Clean Energy Solutions



Energy Efficiency and Renewable Energy in Maryland

Maryland Public Interest Research Foundation

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Table of Contents

Executive Summary

As Maryland'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 for 39% of Maryland's carbon dioxide (CO2) emissions, the principal 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.

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.

- Wind and solar energy sources could provide at least 4.8% of the total electricity for the state by 2010, and more than 6% by 2012. Biomass energy could push this percentage even higher. Nearly all of this potential remains untapped today, with fossil fuels and nuclear power meeting 97% of Maryland's power needs and less than 0.1% coming from clean renewable sources.

  Wind power is the renewable technology the state could develop most quickly. One thousand peak MW of Maryland's 1,900 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 basic cost-effective energy efficiency measures, Maryland could reduce anticipated total electricity demand by at least 6% by 2010. Studies have shown that more ambitious scenarios could yield cost-effective savings of five times this amount.

Renewable Energy and Energy Efficiency Reduce Pollution

If these 2010 goals were to be achieved, Maryland would reduce annual CO2 emissions by 10%, or 4 million tons, compared to projections for the current path. This would also reduce health-damaging pollution by 8%.

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 bring increases in employment.
- Policies encouraging clean energy would lead to a net increase in employment of 12,500 jobs in Maryland by 2010.

- The best wind, solar, and geothermal projects can produce electricity at a lower cost than fossil fuels when external life-cycle costs of electricity generation are taken into account.
- Energy efficiency programs of the past five years have avoided the need for 25,000-30,000 MW of generating capacity nationwide – the equivalent of 100 power plants – at a cost that is less than that of energy from most new power plants.

Comprehensive Energy Policies Are Needed

Important first steps in helping Maryland realize its clean energy potential include three specific policies:

- A Clean Energy Portfolio Standard requiring all retail electricity suppliers to obtain a set percentage of their electricity from renewable sources. Maryland should enact a standard calling for its energy mix to include 6% renewables by 2012.
- An Energy Savings Investment Program using a set percentage of revenues to finance programs promoting energy efficiency and renewable energy.
- Appliance efficiency standards that would save Maryland consumers hundreds of millions of dollars in energy savings over the next 20 years.

INTRODUCTION

In the wake of electricity deregulation, state officials must make some important decisions that will directly affect Marylanders for the foreseeable future. We have a window of opportunity to adopt policies that will prevent the environmental harm and volatile prices inevitable from our current path. We now rely on fossil fuels and nuclear power to generate 97% of our electricity, 90% of which is generated outside of the state, even though we have substantial clean and sustainable energy resources at our fingertips.

The effects of pollution created by fossil fuel use in power plants are wide-ranging and serious.

- Nearly all of Maryland exceeds the national standards for ground-level ozone. Baltimore and the Washington, D.C. suburbs are classified as either seriously or severely exceeding the standards.
- Each summer, approximately 180,000 asthma attacks and 3,900 emergency room visits in the state are attributed to acute exposure to ground-level ozone.
- Power plant pollution contributes to the acidification of our farmlands, which can reduce crop yields.
- Power plant pollution also leads to nitrification of our waterways, resulting in the destruction of critical habitat and increased mortality of species vital to the health of our ecosystem, including the world-renowned Chesapeake Bay blue crab.
- 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 generation is extremely dangerous. The reaction of nuclear fission in power plants produces high-level radioactive waste, arguably the most dangerous substance known. More than 400 metric tons of high-level radioactive waste are generated in Maryland and surrounding states each year, without any safe disposal method established.[1] In addition to the risk of accidents, concerns are growing over potential terrorist attacks.

The risks associated with these conventional energy sources jeopardize our pocketbooks as well as our health and environment. Oil and gas prices will always be volatile due to their limited nature. Dependency on foreign oil is a proven risk. Natural gas proved to be equally risky last year. With 90% of new power plants expected to be fueled by natural gas, we should be very concerned about price fluctuations and increases due to future shortages or disruptions. 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 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 health problems and global warming, and grow our economy.

Deregulation in Maryland has created a fork in the road. The status quo is not an option. The choice is either to continue increasing our dependence on fossil fuels and nuclear power and the pollution and risks connected with them or begin to get our power from the clean, sustainable resources that exist in our own state. Now is the time for Maryland to develop its renewable resources and ensure a clean and reliable electricity system for the future.

PART I: HEALTH AND ENVIRONMENTAL IMPACTS OF CONVENTIONAL ELECTRICITY PRODUCTION

Impacts of Fossil Fuel Burning

In Maryland, electricity generation is responsible for:

- 39% of the state's emissions of carbon dioxide, the principal global warming gas.[2]
- 92% of the state's emissions of sulfur dioxide, a precursor of fine particulate matter, acid rain, and regional haze.[3]
- 78% 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.[4]
- 26% of the state's emissions of man-made mercury, a toxic metal that bioaccumulates in animals and spreads through the food chain to humans.[5]

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 CO_2 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 CO_2, 95.2% of the SO_2, and 90.9% of the NOx emitted collectively by all electric power plants.[7]

In Maryland, coal is used to generate 59% of the state's electricity, yet it is responsible for 86% of CO_2 emission from power plants.

