsidies Siphon Billions from Taxpayers*, January 2002.
49. J. Nesmith and R. Haurwitz, "Pipelines: The Invisible Danger," *Austin American-Statesman*, 22 July 2001.
50. Ibid.
51. Ibid.
52. San Juan Citizen's Alliance, Oil and Gas Accountability Project, *Western Coalbed Methane Project*, downloaded from www.ogap.org, 18 November 2001.
53. Western Organization of Resource Councils, *Citizens Caught in Crossfire as High Oil Prices Spur Domestic Alternative Fuels Production*, downloaded from www.worc.org/pr_crossfire.html, 28 March 2000.
54. Powder River Basin Resource Council, *The Now Unhidden Costs of Coal Bed Methane Gas Development*, downloaded from www.powderriverbasin.org/costs.htm, 18 November 2001.
55. Linda Ashton, "State Warns of Suit over Hanford Cleanup," *Seattle Times*, 24 March 2001.
56. Nuclear Information and Resource Service, *U.S. Nuclear Debt Clock*, using information from the U.S. Department of Energy, downloaded from www.nirs.org/dontwasteamerica/Nukedeb1.htm, 28 April 2001.
57. Ibid.
58. Electric Power Research Institute, *Electric Power Research Institute Journal*, Nov/Dec 1995, 29.
59. Public Citizen, *Commercial High-Level Nuclear Waste: A Problem for the Next 1000 Millennia*, downloaded from www.citizen.org/cmep/energy/enviro_nuclear/nuclear_waste/hi-level/yucca, 5 October 2001.
60. Willie deCamp, Jersey Shore Nuclear Watch, *A Brief History of Oyster Creek Power Plant*, 26 November 2000.
61. Public Citizen, *Impacts of Nuclear Waste Transportation*, downloaded from www.citizen.org/cmep/RAGE/radwaste/factsheets/45-trans.htm, 2 September 2001.
62. U.S. EIA, State Electricity Summary Information downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/newjersey/nj.html, 14 January 2001.
63. Ibid.
64. National Renewable Energy Laboratory, *U.S. Wind Resources Accessible to Transmission Lines*, 5 August 1994; Pacific Northwest National Laboratory, *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States*, 1991; U.S. DOE, EIA, *Electric Utility Retail Sales of Electricity to Ultimate Consumers*, 2000.
65. Electricity generation is calculated using a capacity factor of 30% for wind power.

66. American Wind Energy Association, *Wind Project Data Base*, downloaded from www.awea.org/projects/index.html, 20 December 2001.
67. U.S. DOE, *Why Consider Renewable Energy?*, downloaded from www.eren.doe.gov/state_energy/why_renewables.cfm, 4 June 2001.
68. U.S. DOE, Office of Utility Technologies, *Renewable Energy Technology Characterizations*, December 1997.
69. U.S. DOE, Energy Efficiency and Renewable Energy Network (EREN), *Renewable Electric Plant Information System Database, Number of Operating Plants with Total Capacity, by State and Technology Code*, 15 November 2001.
70. Ibid.
71. Ibid.
72. Solar PV Total Installed Capacity Growth: International Energy Agency Photovoltaics Power Systems Programme, *Statistics*, downloaded from www.euronet.nl/users/oke/PVPS/stats/home.htm, 15 November 2001.
73. C. Nystrom, "County Installing Nation's Largest Rooftop Solar Power System," *Globestreet.com*, 17 June 2001; "San Francisco to Invest \$100 Million in Renewable Energy," *SolarAccess.com*, downloaded 20 November 2001.
74. U.S. DOE, EREN, *State Energy Program*, downloaded from www.eren.doe.gov/buildings/state_energy/projects/cfm/states, 23 December 2001.
75. U.S. DOE, EREN, *Current Renewable Energy Projects in New Jersey*, downloaded from www.eren.doe.gov/state_energy, 17 October 2001.
76. American Council for an Energy-Efficient Economy, *State Scorecard on Utility Energy Efficiency Programs*, April 2000; Dollar amounts for statewide utility revenues and sales were calculated using EIA records for 1999 (www.eia.doe.gov/cneaf/electricity/esr/esrt17p31.html).
77. American Council for an Energy-Efficient Economy, *State Scorecard on Utility Energy Efficiency Programs*, April 2000.
78. The Alliance to Save Energy, *Opportunity Lost*, 1998.
79. Ibid.
80. Alliance to Save Energy, *Home Energy Checkup*, downloaded from www.ase.org/checkup/home/main.html, 12 December 2001.
