Background Papers on Panel Topics

prepared for

The Search for Wise Energy Policy

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Preface

This series of background papers was prepared by a team of graduate students in the School of Public and Environmental Affairs (SPEA) at Indiana University in support of the conference "*the Search for Wise Energy Policy.*" This conference was organized by SPEA and is scheduled for June 11, 2009 in the Mayflower Hotel in Washington, D.C.

The primary purpose of these papers is to provide background information related to most of the primary topics of the conference. The students were asked to review the appropriate literature and web sites in each of seven areas of energy policy and to prepare fairly concise review articles for use of the panelists. These papers have not yet been subjected to expert peer review. The opinions expressed are those of the individual authors, not the School of Public and Environmental Affairs or Indiana University.

This team of students was supervised by Professors Evan Ringquist and J.C. Randolph. Any omissions or errors are the responsibility of this team.

Panel 2: Changing Patterns in Energy Supply

A. Renewable Energy Sources – *Elizabeth Baldwin*

1.0 The Context for Renewable Energy

Current goals of energy policy in the United States include reduced carbon dioxide emissions and increased domestic energy production. Renewable energy resources offer advantages in both of these areas when compared with fossil fuels. The next several years will offer unprecedented opportunities to make renewable energy a significant portion of the US energy mix, particularly in the electric sector. In the near future, the US electric industry will replace significant portions of its aging power plants and update its transmission system to use 21st century information technology. At the same time, regulators are re-thinking the way electricity is used and the way electricity rates are set. These changes present an opportunity for policy-makers to think about the role that renewable electricity should play in the US energy mix, and to adopt cost-effective policies that allow renewable energy to play that role.

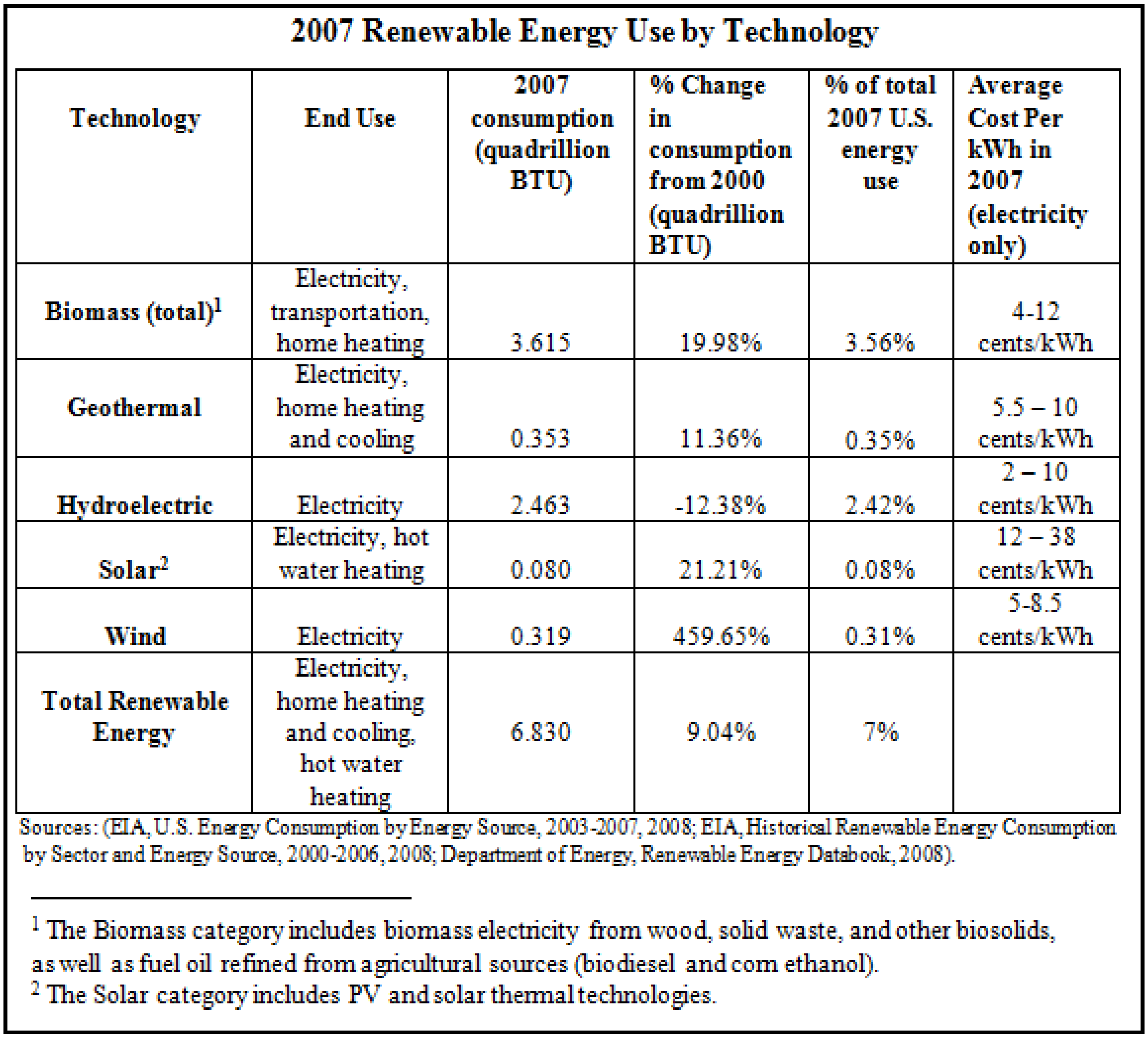
1.1 Renewable Energy Defined

Renewable energy resources are naturally replenished in a relatively short period of time. The major sources of renewable energy that are commercially viable using current technologies are biomass, conventional hydropower, geothermal energy, wind energy, and solar energy. Table 1.1 lists these sources and their contribution to the national energy mix in 2007. A more detailed description of these renewable energy sources, along with potential renewable energy sources in development, is in Appendix One.

Renewable energy policy in the U.S. is made at both the state and national levels, and these policies may differ significantly in what technologies are considered “renewable.” Conventional hydroelectric power and municipal solid waste (MSW) incineration in particular have been criticized as having a negative environmental impact, and many policies exclude these sources of renewable energy. The focus of this paper is on policies to promote non-hydro, non-MSW sources of renewable energy.

A key feature that distinguishes renewable energy from fossil fuels is that it is suitable for small, medium and large-scale generation. Small-scale wind and solar energy facilities can be installed by customers to feed into the electricity grid, providing a source of “distributed generation” that is not subject to the line losses associated with bringing distant electricity into population centers. Distributed generation currently makes up about 10% of total renewable energy production. (EIA 2009).

Table 1.1: 2007 Renewable Energy Use by Technology



2007 Renewable Energy Use by Technology

Technology	End Use	2007 consumption (quadrillion BTU)	% Change in consumption from 2000 (quadrillion BTU)	% of total 2007 U.S. energy use	Average Cost Per kWh in 2007 (electricity only)
Biomass (total)[1]	Electricity, transportation, home heating	3.615	19.98%	3.56%	4-12 cents/kWh
Geothermal	Electricity, home heating and cooling	0.353	11.36%	0.35%	5.5 – 10 cents/kWh
Hydroelectric	Electricity	2.463	-12.38%	2.42%	2 – 10 cents/kWh
Solar[2]	Electricity, hot water heating	0.080	21.21%	0.08%	12 – 38 cents/kWh
Wind	Electricity	0.319	459.65%	0.31%	5-8.5 cents/kWh
Total Renewable Energy	Electricity, home heating and cooling, hot water heating	6.830	9.04%	7%	

Sources: (EIA, U.S. Energy Consumption by Energy Source, 2003-2007, 2008; EIA, Historical Renewable Energy Consumption by Sector and Energy Source, 2000-2006, 2008; Department of Energy, Renewable Energy Databook, 2008).

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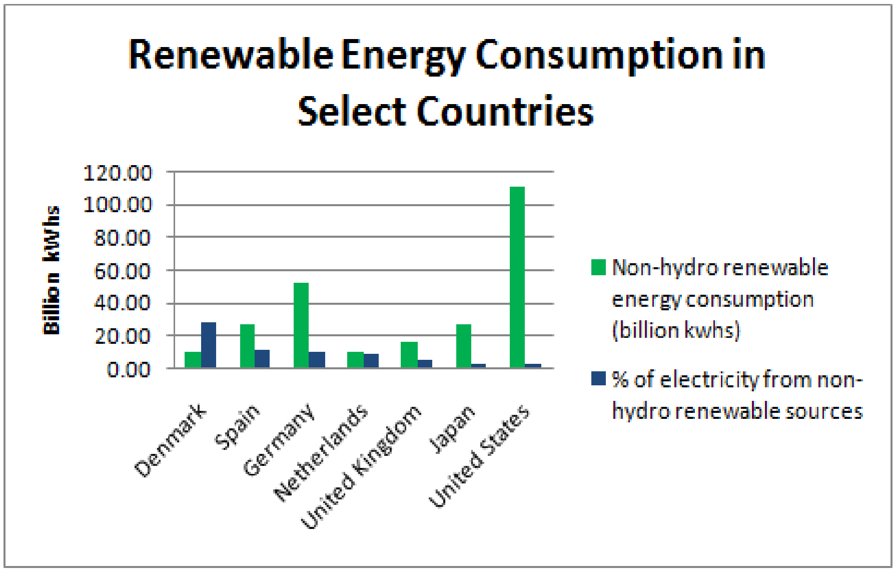
[1] The Biomass category includes biomass electricity from wood, solid waste, and other biosolids, as well as fuel oil refined from agricultural sources (biodiesel and corn ethanol).

