A Federal Renewable Portfolio Standard: Policy Analysis and Proposal

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Abstract—**Increasing national concerns about the United States' energy portfolio, electric reliability, and the environmental hazards of current electricity generation technologies, among other issues, have led many to believe that a policy change should be adopted to increase reliance on renewable energy. Renewable Portfolio Standards, or RPS, is a policy measure that dictates the amount and type of renewable energy that must be produced, who is obligated, as well as the timeframe for meeting these standards. This paper examines the pros and cons of implementing a federal RPS and investigates the many questions that would accompany it. This paper finds that the early success achieved in the states could be duplicated by a national policy if designed correctly. However, enough questions still remain about proper implementation that a policy should only be adopted after more careful study.**

I. INTRODUCTION

Increasing national concerns about the United States' energy portfolio, electric reliability, and the environmental hazards of current electricity generation technologies, among other issues, have led many to believe that a policy change should be adopted to increase reliance on renewable energy. Renewable Portfolio Standards (RPS) have been implemented in 13 states and have met with varied success. Several proposals have been made to implement an RPS on a national level. This paper will investigate the successes and failures of state RPS, and reasons attributed. The pros and cons of these state RPS policies, will be examined as evidence for whether a federal program could combine the best elements of current RPS policies and encourage long-term renewable energy competitiveness in the market.

There are many reasons why proponents of renewable energy seek to encourage its use as an energy source in the future. These reasons will be mentioned briefly in order to establish a background for the topic of this paper. Each of these reasons has numerous facets and counterarguments that have been explored on an in-depth level in other sources; for this paper, these arguments will be given in a simplistic form for the purpose of brevity.

The first reason renewable energy is promoted is the potential for distributed generation. This would allow power to be generated at various points throughout the grid. The benefits of this are two-fold: first, there would be lower transmission losses if this distributed energy were used at or near the point of production. Second, spreading out the distribution of power allows for greater national security since power is being generated at multiple sources, rather than at centralized locations, which could be prone to debilitating attacks. These two benefits combine to alleviate strain on the electricity grid, and could help prevent blackouts, such as the one from August 2003, from reoccurring.

Another reason why renewable energy is promoted is due to the fact that the U.S. currently would like to have less dependence on foreign sources of energy. Currently, close to 30% of the energy consumed by the U.S. is imported [1]. Increasing the amount of renewable energy used in this country would result in greater energy independence that would keep money in the U.S. and give the country a larger number of options for the energy it would need to import. However, even if the U.S. could supply all of its own energy sources from within its boundaries, current reliance on fossil fuels like coal would increase pollution and would have negative effects on the health of U.S. citizens and the environment. Renewable energy is touted as having less emissions or harmful byproducts, while utilizing readily available energy sources like the sun and the wind that cannot be depleted. On the other hand, fossil fuels are being depleted much faster than they can be replaced and there may come a point when supplies peak, indicating that future reserves will be harder and more costly to extract [2]. As the energy needs of the country grow, it will be necessary to determine how to achieve a long-term energy source.

Reliance on fossil fuels is also a problem due to concerns about global climate change. Although there is not a total agreement on this debate, many scientists urge caution nonetheless, noting that if we make changes now "there is still a good chance of mitigating the worst effects of climate change" [3]. If current energy usage trends continue, climate change could result in problems that many think could be slowed through increased use of renewable energy among other solutions [4]. To be sure, the lack of consensus on the issue creates confusion, but it also highlights the fact that caution should be taken surrounding the use of non-renewable energy sources.

The problem resulting from this myriad of reasons in support of renewable energy is how best to implement policies to promote its use. Current U.S. government policy consists of a variety of

programs seeking to promote renewable energy. A policy analysis will be done on the Renewable Portfolio Standards idea to determine whether its successes could be achieved and failures avoided if implemented on a national level.

II. Current Status of Renewable Energy

Currently, renewable energy is a blanket term applied to a group of energy sources that are considered renewable because they use energy that comes from an inexhaustible source or they regenerate fast enough that there is no danger of depleting them. The raw materials necessary for converting a renewable source to a usable energy form, whether abundant or scarce, does not factor into the definition of renewable energy. Also, a certain amount of energy is necessary to manufacture these materials into a usable form, but this amount is generally ignored as well.

A. Approved Types of Renewable Energy

Because the term 'renewable energy' can be applied to a variety of energy sources, most policy documents explicitly define what sources are covered. Several issues are typically taken into consideration: first, there is debate about which sources are actually renewable. For example, solar and wind are considered by all to be renewable, but depending on the definition of biomass, it may not be defined as renewable by all policies [5]. The state of Texas "considers combined-cycle gas turbines to be green, in others run-of-the-river [hydropower] is allowed, but not woodwaste, and so on" [6]. Second, various policies may attempt to exploit local energy sources which are in high abundance, or conversely a policy may exclude a certain type of energy source if it is already a mature technology and needs no further encouragement [7].

There is some level of importance in attempting in future years to standardize the definition of renewable energy. Doing so would make common standards about renewable energy more transparent. It would also settle the debate about what is and is not renewable energy so that policymakers would not have to reconsider the definition with every new piece of legislation.

However, because there is still debate and uncertainty on the issue, it is inconsequential for the purposes of this paper to settle the matter. The question of "how green is green?" has no specific answer and must for the moment be left broad [6]. However, for the purposes of discussion, the U.S. Department of Energy's definition will be used, which includes "wind, solar, geothermal, hydrogen, and biomass" [8].

B. Current National Statistics

For the U.S. in the year 2002, about 9% of the nation's total energy for electricity generation came from renewable sources [1]. Fig. 1, shown below, visually shows the breakdown of the power generated for electricity; 7% came from hydroelectric power, and 2% came from other renewables, including wood, waste, geothermal, solar, and wind [1].

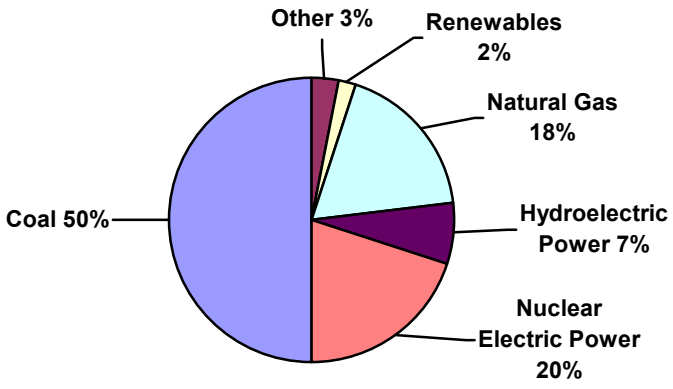

Fig. 1. Sources of U.S. Electricity Generation for 2002 [1].

C. Recent Cost Trends

The past twenty years have seen drastic reductions in the cost per kWh (kilowatt hour) of typical renewable energy sources. The figure shown below indicates the cost decreases that have occurred for wind and solar energy sources. Solar thermal, geothermal, and biomass all have similar cost trends over the past 20 years.

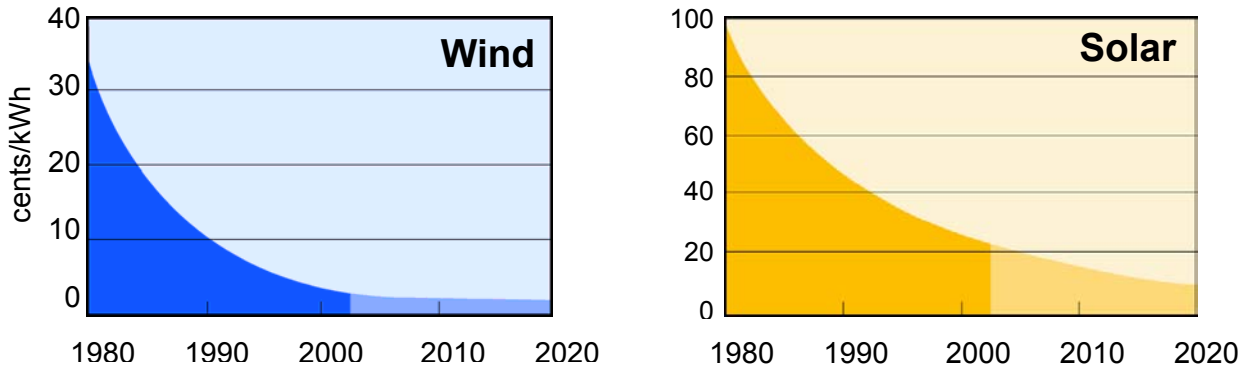

Fig. 2. Reduction in cost of wind and solar energy sources, in levelized cents/kWh and constant $2000 [9].

This figure indicates the successes the renewable energy industry has had in the past twenty years, but it also shows a leveling-off as the technologies reach less-expensive levels. Since renewable energy has not achieved a low enough cost to be competitive with traditional fuel sources, there is a common view that these technologies have in some way not met their goals [10], [11]. However, costs for renewable technologies have declined by amounts equal to or exceeding those of earlier projections [10]. The costs of fossil fuels have also decreased significantly, creating the perception that renewable technologies have underperformed [10], [12].