81. S. Nadel et al., American Council for an Energy-Efficient Economy, *Energy Efficiency and Economic Development in New York, New Jersey, and Pennsylvania*, February 1997.
82. Based on growth projections of the New Jersey utilities in: The Load Analysis Subcommittee, *PJM Load Forecast Report*, February 2001.
83. U.S. EIA, *United States Electricity Production, Table 5: Net Generation by Source and Sector*, downloaded from www.eia.doe.gov/cneaf/electricity/epav1/elecprod.html, 2 October 2001.
84. U.S. EIA, *Supplement to the Annual Energy Outlook 2001, Table 72*, 22 December 2000.
85. Wind: American Wind Energy Association, *Wind Project Data Base*, 6 November 2000; solar: U.S. DOE, *Annual Photovoltaic/Cell Manufacturers Survey (EIA-63B)*; Louise Guey-Lee, U.S. EIA, personal communication, 4 May 2001, KJC Operating Company, *Recent Improvements and Performance Experience*, 1996; geothermal: Geothermal Energy Association, *Geothermal Facts and Figures*, downloaded from www.geo-energy.org/usfacts.htm, 13 April 2001.
86. Capacity Factors used in calculations in this report: Geothermal: 95%; Solar: 20%; Wind: Capacity factor of 30% is already factored into average megawatts.
87. MWA: see *Box: Note on Units* in New Jersey Wind Energy Potential section.
88. Pacific Northwest Laboratory, *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States*, 1991, as cited by the American Wind Energy Association, *Wind Project Data Base*, 6 November 2000.
89. National Renewable Energy Laboratory, *U.S. Wind Resources Accessible to Transmission Lines*, 5 August 1994, as cited by the U.S. EIA, *Renewable Energy Annual 1995*.
90. Lester Brown et al., *State of the World 2001* (NY: W.W. Norton, 2001), 94; American Wind Energy Association, *Global Wind Energy Market Report*, May 2001.
91. American Wind Energy Association, *Wind Project Data Base*, 6 November 2000.
92. Scott Sklar, The Stella Group, personal communication, 4 May 2001; John Thornton, National Renewable Energy Laboratory, personal communication, 11 December 2001.
93. Pilkington Solar International, *Status Report on Solar Thermal Power Plants*, 1996, as cited in Solar Energy Industries Association, *Solar Thermal: Making Electricity from the Sun's Heat* (factsheet), downloaded from www.seia.org/solar_energy, 19 April 2001.

94. International Energy Agency Photovoltaics Power Systems Programme, *Statistics*, downloaded from www.euronet.nl/users/oke/PVPS/stats/home.htm, 15 November 2001.
95. U.S. DOE, *Annual Photovoltaic/Cell Manufacturer's Survey* (EIA-63B); Louise Guey-Lee, U.S. EIA, personal communication, 4 May 2001
96. U.S. DOE, Office of Energy Efficiency and Renewable Energy, *Scenarios for a Clean Energy Future*, November 2000.
97. Alaska, Arizona, California, Hawaii, Idaho, Nevada, New Mexico, Oregon, and Utah.
98. United States Geological Survey (USGS), *Statement of Suzanne D. Weedman, Energy Resources Program Coordinator, before the Energy Subcommittee of the Science Committee, U.S. House of Representatives*, 3 May 2001.
99. U.S. EIA, *Renewable Resources in the U.S. Electricity Supply*, downloaded from www.eia.doe.gov/cneaf/electricity/pub_summaries/renew_es.html, 23 October 2001.
100. American Council for an Energy-Efficient Economy, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency*, September 2001.
101. Primary energy includes energy used for transportation, heating, electricity, and all other uses.
102. 90% of coal is used for electricity generation, 13% of natural gas, and 100% of nuclear, hydro, and renewables.
103. Pollution is calculated using the U.S. Environmental Protection Agency's Emissions and Generation Resource Integrated Database (Egrid 2000), Version 2.0, September 2001, and includes CO₂, SO₂, and NO_x, from coal, petroleum, and gas plants, and mercury from coal plants.
104. 1999 Electricity Generation: U.S. EIA, *State Electricity Profiles: New Jersey*, downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/new_jersey/nj.html; Projected annual growth rate of 1.63% is the average annual growth rate projected by New Jersey's three largest utilities, Public Service Electric & Gas Co., Jersey Central Power & Light Co., and Atlantic City Electric Co., published in: "The Load Analysis Subcommittee," *PJM Load Forecast Report*, February 2001.
