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Renewable Portfolio Standards for the Promotion of Renewable Energy

The Dilemma of Developmental Inequity in the United States

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Abstract

Implementation of the Renewable Portfolio Standard (RPS), a political tool intended to increase investment in renewable energy, has become increasingly common in the early 21st century. RPS policies require that a certain amount, or percentage, of electricity in a providers electricity supply mix is generated from renewable energy sources. The distribution of renewable energy generation capacity development which has resulted from the implementation of RPS policies in the United States was investigated in this thesis research. As it relates, the political implications of developmental inequity which may result from RPS policies was also investigated.

This thesis research presents a link between the geographic distribution of the installed renewable energy generation capacity that has resulted from the implementation of state RPS policies and corresponding boundary definitions of Tradable Renewable Energy Credit (TREC) markets. TRECs, which represent the renewable attributes of electricity generated from renewable energy generation installations, are often included in RPS policies as a compliance and flexibility mechanism. Several American states have declared TRECs generated by out-of-state renewable energy generation facilities eligible for RPS compliance in their state, thereby extending their TREC compliance market boundaries. As a result, it was found that much of the renewable energy credited for RPS compliance in those states with extended TREC market boundaries, is generated outside of that state which implemented the policy. As such, those states which have included an extended TREC compliance market in accordance with their RPS have developed comparatively less in-state renewable energy capacity than states which have restricted compliance eligibility to renewable energy facilities to a more regional, or state-wide market.

The development of new installed renewable energy generation capacity that results from RPS policies may therefore be displaced to neighbouring regions if an extended TREC compliance market is included in the policy design. Additionally, this thesis research was supplemented with a presentation of the effects of RPS on renewable energy generation installations by technology type. Following the implementation of RPS, wind energy generation, a comparably low cost renewable energy technology, was found to have been disproportionately successful in comparison with alternative renewable energy technologies.

Based upon the geographic and industrial distribution patterns of renewable energy generation capacity installations that have resulted from state RPS policies, the likely distribution of development that would result from a federal RPS is presented and discussed. If a federal RPS were to include a national-scale TREC compliance market, large increases in wind energy installations, especially within the Upper Midwestern states, have been projected. Trends in American politics, which were found to favour equity and regional economic development in policy design, seem to stand in opposition to this possible developmental inequity. As such, it is recommended that a federal RPS, if implemented, should take into consideration design features which act to limit inequity. Such design features could include a TREC compliance market with regional boundaries, specifications for TREC allowances in regions with less indigenous resource, or an altogether exclusion of a national-scale TREC compliance market. As such, national goals to foster the implementation of an increased percentage of renewable energy generation capacity may simultaneously achieve political goals for geographic equity through the implementation of RPS.

Executive Summary

The promotion of renewable energy in policy has been increasing internationally over the last decade for reasons which include regional and national energy security, the mitigation of climate change, and economic development. The Renewable Portfolio Standard (RPS), a policy tool utilized widely in Europe and the United States, is designed to support investment in the construction of new renewable energy generation capacity by requiring that a specified capacity or percentage of the electricity supply originates from renewable sources.

RPS policies often include markets for Tradable Renewable Energy Credits (TRECs) as a compliance tool and flexibility mechanism. TRECs represent the unbundled renewable attributes of electricity produced from renewable energy sources, typically 1 MW of generated renewable energy. TRECs are usually sold on a market separate from the actual unit of electricity. As TRECs are not subject to geographic boundaries or limitations, the inclusion of TREC compliance markets as a flexibility mechanism in RPS policies allows the indiscriminate purchase of renewable energy generation capacity, regardless of location, at the least possible cost.

There has been increasing discussion in Europe and the United States on the integration of RPS policies and an accompanying extension of TREC market boundaries beyond national and state borders respectively. These discussions are based on the theory that extended TREC markets provide greater economies of scale, stabilize the price of TRECs, and encourage the development of new renewable energy installations in the most cost-efficient areas (those of maximal resource). However, the increased economic efficiency provided by extended TREC compliance markets may be at the cost of regional benefits associated with the installation of new renewable energy generation capacity. An extension of TREC compliance markets may therefore increase the inequity of RPS as a political tool; those nations or states with fewer indigenous renewable energy resources may sacrifice the economic and environmental benefits associated with *regional* renewable energy development for the sake of cost efficiency. The developmental inequity which may result from the implementation of RPS policies with respect to the definition of TREC compliance markets is an important investigation for further discussions of integration.

With the United States as a focus, this researcher examined the distribution of installed renewable generation capacity that has resulted from the implementation of RPS policies. The geographical distribution of the development of renewable energy generation capacity which has followed the implementation of state RPS policies is examined and compared against the boundary definitions of accompanying TREC compliance markets. This examination led to conclusions on the geographic equity of RPS policies and the effects of extending TREC eligibility beyond state boundaries. The development of renewable energy generation capacity by industrial sector following the implementation of RPS policies is similarly identified. This secondary examination led to conclusions on the equity of RPS policies in terms of renewable energy industry. Projections are then presented for the likely distribution of development which could result from a federal RPS designed to include a national-scale TREC compliance market.

Finally, the equity of distribution as defined in Chapters 5, 6, and 7 of this thesis research was compared against trends in American politics shown to favour equity and regional economic development. Recommendations are then made on the design features of a federal RPS which would act to limit geographic inequity and more adequately satisfy political priorities. Possible design features could include a national-scale TREC compliance market with regional trading boundaries, or specifications for TREC allowances in regions with less indigenous resource.

Alternatively, an extended TREC compliance market could be completely excluded from the design of federal RPS, effectively mirroring the Directive of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources.

Project Approach

This thesis is divided into five sections. The first, the literature review, introduces the reader to RPS policies and TREC compliance markets and aims to establish a thorough basis for understanding these political tools and their functions. The second section examines data on the distribution of renewable energy generation capacity that has been installed as a result of the implementation of RPS policies and its consequent definition of TREC compliance market boundaries. The third section presents projections by the United States Energy Information Administration (EIA) on the distributional effects of the implementation of a federal RPS which incorporates a national-scale TREC compliance market. The fourth section presents the results of stakeholder interviews organized into political trends. The final section summarizes the distributive results from the preceding sections and the results of qualitative interview analysis on trends in American politics. Recommendations are made in the final section on the design features of a federal RPS with respect to TREC compliance market definition. These recommendations are made with regard to fulfilling the simultaneous objectives of support for significant new renewable energy generation capacity and equity in terms of the geographic distribution of that development.

The Distributional Equity of RPS policies and TREC Compliance Markets; Results and Political Implications

The quantity of renewable energy generation capacity that has been developed in response to the implementation of RPS policies varies considerably, by state. States that have experienced no new renewable energy generation capacity development in-state, are typically small, North-eastern states. It is shown that a majority of these states have declared renewable energy generation facilities which lie beyond state boundaries eligible to meet RPS compliance obligations. States that have experienced the most new capacity development, in-state, are typically larger Western states. Most of these states, conversely, have generally restricted TREC markets to state boundaries or to immediate, in-state contributory transmission grids.

Across those states with active RPS policies, 91.6% of the new renewable energy generation capacity which was installed was wind-based. As such, the windpower industry has been, by far, the main beneficiary of RPS policies across the United States.

The geographic and industrial distributional inequity of renewable energy generation capacity that has resulted from the implementation of RPS policies is reflected in projections for a federal RPS. A federal RPS policy which incorporates a TREC compliance market extended to a national scale is projected to strongly favor wind energy development, and biomass co-firing to a lesser degree. A significant portion of that development would likely occur in the upper Middle Western American states due to their significant indigenous wind resources in that region.

The perception that RPS policies result in regional economic development has been a significant driver for their implementation in state policies. This consideration for regional economic development is important at both the state and federal level in American politics. Political decision-making tends to favor regional benefits over national achievements with respect to the implementation of renewable energy generation capacity. Moreover, it was found that regional development is often given considerable priority even if the ultimate compliance cost of the policy may increase as a result. Across all interviewed stakeholders in this research, there was consensus that political emphasis is placed upon those policies which encourage regional development in the politicians' home state. This political emphasis translates into concern for the inequity that may result from a federal RPS and an extended national-scale TREC compliance market. This is exhibited by the vocal opposition to a federal RPS from politicians in the South-eastern states which results from their perception of their disadvantage to those states with larger renewable energy resources.

Therefore, the inequity of renewable energy generation capacity development that may result from the implementation of RPS policies, in accordance with TREC compliance market boundary definitions, may have impeded the success of proposals for a federal RPS. New proposals for a federal RPS may be received more favorably by American politicians if they take larger account of the emphasis on regional equity.

Recommendations

State RPS policies are not uniformly implemented across the United States. A federal RPS has the potential to stimulate significant development of new renewable energy generation capacity where state policies alone may fall short. Were a federal RPS to include a national TREC compliance market as has been included in each subsequent proposal, the data found in this research suggest that the resulting development would be dominated by the windpower industry. Moreover, that development is likely to be geographically concentrated in the Upper Midwest. The total contribution of renewable energies in the energy portfolio of the United States would grow, but the distribution of that growth would exhibit inequity by region and by industry. Therefore, a federal RPS which includes a national-scale TREC compliance market may not be capable of achieving political goals designed to support new renewable energy generation capacity development *and* regional equity, at the same time.

Every area of the nation has exploitable indigenous renewable energy resources. In order to support a goal of geographic equity in a diversified energy portfolio, these resources must be utilized. A federal RPS with stipulations for a minimum renewable energy generation requirement that did not include a national-scale TREC compliance market scheme would allow states the benefit of regional renewable energy generation capacity development while simultaneously diversifying the national energy portfolio. Such design features reflect the EU Directive on Renewable Energy (EU, 2001) which specifies requirements for percentages of renewable energy, but has left the mechanism by which to do so to the liberty of the individual states. Alternatively, a national-scale TREC compliance market could be designed with many regional market boundaries, or specifications for additional TREC allowances in regions with less indigenous resources. It is important to note, however, that such design features intended to lessen developmental inequity, may result in the sacrifice of the least-cost TREC purchase option. As such, the over-all cost of compliance is likely to increase. However, the benefits associated with the local development of renewable energy generation capacity such as regional energy security and self-reliance, as well as reductions in local air pollution and greenhouse gas contributions are not readily or properly quantifiable in normal cost calculations. The balanced integration of these factors is an important consideration for decision makers at both the state and federal levels.

Therefore, although the inclusion of geographic and industrial equity in the design of an RPS policy may lead to an increased compliance cost, the regional benefits associated with a restricted TREC compliance market, reflected in political trends which favour regional development and equity, may outweigh the increase in compliance costs.

Table of Contents

List of Figures

List of Tables

List of Boxes

Abbreviations and Terms

CO_2 – Carbon Dioxide

ERCOT – Electric Reliability Council of Texas

EIA – Energy Information Administration

EU – European Union

MADOER - Massachusetts Division of Energy Resources

MW – Megawatt

NEMS – National Energy Modelling System

NEPOOL – New England Power Pool

PJM – Pennsylvania-Jersey-Maryland

PTC – Production Tax Credit

RPS – Renewable Portfolio Standard

TREC – Tradable Renewable Energy Credit

1 Introduction

The political promotion of renewable energy has been increasing for reasons including regional and national energy security, the mitigation of climate change, and economic development. The Kyoto Protocol, which entered into force in February of 2005, has acted as an international driver for furthered development of renewable energy. Because energy generation from renewable energy sources can act to replace energy that may otherwise be generated from carbon dioxide emitting facilities, renewables are an important approach by which to decrease carbon dioxide emissions into the atmosphere. A variety of political tools has been developed and employed that are aimed at driving new renewable energy generation capacity development in accordance with goals established by Kyoto, the European Commission, and U.S. states.

Under The Kyoto Protocol, the European Union (EU) has committed itself to an 8% reduction in greenhouse gas emissions relative to their 1990 levels by 2012. Additionally, the European Commission established legislative targets for the entirety of the EU to supply at least 21% of its energy consumption from renewables by 2010[1] with indicative targets for each member state. Individual EU member states have the liberty to extend targets for renewable energy beyond the requirements of the aforementioned *Directive on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market* and the freedom to implement the policy tools of choice to achieve said targets. As a result, the policy structure in favour of renewables across the EU is a decentralized mosaic of political tools.

The United States, a non-signatory party to the Kyoto Protocol, only has set voluntary targets with no formal requirements, for the implementation of renewable energy production to date. Individual American states, however, have taken an active role in driving development of new renewable energy generation capacity with concrete political requirements. As it currently exists, new renewable energy generation capacity development in some states may receive financial incentives in addition to a Production Tax Credit offered by the federal government. Individual states, similar to individual EU member states, have implemented a variety of political tools in favour of renewable energy.