There are various public policy measures that can be implemented to promote the use of renewable energy for electricity generation. These policy measures can focus on any portion of the energy production and consumption process. Having a variety of policy measures allows different portions of the market to be targeted and may allow the policies to complement each other [12]. By mandating or subsidizing renewable technologies, policy makers seek to overcome the higher cost barriers that limit renewable energy from competing in a free market [12]. These cost barriers come primarily from the amount of larger capitol needed for new renewable development compared to equivalently sized new fossil fuel development. Ideally

policy measures to promote renewable energy will result in more renewables development that will cause long-term prices to decrease.

D. Renewable Energy Policy Overview

There are two main categories of renewable energy policies. The first category gives some financial incentives to encourage renewable energy that includes tax incentives, grants, loans, rebates, and production incentives [13]. Tax incentives cover personal, sales, property, and corporate taxes and they help to reduce the investment costs and to reward investors for their support of renewable energy sources [12], [13]. As an example, 24 states currently have some form of grant program in place that ranges from as small as $500 up to $1,000,000 [13].

The second category of renewable energy policies is called rules and regulations, which mandate a certain action from an obligated entity. Included within this category are renewable portfolio standards, equipment certification, solar/wind access laws, and green power purchasing/aggregation polices [13]. As an example, equipment certification allows the states to regulate the performance criteria that equipment is required to meet in order to be eligible for financial incentives [12]. Seven states currently have equipment certification programs in place [13].

While each of these renewable energy policies has its own implications and may deserve additional analysis, this paper will focus on one of the types, Renewable Portfolio Standards (RPS). Initial success that has occurred in states such as Texas has raised interest in this type of policy [14]. An RPS employs market tools to accomplish its goal, a device that has worked for other policies, and there is increased interest in this aspect of an RPS. In fact, an RPS has been called by some as "the ideal way to encourage renewable energy development" because it "aims to ensure that renewable energy targets are met at least cost and with a minimum of ongoing

administrative involvement by the government" [14]. Other renewable energy policies have their own positives and negatives, but will not be focused on for this analysis.

There have been efforts in the past several years to look at other portfolio standards similar to an RPS, such as an energy efficiency portfolio standard [15]. While these efforts have not gained as much attention as the debate over RPS, energy efficiency is a topic that deserves more consideration. Energy efficiency could be built into a RPS policy because these efficiencies would offset energy usage. However, energy efficiency may represent only a partial solution to "buy time for the world to develop 'low-energy paths' based on renewable sources" [16]. For the purposes of this paper, energy efficiency will not be discussed, but it is important to note that there are other ways the portfolio idea could be used or expanded.

III. Renewable Portfolio Standards

The Renewable Portfolio Standard is a market-oriented policy that mandates the amount and type of renewable energy that must be produced by an electric utility, as well as the timeframe for meeting these standards [7]. Renewable Portfolio Standards are also called Renewable Energy Standards, Environmental Portfolio Standards, or similar terms, but the most commonly used term seems to be RPS. An RPS, like the other renewable energy policies listed above, is intended to achieve the public policy goals of environmental protection and technology development using the tools of the market [7]. This means that the market will dictate which technologies will be implemented, rather than a specific mandate for a certain type of renewable energy technology.

While this is a broad definition, each part of an RPS policy needs to be carefully defined. The main components that make up an RPS can be grouped into the following seven categories: goals

and targets, eligible resources, seller obligation, compliance mechanisms, enforcement, coordination of other policies, and administrative duties.

A. Goals and Targets

The goals and targets component of an RPS consists of both setting a policy goal and setting a production target. A policy goal can have multiple aims, "including environmental protection, resource diversity, technology advancement, and economic development" [7]. A production target consists of numerous essential parts. The first is defining the start and end dates, which generally start a reasonable amount of time after the policy is made into law, to give utilities time to prepare, and end after a period of time, after which it is assumed that the policy has sufficiently encouraged renewable energy. While an end time could be clearly defined, another possibility is to have an RPS that sunsets when an event occurs, such as when renewable energy becomes cost-effective in the market without the need for government policy.

Another important target for the RPS is whether the amount that utilities are mandated to produce is a fixed amount of electricity generated or a percentage of sales [7], [17]. The key difference between these two is that a fixed amount has a clearly defined goal, such as 100 MW of renewable energy capacity developed by a certain date. On the other hand, a percentage is tied to the increases or decreases that occur in sales, and for example, could specify that 10% of energy sold must come from renewable sources by a certain date [17]. Once this decision has been made, a target must be set for the initial amount, what the intermediate goals will be, and what the final amount will be.

B. Eligible Resources

Eligible resources specify what types of renewable energy are acceptable to meet the targets that the RPS sets [12]. An RPS that seeks to encourage all types of renewable energy may specify a broad range of renewable energy sources, but an RPS that wants to encourage the

development of more expensive renewable energy sources may exclude a cheaper, more mature technology. Other RPS policies may seek to protect existing renewable energy facilities that are in danger of being retired, while alternately, an RPS may encourage development of new capacity. Also, an RPS can specify whether it is allowable that renewable energy production can be imported from outside the jurisdiction of the mandate, or must come from within the bounds of the program's jurisdiction [7].

C. Seller Obligation

The obligation of an RPS could be placed on retail sellers, default suppliers, or self-generators. An RPS could be crafted to oblige certain segments of the market to purchase the renewable energy or it could mandate the entire generating market [17]. Exempting portions of the market may place extra burdens on those suppliers the RPS mandate applies to [17], [18].

D. Compliance Mechanisms

In order to allow flexibility for obliged sellers to meet the RPS targets, there must be several different allowed mechanisms. The most obvious method for the targets to be met is for the sellers to purchase and supply the renewable energy themselves. Additional flexibility can be obtained using "tradable renewable energy credits that represent the production of electricity from renewable energy facilities" [7]. This allows sellers to enter into contracts with renewable energy facilities rather than directly generate it themselves. Credit trading can be made more flexible by introducing a compliance or grace period to allow sellers a chance to fulfill their mandates or sell the extra credits they may have [17]. Additional options are credit banking or credit borrowing, which allow credits to be carried forward in time or deferred [7], [17].

E. Enforcement

Enforcement of the RPS requires setting appropriate penalties for noncompliance that will encourage fulfillment of the target. In other words, sellers must be motivated to comply by

ensuring that the penalties will be higher that the cost of full compliance [17]. This will create a situation in which the market will dictate that sellers meet the targets because it would cost more to not do so. This can be done by pegging the compliance costs to a certain percentage greater than the costs of purchasing renewable energy credits [7]. Additionally, penalties could involve actions such as revoking the seller's license to sell electricity in the state [12].

F. Coordination of Other Policies

Another facet of the RPS is its interaction with other policies that may be in place. Ideally these other policies could be rewritten to "minimize conflict and maximize complementarity," which would increase the effectiveness of each policy [7]. If the existing policies cannot be changed to best interact with the RPS, the RPS must be written carefully to avoid problems. Ignoring the impact of multiple policies, which might overlap on certain provisions, could result in undesirable consequences such as confusion or court challenge [17].

G. Administrative Duties

In order to make it clear where the responsibility lies for the administrative duties of an RPS, a responsible agency should be defined [12]. This agency will be in charge of imposing regulations and performing all administrative activities. In addition, the RPS should define which agencies need to support the RPS in other roles and how the administrative costs will be paid for.

IV. State Renewable Portfolio Standards

State Renewable Portfolio Standards can be viewed as a useful indication about the possibilities for a federal RPS. There are various nuances between the policies of each state's programs and these differences have resulted in varied outcomes. The successes and failures that have resulted from these state RPS policies can be seen as both a warning about the pitfalls inherent in a potential federal RPS, as well as an indication about how an RPS could be properly

implemented. While an RPS can be applied at the city level (Austin, Texas and Fort Collins, Colorado) as well as the utility level, portfolio standards with a broader applicability will be focused because they have more relevance for consideration of a federal RPS [13].

A. Summary of State RPS Policies

In a manner similar to the confusion over the definition of renewable energy, the classification about which states have an RPS and which do not is dependant on whose definition of an RPS is used. Disagreement comes from the variety of methods in how an RPS can be implemented. The RPS gives states great flexibility, but resists easy classification. This section will briefly summarize and attempt to broadly classify the state RPS policies.

Several databases count 13 states with an RPS, although the specific states that are counted vary slightly [13], [19], [20]. Because the RPS is being examined by many states, these databases are all slightly out of date or use different definitions about which states do and do not have an RPS. Currently 14 states have an RPS in place: Arizona, California, Connecticut, Hawaii, Iowa, Maine, Maryland, Massachusetts, Nevada, New Jersey, New Mexico, Rhode Island, Texas, and Wisconsin. Three other states that are noted with RPS-like standards are Illinois, Minnesota, and Pennsylvania. In total there are 17 states that have an RPS or RPS-like program and several more states, such as New York, that have a program under consideration [21]. The figure shown below summarizes this information.