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.[8]

Figure 1: CO_2 Emission Rates of Power Plants Burning Fossil Fuels[6]

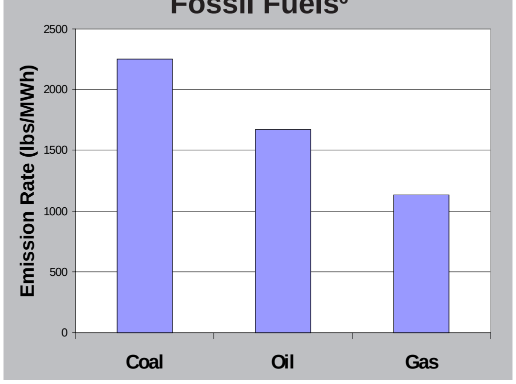
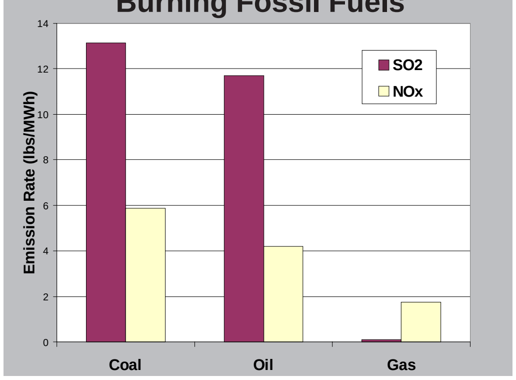


Figure 2: SO_2 and NOx Emission Rates of Power Plants Burning Fossil Fuels



- The 1990s were warmer than the 1980s, previously the warmest decade on record. The warmest year on record was 1998.[9]

The IPCC predicts that the average global surface temperature will increase by 1.4-5.8°C between 1990 and 2100, depending on how far we go to reduce carbon emissions.[10] 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.[11]

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 CO_2, 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 (CO_2) is by far the most abundant greenhouse gas. The atmospheric concentration of carbon dioxide has increased by 31% since 1750.[12]

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."[13] Fossil fuel burning accounts for three-quarters of the CO_2 emissions associated with human activities. The U.S. electric industry alone, which accounts for 40% of total U.S. CO_2 emissions, emits more CO_2 than the total CO_2 emissions from any other nation.

Soot and Sulfur Dioxide

Power plants are by far the largest source of sulfur dioxide (SO_2).[14] More than 12,000 of the nearly 19,000 tons of SO_2 the nation emits annually comes from electric power plants. SO_2 is a large component of fine particulate matter, or "soot."[15] 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.[16] Fine particulate matter is of most concern to vulnerable populations, including young children, 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.[17] This pollution cuts short the lives of an estimated 927 people throughout the state of Maryland each year.[18]

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.

Coal-fired power plants account for 84% of power plant SO_2 emissions in Maryland.[19] Although pollution control equipment that can reduce these emissions by 90% is readily available, none of Maryland's six large coal-fired power plants uses such equipment.

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.[20] In 1999, the ozone health standard adopted by the EPA in 1997 was exceeded 7,200 times.[21]

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.[22]

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.[23] 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.[24] 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.[25]

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.[26]

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 components 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.[27]

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.[28]

Nitrogen Loading and Nitrogen Oxides

Nitrogen oxide emissions from power plants are a major contributing factor to nitrogen loading in the Chesapeake Bay and other 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.[29] 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.[30] Other studies have linked a history of mercury exposure with neurological problems, heart disease, and Alzheimer's disease in adults.[31]

Numerous species of fish in thousands of bodies of water across 41 of the 50 states, including Maryland, 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.[32]

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.[33] 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.[34]

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.[35] 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%).[36]

Other Impacts of Energy Production

Coal Mining

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, cropland, 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.[37] 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.[38] The U.S. Bureau of Mines estimates that the U.S. spends over $1 million each day to treat acidic mine water.[39] The cost of cleaning up abandoned lands that had been used for mining coal is $10,000 per acre.[40]

"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.[41] $2 billion has been spent so far, and current proposals would double that amount.[42]

Natural Gas Drilling

When natural gas is retrieved from reservoirs, the construction of roads, drilling rigs, 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.[43] Over the past decade, the number of serious accidents has steadily increased.[44]

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.[45]

Coalbed Methane Excavation

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. 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.[46] 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.[47]

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.[48]

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.[49]

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.[50] This waste material will remain hazardous for the next 250,000 years.[51] 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.[52] 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.[53]

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. Slight leaks of the waste from Maryland's Calvert Cliffs plant – now stored in dry casks on the shores of Chesapeake Bay – could be catastrophic.

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.

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.”[54]

The sooner nuclear generation stops, the less all of these risks will be increased or extended.

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.

Economic analysis and technological considerations suggest that Maryland could generate 6% of its electricity with zero emissions by 2012.

Investing in the development of clean energy sources will grow the 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 and price stability benefits are considered. The cheapest and quickest way to meet urgent power demand is through energy efficiency.

Developing the small portion of the total renewable energy and energy efficiency potential outlined below will reduce pollution dramatically by 2010. Maryland would cut its power plant pollution by 10% by 2010 compared to projections for the current path.

Renewable Energy and Efficiency Potential in Maryland

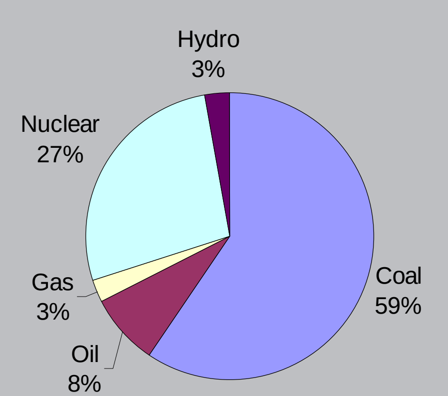
The vast majority of electricity in Maryland is generated using dangerous and polluting energy sources. Fossil fuels and nuclear power provide 97% of the energy used by utilities for electricity generation. Of that, coal is the dominant source, providing 59% of the energy, and nuclear power ranks second, providing 27% of the energy for electricity production.

For the majority of the past 100 years, Maryland had no other real alternatives for its energy supply. Now, clean and affordable options are finally available. No longer do the people of Maryland 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 vast energy savings and renewable energy potential, the state can now dramatically reduce power plant pollution while cost-effectively meeting its growing electricity demand. Non-hydro renewable resources could be providing 4.8% of the total electricity generated in the state by 2010 and 6% by 2012.

Wind Energy Potential

Maryland has good wind potential. The Pacific Northwest Laboratory (PNL) estimates the state could generate 5,000 gigawatt-hours per year (GWh/yr) of electricity from wind – enough to provide 10% of the state's current electricity demand.[56] However, outside

Figure 3. Maryland's 1999 Profile of Electricity Sources[55]



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).

of one small project (3 kW), none of this valuable resource has been tapped.