Two well-known support schemes for renewable energy include the quota obligation system or Renewable Portfolio Standard (RPS) and the feed-in tariff system. RPS policies, the focus of this research, set a requirement for a given amount or percentage of the electricity supply that must originate from renewable sources. The use of RPS policies in Europe and in the United States has been increasing in recent years. Feed-in Tariff schemes, well known for their success in Germany, Denmark, and Spain set a premium price for renewable energy delivered to an electrical grid. Utilities are obligated under feed-in tariff schemes to purchase the electricity at this set price. (Van der Linden et al., 2005) Although not uncommon in Europe, there has been no incidence of feed-in tariff use in the United States. Direct subsidies, grants, rebates, and tax credits are also offered in support of new renewable energy development in many countries around the world, as well as in many American states.

Although RPS policies are only one of many support schemes for renewable energy, this thesis research is focused on RPS and Tradable Renewable Energy Credit (TREC) compliance markets for several reasons. Firstly, the increasing use of RPS in the United States makes its' examination important for informed political decision-making. In addition, its inherent design

[1] Directive 2001/77/EC of the European Parliament: The Directive on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market

features in support of the least-cost renewable energy development option based on market mechanisms is believed, by this thesis author, to be especially compatible with current American cultural and political possibilities. As such, it is a realistic, viable option for catalyzing significant increases in renewable energy generation capacity in the United States.

Furthermore, as a comparably new political tool for the promotion of new renewable energy generation capacity development, there is much research to be done on the results of its implementation. Since TRECs are widely used in RPS policies and have been the focus in discussions of national integration, its use as a compliance mechanism was chosen for examination.

The RPS is also known as a quota obligation system, or a renewable mandate, is a policy tool designed to support the development of renewable energy capacity. RPS policies require that a minimum amount of renewable energy is included in the energy generation portfolio of retail suppliers of electricity, thereby increasing the demand for renewable energy. RPS's are increasingly being looked with favour and are gaining in popularity as a useful tool.

> "The Renewable Portfolio Standard (RPS) is a policy that obligates each retail seller of electricity to include in its resource portfolio a certain amount of electricity from renewable energy resources." (Rader and Hempling, 2001, p.1)

RPS policies set a minimum requirement for renewable energy, but the mechanism by which obligations are fulfilled by a given retailer is left to the market. As such, an important objective of the policy is to support the development of renewable energy at the least possible cost. The first RPS policies were implemented in the late 1990's on a state level in the United States. Since that time, RPS's have been incorporated into the policies of 22 U.S. states and the District of Columbia, several European nations, Japan, and Australia.

TRECs, also known as tradable green certificates, renewable energy certificates, or green tags, represent the unbundled renewable attributes of electricity produced from renewable energy sources[2]. These credits typically represent 1 MW of generated renewable energy and are sold on a market separate from the physical electricity. The actual structure of TRECs can take the form of a formal certificate, or may simply be a representation in an electronic data base entry. TREC specifications vary widely across RPS policies; however most include basic, documented information such as the type of generating facility and geographic location. (Hamrin and Wingate, 2003) By assigning a TREC to a unit of generated renewable electricity and then tracking that TREC from source to sink, it is possible for regulators to verify RPS compliance.

These credits are sold separated, or unbundled, from the sale of the physical electricity, effectively removing the geographic and physical limitations of commodity electricity. (Holt and Bird, 2005). Many fragmented markets for TRECs exist that are often limited by geographic area and RPS specifications. The definition of a renewable attribute, or TREC independent of a given unit of energy, creates a mechanism by which renewable energy generation may be distributed to those who value them the most, independent of locale. As such, as TRECs are not subject to geographic boundaries or limitations, the incorporation of TREC markets into RPS policies allows the purchase of the generation of renewable energy in locations of the least possible cost to satisfy the requirements of the policy.

[2] TRECs may also be sold in bundled form with the unit electricity. Further clarification of this definition is provided in Chapter 4.

1.1 Problem Definition

The diversification of energy resources to include renewable energy technologies is an important mechanism in the mitigation of many societies' dependence on imported energy. Moreover, as the generation of electricity from renewable energy sources may act to displace energy generated from conventional, carbon dioxide emitting sources, support for renewable energy is an important mechanism by which to combat climate change. RPS policies which have incorporated TREC compliance markets are one mechanism by which to support the development of renewable energy technologies for the purpose of increased energy security and action against climate change. Several European nations which include Italy, Sweden, and the United Kingdom, have implemented such policies. In the United States it has been the states which have assumed a leadership role in the promotion of renewable energy technologies by means of RPS policy implementation.

The use of RPS, or purchase mandates, to promote investment in new renewable energy generation capacity has been growing rapidly in recent years. Its effectiveness in the support of new investment in renewable energy production capacity has been discussed thoroughly in energy policy literature, often in comparison with other political tools. (See Van der Linden et al, 2005, Wiser Porter and Grace, 2004) The appeal of an RPS lies in its drive for a known quantity of new renewable development with relatively little administrative burden. It inherently ensures buyers for renewable energy and allows obligated parties the flexibility in the mechanism by which they choose to meet their purchase requirements. (Wiser, Porter, and Grace, 2004) A thorough explanation of the variations in structure of this political tool is presented in Chapter 3.

According the energy policy literature, however, RPS policies can be difficult to design and implement well. Poorly designed policies have resulted in little or no stimulation in new renewable energy generation capacity development. In response, although RPS is a comparatively new political instrument, recommendations for its optimal design have been made in accordance with the goals of the specific regulators. These recommendations are based upon comparisons of the effectiveness of explicit variations of the tool. (See Berry and Jaccard, 2001)

TRECs, often incorporated into RPS policies as an effective verification mechanism are often looked upon favourably as they enable obligated parties to fulfil their renewable energy portfolio requirements without having to "wheel the energy from where the renewable energy facility is actually located." (Hamrin and Wingate, 2003, p.8) As such, TRECs may lower the overall compliance costs of an RPS. Studies have been done and recommendations made on the prerequisite components of well-functioning TREC compliance markets. (See Chupka, 2003, Berry, 2002) For example, tracking systems are recommended to prevent complications such as double-counting, and often design features such as banking and borrowing allowances are recommended in the establishment in RPS policies to stabilize the price of certificates. A drawback of TREC compliance markets that is often cited; by removing the renewable attributes from the commodity electricity, as is common with TRECs, the benefits associated with renewable energy may not be achieved in the geographic region of the purchasing obligated party.

According to the literature, RPS with TREC compliance markets has been successful in the promotion of renewable energy under widely diverse circumstances. These policy tools have gained support across partisan politics in the U.S. and internationally as cost efficient mechanisms that require relatively little governmental involvement or administration. Moreover, they are perceived as an important developmental opportunity for employment and for the economy; this has played an important role in their promotion and implementation. (Rabe, 2006)

The continued proliferation of RPS policies has been accompanied by increasingly frequent discussions on the benefits of collaboration in Europe and among American states, especially as regards the integration of TREC market boundaries beyond national and state boundaries respectively. In the United States, individual state RPS policies have been increasing, and have been responsible for facilitating the development of increases in new renewable energy installations. However, state RPS policies are not implemented evenly or uniformly across the United States. As such, significant discussion has surrounded the possible benefits of federal RPS proposals which would incorporate a national-scale TREC compliance market, initiated in part on the idea that policies implemented solely at the state level are insufficient to achieve significant national targets for renewable energy. It is argued further that extended TREC markets provide greater economies of scale and stabilizes the price of TRECs. (Mozumder and Marathe, 2004) The steps necessary for the successful integration of RPS policies and TREC compliance markets in the United States and abroad have been a popular topic in recent literature. (See Grace and Wiser, 2002, Nielsen and Jeppesen, 2003, Mozumder and Marathe, 2004) The compatibility of existing regulations and agreements among parties on the eligibility of renewable energy technologies are two important components of integration.

Discussions on the integration of TREC compliance markets must also consider that the benefit of economic efficiency associated with extended TREC market boundaries may be at the cost of reduced regional employment and economic benefits to neighbouring states or nations. Assuming that the development of new renewable energy installations is most cost-efficient around areas of optimal renewable energy resources, it follows that the cost of TRECs is likely to decrease should market boundaries extend to include geographic areas with significant indigenous renewable energy resources. The cost of new renewable energy generation capacity is expected to decrease as installations are implemented in areas of the least cost and highest renewable resource, thus stabilizing and lowering the cost of each TREC. (Mozumder et al., 2004) With an extension of TREC markets, those nations or states with fewer indigenous renewable energy resources may sacrifice the regional economic development and related employment benefits for the sake of a more cost efficient political tool. As politicians have historically favoured the implementation of RPS and TREC compliance markets due to the perception that these tools encourage the development of regional employment opportunities and support the local economy, their willingness to collaborate with external state or national governments may be affected if cooperation caused these developmental benefits to be lost to the neighbouring regions.

The geographic distribution of the renewable energy capacity installed as a result of the implementation of TREC compliance markets is an important component of discussions surrounding the extension of such markets across state or national boundaries. "A fair distribution of costs and benefits resulting from the obligation scheme is an important aspect for ensuring the long-term sustainability of the system." (Van der Linden et al., 2005) This inequity and its political implications have not yet been investigated in energy policy literature.

This thesis author investigated the effects of RPS policies and TREC compliance markets on the geographic and industrial equity[3] of distribution of new renewable energy capacity. The

[3] Geographic equity in this thesis refers to the evenness of distribution of new installed renewable energy generation capacity across a given geographic area. In other words, when divided into subsections, a geographic area with strong equity has similar new installed renewable energy generation capacity in each subsection. A geographic area with weak equity may have subsections with significantly higher new installed renewable energy generation capacity than others. Industrial equity refers to the evenness of support by the political instrument for individual renewable energy industries.

geographic distribution of new renewable energy generation capacity installations that has resulted from the implementation of RPS policies in the United States is examined. In order to define a correlation between development of new renewable energy generation capacity and TREC compliance market definitions, the renewable energy development that has occurred in states with RPS policies is compared against the definition of the TREC compliance market boundaries in those respective states. Additionally, the development by the renewable energy industry was identified by means of investigating the development of the unique renewable energy industries that has occurred in states with RPS policies. By investigating the geographic and industrial development of new renewable energy generation capacity that has been witnessed to date in conjunction with RPS policies and TREC compliance markets, it is possible to draw conclusions as to the equity of the tools themselves.

Political objectives in terms of renewable energy, especially with respect to RPS policies were examined in order to identify applicable trends in American politics. Qualitative interviews were conducted with a variety of stakeholders regarding RPS policies. Areas of consensus across the interviews were identified as trends and used to direct the recommendations of this thesis research. By defining the equity of the instruments in these terms and comparing the equity effects to trends in American politics, it was possible to draw conclusions as how best to utilize these tools to achieve the effective catalyzation of increased investments in renewable energy generation capacity. The implications of regional equity considerations in American politics led to recommendations on the design features of RPS policies likely to encourage new renewable energy generation capacity development while at the same time emphasizing optimal geographic equity.

As the concern across both the American citizenry and its political representatives grows for reducing the dependence of the American culture on imported energy sources, the diversification of energy resources to include renewable energy technologies as a growing percentage of the energy portfolio, becomes an increasing priority. Insight obtained from this research will contribute to the ability of national governments, of American state governments, and of other interested parties to recognize the effects, strengths, and weaknesses of integrating TREC markets to extend beyond state or national boundaries in terms of equity in regional renewable energy generation capacity development and in employment that can result from such developments. As such, this research may be used to aid in developing and implementing trading schemes for TRECs in the United States and in other nations with similar political structure. Although this thesis is intended to convey a thorough understanding of RPS and TREC compliance market tools to a general audience, its lessons are intended for those working in-depth with these issues in the context of implementation. The principle audience for this thesis, therefore, includes regulators and organizations working towards the development and implementation of effective renewable energy policies.

1.2 Objectives and Research Questions

The objective of this thesis research was to examine existing TREC compliance markets in terms of the equity of the geographic distribution of installed renewable generation capacity developed as a result of RPS implementation. The distribution of installed renewable energy generation capacity by state as it relates to the definition of the boundaries of the TREC market is addressed as an integral component of this examination. A further objective of this thesis research was to examine existing TREC compliance markets in terms of the equity of support across renewable energy industries. As such, renewable energy technologies were identified which receive disproportionate support from the policy design itself. Furthermore, it was a goal of this research to determine what the witnessed distribution by region and by industry implies for the likely distribution of development in case a federal RPS, which included a national-scale TREC compliance market, were implemented. Finally, in consideration of the equity of distribution defined in the early chapters of this thesis research, it was a goal of this thesis researcher to examine the implications of trends in American politics for the integration of RPS policies and for an extension of TREC compliance markets.

