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Evaluating Experience with Renewables Portfolio Standards in the United States

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Abstract

Increased use of renewable energy is one of several promising strategies for reducing emissions of local, regional and global air pollutants, and for hedging against volatile natural gas prices. Among the available options for encouraging renewable energy is the renewables portfolio standard (RPS). The RPS is a relatively new policy mechanism, and experience with its use has not been widely documented and evaluated.

This report offers a comprehensive analysis of U.S. experience with the renewables portfolio standard (RPS), and has a goal of providing detailed information on lessons learned with this policy approach. This report specifically describes and evaluates the design, impacts, and early experience of 13 U.S. state RPS policies. These 13 policies share a common goal of encouraging renewable energy supply, but each specific RPS is designed differently. Our evaluation shows both successes and failures with this policy mechanism – some state RPS policies are positively impacting renewable energy development, while others have been poorly designed and will do little to advance renewable energy markets.

We emphasize the importance of policy design details, and specifically highlight critical design pitfalls that have been commonly experienced. Though experience with the RPS is still limited, we have now gained some knowledge of the conditions and design features necessary to make an RPS policy work. An important objective of this report is therefore to identify and describe broad policy design principles and specific best practice design elements that might be used to guide the design of future renewables portfolio standards.

1. Introduction

Renewable electricity can provide fuel diversity, security, economic development, and environmental benefits. Because of these advantages, policymakers in the U.S. and other countries have long been interested in encouraging the development of renewable energy markets through specific incentive policies and mandates.

Among the available policy tools, the renewables portfolio standard (RPS) – also known as a renewables "obligation" or "quota" system – has become increasingly popular in some jurisdictions. An RPS ensures that a minimum amount of renewable energy is included in the portfolio of electricity resources, and does so by requiring retail electricity suppliers to add a specified amount or percentage of eligible renewable resources to their supply mix.

Some stakeholders consider the RPS to be a superior way to encourage renewable energy development; proponents of the RPS claim that it will ensure that renewable energy targets are met at a lower social cost and with less ongoing administrative involvement by the government than other renewable energy policies (Rader and Norgaard 1996; Haddad and Jefferiss 1999; Clemmer et al. 1999; Berry and Jaccard 2001). Detailed recommendations for the design of an RPS have been provided in other papers (e.g., Rader and Hempling 2001; Schaeffer et al. 2000).

Despite the recent acclaim and popularity of the RPS, however, the policy also has detractors. Just as the RPS has certain advantages relative to other policy types, it also has disadvantages (see Section 2.2). Moreover, detailed evaluations of RPS policy experience are just beginning to emerge, in part because the RPS is a new policy and practical experience with the application of the policy has, until recently, been limited. Where experience does exist, that experience has been decidedly mixed (Rader 2000).

This report describes the status and results of 13 existing state RPS policies in the United States, and critiques the effectiveness of these policies based on a series of objective criteria. The need for such a review is urgent: the RPS has grown in popularity worldwide, but much remains to be learned about the advantages, disadvantages, and appropriate design of such policies.

The report is organized as follows:

- Section 2 provides a more detailed introduction to and description of the RPS, and briefly summarizes the theoretical advantages and disadvantages of the policy.
- Section 3 identifies jurisdictions that have established RPS policies, highlights some of the key features of U.S. RPS programs, and describes the impacts of these policies to date.
- Section 4 summarizes a set of evaluation criteria that can be used to judge the effectiveness of RPS policies. This section then applies those evaluation criteria to the 13 existing state RPS policies in order to judge the effectiveness and design of these policies, and to identify policy design failures and successes in each state.
- Based on this experience, Section 5 identifies broad policy design principles and specific best practices that might be used in the future to guide the design of RPS policies.
- The report concludes with a summary of key findings in Section 6.

2. The RPS in Context

2.1 What is an RPS?

The RPS is a policy that requires retail suppliers of electricity (otherwise referred to as load-serving entities, or LSEs) to meet a specific portion of their energy supply needs with eligible forms of renewable energy. RPS policies are generally designed to maintain and/or increase the contribution of renewable energy to the electricity supply mix. The RPS establishes numeric targets for renewable energy supply, applies those targets to retail electricity suppliers (i.e., LSEs), and encourages competition among renewable developers to meet the targets in a least-cost fashion. RPS purchase obligations generally increase over time, and LSEs typically must demonstrate compliance on an annual basis. The administrator of an RPS frequently levies penalties on those suppliers that fail to meet their renewable energy purchase obligations. Because the RPS sets quantitative targets for the supply of renewable energy, but allows electricity suppliers flexibility in how to meet those targets, it is expected that a properly designed RPS will lead to strong incentives for cost reduction.

LSEs can meet their RPS requirements with renewable energy facilities that they already own or that they construct, or through bilateral purchases of renewable electricity from independent generators. In some jurisdictions, LSEs can use tradable renewable certificates (TRCs) – also known as “green certificates” or “renewable energy credits” – to comply with their RPS requirements. A TRC is created when a megawatt-hour of renewable energy is generated, is a purely financial product, and can be traded separately from the underlying electricity generation, much like tradable emissions permits. TRC transactions create a supplemental revenue stream for renewable generators, and allow LSEs to demonstrate compliance with the RPS by purchasing TRCs in lieu of directly purchasing renewable electricity. In theory, TRCs should trade at a price that represents the incremental cost (relative to conventional power) of the marginal renewable generator needed to meet RPS requirements (see, e.g., Morthorst 2000). Relative to tracking actual renewable electricity contracts to verify compliance with an RPS, the use of TRCs can create liquidity and depth in the renewable energy market, increase compliance flexibility, and ease administrative burdens by simplifying compliance demonstration (see, e.g., Rader and Hempling 2001, for more information on TRCs and other RPS verification systems).

2.2 Comparing the RPS to Other Policy Approaches

In addition to the RPS, several other state and national policy approaches have been used to support renewable energy in the U.S. and worldwide, e.g., feed-in tariffs, tax incentives, renewable energy funds, tendering systems, and encouragement of voluntary purchases of green power.[1] While it is not the role of this document to evaluate these alternative policy options in

[1] Most prominent among these alternatives are feed-in tariffs, which offer fixed prices for renewable electricity supply. Feed-in tariffs have been especially popular in Europe, and have seen significant success in encouraging additional renewable energy development (see, e.g., Sijm 2003). There is an active international debate on whether the feed-in tariff approach, or the RPS, is the “best” mechanism for supporting renewable energy (see, e.g., Hvelplund 2001; Meyer 2003; Meyer and Koefoed 2003; Menanteau et al. 2003; and Huber et al. 2001).

detail, or to compare the RPS to each of these policy approaches, it is useful to consider the specific advantages and disadvantages of the RPS as a policy mechanism. The use of an RPS to support renewable energy development does have some *theoretical* appeal:

- The RPS can drive a known quantity of new renewable development, based on the specific standards that are established, and can ensure that there are buyers for that renewable energy.
- It can help lower the total cost of that development by giving LSEs the flexibility to meet their purchase targets in the way they deem best, and by encouraging competition among renewable developers for contracts with LSEs.
- An RPS can be competitively neutral if it is applied equally to all retail electricity suppliers.
- An RPS imposes relatively low administrative burdens and direct administrative costs on those responsible for overseeing the policy, because LSEs have the burden of contracting with renewable generators.
- An RPS can be applied in both restructured and monopoly electricity market contexts.

While the RPS has some theoretical advantages, the RPS also has some potential disadvantages:

- As documented in this report, due to its complexity, an RPS can be difficult to design and implement well.
- The exact cost impacts of an RPS cannot be known with certainty in advance, and will depend on the results of LSE efforts to comply with the policy.
- If an RPS does not lead to the availability of long-term power purchase agreements, the ability to finance new renewable projects will be limited and compliance costs may increase.
- An RPS may be less flexible in offering targeted support to renewable energy than policies that provide greater discretion to government regulators to oversee specific policy supports.
- An RPS is not necessarily suited to supporting diversity among renewable technologies (because it will encourage least-cost renewable supply options), although an RPS can be designed to do so through the use of “resource tiers” or “credit multipliers.”[2]
- Operating experience with the RPS remains limited, and lessons on the appropriate design of an RPS are only beginning to emerge.

[2] With “resource tiers,” electricity suppliers could, for example, be required to purchase a certain percentage of electricity from each renewable generation source: wind, solar, geothermal, etc. “Credit multipliers,” on the other hand, would effectively offer higher-cost renewable technologies multiple TRCs for each megawatt-hour of production, thereby giving those technologies more “credit” under an RPS than lower-cost renewable sources.

3. State RPS Policy Background

3.1 State RPS Policies and Their Design

The U.S. Congress has considered applying an RPS on a federal level in the United States, and a number of other countries have recent experience with the policy; countries with operating RPS policies include Australia, Belgium, Italy, Sweden, and the United Kingdom.[3]

The most extensive and diverse base of experience with the RPS on a worldwide basis arguably exists in the United States, however, where 13 states have created some form of RPS policy: Arizona, California, Connecticut, Iowa, Maine, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, Pennsylvania, Texas, and Wisconsin. Electricity suppliers in these states collectively serve over 30% of total U.S. electricity consumption. More than half of these existing RPS policies are located in states that have restructured their electricity markets, opening those markets to retail competition. Nonetheless, a growing number of state RPS policies have been established in traditional, still-regulated monopoly electricity markets. Importantly, while the number of states that have created RPS policies is large, experience with these policies remains somewhat limited; few of the states have more than four years of experience with their RPS programs, and some of the policies have been established but have yet to take effect.