[2] The Solar category includes PV and solar thermal technologies.

1.2 International Experience

Internationally, several countries have significant experience with renewable energy. As seen in Figure 1.1, the United States leads the rest of the world in renewable energy production and consumption, but lags behind other countries in the percentage of electricity that comes from non-hydro renewable energy sources. While some nations (principally Denmark) are particularly well-suited for technologies such as wind generation, other countries such as Spain and Germany are no better-suited for renewable energy than the U.S. is, yet have managed to procure a much greater percentage of their electricity mix from renewable sources compared with the U.S.

Figure 1.1: International Renewable Energy Consumption

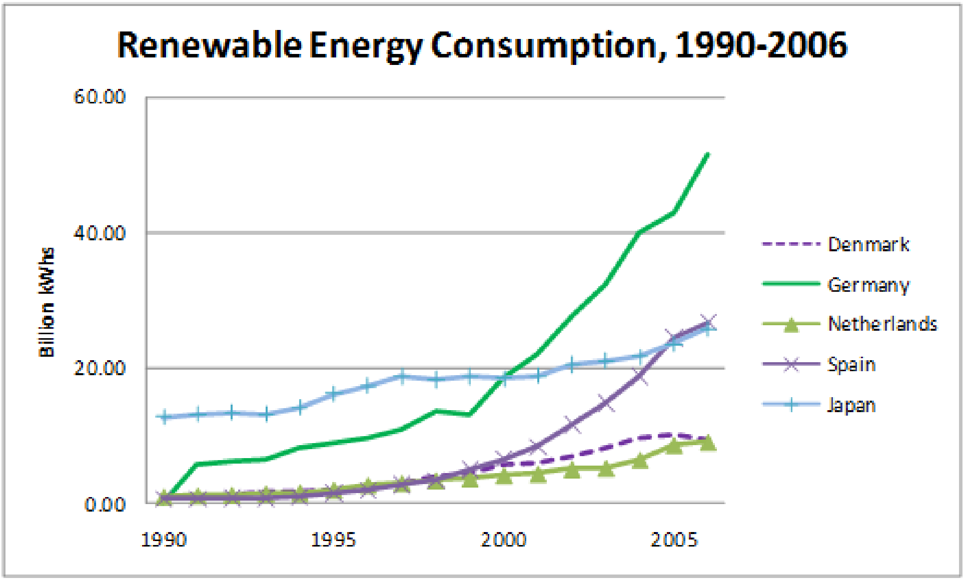


Source: EIA, World Net Geothermal, Solar, Wind, and Wood and Waste Electric Power Consumption 1980-2006 (2008).

The international experience illustrates that it is both possible and feasible to obtain significant amounts of a nation's electricity from renewable energy sources.

The international experience also shows that significant increases in renewable energy production and consumption may be achieved quickly, given adequate levels of policy support. As Figure 1.2 shows, Spain and Germany in particular experienced sharp increases in renewable energy consumption since 2000. The policies these countries have used to promote renewable energy may be instructive for the US. Appendix Two summarizes the average increase in renewable energy use in selected countries, and lists some of the policy approaches that have been used in those countries.

Figure 1.2: Trends in International Renewable Energy Consumption



Source: EIA, World Net Geothermal, Solar, Wind, and Wood and Waste Electric Power Consumption 1980-2006 (2008).

2.0 Changing Patterns of Renewable Energy Use

2.1 Renewable Energy Use – Current and Potential

Non-hydroelectric renewable energy currently meets less than 2% of US electricity needs. If current state and federal policies are extended as planned, non-hydro renewable energy will meet about 8% of the nation's electricity needs by 2030. (EIA, 2009). This projected usage falls far short of the total renewable energy resource potential. A recently released report from the Department of Interior estimates that offshore wind alone could provide the U.S. with over 3,500 terawatt hours (TWh)[1] per year. (DOI, 2009). This amount is roughly equal to the 3,670 TWhs of electricity that were consumed in the U.S. in 2006. (EIA, 2009).

There are essentially three different types of renewable electricity potential that are useful for policy makers to consider. *Theoretical potential* is a measure of the entire renewable resource. *Technical potential* measures the renewable resources that could be built on accessible land (e.g., not protected for environmental reasons or otherwise restricted from development). *Economic potential* refers to renewable energy that could be installed at a lifetime cost less than current generation and planned projects.

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[1] One terawatt hour is equivalent to one billion kilowatt hours.

Potential may be limited, however, by the grid's ability to accommodate renewable energy, particularly wind and solar, which produce electricity intermittently. When these resources are not producing electricity, the grid must turn to other resources to provide constant flows of electricity. Using current technologies, the Department of Energy estimates that renewable energy could reliably provide at least 20% of U.S. energy needs. Changes in technology and grid improvements could allow greater renewable energy penetration, although the costs to operate the system increase as the percentage of renewable energy increases. (Department of Energy, 2008).

Even excluding the offshore wind resource, the nation's onshore renewable energy potential remains largely untapped.[2] State and regional potential assessments consistently indicate that the renewable energy resource can meet significant portions of electricity needs. A study by the Massachusetts Department of Energy Resources (DOER), for example, found that Massachusetts has 16,950 MW of technical potential capacity in the state, and would have 3,529 MW of economic potential by 2020. (DOER, 2008). These numbers are significant when compared to Massachusetts' current nameplate capacity of 15,690 MW. (EIA, 2009). Studies in other states and regions also show that renewable energy can be a significant part of state and regional energy mixes. (Navigant Consulting, 2008).

In 2008, the U.S. consumed 9 billion gallons of corn ethanol and roughly 400 million gallons of biodiesel. (Congressional Budget Office, 2009; Westhoff, 2008). The Department of Energy has estimated that agricultural and forestry feedstocks could theoretically produce 42 billion gallons of biofuel annually, equivalent to about one-third of transportation fuel use in 2004. (Congressional Research Service, 2008). However, this figure does not reflect the more realistic technical potential that might be available considering current and potential environmental restrictions on production of biofuel feedstocks. In addition, potential is limited by refinery capacity to turn feedstocks into biofuels. Current refinery capacity is 15 billion gallons annually. (Congressional Budget Office, 2009).

2.2 Barriers to Achieving the Full Potential from Renewable Energy

There are four main barriers to increased use of renewable energy.

Profitability barriers reflect the fact that renewable energy investments are not always profitable in current energy markets. Economic uncertainty is a significant barrier for new investment in renewable energy – investors need to be certain about the total payoff and the time-frame in which a project will become profitable. Because renewable energy is well-suited to small-scale, medium-scale, and large-scale installations on both sides of the utility meter, profitability barriers must be addressed for utilities, merchant generators, and residential, commercial, and industrial customers. Profitability barriers cannot always be overcome by pricing alone. For example, residential customers need sufficient access to capital before they can invest in renewable energy, even if they are certain to realize significant profits within 10 years. Similarly, utilities need ratemaking structures that make renewable energy more profitable than investments in fossil-fuel plants. Addressing profitability requires a comprehensive set of policies specifically tailored to the stakeholders who will decide whether to invest in renewable energy.

In the case of biofuels, profitability barriers are closely linked to technology barriers. Current production processes are too expensive to make biodiesel and corn ethanol production economically viable without

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[2] There are no comprehensive national assessments of renewable energy potential available at this time. The National Renewable Energy Laboratory is conducting a nationwide potential study, but it was not available at time of publication.

federal subsidies. However, advances in distillation technology are expected to make cellulosic ethanol – a fuel distilled from the entire feedstock plant, rather than from corn kernels or soybeans – commercially profitable in the near future.

Regulatory barriers are legal and regulatory hurdles that might prevent or delay renewable energy projects. These include lack of access to the electric grid; lack of access to suitable locations; regulatory delays in the siting and permitting processes; and local opposition to renewable energy installations.

Uneven playing field barriers take two basic forms: regulatory structures that favor fossil fuels, and a marketplace in which energy prices do not reflect their true costs.

Utility regulation often encourages utility investment in fossil fuels by allowing utilities attractive rates of return on money invested in capital-intensive fossil fuel plants. This effect is compounded by fuel adjustment clauses, which shield utilities from the effects of high fossil fuel prices by allowing the utility to pass price increases directly on to customers. Regulators' perceptions of renewable energy can present an additional barrier, since regulators who are uncertain about renewable energy technology are unlikely to address these regulatory barriers.