Therefore, the research questions for this study were:

1) In those American states which have implemented RPS policies, how has the development of new renewable energy generation capacity been geographically dispersed?

2) How has the geographic distribution of new renewable energy generation capacity in those states been influenced by the definition of TREC compliance market boundaries?

3) Has any renewable energy technology industry exhibited more direct stimulation in its development as the result of RPS implementation?

4) What does the geographic and industrial distribution of renewable energy generation capacity development which has resulted from existing state RPS policies, imply for the development that would likely result from a federal RPS with a national-scale TREC compliance market?

5) What do trends in American politics, in consideration of the distributional equity of RPS policies, imply for the possible implementation of a federal RPS policy and its design features?

1.3 Scope and Limitations

A review of the pertinent experiences with RPS, or purchase mandates, and TREC compliance markets in an international context to date provides the reader necessary background information and understanding. The focus of this research is upon experiences with these policy instruments in the United States. The TREC compliance markets in Texas and Massachusetts, specifically, were chosen for study as representative samples of compliance markets in the United States. Texas, the first state to have implemented a TREC compliance market, offers insight into the distributional equity of a sizable market limited to in-state boundaries. Massachusetts, which allows TRECs generated out-of-state boundaries for compliance with its individual state RPS requirements, provides insight into the distributional equity in small state markets, and the equity effects of extending those markets. These cases were not chosen as exemplary illustrations, but for demonstration purposes.

A variety of terminologies describe the attributes of renewable energy which is sold on a compliance market under RPS policies including; tradable renewable energy credits, green tags, tradable green certificates, and renewable energy certificates. Because the purpose of this research was to examine the effects of compliance markets, it is appropriate that the term ‘credit’ and its association for use in satisfying an obligation was chosen. Moreover, to emphasize the ‘tradable’ market aspect of the credits themselves, this term was also chosen to be included in the description. As such, the title of Tradable Renewable Energy Credits (TRECs) is used throughout this research to represent the renewable energy attributes of some electricity.

This research is limited in focus on TREC compliance markets. Voluntary TREC markets are mentioned to provide context, but their role in the distribution of renewable energy generation capacity and employment is not considered. This research is focused on RPS as a tool for promotion of investment in renewable energy generation capacity. As such, concentration on TREC compliance markets, not voluntary TREC markets, follows logically. In addition, as this research leads to a discussion of the political desirability for the expansion of TREC compliance markets, unbundled TRECs, sold separately from the actual unit of electricity, are the only renewable energy credit application examined. Bundled TRECs require geographic proximity to a renewable energy generation source, and are excluded from focus in this research.

To accompany the discussion on the specifications of the structural limitation of the research on TREC markets, it is also necessary to delimit TREC markets from Carbon Dioxide Emission trading markets. There is increased discussion with regards to the similarities between TREC markets, markets which trade the renewable attributes of green energy generation, and cap-and-trade CO_2 markets, trading credits for units of carbon dioxide which have been successfully abated. A CO_2 trading scheme has been established in the European Union to work in conjunction with the Kyoto Protocol requirements. Renewable energy generation does not receive emission allowances under this scheme. No similar trading scheme currently exists in the United States. However, initiatives have been developed in regions of the U.S. such as the North Eastern states, to establish similar programs. It is unclear how renewables may be incorporated into such schemes. (Holt and Bird, 2005). Although an important issue for future study, the relationship between TREC compliance markets and cap-and-trade markets is outside the scope of this research.

Assumptions

For this research it was assumed that renewable energy generation installations are most cost-efficient in areas of significant renewable energy resources. The basis for this assumption was found by an examination of wind energy installations. The installation cost for a wind turbine is fixed[4]. This up-front cost is based on turbine components and labour costs for manufacture and installation. A turbine placed in a significant wind resource will generate more electricity than a turbine located in regions of poor wind resources. This additional electricity generation over the life-time of a renewable energy generation facility translates into increased capital for the turbine owner. As investors wish to maximize their return on investment, new installations are thus more likely to be located in area of significant renewable energy resource.

Based on the literature that has thoroughly reviewed the effectiveness and efficiency of RPS policies (see Van der Linden et al, 2005, and Wiser, Porter, and Grace, 2004) a causal link between the implementation of RPS policies and the installation of documented renewable energy generation capacity development is assumed. The influence of co-existing policies offered by individual state governments and the United States federal government, such as the Production Tax Credit (PTC) is acknowledged. (See Box 1. for an overview of co-existing American policies) This influence is exhibited by the fact that new renewable energy generation capacity development has been witnessed in states without an established RPS policy. For example, wind energy development has grown in recent years in the states of

[4] The 'fixed' cost of a wind turbine in this thesis does not include transmission distances, which may vary considerably and significantly affect the cost of an installation. Moreover, it is recognized that the cost of wind turbine installations in off-shore locations or other unique circumstances may further affect cost. However, the term 'fixed, is used in this instance for illustrative purposes.

Nebraska, Wyoming, and Idaho without an RPS. See Appendix IV. As reported by the Energy Information Administration, states with RPS policies accounted for only 45 percent of total U.S. electricity supply, but almost 60 percent of all new renewable energy generation capacity added in 2004 and 2005 was installed in those states. Based on these data, for the purpose of this research it was assumed that the documented installation of new renewable energy generation capacity following the implementation of an RPS policy in a given region is at least influenced by, if not directly related to, that policy's implementation.

Box 1. Co-existing American Policies in support of Renewable Energy Generation Capacity Development

A Federal Production Tax Credit (PTC), which provides a 1.8¢ per kWh[5] tax credit for the first 10 years of a renewable facility's generation, originally enacted as part of the Energy Policy Act of 1992, has been a major driver for renewable energy generation installations. (UCS, 2006, Steve, 2006) The PTC may act in conjunction with RPS policies acting as an additional incentive for investment in renewables in those states. The Energy Policy Act of 2005[6], signed into law in August, 2005, offers additional federal incentives in the form of subsidies for research and development, demonstration, and commercial application. (Section 931.A) In addition, incentives offered by individual states in support of renewable energy vary considerably. Many states have established Renewable Electricity Funds, generated by means of placing a small fee on consumers' monthly electricity bills, which are often used to subsidize investment in renewable energy, demonstration projects, and research and development. (Fitzgerald, Wiser, and Bolinger, 2003) Moreover, many utilities have begun to offer voluntary purchase of renewable energy to consumers for those willing to pay a premium for green energy, establishing more concrete market for renewable energy generation.

Limitations

Texas was the first U.S. state to employ TRECs as a compliance mechanism for its RPS in 1999. Italy and the United Kingdom were the first European nations to establish a TREC compliance market for their renewable energy obligation quota systems in 2001 and 2002 respectively[7]. This study was restricted by the limited practical experience with and empirical information available for analysis of TREC compliance markets in RPS policies.

This thesis research was further limited by the unavailability of consistent data in terms of renewable energy technologies. For example, information on the indigenous renewable energy by state across the United States only included estimates for bioenergy, landfill gas, solar photovoltaic and wind. There was no distinction between bioenergy co-firing, and bioenergy dedicated technologies. Moreover, emerging or novel technologies such as geothermal and energy from municipal solid waste were excluded completely. The United States Energy Information Administration's (EIA) projected levelized[8] costs of new renewable energy generation technologies by the National Energy Modelling System was similarly inconsistent

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5 This 1.8¢ per kWh amount has been adjusted for inflation. Originally, tax credits were set at 1.5¢ per kWh.

6 United States Public Law 109-58

7 The United Kingdom was the first European nation to implement a renewable obligation quota in policy, but Italy was the first nation to implement and initiate the obligation and TREC system in practice. Italy's start date was January 1st, 2001and the U.K.'s start date was April 1st, 2002.

8 Levelized costs represent the present value of the total cost of building and operating a renewable energy generation facility over the course of its financial life. (EIA, 2006a)

with regard to renewable energy technology. In order to combat this inconsistency, the thesis author ensured that each study that was selected for use in the research provided a minimum inclusion of data for bioenergy, solar voltaic and wind technologies upon which to draw conclusions.

A final limitation lies in complications that arose in assuming a causal link between new renewable energy generation capacity development and the implementation of RPS policies. Significant development of new renewable energy generation capacity, especially wind, has occurred in states that have not implemented RPS policies. As such, it is recognized by this thesis author that alternative political tools for the promotion of new renewable energy developments are being used effectively in states without RPS policies. Additionally, as renewable technologies become increasingly cost competitive with conventional energy generation, increased development may be directly fostered by independent economic interests and may not necessarily be due to the incentive provided by RPS policies. Therefore, the causal link between new renewable energy generation capacity development and the implementation of RPS policies assumed for the purpose of this research may be limited in its direct applicability.

2 Methods

While the introductory chapters (Chapter 1 and 2) introduce the reader to the thesis project and the objectives of the research, the essence of the thesis research was divided into five primary sections. The first, presented in Chapters 3 and 4, is the literature review that is designed to introduce the reader to the policy tools and to establish a thorough basis of understanding of them and their functions. This first section incorporates examples from throughout the world. The remaining sections focus on American examples. The second section, presented in Chapters 5 and 6, examines data on the distribution of newly installed renewable energy generation capacity as it relates to renewable resources and the size of the TREC market. The third section, presented in Chapter 7, presents projections by the United States EIA on the distributional effects of the implementation of a federal RPS which incorporates a national-scale TREC compliance market. The fourth section, presented in Chapter 8 documents the results of stakeholder interviews organized into political trends. The fifth section, presented in Chapter 9, integrates the distributive results from the precursory sections with the results of qualitative interview analysis. This integration allowed this thesis author to make recommendations on the design of a federal RPS with respect to TREC compliance market definition. This sequence is explained in more depth in the following paragraphs and is summarized in Table 1.

Table 1 Structure of the Research divided into 5 Primary sections based on methodology, topic, and purpose.

Section	Chapter	Subject
--	1 & 2	Introduction to Project. Methodology
1	3 & 4	Literature Review. Background to RPS and TRECs
2	5 & 6	Distributive Data. Geography, Industry, Case Studies
3	7	Projections for an Extended RPS and TREC Compliance Market
4	8	Political Trends and Implications
5	9	Conclusions and Recommendations

Experience with existing RPS regulation and TREC market structures is examined in an international context as a starting point for this analysis. This qualitative information was gathered from academic literature, policy evaluation studies, and Internet resources of organizations actively working with these policy tools. These sections are intended to give the reader a thorough understanding of the basic components of these policy instruments prior to further discussion.

The remainder of the research was focused on the United States and its experiences with regional developmental effects of RPS policies and corresponding TREC compliance markets. Data on the type and geographic distribution of renewable energy generation capacity that has resulted from the initiation of the implementation of compliance markets in the United States was collected from the United States Department of Energy, TREC system administrators, and renewable energy industry representatives. Areas that did not develop any new regional renewable energy generation capacity as a result of the TREC compliance markets were also identified. Data on the geographic distribution of renewable energy generation capacity which has been the result of the implementation of state RPS policies was then compared against the definition of TREC compliance market boundaries in order to examine the effect of extending TREC markets beyond state boundaries.

The distributive data of new renewable energy capacity generated as a result of the implementation of RPS policies was then examined in two case studies. Texas and Massachusetts case studies were utilized in this research as contrasting, representative examples of markets defined by state and by power pool respectively. The dissimilar results of the two states in terms of new in-state renewable energy generation capacity spurred by the implementation of their state policies offer further insight and clarity into the effects of RPS policies which have varied in accordance with the definition of TREC compliance markets. Initially, from the TREC system administrators, those renewable energy industries which accounted for a majority of the compliance credits in the state were identified. Following, a comparison of the geographic distribution of the renewable energy generating facilities being used for compliance in existing RPS policies was examined in terms of in-state and out-of-state development. This information on the renewable energy generation capacity by industry and location in each case study is presented and analyzed in Chapter 6.

Further data were incorporated into Chapter 7 based upon analysis made by sophisticated modelling by the United States Department of Energy, Energy Information Administration for projections on the effect of a nation-wide TREC compliance market and comparable renewable energy technology pricing. As such, Chapters 5, 6, and 7 present an analysis of the equity effects of TREC markets in terms of existing and projected impacts on the distribution of renewable energy technologies across industry and geographical boundaries.

A broad array of stakeholder interview results was then integrated to determine the political implications of such development in consideration of discussions and movements towards extended TREC compliance markets. For this purpose, qualitative, in depth expert interviews were conducted with stakeholders who are both in favour of and against extending TREC compliance markets. The principle behind using qualitative interviewing techniques in this situation was to derive individual interpretations of the political situation in the United States from those with experiential knowledge of the political decision-making process.