If Maryland built just three typical-sized wind farms (30 MW each) per year for the next three years (2003-2005), and then increased capacity at today's common growth rate of 30%, the state could be generating 2,600 GWh/yr of electricity by 2010. Wind power would then be generating 4.8% of Maryland's electricity. If the state added another 400 MW by 2012, wind power alone would be providing Maryland with 6% of its electricity. Given the total amounts involved, this growth rate is easily feasible.

Other nearby states that have begun tapping into their wind resources are adding capacity at even more aggressive rates than this timeline. New wind projects scheduled to come online in 2002 in Pennsylvania have a collective capacity of 110 MW, those in New York, 160 MW, and those in West Virginia, near the Maryland border, total 220 MW.[58]

Table 1. Potential Growth in Maryland Wind Power Capacity and Generation[57]

Year	Capacity (MW)	Generation (GWh/yr)
2002	0.003	0.008
2003	90	240
2004	180	470
2005	270	710
2006	350	920
2007	460	1,200
2008	590	1,560
2009	770	2,030
2010	1,000	2,600
2011	1,200	3,150
2012	1,400	3,680

Solar Energy Potential

People often think solar energy can only be harnessed effectively in the Southern and Southwestern states, but solar PV is a valuable resource for Maryland. At this time, the state is just beginning to tap it. Current capacity stands at 323 kW.[61] Other states with solar potential similar to Maryland have already begun to utilize this resource on a much larger scale. Compared to Maryland, Illinois has slightly greater solar potential and New York has lower potential, yet their current solar PV capacities of 553 kW and 1,350 kW, respectively, overshadow Maryland's capacity. Maryland has plenty of room to grow.

Cost has been the biggest impediment to solar technology. Like the other renewable energy technologies, nearly all of its costs are up-front capital costs. Although it is cost-effective over the lifetime of the system, solar technology has the greatest up-front capital costs.

The National Renewable Energy Laboratory analyzed policies and residential electricity rates in every state to determine today's breakeven turnkey cost (BTC) for a 1 kW installed PV system for each state. At the BTC, the consumer can pay for a PV system and neither gain nor lose money over the life of the system. While Maryland had a solar buy-down program in place, the 1999 BTC cost for a PV system was determined to be $6,133/kW. An installed PV system cost $3,900/kW in 1999, down from $6,200/kW just three years prior. Hence, consumers who bought solar systems at 1999 prices will realize a $2,233/kW net savings over the lifetime of the system.[62] Unfortunately, the buy-down program ended in June 2001.

Maryland could dramatically increase its current capacity by reestablishing the buy-down program. If total installed PV systems increased at the same rate as the 1999-2000 national growth rate (18.5%), PV capacity would reach 2.2 MW 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%), Maryland would have 4.9 MW to 7 MW, respectively.[63]

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

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. It 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.[59] 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."[60]

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 are used in conjunction with back-up heating system, most commonly fueled by natural gas.

in larger increments. Alameda County's Santa Rita Jail recently installed a 500 kW PV system, and San Francisco is now planning to add 10-12 MW within three years.[64]

Similar aggregate purchases of PV by Maryland 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 Maryland, the state has ample geothermal resources for geothermal heat pumps, which can significantly reduce demand for electricity. Currently, however, none of this important resource is being tapped.

Biomass Potential

Current biomass power capacity in Maryland is 140 MW.[65] Unfortunately, the majority of this capacity utilizes municipal solid waste (MSW) combustion, which is highly polluting. As a major source of mercury, dioxin, and other highly toxic substances, MSW combustion is not a clean energy alternative. Landfill gas, biogas digesters, indigenous energy crops, and gasified animal waste are more sustainable options for biomass resources in Maryland.

The U.S. Department of Energy estimates that Maryland could generate 2,900 GWh/yr of electricity from biomass resources, 6% of 1999 generation.[66] However, this likely contains some potential projects that would be excessively polluting.

Energy Savings Potential

During much of the 1980s and 1990s Maryland utilities had effective energy efficiency programs in place. However, investments in these programs dropped significantly by 1998. According to an analysis conducted by the American Council for an Energy-Efficient Economy (ACEEE), in 1998 Maryland spent 0.80% of utility revenues, $13.6 million, on energy efficiency programs, down from 1.83%, $31 million, in 1993. This overall spending yielded an annual energy savings equaling 3.52% of electricity sales in 1998, or 880 GWh/yr.[67]

Maryland needs to begin reinvesting in these utility programs on a larger scale. The programs have proven to be one of the most cost-effective ways to address electricity needs. Results in other states reveal that Maryland has much more energy savings potential it could reach through these programs. The top five states, whose savings ranged from 5% to 9% of their electricity sales in 1998, had each invested at least 1% and as much as 7% of utility revenues in their energy efficiency programs.[68]

The Northeast Energy Efficiency Partnerships (NEEP) submitted a detailed analysis of a proposed statewide utility energy efficiency program to the Public Service Commission of Maryland in 2000.[69] The proposal included twelve energy efficiency programs that would deliver the greatest long-term energy saving per dollar invested:

- Residential Programs
  - HVAC Tune-Up/Repair Program
  - Electric HVAC Replacement Program
  - Energy Star Appliance and Consumer Products Program
  - Energy Star Lighting Program
  - Energy Star Windows Program
  - New Construction Program
  - Low Income Program
- Commercial and Industrial Programs
  - Industrial Efficiency Program
  - C&I Building Operation and Maintenance Program

Commercial Building Retro-commissioning Program

C&I Energy Efficient Construction Program and Equipment Replacement Program

C&I Motor System Optimization Program

Analysis of the proposal determined that the plan would be cost-effective and would provide significant economic benefits to Marylanders. Implementation of these programs would save the state 3,400 GWh/yr by 2010 – nearly 6% of 1999 demand.