In addition, prices in the energy marketplace are distorted in two main ways. As discussed in Part One of this document, fossil fuel prices do not incorporate their full costs, particularly their carbon dioxide emissions costs. This keeps fossil fuel prices low and prevents renewable energy from competing with fossil fuels. A second source of distortion is government subsidies. Direct government subsidies, such as tax credits and payments to producers, currently favor renewable energy, with producers of wind and solar energy receiving over $20 per MWh produced, compared to $0.25 per MWh for natural gas, $0.44 per MWh for coal, and $1.59 per MWh for nuclear energy. (Energy Information Administration, 2008). However, these amounts do not reflect the $110 billion the U.S. has spent on research and development since 1948, over 80% of it going to the nuclear and fossil fuel industries. (Kammen & Pacca, 2004). These amounts also exclude indirect subsidies, such as federal provision of insurance for the nuclear power industry, provision of low interest loans, and defense of fossil fuel supplies and infrastructure. When both direct and indirect subsidies are considered, renewable energy receives a much smaller share of total subsidies – less than 1% in 1999. (Kammen & Pacca, 2004).

Technological barriers are gaps in technology that either prevent a renewable energy resource from becoming fully viable, or that prevent that resource from fully functioning within the existing energy infrastructure. Technological barriers include the upgrades in transmission infrastructure that will be necessary in order to bring large quantities of intermittent renewable energy online, as well as the need to store wind and solar energy when these resources are abundant, and transmit the energy to the grid when peak electricity is needed. Biofuels in particular face a significant technological barrier, because current methods of producing biodiesel and corn ethanol are economically and environmentally inefficient and are not expected to become economically viable without significant federal support.

A more detailed list of the barriers to renewable energy development, along with specific policy recommendations to overcome these barriers, is in Appendix Three.

3.0 Renewable Energy Policy

3.1 What Are the Goals of Renewable Energy Policy?

Renewable energy policy should be driven by the goals that policy seeks to achieve. Goals of renewable energy policy could include decreased carbon dioxide emissions; cost stabilization; domestic control of the energy supply; and economic development. These goals are not mutually exclusive, but use of renewable energy to achieve one goal could come at the expense of another. For example, use of biofuels to meet energy independence objectives could have a negative impact on price stabilization if land and commodity prices fluctuate. Similarly, some forms of biofuels may offer little or no advantage in terms of reduced carbon emissions; promoting these fuels might help with job creation while increasing carbon dioxide emissions. Table 3.1 summarizes the ways that different sources of renewable energy may contribute to or detract from the policy drivers of environmental quality, energy security, and affordability.

Table 3.1: Impacts of Renewable Energy on Policy Drivers

	Environmental Quality		**Energy Security**	**Affordability**	
	CO_2	Other		Life Cycle Costs[1]	Cost Stability
Wind	Reduces emissions compared with current electricity mix	Reduces air pollution No extraction impacts Reduced water use Possible impact on wildlife, aesthetics	Increases energy security	Reduced costs compared with pulverized coal, IGCC,[2] and advanced nuclear generation Increased costs compared with natural gas generation	Increases cost stability
Solar	Reduces emissions compared with current electricity mix	Reduces air pollution No extraction impacts	Increases energy security	Increased costs compared with current electricity mix	Increases cost stability
Geothermal	Reduces emissions compared with current electricity mix	Minimal environmental impacts	Increases energy security	Reduced costs compared with advanced nuclear Increased costs compared with current electricity mix	Increases cost stability
Biomass	May reduce or increase emissions, depending on production methods	May increase soil erosion, increase water pollution, deplete water supplies	Increases energy security	Reduced costs compared with advanced nuclear Increased costs compared with current electricity mix (using current technology)	May decrease cost stability by linking costs to agriculture commodity prices

[1] Life cycle (or bus bar) costs include all expenses over the life cycle of the resource, including design, licensing, installation, operating and maintenance, taxes, and decommissioning.

[2] Integrated coal-gasification combined cycle generation plants.

Sources: Kammen & Pacca, 2004; DOE 2008; (Congressional Budget Office, 2009).

Table 3.1 shows the various trade-offs involved with increased use of renewable energy. At current fossil fuel prices and using current technology, no renewable energy resource offers clear benefits in all three major policy areas when compared to current energy sources. Wind energy offers the greatest benefits, with life cycle costs that are lower than all current fossil fuel generation sources other than natural gas. In the long run, changes in fossil fuel prices could make wind energy more affordable than even natural gas. In the short run, however, the per-kWh price consumers pay for fossil fuel sources may not include full life cycle costs, particularly costs at the beginning and end of a plant's operating life that may have been subsidized by the federal government. (Kammen & Pacca, 2004).

3.2 What are the Challenges in Designing Renewable Energy Policy?

In order to achieve full renewable energy potential, policies are needed to address the entire spectrum of decisions that determine whether new renewable energy is installed. It is not enough, for example, to require utilities to purchase renewable energy. Policy makers must also ensure that the stakeholders who need to invest in the facility have an incentive to invest; that the facility is properly sited; and that the transmission facilities and policies are adequate to get the electricity to customers efficiently. Thus, the challenge in designing renewable energy policy is to recognize the behaviors that need to change and to implement a comprehensive approach to change that behavior. Moreover, this must all be done in the context of rapid changes in energy markets, regulatory regimes, and available technologies.

In addition, renewable energy policy does not exist in a vacuum. Effective policy will work in tandem with related policy areas, such as environmental protection, so that common policy goals are achieved.

Finally, a major challenge with renewable energy policy is addressing both long-term and short-term needs (Logan & James 2009). Long-term, it is clear that the U.S. needs to adopt clean energy policies, including greater use of renewable energy. Short-term, however, policies need to be ambitious enough to spur new investment, yet flexible enough to deal with the inevitable problems, technical glitches, and regulatory corrections that will occur as we transition to a clean energy future.

3.3 What Different Policy Instruments Can Be Used?

Policies to overcome profitability barriers, regulatory barriers, and technological barriers are discussed further below. A more detailed summary table of policy approaches to overcoming barriers is in Appendix Three.

This section will not provide an in-depth discussion of policy approaches that reduce fossil fuel use by regulating carbon dioxide emissions, but it is important to note that carbon dioxide regulation could change the policy implications for renewable energy, particularly by reducing the amount of subsidizing needed in order to make renewable energy cost-competitive with fossil fuels.

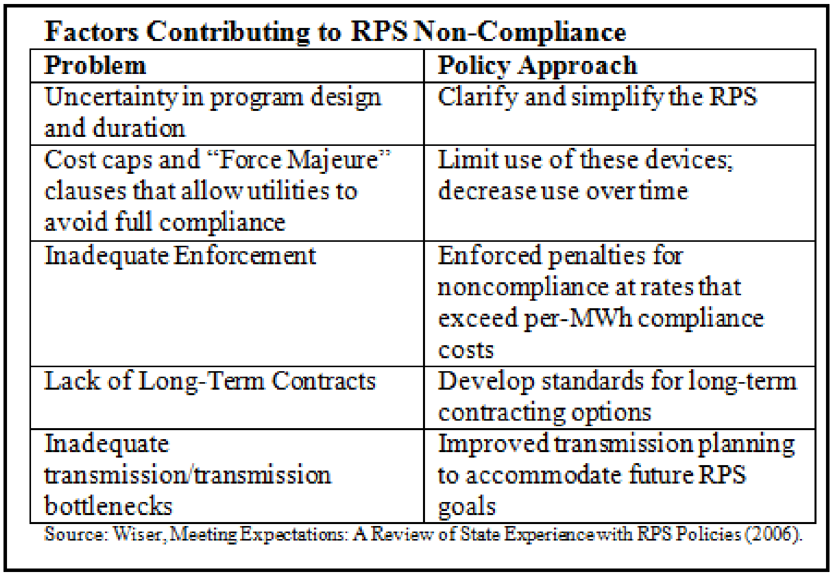
3.3.1 Policy Approaches to Overcoming Profitability Barriers

Creating a Market for Renewable Energy

A market will emerge for renewable energy when renewable energy is cost-competitive with other sources, *and* all parties who make energy purchase decisions have an incentive to buy the least expensive source. Developing such a market will require a long-term approach in which policies are deployed to incorporate carbon dioxide emissions costs into fossil fuels, and utility ratemaking procedures are designed to remove utility incentives to invest in fossil fuel-based power plants. However, short-term efforts are needed to ensure that a market for renewable energy develops while these long-term strategies are developed.

The most common policy approach to creating renewable energy markets in the U.S. is the Renewable Portfolio Standard (RPS). Under the basic RPS model, distribution utilities are required to procure a minimum percentage of total retail electricity sales from renewable energy sources. Design elements can vary considerably between state models; some of the more important design elements are discussed below in Section 3.4.1. Currently, at least 40% of total U.S. electric load is covered by a Renewable Portfolio Standard. (Wiser, 2006). [3]

Table 3.1: Factors Contributing to RPS Non-Compliance



Factors Contributing to RPS Non-Compliance

Problem	Policy Approach
Uncertainty in program design and duration	Clarify and simplify the RPS
Cost caps and "Force Majeure" clauses that allow utilities to avoid full compliance	Limit use of these devices; decrease use over time
Inadequate Enforcement	Enforced penalties for noncompliance at rates that exceed per-MWh compliance costs
Lack of Long-Term Contracts	Develop standards for long-term contracting options
Inadequate transmission/transmission bottlenecks	Improved transmission planning to accommodate future RPS goals

Source: Wiser, Meeting Expectations: A Review of State Experience with RPS Policies (2006).