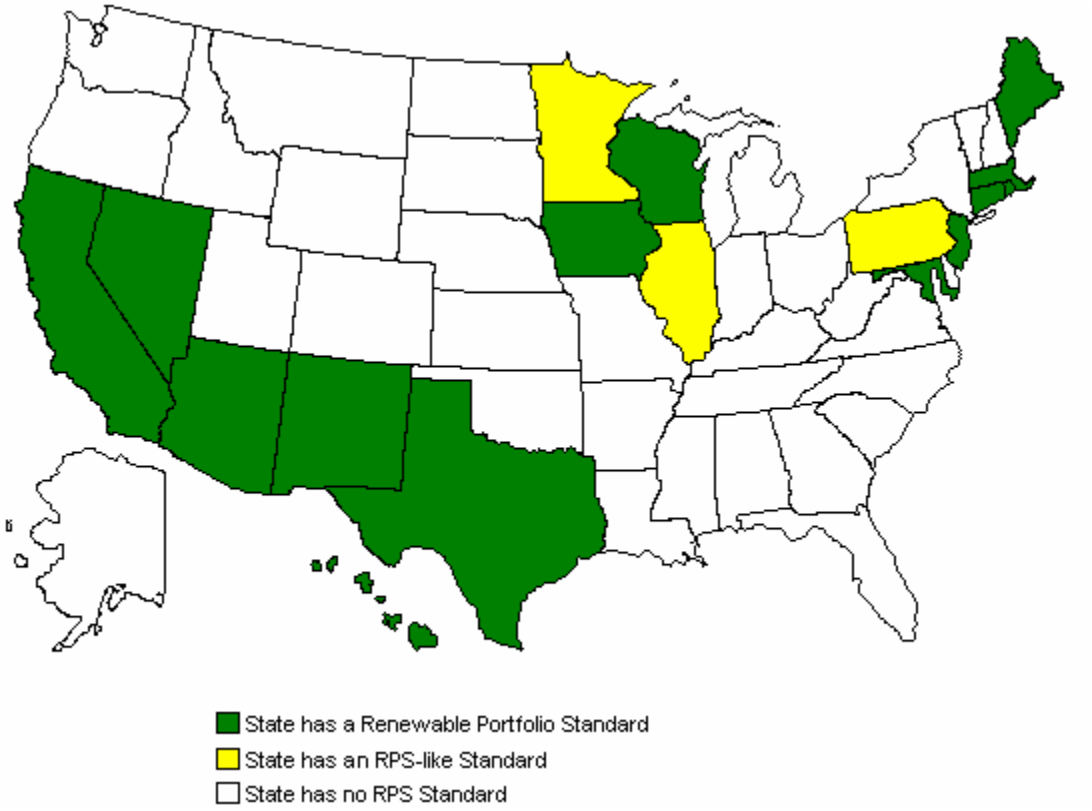

Fig. 3. Map of the United States showing which states have an RPS or similar program. Map outline adapted from http://www.ed.gov/pubs/goals/progrpt/us-map.gif.

Due to the complicated nature of the RPS, there are numerous ways the state programs can be categorized. None of these ways will quite capture all of the elements that distinguish one program from another. A categorization can, however, give a broad overview of the similarities and discrepancies between programs. Therefore, this section provides classification of several important issues that were selected in order to give an overview of certain issues that will be useful for future discussion about a federal RPS.

State RPS policies can be quickly summarized by the type of goal the program specifies. Iowa, Minnesota, and Texas all have RPS policies that require generation of a fixed amount of electricity. Iowa's state RPS required 105 MW of new renewable energy to be built in the state, while Minnesota's program requires 950 MW to be built by 2006 [22]. The goal in Texas is 2000 MW, which includes the preservation of 880 MW that is already on line [14].

The majority of state programs set a percentage goal, requiring that a certain percentage of the electricity produced or sold in the state must come from renewable sources. Twelve states use the percentage goal and include a timeline for what percentage needs to be met by what time. All of the state RPS goals except Maine's increase over time, giving the obligated sellers intermediate goals to meet. The figure shown below summarizes the 12 state programs that have percentage goals and what year they are required to be met.

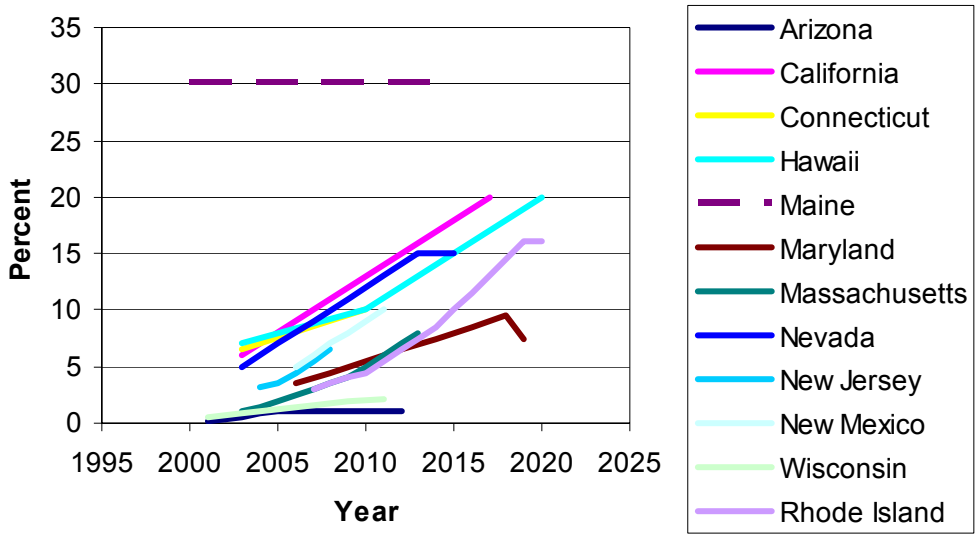

Fig. 4. Summary of state RPS policies with percentage goals.

The figure shows the varying goals that each state thought appropriate to encourage renewable development. What this figure does not represent well is the ending period of the state RPS policies. Certain states, like Texas have a defined ending point for the program, while others like New Jersey are designed to be readjusted after a certain amount of time [13]. This figure shows the starting point for each state and depending on the state, either ends when the percentage is due to be reevaluated by a regulatory board within the state, when the state program actually ends, or in the case of a non-specific date for the program to sunset, a few years after the last

percentage increase. What the figure can show is an overall comparison of the state RPS policies and the general trends.

Another categorization of state programs concerns what resources are eligible. No states have exactly the same resources that are eligible to fulfill the RPS. This comes from both politics and geographic resources. For example, a state like Iowa would not include tidal because this is not available in the state. Certain types of renewable energy can be encouraged by counting the energy produced from certain sources as more valuable, while other types of renewable energy can be discouraged by the opposite, or by completely eliminating it as an eligible resource.

Connecticut and New Jersey have two defined classes of renewable energy that have different percentage goals attached to them; both states define their class II resources to be certain types of biomass and hydro [22]. Nevada uses a multiplier to encourage certain technologies, setting distributed generation at a 1.15 multiplier, customer-sited photovoltaics at 2.4, and a certain type of customer-sited waste tire facilities at 0.7 [22]. New Mexico has a similar multiplier system, with biomass, geothermal, and fuel-cell counting double, and solar counting triple [22].

Another classification is who is exempt from the RPS and who is obligated to comply. A large number of states specifically exempt municipal utilities, including Arizona, Connecticut, Iowa, Maine, Massachusetts, Nevada, New Mexico, New Jersey, and Texas [22]. A large number of these same states also exempt cooperative power companies, including Connecticut, Iowa, Maine, Massachusetts, Nevada, and New Mexico [22]. Minnesota only obligates one utility, Xcel Energy, to meet a 10% standard, while all other utilities in the state have a 10% goal, which they are expected to make good faith efforts toward completing by 2015 [22], [23]. This unique agreement came from an agreement that allows Xcel Energy to have “increased onsite storage of used nuclear fuel at its Prairie Island nuclear plant” in exchange for compliance

with the 10% mandate [23]. Pennsylvania also has a unique RPS-like program that only applies to a handful of utilities [22]. Through utility restructuring settlements with several utilities, RPS-like requirements were established that set low goals of 1 to 2% [13].

A final classification is what type of credit trading exists for the state's RPS. A few states have their own credit trading within their own state, such as Nevada, New Mexico, Texas, and Wisconsin [22]. Other states allow credit trading within regional systems, such as the NEPOOL Generation Information System, which Connecticut and Massachusetts have agreed to trade under [22]. California and New Jersey both have credit trading under development, with New Jersey seeking to integrate with a regional trading option under development by PJM, a regional transmission organization [22], [24], [25]. Lastly, Maine is considering joining the trading system set up by NEPOOL, while Minnesota may establish its own system in the future similar to Wisconsin's that would also perhaps allow for regional credit trading [23], [26].

Regional credit trading is quickly becoming an option for states with an RPS. The NEPOOL Independent System Operator mentioned above allows trading between the states it serves, which are Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont [27]. While only three of these six states have an RPS, the system that has been adopted allows for the other states to generate renewable energy and trade these credits using NEPOOL. Similarly, PJM is "a regional transmission organization…that serves in all or parts of Delaware, Illinois, Maryland, New Jersey, Ohio, Pennsylvania, Virginia, West Virginia, and the District of Columbia" and so the possibility for regional trading between all of these states exists as well [28]. The last possible regional trading situation is under investigation by the Western Governor's Association and would allow renewable energy credit trading between the 18

member states [29]. This regional cooperation seems to be a positive direction for credit trading, allowing for more flexibility for obligated sellers to fulfill state RPS policies.

