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Green Electricity Market Development in the United States

Policy Analysis and Case Studies

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Sammendrag:.
Denne artikkelen studerer utviklingen i produksjonen av grønn elektrisitet i USA og fokuserer på politiske tiltak som har blitt innført for å stimulere til produksjon av grønn elektrisitet.

Med grønn kraft mener vi elektrisitet som kommer fra enkelte fornybare energikilder som vind og sol, geotermisk varme, små vannkraftverk og noen former for biomasse. Det har vært interesse for å stimulere til produksjon av fornybar energi i årevis. Men USA er i dag sterkt avhengig av ikke-fornybare fossile brensler til sitt energiforbruk. Denne artikkelen går i gjennom de viktigste energiformene som brukes i produksjonen av elektrisitet, vurderer endringene i miljølovverket for el-industrien og beskriver politiske tiltak som har blitt brukt for å øke produksjonen av grønn elektrisitet i USA. Viktige faktorer som har påvirket utviklingen av grønne kraftmarkeder blir diskutert, inkludert underliggende økonomiske spørsmål, politiske tiltak, regelverk, eksterne kostnader, subsidier og andre faktorer.

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Abstract:
This paper reviews green electricity development in the United States, focusing on policies that have been enacted to promote green electricity. Green power is a term that refers to electricity generated from particular renewable energy sources including wind and solar power, geothermal, low-impact hydropower, and certain forms of biomass. While there has been interest in promoting the use of renewable energy sources for a number of years, the United States currently relies heavily on nonrenewable fossil fuels for energy. The paper reviews the principal energy resources used for electricity production, considers the changing regulatory environment for the electricity industry, and describes government policies that have been used to promote green electricity in the United States. Important factors that have influenced the development of green electricity markets are discussed, including underlying economic issues, government policy measures, the regulatory environment, external costs and subsidies, and other factors.

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1 Introduction

While there has been interest in promoting the use of renewable energy sources for a number of years, the United States currently relies heavily on nonrenewable fossil fuels for energy. The share of net electricity generation in the United States produced from renewable sources (including hydropower) declined from nearly 12 percent of in 1990 to about 8 percent in 2001. While much of the recent decline was caused by a drop in hydroelectric production from lack of rainfall in the Pacific Northwest, production of electricity from other renewable sources – with the exception of wind power – has been virtually constant for the last several years. This is surprising because it was generally anticipated that traditional fossil fuels would be gradually replaced by cleaner renewable energy sources because of rising costs for traditional fossil fuels, growing concern about environmental issues such as climate change, and national security concerns with imported oil.

This study focuses on "green power," a term that refers to electricity generated from particular renewable energy sources including wind and solar power, geothermal, low-impact hydropower, and certain forms of biomass. The paper reviews green electricity development in the United States, focusing on policies that have been enacted to promote green electricity. The next section of the paper reviews the principal resources available for electricity production, the shares currently produced from different energy sources, and the potential for increased use of renewable sources for electricity generation. The third section describes the regulatory and institutional environment for electricity and government policies that have been used to promote green electricity in the United States. The fourth section reviews studies of the effectiveness of the various policies that have been used to promote green power development. The fifth section discusses factors that might lead to increased supply and/or demand of green power over time, and barriers to future market development. The final section presents concluding comments.

2 Electricity Production in the United States[1]

2.1 Resources currently used for electricity production

The principal resources for electricity production in the United States include conventional resources such as coal, nuclear power, natural gas, and petroleum products and renewable resources including water, wind, solar, geothermal, and some combustible materials such as biomass, and municipal solid waste.[2] The share of electricity generation from various sources in selected recent years is shown in Table 1. Coal is the principal resource used to produce electricity in the United States, accounting for more than 50 percent of electricity production in the United States in 2002. From 1990 to 2002, the share of electricity generated from

[1] Unless otherwise noted, the information in this section comes from publications by the US Department of Energy and the Energy Information Administration. The primary sources are Energy Information Administration (2002, 2003a) and US Department of Energy (2003a).

[2] This list of renewable resources is from the US Department of Energy (e.g., US Department of Energy, 2003a), but not all of these are "green." Small-scale, or run-of-the-river, hydropower is green, but large-scale hydro facilities are not usually considered green because opportunities for their expansion involve significant environmental tradeoffs. Municipal solid waste is also not a "green" resource.

renewable sources other than hydropower remained relatively constant, accounting for 2.2 percent of electricity generated in 2002.

Table 1. Percent of Net Electricity Generation by Energy Source: Total (All Sectors)

	1990	1995	2000	2001	2002
Fossil fuels					
Coal	52.5	51.0	51.7	50.9	50.1
Natural gas	12.3	14.8	15.8	17.1	17.9
Petroleum	4.2	2.2	2.9	3.3	2.3
Nuclear	19.0	20.1	19.8	20.6	20.3
Renewable sources					
Hydroelectric	9.6	9.2	7.2	5.6	6.6
Wood	1.1	1.1	1.0	0.9	1.0
Other waste[1]	0.4	0.6	0.6	0.6	0.6
Other renewables[2]	0.6	0.5	0.5	0.6	0.6

[1] Includes municipal solid waste, landfill gas, sludge waste, tires, agricultural waste, and other biomass.
[2] Includes geothermal, solar thermal and photovoltaic, and wind

Source: Energy Information Administration, 2003d

Coal and nuclear power have accounted for about two-thirds of net electricity generation in the United States for the last several decades. US coal reserves exist under 13 percent of the land area in a total of 38 states. Given the abundance of coal, the US Department of Energy forecasts a continuing drop in its real price over the next two decades and expects coal to still account for nearly 50 percent of net electric generation in 2025 (Energy Information Administration, 2003a). Continuing technological advances and improved environmental performance in coal combustion technologies also suggest that coal will continue to play a central role in US electricity supply. Nuclear power generation increased by 35 percent between 1990 and 2002 and has accounted for about 20 percent of net electricity generated since 1990. Though the underlying nuclear resource base is virtually unlimited, the nuclear share of total electricity production is expected to fall to less than 15 percent in 2025 because of public concerns about the safety of nuclear power plants and difficulties in dealing with radioactive waste.

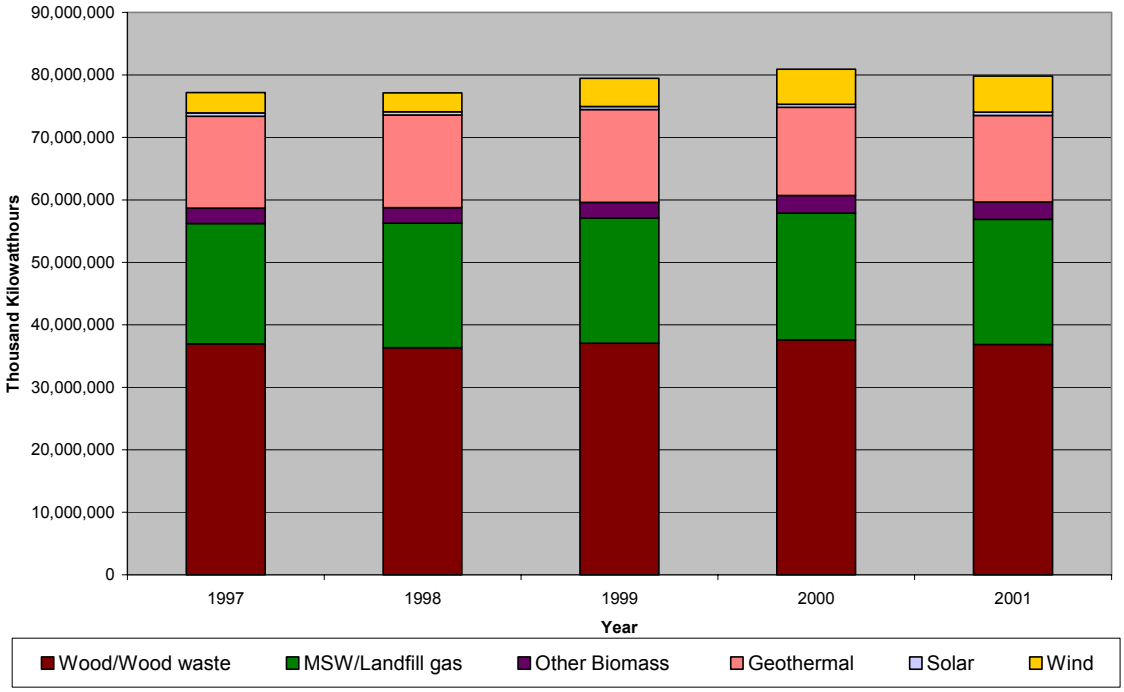
Natural gas has accounted for a steadily increasing share of net electricity generated in the United States since the late 1980s because it is both relatively abundant and cleaner than other fossil fuels. From 1990 to 2002, electricity generation using natural gas increased by 84 percent, and natural gas is expected to account for nearly 30 percent of net electricity production in 2025 (Energy Information Administration, 2003a). Natural gas reserves are located in several regions of the United States and continued growth in natural gas production is expected to come from the Gulf of Mexico, Alaska, Canada's Mackenzie Delta, and imports of liquefied natural gas (Energy Information Administration, 2003c).