Initial results show that many states will not meet their early RPS goals. Table 3.1 summarizes some of the factors contributing to non-compliance, and suggests approaches to overcome these problems. However, most state RPS policies were enacted less than five years ago, and compliance is expected to improve over time, particularly as regulatory and technological barriers are addressed. (Chen, Wiser, & Bolinger, 2007). This limited experience with the RPS indicates that these policies are not sufficient by themselves to overcome all the hurdles to full use of the renewable energy resource.

Another common policy approach, net metering, creates a market for renewable energy installed on the customer side of the meter. Net metering programs allow customers who install renewable energy systems to sell electricity to the grid at retail rates – either by running their meters backward for energy consumed within the home, or by selling all output to the utility at retail rates (Department of Energy, 2006). Forty states have net metering programs, but most establish limits on the program; once a given

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[3] This number is probably higher, since a number of states have added RPS obligations since this figure came out.

level of capacity has been installed through net metering, additional programs are ineligible (North Carolina Solar Center, 2009).

An analysis by the National Renewable Energy Laboratory (NREL) indicates that full compliance with current state RPS policies would result in 348,000 GWhs of new renewable energy by 2025, an amount equivalent to about 8% of EIA's projected electricity demand in 2025. In order to develop a larger market, additional policy approaches are needed. These could include expanding use of RPSs to all states, adopting a national RPS, expanding the use and capacity limits of net metering programs, or adopting additional approaches. One such approach that is gaining traction in Europe is the Feed-in Tariff, a modification of net metering that is used in Spain and Germany. The feed-in tariff is described in greater detail in Section 3.4.2.

The federal government has traditionally mandated minimum percentages of motor vehicle fuel to come from biofuels, and has recently established a national Renewable Fuel Standard (RFS) requiring 4% of motor-vehicle fuel to come from renewable sources in 2007 and increase annually through 2012. The standard will require at least 20.5 billion gallons of renewable fuel by 2015, with limits on the amount of corn-based ethanol that can be used to meet the standard; the rest of the standard must be met through cellulosic ethanol or other advanced biofuels. Historically, ethanol consumption has outpaced federal mandates, suggesting that these mandates do not drive ethanol production. (Congressional Budget Office, 2009; Westhoff, 2008).

In addition to quotas, the federal government has also created a market for ethanol by providing production incentives to firms that blend ethanol with gasoline. This subsidy has kept ethanol prices competitive with gasoline prices and has helped drive ethanol consumption. (Congressional Budget Office, 2009).

Both the RFS and the subsidy system have supported widespread use of corn ethanol, a technology that provides minimal amounts of energy in comparison the fossil fuels required to produce it using current technologies.[4] (Gallagher & Shapouri, 2009). Unlike wind and solar energy, it is unlikely that technological changes will improve the efficiency of corn ethanol; and corn ethanol prices are highly linked to fossil fuel prices, so that changes in fossil fuel prices are unlikely to make corn ethanol a more viable alternative. As a result, these policies have supported a renewable technology that is not currently viable and is not expected to be viable in the future. The new RFS requirements mitigate this effect somewhat by requiring that increasing portions of the RFS are met by advanced biofuels such as cellulosic ethanol, which are not corn-based and are likely to be exponentially more efficient than corn ethanol. However, this technology is not yet commercially viable.

Reducing Costs of Investment and Subsidizing Production

Investment subsidies reduce the up-front costs of installing renewable energy, and reduce the economic uncertainty that can discourage investors from pursuing renewable energy projects. In addition to creating new investment, these subsidies can be targeted toward particular technologies that offer benefits in line with other policy goals. For example, many states offer subsidies for solar energy because it has minimal environmental impact; other states might offer investment incentives that are likely to produce jobs and economic development.

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[4] Gallagher & Shapouri show that the ratio of BTUs produced from corn ethanol to BTUs required to produce corn ethanol ranges from 1.14 – 1.38 when natural gas and purchased electricity are used to power corn ethanol refineries. However, the ratio may increase to the 3.0 – 6.0 range if natural gas and purchased power are replaced with biomass inputs such as corn stover or willow.

The US government rewards investment in renewable energy primarily through tax credits. Eligible renewable technologies receive a tax credit of $0.019 per kWh. In addition, a corporate tax credit applies to 30% of commercial investment in most viable forms of renewable energy; this tax credit is available to utilities, merchant generators (who sell power to utilities), and commercial and industrial electricity companies who wish to self-generate. Residential customers are eligible for a similar credit, up to dollar limits for certain applications. Additional investment and production incentives are available in some states. (North Carolina Solar Center, 2009).

A slightly different approach to subsidizing renewable energy production is used in some states by adding a renewable energy surcharge to customer utility bills. This surcharge, typically less than a cent per kilowatt hour, can provide a dedicated funding stream that the utility must use to meet renewable energy goals.

The effectiveness of the current system has been mixed. Production subsidies, combined with technological advances and increased fuel costs, have made investments in wind energy attractive in some parts of the country. Federal subsidies have not, however, removed profitability barriers for other renewable energy technologies. (Wiser, Bolinger, & Barbose, 2007). In addition, the production incentive program in the US has consistently expired before being renewed. Studies show that these lapses discourage new investment in renewable energy. (Olz, 2007). Policies need to provide better levels of certainty to investors if they are to attract significant new investment in renewable energy.

The current approach to subsidies in the US has been to provide a minimum level of financial support to investors in renewable energy. A better approach would treat subsidies either as 1) a temporary measure designed either to attract the investment needed to meet renewable energy policy goals, such as RPS requirements, or 2) a mechanism that supports a clean energy market by rewarding producers for the environmental benefits of renewable energy.[5] Current subsidy programs fall short by either measure, because they are not linked to broader renewable energy goals, nor are they based on the environmental benefits of renewable energy.

As an addition or alternative to changes in current investment and production incentives, policy makers could consider implementation of feed-in tariffs. These tariffs (described in Section 3.4.2) require utilities to purchase renewable energy from residential, commercial, and industrial stakeholders on the customer's side of the meter at specified prices. The tariffs reduce uncertainty and provide investors with assurance that the project will be profitable in the long run.

3.3.2 Policy Approaches to Overcoming Regulatory Barriers

In addition to profitability, policy needs to address other hurdles to renewable energy. Major categories of soft law barriers are addressed below.

Ensuring Grid Access

The Public Utility Regulatory Policies Act (PURPA) requires utilities to allow merchant generators and small-scale renewable energy producers access to the grid and to wholesale electricity markets. Regulated utilities are required to purchase renewable energy that is less than the utility's "avoided cost" to produce an additional unit of electricity, although the current "avoided cost" is generally lower than the cost to generate renewable energy. (Beck & Martinot, 2004).

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[5] A complementary approach to creating a competitive clean energy market would be to reduce the subsidies available for fossil fuels.

Access to land

Unlike traditional energy sources, renewable energy tends to be low-density and is highly geography-specific. Potential investors in wind energy in particular may face challenges if they do not own the land most suitable for windmill installation.

On federal lands, the U.S. has no defined policy approach to land leases for renewable energy. However, the Department of the Interior (DOI) currently leases federal lands and offshore lands for exploration of fossil fuels, and DOI and the Federal Energy Regulatory Commission recently announced plans to work together to streamline the permitting process for onshore and offshore renewable energy development. (DOI, 2009). DOI has also begun assessing renewable energy potential on federal lands, including detailed GIS mapping of areas that are suitable for development from an environmental perspective. (U.S. Department of Interior, 2009; (Department of Interior & Department of Energy, 2003).

Siting Regulations

Siting processes for renewable energy installations can require investors to obtain permits from utility regulators, environmental regulators, and local planning boards. In addition, the siting process can become contentious when local communities object to renewable energy installations for environmental and aesthetic reasons. Policy makers can help streamline the siting process by identifying and prioritizing areas with high renewable energy potential and low environmental and aesthetic impact. At least one state has begun to take this kind of approach, the Maine Wind Energy Act (35-A M.R.S.A. § 3401, et seq.). Policy makers can also combine the various permits and regulatory requirements into a single permit system, reducing regulatory hurdles to investment.

Policy makers can also help to overcome local opposition to renewable energy by offering subsidies to encourage less-intrusive renewable energy technologies. For example, in Denmark and the Netherlands targeted subsidies are offered to investors who install wind turbines that meet low-noise requirements.

3.3.3 Policy Approaches to Overcoming Technological Barriers

The main way that policy makers can overcome technology barriers is by funding research and development and demonstration projects so that, over time, new technologies will become viable, and existing technologies will become more efficient and less expensive. Research and development will be particularly valuable in overcoming technological barriers to integrating intermittent wind and solar resources into the grid. Grid infrastructure can be designed for flexibility to accommodate the intermittent resources; it can also incorporate greater use of high-tech information systems that predict energy flows and adjust energy usage to accommodate fluctuations. (International Energy Association, 2008). In addition, improvements in energy storage can help reduce the intermittent nature of wind and solar power. Research and development in all of these areas will allow greater amounts of renewable energy to connect to the electricity grid.