An important observation is that there is clearly no single way to design an RPS, and each of the 13 states has crafted their RPS policies differently, sometimes radically so. The percentage purchase obligation, for example, increases to just 1.1% in Arizona, but to 20% in California. While wind, solar, and geothermal energy are eligible under most of the RPS policies, criteria for the eligibility of biomass and hydropower varies considerably across states. Some of the key design choices for an RPS are listed in Text Box 1.[4]

Cursory observations on the design and unique characteristics of each state RPS policy are provided below.

- **Arizona's** RPS was established through regulatory action, not via legislation. The renewable energy percentage obligations are low, starting at 0.2% in 2001 and increasing to 1.1% by 2007, but much of the standard (50-60%) must be met with new solar energy production. The RPS is funded, in large part, through a system-benefits charge.[5] A cost-benefit evaluation of the RPS was completed in 2003, but the future design of the RPS in Arizona is currently the subject of regulatory and stakeholder discussions.

[3] For information on the RPS policies being used or considered outside of the United States, see Meyer and Koefoed (2003), Meyer (2003), Verbruggen (2004), Lorenzoni (2003), Espey (2001), Berry and Jaccard (2001), Fristrup (2003), and Nielsen and Jeppesen (2003).
[4] For more detailed information on design options for an RPS, and the advantages and disadvantages of these design options, see Rader and Hempling (2001), Schaeffer et al. (2000), and Grace and Wiser (2003).
[5] A system-benefits charge is, effectively, a small tax on electricity rates, the funds from which can be used, in part, to support renewable energy projects.

- **California's** RPS was established in 2002, and may be the most complex of the state RPS policies. The targets are aggressive, requiring renewable energy additions of 1% each year on top of existing renewable production, until an ultimate target of 20% is reached. Renewable energy procurements are to be governed largely by the California Public Utilities Commission (CPUC) through a process that is not yet fully designed. LSEs are only obligated to purchase renewable energy to the extent that sufficient system-benefits charge funds are available to cover any above-market costs of these purchases.
- **Connecticut** has a two-tiered RPS: Class 1 includes solar, wind, ocean, landfill gas, fuel cells, new run-of-river small hydro, and certain biomass facilities, while Class 2 includes existing run-of-river small hydro, waste-to-energy, and certain other existing biomass facilities. Under legislation passed in 2003, Class 1 targets are to begin at 1% in 2004 and increase to 7% in 2010; the second tier, which can be met with Class 1 or Class 2 resources, has a target that remains constant at 3%. Connecticut's RPS began in 2000, but at that time exempted the largest electricity suppliers in the state. Legislative changes approved in 2003 have strengthened the policy, and stiff penalties for non-compliance were adopted.
- **Iowa's** legislature passed a law in 1985 (amended in 1991) requiring the state's investor-owned utilities to purchase 105 average MW of new renewable power. After years of legal battles, the utilities made the requisite purchases of wind power; the obligation is therefore no longer enforced.
- **Maine** nominally has the distinction of having the most aggressive standard, at 30% of load, beginning in 2000. Both existing and new renewable generation are eligible to meet the targets, however, and eligible resource types are broad, including fossil-fuelled cogeneration as well as more traditional renewable energy sources.

TEXT BOX 1:
RPS DESIGN ELEMENTS

Structure, Size, and Application of the RPS
- Percentage purchase obligation targets over time
- Start date for purchase obligations
- Duration of purchase obligations
- Structure (e.g., single % requirement, or multiple % requirements for each technology group)
- Renewable resource diversity requirements or incentives
- Application to LSEs – who must meet the obligations
- Product- or company-based application

Eligibility
- Resource type eligibility
- Allow imports, or just in-state facilities
- Eligibility of existing renewable generation
- Definition of new/incremental generation
- Eligibility of customer-sited renewable facilities

Administration
- Regulatory oversight body(ies)
- Verifying compliance – TRCs or contract-path
- Certification of eligible generators
- Compliance filing requirements
- Enforcement mechanisms (i.e., penalties)
- Existence of cost caps
- Compliance flexibility mechanisms
- Contracting standards for regulated LSEs
- Cost recovery for regulated LSEs

Interactions Between the RPS and Other Policies
- Interactions with other renewable energy policies
- Linkages with emissions credits policies

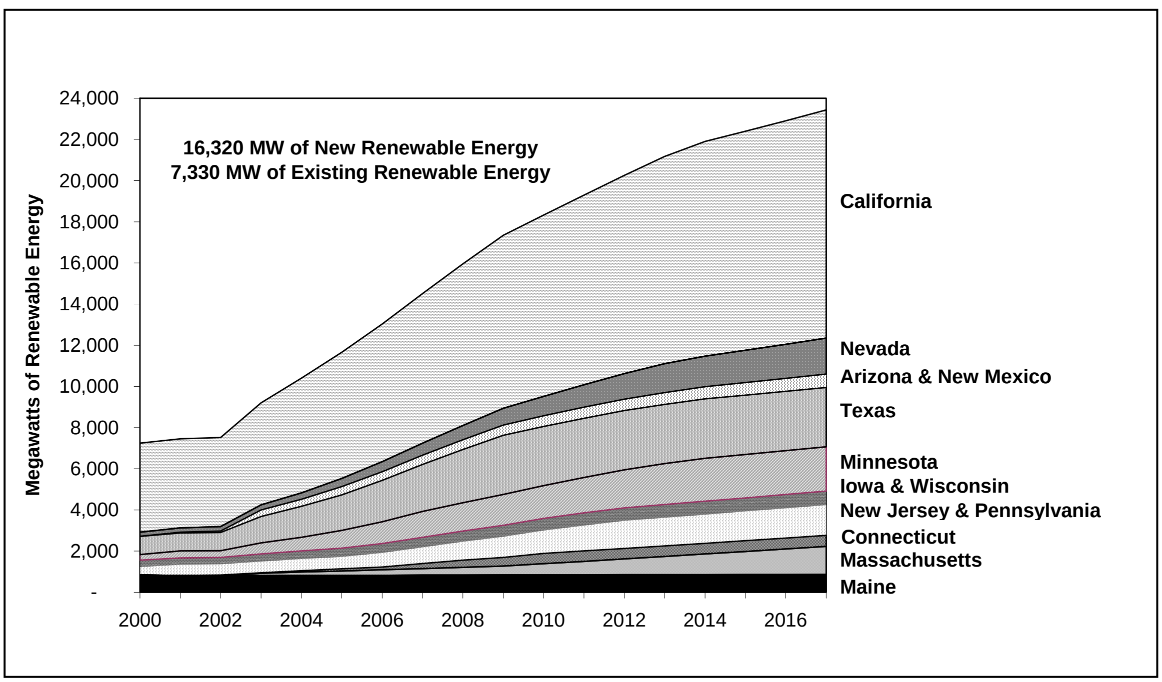
- **Massachusetts'** RPS focuses on new and incremental generation, and starts at 1% in 2003, increases to 4% in 2009, and increases further thereafter. An "alternative compliance mechanism" caps the incremental cost of the RPS at ~5 cents/kWh, and TRCs are used to verify compliance through a New England wide tracking system.
- **Minnesota's** legislature (in 1994) required Xcel Energy (the largest utility in the state) to purchase 425 MW of wind and 125 MW of biomass by 2002, as part of a radioactive waste management settlement, with an additional purchase of 400 MW of wind by 2012 (recently moved up to 2006). Legislation in 2003 established a statewide RPS goal of 10% by 2015. Most utilities must make "good faith efforts" to achieve this goal; Xcel Energy, however, is obligated in most circumstances to strictly meet those obligations.
- **Nevada** replaced a previously existing RPS with a more aggressive policy in 2001. The renewable energy purchase obligation begins at 5% in 2003 and increases to 15% in 2013; 5% of the obligation must come from solar energy. Both existing and new renewable generation may count towards the RPS.
- **New Jersey**, like Connecticut, has a two-tiered RPS: Class 1 technologies include wind, solar, geothermal, fuel cells, ocean power, landfill gas, and certain biomass technologies, while Class 2 includes certain hydropower and MSW facilities. Purchases of Class 1 technologies must start at 0.5% in 2001, and increase to 4% by 2012; purchases of Class 2 or Class 1 resources remains constant at 2.5%. A recent Task Force to the Governor has recommended significantly strengthening the state's existing RPS, and the state's regulatory body has proposed changes to the RPS to reflect those recommendations; proposed changes include raising the RPS to 4% by 2008, adding a specific purchase requirement for solar energy, and implementing an "alternative compliance mechanism."
- **New Mexico** first created an RPS through regulation in 2002, and then adopted legislation in 2004. The purchase targets start at 5% by 2006, increasing one percent annually to 10% by 2011. Existing and new renewables both qualify under the RPS. Certain large industrial customers are exempt from the RPS, and utilities may not have to comply with the RPS in a given year if the costs of complying would exceed a threshold that will be established by the New Mexico Public Regulation Commission by the end of 2004. Certificate trading is allowed but energy must accompany the certificate for delivery into New Mexico, unless the Commission determines that there is a regional market for exchanging certificates. Finally, the legislation does not supersede the earlier regulations, and the Commission could conceivably maintain some of the earlier regulations in implementing the legislation.
- **Pennsylvania's** renewable energy purchase obligations apply to a very small subset of electricity suppliers in the state. The standards are also quite low, and both existing and new renewable generation are eligible.
- **Texas** has perhaps the most well known RPS policy. The policy contains a target of 2000 MW of additional renewables by 2009 (~2.5% of state load), allows TRC trading, and includes explicit penalties for non-compliance. Existing renewable generation is allowed to offset a LSE's new renewable purchase obligations.
- **Wisconsin's** RPS begins at 0.5%, growing to 2.2% by 2011. Up to 0.6% can be met with existing renewable generation.