> "Qualitative interviewing provides an open-ended, in-depth exploration of an aspect of life about which the interviewee has substantial experience, often combined with considerable insight." (Gubrium and Holstein, 2002, p.676)

In-depth qualitative interviews were conducted to provide a political context to the findings presented in Chapter 5, 6, and 7. A further purpose of the qualitative interviews was to gather insight into the inter-workings of the American political system based on the experience, observations, and judgements of a variety of stakeholders. All interviews were transcribed by the researcher and were edited and approved by the interviewee, prior to incorporation into the thesis. Based on this verified information, themes were identified in order to determine the role of regional equity issues in American political decision-making and their effects on the extension of TREC compliance markets. This information is presented in Chapter 8.

Finally, based upon the data analyses on the distributional equity of RPS policies implemented in the United States presented in Chapters 5 and 6, the projections for an extended national-scale TREC compliance market presented in Chapter 7, and American political trends identified through qualitative interviews with a variety of stakeholders, recommendations are made on the design of a national RPS in the United States, with respect to TREC market definition.

A brief discussion of the prerequisites for the integration of RPS and TREC compliance markets based on the literature, supplements this investigation, and are presented in Appendix I. Other appendices have been included to aid the reader's understanding of the American electrical power markets, the witnessed development of new renewable energy generating capacities across the United States (and Texas as a state focus) in recent years, and the context of employment gains with respect to renewable energy. Finally, a table outlining the existing RPS policies across the globe and subsequent requirements provides the reader an understanding of the scope of the applicability of this research.

3 Renewable Portfolio Standards

This Chapter gives a brief introduction to RPS policies. The purpose of the tool, advantages and disadvantages to its use, and its structural basis are explained. Those locations around the world which have implemented RPS policies are presented as well as the key design features which vary across RPS; target or quota of renewable energy, eligible resources, flexibility mechanisms, and applicability. The purpose of this Chapter is to provide the reader a thorough basis of understanding of RPS through a review of current energy policy literature.

3.1 Definition and Purpose of RPS

The broad goals of RPS pertain to environmental, energy security, resource diversity, and economic benefits associated with renewable energy. The purpose of a RPS, purchase mandate, or quota obligation scheme in policy is to support investment in construction of new renewable energy generation capacity in order to increase the contribution of renewable energy in the electricity supply mix. (Van der Linden et al., 2005, Wiser et al., 2004) The RPS requires that utilities, or retail suppliers of electricity, supply a specific capacity or percentage of energy with eligible forms of renewable energy. In other words, RPS policies may specify generation in terms of MW of new installed generation capacity, or as a percent of the total electricity sales of a given energy supplier. Energy suppliers can satisfy their obligation either by producing their own renewable energy in a facility owned by the utility itself, or by purchasing renewable energy from an external renewable generation facility. (Rader and Hempling, 2001)

The mechanism by which RPS policies encourage investment in new renewable energy generation is based on the guarantee of a market for energy supplied by renewable energy sources. Energy supplied by renewable energy technologies has historically been less cost-competitive than energy supplied by conventional, fossil-fuel technologies such as coal or natural gas. As such, purchase of energy generated by renewable sources would come at a higher price, reflecting the higher cost of the technology. RPS policies establish a guaranteed market for energy generated by renewable energy technologies. As investors are able to verify that the energy produced from investments in renewable energy technologies will be purchased, despite a higher cost, they are able to verify a return on their investment. Therefore, RPS policies provide incentive for investments in renewable energy.

RPS policies are usually accompanied by a penalty for non-compliance which is imposed on those suppliers that have failed to meet their purchase requirements. Although quantitative targets are set for the supply of renewable energy, utilities are allowed flexibility in how those targets are met, thus theoretically lowering the total cost of renewable energy development by means of maximizing reliance on the market. (Wiser et al., 2004, Rader and Hempling, 2001) The mechanism of support for renewable energy generation in RPS policies lies in its guarantee of a market for energy generated by renewable sources. In requiring utilities to supply a specified capacity or percentage of their electricity from renewable sources, investors are guaranteed a buyer for their electricity, even though the cost of that electricity may exceed the cost of conventionally generated electricity. As such, a guaranteed market is established. Competition on this market encourages least-cost options for the development of new renewable energy generation capacity in order to fulfil obligations set by the RPS. Ideally, over time, as the quantity of renewable energy generation installations increases, the cost of new renewable generation capacity will decrease proportionately.

3.2 Advantages and Disadvantages to RPS

"A key advantage of the RPS policy is that it relies on the market to deliver a given quantity of renewable energy to the electric system at the lowest possible cost." (Rader and Hempling, 2001, p. xi) Theoretically, RPS policies maximize cost-efficiency in allowing each retail seller to meet its renewable energy obligation as efficiently as possible. Specifications as to the type of technology, resource, or project are not made in the requirements on utilities for the fulfilment of their renewable energy quotas. Thus, each utility is allowed to meet its obligations as efficiently as possible. (Rader and Hempling, 2001) The least expensive renewable technologies will be employed to meet quota obligations in theory. As such, competition encourages a reduction in the costs of renewable technologies. (Van der Linden et al., 2005) RPS entails relatively little administrative involvement and is flexible in its application to both deregulated and monopolized electricity markets. (Wiser et al., 2004)

> "The RPS is a policy tool whose rapid rise in popularity is explained by its continuous incentive for renewable producers to reduce costs, its direct link to the attainment of environmental targets, and its reduced requirements for government financial and management involvement." (Berry and Jaccard, 2001, p. 276)

Because many RPS policies are relatively novel, the practical conclusions which may be drawn with regards to their success are limited. However, studies, to date, have shown that well-designed RPS policies are successful in effectively promoting the development of new renewable energy generation capacity. For example, in the United States, the Texas RPS has been responsible for stimulating the installation of 1,868 MW of new windpower installations. (ERCOT, 2006)

Practical experience has also shown that poorly designed RPS policies may not achieve the intended political objectives. For example, new renewable energy installations resulting from the RPS policies in Maine and Pennsylvania have been negligible.

The potential disadvantages of RPS policies include: 1) An indeterminate cost of the system; costs will depend on the ability of individual utilities to comply with the requirements. 2) Support of the least-cost renewable energy generation option, which indirectly places less emphasis on a diversified renewable energy resource base. 3) Favour may be given to large renewable energy producers. "All case studies show that small renewable energy producers are likely to face additional barriers in an obligation system[9], because they are less able to absorb the risk inherent in an obligation system." (Van der Linden et al., 2005, p. 58)

3.3 Locations of RPS Employment

Although a relatively new policy tool, RPS purchase mandates are becoming increasingly popular worldwide. In the European Union, the United Kingdom (April 2002), Italy (January 2001), Sweden (May 2003), and Poland (July 2003) have implemented purchase obligations, as well as two regions in Belgium (January 2002). Figure 1[10] presents a geographic overview of these European RPS support schemes. Additionally, Japan (April 2003) Australia (April 2001) and regions of Canada have also established individual versions of RPS policies. In the United

[9] The term 'obligation system' is used as a substitute for RPS policies and other renewable energy purchase mandates. It was utilized in this instance in order to properly reflect the author's wording.

[10] Nations and states in these maps which have not implemented RPS policies often have implemented alternative political tools in support of renewable energy development. It relates that the distribution of RPS policies shown in these maps does not necessarily correlate with the distribution of new installed renewable energy generation capacity.

States, the state governments have led the development of renewable energy policies and RPS implementation. As of 2006, 22 U.S. states and the District of Columbia have developed RPS policies. Figure 2 presents an overview of RPS state policies and corresponding minimum renewable energy purchase requirements. See Appendix I for a comprehensive list of RPS policies and for the corresponding requirements employed worldwide.

Figure 1 European RPS policies. Presented in blue are those nations in Europe which have implemented a national version of an RPS mandate which include Italy, Poland, Sweden, the United Kingdom and several regions in Belgium.

Source: (Van der Linden et al., 2005)

It is important to note upon examination of RPS policies across the United States, its uneven distribution. Moreover, there is a notable lack of RPS in geographic regions such as the Southeast states. "Well over half of the American public now lives in a state in which an RPS is in operation and at least one state has such a policy in every region of the nation except the Southeast" (Rabe, 2006, p.v)

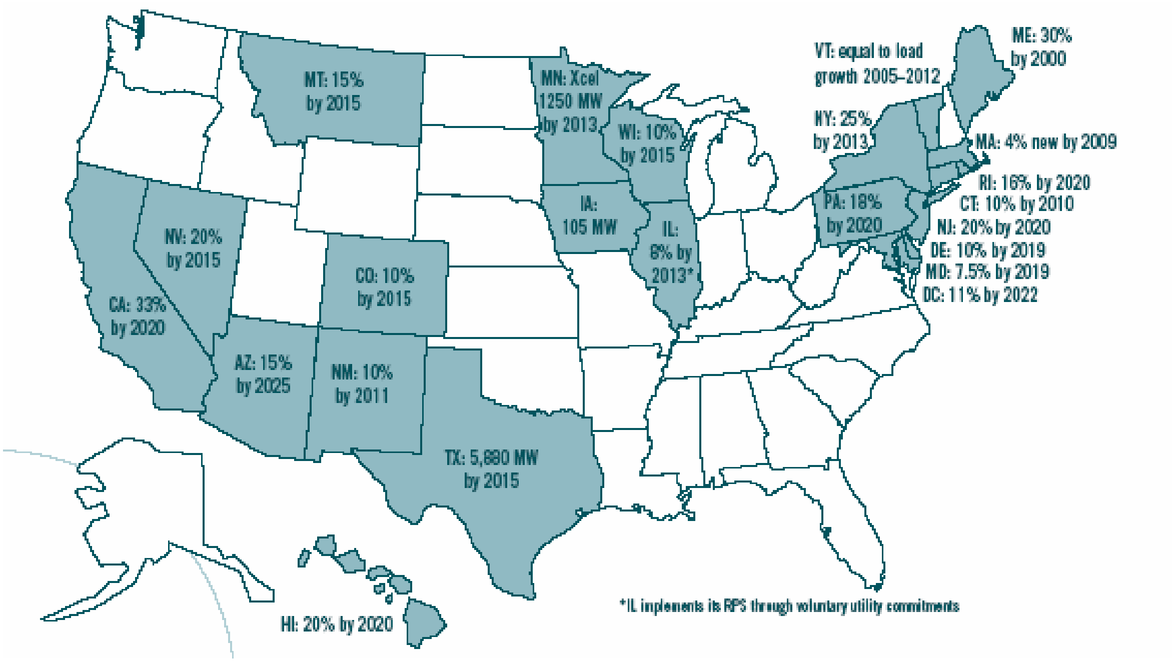

Figure 2 U.S. state RPS policies and minimum purchase requirements. Presented in blue are those U.S. states which have implemented a RPS mandate. Data in each of the state outlines presents the minimum percentage and date of their required renewable energy target as established by each individual state policy. For a comprehensive list of these targets see Appendix I.

Source: (Rabe, B., 2006)

3.4 Variations in RPS Design

Although the basics of the design features of RPS policies currently in place are similar, they differ in various ways according to the unique political objectives, priorities, and circumstances. These variations are outlined and described below.

Detrimental RPS design considerations and other effects have been outlined in the literature with regards to less successful RPS policies. While it is not the intent of this researcher to discuss ideal design attributes of RPS policies, the subject is addressed briefly in order to provide contextual background. These impairments include: exemptions or partial exemptions from RPS requirements for publicly owned electric utilities, inadequate enforcement, and insufficient targets or quotas creating uncertainty for investors in renewable energy generation capacity. (Wiser et al., 2004)

3.4.1 Target Selection

The level of the target or quota of renewable energy generation is one of the most important considerations in the design of an RPS. Targets are selected in accordance with the specific benefits sought in the establishment of the policy.

> "Contributing to technical advancements in renewable energy conversion technologies, for example, will require a smaller quantity of renewables than significantly increasing the resource diversity of the electric system or delivering substantial environmental benefits." (Rader and Hempling, 2001, p.7)

Initial requirements should be designed such that the relationship between supply and demand of renewable energy generation capacity is realistic and achievable for the given geographic area. Initial targets are often extended from the initial levels on a fixed schedule to provide continued incentives for investment in renewables.

The definition of the target may also vary in terms of defined quantities of new installed generation (i.e. Texas has established the target for the installation of 5,880 MW by 2015[11]); in contrast the target may be based upon a quota for a percentage of renewables of the total electrical energy generation as illustrated by Wisconsin that requires 10% of the state energy supply to be generated from renewable sources by 2015.