The Maryland Power Plant Research Program (PPRP) found even greater potential energy savings. PPRP estimated that the utility energy efficiency programs were saving 10% of the state's total peak electricity demand in 1997. PPRP also estimated utility energy efficiency programs could reduce peak demand by an additional 20% by 2007.[70]

In 1997, the ACEEE studied the energy efficiency potential of three Mid-Atlantic states – New York, New Jersey, and Pennsylvania. They found that cost-effective energy efficiency technologies could reduce electricity by 33% below business-as-usual projections in the region by 2010.[71]

The final report of the Maryland Task Force on Energy Efficiency, released in December 2001, stated that "all ratepayers benefit from the implementation of an energy efficiency program." The task force recommended the creation of a uniform charge on utility bills to fund energy efficiency measures, as well as energy efficiency standards for products not covered by current standards.[72]

Such standards could enable Maryland to save energy, reduce peak energy demand, and cut pollution. Household and commercial products that are currently unregulated, but for which energy-saving models are available, include:

Geothermal Energy

Geothermal energy is the heat that flows constantly from the center of the earth, where temperatures are believed to reach 4000ºC. 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 wastes (garbage) and construction debris, which can release dangerous toxins from the combustion of plastics and chemicals.

Burning timber wastes and agricultural wastes are 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 or other organic compounds into fertilizer and biogas, which consists mainly of methane (the main component in natural gas). Biogas can be used for heating, cooking, 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.

CONTINUED ON NEXT PAGE

Biomass Energy

FROM PREVIOUS PAGE

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. Burning the methane to generate electricity thus adds a benefit to methane that is already being burned and results in a decrease in gas emissions in those cases when it is not otherwise being burned.

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 need thorough assessment. 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 the various types 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 relatively wide usage and growing popularity.

- torchiere lamps
- transformers
- refrigerated vending machines
- traffic signals
- illuminated exit signs
- commercial ice-makers
- air-conditioning equipment
- commercial clothes washers

The energy savings per individual unit may be small, but taken together can add up to great savings. Implementing efficiency standards for these products could reduce peak electricity demand in Maryland by 150 MW by 2010. Standards on six of the above products would yield net savings of $234 million for products sold in Maryland through 2020.[73]

Taken together, these studies demonstrate that the potential electricity reduction of 6% by 2010 identified in the NEEP study is a very conservative and achievable goal.

Pollution Reduction Realized with Clean Energy Development

Tapping the renewable energy and energy efficiency potential ready for development now would dramatically reduce power plant air pollution. By 2010, Maryland would reduce its CO_2 emissions by 4 million tons per year by developing clean energy solutions in place of coal.

As of 1999, Maryland's utilities were pumping an alarming 37 million tons of carbon dioxide, 300,000 tons of sulfur dioxide, 120,000 tons of nitrous oxides, and 1,500 pounds of mercury into the air annually, along with deadly particulate pollutants and a host of other toxins.[74] Current plans to meet projected demand would increase this amount by nearly 9% by 2010.

As outlined above, Maryland could develop 2,600 GWh/yr of wind energy and save 3,400 GWh/yr through energy efficiency measures by 2010. Together these clean energy sources could meet 68% of the state's projected growth in electricity demand through 2010. This would reduce power plant emissions by 6% below projected 2010 emissions if all demand were met with natural gas.

However, Maryland could reduce more power plant pollution by 2010 if clean energy sources were used to replace some existing coal use. If enough natural gas power plant capacity were built by 2010 to generate 5,400 GWh/yr of electricity, together with the amount of clean energy development outlined above, generation from coal power plants would decline by 2,600 GWh/yr. Choosing this path over business as usual would reduce CO_2 emissions by 600,000 tons, rather than increasing CO_2 emissions by 3.5 million tons.

Comparing the outlook for Maryland in 2010, this strategy would result in 10% less CO_2 emissions from power plants than if all demand growth were met with new gas plants. Power plants would also emit 8% less SO_2 and NOx.

This amount of pollution reduction would have a major impact on Maryland's struggle to attain air quality goals. Every monitoring station in the state recorded violations for smog standards in each year from 1997-99. Maryland is at risk of losing federal transportation funding because of this lack of attainment. Development of clean energy resources could make the difference in maintaining this funding.

Table 2. Demand Growth and Clean Power Development

	Capacity (MW)	Electricity Generation (GWh/yr)
1998 Use	10,995	49,323
2010 Projected Demand	13,000	58,100
Additional power needed by 2010	2,000	8,800
Wind Energy Growth by 2010	1,000	2,600
Energy Efficiency Development by 2010	600	3,400
Total Clean Energy Development by 2010	1,600	6,000

Table 3. Maryland Power Plant Pollution: Business As Usual vs. Clean Energy Development

Year	Scenario	Electricity Generation (GWh/yr)[75]	CO_2 Emissions (thousand tons)	SO_2 Emissions (thousand tons)	NOx Emissions (tons)	Mercury Emissions (pounds)
1999		49,323	37,100	303,800	122,200	1,500
2010	Natural Gas Development	58,100	40,600	308,300	128,400	1,500
2010	Clean Energy Development	54,700	38,200	305,200	124,200	1,500
2010	Emissions Avoided		2,400	3,100	4,200	n/a

Table 4. Maryland Power Plant Pollution: Business As Usual vs. Clean Energy and Natural Gas Development

Year	Scenario	Electricity Generation (GWh/yr)[76]	CO_2 Emissions (thousand tons)	SO_2 Emissions (thousand tons)	NOx Emissions (tons)	Mercury Emissions (pounds)
1999		49,323	37,100	303,800	122,200	1,500
2010	Natural Gas Development	58,100	40,600	308,300	128,400	1,500
2010	Clean Energy and Natural Gas Development	54,700	36,500	284,000	116,600	1,400
2010	Emissions Avoided		4,100	24,300	11,800	100

Economic Feasibility of Clean Energy Solutions

Clean energy resources are 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 up-front capital costs of constructing a new fossil fuel power plant may be less than the up-front 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. Hydropower is not being considered 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, utilities have saved 25,000 to 30,000 MW annually, the equivalent of 100 large power plants, over the past five years through energy efficiency programs. These programs averaged 2.8 ¢/kWh, a cost that is less than that of most new power plants.[77] 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 CO_2.[78]

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.[79] 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.[80]

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.[81] 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.[82]

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 electricity where significant losses of energy occur.
- More efficient motors and use of steam for all industrial operations.
- Better lighting and refrigeration equipment for commercial uses.
- Advanced heating and air conditioning systems.