2.2 Renewable resources in US electricity production

Hydroelectric power is the major renewable source of electricity in the United States, accounting for 6.6 percent of net electricity generation and about three-fourths of electricity produced from all renewable sources in 2002. More than 90 percent comes from conventional large-scale and pumped storage facilities operated by electric utilities. While hydropower is produced in almost every state of the country, the Pacific states (Washington, Oregon, and California) account for approximately 60 percent of total hydroelectric production in the United States. In Alaska, Colorado, Idaho, Oregon, and Washington, virtually all of the electricity produced from renewable sources is hydropower and in many other states, particularly in the western and north central regions of the country (e.g., Arizona, Colorado, Kansas, Missouri, Oklahoma, and Wyoming), conventional hydroelectricity was responsible for more than 90 percent of total electricity from renewable energy sources in 1999 and 2000 (Energy Information Administration, 2002). Because virtually all of the nation's hydropower capacity is currently utilized, the share of electricity generated by conventional hydroelectric facilities is expected to decline to 5.2 percent of total generation in 2025 (Energy Information Administration, 2003a).

Figure 1 shows electricity generation from non-hydroelectric renewable resources from 1997 to 2001. During this period, the total amount of electricity production from biomass, geothermal, and solar sources remained essentially unchanged, while production from wind facilities increased by more than 75 percent.

Figure 1. Electricity Net Generation From Non-hydro Renewable Energy Sources, 1997-2001



Source: Appendix A, Table A-1

Wind energy is the fastest growing renewable electricity resource in the United States. From 1997 to 2001, generation from wind sources increased by more than 75 percent, and wind power accounted for 2.2 percent of electricity from all renewable sources in 2001 (Table A-1). As of 2000, wind power's share of total electricity produced from renewable sources was greatest in Iowa (33 percent), Minnesota (24 percent), Texas (19 percent), and California

(5.8 percent) (Energy Information Administration, 2002). States with the highest potential for wind power relative to electricity sales are in the central United States, including Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Wyoming (Deyette, Clemmer, and Donovan, 2003).

The amount of solar electricity produced in the United States declined slightly from 1997 to 2001. Its relatively high cost remains an impediment, particularly in grid-interactive applications. Almost every state in the United States has solar resources that could be used to produce electricity using solar photovoltaic cells. However, the only state that produces a significant amount of solar electricity is California, and the amount produced in California (~500 million kWh) remained virtually constant from 1997 to 2001.

Biomass includes wood, wood waste, agricultural byproducts, and municipal solid waste (MSW). Biomass is the second largest source of renewable electricity in the United States (after hydropower), accounting for about 20 percent of electricity from all renewable sources in 2001. Wood and agricultural waste currently account for more than two-thirds of biomass capacity. Electricity generation from biomass is expected to more than double between 2001 and 2025 (Appendix Table A-3). Most of the electricity generated from wood and wood waste is from co-generation facilities operated by non-utility producers, whereas utilities produce most of the electricity from MSW and landfill gas. The forest products industry – the second largest consumer of electricity in the United States – self-generates about one-third of its electricity from wood and wood waste. States with the highest portion of their total renewable electricity from wood/wood waste are Mississippi, Louisiana, Virginia, Georgia, and Maine.

Geothermal electricity production declined by 5.7 percent over the 1997 to 2001 time period and comprised just 4.4 percent of electricity generated by all renewable sources in 2001. California accounts for about 90 percent of geothermal electricity production in the United States. The only other states that were producing geothermal electricity in 2001 were Nevada, Hawaii, and Utah, but geothermal electricity generation is expected to increase significantly and account for 0.6 percent of total generation in 2025 (Appendix Table A-3).

2.3 Potential for renewable sources of electricity

The Union of Concerned Scientists (UCS) recently estimated that major renewable resources excluding hydropower – wind, solar, biomass (excluding MSW), geothermal, and landfill gas – could potentially provide 5.6 times the total amount of electricity used in the country in 2001 (Deyette, Clemmer, and Donovan, 2003).[3] According to the UCS study, wind power has the greatest potential of all green power sources and could have met 459 percent of the nation's electricity needs in 2001. Estimated potentials for the other renewable sources as a percent of 2001 electricity sales were solar (photovoltaic), 71 percent; biomass (natural materials only), 24 percent; geothermal, 6 percent; and landfill gas, 1 percent.

The UCS study estimated that the best wind resources are located in the Great Plains and upper Midwest states. States with the highest solar energy potential are located in the southwestern part of the country and along the southern Atlantic coast. More than 25 states could potentially generate more than 20 percent of their electricity from biomass (excluding MSW); those with the most potential are located primarily in the Midwest and Great Plains. Nine states in the western United States could potentially produce geothermal energy, with Nevada having the greatest potential. Landfill gas could potentially meet between 2 and 4

[3] This estimate was based on the technical potential of the resources, measured as the theoretical potential without considering their economic viability (Deyette, Clemmer, and Donovan, 2003, pg. 35). Hydropower was excluded because of environmental concerns with further development of hydropower resources.

percent of the 2001 electricity requirements in 7 states (Deyette, Clemmer, and Donovan, 2003).

3 Government Policies and Renewable Energy

3.1 3.1 The regulatory environment

Regulatory responsibility for the electricity industry in the United States rests with both state public utility commissions and the Federal Energy Regulatory Commission (FERC). Under US law, state public utility commissions have oversight over utility planning, distribution service territories, terms and conditions of service, and retail rates for electricity. Retail prices have traditionally been set through ratemaking processes based on cost of service. FERC sets the rules for wholesale electricity market design and pricing and also has regulatory responsibility for interstate transmission of electricity.

Numerous federal and state initiatives beginning in the late 1970s have changed the structure of the electricity industry in many states. The restructuring process began in 1978 when the Public Utility Regulatory Policies Act (PURPA) opened the electricity market to competition by requiring electric utilities to purchase electricity produced by nonutility entities using cogeneration or small-scale renewable sources. The Energy Policy Act of 1992 (EPACT) further opened the market to competitive wholesale generation. In 1996, FERC implemented the intent of EPACT with regulatory orders that were intended to "remove impediments to competition in wholesale trade and to bring more efficient, lower cost power to the Nation's electricity customers" (Energy Information Administration, 2003b). The FERC orders required open and equal access to utilities' transmission lines for all electricity producers, thus facilitating direct access of retail customers to choose among different types of power generation.

In 1996, California and Rhode Island passed legislation to restructure their electricity industries and give consumers the right to choose their electricity supplier. By 2000, approximately 16 percent of all electric utility generating capacity had been sold or transferred to unregulated entities selling power in competitive markets (Energy Information Administration, 2003b). As of February 2003, 23 states and the District of Columbia had passed legislation to either require or encourage the divestiture of generation facilities by utilities (Energy Information Administration, 2003e). Following the California electricity crisis in 2001, several states that had been actively restructuring retail electricity markets delayed their efforts. Most states that are restructuring have also passed laws or issued regulatory orders to implement retail access, giving customers the opportunity to purchase green electricity products. Although generation now takes place in a competitive market in many states, transmission and distribution of electricity have for the most part remained regulated and non-competitive.[4]

3.2 Policies to promote green electricity

Governments and regulatory agencies at the federal, state, and local levels have adopted specific policies to support wind, solar, biomass, hydroelectric, and other renewable energy sources.[5] The federal government has provided R&D funding, demonstration grants, and

[4] For a critical review of electricity sector restructuring in the United States and other countries, see Joskow (2003).

[5] Support for hydroelectric facilities is usually limited to small-scale, low-impact facilities, although the definition of "small-scale" varies.

other financial incentives to promote green electricity, including tax deductions (accelerated depreciation for solar, wind, and geothermal investments) and tax credits to individuals and corporations for electricity produced from wind, solar, geothermal and closed-loop biomass facilities. The production tax credit for new wind energy systems (1.8 cents/kWh for the entire output of a facility during the first 10 years of its operation) has played an important role in encouraging recent wind energy development (Bird et al., 2003). The federal Public Utilities Regulatory Policies Act (PURPA) also played an important role in renewable energy development by requiring utilities to purchase electricity from small-scale production facilities at the avoided cost.

There is considerable variation among the states in their regulatory environments and policies for green power development. In the following discussion, state and local policy instruments are categorized as *financial incentives*, *rules and regulations*, and *voluntary measures*.[6] Financial incentives include various forms of government subsidies and/or funding in direct support of green electricity projects, tax incentives (credits, deductions, or exemptions), and provisions for zero-interest or low-interest loans. Rules and regulations include requirements that utilities distribute a minimum share of electricity from renewable or green energy sources, construction and design standards for green energy in building codes, green power purchase requirements for government entities, and requirements that consumers with small renewable facilities such as wind or solar be credited by their utility for the amount of electricity they generate (net metering). Voluntary measures include green power products aimed at electricity consumers (green power choices in competitive markets and green power pricing in regulated markets), green power certificate programs, and other programs to increase awareness and market support for renewable energy technologies.

3.3 State financial incentives

Table 3 lists the most important state financial incentives and the number of states where each incentive was available as of 2003. Some states (e.g., California, Montana, and Oregon) use a number of different financial incentives, and every state except Maine and South Carolina used at least one type of financial incentive to promote green electricity in 2003.