In addition to these 13 states, a number of other states are currently considering the application of an RPS policy, but have not yet formalized that consideration through legislative action. These states include, but are note limited to, New York, Colorado, the District of Columbia, Hawaii, Illinois, Vermont, Rhode Island, Maryland, Pennsylvania, and Washington.

3.2 The Impacts of State RPS Policies

Though the majority of the 13 state RPS policies have begun only recently, their collective impact over time could be reasonably substantial (Deyette et al. 2003). Figure 1 presents estimates by the Union of Concerned Scientists (UCS) of the projected effect of these existing policies on renewable energy development through 2017. The estimates in Figure 1 are derived from predicting the renewable energy generation needed to meet existing state RPS policies, then converting that generation to capacity by applying typical expected capacity factors. Importantly, the UCS estimates assume that the state RPS programs are designed effectively, and therefore represent an upper bound on the possible impacts of existing state RPS policies.

The figure clearly shows that, in aggregate, the 13 state RPS policies have the possibility of driving a substantial amount of renewable energy development, at least relative to historic rates of growth. In particular, the figure shows that existing RPS policies have the potential to stimulate over 16,000 MW of new renewable energy capacity by 2017 (and support the continued operation of over 7,000 MW of existing generation capacity). This is comparable to the total amount of existing, non-hydro renewables capacity currently in place in the U.S. It deserves note, however, that in the context of national electricity demand, these policies are modest; the generation delivered by 16,300 MW of new renewables capacity would represent approximately 1.7% of current electricity sales in the entire U.S. Moreover, the vast majority of the incremental renewable energy demands are expected to come from just a few states



Source: Union of Concerned Scientists

Figure 1. The Impact of State RPS Policies

While Figure 1 estimates the potential impacts of existing state RPS policies in the long run, these policies are already beginning to have an effect; this is especially apparent for wind power. In Texas, 915 MW of wind power came on line in 2001 in large part to serve the state's RPS; another 204 megawatts came on line in 2003. Iowa's policy has been met with 250 MW of wind installation, while Minnesota's initial mandate for 425 MW of wind and 125 MW of biomass has also largely been met. At the end of 2003, over 560 MW of wind and 33 MW of biomass were installed in Minnesota.[6] Wisconsin's RPS has supported approximately 140 MW of renewable energy so far, most of which is wind power, and much of which is new. An interim renewable energy procurement directed by the California Public Utilities Commission, in advance of that state's RPS, has resulted in substantial new procurements by the state's three investor-owned utilities.[7] In Nevada, a 2001 renewable energy solicitation resulted in contracts for 130 MW of wind, 97 MW of geothermal, and 50 MW of solar. Arizona's small RPS, meanwhile, has supported 7 MW of solar, over 10 MW of landfill gas and biomass, and has resulted in contracts for 15 MW of wind and 20 MW of geothermal capacity as well. The Massachusetts RPS, though it began in 2003, has already resulted in some merchant landfill gas activity, some incremental production at existing biomass plants, and increased site prospecting by wind, landfill gas, and biomass developers. New Mexico's RPS that was adopted through regulation was perhaps a contributing factor to a recent 204 MW wind power project in that state. Finally, New Jersey's RPS has contributed somewhat to the increased renewable development efforts of renewable companies in the mid-Atlantic region.

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[6] The Minnesota Legislature reduced the biomass mandate from 125 MW to 110 MW in 2003. The Legislature also allowed two planned biomass projects to increase their capacity, one from 50 to 55 MW and the other from 25 MW to 33 MW, and for a third biomass project to reduce capacity from 50 MW to 35 MW. Of these three biomass projects, only the 33 MW project is currently operating.

[7] One large utility has entered into five power purchase agreements with renewable energy generators, totaling over 1.5% of the utility's annual retail sales. Another utility signed contracts with 15 renewable energy projects that will produce nearly 4% of that utility's electricity needs in 2003, rising to approximately 7% in 2004. A final utility has reportedly signed contracts for 1.1% of their electricity requirements.

4. Evaluating State RPS Policies

4.1 Overview

A number of evaluation criteria might be applied to assess the actual or expected effectiveness of an RPS policy in supporting new renewables development. The principal goal of this section is to introduce and apply criteria for making such judgments. We first list and briefly describe 16 evaluation criteria that we developed to judge RPS policies. We then apply those criteria to the 13 existing state RPS policies identified in the previous section.

4.2 Policy Evaluation Criteria

RPS policies are at different phases of implementation: some have been operating for several years, while others have yet to begin. To accommodate the different phases of RPS implementation, our 16 evaluation criteria fall within three broad categories:

- **Outcome criteria** assess the actual impacts and results of state RPS policies. Where an RPS policy has been operating for several years, an assessment of the impact of that RPS on renewable energy development, economic costs, and other factors can be made. In other cases, state RPS policies have not been operating for a sufficient duration to conclusively apply the outcome-based criteria.
- **Policy design criteria** include legislative and regulatory RPS design features that will affect the success of an RPS. Particularly where an RPS has not been operating for sufficient time to judge its success in meeting the outcome criteria, we must instead judge that state's policy against a series of policy design criteria. A well-designed RPS is more likely to be effective in the long run than a poorly designed policy.
- **Market context criteria** are included to reflect the fact that even a well-designed RPS may fail to have its intended effects if the market in which it is applied is not conducive to such a policy, for example, if viable renewable resource options do not exist or long-term renewable energy contracts are not available.

We identify and briefly describe our specific evaluation criteria in Table 1. We base these criteria on experience with RPS policies in the U.S. and abroad, our own professional judgment, review comments provided by a stakeholder group overseeing the initial drafting of this paper, and interviews with a variety of individuals knowledgeable with RPS policies. Ultimately, 16 criteria were developed, including 4 outcome criteria, 9 policy design criteria, and 3 market context criteria. More information on the criteria, and their creation, can be found in Wiser et al. (2003).

Table 1. Renewables Portfolio Standard Evaluation Criteria

OUTCOME CRITERIA	
Amount of New Renewable Energy Development	The principal goal of an RPS is typically to drive renewable resource development and increased production of renewable electricity. As such, a critical outcome-based criterion is the degree to which an RPS drives such development.
Full Compliance with RPS Policies	A hallmark of an effective and sustainable RPS is one in which all load-serving entities (LSEs) are in full compliance with the renewable energy purchase obligation. If some obligated LSEs are not in compliance with the policy, that lack of compliance may undermine the political stability of the policy as a whole.
Reasonable and Stable Cost Impacts	Load-serving entities, end-use electricity customers, and policymakers desire stable, reliable, and reasonably priced electricity supply. An RPS that unduly raises the cost of electricity to end-use customers, or whose costs vary considerably from one year to the next, is unlikely to be viable over the long run. Compliance with the RPS should not be unduly burdensome.
Prudently Incurred Compliance Costs Borne by Ratepayers	Because the benefits of renewable electricity flow to consumers at large, it is also important that those same consumers bear the costs of the policy. Prudently incurred RPS compliance costs should therefore be recovered from end-use electricity customers.
POLICY DESIGN CRITERIA	
Broad Applicability	A well-designed RPS would ideally apply equally and fairly to all load-serving entities in a state (or, at minimum, to all possible suppliers to any customer whose load is included in the mandate), ensuring that all those who benefit from increased renewable energy production also bear a proportion of the costs.
Carefully Balanced Supply-Demand Condition	An effective RPS will have renewable energy purchase standards of sufficient size and structure, coupled with sufficiently tight resource eligibility rules, to ensure that the policy is (1) binding enough to lead to new renewable energy development, without (2) being so binding as to foreclose feasible compliance.
Sufficient Duration and Stability of Targets	Well-designed RPS policies will be of sufficient duration to allow long-term contracting and financing to occur for renewable energy projects, and have purchase targets that are stable over time and are not subject to sudden or uncertain shifts. Without this certainty, renewable developers are unlikely to be able to bring their projects to fruition.
Well-Defined and Stable Resource Eligibility Rules	The eligibility of specific renewable energy technologies under an RPS should be well defined. Ambiguity as to what resources are eligible, or may become eligible, creates market uncertainty for both renewable developers and LSEs.
Well-Defined and Stable Treatment of Out-of-State Resources	Decisions on the eligibility of out-of-state renewable generation affect the aggregate impact of an RPS, the location of the benefits delivered by an RPS, and the legal defensibility of the policy as a whole. Well-designed RPS policies will have a well-defined, supportable stance on this issue that is both consistent with the stated objectives of the RPS and that is not subject to sudden change.
Credible and Effective Enforcement	An effective RPS must typically be mandatory and impose repercussions on those LSEs that fail to meet the specified renewable energy purchase mandates. Only with credible enforcement will state policymakers ensure that the RPS is met, will renewable developers know that their efforts are not in vain, and will financiers understand the risk of their investments.