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.

Individual households can always see significant savings in their electricity bills by implementing simple energy efficiency measures. Replacing a single incandescent light bulb with a compact fluorescent bulb saves its owner $40 in electricity costs over the lifetime of the bulb. Weatherizing a home reduces the average household's energy expenditures by $200-$400 annually.[83] There are energy savings opportunities in every home or business.

A new energy efficiency program in Vermont helps households improve lighting, appliances, heating, insulation, and water heating. The households that made one or more efficiency improvements in 2000 will save an average of $550 over time.

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 up-front 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 predicted 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.[84]

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.[85]

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 procedures. 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.[86] 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

Figure 4: Annual PV Manufacturing Volume[95]

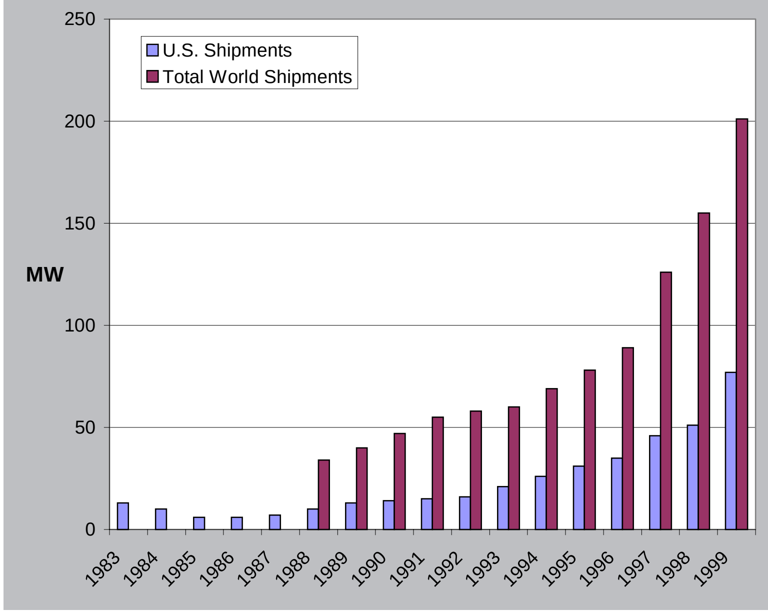


Figure 5: PV Market Growth Rates[96]

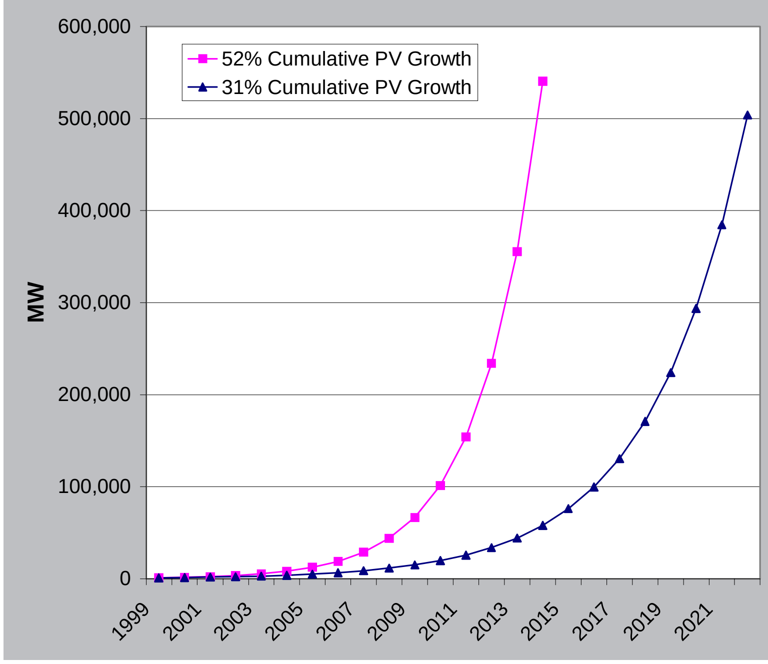


Table 5: Experience Curve for PV Module Price

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

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.[87] 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.[88] 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.[89] This is a dramatic reduction in cost from $20 per watt ten years ago and a hundred-fold drop in cost since 1972.[90] 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%.[91]

In 1999, total worldwide installed PV capacity was 1,034 MW.[92] 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.[93] 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 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%.[94]

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.[97]

The Geysers in California are a good example of how renewable energy, with the bulk of its costs up-front, 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.[98]

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.[99]

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.[100]
- 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 CO_2 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.[101]

- 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.[102]
- 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.[103]

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 to 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.[104] 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.[105]

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, including:

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

Supply and Demand

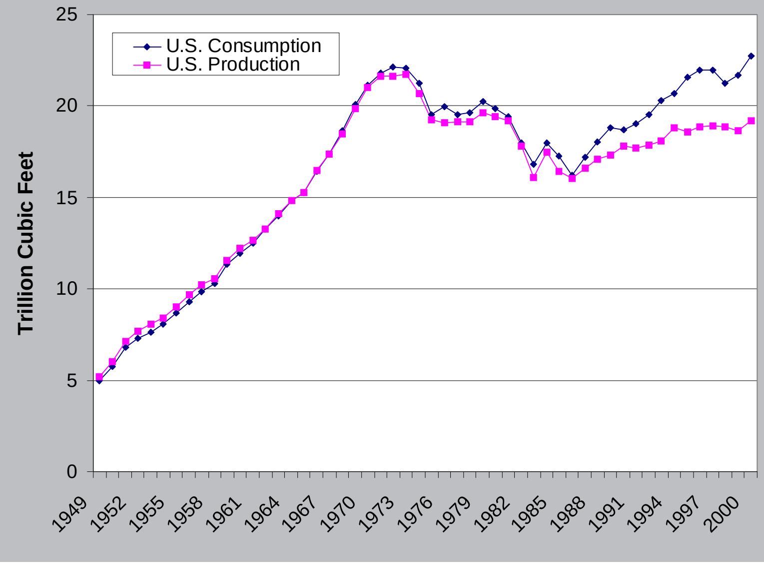
The U.S. does not have enough domestic reserves of natural gas to satisfy our growing demand. The U.S. Geological Survey estimates that the U.S. has 1,049 trillion cubic feet of gas remaining, of which only 16% are proved reserves. If demand were to grow by 2.3% through 2020 as predicted by the Department 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.[106]

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."[107]

Figure 6. U.S. Natural Gas Consumption vs. Production

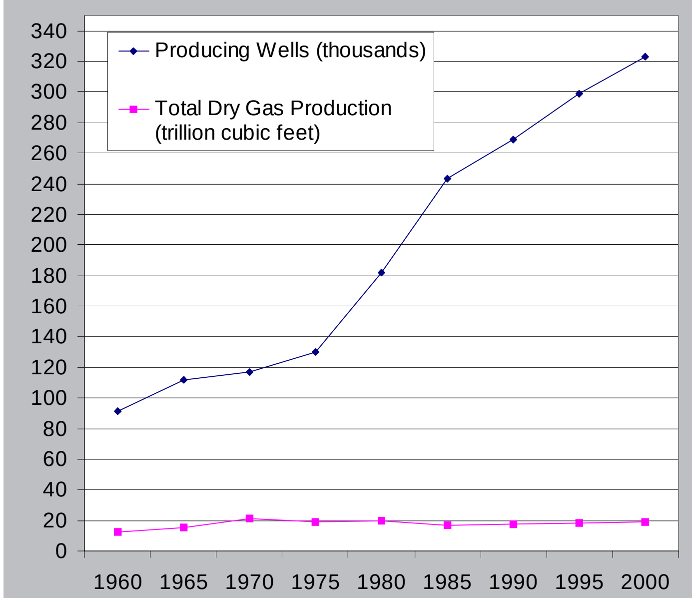


Energy companies have had to drill a vastly increasing number of wells each year to provide a marginally increasing supply of gas. If they are to increase production dramatically over the next twenty years as projected, they will have to increase drilling far beyond current and previous rates. Due to 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.

Figure 7: U.S. Production Wells vs. Total Dry Gas Production



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 treading 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.[108]

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 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.[109]

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 oversees 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 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.[110] 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.[111] 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 te 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.[112] When external costs are accounted for, the cost rises to more than 8 ¢/kWh.[113] 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

Table 6: Studies of External Costs of Electricity Generation (¢/kWh)[114]

Study	Coal	Combined Cycle Natural Gas	Solar PV	Wind	Geothermal	Biomass
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 7: Electricity Generating Costs with Some External Costs (¢/kWh)[115]

	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.[116]

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.[117] 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 Corporation, 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.[118] 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.[119] 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 generating 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

Maryland 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 policies addressing the buildings and industry sector and the transportation sector along with a renewable portfolio standard and caps on CO_2, SO_2, and NOx emissions to directly address the electricity sector. Under this climate protection policy scenario, the study estimated Maryland would see a net job gain of 12,500 jobs.[121]

Maryland is already home to a major photovoltaic manufacturing plant, a BP Solar plant that employs more than 700 people. The state is thus well positioned to capitalize on future expansions of the solar market.

Table 8: Job Impacts of Electricity Generating Technologies[120]

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

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) Ending wasteful subsidies for fuels and technologies that are neither clean nor sustainable.

4) Promotion of more local control and democratic governance over energy.

With energy policies that address these four areas, Maryland can begin cost-effectively phasing out dirty 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

Maryland has some modest energy efficiency-promoting programs in place, but lacks two of the most effective programs.

Energy Savings Investment Program

An Energy Savings Investment 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 in other states, saving money, reducing electricity demand, and reducing pollution. Maryland should adopt a statewide Energy Savings Investment Program, with the Maryland Energy Administration as the initial administrator of the program. The Maryland Energy Administration should then assign an independent administrator to manage the funds, modeling the program after the New York Energy Research and Development Authority.

Appliance Efficiency Standards

Minimum efficiency standards on common energy consuming appliances and products would result in significant energy savings for Maryland and result in significant savings for consumers through lower energy bills.

2) Policies Promoting Clean, Renewable Energy

Maryland lacks some essential statewide policies necessary to realize its renewable energy potential.

Renewable Energy Standard

A renewable energy standard would require all retail electricity suppliers to include a percentage of renewable resources in their generation mix. Maryland should enact a standard calling for its energy mix to include 5% renewables by 2010 and 6% by 2012. Meeting these specific requirements would have a major impact on air quality and energy security, and would springboard Maryland toward even greater market penetration of renewables as they gain economies of scale, technological advancement, and market acceptance.

Utility Renewable Energy Development Program

Maryland should adopt a benefit charge like the Energy Savings Investment Program, setting aside a portion of revenues received for a variety of renewable energy programs.

Net Metering

For those electric utility customers with their own on-site electricity generating systems, net metering allows electricity to flow both to and from the customer. When excess electricity is generated by the customer's own system, the excess is fed back into the grid and the customer is credited for it.

Wind and solar power, two popular on-site generating systems, produce electricity intermittently according to the availability of their sources. Often they generate more power during peak times than the immediate site requires. Net metering allows more efficient use of electricity by capturing all electricity generated from these on-site systems and distributing it to other users. In turn, the centralized power plant provides electricity to net-metering customers during times when the sun is not shining or the wind is not blowing.