Table 3: State Financial Incentives, 2003

Type of Incentive	Number of states with incentives
Personal Income Tax	14
Corporate Income Tax	16
Sales Tax	14
Property Tax	26
Rebates/Buy-downs	20
Grants	16
Loans	22
Production Incentives	45
Leasing/Purchase	3
Industry Recruitment	11

Source: *Database of State Incentives for Renewable Energy* (North Carolina Solar Center, 2003).

[6] Much of the information comes from the *Database of State Incentive for Renewable Energy* (North Carolina Solar Center, 2003) and Energy Information Administration (2003f).

Tax incentives for the purchase and installation of renewable energy equipment are widely used by states to promote renewable energy sources. Personal tax incentives include state income tax credits or deductions of interest payments on the purchase and installation of renewable energy systems. Sixteen states have corporate income tax credits for investments in solar and/or wind energy facilities or for using green electricity in new buildings. State credits against income tax range from 10 percent to 35 percent of equipment and installation costs for both retail and commercial customers (Gouchoe, Everett, and Haynes, 2002). Fourteen states exempt solar photovoltaic, wind energy and other renewable energy equipment from sales taxes. Local governments in 26 states either completely exempt renewable electricity sources from property taxes or assess new or existing green energy systems in residential, commercial, or industrial buildings at a reduced value. Tax incentives in some states are limited to non-hydro green energy sources, while others (Connecticut, Indiana, Kansas, Massachusetts, and Vermont) also include hydroelectric facilities in some tax incentive programs.

Rebate (or buy-down) programs are offered to commercial and residential customers by some local and state governments and utilities to promote the installation of renewable electricity generating facilities, particularly solar photovoltaic systems. Buy-down payments provide a rebate of the purchase price on a per-watt basis, often up to a certain percentage of the equipment and installation costs. Sixteen states provide research and development grants, support for specific projects or facilities, or grants to facilitate commercialization of new renewable technologies. Loan programs in 22 states provide low interest or zero interest loans to residential and commercial electricity customers for the purchase of renewable electricity equipment.

Production incentive programs in 45 states provide payments to qualifying residential or commercial facilities for electricity produced from renewable energy sources. The payments take the form of a tax deduction or credit, an actual cash payment, or a renewable energy credit (REC). Forty of these states are in a program administered by Mainstay Energy, a private firm operating at a national scale that offers customers who install renewable energy systems the opportunity to sell the electricity generated by these systems as a transferable credit called a *green tag*.[7] Participating customers receive regular payments depending on the specific renewable energy technology, the amount of electricity produced, and the duration of the contract period (3, 5, or 10 years). Eligible technologies include solar photovoltaic, wind, biomass, geothermal, and low-impact hydro. Seven states are in a program administered by the Tennessee Valley Authority that purchases the entire output of qualifying photovoltaic and wind turbine systems for a minimum 10-year period.

Industry recruitment programs are designed to attract renewable energy equipment manufacturers to locate within a city or state and usually consist of state income or excise tax credits, grants, or a commitment to purchase a specific amount of the product for use by government agencies. Three states (California, Texas, and Wyoming) have leasing/lease purchase programs that target power customers in remote areas for whom line extension is very costly; customers can lease renewable energy technology from the utility and given the option to purchase the equipment after a certain time period.

3.4 State rules and regulations

Table 4 lists the most widely used rules and regulations and the number of states in which each were in place as of 2003. In some cases, regulations such as construction and design standards and green power purchasing requirements have been implemented at the local level

[7] For information, see http://www.mainstayenergy.com/

rather than statewide. Most states use several of the regulations in Table 4, although four states have no rules or regulations to promote electricity from green energy sources at either the state or local level (Alabama, Mississippi, South Dakota, and West Virginia).

Table 4: Rules and Regulations, 2003

Type of Regulation	Number of States with Rules and Regulations
System Benefits Charge/Renewable Electricity Funds	15
Renewable Portfolio Standards	15
Generation Disclosure and Certification Rules	23
Net-metering Rules	38
Mandatory Green Power Option for Customers	5
Green Power Purchase Requirements	16
Solar Access Laws and Guidelines	33
Construction Design Standards	12

Source: *Database of State Incentives for Renewable Energy* (North Carolina Solar Center, 2003).

System benefits charges (SBC) are used in 15 states to collect surcharges from electricity customers to support renewable electricity funds (sometimes called public benefits funds). Most states established these funds in conjunction with electric industry restructuring in the late 1990s to replace similar programs traditionally administered by regulated electric utilities. SBC are imposed directly on customers' monthly electricity bills usually on a cents per kilowatt-hour basis. Renewable electricity funds have been used in a variety of ways to promote renewable technologies, and have been particularly effective in stimulating wind energy facilities in states such as California, New York, and Pennsylvania (Bird et al., 2003). Most of the funding has been obligated to three broad categories of programs: financial incentives (production incentives and grants) for large-scale renewable energy projects, with wind being the most-favored technology; buy-downs and consumer financing programs for customer-sited distributed generation programs (solar photovoltaic systems being most-favored); and support for customer choice and green power marketing programs (Bolinger et al., 2001). In most states, the funds have been used to support green electricity development (wind, solar photovoltaic, small-scale hydropower, and biomass) both at the utility scale and in smaller-scale generation projects.

Renewable portfolio standards (RPS) require electricity providers to supply a given percentage of electricity from renewable sources by a certain date. The design of RPS programs varies considerably among states, but all require a gradually increasing percentage of an electricity provider's overall generating capacity or electricity sales to come from qualifying renewable energy sources by a certain date. RPS had been adopted by 15 states as of 2003, although the goal is non-binding in three of these states (Hawaii, Illinois, and Minnesota). RPS requirements in most states apply only to private electricity providers.[8] In some states, the RPS can be met only through investments in new renewable sources, while others allow the requirement to be met with both existing and new renewable sources. Some states allow retail electricity providers to use tradable renewable energy credits to satisfy the RPS requirement.

[8] In New Mexico, public utility companies are required to produce 5 percent of all energy they generate for New Mexico customers from solar, wind, hydropower, biomass, or geothermal sources by 2006, and generation from renewable resources must increase by at least 1 per cent per year until the renewable portfolio standard (RPS) of 10 per cent is attained in the year 2011.

Generation disclosure and certification rules require utilities to disclose information about the fuel source of the electricity such as energy resource mix and emissions statistics to customers on a regular basis. They are also required to certify that they are using the type and amount of renewable energy that is claimed. A voluntary certification program called the *Green-e Renewable Branding Program,* administered by the Center for Resource Solutions, currently certifies renewable electricity products in 13 states (Center for Resource Solutions, 2003).

Net-metering regulations allow electricity customers to use their own renewable generating facilities to replace power from their electricity provider using the electrical grid as a backup. A single, bi-directional meter measures flows to and from the grid, and the customer pays only for the net electricity consumed. Customers are generally not allowed to generate more electricity than they use themselves. Net-metering rules have been implemented in 38 states, although they apply to only selected utilities in five of those states (Colorado, Florida, Idaho, Illinois, and Kentucky). Qualifying technologies and their maximum capacities vary among states, but wind and solar systems are eligible in most states with net-metering rules.

Five states (Iowa, Minnesota, Montana, New Mexico, Washington) have recently adopted mandatory green power options, which require electricity providers (in some cases, only regulated utilities) to offer customers the option to purchase electricity from renewable sources. Wind, solar, geothermal, hydro, and biomass are eligible technologies in most states. In some states, this regulation has been adopted in conjunction with implementation of a renewable portfolio standard.

Green power purchase requirements in 16 states require a minimum percentage use of renewable energy in government buildings and public utilities (street lighting, water pumping stations, etc.). The requirements are statewide in 6 states (Illinois, Maryland, New Jersey, New York, Pennsylvania, and Tennessee) and mandated by local governments in 10 other states. Eligible technologies in most of the minimum purchase programs include wind, solar, landfill gas, and biomass, but several of the state programs also include hydropower.

Solar and wind easements are used in 33 states to guarantee access to solar or wind resources for those whose access to the resource might be impeded through development or sale of property. Easements secure continuing access to a renewable resource for a property owner regardless of what other property owners could do to interfere with access, and are transferred with the property title. Solar easements are the most common type of state access rule. At the local level, zoning ordinances, development guidelines, and permits are also used to guarantee solar access in a number of states.

Construction and design standards are used in 12 states to promote green energy in building construction or renovation projects. Some states require contractors to evaluate the costs and performance of installing renewable energy systems in state construction projects such as schools and state buildings and to use renewable sources if feasible. Cities and localities in several states have developed “Green Building" guidelines that require that renewable energy technologies be evaluated in municipal building or residential construction projects.

3.5 State voluntary measures

Numerous state and local governments, industry associations, private firms, and NGOs sponsor market-based measures for electricity customers and the general public in a number of states. Table 5 lists the most important voluntary measures in use as of 2003.

Table 5: Voluntary Measures, 2003

Programs	Number of States with Voluntary Programs
Green Power Choices	12
Green Power Pricing	31
Outreach Programs	38

Source: *Database of State Incentives for Renewable Energy* (North Carolina Solar Center, 2003) and *Green Power Network* (National Renewable Energy Laboratory, 2003).

Green power choice programs (sometimes called *green power marketing*) allow customers in states with competitive electricity markets to purchase electricity directly from renewable sources through their retail providers. Electricity markets are open to full competition with multiple suppliers and service offerings in a number of states, while other states are gradually phasing in competition (National Renewable Energy Laboratory, 2003. As of 2003, customers could purchase green power at the retail or wholesale level in California, Illinois, Maryland, New Jersey, New York, Pennsylvania, Texas, Virginia and several New England states. In some states, providing green power is the only way utility distribution companies have been able to distinguish their products.