Additional research and development is needed for biofuels as well. The net energy balance of corn grain ethanol is estimated at 67% (e.g., the corn will produce 67% more energy than the fossil fuel energy used to produce it). In comparison, cellulosic ethanol is expected to have a net energy balance of 200-300%, enough to make cellulosic ethanol a viable technology without government subsidy. (Congressional Research Service, 2008). Economically viable distillation techniques are not currently available on a commercial scale, although recent breakthroughs suggest that distillation techniques will be available in the near future.

On-going research and development also is needed to test the feasibility of emerging renewable energy technologies, such as wave, tidal, and algal power.

3.4 Analysis of the Renewable Portfolio Standard and the Feed-in Tariff

Worldwide, two policies are most widely credited with recent increases in renewable energy capacity: the Renewable Portfolio Standard (RPS) and the Feed-in Tariff (FIT). This section examines the design elements of these policies, identifying aspects of each that are necessary in order for the policy to effectively drive new investment in renewable energy.

3.4.1 The Renewable Portfolio Standard

At least 30 states have RPS policies in place,[6] most of them newly enacted within the last five years. While significant investment has occurred in states with RPS policies, there is some uncertainty about the role of the RPS in driving new investment. (Menz & Vachon, 2006; Wiser, Namovicz, Gielecki, & Smith, 2007). While it is clear that numerous factors drive investment in renewable energy, an effective RPS can act as a floor to ensure that minimal amounts of renewable energy are procured.

RPS design can vary considerably from state to state. Design variability is a relative strength of the RPS, as it allows states to integrate renewable energy goals into the existing state regulatory structure and pursue renewable energy development strategies that are suited to the geographic and economic conditions in the state. However, use of the state-by-state approach also means that not all states have adopted the policy, and policy design in some states can be marginally effective at achieving goals.

<u>RPS Targets and Timeframes</u>

RPS targets vary widely, from Iowa’s goal of 105 MW annual capacity, to more ambitious goals of 20% or more in several states. (Department of Energy, 2008). Second, the time-frame can differ. Most states must begin meeting goals within a few years of enactment, but full RPS compliance may be schedule to occur as early as 2013 or as late as 2025.

Setting targets and time-frames poses several challenges for policy makers. An RPS cannot spur new investment in renewable energy unless it adopts ambitious goals. Too ambitious a goal, however, and the RPS cannot be met. RPS goals and timetables need to be informed by a careful study of technical and economic potential. Ambitious long-term goals can be set based on technical potential, while short-term goals should be based on existing capacity and the state’s ability to quickly invest in new capacity.

<u>Eligible Technologies</u>

State approaches to resource eligibility vary based on geographic suitability for certain technologies and other state policy goals. For example, a state might prioritize the environmental values associated with renewable energy by excluding conventional hydropower and certain kinds of biomass that are often criticized for causing harmful environmental impacts. A state might use the RPS as a means of encouraging a local renewable energy industry, by allowing experimental or unproven renewable energy resources to compete. These are all viable approaches to the question of eligibility, and the RPS will be more successful if eligibility requirements are tied to state policy goals and available resources.

A small number of states have included renewable energy resources such as coal ash, waste incineration, and other resources that offer few, if any, of the traditional benefits of renewable energy. Inclusion of these resources may help diminish political opposition to an RPS, but these should be viewed with caution, and policy makers should consider phasing these resources out over time, or using devices such as tiering (described below) to limit their use.

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[6] A summary table of state RPS goals can be found in Appendix Four.

In addition to renewable energy, some states allow verifiable reductions in energy consumption to count toward RPS goals. This can be a useful strategy for states that are concerned about the cost impacts of the RPS, or for states that do not possess land areas suitable for significant renewable energy development. As with the basic question of eligibility, the question of whether to include energy reductions should be based on state policy goals. If the purpose of the RPS is reduced carbon dioxide emissions, then reductions in energy consumption are equivalent to generation from renewable energy. If the RPS is intended to spur investment in renewable energy, inclusion of energy efficiency may dilute that purpose somewhat. It is also questionable whether the RPS is the most effective vehicle to spur energy efficiency, compared with other policy approaches.

Devices to Prioritize Resources and Provide Compliance Flexibility

Some states allow utilities to meet their RPS goals through the use of renewable energy credits (RECs), tradable credits that allow utilities to purchase the renewable attributes of energy generated in another state or region. REC tradability allows utilities some flexibility in meeting their RPS requirements, but the effectiveness of this device in spurring new investment in renewable energy is uncertain. REC trading also requires extensive documentation and record-keeping. States should carefully weigh the expected benefits against the risks and administrative burden before deciding to use REC to comply with RPS goals.

A related aspect of RPS design involves the promotion of specific resources. Many RPSs are “tiered,” with different goals for different classes of renewable energy. A state might have an overall 15% RPS obligation, for example, and require a certain amount of that 15% to be met through resources the state seeks to develop, such as wind or biomass. Tiering can be used to prioritize among resources. It can also be used to help states meet long-term goals by establishing a plan by which small amounts of a wide range of capacity are added to the system over time.

Similarly, a state might prioritize certain resources by allowing one kWh of that resource to count as two or three kWhs toward the RPS goals. Extensive use of this device, however, can diminish the environmental benefit of the RPS program.

RECs, tiering, and resource prioritization can be useful tools, but they also carry an administrative cost. The more complex the RPS is, the more difficult it will be for utilities to comply and agencies to administer. The benefits from use of these devices should be weighed against the administrative burdens.

Compliance and Enforcement

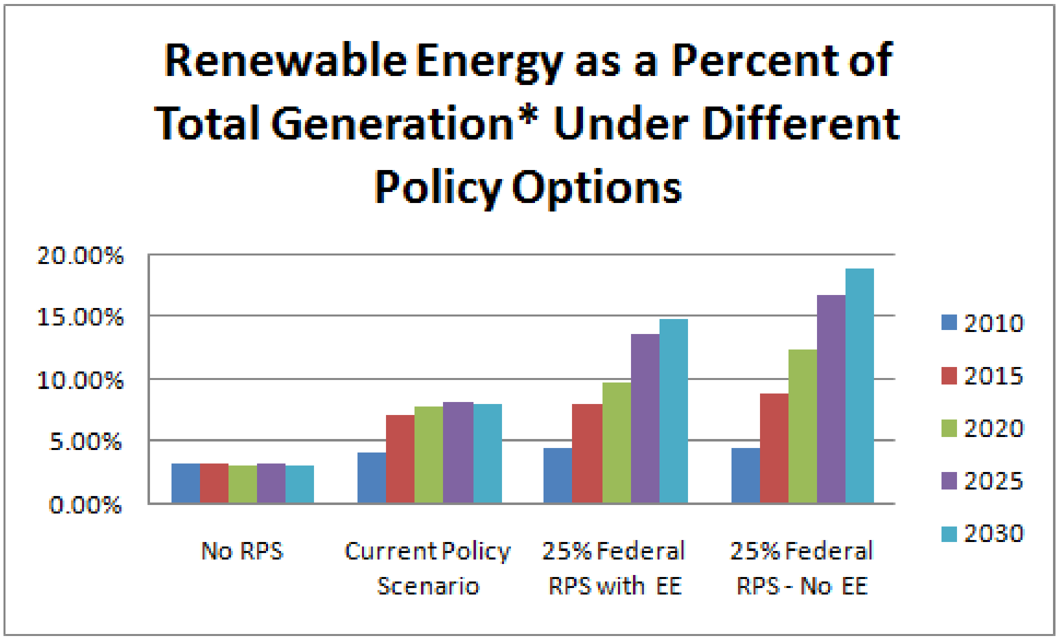
Compliance is an easily-overlooked but crucial element of RPS design. As states have launched their RPS programs, many utilities have struggled to meet RPS goals, raising the question of how the RPS should be enforced, and what steps should be taken when utilities fail to comply. A common approach is to issue a per-kWh fine for compliance failures. In order to be effective, the fine must exceed the cost of purchasing the renewable energy.

Federal RPS

Several federal RPS proposals have been presented to Congress. President Obama has called for a 10% RPS by 2012, Senator Bingaman has proposed a 20% standard, and Representatives Markey and Platts have proposed a 25% standard. The EIA recently assessed the impacts of the 25% standard under two different scenarios: one in which utilities are allowed to use energy efficiency (EE) to count toward their RPS goals, and one in which no energy efficiency is allowed to meet goals. Figure 3 compares the percentage of the nation’s electricity that would be met through non-hydro, non-MSW renewable energy under these two scenarios, along with a “no state RPS” scenario and scenario based on current state and federal renewable energy policies, including state RPS obligations.

As Figure 3.2 shows, a federal RPS would have relatively little impact on the nation's generation mix in the early years of the program. Over time, however, the differences in energy mix become significant under a 25% federal RPS, reaching nearly 20% by 2030, compared to less than 10% under current state RPS programs and other policy options.