B. Successes and Failures of State RPS Policies

The state RPS policies mentioned in the preceding section have all for the most part been introduced within the past five years. Since many of them have had a few years or less of actual implementation in the market and most have a time frame stretching 10, 15, or 20 years, it is somewhat hard to offer a definitive analysis of how these programs have done. The best analyses will be able to be done once the programs have ended and their full effects are known. However, certain criteria can be used to provide a partial answer of what has worked and what has not. This analysis will then be useful for a discussion about whether or not a federal RPS should be implemented.

1) Successes

The easiest way to define which programs have been successful is based on whether or not the RPS has thus far worked. Has it caused the development of any new renewable energy? Has it caused the development of the renewable energy it wanted to? Have its goals been fully met up to this point? Have the costs been manageable for both utilities and consumers? These questions offer a beginning for evaluation and examine the broad, end goals of the RPS.

Texas is, according to most experts, the best designed and the most effective of all of the state RPS policies thus far. It has even been described as the most successful RPS in the world and is "frequently pointed to as a model for other states to follow" [22], [23]. Texas' RPS has proven that "a well-crafted and implemented RPS can deliver on its promise of strong and cost-effective support for renewable energy" [14]. It has driven substantial new renewable energy development in the form of wind development [22]. Due to the state's ranking as second in the nation for wind energy potential, enough new wind installation occurred in the earliest years of

the RPS to meet and surpass the initial goals [22], [23]. The costs of this wind development have been reasonable enough that they are being passed along to consumers through competitive pricing mechanisms [22]. While the earliest development boom took advantage of a federal production tax credit (PTC) and has since slowed down, "additional wind development is expected in future years" [23].

Interestingly, Texas' RPS mandates an amount in megawatts (MW) that begins at 3% of the state's energy needs and with overall growth in energy demand in the state, ends at just 2.2% by 2009 [14]. This means that there is substantially greater potential for renewable energy in the state than the RPS mandates. However, the early success of the RPS, even as a relatively small percentage of the state's potential, can be and has been a useful guide for other states and perhaps countries as they develop their own programs.

Iowa and Minnesota have also seen success with their RPS policies. Iowa's RPS was first passed into law as the Alternate Energy Production Law in 1983 and later revised in 1991 [30]. The law mandated 105 average MW (aMW) of renewable power to be installed by the state's investor owned utilities [23]. After years of legal battles, the Iowa Utilities Board ordered compliance in 1996, and subsequently 250 MW were installed [23]. This development was done at reasonable cost and has been passed along to the consumer, as allowed by the state's legislation [22]. Similar to Texas, the renewable energy installed as a result of Iowa's RPS amounts to a modest 2% of the state's electricity usage in 1999 [30]. Since the RPS mandate has now been met, the law is no longer driving any development in the state, but a new voluntary goal of 1000 MW by the end of the decade has been proposed by the governor and has seen some success so far [22], [23].

Minnesota is often is often mentioned as another state that has a successful program. As discussed in a previous section, the mandate only applies to one utility, Xcel Energy, and so the success that has been made thus far has only applied to a portion of the market. However, the RPS is driving new development of wind and biomass in the state and initial goals have been met [22]. Xcel Energy so far has installed 425 MW of wind generating capability and 125 MW of biomass generating capability to meet its obligations and must install 400 MW of wind by 2006 as part of an updated agreement [22], [23]. The total power that will be installed under the RPS mandate will be 950 MW, which is projected to amount to 4.8% of the state's power needs in 2012. In addition to the development being done, another note of success for the program, costs have been stable so far, in part due to long-term contracts that Xcel negotiated with its suppliers [22].

Massachusetts has also encouraged a fair amount of development with its policy so far and can be labeled as successful. Through a properly designed program, the 1% goal by 2003 was met and over 200 MW have been approved as of July 12, 2004, with the majority coming in the form of landfill gas and biomass [19], [31]. It is likely that new renewable energy development will continue, although there is increasing concern about the lack of long-term contracting [22]. Without a framework for long-term contracts, there are fewer new development opportunities, and compliance with the state's mandate may include payments to the Alternative Compliance Mechanism [22]. The Alternative Compliance Mechanism is "a 5 cent/kWh buy-out payment that can be made in lieu of purchasing [tradable credits]" [22]. However, if development opportunities continue to come slowly, future compliance may drive the cost of tradable credits higher [22]. If the future holds rising prices for compliance, Massachusetts' overall success will be more mediocre.

Lastly, Wisconsin has gained early success with its RPS. For 2001, 1.3% of electricity was generated from renewables, and for 2002, 1.6% was achieved, surpassing the goals set by the state [13], [32]. In fact, it seems that enough development has taken place, combined with the state's credit-banking policies, that the RPS goal of 2.2% by 2011 will easily be met [33]. Much of the development that led to the success of this goal has come from out-of-state renewable generation, primarily wind power from Iowa [33]. This has led many to suggest that the RPS should be increased, and a study has shown that enough potential exists to meet a higher standard [34].

2) Partial Successes

Since the aforementioned states are the only RPS policies that are discussed as successes, the other programs have either not been in place long enough to know their effectiveness or have met with some level of failure. Further criteria for evaluation must examine more minor questions about a state's RPS. For the state standards that have been in effect for enough time and have not succeeded, reasons must be established for where problems have occurred. Rather than fully survey every state, a representative sampling will be taken that examines states from various parts of the country and that have various goals.

Arizona has seen some level of development but also some level of non-compliance. The state's RPS, which focuses heavily on solar power and rises to 1.1% by 2007, has so far promoted the development of at least 5 MW of solar power [35]. However, the level of non-compliance has been substantial and no utilities have met the targets on schedule [22], [35]. This lack of compliance is due to "uncertainty in the duration and stability of the policy" and a lack of penalties [22]. Utilities were willing to comply to the extent that state funding existed to help them and no further [22].

Arizona's original plan called for an evaluation of the percentage goals in 2004 to determine whether to allow them to increase the goals or to freeze them [13]. On February 10, 2004, Arizona's Corporation Commission approved increasing the goals as planned [13], [36]. This decision was made despite the non-compliance that had occurred up until that point, indicating that the commissioners were committed to the renewable energy program [36]. This decision may encourage future growth in the state because some level of uncertainty has been removed.

California's policy has been in effect since the start of 2003, but little information seems to be available about whether it has caused any development. The California energy commission and California public utilities commission are still in the process of rule making and working out the details of the program. It is notable that California has implemented one of the most aggressive standards and has made that even more impressive by adopting a goal to meet the 20% standard by 2010 instead of 2017 as the original mandate proposed [37]. California's commitment to an RPS sends a strong message that it is seeking to diversify its energy supply and lessen its reliance on natural gas fired production [38]. If its efforts to enact an RPS succeed, it will be a large encouragement to renewable energy development around the country and due to California's size, will prove the efficacy of a larger scale RPS [38].

Maine's RPS, although it has been met every year so far, is largely considered a failure [22]. Maine's goals are proposed at a constant 30% level, however the state already had been generating more than 30% of its power from renewables before the passage of this legislation, most of that coming from hydropower or biomass [13]. The standard is having no effect on existing renewables and is certainly not encouraging new renewables, and so the RPS is not seen as a successful one [22]. It could be argued that the standard was enacted to safeguard the loss of any renewable generation and is achieving its goals in this realm. Another suggestion is that

Maine could sell some of its excess renewable credits to other states under a regional trading system [13]. Maine's RPS will be up for reexamination in 2005 and perhaps changes in the statute will result in changes to spur new development.

3) Too Early to Tell

There are several states that have within the past few months enacted a state RPS and it is too early to tell if their policy has been effective. Maryland passed their state's RPS on April 10, 2004 and made it effective as of January 1, 2006 [19]. Rhode Island enacted and made their RPS effective on June 29, 2004 [13]. In general, it is hard to predict how effective these programs will be. The Maryland Public Interest Research Group commissioned an analysis prior to the passing of Maryland's RPS that suggests that retail electric costs would increase by less than 1% [39]. Work during the drafting of Rhode Island's RPS was suggested to rely heavily on other RPS policies from similar states [40]. It is likely that Rhode Island was able to learn from the problems that other state RPS programs faced during the drafting of their legislation. For example, seeing the early problems experienced by Massachusetts with their RPS, Rhode Island's policy enables a state corporation to enter into long-term contracts for renewable energy [41]. Rhode Island's policy also allows for renewable credits to be generated outside of the state, adding flexibility that may promote lower cost development of renewable energy in the region [41].

Lastly, Hawaii enacted and made effective their state's RPS on June 2, 2004 [13]. Hawaii's RPS has a high chance of success due to the unique nature of power generation on the islands. A report commissioned by the state found that "increased use of renewable energy can result in net savings in electricity costs for the citizens of Hawaii" [30]. Under Hawaii's plan, existing renewables can be used to meet the required percentages [13]. Renewables currently account for

about 8% of Hawaii's total energy usage and so it is likely that this will serve as a good starting point to meet the incremental goals of 10% in 2010, 15% in 2015, and 20% in 2020 [13].