In states that have retained traditional regulated electricity markets, green-pricing programs give utility customers the option to pay a premium on their electric bill to cover the incremental cost of producing electricity from renewable energy sources. Most green-pricing programs allow customers to purchase increments of green electricity in discrete blocks – for example, 100-kWh blocks – at a given price, with no limit on the number of blocks they can buy. Product prices vary significantly across programs, but the median premium is around 2.5 cents per kWh (North Carolina Solar Center, 2003). Since these programs are offered by utilities in 31 different states, there is considerable variation in terms of the eligible technologies and scope of coverage.[9] While wind, solar, and landfill gas are the most common renewable sources in green-pricing programs, low-impact hydropower is also eligible in some states (e.g., Arizona, California, Colorado, Indiana, Michigan, and Montana).

Another market-based product – tradable renewable energy certificates (*green tags*), representing the environmental and other non-electrical attributes of renewable energy sources – is emerging.[10] The certificate gives the holder contractual rights to the value of the non-electrical benefits from using a renewable energy resource, and can be priced and traded separately from the electricity (Blank, Bird, and Swezey, 2002). Mainstay Energy purchases green tags from small-scale renewable producers (about 200 as of November 2003) on a national scale. A coalition of western states is in the process of designing a cap-and-trade program for air pollution control and is considering the feasibility of including emission reduction allowances for zero- or low-emission renewable energy technologies (Western Regional Air Partnership Program, 2000). Allowances for renewable sources were included in the sulfur dioxide (SO_2) emissions trading program under the Clean Air Act amendments of 1990. By investing in renewable energy sources, utilities would earn special emission allowance awards that could be used to meet SO_2 emissions compliance obligations or sold to others.[11] Credits for emissions reductions from renewable energy sources are being

[9] See *Green Power Network* (National Renewable Energy Laboratory, 2003) for further information.

[10] For example, non-electrical attributes of wind power include environmental benefits, diversification of risk, and energy security.

[11] The (300,000) allowances were set aside from the total emissions cap imposed on electric utilities. An allowance could be earned for every 500 megawatt-hours of energy produced by a qualified utility

increasingly included in state implementation plans for meeting federal air quality standards (Blank, Bird, and Swezey, 2002).

Educational/outreach programs in 38 states include renewable energy awareness campaigns, public exhibitions and workshops, technical assistance, and demonstration projects to increase public awareness of renewable energy technologies. Most of the programs are associated with the Million Solar Roofs Initiative (MSRI), an initiative to install solar energy systems (solar photovoltaics and solar thermal systems) on one million US buildings by 2010. Members of MSRI include the building industry, federal agencies, local and state governments, utilities, energy service providers, the solar energy industry, financial institutions, and non-governmental organizations. The goal of MSRI is to remove market barriers to solar energy use and develop and strengthen local demand for solar energy products and applications (US Department of Energy, 2003b).

3.6 Green power policies in California, Minnesota, New York, and Texas

California, Minnesota, New York, and Texas were selected for further study because of their diversity in energy resources, regulatory environments, electricity usage, and policies to promote green electricity. In a recent study by the Union of Concerned Scientists evaluating state efforts to promote the use of energy from green sources, California received a grade of **A**$^{-}$, Minnesota was given a **B**, Texas received a **C**, and New York was given a **D** (Deyette, Clemmer, and Donovan, 2003).[12] California generated 10.3 percent of its total electrical sales in 2003 from green sources (renewable energy sources other than hydroelectric and municipal solid waste). The shares in the other states were Minnesota, 2.7 percent; Texas, 1.5 percent, and New York, 0.8 percent.

Specific information about these four states and their policies to promote green electricity is in Appendix B. Each state has numerous financial incentives including personal, corporate, and property tax exemptions, credits or deductions; loan provisions; and direct grants for investments in renewable energy technologies. All four states require net metering and have generation fuel disclosure and emissions rules. Binding renewable performance standards (RPS) have been adopted in three of the four states: California (20 percent of total retail electricity sales from green sources by 2017); Minnesota (10.5 percent for one utility, Xcel, by 2006); and Texas (3 percent by 2009). Minnesota also has a non-binding goal for the entire state of 10 percent of its electricity from green sources by 2015. New York is currently developing an RPS.

California, Minnesota, and New York have public benefits funds generated from mandatory fees on customers of investor-owned utilities. The funds are used to support renewable energy sources in a variety of ways, including grants for R&D and new investments, rebates, low-interest loans, and outreach programs. Expenditures from California's renewable electricity funds accounts for nearly half of all public benefits funding in the United States (Bolinger and Wiser, 2001). These four states also extensively promote the use of renewable energy through voluntary and outreach measures. Green-pricing programs offered by utilities in California, Minnesota, and Texas are considered to be among the most successful in the nation (US Department of Energy 2003c). Electricity customers in New York can purchase electricity

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through renewable energy generation measures (biomass, including landfill gas; geothermal; solar; and wind energy projects implemented between 1992 and 1999. See Wooley (2000) for a discussion of why this program failed to encourage renewable energy sources.

[12] Grades were based on state commitments in terms of mandated renewable portfolio standards and support of renewable energy generation through renewable electricity funding. Hydropower and municipal solid waste were not included in the study.

from green energy producers and marketers as part of the transition into a competitive electricity market that began in 1998.

California and Texas combined are expected to account for nearly 60 percent of the projected gains in electricity production from green sources (excluding hydropower) in the United States by 2017 because of California's ambitious renewable performance standard and sizable renewable electricity fund (accounting for nearly half of all state renewable electricity funding) and Texas' geographic size, high rate of electricity consumption, and the quality of its green energy sources (Deyette, Clemmer, and Donovan, 2003). The four states are leaders in wind power development: California and Texas currently account for nearly 60 percent of the total wind power produced in the United States; Minnesota is the fourth leading state; and New York has more wind power projects under development than any other state in the country.[13] Texas' emergence as a leading state in terms of wind power development is credited largely to the design and implementation of its renewable portfolio standard, one of the most ambitious in the nation in terms of additional renewable capacity (Langness and Wiser, 2003).

4 Effectiveness of policies to promote green electricity

Policies to directly promote green electricity in the United States are still in the early stages of implementation, so reliable data on program funding, costs, and energy savings from different types of policy measures are not available. Furthermore, state policy measures that appear to be identical have important differences in form and detail, eligible technologies, implementation timeline, and other factors. Most existing evaluations of state green electricity policies have been case studies or have simply judged the effectiveness of different policy instruments in terms of their impact on stimulating investment in renewable technologies or the anticipated effect on green electricity production.

Mandatory renewable portfolio standards (RPS) and net metering rules are considered to be the most effective policy measures in stimulating electricity production from green energy sources. Used in conjunction with financial incentives, RPS have had an important effect on wind energy development in a number of states, particularly in situations where wind generation is competitive with conventional generation resources (Bird et al., 2003). The Texas RPS, in particular, has been credited for stimulating considerable renewable energy development. Capacity targets for 2003 (400 MW) and 2005 (850 MW) were met by 2001 due to the availability of outstanding wind power resources in west Texas and key provisions in the RPS.[14] Provisions judged to be the most effective in stimulating new investment included near-term purchase requirements sufficiently high to trigger market growth; requirements that apply to all electricity providers; renewable electricity certificate (REC) trading; and substantial penalties for noncompliance (but with flexibility mechanisms such as a yearly compliance period and allowance for the banking and borrowing of RECs). Electricity suppliers were also willing to sign long-term (10-25 year) contracts, ensuring more stability in the market and access to low-interest project financing. The size and scope of the Texas RPS are of sufficient scale to allow economies of scale, particularly for wind facilities (Langniss and Wiser, 2003).

A study of financial incentive programs to promote renewable energy in six states found that the programs have had mixed success, with performance affected by a number of factors (Gouchoe et al., 2002). The study found that: (1) income tax credits were not the primary

[13] For further information, see American Wind Energy Association, 2003.

[14] Annual production-based obligations for electricity retailers are derived from capacity targets for eligible new renewable sources.

motivating factor for deciding to purchase a renewable energy system and that caps on eligible costs or low maximum amounts for high-cost technologies may limit the effectiveness of tax credits; (2) rebate/buy-down programs used in three of the states significantly increased the market for solar photovoltaic systems, although offering buy-downs without an adequate number of qualified installers deterred potential purchasers; and (3) low-interest loan programs did not appear to play a large role in renewable energy market development. Other factors that influenced renewable energy investment included the level of difficulty in connecting renewable systems to the grid; the adequacy of the distributor and installer infrastructure; non-economic factors such as awareness of environmental and energy-conservation issues; interest in independence from utilities and foreign energy sources; and general awareness of renewable energy technologies. A set of complementary measures including net-metering rules, low-interest loans, tax credits, tax exemptions, and buy-downs, appears to be necessary to ensure market penetration by renewable energy technologies (Gouchoe, Everett, and Haynes, 2002).