Flexible Verification Mechanisms	A variety of approaches can be used to verify compliance with an RPS. The TRC approach is generally preferable because it can simplify verification, provide greater assurance of no double counting, increase contracting flexibility, and lower compliance costs. In monopoly markets with stable resource portfolios and few transmission constraints, however, a contract-path approach of tracking electricity contracts may be sufficient.
Adequate Compliance Flexibility	Compliance with stringent and unyielding renewable purchase obligations in the face of supply constraints and demand fluctuations that are difficult to predict or control can prove challenging and costly, and may encourage the exercise of market power by renewable energy generators. State RPS policies would ideally build in some compliance flexibility. If RPS policies are overly flexible and lenient, however, the likelihood of gaming and non-compliance could intensify, and the complexity of administering the RPS could increase.
Contracting Standards and Cost Recovery Mechanisms for Regulated Utilities and Providers of Last Resort	For competitive electric suppliers, regulators cannot realistically specify renewable energy contracting standards or RPS compliance cost recovery mechanisms; in most cases, the competitive market must be relied upon to handle these issues. RPS policies have now been implemented in a number of markets that remain vertically integrated and tightly regulated, however, and even in purported competitive markets providers of last resort remain regulated (providers of last resort are the suppliers that offer electrical service to those consumers who have not selected a competitive provider). In these cases, regulatory bodies may need to establish standards for how renewable energy should be procured to ensure that renewable projects receive the long-term contracts necessary to attract financing. Regulators must also establish clear mechanisms for the recovery of prudently incurred RPS compliance costs by rate-regulated LSEs.
Product-Based, as Opposed to Company-Based Compliance Mechanisms	A *company-based* application of an RPS would allow LSEs to meet their RPS obligations through the sale of green power to those customers willing to pay a premium for that product. An emerging best practice, however, is the application of the renewable energy target to each electricity *product* sold to end-use customers. Such an application ensures that customers are not misled as to the incremental effect of their purchases, that voluntary customer demand for renewable energy is *additive* to any demand generated by the RPS, and that the cost of the RPS is shared equitably among all electricity users.
MARKET CONTEXT CRITERIA	
Presence of Creditworthy Long-Term Power Purchasers	Renewable projects generally require long-term contracts for the sale of their electrical output in order to receive reasonably priced financing. Markets in which such contracts are unavailable or extremely scarce are unlikely to be conducive to the effective implementation of an RPS.
Stable Political and Regulatory Support	To minimize uncertainty and allow for the staged development of renewable resources, a stable level of political and regulatory support for an RPS is essential.
Adequate and Accessible Developable Resource Potential	Some regions are poorly endowed with renewable resource potential, while in other regions adequate potential may not be cost-effective given transmission constraints, wholesale market rules, and interconnection barriers. Applying an RPS in such regions must be done with care.

4.3 Application of the Evaluation Criteria

The evaluation criteria described above were devised to provide a useful framework for qualitatively assessing the actual or likely effectiveness of RPS policies. Nevertheless, it is challenging to precisely evaluate policies based on this framework. In Wiser et al. (2003), we apply these criteria, identify the most critical strengths and weaknesses of the 13 state RPS policies currently in place, and offer an overall qualitative assessment of each of the existing policies. In the body of the present report, however, we avoid that level of detail, and instead summarize the key findings from this assessment, discussing each category of criteria in turn. As with most evaluations, a significant amount of judgment was required on our part to complete this assessment.

4.3.1 Outcome Criteria: The Good, the Bad, and the Ugly

Many of the state RPS policies have not been in operation long enough to judge them comprehensively based on the outcome criteria. Nonetheless, despite limited experience to date, a variety of states are succeeding on one or more of these criteria.

Of the 13 state RPS policies currently in place, **Texas** has clearly shown the most success overall. The Texas policy has driven substantial new wind power additions, with over 900 MW installed in 2001, and 204 additional megawatts installed in 2003. This wind power development has been achieved with reasonable cost impacts that are being passed on to customers (long-term wind power contracts have averaged ~3 cents/kWh, equivalent to or below the cost of conventional power) and, with only very modest exceptions, retail suppliers are fully complying with the policy. Relative to aggregate electricity usage in the state, however, the Texas RPS contains a very modest renewables requirement (~2.5% by 2009). Despite this, the Texas policy clearly meets all four of the outcome-based criteria listed in Table 1 (for more information on the Texas RPS, see Wiser and Langniss 2001).

The renewable energy mandates in the regulated markets of **Iowa** and **Minnesota** have also succeeded in meeting their stated objectives, with hundreds of megawatts of wind developed in each state so far.[8] Each of these state policies has been met with nearly full compliance (after substantial delay in Iowa), and has had reasonably stable costs supported by end-use customers. Again, these policies largely meet all four of the outcome-based criteria. Legislative amendments that make a previously enacted renewable energy goal mandatory for Xcel Energy could stimulate more renewable energy in Minnesota, although how the new requirement is implemented will determine the success of these amendments.

The success of other states in meeting these criteria is mixed, but some success has been achieved or is expected in a number of different jurisdictions:

- **Nevada** has an aggressive policy that has already led to 277 MW of new renewable energy contracts, though the development of many of these projects has been delayed. Costs are likely to remain reasonable and stable (initial contracts are priced at 3 - 5.5 cents/kWh), with prudently incurred costs passed on to customers. Utility compliance will not be complete, however, at least in the initial years in part due to the poor credit of the state's utilities.
- **California's** RPS design has not yet been entirely finalized, so the ultimate effectiveness of the policy remains uncertain. Despite this, the three major investor-owned utilities in the state have already procured a significant amount of renewable resources under a 2002 interim procurement, in advance of the RPS, and additional procurements have occurred in 2003.

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[8] Here we are rating the earlier wind and biomass mandates for Xcel, not the newly enacted renewable energy obligation.

Whether full compliance with the 20% requirement will be achieved is somewhat uncertain, however, given the potential scarcity of system-benefits charge funds to pay for the above-market cost of renewable energy.

- **Connecticut's** policy has had little effect on new renewables supply to date, though with changes to the statute in mid-2003, the RPS in that state has been greatly improved; Connecticut may therefore rate far better on the outcome-based criteria in coming years.
- **Wisconsin's** program rates highly on the outcome criteria: utilities are complying and in many cases over-complying with the RPS, costs are reasonable and stable, and prudently incurred costs are being passed on to ratepayers. With a low overall RPS standard combined with early over-compliance, however, the policy is unlikely to drive substantial additional development for years to come.
- **Arizona's** policy has led to some modest new renewable energy development (perhaps most notably, ~7 MW of solar), with costs recovered through rate surcharges, but full compliance with the state's renewable energy targets has not been achieved.
- **Massachusetts'** RPS is leading to increased renewable energy development activity in New England. Whether that development activity results in substantial additions to new renewable energy supply, at reasonable and stable costs, remains unclear given the current scarcity of long-term contracting.
- **New Jersey's** policy has been met with full compliance so far, and the cost burden has been low. The RPS has had an indirect influence on renewable energy development in the region, but will not alone help build new markets for renewable energy for years to come unless the RPS targets are strengthened, as expected based on recently proposed revisions to the RPS by the state's electricity regulators.
- **New Mexico's** policy has only recently been established, and because of this, no direct impacts can yet be reported.
- **Minnesota's** renewable energy obligation, adopted in 2002, imposed a "good faith" obligation on utilities to provide 10% of their energy needs from renewable energy by 2015. In 2003, the obligation was made a requirement for Xcel Energy, and was maintained as a "good faith" goal for other utilities. Much depends on how the Minnesota PUC implements the legislation and defines "good faith." A PUC decision is due by June 2004.

Other state RPS policies have had little to no impact on renewable energy markets so far, despite some operational experience, and therefore clearly rate poorly on the outcome-based criteria.

- **Maine's** policy is designed in a way that ensures that no new renewable energy development will occur, and the policy will have no impact without fundamental redesign.
- **Pennsylvania's** policy has had no impact on new renewable energy supply, and with few suppliers required to comply with the policy, its impact will remain muted.

In sum, based on the outcome criteria, Texas, Minnesota (earlier Xcel mandate), and Iowa rate most highly: these policies have worked (Iowa) or are working (Texas and Minnesota). Maine and Pennsylvania receive failing grades. All other states operate in a gray area where either some success has been achieved, but that success is not complete, or the policy has not been operating long enough to fairly judge its success on the outcome-based criteria.

4.3.2 Policy Design Criteria: Common Pitfalls

Experience with state RPS policies is clearly mixed. Some states have succeeded with their policies, in part due to strong design features, while the policies in many other states are not operating as was expected. It is evident from this experience that crafting a well designed RPS is a balancing act: a number of elements need to be designed well, and if any one design element falls short, the policy may fail to achieve its objectives. Equally clear is that U.S. states have implemented policies that contain a variety of design pitfalls.

Based on our evaluation, the key design weaknesses and strengths of each state's RPS are briefly summarized in Table 2, below.