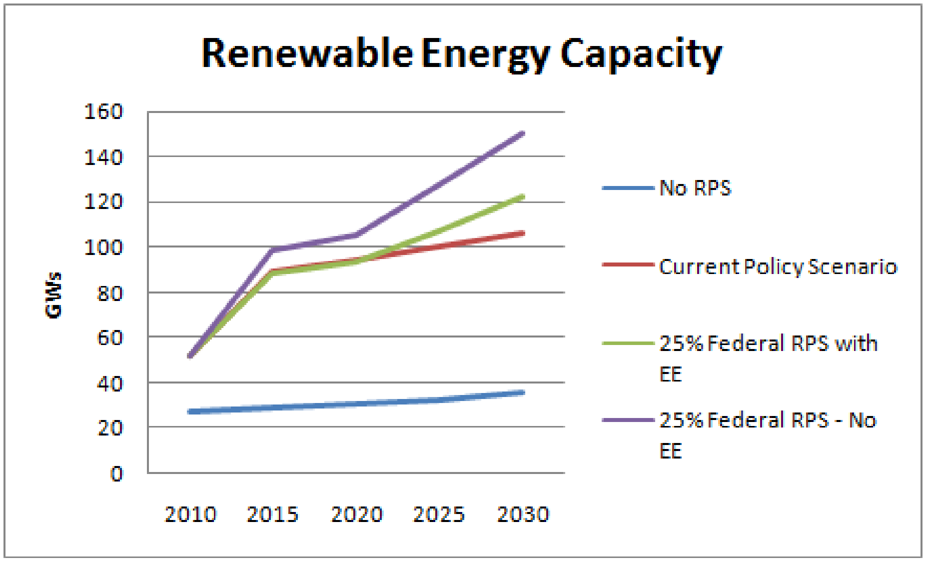
Figure 3.2: Percentage of renewable generation under different policy options



Source: EIA 2007 Annual Energy Outlook (no RPS); EIA 2009 Annual Energy Outlook (current policy scenario); EIA; EIA *Impacts of a 25-Percent Renewable Electricity Standard* (2009) (25% RPS options).
* Even under the 25% scenario, renewable energy does not reach 25% because "renewable energy" excludes electricity generated from conventional hydro and municipal solid waste; under some scenarios, energy efficiency (EE) may be used for compliance; under some scenarios, eligible technologies (e.g. solar) are granted multiple credits; and some electricity generators are excluded from the requirements.

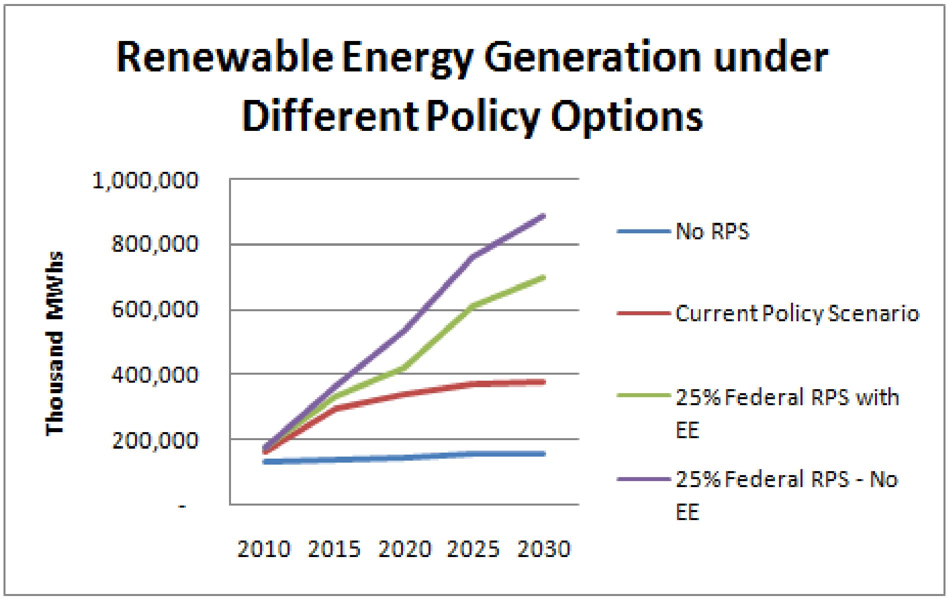
Figures 3.3 and 3.4 show the expected impact of these policies on the amount of non-hydro, non-MSW capacity and generation through 2030.

Figure 3.3: Renewable Energy Capacity



Source: EIA 2007 Annual Energy Outlook (no RPS); EIA 2009 Annual Energy Outlook (current policy scenario); EIA; EIA *Impacts of a 25-Percent Renewable Electricity Standard* (2009) (25% RPS options).

Figure 3.4: Renewable Energy Generation



Source: EIA 2007 Annual Energy Outlook (no RPS); EIA 2009 Annual Energy Outlook (current policy scenario); EIA; EIA *Impacts of a 25-Percent Renewable Electricity Standard* (2009) (25% RPS options).

3.4.2 The Feed-in-Tariff

The feed-in tariff (FIT) is a policy that has been credited with driving a significant portion of renewable energy investment in Europe, particularly in Germany and Spain. Under the feed-in tariff, anyone who installs a qualifying renewable energy project can sign a long-term contract to sell electricity to the utility. Payments are set by the regulatory body for different types of renewable energy, and are designed to ensure that the investment cost will be recovered during the contract period.

The FIT shares some similarities with avoided cost transactions under PURPA. Both policies create a “must-buy” obligation for utilities, but there are key differences. First, avoided cost payments have generally been set too low to stimulate renewable energy development. FIT payments are based not on utility avoided cost, but on the cost to install specific renewable energy technologies. Second, unlike avoided cost payments, FIT payments are tailored to stimulate specific types of renewable energy technology, decrease over time, and end after a specified number of years. Finally, the qualifying resources and FIT payment amounts can be adjusted to avoid the overcapacity problems that resulted from early use of avoided cost payments.

Advantages of the FIT

The chief advantage of the FIT is that it combines a reliable investment funding stream with guaranteed grid access for new renewable projects. The FIT also allows policy makers to provide a targeted investment incentive for stakeholders on both sides of the meter, encouraging installation of renewable energy by those that previously had little or no incentive to invest. In California, for example, a proposed FIT would be targeted at installations in the 20 MW range – that is, installations not currently pursued by utilities seeking to meet RPS goals or by customers seeking to install renewable energy for residential use.

Another significant advantage to the FIT is that it encourages maximum installation of renewable energy using existing transmission lines. The ability to add new renewable capacity without the need to install new transmission can provide significant savings for utilities trying to meet RPS goals, and can allow goals to be met more quickly since new capacity will not delay new projects.

Disadvantages of the FIT

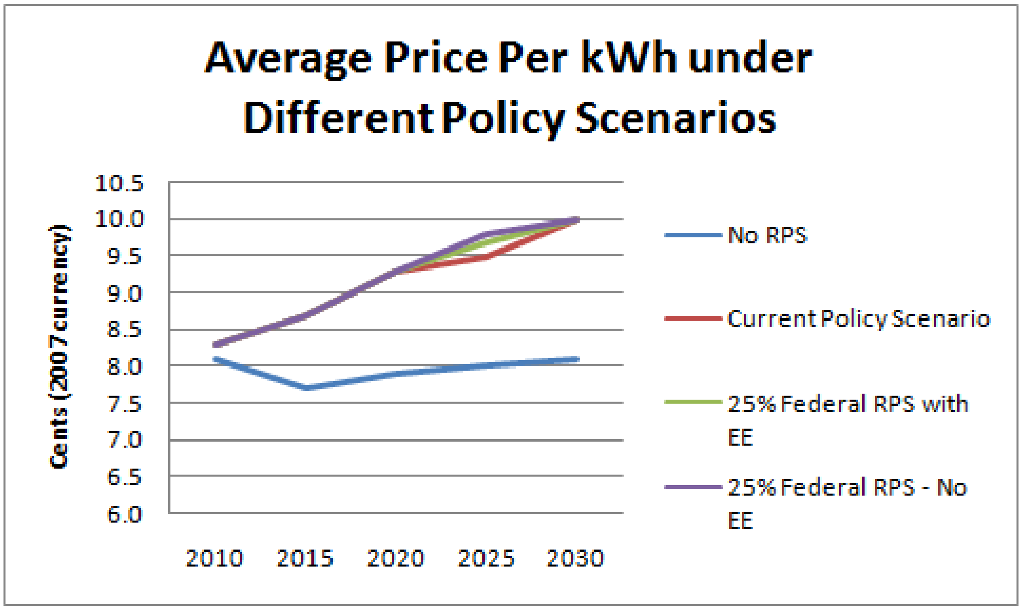
While the FIT has proven clearly effective at increasing renewable energy investment, it has also been criticized as inefficient, expensive, and unresponsive to market conditions. Policy makers considering adoption of the FIT should consider the tradeoffs between rapid installation of renewable energy and maximum economic efficiency. Some of the inefficiencies related to the FIT can be mitigated by building in flexibility for regulators to adjust payments and change qualifying facilities to increase or reduce incentives for investors to participate in the program. This will allow regulators to increase or decrease the scope of the FIT as needed to meet renewable energy and economic efficiency goals.

3.5 What Are the Unintended Consequences of Renewable Energy?

3.5.1 Economic Impacts

One of the main drawbacks to renewable energy is that its price is currently higher per kWh than most sources of conventional electricity. In the long term, however, this may not continue to be the case. The price of renewable energy is expected to decrease as renewable energy technologies mature and increase market share, and the price of fossil fuels is expected to increase as carbon dioxide emissions are regulated. Figure 3.5 shows the anticipated impact on electricity prices of current state and federal policies, compared with the proposed 25% RPS.