3.4.2 Eligible Resources to Fulfil RPS Requirements

RPS policies are diverse in their specifications of which resources are eligible for compliance. Based on the prerequisite that those resources to be considered for eligibility are in need of financial support to enter or remain in the market, decisions as to which renewable sources qualify for RPS requirements depend on the objectives of the individual RPS and the local viability of different types of resources. (Berry and Jaccard, 2001, Rader and Hempling, 2001) Policy makers wishing to support a diversity of resources define eligibility broadly. (Rader and Hempling, 2001) Most RPS policies have established eligibility for wind, solar, and geothermal energy. However, the eligibility of biomass, hydropower, and non-traditional sources such as energy efficiency and landfill gas varies considerably across individual policies. (Van der Linden et al., 2005)

Although it may be the political objective to favour the most cost effective solution in implementing new renewable energy generation, individual renewable industries do not necessarily receive equal support under RPS mandates. This is due to the fact that least cost technologies are favoured by the inherent design of the policy. It has become more common for States to mandate percentages of specific energy resources in an attempt to provide support for less cost competitive technologies. (Rabe, 2006) For example, Nevada made specifications for 5% of the state's 2015 20% RPS to be generated or acquired from photovoltaic solar energy systems.

Specifications are often made granting eligibility only for renewable installations which are connected to an electric grid. In such specifications, off-grid facilities are therefore considered ineligible. Similar specifications may be enacted in conjunction with the eligibility requirements pertaining only to renewable facilities located within state boundaries[12]. Alternatively, policies may be tailored to allow the generation of renewable energy out-side of state boundaries to fulfil RPS requirements of that state. This concept is discussed thoroughly with regards to the geographic eligibility of TRECs. (See Chapter 4.4)

Further resource considerations that vary across RPS policies include but are not limited to: the application of existing renewables or restriction of compliance to new investments and installations, and installation size specifications or limits. As it is often a goal of RPS policies to stimulate new renewable energy generation capacity development, the policy may be

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[11] Renewable energy targets in Texas, originally established at 5,880 MW by 2015 were expanded in 2005 to 10,000 MW of new installed capacity by 2025.

[12] There has been some debate on the applicability of the Interstate Commerce Clause and North American Free Trade Agreement to the restrictions of TREC markets to state or power pool boundaries. (Grace and Wiser, 2002) The specification of geographic boundary has been said to challenge these agreements in some cases, but no concrete legal implications have been made at the time of writing this thesis.

designed such that renewable installations which were energized prior to the implementation of the policy (or any specified date) are ineligible to qualify for compliance with the policy.

3.4.3 Flexibility Mechanisms

Flexibility mechanisms, policy tools designed to assist with the challenges of stringent purchase obligations in the face of supply constraints and demand fluctuations by providing flexibility in achieving compliance may be introduced in accordance with RPS policies. (Wiser et al., 2004) Such mechanisms allow retail energy suppliers to meet policy requirements for renewables in aggregate, rather than requiring each retail supplier to exhibit installed renewable energy generation contribution to their respective electrical grids. In other words, renewable energy generation installations will be implemented in those areas which require the least financial burden; thus some utilities (most likely those with the most indigenous renewable energy resources) may exceed their requirements, while others may fall short. By allowing compliance based on the aggregate, the total cost of the RPS can be established at the least possible cost of renewable energy generation installation capacity. (Berry and Jaccard, 2001)

The creation of a market for TRECs is a common flexibility mechanism employed in RPS policies. This mechanism allows utilities to purchase credits of renewable energy if other utilities can produce the energy more cheaply. "If based on tradable credits, the RPS policy allows *the market as a whole* to meet the overall obligation as efficiently as possible." (Rader and Hempling, 2001, p. 3) As such, introducing a flexibility mechanism of this type into the RPS assures that the quota is met in aggregate by utilities while allowing modifications to the generation requirements of individual utilities.

> "The benefits of TREC systems are obvious: They allow 'the market' to guide investment in cost-effective renewable generation technologies in the most advantageous geographic locations while attaining a state or national goal of renewable contribution." (Chupka, 2003, p.47)

According to individual policies, TRECs may be used to meet part or all of a utility's RPS requirements. Details of this instrument are discussed in depth in Chapter 4.

3.4.4 Applicability

The duration of a RPS policy should be long enough to give assurance to investors in renewable energy projects. Often in RPS policies, sun-set clauses are established in one of two forms in order to set a formal expiration date. A self sun-set clause ends the RPS when renewables are considered competitive on the market, thus removing the need for further legislative support. Renewables may be considered competitive when the additional cost of renewable energy has declined to negligible levels for at least two years, or the value of TRECs is stabilized at negligible levels. (Rader and Hempling, 2001) It is also possible to establish a fixed date at which the policy should end, however this may terminate the RPS before renewables are truly cost competitive. Furthermore, a fixed sunset clause of this type will have a significant impact on the amount of renewable energy development stimulated by the end of the validated period. Utilities or other responsible parties will be more inclined to pay penalty prices than to build additional renewable energy capacity for which they would not be credited past the expiration date of the policy. (EIA, 2003) As a result, the establishment of a fixed sunset clause may have unintended negative impacts towards the ultimate goal of the policy: to increase renewable energy generation capacity.

4 Tradable Renewable Energy Credits

This Chapter familiarizes the reader with TRECs as a flexibility and compliance mechanism of RPS policies. A basic description of the tool is provided to accompany a thorough explanation of the system in which TRECs are most often employed. As TRECs are often difficult to conceptualize, the goal of this Chapter is to provide the reader a thorough understanding of the mechanisms of the tool, its advantages and disadvantages, and variations in its design features.

4.1 Definition of TRECs

TRECs represent the renewable attributes of electricity produced from renewable energy sources. Credits are created by the producers of electricity; commonly one credit is assigned to 1 MW of renewable energy generation. They are "market-created instruments that can be bought and sold, and that convey the value of a unit of renewable generation". (Hamrin and Wingate, 2003, p. 24) The actual structure of TRECs can take the form of a formal certificate, or may simply be a representation in an electronic data base entry. TREC specifications vary widely across RPS policies, however most include basic, documented information such as the type of generating facility and geographic location. (Hamrin and Wingate, 2003) These credits are sold separated, or unbundled, from the sale of the physical electricity, effectively removing the geographic and physical limitations of commodity electricity. (Holt and Bird, 2005) See Figure 3.

In practice TRECs are sold under many different names on both voluntary and RPS compliance markets. Demand for TRECs is typically the result of: 1) Voluntary demand for green electricity by customers willing to pay a premium; or 2) Purchase obligations established by governments in RPS or similar policies. (Schaeffer et al., 1999) As this thesis research investigated the distributional effects of RPS policies as it relates to the definition of TREC compliance market boundaries, the remainder of this thesis research was focused only on TREC markets driven by RPS purchase mandates. Voluntary TREC markets were beyond the scope of this research.

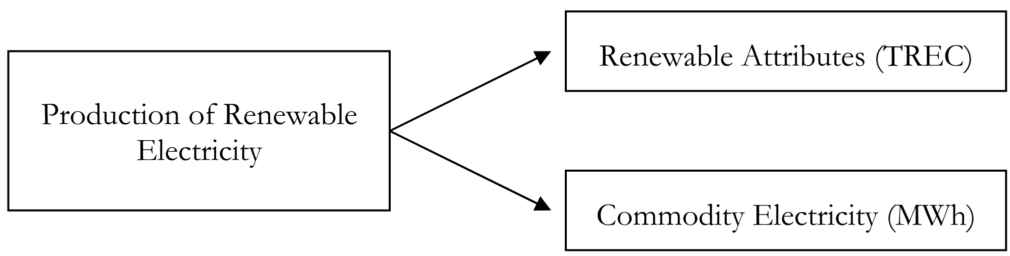


Figure 3. Visual representation of unbundled TRECs. When electricity is produced from a renewable energy generator the electricity is fed into a grid where it is indistinguishable from electricity produced by conventional technologies. The renewable attributes, or TRECs, are therefore separated from the commodity electricity and sold as an individual entity.

Source: (Hamrin and Wingate, 2003)

A producer of a unit of renewable electricity sold to the common grid is issued a TREC by a formal issuing body, ideally at the moment the electrical output of the renewable energy facility is measured. As such, the physical electricity is sold to the grid in accordance with individual utility power purchase agreements, but the ownership of the TREC is typically granted to the owner of the renewable energy facility. (Nielsen and Jeppesen, 2003, Hamrin and Wingate, 2003) The producer of renewable energy thus receives in sum the market price for the physical energy and the market price for the TREC. The credit created to represent the renewable energy attributes of a unit of renewable energy generated may then be traded and sold on a separate market. Many fragmented markets for TRECs exist often limited by geographic area and RPS specifications. "There is not one single market for TRECs; instead, there are a variety of fragmented markets, in which prices may vary considerably." (Holt and Bird, 2005, p.19)

Utilities, or obliged actors under RPS policies, purchase TRECs to verify their compliance. TRECs demonstrate to the authoritative body that the requisite amount of renewable energy was purchased by the utility. If this requisite amount has not been obtained by the utility, a non-compliance penalty is allocated for each unit of renewable energy that the utility failed to purchase. A schematic diagram of this concept and the actors involved in TREC markets is presented in Figure 4.

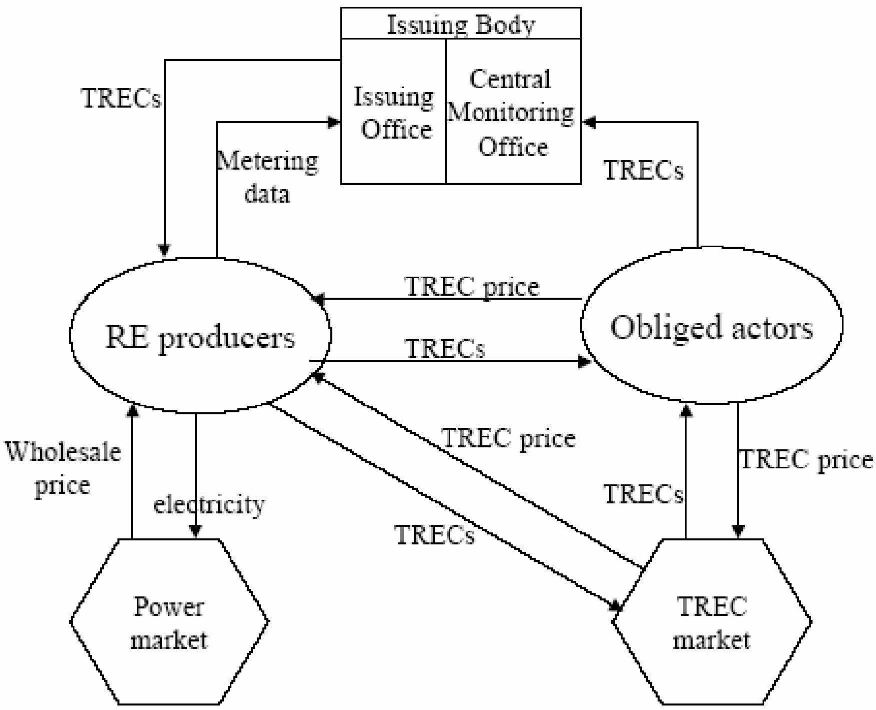


Figure 4. Flow chart of the main components of a TREC system. TRECs originate with the production of one unit of electricity. The renewable attributes, unbundled from the unit of electricity, are assigned a TREC by a formal issuing body which monitors the production of energy. TRECs may then be sold directly to the obliged retailers or to a market specifically for TRECs. At a date specified by the issuing body (typically per annum) obliged actors turn over the TRECs they have purchased for compliance with RPS requirements.

Source: (Van der Linden et al., 2005)

TREC markets have been incorporated as a compliance mechanism in most RPS policies across the globe. In Europe, this includes the UK, Sweden, Italy, and regions of Belgium.

Australia has also incorporated a TREC trading scheme into its version of RPS, in order to achieve their mandatory renewable energy target. (Kent and Mercer, 2006) In the U.S. state RPS policies which have built in TREC compliance markets include: California, Colorado, Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, Montana, Nevada, New Jersey, New Mexico, New York, Pennsylvania, Rhode Island, Texas, Vermont, and Wisconsin. The only U.S. states that have not incorporated TREC compliance markets into their RPS policies are Arizona, Hawaii, Illinois, Iowa, and Minnesota.