Maryland's Public Service Commission should amend its net metering rule to eliminate the statewide limit on capacity enrollment and increase the limit on individual systems to 500 kW of renewable energy. The Commission should also make small wind systems eligible for net metering, in addition to the solar projects that now qualify.

Capital Cost Rebate Program

A capital cost rebate program reduces the up-front costs of purchasing and installing on-site renewable energy systems. Since nearly all of the costs of a new solar PV system or wind turbine are included in the initial purchase and installation, consumers often need financial assistance. Rebate programs have been very successful in removing that barrier and increasing renewable energy capacity in several states. Maryland should re-implement a rebate program for wind energy and solar PV systems so it can better utilize these valuable resources.

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

Maryland should not subsidize fossil fuel production, which cost us dearly in environmental and public health consequences. Subsidies to non-renewable energy sources are a waste of money that neglect the progress needed in the renewable energy infrastructure.

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 the voices of Maryland citizens are heard, the state should:

- Include public participation in energy policy decisions.
- Guarantee that communities are notified about policy decisions that could affect their future.
- 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.

NOTES

1. Includes total waste generated in MD, NJ, and PA; Nuclear Information Resource Service, *High-level Radioactive Waste Fact Sheet*, downloaded from www.nirs.org/factsheets/hlwfcst.htm, 29 January 2002; U.S. Department of Energy (DOE), Energy Information Administration (EIA), *Nuclear Reactors Operating in the United States, 2000*, downloaded from www.eia.doe.gov/cneaf/nuclear/page/at_a_glance/reactors/states.html, 30 January 2001.

2. U.S. EPA, *Global Warming Site: State Energy* CO_2 *Emissions*, downloaded from yosemite.epa.gov/globalwarming/ghg.nsf/emissions, 18 January 2002; percentage calculated from total state fossil fuel combustion.

3. U.S. EPA, *AIRData – NET SIC Report*, downloaded from www.epa.gov/air/data/netsic.html, 20 December 2001.

4. Ibid.

5. U.S. EPA, *AIRData – NTI MACT Report*, downloaded from www.epa.gov/air/data/ntimact.html, 20 December 2001.

6. U.S. EPA, *The Emissions and Generation Resource Integrated Database 2000 (EGRID 2000)*, Version 2.0, September 2001.

7. EGRID calculation using U.S. data for 1999.

8. Intergovernmental Panel on Climate Change, *IPCC Third Assessment Report: Climate Change 2001*, January 2001.

9. Ibid.; Goddard Institute of Space Studies.

10. See note 8.

11. Clean Air Network, *Poisoned Power: How America's Outdated Electric Plants Harm Our Health and Environment*, September 1997.

12. See note 8.

13. Ibid.

14. U.S. EPA, Office of Air Quality and Standards, *National Air Quality Trends Report*, 1999, Table A8, downloaded from www.epa.gov/oar/aqtrnd99, 2 October 2001.

15. Natural Resources Defense Council, *Breathtaking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities*, May 1996.

16. 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.

17. Ibid.; Natural Resources Defense Council, *Breathtaking: Premature Mortality Due to Particulate Air Pollution in 239 American Cities*, May 1996.

18. Clean Air Task Force, *Death, Disease & Dirty Power: Mortality and Health Damage Due to Air Pollution from Power Plants,* October 2000.

19. U.S. EPA, EGRID.

20. American Lung Association, *Lungs at Risk*, December 1997.

21. Clean Air Network, U.S. Public Interest Research Group, *Danger in the Air*, January 2000. Based on data from state air pollution officials.

22. 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.

23. American Lung Association, *American Journal of Respiratory and Critical Care Medicine*, February 2000.

24. Abt Associates, Clear the Air, *Out of Breath: Health Effects from Ozone in the Eastern United States*, October 1999.

25. 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.

26. Rob McConnell et al, "Asthma in Exercising Children Exposed to Ozone: A Cohort Study," *The Lancet,* 2 February 2002.

27. 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.

28. The U.S. National Acid Precipitation Assessment Program, *1990 Integrated Assessment Report 48*, 1991.

29. U.S. EPA, *Mercury Study Report to Congress*, 1997.

30. Ibid.

31. 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.

32. U.S. EPA, *Update: National Listing of Fish and Wildlife Advisories* (EPA-823-F-01-010), April 2001.

33. U.S. EPA, *Mercury Study Report to Congress*, 1997.

34. Ibid.

35. Ibid.

36. Ibid.

37. 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.

38. Ibid.

39. T.D. Pearse Resource Consulting, *Mining and the Environment*, March 1996, 14.

40. The Ohio Department of Natural Resources, *Geofacts #15: Coal Mining and Reclamation*, July 1997.

41. 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.

42. Friends of the Earth et al., *Running on Empty: How Environmentally Harmful Energy Subsidies Siphon Billions from Taxpayers*, January 2002.

43. J. Nesmith and R. Haurwitz, "Pipelines: The Invisible Danger," *Austin American-Statesman*, 22 July 2001.

44. Ibid.

45. Ibid.

46. San Juan Citizen's Alliance, Oil and Gas Accountability Project, *Western Coalbed Methane Project*, downloaded from www.ogap.org, 18 November 2001.

47. 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.

48. 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.

49. Linda Ashton, "State Warns of Suit over Hanford Cleanup," *Seattle Times*, 24 March 2001.

50. 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.

51. Ibid.

52. Electric Power Research Institute, *Electric Power Research Institute Journal*, Nov/Dec 1995, 29.

53. 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.

54. Public Citizen, *Impacts of Nuclear Waste Transportation*, downloaded from www.citizen.org/cmep/RAGE/radwaste/factsheets/45-trans.htm, 2 September 2001.

55. U.S. EIA, State Electricity Summary Information, downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/maryland/md.html on 7 January 2002.

56. Pacific Northwest National Laboratory, *An Assessment of Windy Land Area and Wind Energy Potential in the Contiguous United States*, 1991.