Table 2. RPS Policy Design Strengths and Weaknesses, by State

State	Design Strengths	Design Weaknesses
AZ	• reasonable supply-demand balance ensuring some limited new supply, especially solar • reasonably broad application, with some exemptions • adequate verification and compliance flexibility • cost recovery mechanisms exist for utilities	• uncertainty in duration and stability of targets due to 2003/2004 evaluation of policy • uncertainty in resource and geographic eligibility rules due to 2003/2004 evaluation; unclear eligibility of geothermal • lack of enforcement and non-compliance penalties has resulted in significant under-compliance with the standards • legality of in-state restriction for some resources is unclear • company based application of RPS and even encouragement of green power sales to meet RPS
CA	• supply-demand balance ensures substantial new renewables development • broad applicability, with partial exemption to publicly owned utilities • well defined and stable resource and geographic eligibility rules • policy duration is sufficient • PUC and CEC developing effective enforcement, compliance flexibility, and verification • detailed contracting standards and cost recovery mechanisms to be established	• policy design complexity and uncertainty and delaying implementation of the policy • decisions that might best be left to the market are instead made administratively in part because of use of SBC funds to support over-market costs • availability of SBC funds may limit impact of policy • temporary exemption of non-creditworthy utilities may delay impact of policy, but unlikely to have major long-term effect
CT	• few strengths in original RPS, but new legislation improves RPS design • supply-demand balance ensures new renewables development • reasonably broad application, with publicly owned utilities exempt • duration and stability of targets appear reasonable • enforcement is strong, with penalty of 5.25¢/kWh • adequate verification and compliance flexibility • some long-term contracting standards for utilities	• original RPS had many weaknesses: it was not broadly applicable, with exemptions provided to providers of last resort who dominate the market; the supply-demand balance was poor; there was uncertainty in the duration and stability of targets; it had poorly defined resource eligibility rules, with "sustainable" biomass not adequately defined; and it had vague noncompliance penalties • new RPS legislation improves RPS, but possible weaknesses include: biomass eligibility rules remain vague; scope of geographic eligibility and inter-region TRC trading is unclear; and it is not clear if the policy applies on company or product basis

State	Design Strengths	Design Weaknesses
IA	• supply-demand balance and policy design led to 250 MW of wind installation • well defined and stable resource and geographic eligibility rules • reasonably broad application, with publicly owned utilities exempt	• with delays and legal maneuvers, policy took more than 15 years to implement; policy stability and enforcement were therefore both problems • legality of in-state restriction is unclear, though it was never successfully challenged
ME	• reasonably well defined and stable resource and geographic eligibility rules • reasonably broad application, with publicly owned utilities exempt • adequate verification and compliance flexibility • product-based application of targets	• supply-demand balance is poor, with eligible supply far outweighing RPS-driven demand • uncertainty in duration and stability of targets given policy review required after 5 years of experience • vague noncompliance penalties • perhaps too lenient in compliance flexibility
MA	• reasonably broad application, with publicly owned utilities exempt • duration and stability of targets are strong • well defined and stable resource eligibility rules • enforcement is likely to be adequate, with alternative compliance mechanism of ~5¢/kWh • adequate verification and compliance flexibility • product-based application of targets	• lack of contracting standards for providers of last resort contributes to deficiency of long-term contracts • some uncertainty in long-term treatment of out-of-region resources • supply-demand balance weakness possible in early years, due to insufficient lead time to bring new renewables on line
MN	• supply-demand balance and policy design has already led to substantial wind and some biomass • reasonably well defined resource and geographic eligibility rules • duration and stability of targets are strong • contracting guidelines and cost recovery mechanisms • while penalties are not explicit, regulatory oversight has ensured compliance • flexible compliance is allowed in future years	• original mandate and more recent RPS legislation are not broadly applicable; only Xcel is obligated • in the past, utility has tried to green price some of its obligated renewable energy capacity (company-based application), and 2003 legislation is unclear on whether it will be company-based or product-based • 2003 renewable energy obligation is a "good faith" obligation for utilities other than Xcel—up to PUC to determine what that means • 2003 legislation has unclear rules for geographic eligibility • 2003 legislation is not entirely clear on the circumstances in which Xcel might be relieved of its RPS obligations, but such circumstances clearly exist • in 2003 legislation, unclear whether flexible compliance mechanisms such as credit trading will be adopted
NV	• supply-demand balance ensures substantial new renewables development • reasonably broad applicability, with exemption for publicly owned utilities • well defined and stable resource and geographic eligibility rules • duration and stability of targets appear strong • adequate verification and compliance flexibility • contracting standards and cost recovery mechanisms	• legality of geographic requirements is unclear • aggressive purchase requirements may strain resource availability in the long term • supply-demand balance weakness in early years, with insufficient lead time to bring new renewables on line • vague noncompliance penalties not yet a concern, but could become an issue in the future • eligibility recently expanded via legislation, suggesting some instability in eligibility rules

State	Design Strengths	Design Weaknesses
NJ	• reasonably broad applicability, with exemption to publicly owned utilities • duration and stability of targets appear strong, with consideration given to increasing the policy's stringency over time • legislative definition of eligible biomass is unclear, but regulatory authorities have clarified the situation somewhat • alternative compliance mechanism under new RPS rule will provide strong enforcement	• supply-demand balance, poor under old rules, will be strengthened under new rules; solar requirement may be a stretch to meet, unless contracting standards are established • strong and flexible compliance mechanisms do not yet exist, although proposed PJM certificate system will resolve this • contracting standards once the RPS becomes binding may become an issue for providers of last resort • current policy appears to apply on a company basis, though proposed revisions apply on product basis
NM	• supply-demand balance should drive new renewables, though much will depend on ultimate rules for the eligibility of existing out-of-state generators • duration of policy appears strong • reasonably well defined and stable resource eligibility rules • adequate verification and compliance flexibility allowed in legislation • contracting standards and cost recovery mechanisms to be overseen by regulatory commission • Although not clear, appears that policy applies on a product basis	• no specific enforcement mechanisms established in legislation • RPS may be deferred if utility determines costs are too high via yet-to-be-established PUC thresholds • some large industrial customers are exempt from RPS • vague portfolio diversification provisions will require careful PUC implementation
PA	• resource eligibility rules are reasonable clear and well defined • policy effectively applies on a product basis	• not broadly applicable, with all but a very few electric service providers exempt • poor supply-demand balance ensures that new renewable generation will not be required to meet policy • unclear policy duration • enforcement mechanisms are unspecified • geographic eligibility rules are not specified • strong and flexible compliance mechanisms do not exist
TX	• supply-demand balance ensures new renewables development • reasonably broad applicability, with exemption to publicly owned utilities • well defined and stable resource and geographic eligibility rules • duration and stability of targets are strong • adequate verification and compliance flexibility • enforcement is strong • policy applies on a product basis	• legality of geographic requirements is unclear • some have argued that RPS should provide greater compliance flexibility to LSEs, given run-up in TRC prices in late 2002
WI	• supply-demand balance ensures some new supply • broad applicability, with few exemptions • well defined resource and geographic eligibility rules • enforcement is somewhat vague, but in a regulated market this has done little damage • adequate verification and compliance flexibility	• low RPS standard ensures only limited new supply • duration of policy is somewhat vague

Rather than describing these weaknesses and strengths by state in detail here, below we instead identify and provide examples of some of the more common and critical design pitfalls experienced by state RPS policies to date. Each of these pitfalls correlates with one of the design criteria listed in Table 1, and these are pitfalls that other jurisdictions should generally seek to avoid because, as we show, they can completely undermine the objectives of an RPS:

- **Narrow Applicability:** State RPS policies typically apply to investor-owned electric utilities and (if they are allowed in the state) competitive energy service providers. Many states have provided partial exemptions in meeting RPS requirements, the most common of which is to exempt publicly owned electric utilities from meeting the standards (most, but not all, states provide this exemption). Such minor exemptions (publicly owned utilities typically serve less than 30% of electricity load), while not ideal and certainly not competitively neutral, will not generally do major damage to an RPS. More comprehensive exemptions, however, can destroy the potential impact of RPS requirements. In fact, such broad exemptions are the key reason that Pennsylvania rated so poorly on the outcome-based criteria, described earlier. Connecticut's *initial* RPS law also rated poorly on this metric, because the legislature originally exempted providers of last resort from meeting the RPS. These providers serve the customers that have chosen not to switch to a competitive provider, and have accounted for well over 95% of the total load in the state. As such, until recently (under the legislative changes to the policy in 2003), the RPS applied to less than 5% of electricity load in the state, eviscerating the impact of the RPS. Furthermore, when an RPS requirement does not apply to every potential supplier, it is not competitively neutral and creates barriers to entry to competitive electricity suppliers. Though Connecticut recently expanded the applicability of their policy to "fix" this problem, Pennsylvania's policy still exempts most major LSEs in the state and, in part as a result, the policy is not expected to benefit the renewable energy industry. New Mexico's 2004 RPS legislation, meanwhile, exempts large industrial customers and a single utility that has an all-requirements power contract, which will limit the impact of that state's RPS. The 2003 legislative amendments in Minnesota impose an RPS on Xcel Energy, requiring other utilities to make "good faith" efforts to comply, and even Xcel's RPS may not be applied if reliability impacts are determined to be significant.

- **Poorly Balanced Supply-Demand Conditions:** Another key design pitfall relates to supply-demand imbalances for renewable energy. Maine provides the quintessential example for this pitfall, and this is the critical reason for Maine's poor showing on the outcome-based criteria. Even with a nominally high RPS obligation of 30%, resource eligibility rules are so expansive in Maine that eligible supply far exceeds demand; in Maine, existing renewable generation is eligible, as is existing fossil-based cogeneration, with in-state renewable energy supply alone exceeds 30%. The policy has therefore had no effect on new renewable generation in the region, or even provided significant support to existing sources of renewable generation. Other states that have had similar, yet less severe problems include Connecticut (resolved because of the 2003 legislation); New Jersey (will be resolved once the proposed RPS regulations in that state take effect), and Pennsylvania. New Mexico may also face this problem, because the 2004 RPS legislation allows existing renewable resources to qualify for that state's RPS, and because of the ample supply of out-of-state renewable energy if New Mexico allows out-of-state certificates without requiring energy delivery as well. Still other states have left insufficient time between finalizing the implementation rules of their RPS and the incidence of the first standard, with early non-compliance or shortages of renewable energy generation a likely result. Nevada and perhaps Massachusetts appear likely to fall in this camp, while New Jersey's solar requirement may also prove challenging to meet.