4) Overall Results

The overall results from State RPS policies have been positive. Although not every state's policy has resulted in the desired amount of renewables development, most states have had some level of success. There are also signs that states that have enacted a policy that was either too aggressive or not aggressive enough have been willing to adjust their goals accordingly. This demonstrates that although the RPS is a complicated public policy measure, it can be reevaluated after it is implemented and changed as appropriate. Table I summarizes the states programs and their results.

TABLE I
SUMMARY OF STATE RENEWABLE PORTFOLIO STANDARDS

	Type	Goal	Credit Trading	Results
Arizona	RPS	Percentage	Under Development	Partial Success
California	RPS	Percentage	Under Development	Inconclusive
Connecticut	RPS	Percentage	NEPOOL*	Too Early
Hawaii	RPS	Percentage	Under Development	Too Early
Illinois	RPS-like	Percentage	*-none-*	Inconclusive
Iowa	RPS	Fixed Amount	*-none-*	Success
Maine	RPS	Percentage	Considering NEPOOL*	Partial Success
Maryland	RPS	Percentage	Under Development	Too Early
Massachusetts	RPS	Percentage	NEPOOL*	Success
Minnesota	RPS-like	Fixed Amount	*-none-*	Success
Nevada	RPS	Percentage	In-state	Early Success
New Jersey	RPS	Percentage	Under Development	Partial Success
New Mexico	RPS	Percentage	In-state	Too Early
Pennsylvania	RPS-like	Percentage	*-none-*	No Development
Rhode Island	RPS	Percentage	NEPOOL*	Too Early
Texas	RPS	Fixed Amount	In-state	Success
Wisconsin	RPS	Percentage	In-state	Success

*NEPOOL is an Independent System Operator that allows credit trading between states

C. International Renewable Portfolio Standards

In the same way that state renewable portfolio standards are a good indication about a possible federal RPS, international efforts with renewable standards can also be a good tool. For the most part, international experience with the RPS as strictly defined in this paper is limited compared

with what has been implemented by the U.S. This does not mean that there is a limited amount of work being done worldwide with renewable energy, but that an RPS has not always been the policy measure chosen to encourage renewables. At least 32 countries have established renewable energy targets, which vary from Austria's 78% goal to Hungary's 3.6% goal [42].

Several countries have policies that are similar enough to the RPS to be mentioned here. The first country is Italy, which has a 25% goal by 2010 [42]. Their country currently has around 20% of their electricity generated from renewable sources, and so this goal is certainly attainable. Another country with a renewables standard is the United Kingdom, which has a 10% goal by 2010 [42]. It establishes "an obligation on all licensed electricity suppliers in England and Wales to supply a specified and growing proportion of their electricity sales from a choice of eligible renewable sources, with the ultimate aim of achieving 10% by 2010" [43]. This policy includes a buyout option if the utility is having trouble meeting its goal and also includes tradable credits [43]. The program is still in its first few years and an initial government review has not yet been done. Lastly, Australia has a mandatory renewable energy target of 9500 gigawatt-hours (GWh) by 2010 [44], [45]. This policy uses tradable credits and lasts until 2020 in order to give long-term stability to the policy [45].

V. Analysis of a Potential Federal Renewable Portfolio Standard

Analysis of any energy issue facing a large nation such as the United States is by very nature complicated. Analysis of a federal RPS is no different and involves many multi-faceted questions that may not even be known for such a new policy measure. There are many reasons that are typically given in support of a federal RPS, and these are detailed below. Since there are also many questions about a federal RPS, these must be examined as well. The analysis of these questions will then point to further implementation or planning work that can be done.

A. A National Need

There are a number of strong reasons for support of a federal RPS. First, the bulk (88%) of the electricity generation in the U.S. comes from coal, natural gas, and nuclear power [1]. To meet the electricity needs of the U.S. these sources are definitely needed, but there is currently too much reliance. Much of the new electricity generation has relied on natural gas, a fuel that has seen dramatic increases in price in the past several years [46]. Increased diversification of electricity generation sources, exactly the kind that would come from a federal RPS, will decrease demand on natural gas and avoid the cost fluctuations associated with higher demand [46], [47].

There are numerous environmental benefits that would come from a federal RPS. The biggest impact would come from a decrease in CO_2 emissions, "because the renewable plants added to meet the RPS would displace plants fueled with natural gas and, to a lesser extent, coal that would have been added without the RPS" [48]. Compared to the reference case, CO_2 emissions would drop by 7% with a 10% RPS and 18% with a 20% RPS [48]. Small decreases would also occur on SO_2, NO_x, and mercury emissions [48]. Thus, the implementation of a federal RPS will result in a net benefit on air quality.

As discussed in the previous section, states are already implementing renewable portfolio standards. Seventeen states have an RPS or similar policy and more are under consideration, but this is not doing enough to promote and develop renewable energy nationwide. Current policies concerning renewable energy such as government money for research and development and tax credits have provided benefits, but have not done enough to make renewable energy competitive. So-called "green power" customer choice programs, which are made available for consumers to purchase "green power" from their utilities, have also seen some support, but not enough to fully lower the cost gaps between renewables and other sources of energy [49]. Typically only a small

percentage of consumers are willing to pay for the higher costs of "green power" despite poll numbers that indicate otherwise [50]. Until the costs of renewable energy "become comparable to those of conventional energy, green marketing programs are unlikely to attract many customers" [50]. There is a market failure happening in which the market on its own, or even the market coupled with current policies for encouraging renewable energy, is not providing the proper impetus to encourage renewables.

B. Unanswered Questions

Some of the biggest questions about mandating a federal RPS involve the proper implementation, costs and who will pay them, environmental benefit, technological ability, economic benefit, and interaction with current policies, particularly state RPS programs. Each of these questions has many facets and deserves thorough investigation.

1) Proper Implementation

Although the RPS would promote renewable energy, there are many questions about the proper way to implement such a policy. If an RPS was implemented, it would probably take the form of proposed legislation or at least be based on the experience of the states. Since so many states are implementing RPS policies, there is a wealth of information that has become available about the best ways to implement an RPS. However, the experience of the states has been mixed so far and no clear solution has emerged about the specifics that make up a successful RPS. There are numerous examples of elements of an RPS that have worked for some states, but there is no guarantee that those elements will translate onto a larger federal level.

Since 1997, there have been numerous federal proposals for an RPS. These are summarized in Fig. 5, shown below. Note that every bill proposed so far includes a percentage target to be met, rather than a fixed amount of generation.

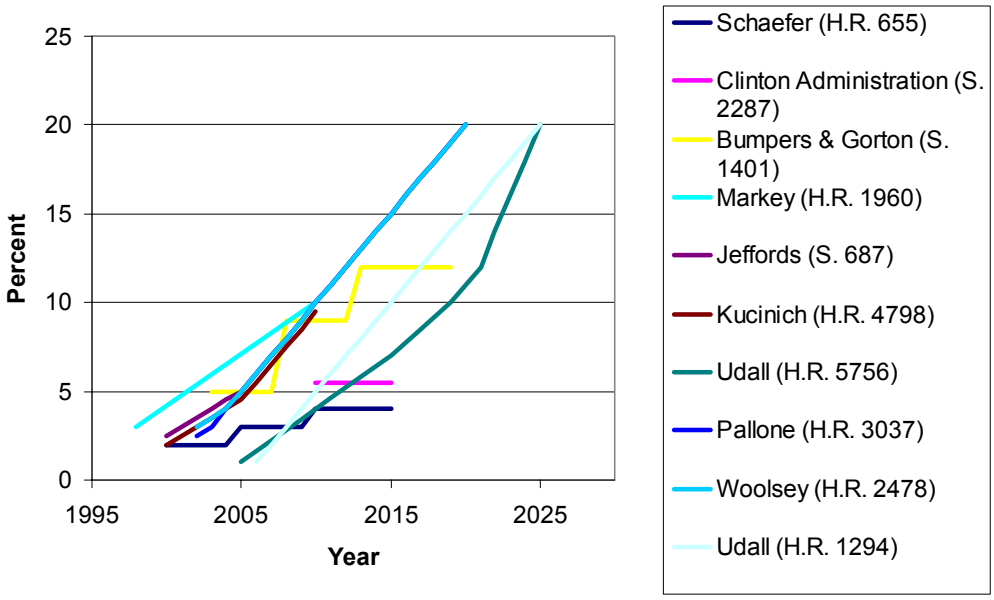

Fig. 5. Proposals for a federal RPS, shown in the legend in chronological order.