4.2 Advantages and Disadvantages to TREC Employment in RPS

There are many benefits to incorporating a TREC compliance market into RPS purchase requirements. As electricity is characterized by an untraceable electron flow, title to the renewable energy attributes of a given amount of electricity, by means of TREC, creates an accounting system to verify individual compliance. (Grace and Wiser, 2002) In separating the renewable attributes from the physical electricity, competition for the renewable attribute, an independent financial entity, is enhanced as the difficulties associated with trade of bundled, grid-associated TRECs is removed. Unbundled TRECs therefore encourage price transparency and liquidity. As TRECs make the lowest-cost renewable resources available to utilities beyond the geographic range of indigenous resources, the efficiency of the political instrument is increased. (Rader and Hempling, 2001) "In short, TRECs offer the potential to create more liquid markets for renewable energy attributes, increasing competition and lowering costs." (Holt and Bird, 2005, p. 10)

Despite the advantages of incorporating TREC compliance markets in RPS policies, challenges exist to their implementation. Since tracking systems have been developed in comparatively few regions, it is difficult to track and verify the legitimacy of TRECs in many areas. New markets are often associated with price volatility and uncertain stability. These associations may complicate the initiation of a successful TREC compliance market. In addition, the market is complicated in that "neither the supply of nor the demand for [TRECs] is price responsive". (Chupka, 2003, p.48) Demand for TRECs, most often based on percentages of total electricity sales in the RPS, is inherently affected by economic activity and weather. Although the price of TRECs will influence the installation of new renewable capacity, the planning, permitting, and construction of renewable facilities usually requires at least one year. As such, TREC price will not affect the amount of renewable energy supplied in that given year. Once renewable energy infrastructure is established, energy is generated quantitatively depending on climactic conditions, regardless of market demand. (Chupka, 2003) Further, it has been a criticism of TREC markets that the environmental benefits associated with the renewable energy may be displaced from the actual sale of the credit. This is addressed in the following sections.

4.3 Market Stabilizing Mechanisms

Stabilization of market price is extremely important, especially in new markets, to establish credibility and trust in the market itself. Dramatic fluctuations in the price of TRECs are associated with an unstable market. Such price fluctuations may occur, for example, if the existing capacity of generation facilities in existence does not suffice to fulfil RPS requirements, the prices of TRECs could increase dramatically. As such, market stabilizing mechanisms may be implemented to limit the price fluctuations of TRECs and thus stabilize the emerging market. Represented by a vertical line, the demand for TRECs is equal to the RPS requirements established by the authoritative body in accordance with the specific policy goals. Two circumstances are presented in Figure 5. In the first, denoted by S', the supply of renewable energy is sufficient to meet RPS requirements. As such, the price of TRECs occurs where the supply curve crosses the established demand. In the second case, denoted by S", supply of renewable energy generation is not sufficient to meet RPS requirements. The TREC price therefore may increase dramatically. Because no consumer is willing to pay more than the penalty fee in a compliance market, it acts as a maximum price, or a cap on the price of TRECs. (Nielsen and Jeppesen, 2003)

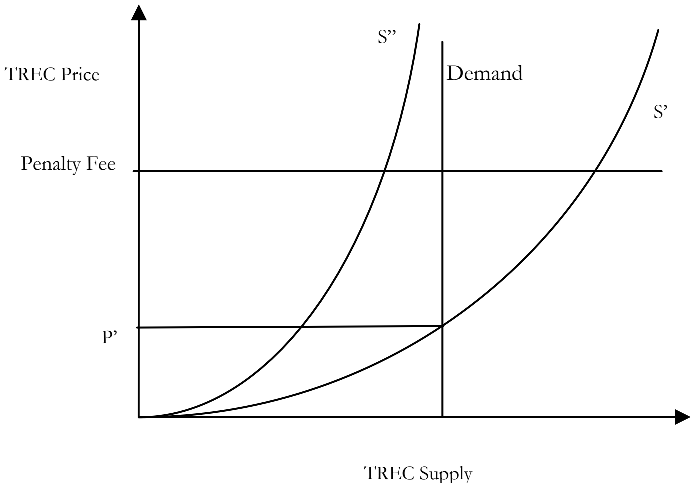


Figure 5 Supply and Demand Curve of a hypothetical TREC in a Compliance Market. TREC demand, represented by the vertical line, is specified by RPS requirements. S' represents a supply curve in which the supply of renewable energy is sufficient to meet RPS quantified demand. The price of the TREC, then, is the point at which the supply curve crosses the demand curve, or P'. S" represents a supply curve in which the supply of renewable energy is insufficient to meet RPS quantified demand. As no party will pay more for TRECs than the penalty price, that fee acts as a price cap.

Source: Modified from (Nielsen and Jeppesen, 2003)

Penalty fees have often been designed to serve a secondary purpose. The revenue generated by these fees may be placed into a fund specifically designed to further support the development of renewable energy. State clean energy funds, as they are known in the United States, have been used to subsidize renewable energy directly, fund education campaigns about renewable energy, and to fund TREC tracking systems. (Fitzgerald et al., 2003) Alternatively, the revenues have also gone directly into the state financial system. In Sweden, for example, revenue from penalty fees goes directly to the public treasury. (Van der Linden et al., 2005) As such, the involvement of individual governments in RPS policies and TREC compliance markets differ substantially.

Other mechanisms, such as banking and borrowing allowances, exist to further stabilize TREC markets in the face of fluctuating renewable energy supply and inadequate generation capacity. Specifications as to the details and structure of the TREC market depend on the individual RPS policy. It is possible for "TRECs [to] be traded, banked, and consumed like any other commodity" (Van der Linden et al., 2005, p.10).

4.3.1 Banking

Banking permits purchasers of TRECs to retain credits for use in future years. This mechanism was established on the assumption of periodic over-compliance for RPS requirements that may result from fluctuating resources or inadequate technology. As such, "consumers can buy certificates in years with excess supply and use them in years with low supply" (Nielsen and Jeppesen, 2003, p. 6). TRECs may also be retained by producers and kept for sale in years with excess demand.

In allowing utilities or other obliged actors to bank TRECs, demand becomes more elastic, thus helping to reduce price volatility on the TREC market. In years when renewable energy supply exceeds the requirements set by RPS mandates, banking creates a 'floor' for TREC prices. In such circumstances, where TREC prices would have negligible price, the value of the credits may be captured and retained for use in future years. (Chupka, 2003)

Banking may be limited by year or may be valid for an indefinite time depending on the preference and priority of the administrative body. For example, in the Texas RPS banking is limited to 2 years, in regions of Belgium 5 years, while in California and Sweden banking is allowed indefinitely. (Van der linden et al., 2005)

4.3.2 Borrowing

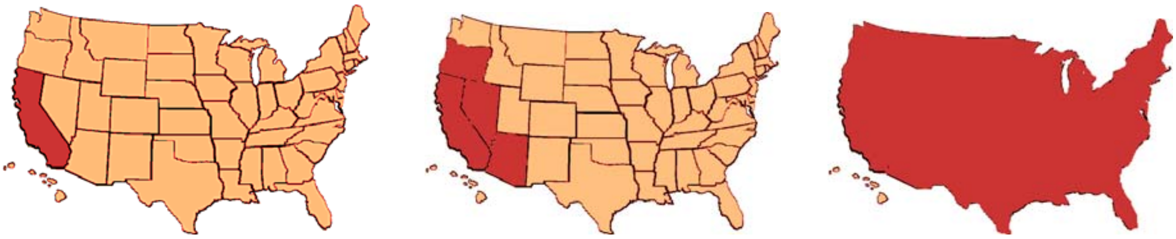
Borrowing of TRECs attempts to stabilize market prices in years of excess demand, or renewable shortage. In years of excess demand, utilities are able to purchase future RECs for immediate compliance in an inter-temporal transaction. Although this mechanism requires extensive enforcement, it may be an economically efficient way to defer excess demand into future periods. (Chupka, 2003)

Specifications and limitations are common in those policies which allow borrowing, a mechanism less common than banking. For example, in Sweden it is only TRECs produced in the first three months of the year which may be used to meet obligations from the previous year. (Van der Linden et al., 2005) California and Texas have placed 25 and 10 percentage limits respectively on the amount of TRECs which may be borrowed across years. Moreover, Texas limited this stabilizing mechanism to the early years of its implementation. (Van der Linden et al., 2005)

4.4 Geographic Eligibility

In designing an RPS policy, the geographic area in which renewables are eligible to receive TRECs must be specifically defined. Based on definitions by Robert Grace and Ryan Wiser in Transacting Generation Attributes Across Market Boundaries there are three primary possibilities for the definition of TREC market areas utilized in this thesis research: an unconstrained market, a super-market area, and a market area. An unconstrained market recognizes credits generated anywhere in the nation or beyond. For the purposes of this research, an unconstrained market area will be equated with the term 'national-scale' TREC compliance market. Super-market areas refer to eligibility allotted for credits generated in a defined region which spans two or more contiguous market areas. This boundary definition may include states which recognize any credit generated within the regional electricity pool. It is important to note here that electricity markets in the United States do not correspond with geographic state boundaries. For the purposes of this research the power pool definition corresponds to regional transmission organizations, or geographical areas between which there are transmission constraints and unique dispatching organizations. (Grace and Wiser, 2002).

(See Appendix III for a complete map of existing regional transmission organizations in North America as of March 2006.) Finally, market areas refer to TREC compliance market boundary definitions based upon state boundaries and therefore may only include portions of an electricity grid. This concept is demonstrated in Figure 6.



Market Area **Super-market Area** **Unconstrained Market Area**

Figure 6 Visual representation of possible TREC compliance market geographic boundaries. A single state, California, may chose to define its TREC compliance market boundaries only to include those renewable energy facilities located within the state, a market area presented in red. Alternatively, it may chose to extend its TREC compliance market boundaries to include any renewable energy generation facility located within several neighbouring states, Nevada, Oregon, and Arizona; a super-market area. Finally, were renewable energy facilities located anywhere within the nation or the entirety of North America, California would have defined an unconstrained market area.

Introduction of a wide TREC market allows utilities to purchase renewable attributes at the lowest possible cost; extending the market to take advantage of renewable energy development in areas of maximum resource and by using the most cost competitive renewable energy technologies. In the United States, geographic eligibility of compliance markets is typically limited either to sub-market areas for TRECs generated within state borders, or market areas allowing compliance eligibility for renewables generated in the regional power pool. In this second case, TRECs generated in neighboring states may be imported for compliance on the condition that the energy contributes to the electricity grid specified in the legislation. For example, in Rhode Island any renewable energy generating facility[13] which delivers energy to the New England Power Pool electric grid is eligible to receive a TREC that may be used to verify compliance in the Rhode Island RPS. Facilities in neighboring states which do not deliver electricity to this grid are not eligible for compliance. Internationally, several cases exist in which TREC compliance markets consider TRECs generated outside of the nation's boundaries eligible for compliance. However, these instances are often restricted by power pool definitions. For example, in the United States, TRECs generated in Mexico may be considered eligible for compliance in California's RPS. However, it is only those facilities whose first interconnection to an electricity grid is within the state boundaries which are eligible. (CRS, 2002)

4.5 Tracking Systems

Electronic databases that track TRECs are employed as accounting and verification systems to assure that the renewable attributes of renewable energy generation are counted only once,

[13] In Rhode Island eligible renewables include solar, wind, ocean, biomass, geothermal, hydro, and fuel cell technologies.

thus avoiding double-counting of TRECs. Certificates are issued a unique serial number by the administrators of the tracking systems. These numbers include information on the origination of the certificate, the renewable energy resource, and issue date. The tracking system then records changes in the ownership of certificates and retires TRECs when appropriate. (Holt and Bird, 2005)

These tracking systems have been developed and are in use in Europe, Australia, and several regions of the United States. In Europe, the European Energy Certificate System (EECS) was created in response to the 2001 EU directive on renewables[14] which calls for certified Guarantees of Origin (GoO) of renewable energy. In this directive, the EU Commission required the specification of "energy source from which the electricity was produced, specifying the dates and places of production" (European Union, 2001) The Association of Issuing Bodies, the organization established for the official generation of GoOs has issued 135 million 1 MW certificates as of May 2006. (AIB, 2006)

In the U.S., tracking systems have been employed in New England, in the Pennsylvania-Jersey-Maryland (PJM) interconnect, Texas, and Wisconsin. In addition, the California Energy Commission and the Western Governors' Association are collaborating to establish a Western Renewable Energy Generation Information Tracking System across the Western Interconnect, and several Midwest states are working to establish a coordinated tracking system, the Midwest Renewable Energy Tracking System. (Holt and Bird, 2005, Lieberman, 2004, EIA, 2006) See Appendix II.

Without such systematic tracking systems, RPS compliance may be demonstrated by means of tracking energy transactions or by means of standardization. Tracking energy transactions often assumes that the green attributes of the renewable energy remain 'bundled' with the delivered electricity and introduces complexity to the compliance tool. Certificate standardization assures that the claims of renewable energy suppliers "are accurate and that the product meets minimum standards for quality." (Holt and Bird, 2005, p. 17) This cross-boundary verification works in conjunction with regional tracking systems where available, but is also extended to regions without tracking systems. (Lieberman, 2004) The goal of standardization is to ensure that TRECs represent renewable energy of specified requirements and that, like tracking systems, only one certificate exists for each MW of generation. (See Appendix VI for more information on standardization as it relates to integrated TREC compliance markets.)