Market-based programs that allow customer choice can also promote the development of green electricity. As of 2000, approximately one-third of US electricity customers were being given the option to purchase some type of green power product in states with competitive electricity markets, and approximately 110 megawatts of new capacity had been added or planned through green marketing programs (Swezey and Bird, 2000). Retail customers in California, New Jersey, Pennsylvania, and some New England states could purchase green power, and green electricity was being sold in wholesale markets in Illinois and New York.[15] As of 2000, green-pricing options were offered to approximately 20 percent of residential households by 80 utilities in 28 states, and resulted in a total of nearly 73 megawatts of new installed capacity, with three-quarters of this capacity installed in 1999 and plans to install another 120 MW of capacity during 2000 (Wiser, Bolinger, and Holt, 2000).

By 2003, green power marketing and green-pricing programs combined had resulted in more than 980 MW of installed new renewable capacity, with another 430 MW in the planning stage (Bird and Swezey, 2003). Two-thirds of the capacity had been installed in just four states (Kansas, Texas, Washington, Wyoming), with Washington accounting for one-third of the total. Nearly all of the new capacity resulting from green electricity marketing programs (which accounts for approximately two-thirds of total new renewable capacity) is wind power. In green-pricing programs, wind power accounts for more than three-fourths of new capacity and biomass accounts for 15 percent.

The success of the voluntary programs can be partially judged by the extent of customer participation. As of 2000, market penetration (number of participants divided by the number eligible to participate) in some utility green-pricing programs was generally around 1 percent or less, although in some cases it was as high as 4 percent (Swezey and Bird, 2001). Where a meaningful green electricity market has emerged, it appears to have resulted from government financial incentives or a high default service price (Wiser, Bolinger, and Holt, 2000).

[15] The California Public Utility Commission curtailed direct access in September 2001 because of wildly increasing wholesale electricity prices, supply shortages, and utility insolvencies, caused by poorly-designed restructuring legislation. For a discussion of the California electricity crisis, see Joskow (2001).

5 Green Electricity Development over Time

5.1 Determinants of Green Electricity Development

Many factors affect the development of the green electricity market. In addition to deliberate government policy measures to promote green electricity development, important determinants include the relative prices of conventional and renewable energy sources; consumer awareness of green power products; the institutional and regulatory environment; government policies, such as subsidies to energy sources and environmental regulations; technical issues, such as the ease of integrating new renewable energy sources into existing transmission/distribution systems; lack of consumer awareness of green power products; and political factors, including the influence of different stakeholders – e.g., utilities, trade associations, environmental organizations, labor unions, and the media – on government policies.

Economic factors – the relative price of electricity produced from renewable sources versus conventional sources – play a key role in development of green electricity markets. Costs of generating electricity from renewable sources have declined consistently over time, and the path of actual cost has equaled or been below earlier projections for that period of time (McVeigh et al., 1999). However, there have also been dramatic reductions in the cost of generating electricity using conventional resources (particularly, coal) during the last couple of decades. Furthermore, while there have been considerable technological advancements leading to improved efficiency and lower costs in green electricity technologies over the past several decades, they are still generally more costly than conventional sources of power in the United States. In 2000, price premiums for energy-based green-pricing offerings by marketers ranged from 0.4 cents/kilowatt-hour (kWh) to as much as 20.0 cents/kWh for new renewable energy content, with a median of 2.5 cents/kWh (Swezey and Bird, 2000).

Wind energy has a lower delivered cost than any other new non-hydroelectric renewable resource (Energy Information Administration, 1998; McVeigh et al., 1999). Improvements in efficiency and lower production costs for wind turbines have resulted in steadily lower costs for wind power since that time, but its ability to compete depends on the quality of the wind resource and access to transmission lines. The increasingly lower cost of wind-generated electricity coupled with federal tax incentives for wind power is making wind power the lowest-cost energy resource option in some regions of the United States (Bird et al., 2003). Recent growth in utility-scale wind energy development in a dozen states has been spurred by a combination of government policies (primarily, financial incentives and renewable portfolio standards), lower costs of wind-generated electricity, and growing consumer interest and markets for green electricity.

5.2 Regulatory changes and green electricity development

Regulatory reform and restructuring of the electricity industry play a central role in green electricity development. Two key federal laws were the 1978 Public Utility Regulatory Policies Act (PURPA) and the Energy Policy Act of 1992 (EPACT). PURPA required utilities to interconnect with and purchase electricity produced by non-utility entities. PURPA encouraged the development of small-scale electric generation facilities, particularly those using renewable resources. EPACT further opened the electricity market to wholesale generation. In 1996, FERC required utilities to open transmission lines to all electricity producers, establishing competition at the wholesale level and allowing access to alternative energy suppliers. At the state level, restructuring allowing retail customer choice began in 1996 in California and Rhode Island. Currently, about half of the states have begun electricity

industry restructuring, although the pace of restructuring has slowed in some states after difficulties in California in 2001.

Restructuring and competitive electricity markets affect the development of green electricity in several ways. Opening markets to new electricity sources creates opportunities for green electricity producers to penetrate the electricity market. As part of the restructuring process, utility distribution companies have been pressured to inform the public about alternative energy choices, which has facilitated market entry by green electricity producers and created an opportunity for more customer choice. Information provided to customers through environmental disclosure mandates and outreach programs has further enabled consumer choice. Even in states with traditional regulated utilities, green-pricing programs allow customers to support their utilities' purchase of electricity from renewable energy sources.

Increased competition in electricity markets may also have a negative effect on green electricity development. While there is evidence that US consumers are willing to pay a premium to obtain electricity produced from renewable sources (Roe et al., 2001), customers with the opportunity to choose their utility may choose among sources according to price. Renewable electricity technologies are generally characterized by relatively high capital costs and low operation and maintenance costs, making them more attractive over long time horizons and less attractive to firms facing short-term competitive pressures. Another concern is that since electricity costs do not typically reflect all costs, including environmental costs, sources that offer the lowest cost could be those that result in the most pollution. Utilities facing competitive pressure would have an incentive to turn to the cheapest source of electricity generation consistent with pollution control regulations. To the extent that prices for electricity produced from renewable technologies more fully capture external costs than prices for electricity from conventional sources, cleaner renewable electricity technologies would be at a disadvantage relative to conventional technologies in restructured, competitive electricity markets.[16]

5.3 External costs, energy subsidies, and green electricity development

External costs and energy subsidies can have an important effect on the development of green electricity markets. Part of the disparity in costs and retail prices for electricity from different energy sources is due to external costs or benefits not reflected in market prices. Differential subsidies can also produce disparities. Two types of external costs may be present in varying degrees for energy sources: external costs associated with the use of energy resources, and those associated with electricity production. Failure to properly account for these external costs creates incentives to use too much energy and to generate too much electricity using conventional energy sources.

Externalities associated with energy resource use include environmental costs from the extraction, processing, or transport of various energy sources. Examples include land degradation and leaching of mine drainage from coal mining; spills and leaks from off-shore oil extraction and transport; and the effects of hydropower facilities on water levels and marine life, including irreversible damages to unique natural environments. Another external cost associated with certain types of energy resources (for example, oil) relates to national security risks involved with importing or exporting energy resources from foreign sources.[17]

[16] Palmer et al. (2002) discuss the regional air pollution effects that could result from more competitive electricity markets.

[17] Alternatively, this could be an external benefit from the use of renewable energy sources. By adding diversity to the fuel mix and decreasing dependence on foreign energy supplies, renewable energy technologies create benefits that accrue to the general public, but not considered in private decisions.

There may also be inter-temporal externalities associated with the use of depletable natural resources, especially if property rights structures are not properly defined. To the extent that environmental damages and other external costs are not borne by the resource owner, the price of the resource will be too low and rate of use too high.

External costs from electricity generation include local, regional, and global air quality impacts on human health, agriculture, materials, and ecosystems); amenity impacts and other environmental damages associated with electrical generation facilities (e.g., noise, visual disturbances, and bird kill associated with wind power); risks of nuclear accidents; and waste disposal costs. There is no recent comprehensive assessment of such external costs in the United States, nor is there a recent study of the external costs of different types of electricity generating technologies.[18, 19] Although the environmental performance of newly constructed fossil-fueled generating facilities has dramatically improved because of pollution control regulations and technological advances, renewable technologies are still considered to be environmentally benign compared to conventional energy technologies. In a recent review of electricity externality studies, Sundqvist and Soderholm (2002) concluded that power generated with fossil fuels, particularly coal and oil, gives rise to the highest external costs, while some renewable energy sources, particularly wind and solar, gave the lowest. Utilities in many states are directed to consider environmental costs in comparing electricity supply options, and regulatory commissions in several states (including California, Massachusetts, Nevada, and New York) completed "externality adder" studies in the 1990s estimating the environmental costs from different types of electric generating facilities. However, for a variety of reasons, few measures have been enacted with the intent of directly passing environmental costs onto electricity consumers.

Subsidies to energy resources can also affect development and use of green electricity markets. Subsidies can take many forms including direct payments, tax expenditures (credits and other tax provisions), regulatory activities, provision of loans or services to energy producers or consumers, R&D support, etc. Many of the subsidies have been enacted to encourage development and production from domestic energy sources and reduce reliance on imported petroleum. One study estimated that total federal energy subsidies ranged from $27 billion to $46 billion (Alliance to Save Energy, 1993, as cited in Energy Information Administration, 1999). The Energy Information Administration estimated federal subsidies to primary energy sources including tax expenditures, direct payments to producers or consumers, and R&D expenditures to be $4.0 billion in 1999 (Energy Information Administration, 1999).[20] Virtually all of the tax expenditures were income tax provisions for fossil fuels. Renewable energy sources received approximately 25 percent of the total and 20 percent of R&D funding.