Several of the earliest proposals, such as the Schaefer bill, mandated amounts as low as 4% by 2015. This bill includes five-year periods of time during which the percentage stays level and jumps at the end of each period. Other early bills were proposed that directed the U.S. Department of Energy to fix a percentage for the mandate, which would eventually peak at a 5.5% level [7]. Later bills, such as the Woolsey bill, began to include yearly increases of around one percent, and generally lasted for 15-20 years, with a final value of up to 20%. Some bills were proposed as standalone items and others were part of larger omnibus restructuring or energy bills. The most successful proposal was a 10% by 2020 RPS that was included in an omnibus energy bill in 2003, passed by the Senate (H.R. 6), but was later dropped from the conference bill [11]. The current 108th Congress may not pass any energy legislation containing an RPS, even after much work to reconcile both sides. Even though the Bush administration does not support an RPS because it "believes these standards are best left to the states," the issue appears to consistently come up and it is possible that in the future a bill could be passed [51].

In the best case scenario under a federal RPS, renewable energy would be developed nation-wide at the lowest cost, and large-scale implementation would drive prices down. It would be hoped in a less than perfect case, that a federal RPS would promote some level of renewable energy development throughout the country. In this moderate case, there is some question about whether the benefits of setting up a nation wide program would be worth all of the time put in by legislators, administrators, and developers. A federal RPS would more than likely involve a system for trading credits in order to meet the renewable energy mandate. Such a system could be complicated, confusing, and costly, because credit trading must carefully address questions about who gets the credits, what their costs will be, and how they are counted. Improper implementation of a federal RPS, even if it did encourage some renewable development could cost more to execute than the benefits that would be gained.

A large part of what makes an RPS policy aggressive or not corresponds to the percentage that is mandated. Various percentages have been proposed and the most recent proposals have generally fallen into either a 10% or a 20% category. The U.S. has enough renewable potential to meet current energy demands several times over, and so either goal is certainly achievable [46]. The costs of a 20% mandate would obviously be much higher than the 10% mandate. Part of the costs to implement this higher standard would include developing solutions for synchronizing the larger amounts of renewable energy to the grid. The 20% mandate may not be moderate enough to gain full support in Congress, based on an amendment proposed by Senator Jim Jeffords in 2003, which failed by a vote of 20 - 79 [52]. As mentioned above, a 10% proposal was actually passed as part of the Omnibus Energy Bill by the Senate and so it seems an RPS with a similar percentage goal may be the most likely to gain passage in the future.

However, it is important to note that passage of a 10% RPS may not amount to exactly 10% of the nation's electricity from renewable sources. Certain segments of utilities are generally exempted from an RPS mandate. An example of how this affects the overall percentage is described below for a simulation run by the U.S. Department of Energy's Energy Information Administration:

> Although the proposed legislation indicates a 10 percent target, small utilities are exempt from holding renewable energy credits and all renewable generation is excluded from the generation base required to hold RPS credits. If targets are achieved, total renewable energy, excluding existing hydroelectric generation, would account for 8.8 percent of electricity sales by 2020 [47].

The example above indicates how the legislation actually ends up slightly different from the mandate in actual implementation. This leads to the question about who should be obligated to follow the mandate. Of course, it has been argued that exempting certain segments of the market "imposes an unfair, anti-competitive cost burden on consumers served by shareholder-owned utilities" [18]. The answer to this question depends on whether the goal is to encourage certain providers such as government-owned utilities and electric cooperatives. This question remains open and must be answered by lawmakers when legislation is again under consideration.

2) Cost

Cost is another large uncertainty for the implementation of a federal RPS. There are conflicting analyses about what it will do to electricity prices. The general assumption made by opponents to a federal RPS is that it will cost utilities or consumers or both much more money [18]. Higher prices are a distinct possibility under a federal RPS according to several analyses. For a 20% by 2020 case, the Energy Information Administration (EIA) predicts that the "the 20% RPS would raise the average electricity price by 3.3% in 2010 and 4.3% in 2020. However, the 10% RPS would raise the price by only 0.5% in 2010 and slide down to 0.2% in 2020" [7].

Another EIA analysis of a 10% by 2020 RPS projects that slightly higher residential electricity costs, with lower natural gas prices due to reduced demand, will result in costs that are 0.1% higher in 2025 [47]. A similar analysis by EIA with an inflation-adjusted cap on renewable energy credits results in significantly more renewable development, but similar costs [53]. A separate analysis done by the Union of Concerned Scientists using a slightly modified version of the same modeling system as EIA, results in consumer energy bills that are 1.5% lower in 2010 [46].

Several of these analyses assume that a federal Production Tax Credit (PTC) would be passed at the same time as legislation containing a federal RPS. Because a PTC gives a cents/kWh credit (the most recent PTC was 1.8 cents/kWh) for businesses that generate power from renewable sources, this would lower prices for utilities considerably and affects the analysis dramatically [11]. While there is some variability between the analyses discussed above, the common theme is that a federal RPS will reduce demand for natural gas and either decrease or slightly increase overall electricity prices [46]. Even if electricity prices were to increase, this could make consumers more aware of the environmental issues involved in power generation and may result in more conservation.

Another cost-related question is whether the costs of renewable energy could be driven down by research and development, rather than by a government mandate like an RPS. This question implies that giving extra money to renewable energy R&D now may result in future cost reductions that would decrease or even eliminate the cost gap between renewables and traditional fuels. While great benefits have been seen from money spent on R&D, there are a number of reasons why implementing an RPS may be the best approach.

First, a federal RPS would bring large-scale development of renewable energy and nationwide standards that would lower costs. This is a "learn by doing" approach that will more than likely decrease installation costs and general product costs due to the benefits of economies of scale. Second, the difference in magnitude between the funding that is typically given for renewable energy and the investment that will be made to fulfill an RPS will be orders of magnitude different. This difference will contribute to the economies of scale mentioned above.

Third, the boom and bust cycles of renewable energy funding will be avoided. Because some tax incentives, such as R&D funding or the PTC, are short-lived and unstable, this leads to "'boom and bust' cycles that may not be as conducive to building a strong renewable energy industry as the steady market growth offered by a well-designed RPS" [22]. Lastly, companies may naturally choose to invest in R&D since renewable energy requires large amounts of capital. Private R&D could be funded as a way for companies to seek more cost-effective methods of fulfilling the federal mandate. To summarize, using an RPS allows the market to decide which type of renewable energy to use to meet the mandate, benefits from economies of scale, and avoids inconsistent government funding.

3) Environmental Benefit

One of the main reasons that renewable energy is promoted is due to the environmental benefit that comes, mainly in a decrease into the atmosphere of CO_2 [48]. Proponents of renewable energy argue that fossil fuels such as coal have an added environmental cost that is not included with the market cost. Since the 1970s, however, various environmental regulations have attempted to take this environmental cost into consideration, and firms that use fossil fuels have had to pay extra to try to represent the full price of use [50].

The main question is whether the price that would be paid to fulfill a federal RPS would be appropriate for the incremental net benefits that would arise from reduced pollution [50]. It

could be argued that "electricity from renewable energy usually costs so much more than electricity from fossil fuels that externality considerations do not overcome the difference" [50]. Although this is a hard argument to substantiate economically, there may perhaps be some truth in this fact. It is important that the goals of a program such as a federal RPS be remembered. Not only is the goal to reduce pollution but also to subsidize the renewable energy industry so that large-scale implementation will bring overall costs into a more competitive range.

4) Technological Ability

The main technological question surrounding a federal RPS is whether or not the current power transmission grid could handle the added transmission from renewable sources. In many cases, building new renewable generation sources would require supplemental transmission lines to be built, adding cost to an already expensive technology [23]. Oftentimes the sites that are the best for renewable generation are located far from where people want to live, for example with wind generation, "people don't like to live where it's windy enough to be of commercial significance" [23]. This means that new generation is often built where the resource is best, but far away from where large densities of people—and the best transmission lines—are located [23]. These new transmission lines can be quite costly and can face lengthy permitting delays [18]. In some cases, it is possible that the rapidity of renewable development could outpace the ability of the transmission lines, leading to available capacity with no technological ability to be used [23]. In order to prevent such delays, careful planning must be done to make sure proper local and state procedures have been followed.

Another technological aspect of adding renewable generation capacity to the grid has to do with the intermittent nature of some sources. Wind and solar are often cited as being problematic because their generation is dependant on natural phenomenon and cannot be controlled or even predicted. The addition of new renewable generation will therefore require

some amount of additional conventional generation to supplement the times when renewables are not generating electricity [18]. Increased experience with this sort of problem will enable new solutions to be developed between "transmission operators and utilities in finding different ways of doing interconnections" [23]. A recent study on whether or not intermittent wind generation has caused problems for Xcel Energy in Minnesota points out that the 280 MW wind system under study resulted in negligible costs to the grid, but that larger penetration of wind generation would increase the costs [54]. Larger amounts of wind, or any renewable, will begin to cost more and more in order to meet the extreme technical challenges presented by these intermittent sources.

5) Economic Development

One hindrance to developing a federal RPS is that not all states have the same renewable generation capacity and so under a federal plan, not all states would benefit in the same way. It has been argued that a federal RPS will result in huge flows of cash from Eastern states, which generally are 'renewable poor' to Western states, which generally are 'renewable rich' [55]. Under a federal RPS, two scenarios could occur: the first is that the best energy sites in the country will be used because these have the most economic benefits and money will indeed, flow to the states with the best potential. The second scenario is that states will use their own RPS to control where generation of renewables will occur [40].