105. U.S. EIA, *State Electricity Profiles: New Jersey*, downloaded from http://www.eia.doe.gov/cneaf/electricity/st_profiles/new_jersey/nj.html, 9 January 2002.
106. Current and projected U.S. electricity generation: U.S. EIA, *Supplement Tables to the Annual Energy Outlook 2001, Table 72*, December 2000; all pollution calculations use U.S. EPA, *EGRID 2000*, Version 2.0, September 2001.
107. The Energy Foundation, *National Energy Policy Factsheet: Utility Energy Efficiency Programs*, downloaded from www.ef.org/national/FactSheetUtility.cfm, 28 September 2001.
108. Calculated using the average rate of carbon emission from fossil fuel power plants in the U.S. from U.S. EPA's Egrid and the average coal capacity factor of 71%.
109. The Energy Foundation, *National Energy Policy Factsheet: Utility Energy Efficiency Programs*, downloaded from www.ef.org/national/FactSheetUtility.cfm, 28 September 2001.
110. Natural Resources Defense Council, *Energy Efficiency Leadership in a Crisis: How California Is Winning*, August 2001.
111. See especially Amory Lovins and Chris Latspeich, "Energy Surprises for the 21st Century," *Journal of International Affairs*, 1999; T. Kubo, H. Sachs, and S. Nadel, *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs*, September 2001; American Council for an Energy-Efficient Economy, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency*, September 2001.
112. American Council for an Energy-Efficient Economy, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency*, September 2001.
113. American Wind Energy Association, *Wind Energy's Costs Hit New Low, Position Wind as Clean Solution to Energy Crisis, Trade Group Says*, 6 March 2001.
114. Dave Rib, KJC Operating Company, personal communication, 24 August 2001.
115. National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies* (NREL/CP-520-28426), May 2000; U.S. DOE, "Technology Characterizations"; CALPIRG Charitable Trust, *Affordable, Reliable Renewables: The Pathway to California's Sustainable Energy Future*, July 2001.
116. National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies* (NREL/CP-520-28426), May 2000.
117. Ibid.
118. Eric Ingersoll, Renewable Energy Policy Project, *Industry Development Strategy for the PV Sector*, 1998.

119. University of Wisconsin-Madison, *The Why Files: Science Behind the News, Buying the Sun*, downloaded from whyfiles.org/041solar/main1.html, 18 October 2001.
120. Eric Ingersoll, Renewable Energy Policy Project, *Industry Development Strategy for the PV Sector*, 1998.
121. Ibid.
122. Ibid.
123. U.S. EIA, *Renewable Energy Annual 2000*, March 2001.
124. U.S. data: U.S. EIA, *Renewable Energy 2000: Issues and Trends, (Technology, Manufacturing, and Market Trends in the U.S. and International Photovoltaics Industry)*, February 2001; World data: Byron Stafford, National Renewable Energy Laboratory, *Renewables for Sustainable Village Power*, downloaded from www.rsvp.nrel.gov, 8 August 2001 and U.S. EIA, *Renewable Energy 2000: Issues and Trends, (Technology, Manufacturing, and Market Trends in the U.S. and International Photovoltaics Industry)*, February 2001.
125. 52%: U.S. EIA, *Renewable Energy Annual 2000*, March 2001; 31%: Byron Stafford, National Renewable Energy Laboratory, *Renewables for Sustainable Village Power*, downloaded from www.rsvp.nrel.gov, 8 August 2001, and U.S. EIA, *Renewable Energy 2000: Issues and Trends, (Technology, Manufacturing, and Market Trends in the U.S. and International Photovoltaics Industry)*, February 2001.
126. National Renewable Energy Laboratory, *Geothermal Today*, May 2000.
127. U.S. DOE, *Geothermal Energy Program: Frequently Asked Questions*, downloaded from www.eren.doe.gov/geothermal/geofaq.html, 8 January 2002.
128. U.S. DOE, Energy Efficiency and Renewable Energy Network, *Biopower: Renewable Energy from Plant Material*, downloaded from www.eren.doe.gov/biopower/basics/ba_econ.htm, 23 October 2001.
129. Argonne National Laboratory (ANL), Lawrence Berkeley National Laboratory (LBNL), National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL), *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2010 and Beyond*, 1997.
130. Alliance to Save Energy (ASE), the American Council for an Energy-Efficient Economy (ACEEE), Natural Resources Defense Council (NRDC), Tellus Institute, and Union of Concerned Scientists (UCS), *Energy Innovations: A Prosperous Path to a Clean Environment*, 1997.