[18] See OTA (1994) and Sundqvist and Soderholm (2002) for reviews of studies of electricity externality studies.

[19] A study of the external costs of producing electricity from different energy technologies in Europe found that electricity generated from renewable energy sources consistently caused the lowest external costs while solid fossil fuels are consistently associated with the highest external costs (European Commission, 2003).

[20] This number is the cost to the federal government for subsidies that involve direct intervention in markets for primary energy sources, including direct subsidies to producers and consumers, tax expenditures, and funding for R&D. Indirect subsidies other than R&D support (e.g., loan guarantees or provision of energy at below-market prices), state and local government subsidies, and programs that cover end-use energy and electricity are not included.

5.4 Other factors affecting green electricity development

While restructuring of the electricity industry and the introduction of competition has facilitated entry by alternative energy sources, restructuring has resulted in other difficulties, particularly those relating to oversight and maintenance of interstate transmission networks. Until issues regarding responsibilities for maintaining regional transmission facilities are resolved and rules governing market access at a regional or national scale clarified, development of green electricity markets may be hindered (Wiser, Pickle, and Eto, 1998). Other factors that have limited mark entry by renewables included the low cost of utility default service, protracted direct access phase-in that favors larger customers, high fees for noncompetitive services imposed on marketers by electricity distributors, lack of uniformity and consistency of operational rules across utility service territories, difficulties related to recovery of stranded costs (costs incurred by electric utilities but not recoverable if customers choose other suppliers), and insufficient unbundling of services such as billing, metering, collections, and customer service (Wiser, Pickle, and Eto, 1998).

Infrastructure issues can also affect green electricity market development. For example, the ease of connecting small-scale renewable energy systems to the utility grid can influence the market for renewable energy products. In cases where the interconnection process is burdensome and costly – for example, in the state of New York – the installation of grid-connected renewable technologies can be severely compromised (Gouchoe, Everette, and Haynes, 2002). Shortages of qualified installers and building inspectors unfamiliar with renewable energy technologies can also influence consumer demand for green electricity products.

Consumer awareness of and ability to purchase green power products also plays an important role in development of green electricity. Numerous studies have found a lack of understanding of renewable energy technologies, although consumers who have purchased green products through financial incentive programs has a long-standing interest in renewable energy and were strongly motivated by non-economic factors including environmental concerns, a desire to reduce dependence on utilities, and security threats (Gouchoe, Everette, and Haynes, 2002). At the same time, there is evidence that US consumers are willing to pay more for green power products (e.g., Roe et al., 2003). Until recently, most US electricity customers have not had been able to participate in green electricity markets, and currently that opportunity is limited to electricity customers in about 30 states.

Development of green electricity markets can also be influenced by stakeholder pressures on the political and regulatory processes, both at the federal and state level. It is well known that conventional energy industry constituencies exert an important influence on federal policy. While there is continuing debate about issues like whether greenhouse gas emissions should be controlled or whether exploration for new sources of oil should be allowed in sensitive natural areas, the prevailing view at the federal level favors continued growth in energy use. While US environmental regulations are relatively stringent, it is clear that there are significant external costs from current methods of electricity production and levels of energy use that are not reflected in current market prices. While some state governments have aggressively promoted green electricity development, there are both practical and legal constraints to their ability to do so.

6 Conclusions

Despite federal and state policies to promote greater electricity production from renewable sources, the relative share of electricity produced from renewable energy sources has remained virtually constant in the United States from 1990 to the present. Electricity produced from non-hydro renewable sources currently accounts for about 2 percent of the

nation's electricity production and renewables' share of electricity production is not expected to grow significantly in the future.

Governments at the federal, state, and local levels have acted to promote renewable energy technologies in the form of financial incentives, rules and regulations, and measures to encourage customer choice of green power, but most of these policies are in the early stages of implementation. Furthermore, while the cost of generating electricity from renewable energy sources has decreased over time, so too has the cost of producing electricity from conventional sources. Thus, various policy measures to promote electricity from renewable energy sources may have played an important role despite the lack of market penetration by green sources.

Financial incentives, used in conjunction with mandatory regulations such as net metering rules and renewable portfolio standards, appear to have been effective in increasing the use of renewable energy technologies. Public benefits funds (supported by surcharges on electricity users) are also considered to be effective in promoting greater use of green power. Recent efforts to extend customer choice, particularly green electricity marketing, while not as effective as regulations and financial incentives in the near term, are considered to be important for long-term development of the green electricity industry.

Competition at the retail level in many states has opened markets for new electricity sources, allowing customers to purchase electricity produced from green sources through their electricity supplier or by purchasing renewable energy certificates. Education programs by public authorities, green electricity marketers, and green electricity trade groups are being offered in many states to develop green electricity markets. Nonutility producers have been steadily increasing their role in electricity supply due to new laws and regulatory orders that have opened transmission lines and encouraged competitive wholesale electricity trade.

While restructuring of the electric utility industry and various government policy measures have given impetus to alternative energy sources, various impediments to green electricity markets remain. The most important barriers include the relatively high cost of electricity from renewable energy sources; price distortions due to external costs or direct subsidies not reflected in market prices for electricity produced using different generating technologies; lack of consumer awareness about customer choice and green power products; and the relative abundance of coal and other conventional energy sources. Absent significant increases in prices of fossil fuels, much more stringent environmental regulations, or significant changes in electricity customer preferences, green electricity markets are likely to develop slowly in the United States, especially in competitive markets where there is a premium on near-term cost minimization.

Appendix A

Table A-1. Electricity Net Generation From Renewable Energy Sources by Energy Use Sector and Energy Source, 1997-2001 (thousand Kilowatt-hours)

Sector and Source	R1997	R1998	R1999	2000	P2001
Total	*457,181,198*	*422,093,324*	*419,006,721*	*382,512,277*	*312,767,216*
Biomass	58,657,514	58,786,319	59,612,909	60,727,650	59,640,051
Wood/Wood Waste	36,948,441	36,338,384	37,040,734	37,594,866	36,871,734
MSW/Landfill Gas	19,276,887	19,930,525	20,072,515	20,304,943	20,018,830
Other Biomass [a]	2,432,186	2,517,410	2,499,660	2,827,841	2,749,487
Geothermal	14,742,595	14,819,063	14,857,542	14,093,158	13,901,229
Conventional Hydroelectric	379,981,886	344,959,773	339,553,190	301,604,833	232,949,965
Solar	511,168	502,473	495,082	493,375	494,158
Wind	3,288,035	3,025,696	4,487,998	5,593,261	5,781,813
Commercial	2,505,414	2,493,233	2,527,119	2,111,620	2,063,254
Biomass	2,385,222	2,372,765	2,412,456	2,011,871	1,963,505
Wood/Wood Waste	43,193	37,716	19,671	26,958	19,523
MSW/Landfill Gas	1,992,309	2,020,757	2,041,934	1,601,152	1,539,085
Other Biomass [a]	349,720	314,292	350,851	383,761	404,897
Conventional Hydroelectric	120,192	120,468	114,663	99,749	99,749
Industrial	34,792,639	33,920,823	33,505,006	33,626,304	32,361,740
Biomass	29,107,498	28,572,250	28,746,698	29,491,149	28,739,925
Wood/Wood Waste	28,225,019	27,692,538	28,060,358	28,651,835	27,735,132
MSW/Landfill Gas	104,281	15,637	20,516	30,858	61,286
Other Biomass [a]	778,198	864,075	665,824	808,456	943,507
Conventional Hydroelectric	5,685,141	5,348,573	4,758,308	4,135,155	3,621,815
Electric Power [b]	396,338,061	364,010,011	362,926,906	320,742,117	262,853,221
Biomass	27,164,794	27,841,304	28,453,755	29,224,630	28,936,621
Wood/Wood Waste	8,680,229	8,608,130	8,960,705	8,916,073	9,117,079
MSW/Landfill Gas	17,180,297	17,894,131	18,010,065	18,672,933	18,418,459
Other Biomass [a]	1,304,268	1,339,043	1,482,985	1,635,624	1,401,083
Geothermal	14,726,102	14,773,918	14,827,013	14,093,158	13,812,908
Conventional Hydroelectric	350,647,962	317,866,620	314,663,058	271,337,693	213,827,721
Solar	511,168	502,473	495,082	493,375	494,158

Wind	3,288,035	3,025,696	4,487,998	5,593,261	5,781,813
Net Renewable Energy Imports	23,545,084	21,669,257	20,047,690	26,032,236	15,489,001
Geothermal	16,493	45,145	30,529	--	88,321
Conventional Hydroelectric	27,095,696	26,025,972	27,042,653	31,422,294	23,610,560
Conventional Hydroelectric (Exports)	3,567,105	4,401,860	7,025,492	5,390,058	8,209,880

[a] Agriculture byproducts/crops, sludge waste, tires, and other biomass solids, liquids and gases.

[b] Includes electric utilities and independent power producers.

R=Revised. Definitions of the electric power, industrial, and commercial sectors are changed and electricity data is revised. See Appendix F for details.

P=Preliminary.