In the first scenario, the absolute lowest cost energy sites in the country would be found and developed, and credits would be traded between states. This would keep costs low, but only certain states would benefit, unlike in the second scenario. The second scenario would result in economic development occurring throughout the country, although at an overall higher cost than in the first scenario. It has been suggested that many 'renewable poor' states could benefit from a federal RPS because the materials and production used in making renewable generators could

be done in any state and shipped to the states where development will occur. It is likely that a federal RPS would have results somewhere in between the two scenarios discussed above. Since 17 states currently have an RPS, these (and other states who wanted to pass a state RPS) could control whether or not renewable credits generated from other states are eligible to fulfill the state's RPS.

The inequities that may arise between states that gain from an RPS and states that do not could be balanced by promoting economic development in 'renewable poor' states. An RPS bill could use tax breaks to encourage manufacture of equipment in certain states used to fulfill the RPS in other states. This would mean that new businesses could be encouraged to start in a state that has poor solar potential such as Michigan, which could produce solar panels that could be shipped to New Mexico to take advantage of that state's superior solar potential. In addition to solar panels, wind turbines, transmission materials, and any other element could be manufactured throughout the country and shipped anywhere else. This type of tax break should not be promoted to discourage the manufacture of renewables equipment that may be occurring already, but should instead promote in 'renewable poor' states the new manufacturing capability necessary to fulfill the RPS. This type of addition to an RPS would result in a more balanced economic benefit for the whole nation.

It is also important to note that some of the economic effects that would come from learning by doing and economies of scale may be hindered since the best nationwide renewable sites would be developed before more higher-cost sites [50]. There is some uncertainty about "how the costs of development might change as developers move from the best sites to those that are less economically attractive" [47]. This situation was included by EIA in their analyses by assuming that development costs increase as more costly sites are developed [47].

6) Interaction with State RPS Policies

To achieve maximum interoperability between state and federal policies, some states may have to slightly change their RPS policies. The general transition from having only state RPS policies, to having both state and federal policies would take careful coordination. It would also require time to prepare for the possible complications that may arise from their interaction. State RPS policies enacted after a federal policy could, of course, be designed to fit within a federal RPS and would likely face fewer difficulties compared to a pre-federal state RPS policy.

The passage of a federal RPS could either facilitate or hinder the ability of the states to enact and enforce their own RPS [17]. The most basic issue is whether a federal RPS would override or work in conjunction with a state RPS. A federal RPS would have to be written using specific language called a "savings clause" that establishes the federal RPS as a floor upon which state may build [17]. Without out such a clause, state RPS policies "could be challenged as violating the Supremacy Clause of the U.S. Constitution, on the grounds that Congress intended to preempt state regimes" [17]. If this were to happen, the federal RPS would effectively act as a ceiling on renewable development. However, it seems that most proposals have intended to make the federal RPS a backstop that would "only apply to a state's retail electric suppliers if that state does not meet the minimum national RPS requirements" [56]. Congress would also need to give states the authority to impose their own criteria such as whether renewable electricity generation must be done in state to count towards a supplier's credits [17]. If this Congressional authorization is not given, states could violate the dormant Commerce Clause, which limits a state's ability to regulate interstate commerce [17].

Another interaction that would need careful consideration would be credit trading. Most federal RPS proposals include credit trading and as mentioned above, most states and some regions already have credit trading in place. Assuming that credits for both a state RPS and a

federal RPS would have shared eligibility, it is possible that a state could produce more credits than it needs and sell them to utilities in other states to fulfill their state/federal RPS requirements. This situation requires careful thought to ensure that no double counting of credits occurs [56].

VI. Conclusion

The Renewable Portfolio Standard is a policy measure that at its most basic dictates the amount and type of renewable energy that must be produced, who is obligated to comply, as well as the timeframe for meeting these standards. On a more in-depth level, the RPS has a wide amount of flexibility with regard to compliance mechanisms, enforcement, coordination of other policies, and administrative duties. This flexibility has led to a wide amount of variation in the successes of state policies, 17 of which have been developed.

A federal RPS could be successfully implemented by following the examples set by some of the states, as appropriate for a larger scale. The most recent proposals in Congress have mandated a 10% by 2020 scenario, with credit trading as a compliance mechanism. Although such a bill has not yet been made law, several groups have done analysis that indicates that a federal RPS could be done appropriately with many benefits for the country. The overall cost for implementing an RPS will, from most analyses, cause electricity prices to rise a few percentage points. This may be an acceptable increase in order to encourage development of renewables. The administrative costs to develop and run an RPS with credit trading are not known for a program of this size. More study would need to be done to determine these costs so that they could be weighed against the positives of such a policy.

Many questions still remain about the implementation of a federal RPS. Because an RPS of this size has never been done, a large amount of work would need to be done to ensure that the

policy would successfully encourage renewable energy development without putting too much of a burden on those who are obligated. Implementation of an RPS would also need to carefully address who would be obligated. And lastly, a federal RPS would need a mechanism to balance the economic benefits that could be gained by certain 'renewable rich' states.

The large amount of questions that remain indicate that passage of a federal RPS should only be done after more study is done. The successes that have occurred in the states could be translated onto a federal system, but the failures could as well. Successful implementation will need to address the questions that remain and will then result in a policy with many long-term benefits for the country.

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VIII. References

[1] U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 2002*, Oct. 24, 2003, [Online]. Available: http://www.eia.doe.gov/emeu/aer/pdf/03842002.pdf

[2] T. Appenzeller, "The End of Cheap Oil," *National Geographic*, vol. 205, no. 6, pp. 80-109, June 2004.

[3] D. A. King, "Climate Change Science: Adapt, Mitigate, or Ignore?," *Science*, vol. 303, p. 176, Jan. 9, 2004, [Online]. Available: http://fire.pppl.gov/gcc_king_science_010904.pdf

[4] D. Kennedy, "Climate Change and Climate Science," *Science*, vol. 304, p. 1565, June 11, 2004.

[5] H.R. 6, Energy Policy Act of 2003 (Engrossed Amendment as Agreed to by Senate), Sec 264, [Online]. Available: http://thomas.loc.gov

[6] D. A. Balser, "Sustainable Generation Portfolio," *IEEE Power Engineering Review*, vol. 22, pp. 12-15, May 2002.

[7] F. Sissine, "Renewable Energy Portfolio Standard (RPS)," *Congressional Research Service Memorandum*, Nov. 27, 2001.

[8] U.S. Department of Energy, *Renewables*, [Online]. Available: http://www.doe.gov/engine/content.do?BT_CODE=RENEWABLES