57. Electricity generation is calculated using a capacity factor of 30% for wind power.

58. American Wind Energy Association, *Wind Project Data Base*, downloaded from www.awea.org/projects/index.html, 20 December 2001.

59. U.S. Department of Energy (DOE), *Why Consider Renewable Energy?*, downloaded from www.eren.doe.gov/state_energy/why_renewables.cfm, 4 June 2001.

60. U.S. DOE, Office of Utility Technologies, *Renewable Energy Technology Characterizations*, December 1997.

61. U.S. DOE, Energy Efficiency and Renewable Energy Network, *State Energy Alternatives: Current Renewable Energy Projects*, downloaded from www.eren.doe.gov/state_energy, 10 January 2002.

62. National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies*, May 2000.

63. 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.

64. 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.

65. U.S. DOE, Energy Efficiency and Renewable Energy Network (EREN), Current Renewable Energy Projects I Maryland, downloaded from www.eren.doe.gov, 26 December 2001.

66. U.S. DOE, EREN, *Maryland Bioenergy Sources*, downloaded from www.eren.doe.gov, 25 March 2002.

67. American Council for an Energy-Efficient Economy (ACEEE), *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/esrt17p6.html.

68. ACEEE, *State Scorecard on Utility Energy Efficiency Programs*, April 2000.

69. Northeast Energy Efficiency Partnerships, Inc., *Letter to Public Service Commission of Maryland Regarding Case Number 8738 – Economic and Environmental Analysis for Proposed Statewide Energy Efficiency Program Plans and Budgets for Maryland*, 17 November 2000.

70. Maryland Department of Natural Resources Power Plant Research Program, *Maryland Cumulative Environmental Impact Report, 11th Edition*.

71. Steve Nadel et al, American Council for an Energy Efficient Economy, *Energy Efficiency and Economic Development in New York, New Jersey, and Pennsylvania*, February 1997.

72. Governor's Task Force on Energy Conservation and Efficiency, *Final Report*, 15 December 2001.

73. ACEEE, *Analysis of Proposed Product Efficiency Standards in Maryland*, 2002. The six products analyzed are those listed except commercial ice-makers and air-conditioning equipment.

74. Pollution is calculated using EGRID and includes CO_2, SO_2, and NOx, from coal, petroleum, and gas plants, and mercury from coal plants.

75. U.S. EIA, State Electricity Profiles: Maryland, downloaded from www.eia.doe.gov/cneaf/electricity/st_profiles/maryland/md.html, 7 January 2002.

76. Ibid.

77. The Energy Foundation, *National Energy Policy Factsheet: Utility Energy Efficiency Programs*, downloaded from www.ef.org/national/FactSheetUtility.cfm, 28 September 2001.

78. 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%.

79. See note 77.

80. Natural Resources Defense Council, *Energy Efficiency Leadership in a Crisis: How California Is Winning*, August 2001.

81. See especially Amory Lovins and Chris Lotspeich, "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.

82. American Council for an Energy-Efficient Economy, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency*, September 2001.

83. Alliance to Save Energy, *Home Energy Checkup*, downloaded from www.ase.org/checkup/home/main.html, 15 December 2001.

84. 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.

85. Dave Rib, KJC Operating Company, personal communication, 24 August 2001.

86. 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.

87. National Renewable Energy Laboratory, *Customer Sited PV – U.S. Markets Developed from State Policies* (NREL/CP-520-28426), May 2000.

88. Ibid.

89. Eric Ingersoll, Renewable Energy Policy Project, *Industry Development Strategy for the PV Sector*, 1998.

90. University of Wisconsin-Madison, *The Why Files: Science Behind the News*, *Buying the Sun*, downloaded from whyfiles.org/041solar/main1.html, 18 October 2001.

91. See note 89.

92. Ibid.

93. Ibid.

94. U.S. EIA, *Renewable Energy Annual 2000*, March 2001.

95. 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: EIA "Issues and Trends" and Byron Stafford, National Renewable Energy Laboratory, *Renewables for Sustainable Village Power,* downloaded from www.rsvp.nrel.gov, 8 August 2001.

96. 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.

97. National Renewable Energy Laboratory, *Geothermal Today*, May 2000.

98. U.S. DOE, *Geothermal Energy Program: Frequently Asked Questions*, downloaded from www.eren.doe.gov/geothermal/geofaq.html, 8 January 2002.

99. 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.

100. 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.

101. Alliance to Save Energy (ASE), ACEEE, Natural Resources Defense Council, Tellus Institute, and Union of Concerned Scientists, *Energy Innovations: A Prosperous Path to a Clean Environment*, 1997.

102. 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.

103. 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.

104. U.S. EIA, "Rising Demand Increases Natural Gas Prices in All Economic Growth Cases," *Annual Energy Outlook 2001*, 22 December 2000.

105. 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.

106. U.S. EIA, *Annual Energy Review 2000*, August 2001.

107. U.S. EIA, "Rising Demand Increases Natural Gas Prices in All Economic Growth Cases," *Annual Energy Outlook 2001*, 22 December 2000.

108. C. Bryson Hull, "North American Gas Production Flat, Despite Drilling Boom," *Reuters*, 26 March 2001.

109. U.S. EIA, "Oil and Gas Supply," *Annual Energy Outlook 2001*, 22 December 2000.

110. Joseph Kahn, "Cheney Promotes Increasing Supply as Energy Policy," *New York Times*, 1 May 2001.

111. 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.

112. 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.

113. 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.

114. Ibid. Amounts converted to 2001 dollars.

115. 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.

116. See note 87.

117. Fred Sissine, Congressional Research Service, *Renewable Energy: Key to Sustainable Energy Supply,* 27 May 1999.

118. Safe Energy Communications Council, *The Great Ratepayer Robbery,* Fall 1998.

119. Renewable Energy Policy Project, *The Work that Goes into Renewable Energy*, November 2001.

120. 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.

121. Tellus Institue, *Clean Energy: Jobs for America's Future*, October 2001.