-- = Not applicable.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Domestic Sectors: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report," Form EIA-867, "Annual Nonutility Power Producer Report," Form EIA-860B, "Annual Electric Generator Report - Nonutility," and Form EIA-906, "Power Plant Report;" Net Imports: National Energy Board of Canada and California Energy Commission.

Source: Energy Information Administration, 2002, Table 4.

Table A-2. US Renewable Energy Generation* Forecasts to 2025 (Billion Kilowatt-hours)

Year	Conventional Hydropower	Geothermal	Biomass and Wood	Solar Photovoltaic	Wind	Total
2000	271.03	14.09	37.85	0.01	5.59	328.57
2001	213.82	13.81	38.05	0.02	5.78	271.48
2002	258.60	13.78	41.37	0.13	12.16	326.04
2003	296.33	13.85	42.91	0.18	16.70	369.97
2004	301.66	13.97	25.68	0.25	18.02	359.58
2005	301.77	15.31	50.03	0.33	19.28	386.72
2006	302.12	16.44	52.01	0.43	20.53	391.53
2007	302.22	17.81	52.87	0.55	21.50	394.95
2008	302.12	18.63	54.42	0.68	21.82	397.67
2009	302.05	19.16	56.15	0.86	23.21	401.43
2010	301.89	19.81	58.50	1.06	23.62	404.88
2011	301.70	20.98	60.43	1.11	24.49	408.71
2012	301.62	21.42	61.72	1.18	25.19	411.13
2013	301.57	22.54	63.08	1.23	26.52	414.94
2014	301.51	23.45	64.37	1.30	27.66	418.29
2015	301.41	24.33	65.43	1.40	29.14	421.71
2016	301.34	25.71	66.17	1.51	29.64	424.37
2017	301.26	26.11	65.05	1.61	30.84	424.87
2018	301.21	27.09	68.05	1.72	31.20	429.27
2019	301.12	29.18	69.19	1.82	32.21	433.52
2020	301.05	31.78	70.09	1.99	32.70	437.61
2021	301.10	32.70	71.10	2.16	33.65	440.71
2022	301.16	33.41	72.65	2.33	34.14	443.69
2023	301.22	34.08	74.40	2.51	35.35	447.56
2024	301.28	35.48	76.47	2.69	35.69	451.61
2025	301.34	36.92	78.46	2.86	36.21	455.79

*Electric Power Sector and End Use Sector combined.

Source: Energy Information Administration, 2003a.

Appendix B

Policies for Promoting Renewable Electricity in Case Study States

The following sections discuss policies adopted in California, Minnesota, New York, and Texas to promote green electricity. These states were selected for further study because they represent different regions of the country and have different resource endowments, political interests, and regulatory environments. Summary information about financial incentives, rules and regulations, and market-based policies used in the four states is presented at the end of this appendix, in Tables B.1, B.2, and B.3. The information that follows comes primarily from the Database of State Incentives for Renewable Energy (North Carolina Solar Center, 2003) and State Energy Information (Energy Information Administration, 2003h).

California

California has abundant renewable energy resources including geothermal sites, inland wind passes, significant landfill gas, and large biomass potential from agriculture and forestry residue (Bolinger and Wiser, 2001). Total electricity generation in California in 2000 was 262,225,213 MWh. Hydropower accounted for 19 percent of electricity generated in the state; all other renewable sources accounted for 10 percent. Investor-owned utilities account for about three-fourths of total electricity sales in the state. In 2003, electricity generated from renewable energy sources other than hydropower accounted for 10.3 percent of total sales in California (Deyette, Clemmer, and Donovan, 2003).

California has more financial incentives, rules, and voluntary measures to promote green power than any other state. California's renewables portfolio standard is the most aggressive in the county. The state's clean energy fund (Renewable Resources Trust Fund) – the largest in the country – was first established in 1996 in conjunction with electric industry restructuring legislation requiring that $540 million be collected with a surcharge on electricity sales to customers of the state's three investor-owned utilities – Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric – between 1998 and 2002. Legislation passed in 2001 extended the funding through 2012. The funding is administered by the California Energy Commission to support existing and new renewable technology projects with production incentives, emerging technologies with rebates (or buy-downs), and green power with credits (1cent/kWh) for purchases of green power through the competitive market by residential and small commercial customers (Bolinger and Wiser, 2001).

California was the first state in the nation to restructure its electric utility industry. Retail competition was first implemented in California on April 1, 1998, and had been one of the most aggressive states in providing direct access and green power marketing (Bolinger et al., 2001). However, in September 2001, the California Public Utilities Commission repealed direct access following wildly increasing wholesale electricity prices caused by a severe curtailment of generating capacity and poorly-designed deregulation policy that: (1) forced all utilities to divest themselves of their generation assets; (2) capped electricity prices until all the assets were divested; and (3) forced utilities to buy power on spot markets rather than with long-term contracts (Joskow, 2001). At one point, about 3 per cent of California customers had switched to an alternative electricity supplier, many of which were selling green power (National Renewable Energy Laboratory, 2003). Currently, a few green power marketers continue to serve existing customers.

The principal financial incentives currently used statewide in California include (date of implementation in parentheses):

- corporate/personal income tax credits (lesser of 15 percent of project costs and $4.50/Watt) for commercial/residential investments in solar photovoltaics and wind energy with peak generating capacity up to 200 kilowatts of installed capacity (1/1/01).
- property tax exemptions for active solar energy systems, including those used for production of electricity ((1/1/99).
- low-interest industrial development loans to manufacturers for the purchase of renewable energy systems or manufacturers of renewable energy systems expanding or establishing production facilities in California (3/14/02).
- rebates/buy-downs for new investments in solar photovoltaic, wind power, and fuel cells (30 kW or less) to all grid-connected utility customers served by investor-owned utilities, Pacific Gas and Electric, San Diego Gas and Electric, and Southern California Edison (3/98).
- low-interest loans/rebates/buy-downs to public utility customers for investments in solar photovoltaics (1999, 2002).

The principal statewide regulations in California include:

- the most aggressive renewables portfolio standard in the country, requiring the state's three largest investor-owned utilities to purchase 20 percent of their electricity from renewable sources by 2017 (1/1/03).
- net-metering rules requiring all investor-owned utilities to allow net metering for all customer classes for systems up to 1 MW (1/1/96).
- generation fuel disclosure rules requiring all California energy suppliers to disclose the energy resource mix at least four times per year. The Green-e Renewable Branding program is being used to certify renewable energy sources (1/1/98).
- surcharges on electricity levied on customers of the state's three investor-owned utilities to fund the Renewable Resources Trust Fund (1996).
- a solar access law to insure that proper sunlight is available to those who operate solar energy systems (1994).
- wind access laws to insure that any ordinances adopted by local agencies do not unreasonably restrict the ability of homeowners, farms, and small businesses to operate wind energy systems outside of urban areas (10/15/01).

In addition to these statewide policy measures, a number of other measures have been adopted at the local level by governments or municipal utilities, including:

- financial incentives, including rebates and buy-downs for renewable energy investments offered to customers by several municipal utilities.
- regulations, including construction/design standards requiring the use of renewable energy in new buildings, green power purchasing requirements (Los Angeles, Oakland, and Santa Monica), and local zoning regulations requiring that potential impacts on solar access be minimized.
- voluntary measures, including green-pricing programs offered by six utilities and participation in the Million Solar Roofs Initiative by a number of cities (including San Diego, San Francisco, and San Jose) and the California Clean Energy Partnership.

Minnesota

In 2003, electricity generated from renewable energy sources other than hydropower accounted for 2.7 percent of total sales in Minnesota (Deyette, Clemmer, and Donovan, 2003). Wind and biomass resources provide Minnesota's greatest technical potential, and its policies place particular emphasis on promoting wind power. Total electricity generation in Minnesota in 2000 was 65,935,594 MWh. Hydropower accounted for 2 percent of electricity generated in the state; all other renewable sources generated 4 percent of the total. Although four investor-owned utilities in Minnesota account for about 70 percent of total electricity sale, Xcel Energy is the state's largest electricity generator, producing about 60 percent of total electricity generated in Minnesota in 2000.

The principal financial incentives currently used statewide in Minnesota include (date of implementation in parentheses):

- production incentives (1.5 cent per kilowatt hour) for energy produced from qualifying green energy sources (wind < 2MW in capacity, hydro, and on-farm anaerobic methane digesters) until new wind capacity statewide totals 100MW (1/1/97).
- sales tax exemptions on purchases of photovoltaic systems ((8/1/01) and wind systems (7/1/98).
- property tax exemptions for value added by photovoltaics and wind energy systems (1/1/92).
- low-interest loans for agricultural investments in wind energy systems (1/1/95).
- rebates (funded by Xcel Energy) for new investments in grid-connected solar photovoltaic systems (3/98).
- low-interest loans/rebates/buy-downs to public utility customers for investments in solar photovoltaics (1999, 2002).
- production incentives through the Mainstay Energy Rewards Program that offer customers who install renewable energy systems the opportunity to sell the green tags associated with the electricity generated by these systems (2003).