[9] National Renewable Energy Laboratory, Energy Analysis Office, *Renewable Energy Cost Trends*, October 2002, [Online]. Available: http://www.nrel.gov/analysis/docs/cost_curves_2002.ppt
[10] J. McVeigh, D. Burtraw, J. Darmstadter, and K. Palmer, *Winner, Loser, or Innocent Victim? Has Renewable Energy Performed as Expected?*, June 1999, [Online]. Available: http://www.rff.org/Documents/RFF-DP-99-28.pdf
[11] F. Sissine, "Renewable Energy: Tax Credit, Budget, and Electricity Production Issues," *Congressional Research Issue Brief for Congress*, June 21, 2004.
[12] U.S. Department of Energy, Energy Efficiency and Renewable Energy State Policy Issues, May 27, 2004, [Online]. Available: http://www.eere.energy.gov/state_energy/policies.cfm
[13] Database of State Incentives for Renewable Energy, June 17, 2004, [Online]. Available: http://www.dsireusa.org
[14] R. Wiser and O. Langniss, *The Renewables Portfolio Standard in Texas: An Early Assessment*, Nov. 11, 2001, [Online]. Available: http://www-library.lbl.gov/docs/LBNL/491/07/PDF/LBNL-49107.pdf
[15] Energy Vortex, *U.S. Government & the States Should Create Energy Efficiency Portfolios*, June 9, 2004, [Online]. Available: http://www.energyvortex.com
[16] United Nations World Commission on Environment and Development, *Our Common Future*, Aug. 4, 1987.
[17] N. Rader and S. Hempling, *The Renewable Portfolio Standard: A Practical Guide*, prepared for the National Association of Regulatory Utility Commissioners, Feb. 2001, [Online]. Available: http://www.naruc.affiniscape.com/associations/1773/files/rps.pdf
[18] Edison Electric Institute, *A Nationwide 'Renewable Portfolio Standard' (RPS) Would Raise Consumers' Electricity Prices and Create Inequities Among States*, Sept. 2003, [Online]. Available: http://www.eei.org/industry_issues/electricity_policy/federal_legislation/EEI_RPS.pdf
[19] Renewable Energy Policy Project, *REPP Renewable Portfolio Standard (RPS) Map*, June 2004, [Online]. Available: http://www.repp.org/rps_map.html
[20] Union of Concerned Scientists, *State Clean Energy Maps and Graphs: Renewable Energy Standards*, Jan. 8, 2004, [Online]. Available: http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=895#res
[21] New York State Public Service Commission, *Retail Renewable Portfolio* Standard, July 2, 2004, [Online]. Available: http://www.dps.state.ny.us/03e0188.htm
[22] R. Wiser, K. Porter, R. Grace, and C. Kappel, *Evaluating State Renewables Portfolio Standards: A Focus on Geothermal Energy*, Sept. 3, 2003, [Online]. Available: http://www.geocollaborative.org/publications/RPS_Summary.pdf
[23] A. Clamp, "Wind Flies High," *Electric Perspectives*, vol. 28, no. 4, July/Aug. 2003, [Online]. Available: http://www.eei.org/magazine/editorial_content/nonav_stories/2003-07-01-wind.htm
[24] New Jersey Board of Public Utilities, *The Renewable Energy Task Force Report*, Apr. 24, 2003, [Online]. Available: http://www.state.nj.us/bpu/reports/RenEnergyTFR.pdf
[25] PJM Generator Attribute Tracking System Working Group, *GATS Concept Draft*, Mar. 4, 2004, [Online]. Available: http://www.pjm.com/committees/working-groups/gats/download/20040304-draft-concept-paper.pdf
[26] Minnesota Public Utilities Commission, *Staff Briefing Papers*, May 4, 2004, [Online]. Available: http://www.puc.state.mn.us/docs/briefing_papers/b04-0075.pdf
[27] ISO New England, *Overview of ISO New England*, March 2004, [Online]. Available: http://www.iso-ne.com/iso_news/Information_Kit/01_Overview_of_ISO_New_England.pdf
[28] PJM Interconnection, *Overview*, July 2004, [Online]. Available: http://www.pjm.com/about/overview.html
[29] Western Governor's Association, *Needs Assessment for a Western Renewable Energy Generation Information System Final Report,* December 29, 2003, [Online]. Available: http://www.westgov.org/wieb/wregis/12-30-03fnl.pdf
[30] GDS Associates, *Analysis of Renewable Portfolio Standard Options for the State of Hawaii*, Prepared for the Department of Business, Economic Development and Tourism, State of Hawaii, March 2001, [Online]. Available: http://www.hawaii.gov/dbedt/ert/rps01/rps01.pdf
[31] Massachusetts Division of Energy Resources Renewable Portfolio Standard, *RPS-Qualified New Renewable Generation Units*, July 12, 2004, [Online]. Available: http://www.mass.gov/doer/rps/approved.htm
[32] Public Service Commission of Wisconsin, Renewable Resource Credit Program, *Public RRC Annual Report*, Accessed Apr. 14, 2004, [Online]. Available: https://www.wirrc.com/rrc/index.html
[33] RENEW Wisconsin Newswire, *Wisconsin's RPS Off to a Flying Start*, May 20, 2002, [Online]. Available: http://www.renewwisconsin.org/reports/newswire5_02.html
[34] P. D. Thompson, *A Study Evaluating the Impacts of Increasing Wisconsin's Renewable Portfolio Standard*, Oct. 31, 2003, [Online]. Available: http://energytaskforce.wi.gov/docview.asp?docid=1

[35] Arizona Environmental Portfolio Cost Evaluation Working Group, *Costs, Benefits, and Impacts of the Arizona Environmental Portfolio Standard*, June 30, 2003, [Online]. Available: http://www.cc.state.az.us/utility/electric/CostEvalRpt.pdf
[36] Arizona Corporation Commissioners News Release, *Commissioners Boost Renewable Energy Requirement*, Feb. 11, 2004, [Online]. Available: http://www.cc.state.az.us/news/pr02-11-04.htm
[37] State of California Energy Commission, *Renewable Resources Development Report*, November 2003, [Online]. Available: http://www.energy.ca.gov/reports/2003-11-24_500-03-080F.PDF
[38] C. A. Smoots, "An Overview of the California Model for Renewable Energy Procurement," *Oil, Gas, and Energy Law Journal*, Summer 2004, [Online]. Available: http://www.thelenreid.com/articles/article/art_216.pdf
[39] Synapse Energy Economics Inc., *The Maryland Renewable Portfolio Standard: An Assessment of Potential Cost Impacts*, March 27, 2003, [Online]. Available: http://www.synapse-energy.com/Downloads/report-mdpirg-md-rps.pdf
[40] R. Grace, R. Wiser, *Crafting a Renewable Portfolio Standard for Rhode Island: Design Choices, Best Practices, and Recommendations*, Jan. 10 2003, [Online]. Available: http://righg.raabassociates.org/Articles/RPS-Design-final.doc
[41] SolarAccess.com, *Rhode Island Passes 15 Percent RPS*, June 25, 2004, [Online]. Available: http://www.solaraccess.com/news/story?storyid=6998
[42] Johannesburg Renewable Energy Coalition, Accessed Jul. 13, 2004, [Online]. Available: http://www.iea.org/dbtw-wpd/textbase/pamsdb/jr.aspx
[43] United Kingdom Department of Trade and Industry Energy Group, *Policy and Renewables Obligation*, Apr. 20, 2004, [Online]. Available: http://www.dti.gov.uk/energy/renewables/policy/index.shtml
[44] T. Berry, M. Jaccard, "The Renewable Portfolio Standard: Design Considerations and an Implementation Survey," *Energy Policy*, vol. 29, pp. 263-277, 2001, [Online]. Available: http://www.emrg.sfu.ca/articles/RPSsurvey.pdf
[45] International Energy Agency Renewable Energy Database, *Policies and Measures*, Accessed Jul. 13, 2004, [Online]. Available: http://www.iea.org/dbtw-wpd/textbase/pamsdb/search.aspx?mode=re
[46] Union of Concerned Scientists, *Renewing Where We Live: A 10 Percent by 2020 National Renewable Electricity Standard Will Benefit America's Economy*, September 2003, [Online]. Available: http://www.ucsusa.org/documents/National_Senate_RWWL_-_2003_September_Update.pdf
[47] U.S. Department of Energy, Energy Information Administration, *Analysis of a 10-Percent Renewable Portfolio Standard*, May 2003, [Online]. Available: http://www.eia.doe.gov/oiaf/servicerpt/rps2/pdf/sroiaf(2003)01.pdf
[48] U.S. Department of Energy, Energy Information Administration, *Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants: Sulfur Dioxide, Nitrogen Oxides, Carbon Dioxide, and Mercury and a Renewable Portfolio Standard*, July 2001, [Online]. Available: http://www.eia.doe.gov/oiaf/servicerpt/epp/pdf/sroiaf(2001)03.pdf
[49] Union of Concerned Scientists, *Plugging in Renewable Energy: Grading the States*, May 2003, [Online]. Available: http://www.ucsusa.org/documents/Plugging_In_RE_-_Fact_Sheet.pdf
[50] Cato Institute, *Evaluating the Case for Renewable Energy: Is Government Support Warranted?*, Jan. 10, 2002, [Online]. Available: http://www.cato.org/pubs/pas/pa422.pdf
[51] Executive Office of the President, Office of Management and Budget, "S. 14 – Energy Policy Act of 2003," *Statement of Administration Policy*, May 8, 2003, [Online]. Available: http://www.whitehouse.gov/omb/legislative/sap/108-1/s14sap-s.pdf
[52] U.S. Senate Roll Call Votes 107th Congress – 2nd Session, *On the Amendment (Jeffords Amendment No. 3017)*, Mar. 14, 2002, [Online]. Available: http://www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=107&session=2&vote=00050
[53] U.S. Department of Energy, Energy Information Administration, *Addendum to 'Analysis of a 10-Percent Renewable Portfolio Standard'*, June 2003, [Online]. Available: http://www.eia.doe.gov/oiaf/servicerpt/rps2/pdf/addendum01.pdf
[54] D. Brooks, E. Lo, R. Zavadil, S. Santoso, and J. Smith, *Characterizing the Impacts of Significant Wind Generation Facilities on Bulk Power System Operations Planning*, May 2003, [Online]. Available: http://www.uwig.org/UWIGOpImpactsFinal7-15-03.pdf
[55] U.S. Senate Chamber Action, Remarks by Senator Jon Kyl, Mar. 14, 2002, [Online]. Available: http://thomas.loc.gov

[56] R. Wiser, *Massachusetts Renewable Portfolio Standard Policy Memorandum #2: Relationship of the Massachusetts RPS to a National RPS*, Feb. 23, 2000, [Online]. Available: http://www.mass.gov/doer/programs/renew/rps-docs/wp02.doc

IX. Biography

Samuel L. Schoofs (M'03) was born in Dubuque, IA on April 4, 1982. He graduated from Calvin College in May 2004 with an engineering degree and a concentration in electrical and computer engineering. In the fall of 2004 he will be attending Georgia-Tech Lorraine to pursue a masters degree in electrical engineering.

He worked on a design project during his senior year with a team that installed a 20 kW photovoltaic array on the new Calvin College Interpretive Center. He also did summer research at Calvin College with Professors Paulo Ribeiro and Matthew Heun in conjunction with Jet Propulsion Laboratory in Pasadena, CA investigating advanced photovoltaic materials for microsatellites to be sent to Mars. He has previously worked at an architectural firm and on the Calvin College Engineering Department Information Technology staff. Research interests include renewable energy, communications, and non-linear dynamics.