- **Insufficient Duration and Stability of Targets:** The renewable energy targets inherent in some state RPS policies are too unclear or of inadequate duration to provide sufficient certainty to renewable energy investors. Without this certainty, renewable generators may not be able to obtain the long-term sales contracts that are necessary to access low-cost finance.[9] At the same time, LSEs may not be able to plan for long-term, least cost compliance with a policy whose duration itself is unclear. Arizona's policy arguably suffers from this failure, with a 2003 cost-benefit evaluation, and ongoing hearings in 2004, that will help determine the fate and design of the policy after just several years of policy experience. The duration of Maine's policy is also unclear, with a legislatively established review of the policy to occur after just 5 years of experience (by 2005). In other cases, the fate of the standard after a certain date is simply left unspecified: this is the case in Pennsylvania and other states.

- **Insufficient Enforcement:** We find that some states inadequately enforce their RPS policies. Arizona perhaps provides the best example. With no penalties for non-compliance, and with specified ratepayer surcharges being collected to help fund the RPS, the utilities appear to have largely opted to comply with the policy only up to the amount of funds that have specifically been collected for that purpose; full compliance has not been achieved. In other cases, the implications of non-compliance are left vague or unspecified: this is the case in Maine, Minnesota, Nevada, New Mexico, and Pennsylvania. In electricity markets that remain tightly regulated, such as Minnesota, Nevada, and Wisconsin, we find that such vague enforcement standards may be sufficient: as long as obligated utilities know that the regulator is serious, they will comply. In restructured markets, however, a more clear non-compliance penalty such as that used in Texas, Massachusetts, Connecticut, and soon New Jersey may be preferred (Texas, for example, applies a penalty of as much as 5 cents/kWh for any shortfall in compliance).

- **Poorly Defined or Non-Existent Contracting Standards and Cost Recovery Mechanisms for Regulated Utilities and Providers of Last Resort:** This design pitfall has emerged as a critical failure that now faces several states. In restructured electricity markets that are open to multiple electricity suppliers, providers of last resort serve the needs of those customers not served by a new competitive electricity supplier. As a practical matter, these providers often serve the majority of customer load and remain regulated by state public utilities commissions. These providers also sometimes rely almost entirely on *short-term* wholesale electricity contracts to serve their customers' needs. Absent regulatory standards that require or encourage *long-term* renewable energy contracts, and cost recovery mechanisms that allow prudently incurred costs to be passed on to customers, the RPS compliance efforts of these providers of last resort may be sub-optimal from a societal perspective. In

[9] For a broader discussion of the need for long-term power purchase agreements, and the impact of policy design on these agreements, see Wiser et al. (1997). For information on the risks inherent in TRC systems that emphasize short-term trade, see Lemming (2003).

Massachusetts, for example, a lack of contracting standards for providers of last resort has (in part) led to an almost complete absence of long-term contracts for new renewable generators. Until long-term contracts develop, RPS compliance costs will likely remain high, shortfalls in compliance may develop, and renewable developers may well be unable to finance new renewable energy facilities. The same situation may ultimately arise in New Jersey and other states. Two potential solutions that have been proposed include: (1) having a state entity centrally procure renewables through a competitive bidding solicitation, such as has been suggested in New York for that state's proposed RPS, and (2) requiring utilities to sign long-term contracts for a portion of their RPS obligations, such as Connecticut's requirement for utilities that provide standard offer service to sign 100 MW of renewables to long-term contracts. In states in which electricity competition is not allowed, meanwhile, the need for contracting standards is even more evident. In these states, only regulated, monopoly utilities serve end-use customer load. Here, one of the key design variables to consider is how utility regulators might best design contracting and cost recovery standards in a way that gives utilities some flexibility in making renewable energy purchases, while at the same time ensuring the prudence of the costs that are then incurred and that different renewable resources are compared with one another in a fair and objective manner.

In addition to these major pitfalls, other pitfalls that states have fallen into are less severe. These pitfalls may not undermine the overall goals of RPS policies, but may make the achievement of those goals more costly, uncertain, or undesirable:

- **Poorly Defined and Unstable Resource Eligibility Rules:** Renewable resource eligibility rules in some states are poorly defined and subject to ongoing change. Several states have sought to limit eligible biomass generation to "sustainably" harvested sources, for example, without an adequate definition of what that term means: Connecticut, even with the legislative changes in 2003, falls into this category.

- **Poorly Defined and Unstable Rules for Out-of-State Renewable Generation:** Other states have left the eligibility of out-of-state renewable generation unclear: Pennsylvania, Minnesota, New Mexico and Connecticut, for example, are somewhat unclear on their geographic eligibility requirements. Still other states have required that eligible renewable projects be located within the state, or have applied rules that have a similar effect, potentially risking legal challenge under the Interstate Commerce Clause and the North American Free Trade Act. Arizona, Iowa, Nevada, and Texas could all face such a challenge.

- **Rigid Verification Mechanisms:** The use of TRCs is not an absolutely essential element of a state RPS; state regulators can instead track electricity contracts to verify compliance with an RPS, not allowing TRCs to trade separately. This is especially true in regulated, vertically integrated electricity markets where internal transmission constraints are limited: Minnesota and Iowa, for example, have implemented successful requirements without the use of TRCs. In all other cases, however, the use of TRCs will provide flexibility to LSEs in meeting their RPS obligations, and will offer other benefits briefly summarized in Table 1. Despite this, several states do not yet use TRCs as an accounting and trading tool – New Jersey, California, and Pennsylvania are obvious examples, though all three states are considering moving towards a TRC system.

- **Inadequate Compliance Flexibility:** Some states may not build in sufficient compliance flexibility into their programs. Compliance flexibility can come in many forms: banking of TRCs from one compliance period to the next, allowance for temporary under-compliance, and specific caps on the price of TRCs. Though experience is not yet sufficient to closely judge RPS policies based on this criterion, some stakeholders in Texas argued for additional flexibility in response to a late 2002 run-up in TRC prices in that state. More generally, there have been calls for greater flexibility in RPS compliance to mitigate potential volatility in TRC prices (see, e.g., Chupka 2003).

- **Company-Based Application of an RPS:** While not a critical design element for an RPS overall, product-based application is the preferable approach, for the reasons discussed in Table 1. And yet, a number of states have chosen to allow a company-based application, risking consumer confidence in green power markets; Arizona falls into this category.

Finally, though not an explicit policy design criterion, many stakeholders believe that the design of RPS policies should be as simple as possible. **Undue design complexity** might therefore also be considered a possible pitfall. The California policy is clearly the most complex and involved of the state RPS policies in place today. This complexity derives in large part from the fact that, unlike most RPS policies, the state's system-benefits charge is to be used to cover the above-market cost of renewable energy purchases. The use of public funds in this way subsequently requires a higher degree of regulatory oversight. A fear exists among some stakeholders that this design complexity and regulatory oversight will undermine the policy's overall effectiveness because it may limit "market" decisions, and because the entire design process may bog down in regulatory design details and be subjected to continual review and attack.

4.3.3 Market Context Criteria

Even where the design of an RPS is strong, some existing state policies do poorly on the market context criteria. In these cases, even an otherwise well-designed policy may fail.

- **Lack of Credit-Worthy Long-Term Power Purchasers:** As already noted, renewable energy projects generally require long-term contracts for their electrical output in order to obtain financing on reasonable terms. In regulated electricity markets, utilities can be obligated to purchase renewable energy under long-term contract. Such is the case in Nevada, California, and other states. In these cases, the question that remains is one of utility creditworthiness. Though it is likely to be a transitional problem, the Nevada RPS has already faced significant hurdles on this score, with some renewable developers hesitant to sign contracts with the state's utilities (or complete projects) because of credit concerns. In restructured markets, the lack of long-term contracting can be more endemic because electricity suppliers are unsure of their long-term load (and therefore renewable purchase) obligations. Even in Texas, only the utilities have been willing to enter long-term (> 10 year) contracts for renewable energy supply, with the smaller competitive electricity retailers generally content to purchase TRCs on the short-term market. In some states, this has led to predictable problems in financing renewable energy development. As noted earlier, Massachusetts provides perhaps the best example, where few suppliers have thus far been willing to enter into long-term contracts with renewable generators. The effect has been to slow renewables development and create a tight renewables supply condition.

- **Unstable Political and Regulatory Support:** The long-term fate of the RPS in several states is unclear given wavering political support. In Arizona, for example, the 2003/2004 cost-benefit assessment discussed earlier and the application of the policy through the regulatory (as opposed to legislative) process has led to substantial uncertainty. New Mexico's previous RPS regulations were challenged in the courts, though the new RPS law enacted in 2004 should ease that concern. The RPS in Maine, meanwhile, seems to face almost yearly legislative proposals for redesign or even elimination.

- **Inadequate or Inaccessible Developable Resource Potential:** Most state RPS policies have not been operating for sufficient time to test potential renewable supply constraints. However, concerns do exist in Massachusetts and Connecticut that supply may not ultimately be able to keep up with demand, at least from in-region sources. Texas, meanwhile, has run into transmission adequacy issues in delivering west Texas wind to the state's load centers, although the electrical grid administrator in Texas has approved a package of transmission expansions and improvements in west Texas that will provide some relief.

5. Policy Design Principles and Best Practices

There is clearly no single, "ideal" way to design an RPS, and the appropriate design of an RPS will depend most fundamentally on the specific goals of the policy. Nonetheless, our analysis of early RPS experience suggests a series of broad policy design principles and specific best practice design elements, identified and described briefly below. These seven principles and related best practices derive from our own experience with RPS policies, from stakeholder interviews described in Wiser et al. (2003), and from the RPS design criteria and state evaluations presented in the last section of this report. We note that some of the best practices will appear under more than one principle, as there is some overlap.