131. Lawrence Berkeley National Laboratory and the U.S. Environmental Protection Agency, *Technology and Greenhouse Gas Emissions: An Integrated Scenario Analysis Using the LBNL-NEMS Model* (LBNL-42054. EPA 430-R-98-021), September 1998.
132. Interlaboratory Working Group (Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, National Renewable Energy Laboratory, Argonne National Laboratory, Pacific Northwest National Laboratory), *Scenarios for a Clean Energy Future*, November 2000.
133. U.S. EIA, "Rising Demand Increases Natural Gas Prices in All Economic Growth Cases," *Annual Energy Outlook 2001*, 22 December 2000.
134. U.S. DOE, *Levelized Cost Summary for NEMS (AEO2001/D101600A)*, 2001; Federal Energy Regulatory Commission, *Order Directing Sellers to Provide Refunds of Excess Amounts Charged*, 9 March 2001; Mike Madden, "What's a Fair Wholesale Price for a Kilowatt of Electricity?," *Gannett News Service*, 30 March 2001.
135. U.S. EIA, *Annual Energy Review 2000*, August 2001.
136. U.S. EIA, "Rising Demand Increases Natural Gas Prices in All Economic Growth Cases," *Annual Energy Outlook 2001*, 22 December 2000.
137. C. Bryson Hull, "North American Gas Production Flat, Despite Drilling Boom," *Reuters*, 26 March 2001.
138. U.S. EIA, "Oil and Gas Supply," *Annual Energy Outlook 2001*, 22 December 2000.
139. Joseph Kahn, "Cheney Promotes Increasing Supply as Energy Policy," *New York Times*, 1 May 2001.
140. California Energy Resources Conservation and Development Commission, *Comments of El Paso Natural Gas Company in Response to Workshop Questions Pertaining to Natural Gas Supply Constraint Issues*, 15 February 2001.
141. U.S. DOE, Energy Efficiency and Renewable Energy Network, *Biopower: The Economics of Biopower*, downloaded from www.eren.doe.gov/biopower/basics/ba_econ.htm, 23 October 2001.
142. U.S. Office of Technology Assessment, *Studies of the Environmental Costs of Electricity* (OTA-BP-ETI-134), September 1994; European Union Commission and U.S. DOE, *ExternE Project – Externalities of Energy: A Research Project of the European Commission*, downloaded from externe.jrc.es, 30 October 2001.

143. Ibid. Amounts converted to 2001 dollars.
144. Coal: U.S. DOE, Energy Efficiency and Renewable Energy Network, *Biopower: The Economics of Biopower*, downloaded from www.eren.doe.gov/biopower/basics/ba_econ.htm, on 23 October 2001; Natural gas: U.S. DOE, *Levelized Cost Summary for NEMS (AEO2001/D101600A)*, 2001; Solar PV: National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies, NREL/CP-520-28426*, May 2000; U.S. DOE, “Technology Characterizations”; CALPIRG Charitable Trust, *Affordable, Reliable Renewables: The Pathway to California’s Sustainable Energy Future*, July 2001; Wind: American Wind Energy Association, *Wind Energy’s Costs Hit New Low, Position Wind as Clean Solution to Energy Crisis, Trade Group Says*, 6 March 2001; Geothermal: National Renewable Energy Laboratory, *Geothermal Today*, May 2000; Biomass: U.S. DOE, Energy Efficiency and Renewable Energy Network, *Biopower: Renewable Energy from Plant Material*, downloaded from www.eren.doe.gov/biopower/basics/ba_econ.htm, on 23 October 2001.
145. National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies*, (NREL/CP-520-28426), May 2000.
146. Fred Sissine, Congressional Research Service, *Renewable Energy: Key to Sustainable Energy Supply*, 27 May 1999.
147. Safe Energy Communications Council, *The Great Ratepayer Robbery*, Fall 1998.
148. Renewable Energy Policy Project, *The Work that Goes into Renewable Energy*, November 2001.
149. Electric Power Research Institute, prepared for the California Energy Commission, *California Renewable Technology Market and Benefits Assessment*, November 2001; calculations are based on 30 years of operation.
150. Tellus Institute, *Clean Energy: Jobs for America’s Future*, October 2001.
151. Solar Energy Industries Association, *Directory of the U.S. Photovoltaics Industry*, 1996; “Energy Alternatives and Jobs,” *Renewable Energy World* 3(6), November/December 2000.
152. The Tellus Institute, *Clean Energy: Jobs for America’s Future*, October 2001.
153. Municipal solid waste is excluded as a source of biomass energy.