Figure 3.5: Price Impacts of RPS



Source: EIA 2007 Annual Energy Outlook (no RPS); EIA 2009 Annual Energy Outlook (current policy scenario); EIA; EIA *Impacts of a 25-Percent Renewable Electricity Standard* (2009) (25% RPS options).

3.5.2 Environmental Impacts

The primary unintended consequences of increased use of renewable energy are environmental impacts related to certain renewable technologies. The environmental effects of solar and geothermal energy appear to be minimal, particularly when compared with the environmental effects of fossil fuel generation. The environmental effects of wind and biomass, however, can be significant, particularly if these resources are deployed in the quantities currently considered by policy makers.

The main environmental concerns related to wind energy is its impact on wildlife and aesthetics. These problems are increased by the fact that wind is a low-density energy resource – it requires much more land area to produce an equivalent amount of power when compared with traditional power plants. Moreover, many of the ideal locations for windmills are also scenic vistas and migratory bird flyways.

Fortunately, many of these concerns can be minimized by proper siting of wind turbines. Policy makers should actively identify and prioritize the areas with maximum wind potential and minimum environmental impact. The federal government is likely to play a major role in this process, and more effort is needed to establish siting processes for wind facilities on federal lands.

The environmental concerns related to biofuels are more significant. Increased agricultural production to provide biofuel feedstocks could lead to removal of farmland from conservation set-asides, cultivation of highly erodible land, and drawing down of the “fossil water” aquifer. In addition, research has shown that some biomass technologies offer minimal carbon dioxide reductions, at best. However, advanced biofuels may have less environmental impact, particularly cellulosic ethanol that could be produced from non-till feedstocks such as switchgrass. Policies to promote biofuels need to recognize the potential environmental impacts of these technologies, and build in mechanisms to encourage only the technologies that offer the most benefit with the least impact.

4.0 Conclusions

The policies discussed above should be administered by a combination of state, local, and federal actors. RPS policies can be administered at either the state or the federal level; federal administration offers potentially greater renewable energy generation, while state implementation allows states to tailor the RPS so that it meets state-specific policy goals. These two approaches need not be mutually exclusive, however, if goals were set at the federal level and implemented at the state level.

Like the RPS, investment and production incentives can be administered at either the federal or the state level. The current dual system, however, does not allow any one set of policy makers to assess subsidy levels and ensure that they are adequate to promote the desired behavior without costing taxpayers more money than necessary to achieve renewable energy goals. In addition, stakeholders have adequate incentives to invest in renewable energy in some states but not in others. State-determined subsidy levels have the advantage that they can be tailored to local geographic and economic conditions, while federal subsidies have the advantage of universal coverage. Overall, the investment and production incentive programs can probably be jointly administered, but increased coordination between the two systems would improve efficiency and effectiveness of the programs.

Feed-in tariffs, net metering, and other policies that use utility rates to promote renewable energy are best implemented at the state level. However, federal advice and leadership in the form of model rules can be used to encourage policy adoption and to help states enact effective policies.

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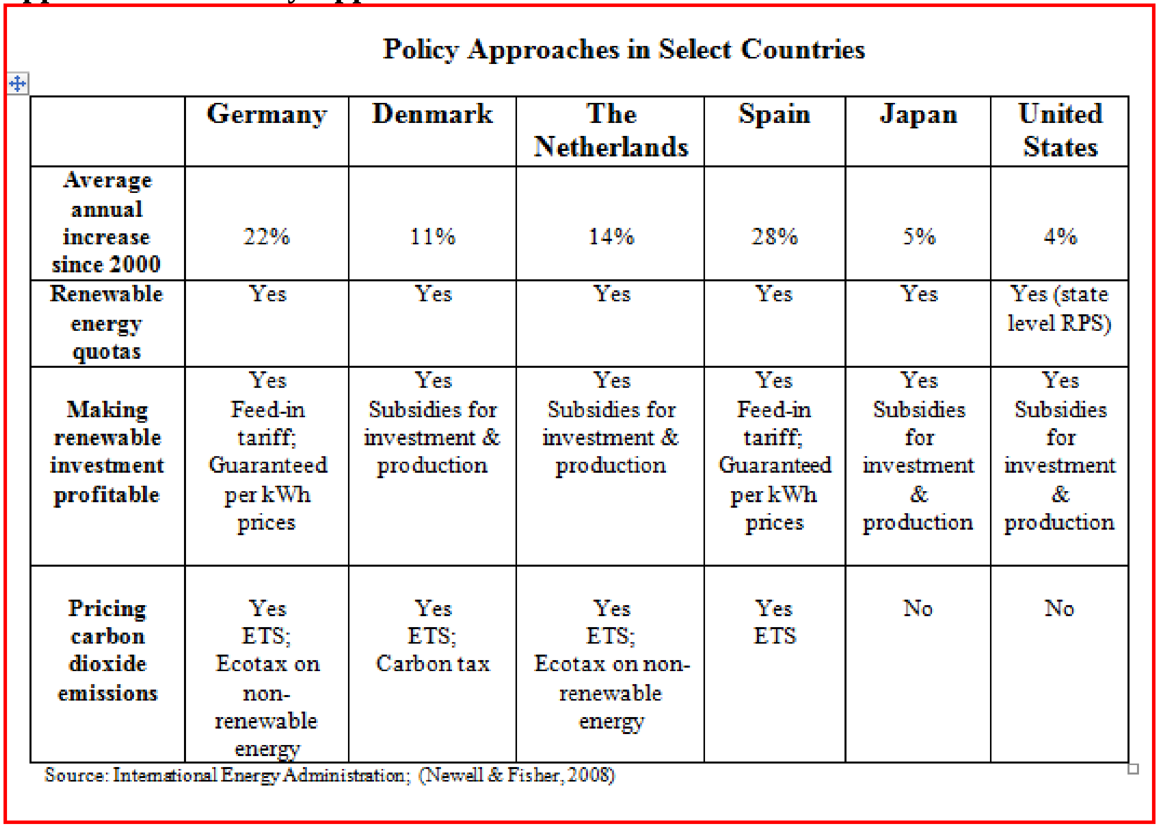
Appendices

Appendix One: Types of Renewable Energy

Technology	Description	Advantages	Disadvantages
Solar			
Photovoltaic (PV)	Electricity is generated in photovoltaic cells located on solar panels or incorporated into roof or other building materials	No carbon dioxide or other emissions Few maintenance costs once installed Can be located anywhere	High installation costs Long payback period No viable energy storage method Dependent on weather
Concentrating Solar Power (CSP)	Mirrors concentrate solar energy to run turbines, which generate electricity	More cost-effective than solar PV Improved energy storage No carbon dioxide or other emissions	Requires sufficient space and sunlight High installation costs Uncertain payback time
Solar Hot Water	Solar panels are used to heat or pre-heat residential or commercial hot water	Saves fossil fuels or energy needed to heat water Easy installation Quick payback time	Weather-dependent
Wind			
Onshore	Turbines are powered by wind energy to generate electricity	No carbon dioxide or other emissions Few maintenance costs once installed Cost-competitive with some forms of fossil energy Cost stability	Requires minimum wind speeds to be viable Provides intermittent electricity Ideal locations are often scenic vistas or migratory bird routes Noise can be disruptive
Offshore	Wind turbines are located in the coastal zone	Constant wind speeds No interference with residential neighborhoods Vast potential	Offshore installation is more difficult Little experience installing offshore wind
High Altitude	Small turbines are suspended at high altitudes	Constant wind speeds No disturbance of birds Vast potential	Technology is still in development Possible interference with aircraft
Geothermal	Heat from the earth's core is used to power turbines, or is transferred to provide energy for home heating	Minimal environmental impact Minimal maintenance costs	Requires specific geologic formations High capital costs

	and cooling	Reliable, non-intermittent baseload	
Biofuels			
Biodiesel	Soybeans or other seed feedstocks are turned into fuel that can be blended with oil for motor vehicle fuels or home heating	Renewable Provides a market for agricultural products	Minimal energy return on fossil fuels invested in growing and harvesting the soybeans Uncertain carbon dioxide reductions Possible environmental impacts from increased cultivation of farmland Possible impacts on food prices
Corn Ethanol	Corn kernels are distilled into ethanol, which can be blended with gasoline to create a motor vehicle fuel	Renewable Provides a market for agricultural products	Minimal energy return on fossil fuels invested in growing and harvesting the soybeans Uncertain carbon dioxide reductions Possible environmental impacts from increased cultivation of farmland Possible impacts on food prices
Cellulosic Ethanol	Ethanol is distilled from entire feedstock plant	Renewable Provides significantly greater energy return than other biofuels Can be created from switchgrass and other plants that require no tilling and can be grown on marginal lands	Distillation technology is not yet economically viable Uncertain carbon dioxide reductions Possible environmental impacts from increased cultivation of farmland Possible impacts on food prices
Woody Biomass	Wood by-products are used to power electric power plants	Renewable Uses by-products of timber industry	Location-specific Uncertain carbon dioxide reductions
Biomass Co-firing	Biological feedstocks are burned along with coal in electric generation plants designed for co-firing	Allows utilities to build new generation without locking in to coal generation	Uncertain carbon dioxide reductions
Ocean	Tidal movements are used to turn small turbines to generate electricity	Clean, vast potential	Technology is not yet economically viable.