[14] EU Directive 2001/77/EC

5 Distributional Effects and Equity of TREC Compliance Markets

After having established a thorough basis of understanding of RPS policies and TREC compliance markets in Chapters 3 and 4, this Chapter examines the effect of their implementation on the geographic deployment of new renewable energy capacity and the distribution of renewable energy generation installations by industry. An introduction to the inequity of distribution of renewable energy resources across the United States is presented early in the Chapter to provide the reader an understanding of the inherent differences in state resources which exist. In consideration of these inherent differences, the development of new renewable energy generation capacity in those states which have implemented RPS policies is presented. This development is compared against the definition of TREC compliance market boundaries in order to define correlation between the two. An examination of the distribution of renewable energy generation installations by industry concludes the Chapter. Thus, this Chapter presents data on the geographic distribution of renewable energy generation capacity and on the developmental distribution across renewable energy industries that have resulted from the implementation of RPS policies.

5.1 Geographic Distribution of Renewable Energy Resources

The RPS is a political tool by which to support the development of renewable energy at the least possible cost. Development is most cost efficient in areas of excellent renewable resources. Renewable resources, however, are neither distributed equally across individual states, nor across the nation. A study done by the Union of Concerned Scientists compiled the renewable energy potential of bioenergy, landfill gas, solar photovoltaics, and wind by state across the United States. (See Figure 7). It was found that the Middle American states clearly exhibit the most renewable energy resource potential in terms of these renewable energy resources. In addition, those states in the East and Southeast have comparably less indigenous renewable resources.

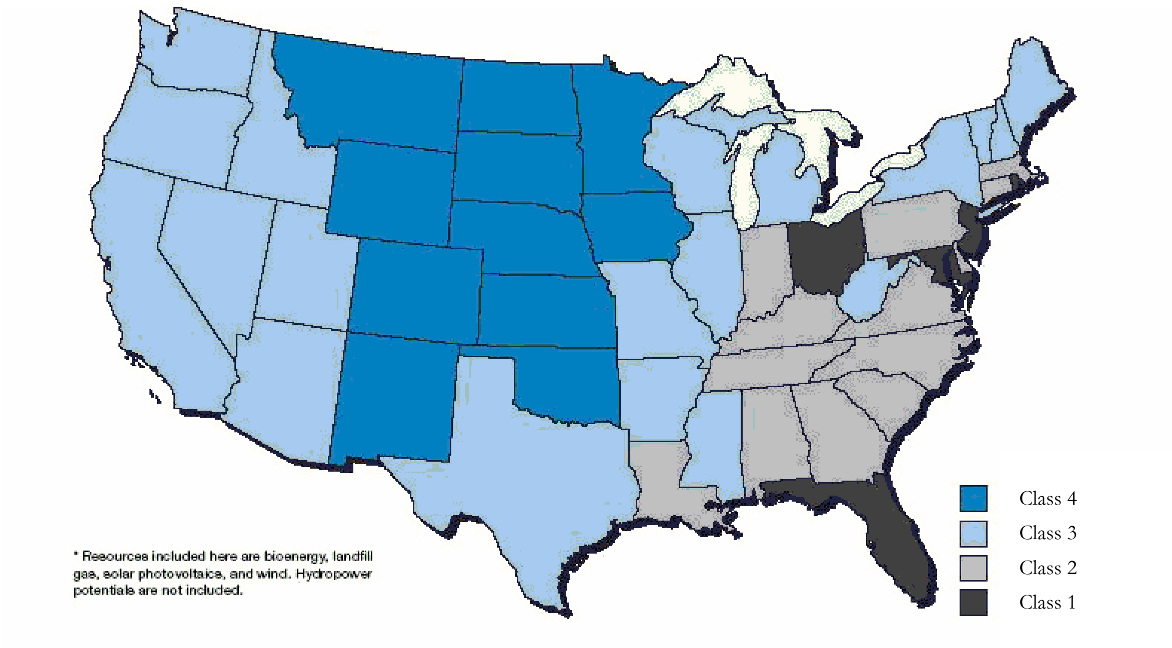


Figure 7 Renewable energy potential by state across the United States. Indigenous bioenergy, landfill gas, solar photovoltaic and wind resources by state have been compiled and labelled by class[15]. Renewable energy potential classes correspond to the technical potential as a percent of total electricity sales in 2001. (Class 4: Greater than 1,000% Class 3: 101-1,000% Class 2: 51-100% Class 1: 27-50%) The Midwest states are shown to have the most significant amount of indigenous resources. Comparably, states in the East and Southeast have comparably less indigenous resource.

Source: (Deyette et al., 2003, p.10)

The development of new renewable energy generation capacity may be affected by differences in such natural endowments in addition to co-existing policies, electricity consumption levels and rates of demand growth and variations in consumer preference.

5.2 Geographic Distribution of Renewable Energy Generation Capacity Development

Renewable energy development in states with RPS policies has varied considerably. Spanning the years 2004 and 2005 development ranged from no new renewable energy capacity to 700 MW of new development in Texas. (EIA, 2006). See Table 2 for a categorized reflection of state renewable energy capacity development.

[15] Wind potential is based on data regarding average annual wind speeds. Solar potential is based on solar radiation data. Biomass potential is based on a study by state performed by the Oak Ridge National Laboratory. Geothermal and landfill gas potential was estimated from data taken from NEMS and the United States Environmental Protection Agency modeling. (See Deyette et al., 2003 for more information)

Table 2 New Renewable Energy Generation Capacity Development in States with RPS Policies 2004-2005. The development by state is compared against the TREC compliance market boundary definitions established in Chapter 4.4. Indigenous renewable resources as presented in Figure 5 are also included in this comparison. A majority of U.S. states with less than 15 MW of new renewable energy development, in-state, have allowed out-of state credit compliance. Moreover, those states also have notably less indigenous renewable energy resources, on average, than states with more significant development. States with more than 100 MW of development in-state have more significant indigenous resource, and a majority has limited trading to in-state markets or power pools which deliver energy in-state.

Installed New Renewable Capacity	U.S. State or District	TREC Market Definition	Renewable Energy Potential Class
No New Capacity	Connecticut	Super-Market	2
	Delaware	Super-Market	2
	D.C.	Super-Market	1
	Maryland	Super-Market	1
Less than 15 MW	Arizona	--*	3
	Hawaii	--	
	Massachusetts	Super-Market	2
	New Jersey	Super-Market	1
	Rhode Island	Super-Market	1
	Vermont	Super-Market	3
	Wisconsin	Market	3
Between 25 and 35 MW	Maine	Super-Market	3
	Nevada	Market**	3
	Pennsylvania	Super-Market	2
Between 100 and 200 MW	Minnesota	--	4
	Montana	Market	4
	New Mexico	Market	4
	New York	Market	3
Over 500 MW	California	Market	3
	Texas	Market	3

Source: (EIA, 2006, DSIRE, 2006, Holt and Bird, 2005, Deyette et al, 2003)

**-- This symbol denotes that the state has not included a TREC compliance market scheme in the design of its RPS policy*

*** Nevada specifications in its state RPS policy outline NRS 704.7821 does clearly specify TREC eligibility. In-state electricity delivery, and therefore market area boundary definition was inferred from the fact that all generating facilities which currently qualify for Nevada's RPS are located within Nevada or Utah. (See http://www.puc.state.nv.us/renewable_energy.htm)*

Each of the states with no new renewable energy generation capacity development allow compliance from within extended, super-market areas, or generation facilities which lie in a greater power pool or transmission grid; Maryland, Delaware, and Washington D.C. from the PJM Interconnect, and Connecticut from the NEPOOL market. Moreover, in Maryland and Connecticut, compliance is eligible from generation outside of the respective regional power pool. The Maryland RPS, enacted in May of 2004, allows credits generated from across 16 states and D.C.; eligibility has been extended beyond the PJM region to include bordering states. The RPS in Connecticut allows credits generated in the NEPOOL jurisdiction, but also grants limited eligibility to renewable generators in the PJM interconnect on the condition that the generating facility is in a state of equal renewable requirement. (DSIRE, 2006) Furthermore, a majority of states with less than 35 MW of new renewable energy generation capacity have incorporated TREC compliance markets which extend beyond the borders of the state. In these cases, TRECs may have been purchased from neighbouring states at a lesser cost than the alternative cost of in-state development. As such, extended, super-market compliance markets may have been dissuasion to their in-state development.

It is important to note that those states with the most renewable energy generation capacity have proportionately higher levels of indigenous renewable energy resources compared to those states with the least amount of new renewable energy capacity development.

Box 2. TREC Price Reflections

Although data are limited, the price of TRECs in the various regions reflects the availability of renewable energy supply. "Prices of TRECs used for RPS compliance are affected by available supplies, the quality of the renewable energy resources in the region, the ability to site new projects, rules regarding geographic eligibility and banking, and the level of the non-compliance penalty." (Holt and Bird, 2005, p.61) TRECs in supply constrained New England have traded for $35-49/MWh, while credits generated in areas of higher quality renewable energy resources and availability, such as Texas, TRECs trade for $10-$15/MWh. (Holt and Bird, 2005) TREC costs are ultimately reflected in the price of electricity. As such, the cost of compliance with RPS policies in areas with suboptimal renewable energy generation circumstance is higher than those regions of more optimal generation conditions.

Texas, a state which has restricted its TREC market to its' state boundaries[16] accounted for the most new renewable energy generation capacity development in-state in the years 2004-2005

Although those states with extended TREC compliance markets have experienced less renewable development, the comparative lack of installations may also be influenced by an insufficient length of time (at the time of examination) to have witnessed the effect of the policy, and/or inadequate targets in the design of the policy. For example, both Delaware and D.C. implemented their RPS policies in the year 2005, July and January respectively. (DSIRE, 2006) As such, renewables in these areas may not have had adequate time to develop and ensure the market for investments at the time this study was conducted, also in 2005. State targets may be insufficient to promote new investment in renewable energy generation facilities if target levels are set such that they may be satisfied by existing renewable energy generation capacity.

[16] It is important to note that Texas is the only American state which contains an entire electric transmission grid in its state borders. As such, it may be a unique example.

Box 3. The influence of electricity transmission ownership on renewable energy generation capacity development

Ownership of transmission capacity varies across the United States. In regions such as the Southeast, utilities with property rights to transmission lines have frequently used their ownership in discriminatory ways against renewable energy generators. High fines are placed on "Energy and Balance" rules for the purchase of transmission capacity. Generators of renewable energy, when purchasing access to transmission lines, promise to supply a certain amount of energy to the electricity grid. Due to the intermittent nature of many renewable resources, it is difficult to guarantee these amounts. Should the energy supplied to the electricity grid via utility owned transmission lines fall short of promised amounts, high fines are charged to owners of the renewable energy generation facility. These penalties inhibit investment in renewables as they increase the over-all cost of the renewable energy generation. Although the Federal Energy Regulatory Commission is working to combat this problem, it currently stands as a serious challenge to developing renewables in these regions.

5.3 Equity by Industry

Renewable Portfolio Standards do not make any specifications as to technology type by design, unless individually stipulated in a given policy. TREC compliance markets allow the market to determine the least cost method of developing new renewable energy generation capacity. As such, least-cost technologies are typically the most competitive in fulfilling immediate renewable energy obligations. According to the *Annual Energy Outlook 2006 with Projections to 2030*, published by the United States Energy Information Administration (EIA), across those states with RPS policies in place during the years 2004-2005, 2,181.2 MW of new renewable energy generation capacity was installed. Of this, 91.6% was wind, 2.5% landfill gas, 2.5% biomass, 1.7% geothermal, 1.4% conventional hydroelectric, 0.3% solar photovoltaic. Assuming a causal link between RPS policies and new renewable energy installations, the wind industry has been, by far, the main beneficiary of the RPS policies across the United States.

Table 3 Renewable Energy Installations by Technology Type of the total 2,181.2 MW of new renewable energy generation capacity installed in states with RPS policies in the years 2004-2005. These figures clearly exhibit the disproportionate success of the wind energy industry in those states with RPS policies.

Renewable Energy Technology Type	Percentage of new Installed Capacity
Wind	91.6%
Landfill Gas	2.5%
Biomass	2.5%
Geothermal	1.7%
Conventional Hydro	1.4%
Solar Photovoltaic	0.3%

Source: (EIA, 2006)

In certain circumstances, a particular degree of innovation with regard to emerging technologies such as tidal or wave, may be required in order to reach continually increasing renewable targets. Emerging technologies are, by definition, not yet cost-competitive with those renewable technologies that have been established and marketed. As such, they will not receive the immediate favour under RPS policies that less expensive technologies may.