The principal statewide regulations to promote green power in Minnesota include:

- the Renewable Energy Objective, a non-binding renewables portfolio standard suggesting that utilities "make a good faith effort" to generate or procure at least 1 percent of total electricity from photovoltaic, wind, hydro, and biomass sources by 2005, and 10 percent by 2015 (2001).
- a legislative mandate that Xcel Energy build or purchase 425 MW of new wind power and 125MW of biomass by 2002 and an additional 400 MW by 2006 (7/1/97, amended in 2003).
- net-metering rules applicable to all investor-owned utilities, municipalities, and rural electricity cooperatives (1/1/83).
- fuel and emissions disclosure requirements for regulated utilities ((9/3/02).
- a requirement that all electric utilities must give customers the option to purchase power from green energy sources (10/2001).
- a requirement that Xcel Energy pay $16 million annually into a Renewable Development Fund to be used for research and development of qualifying renewable energy resources in the state (2001).
- solar and wind access laws to insure that proper access is available to those who operate solar and wind energy systems (1/1/78).

Green pricing is the principal voluntary measure used in Minnesota to promote green electricity. While some utilities had offered green pricing since 1997, all electric utilities have been required to offer Minnesota customers green power choices since 2001. Green-pricing programs are offered by the four investor-owned utilities in the state (Alliant Energy, Minnesota Power, Ottertail Power, and Xcel Energy), thirteen of seventeen rural electric cooperatives, and two municipal power agencies. In virtually all of the programs, wind is the only qualifying technology. The typical charge is 2.5 cents per kWh for a 100 kWh/month block of green power (the average price of electricity is about 7 cents/kWh).

New York

New York is the third most populous state in the nation and ranks eighth in terms of residential electricity sales. The electricity generation base in New York is currently divided relatively equally among nuclear, hydro, coal, and gas (20-25 percent each), with oil accounting for about 12 percent. The state has significant hydropower potential (largely utilized), good wind potential in certain regions, significant biomass and landfill gas potential, and a relatively poor solar resource (Bolinger and Weiss, 2001). Total electricity generation in New York in 2000 was 133,251,253 MWh. Hydropower accounted for 18 percent of electricity generated in the state; other renewable sources accounted for 2 percent. In 2003, electricity generated from renewable energy sources other than hydropower accounted for 0.8 percent of total sales in New York (Deyette, Clemmer, and Donovan, 2003).

The state's principal regulatory agency, the Public Service Commission (PSC), opened the state's electricity industry to competition in 1998, allowing customers to choose to buy their electricity from new producers known as energy service companies, which include green sources. The PSC regulates the state's six investor-owned utilities, which account for about 70 percent of electricity sales in the state and is taking an active role in promoting voluntary green electricity measures. In February 2003, the PSC instituted a proceeding to develop and implement a renewables portfolio standard. The New York State Energy Research and Development Authority also plays an important role in promoting green power and administers the state's renewable electricity fund.

The principal financial incentives currently used statewide in New York are:

- personal and corporate income tax credits for installation of photovoltaics and fuel cells in "green" buildings (2000).
- personal income tax credit for residential investments in solar photovoltaic electric generating equipment (8/2/97).
- property tax exemptions for value added by commercial, industrial, residential, and agricultural investments in solar photovoltaic, wind, and biomass systems (7/1/88).
- grants from NYSERDA to support R&D in support of power systems, distributed generation, and combined heat/power technologies (2003).
- grants from NYSERDA to assist companies in the development, testing, and commercialization of renewable energy technologies that will be manufactured in the state (2003).
- low-interest loans for renovation or construction projects that incorporate qualifying renewable energy systems (2001).
- rebates for new investments in solar photovoltaic systems (10/28/02).
- production incentives through the Mainstay Energy Rewards Program that offer customers who install renewable energy systems the opportunity to sell the green tags associated with the electricity generated by these systems (2003).

The principal statewide regulations to promote green power in New York include:

- a requirement that all state buildings procure a certain percentage of their electric power from qualifying renewable energy sources (10 percent by 2005 and 20 percent by 2010) (6/10/01).
- a requirement that all electricity providers give information to customers at least twice annually regarding the fuel mix and environmental impacts of electricity products (12/15/98).
- net-metering rules for residential photovoltaic systems of 10kW or less (8/2/97) and for qualifying biogas systems on farms (9/17/02).
- fuel and emissions disclosure requirements for regulated utilities (9/3/02).
- technical standards that must be met for interconnecting net-metered distributed generation systems (12/1999).
- a systems benefits charge (0.6 mill/kWh) for customers of the state's six investor-owned utilities in support of a public benefits fund (1998) power from green energy sources (10/2001).

Voluntary measures used in the state to promote green electricity include education, training, and outreach programs developed by NYSERDA. Green power choice programs have been adopted by a number of utilities, giving electricity customers access to new energy suppliers known as energy service companies.

Other measures that have been adopted by non-state governments or municipal utilities include:

- rebates for commercial and residential installations of solar photovoltaic systems <10 kW by the Long Island Power Authority (1999).
- participation in the Million Solar Roofs Initiative (Long Island Solar Roofs Initiative (2000).

Texas

Texas is the nation's leading state in electricity generation and sales. In 2000, total electricity generation in the state was 346,064,362 MWh. Hydropower and all other renewable energy sources accounted for less than 1 percent of electricity generated in the state. There are ten investor-owned utilities in the state that account for about 80 percent of electricity sales. In 2003, electricity generated from renewable energy sources other than hydropower accounted for 1.5 percent of total sales (Deyette, Clemmer, and Donovan, 2003). The most abundant green energy resources in Texas are solar and wind.

While there are a mix of financial incentives, regulations, and voluntary measures in Texas to promote green electricity, the principal policy instrument is a renewable portfolio standard that was adopted in 1999 and implemented in 2002, when Texas officially opened its electricity market to retail competition. The RPS imposes energy-based purchase obligations on all electricity retailers based on targets of 400 MW of new renewable capacity by 2003, 850 MW by 2005, 1400 MW by 2007, and 2000 MW by 2009, while preserving the 880 MW of capacity already on line. This is expected to result in a renewable electricity share of 2.2 percent of total electricity sales by 2009 (Langliss and Wiser, 2003). Qualifying technologies include photovoltaics, wind, landfill gas, biomass, hydro, geothermal electric, wave, and tidal. Tradable renewable electricity credits (REC) are used to provide flexibility and lower the cost of meeting the standard. REC are issued for each megawatt-hour produced from eligible renewable energy sources and can be banked for up to 2 years, traded, or used by electricity retailers to meet their annual renewable production requirements. Texas does not have a system benefits charge or public benefits funding.

The principal financial incentives currently used statewide in Texas are:

- corporate tax deductions for installation of photovoltaic, wind, and biomass devices (1981).
- franchise tax exemptions for manufacturers of photovoltaic systems (1981).
- property tax exemptions for residential investments in photovoltaics and wind energy systems (1981).
- production incentives through the Mainstay Energy Rewards Program that offer customers who install renewable energy systems the opportunity to sell the green tags associated with the electricity generated by these systems (2003).

The principal statewide regulations to promote green power in Texas include:

- a renewable generation requirement of 400 MW by 2003, increasing to 2000MW by 2009 applicable to all electric utilities (1/10/2000).
- net metering rules requiring certain utilities to offer a net metering option to qualified facilities of 50kW or less (9/23/85).
- technical standards that must be met for interconnecting generation systems up to 10 MW of capacity to the grid (12/21/99).
- a requirement that retail electricity provider information to customers including sources of generation and emissions levels (1/1/02).
- a requirement that state government departments compare the cost of alternative energy sources in all new and reconstructed state buildings (5/5/95).

A number of utilities in the state have adopted green pricing programs, including Austin Energy's GreenChoice program, adopted in 2000, that allows residential and commercial customers and schools to replace their standard (fossil) fuel charge on their electricity bill with a GreenChoice power charge of 2.85 cents per kWh that will remain fixed for a period of 10 years. Green pricing programs adopted by utilities in El Paso in 2001and San Antonio in 2000 allow customers to purchase wind power in 100 kWh blocks.

Table B-1. Financial Incentives in Four Case Study States, 2003

Incentive	California	Minnesota	New York	Texas
Personal Tax Incentive	S		S	
Corporate Tax Incentive	S		S	S
Sales Tax Exemption		S		
Property Tax Exemption	S	S	S	S
Rebate/buy-down Programs	S,U	S	S,U	U
Grants	S		S	
Loan Programs	S,U	S	S	
Industry Recruitment Programs	S			S,L
Leasing/ Purchase Programs	U			U
Production Incentives		S		

S=State, U=Utility, L=Local

Table B-2. Rules and Regulations in Four Case Study States, 2003

Incentive	California	Minnesota	New York	Texas
Renewable Electricity Fund	S	S	S	
Generation Disclosure Rules	S	S	S	S
Renewable Portfolio Standards	S	S		S,L
Net-metering Rules	S	S	S	S,U
Line Extension Analysis Requirements				S
Contractor Licensing Requirements	S			
Equipment Certification Requirements		S		
Solar Access Laws	S,L	S	S	
Construction & Design Standards	S,U,L	S		S
Green Power Purchase Requirements	L		S	
Mandatory Green Power Option		S		

S=State, U=Utility, L=Local

Table B-3. Voluntary Measures in Four Case Study States, 2003

Incentive	California	Minnesota	New York	*Texas*
Green-Price/choice Programs	U	U	U	U
Installer Certification Programs	S		S	S
Outreach Programs	S,L		S,L	S

S=State, U=Utility, L=Local

Source: North Carolina Solar Center, 2003.

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