We believe that these principles and best practices can be productively used to guide RPS policy design in other states and countries. We acknowledge, however, that experience with RPS policies remains somewhat limited. It would therefore be appropriate to revisit these preliminary principles and best practices as additional experience is gained. We also note that designing an effective RPS often requires a balancing of often-conflicting goals. While the principles and best practices developed below can guide design decisions, considered policy tradeoffs will remain essential.

Principle #1: Socially Beneficial. A well-designed RPS will support increased renewable energy production, and thereby contribute to an improvement in environmental quality, to increased diversity in energy supply, to decreased risk, to improved economic development, and to other politically chosen objectives.

Best practices for implementing this principle ensure that:

- The RPS standard and eligibility rules are structured such that the supply-demand balance is sufficiently binding to lead to new renewable generation.
- Renewable energy purchase requirements increase over time to result in increasing benefits.
- An RPS is designed to increase the *net* amount of renewable electricity serving a jurisdiction; attrition of existing renewables should be prevented, or offset by increased new renewable energy development.
- The RPS applies to as many potential suppliers of retail load as possible so that overall RPS targets can be met and cannot be easily bypassed.
- Fuel, technology, and vintage eligibility decisions are guided by policy objectives, by an assessment of the social benefits of particular resources and technologies, and by an evaluation of the need of those projects to receive extra-market revenue from an RPS.[10]
- Customer-sited renewables projects that otherwise meet policy objectives and renewable energy applications that *save* electricity (e.g., geothermal heat) are considered for eligibility.

[10] Jurisdictions may have multiple underlying policy objectives, and those objectives may vary from state to state (e.g., local environmental improvement, reduction in global climate gasses, resource diversification, local economic development). As a result, best practices for geographic eligibility and technology eligibility depend upon the underlying objectives of the policy. At the very least (unless greenhouse gas reductions are the *only* objective), eligibility rules might be designed to encourage some local generation.

- Whether and under what conditions out-of-region projects are eligible is also guided by the social objectives of the RPS (of course, legal and practical constraints may also apply).
- If policymakers want to assure a certain level of resource diversity among different renewable energy technologies, they might consider: (1) specific resource bands or tiers, (2) credit multipliers, or (3) complementary policy approaches (e.g., system-benefits charges, tax incentives, etc.).

Principle #2: Cost Effective and Flexible. A well-designed RPS will be implemented and administered in a straightforward, flexible, cost-effective, and not unduly burdensome manner.

Best practices for implementing this principle ensure that:

- Renewable energy purchase requirements are achievable given available resource potential and other potential supply constraints, including the credit quality of the LSEs.
- Sufficient lead-time exists between when an RPS target is set (or increases) and when it takes effect to accommodate project development, permitting and construction timelines.
- An effective RPS is administered in a simple, straightforward fashion, minimizing regulatory intervention where possible.
- In most cases, tradable renewable credits are used for trading and verification purposes to maximize flexibility and lower compliance, transaction, and administrative costs.[11]
- Where there are serious concerns about the costs of an RPS, due especially to potential supply scarcity or market power, policymakers may wish to consider establishing a cost cap.[12] A cost cap can mitigate concerns of unbounded RPS compliance costs. An effective cost cap is one that is set at a multiple of expected RPS compliance costs, so that electricity suppliers are encouraged as much as possible to procure renewable energy to comply with the RPS.
- Compliance flexibility tools such as early compliance, banking, and annual (or, especially in the case of regulated markets, even multi-year or rolling-average) compliance periods are considered.
- Consideration is given to allowing RPS administrators *limited* flexibility to accelerate or slow the RPS percentage increases (with sufficient notice) in the event of well-defined and extreme circumstances.[13]
- Clarity is provided on eligibility rules (including technology, fuel, vintage, and location) so market participants can assess eligibility *before* making significant financial commitments.[14]

[11] In some limited cases, the use of tradable renewable energy credits may not be as important. In particular, the use of TRCs is not as essential in markets with vertically integrated regulated monopolies, located in jurisdictions with few internal transmission constraints.

[12] For example, one cost cap design would grant electricity suppliers the ability to pay a specified cents/kWh price instead of directly procuring renewable energy, with funds collected from the charge used to support renewable energy in other ways. Another approach would be to lower the aggregate targets for renewable energy if costs rise above a certain threshold.

[13] In most cases, this allowance should be limited, clearly bounded, and exercised only with ample notice, to reduce regulatory risk.

[14] In addition to clear eligibility rules in RPS legislation and regulation, this also includes providing pre-certification and advisory rulings to developers on the eligibility of proposed renewable facilities.

- Consideration is given to establishing long-term contracting standards for regulated utilities and regulated providers of last resort, particularly if conditions suggest that long-term purchases will not result absent such requirements. Such standards should generally assure that the lowest-cost compliance strategies are used, and that even-handed comparisons of different renewable energy sources are made (considering direct and indirect costs).

Principle #3: Predictable. A well-designed RPS will provide market stability for all participants, reducing regulatory risk for generators and electricity suppliers, and improving the ability of renewable developers to obtain financeable long-term contracts.

Best practices for implementing this principle ensure that:

- Legislative and regulatory support for the RPS policy and its detailed design are strong, and that regular changes or even elimination of the policy are unlikely.
- RPS policies have renewable energy targets that are of sufficient duration and stability to minimize risk and enhance the likelihood of long-term contracting.[15]
- Eligibility rules (including technology, fuel, vintage, and location) are well defined and stable, not subject to sudden change.
- Rules for the RPS are clearly defined, any material changes to the policy comes with ample notice and lead-time, and changes occur only within narrowly defined parameters.
- Enforcement mechanisms are established that provide confidence to renewable energy developers that electricity suppliers will make their required renewable energy purchases.
- The RPS applies to all potential suppliers to any retail load covered by the RPS so that the overall RPS targets cannot be easily bypassed, creating uncertain aggregate renewable obligations.
- Clear long-term contracting standards are established for regulated utilities and regulated providers of last resort, if necessary, to help assure long-term contracting.

Principle #4: Nondiscriminatory. A well-designed RPS will be applied fairly, consistently, and proportionately to all market participants and customers.

Best practices for implementing this principle ensure that:

- The RPS applies to all suppliers of retail load in the jurisdiction, and thereby spreads the costs and benefits of the policy to all.[16]
- The RPS applies to all potential suppliers to any retail load covered by the RPS so that the policy does not create barriers to competitive entry.
- The RPS applies on an energy basis, requiring megawatt-hour purchases of renewable electricity (or TRCs) rather than megawatt-denominated capacity targets.
- Prudently incurred RPS compliance costs are recovered in electricity rates.[17]

[15] This includes assuring that a target percentage requirement, once achieved, is maintained long enough to allow the amortization of generation investments and support long-term financing.

[16] Some exemptions are possible without dramatically weakening the policy – publicly owned utilities for instance – but will dilute the strength of the RPS.

- Electricity suppliers are required to meet the minimum RPS requirements for *each product* that they sell (product-based as opposed to company-based compliance).
- Eligibility decisions are made fairly and are guided by policy objectives, by an assessment of the social benefits of particular resources and technologies, and by an evaluation of the need of those projects to receive extra-market revenue from an RPS.
- Customer-sited projects that otherwise meet the eligibility criteria qualify for the RPS, and renewable energy applications that *save* electricity (e.g., geothermal heat) are also considered for eligibility.
- In designing contracting standards for regulated utilities and regulated providers of last resort, renewable energy sources are compared with one another in an even-handed manner, considering the direct and indirect costs and attributes of each resource .

Principle #5: Enforceable. An effective RPS will be enforceable, ensuring that the policy's renewable energy targets and broader goals are achieved.

Best practices for implementing this principle ensue that:

- Clear rules for enforcement in cases of non-compliance are established, thereby providing confidence to renewable energy developers that electricity suppliers will make their required purchases.
- For competitive electricity providers, enforcement might include automatic financial penalties, suspension on the ability to sign up new customers, and supplier license revocation. For regulated providers of last resort in restructured markets, the latter options are not available; instead, financial penalties can be combined with requirements for filing procurement plans and with authorized rate recovery only for prudently incurred costs.
- Consideration is given to alternative compliance mechanisms and cost caps, in which suppliers are given the opportunity to pay a set price into a fund in lieu of procuring renewables, to offer a less punitive approach to enforcement.
- In regulated markets, the need for automatic financial penalties is lessened. Instead, strong oversight by regulators with control over renewable energy procurement practices and rate recovery may be sufficient. Nonetheless, clear implications for noncompliance will ensure that obligated parties take the requirement seriously.

Principle #6: Consistency with Market Structure. A well-designed RPS will be consistent with and complement the structure of a jurisdiction's electricity market, whether regulated or restructured.

Best practices for implementing this principle ensue that:

- The RPS applies to all potential suppliers to retail load so that the policy does not create barriers to competitive entry.

[17] In a regulated market or for providers of last resort, regulators would deem expenditures prudent through oversight of the procurement process. In competitive markets, the dynamics of competition provide automatic discipline on pricing, and suppliers will only be able to charge what the market will bear; if suppliers incur imprudent costs, they automatically risk incomplete recovery of costs.