Appendix Two: Policy Approaches in Select Countries



Policy Approaches in Select Countries

	Germany	Denmark	The Netherlands	Spain	Japan	United States
Average annual increase since 2000	22%	11%	14%	28%	5%	4%
Renewable energy quotas	Yes	Yes	Yes	Yes	Yes	Yes (state level RPS)
Making renewable investment profitable	Yes Feed-in tariff; Guaranteed per kWh prices	Yes Subsidies for investment & production	Yes Subsidies for investment & production	Yes Feed-in tariff; Guaranteed per kWh prices	Yes Subsidies for investment & production	Yes Subsidies for investment & production
Pricing carbon dioxide emissions	Yes ETS; Ecotax on non-renewable energy	Yes ETS; Carbon tax	Yes ETS; Ecotax on non-renewable energy	Yes ETS	No	No

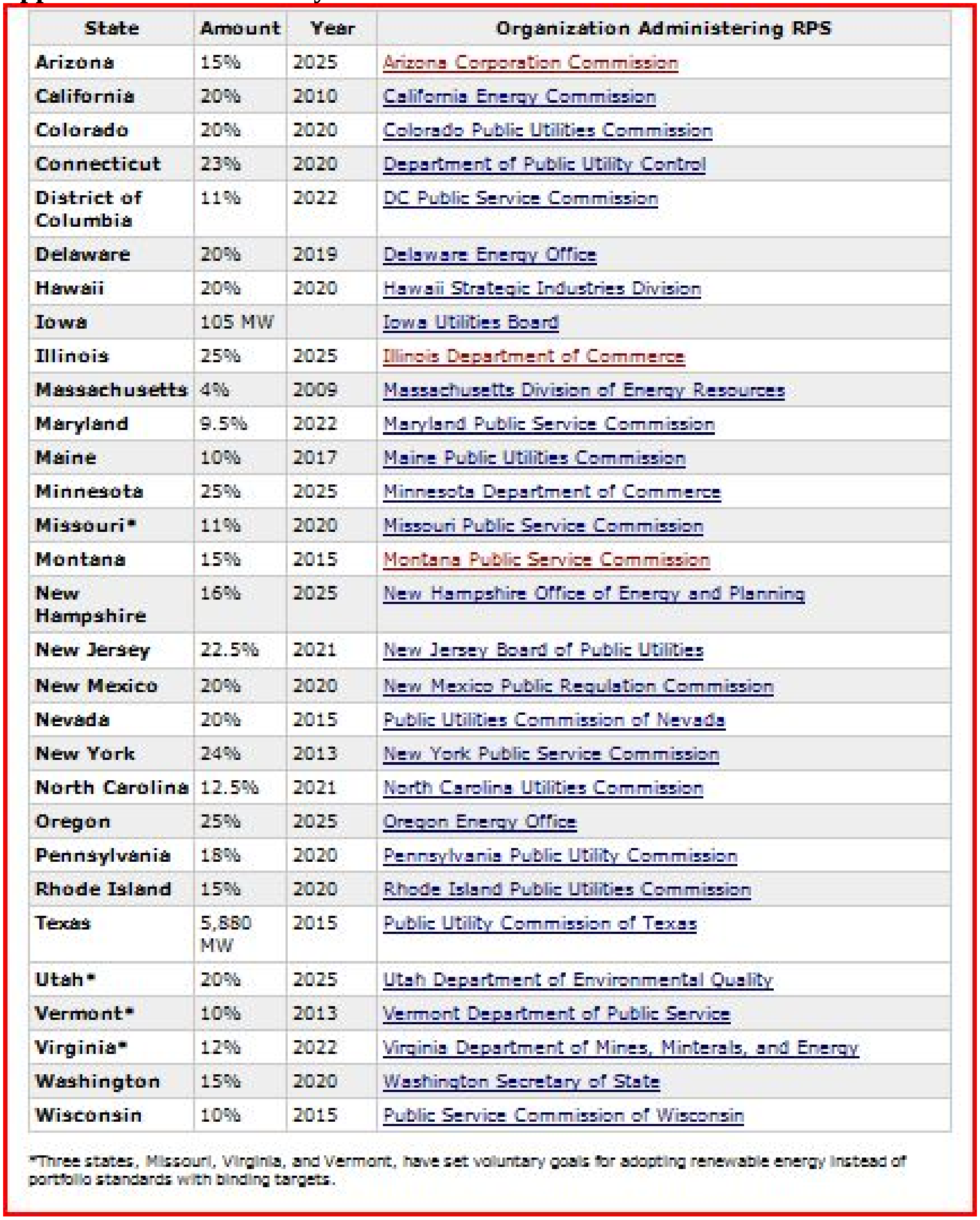
Source: International Energy Administration; (Newell & Fisher, 2008)

Appendix Three: Barriers and Policy Mechanisms

Barrier to Renewable Energy Investment	**Policy Approaches**	**Key Stakeholder(s) Targeted**
Profitability Barriers		
Insufficient incentive for utilities to invest in renewable energy (due to uncertainty, policies for return on capital investment, and ratemaking policies)	Quantity-forcing policies (RPS) Dedicated funding streams for renewable energy (system benefits charges) Prioritize renewable energy in utility resource planning process State or federal investment subsidies and tax credits	Electric Utilities
Real or Perceived Risk & Uncertainty	Federal/state government as leader Federal/state R&D, experimentation Improvement in grid capacity	Regulators and policy makers

	and reliability Use of ratemaking (e.g. smart grid) to address reliability concerns Provide federal or state purchase mandates (RPS)	
Insufficient Incentive for Merchant Generators to invest in renewable energy	Establish a guaranteed price for renewable energy added to grid (feed-in tariffs) Tax credits, production incentives	Merchant generators
Insufficient Incentive for investment on customer side of meter	Establish a guaranteed price for renewable energy added to grid (feed-in tariffs, net metering) Tax credits, production incentives Access to capital via loans	Residential, commercial, and industrial customers
Regulatory Barriers		
Lack of access to the grid	Improve net metering and interconnection policies	Regulators
Lack of access to suitable locations	Streamlined permitting processes on federal lands Contract assistance for access to privately owned lands	Federal agencies (BLM, Forest Service)
Regulatory Delays in Siting Process	Pre-identification of suitable areas Streamlined permitting process	State land-use planners State permitting agencies
Uneven Playing Field Barriers		
Regulation that favors utility investment in fossil fuels	Remove fuel adjustment clauses Adjust rate structures to favor renewable and distributed generation Quantity-forcing policies (RPS)	Electric Utilities
Failure to price carbon dioxide costs	Carbon dioxide regulation	Electric utilities
Technological Barriers		
Insufficient transmission infrastructure to handle intermittent resources	Update infrastructure to “smart grids” Adopt real-time pricing and load management policies to stabilize demand Ramp-up provisions in RPS	Regulators

Appendix Four: Summary Table of State RPS Policies



State	Amount	Year	Organization Administering RPS
Arizona	15%	2025	Arizona Corporation Commission
California	20%	2010	California Energy Commission
Colorado	20%	2020	Colorado Public Utilities Commission
Connecticut	23%	2020	Department of Public Utility Control
District of Columbia	11%	2022	DC Public Service Commission
Delaware	20%	2019	Delaware Energy Office
Hawaii	20%	2020	Hawaii Strategic Industries Division
Iowa	105 MW		Iowa Utilities Board
Illinois	25%	2025	Illinois Department of Commerce
Massachusetts	4%	2009	Massachusetts Division of Energy Resources
Maryland	9.5%	2022	Maryland Public Service Commission
Maine	10%	2017	Maine Public Utilities Commission
Minnesota	25%	2025	Minnesota Department of Commerce
Missouri*	11%	2020	Missouri Public Service Commission
Montana	15%	2015	Montana Public Service Commission
New Hampshire	16%	2025	New Hampshire Office of Energy and Planning
New Jersey	22.5%	2021	New Jersey Board of Public Utilities
New Mexico	20%	2020	New Mexico Public Regulation Commission
Nevada	20%	2015	Public Utilities Commission of Nevada
New York	24%	2013	New York Public Service Commission
North Carolina	12.5%	2021	North Carolina Utilities Commission
Oregon	25%	2025	Oregon Energy Office
Pennsylvania	18%	2020	Pennsylvania Public Utility Commission
Rhode Island	15%	2020	Rhode Island Public Utilities Commission
Texas	5,880 MW	2015	Public Utility Commission of Texas
Utah*	20%	2025	Utah Department of Environmental Quality
Vermont*	10%	2013	Vermont Department of Public Service
Virginia*	12%	2022	Virginia Department of Mines, Minterals, and Energy
Washington	15%	2020	Washington Secretary of State
Wisconsin	10%	2015	Public Service Commission of Wisconsin

*Three states, Missouri, Virginia, and Vermont, have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.

Source: (North Carolina Solar Center, 2009).