- In most cases, the RPS relies on renewable credits to demonstrate compliance, because the use of TRCs does not constrain least-cost contracting for commodity electricity.
- The RPS builds in compliance flexibility, especially in competitive markets, to account for the poor credit and uncertain load of competitive electricity providers.
- Clear long-term contracting standards are established for regulated utilities and regulated providers of last resort, with sufficient regulatory oversight to ensure prudent compliance practices.
- In regulated markets and for regulated providers of last resort, prudently incurred RPS compliance costs will be recovered in electricity rates.

Principle #7: Compatibility with Other Policies. A well-designed RPS will be compatible with other applicable policies and regulations in the state/country.

Best practices for implementing this principle ensure that:
- Compliance flexibility mechanisms such as TRC banking are designed to minimize or mitigate conflicts with fuel source and/or emissions disclosure requirements, or other policies.[18]
- Other renewable energy policies (system-benefits charges, tax incentives, etc.) are designed in a way that does not inappropriately distort the market for RPS compliance in favor of some market participants relative to others. For example, the provision of financial or tax subsidies to one type of renewable generation, if not reciprocally provided to other eligible sources of renewable energy, will skew the RPS playing field.[19]
- In the presence of markets for emissions rights, renewable electricity or TRCs remain fully bundled, with all emissions rights intact and not sold to other parties (unless policymakers do not believe that a reduction in these emissions is a key goal of the RPS). This is because an

[18] We have not previously discussed this issue in this report. For more information, see Grace et al (2001).
[19] It may be appropriate for policymakers to provide more support to certain renewable energy technologies than others. For example, photovoltaics may do poorly under a standard RPS, so other support mechanisms may be necessary. For any given renewable energy application under an RPS, however, other forms of support would ideally be provided on a proportionate basis to minimize market distortions. If this were not the case, outside financial support for a specific renewable energy project would give that project a competitive advantage over other renewable energy projects in the region, not based on cost-effectiveness but based on external policy forces.

unbundling of emissions credits from renewable sales may result in the RPS having no incremental effect on air emissions.[20]

- State RPS rules are developed that authorize the RPS administrator to accommodate the possible creation of a federal RPS in the future.[21]

[20] For more information on the interaction between renewable energy and emissions markets, see, e.g., Morthorst (2001, 2003) and Boots (2003). For information on policy coordination challenges more broadly, see Grace et al. (2000).

[21] We have not previously discussed this issue in this report. For more information, see Grace and Wiser (2003).

6. Conclusions

Worldwide, the RPS is becoming a popular approach to encouraging renewable generation. The RPS has already been implemented in 13 U.S. states and in a number of countries, and additional jurisdictions are expected to implement the policy in the future.

There are both advantages and disadvantages to the RPS relative to other renewable energy policies, and practical experience shows both successes and failures. Experience in some U.S. states demonstrates that a well-crafted and implemented RPS can effectively provide support for renewable energy. Of the 13 state RPS policies in existence today, Texas' approach has been the most successful so far in driving new renewable capacity at reasonable cost. The renewable energy requirements in Iowa and Minnesota have also been successful.

The verdict on other state RPS policies is more mixed, either because the RPS has not been in place long enough to evaluate results, or because some success has been experienced but that success is still incomplete. In still other states, such as Maine and Pennsylvania, experience shows that poorly designed policies will do little to advance renewable markets.

Creating effective RPS policies has clearly proven somewhat challenging in the United States. Some of the more common and critical design pitfalls experienced by states, as highlighted in this report, include:

- narrow applicability,
- poorly balanced supply-demand conditions,
- insufficient duration and stability of targets,
- insufficient enforcement, and
- poorly defined or non-existent contracting standards and cost recovery mechanisms for regulated utilities and providers of last resort.

In addition, we have highlighted market context criteria that, if not present, may undermine even a well-designed RPS; these include the presence of credit-worthy long-term power purchasers, stable political and regulatory support, and adequate and accessible renewable resource potential.

Though experience with RPS policies is still limited, and much will be learned in future years, we have now clearly gained some knowledge of the conditions and design features necessary to make an RPS policy work. Just as important, we understand that getting most design elements right will not matter if one of the major design pitfalls is present. Though there is no single way to design an RPS, we observe that effective RPS designs appear to meet a number of minimum requirements. We therefore recommend that policymakers and others use the policy design principles and best practice design elements highlighted earlier to loosely guide future RPS design efforts.

References

Berry, T., Jaccard, M.: 2001, 'The Renewable Portfolio Standard: Design Considerations and an Implementation Survey', *Energy Policy* 29, 263-277.

Boots, M.: 2003, 'Green Certificates and Carbon Trading in the Netherlands', *Energy Policy* 31, 43-50.

Chupka, M.: 2003, 'Designing Effective Renewable Markets', *The Electricity Journal,* May, 46-57.

Clemmer, S., Nogee, A., Brower, M.: 1999, *A Powerful Opportunity: Making Renewable Electricity the Standard*, Cambridge, MA, Union of Concerned Scientists.

Deyette, J., Clemmer, S., Donovan, D.: 2003, *Plugging in Renewable Energy: Grading the States,* Cambridge, MA, Union of Concerned Scientists.

Espey, S.: 2001, 'Renewables Portfolio Standard: A Means for Trade with Electricity from Renewable Energy Sources?', *Energy Policy* 29, 557-566.

Fristrup, P.: 2003, 'Some Challenges Related to Introducing Tradable Green Certificates', *Energy Policy* 31, 15-19.

Grace, R., Wiser, R.: 2003, *Crafting a Renewables Portfolio Standard for Rhode Island: Design Choices, Best Practices, and Recommendations*, Natick, MA, Prepared for the Rhode Island Greenhouse Gas Action Energy Supply & Solid Waste Working Group's RPS Working Group.

Grace, R., Abbanat, B., Wiser, R.: 2000, *RPS Accounting and Verification Mechanisms and Policy Coordination Report*, Natick, MA, Prepared for the Massachusetts Division of Energy Resources.

Haddad, B., Jefferiss, P.: 1999, 'Forging Consensus on National Renewables Policy: The Renewables Portfolio Standard and the National Public Benefits Trust Fund', *The Electricity Journal* 12, 68-80.

Huber, C, Haas, R., Faber, T., Resch, G., Green, J., Twidell, J., Ruijgrok, W., Erge, T.: 2001, *Action Plan for a Green European Electricity Market. Prepared within the Project 'ElGreen'*, Austria, European Commission.

Hvelplund, F.: 2001, 'Political Prices or Political Quantities? A Comparison of Renewable Energy Support Systems', *New Energy* 5, 18-23.

Lemming, J.: 2003, 'Financial Risks for Green Electricity Investors and Producers in a Tradable Green Certificate Market', *Energy Policy* 31, 21-32.

Lorenzoni, A.: 2003, ‘The Italian Green Certificates Market Between Uncertainty and Opportunities’, *Energy Policy* 31, 33-42.

Menanteau, P., Finon, D., Lamy, M.: 2003, ‘Prices versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy’, *Energy Policy* 31, 799-812.

Meyer, N.: 2003, ‘European Schemes for Promoting Renewables in Liberalized Markets’, *Energy Policy* 31, 665-676.

Meyer, N., Koefoed, A.: 2003, ‘Danish Energy Reform: Policy Implications for Renewables.’ *Energy Policy* 31, 597-607.

Morthorst, P.: 2000, ‘The Development of a Green Certificate Market’, *Energy Policy* 29, 1085-1094.

Morthorst, P.: 2001, ‘Interactions of a Tradable Green Certificate Market with a Tradable Permits Market’, *Energy Policy* 29, 345-353.

Morthorst, P.: 2003, ‘National Environmental Targets and International Emission Reduction Instruments’, *Energy Policy* 31, 73-83.

Nielsen, L., Jeppesen, T.: 2003, ‘Tradable Green Certificates in Selected European Countries – Overview and Assessment’, *Energy Policy* 31, 3-14.

Rader, N.: 2000, ‘The Hazards of Implementing Renewables Portfolio Standards’, *Energy and Environment* 11, 391-405.

Rader, N., Hempling, S.: 2001, *The Renewables Portfolio Standard: A Practical Guide,* Washington, D.C., National Association of Regulatory Utility Commissioners.

Rader, N., Norgaard, R.: 1996, ‘Efficiency and Sustainability in Restructured Electricity Markets: The Renewables Portfolio Standard’, *The Electricity Journal* 9, 37-49.

Schaeffer, G., Boots, M., Mitchell, C., Anderson, T., Timpe, C., Cames, M.: 2000, *Options for Design of Tradable Green Certificate Systems*, ECN-C-00-032, Netherlands, Energy Research Center of the Netherlands.

Sijm, J.: 2003, *The Performance of Feed-in Tariffs to Promote Renewable Electricity in European Countries*, ECN-C-02-083, Netherlands, Energy Research Center of the Netherlands.

Springer, U: 2003, ‘The Market for Tradable GHG Permits Under the Kyoto Protocol: A Survey of Model Studies’, *Energy Economics* 25, 527-551.

Verbruggen, A.: 2004, ‘Tradable Green Certificates in Flanders (Belgium)’, *Energy Policy* 32, 165-176.

Wiser, R., Pickle, S., Goldman, C.: 1997, 'Renewable Energy and Restructuring: Policy Solutions to the Policy Dilemma', *The Electricity Journal*, December, 65-75.

Wiser, R., Langniss, O.: 2001, *The Renewables Portfolio Standard in Texas: An Early Assessment*, LBNL-49107, Berkeley, CA, Lawrence Berkeley National Laboratory.

Wiser, R., Porter, K., Grace, R., Kappel, C.: 2003, *Evaluating State Renewables Portfolio Standards: A Focus on Geothermal Energy*, Prepared for the National Geothermal Collaborative.