> "Promoting systems innovation implies uncertainty, experimentation and a certain degree of economic 'waste' - in the sense that some experiments will fail to become viable technologies yet will still create valuable new knowledge." (Smith and Watson, 2002, p. 4)

However, although emerging technologies may not be directly supported by means of an RPS mandate, indirectly, those areas with less indigenous resource may be compelled to invest in research projects in order to fulfill RPS obligations in future years.

5.3.1 Issues of Size

As relates to the cost effective favour in the design of RPS policies themselves, industrial sized renewable energy technologies have been more readily implemented following the implementation of RPS policies which include TREC compliance markets than small-scale installations. (Langniss, 2006, Steve, 2006) This may be related to the lower manufacture and installation costs per unit of energy generation in large scale as compared to smaller scale installations. As such, it may be stated that RPS policies tend to favour large-scale, multiple MW installations over more residential-scale installations.

The development of new renewable energy capacity at the least cost may also be affected by the status of the development of the industry itself. Comparatively well established industries do not face the capitol costs confronting developing industries, thus creating an advantage for renewable energy industries which are technologically more advanced.

5.3.2 Cost Comparison by Industry

Because RPSs and TREC Compliance Markets have been described as favouring least cost technologies, it is appropriate that this research include a cost comparison by industry. It is important to note that comparing the costs of renewable energy technologies is often complicated by the intermittent nature of the resources themselves. Technologies such as wind and solar may require additional capacity installations in order to generate comparable energy as more stable renewable resources such as landfill gas. Furthermore, renewable energy technologies have significant variability by industry in the cost to exploit the resource. The cost of an installation in a given region may vary significantly from the same type of installation in another locale.

The EIA estimated projected levelized costs of new renewable energy generation technologies with the use of a computer-based, energy-economic model of the U.S. energy system, the National Energy Modelling System (NEMS). Levelized costs, for the purpose of this EIA study, represented the "present value of the total cost of building and operating a generating plant over its financial life" (EIA, 2006a). These cost calculations assume maximum availability of resource and technology, which vary significantly in actuality. As such, the lowest projected cost (in U.S. $/Mwh) assuming optimal resource and technology availability are reflected in this study for the years 2010, 2015, and 2020. See Table 4. According to this study, wind, biomass co-fire, and geothermal technologies will remain the most cost-competitive with conventional coal and natural gas generation.

Table 4 Estimated Levelized Cost of New Energy Generation Resources in U.S. $/MWh in 5 year increments from 2010 to 2020. Although challenging to compare the costs of individual renewable energy technologies, this study estimated their costs based on existing policies. Wind, geothermal, and biomass co-firing technologies were estimated as the most cost-competitive with conventional coal and natural gas energy generation. Solar thermal and photovoltaic, however, remain exceptionally uncompetitive.

Plant Type	2010	2015	2020
Conventional Coal	49.5	50.6	51.6
Conventional Natural Gas	55.7	55.5	57.4
Solar Thermal	139.7	139.2	134.8
Solar PV	237	235.2	223.4
Wind	54.2	55.8	58.2
Geothermal	48	46.7	46.4
Biomass Co-fire	57.6	59.2	59.7

Source: (EIA 2006a)

As the table presents the lowest cost option based on maximal resource and technology availability, it reflects the few low-cost geothermal sites available. However, the number of low-cost sites is comparatively small compared to the number of low-cost wind and biomass sites. Moreover, geothermal technologies are associated with exceptionally slow exploitation rates since significant lead-time is required to prove the resource. (Beamon and Namowicz, 2006) Therefore, in consideration of the relatively small geothermal supply and the long planning horizons required for implementation of this technology, the cost of geothermal installations might easily be higher than low-cost wind or biomass co-firing plants in actuality. As such, it is not surprising that the renewable installations to date have been dominated by wind, the least cost and most readily exploitable renewable energy technology.

This Chapter has shown that the effects of RPS implementation are uneven in terms of the geographic deployment of new renewable energy capacity and the distribution of renewable energy generation installations by industry in the United States. The development of new renewable energy generation capacity in those states which have implemented RPS policies was shown to have varied significantly. Several small, North-eastern states were shown to have experienced no new renewable energy generation capacity development in-state, while several comparably large Western states were shown to have witnessed more than 500 MW of new renewable energy generation capacity development in-state. This development was shown to reflect the definition of TREC compliance market boundaries: states with comparably little in-state renewable energy generation capacity development have defined their TREC compliance market boundaries such that out-of-state renewable energy generation facilities are considered eligible for RPS compliance. The examination of the distribution of renewable energy generation installations by industry showed that the wind energy industry has been disproportionately favored as a result of RPS implementation with 91.6% of new renewable energy generation capacity installed. In examination of levelized costs by renewable energy industry, this was shown to reflect the low cost of wind energy technologies with respect to alternatives such as solar photovoltaic. Further inequity by industry was found in that often RPS policies favor industrial sized installations over smaller-scale technologies.

6 Distributional Case Studies

In Chapter 5, this thesis author showed that the development of renewable energy generation capacity has not been equal geographically across the United States. Moreover, it was shown that in-state development of renewable energy generation capacities may be affected by the definition of TREC compliance market boundaries. In addition, the wind industry was shown to have dominated the development of new renewable energy generation capacity with 91.6% of new installations. This Chapter examines two examples in depth; Texas, with over 500 MW of new in-state installations and Massachusetts with less than 15 MW. The geographic distribution of new installations, as well as development by industry, is examined in each example with the aim of providing the reader an understanding of the distributional variation that results from the implementation of RPS policies.

6.1 Texas

The Texas RPS was established in 1999 under the then governor George W. Bush. Initial renewable energy generation capacity targets were set at 400 MW by 2003, 850 MW by 2005, 1400 MW by 2007, and 2,000 MW by 2009 through 2019. In 2005, Texas Senate Bill 20 was passed in which the Texas RPS was extended and expanded with new targets of 5,000 MW of new installed capacity by 2015 and 10,000 MW by 2025. Eligible renewables under the Texas RPS include solar, wind, geothermal, hydro, wave, tidal, biomass, biomass-based waste products, and landfill gas and are restricted to within Texas state boundaries. Texas is unique in that it is the only U.S. state which contains an entire electricity grid within its state boundaries.

Responsibility for the administration of the TREC trading in Texas was allocated to the Electric Reliability Council of Texas (ERCOT). A formal, web-based tracking system was established in May 2001 prior to the formal beginning of the RPS obligations in 2002. With a non-compliance penalty of $50/MWh, certificates have been traded in the range of $10-15/MWh since the initiation of the market. (Holt and Bird, 2005)

The RPS in Texas has been exceptionally successful. With the announcement of the RPS obligations in 1999, renewable energy markets in the state of Texas grew significantly and initial installation targets were met several years ahead of schedule. (Langniss and Wiser, 2003) As of June, 2006, 1,943 MW of renewable energy credits have been registered online for ERCOT compliance trading, exceeding targets initially set for 2007 by 543 MW. Of this 1,943 MW, 1,868 MW, or 96.7% is generated by wind energy. (See Figure 8.) The remaining 4% of TRECs in Texas are generated from landfill gas (2.3%), hydro (0.6%), biomass (0.3%). (PUC of Texas, 2005). As such, the success of the Texas RPS has largely been affected by the disproportionate development of wind energy with respect to other renewable energy industries.

The wind energy generation which dominates the TREC trading in Texas is primarily large scale wind, concentrated in those areas of excellent resource; the plateaus of West Texas and the panhandle of North Texas. (McCoy, 2006) (See Appendix III.) Property tax revenues generated by the wind farms in Texas are estimated to contribute $11.7 million/year to the state budget. In 2001, utilities and wind companies invested $1 billion in the development of new wind installations resulting in the creation of 2,500 jobs. (Flowers and Kelly, 2005)

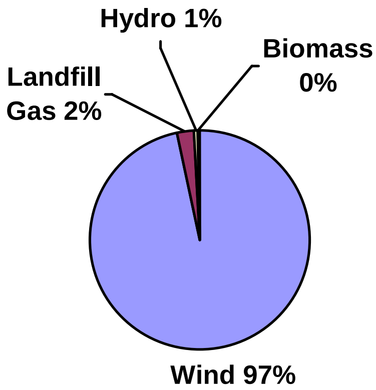


Figure 8 Percentage of Texas RPS Compliance Credit Fulfilment by Industrial type in 2005. Wind accounted for a majority of the compliance credits, while landfill gas, biomass and hydro development together accounted for less than 4%

Source: (PUC Texas, 2005)

Further development of new wind energy generation capacity in Texas has been restricted by existing transmission line capacity. The areas in the state with the most significant wind resources are those with comparatively low populations. As such, the transmission capacity does not exist by which to connect new wind energy generation plants to those areas of electricity demand. The construction of new transmission line capacity is costly and requires significantly more time than that of the plants themselves. (McCoy, 2006, Aaron, 2006) Wind development thus far, has therefore, been concentrated in areas that fulfil two requirements: 1) adequate resources and 2) adequate existing transmission line capacity.

The extension of the Texas RPS in 2005 with Texas Senate Bill 20 included two important specifications with potentially important implications. The first, a target was set as part of the bill to incorporate at least 500 MW of capacity from a renewable energy technology other than wind. This specification may assist those less-competitive technologies, such as solar photovoltaic, which have received relatively little investment facilitation under the original RPS. Secondly, a series of mechanisms was designed to improve the existing transmission capacity. (Texas Senate Bill 20, 2005, Rabe, 2006) As such, Texas has taken legislative action to improve the transmission from areas of excellent renewable resource, e.g. wind resource in West Texas, to areas of high demand.

6.2 Massachusetts

The objectives of the Massachusetts RPS were outlined as follows: To diversify the energy resources by which Massachusetts receives its electricity, and as such to decrease reliance on fossil fuels and to moderate price volatility associated with imported fossil fuels. (MA DOER, 2006a) It is a further goal of the policy to decrease atmospheric pollution associated with regional power plants. By increasing the percentage of renewables in the Massachusetts energy portfolio, the state therefore aims to diversify its energy portfolio, effectually reducing its dependence on fossil fuels, and to decrease pollution.

The Massachusetts RPS, although originally established in 1997, was only implemented in 2002 by the Massachusetts Division of Energy Resources (MADOER). Its initial targets were defined at 1% renewable energy generation of the total energy portfolio by 2003, increasing incrementally to 4% by 2009. Every year following 2009, RPS requirements are set to increase by 1% until the MADOER deems the policy complete. Eligible renewables under the Massachusetts RPS include solar thermal and photovoltaic, landfill gas, wind, biomass, tidal, wave, ocean thermal, and fuel cells. Massachusetts has declared eligible for compliance renewables generated anywhere within the New England Power Pool jurisdiction, as well as generating facilities in adjacent Control Areas, effectively extending its eligibility boundaries across multiple state lines. (MA DOER, 2006a). Massachusetts established a price cap of sorts which provided an 'alternative compliance payment' as part of the state's RPS. Variable by year, in 2006 the 'alternative compliance payment' was set at $55.13 per MWh. These funds enter into the state's Renewable Energy Trust. (DSIRE, 2006)

In the first two years of the applicability of the Massachusetts RPS, all suppliers fulfilled their renewable quota obligations. In 2003, 40% of the renewables accredited for RPS compliance were generated in-state. TREC trading prices ranged from $21-40/MWh in 2003. (Holt and Bird, 2005) As the RPS requirements were anticipated prior to the actual obligation of the policy, early 2002 compliance efforts have been said to have facilitated the ability of many generators to meet 2003 standards. (MA DOER, 2006) In 2004, nearly half of the renewables accredited for RPS compliance were generated in-state. However, while 486,000 MW of accredited compliance credits were generated from qualified renewable sources[17], 265,000 MW of accredited compliance credits were purchased by means of the state's alternative compliance payment. (MA DOER, 2006) TREC trading prices were significantly higher in 2004, ranging from $40-49/MWh. (Holt and Bird, 2005) As such, in 2004, although in-state development of renewables increased on the whole, Massachusetts experienced a shortfall in the availability of new renewable energy generation capacity. It has been suggested that the high prices for TRECs in Massachusetts are a result of the modest quality of renewable resources in the region and the difficulties in siting new renewable energy projects due to public opposition. (Holt and Bird, 2005). At the time of writing this thesis, data were not available for the 2005 compliance level.

The largest percentage, nearly 60%, of Massachusetts RPS compliance credits were taken by landfill methane energy plants located across five states. The second largest percentage originated in two biomass plants in Maine. See Figure 9. Most of the eligible renewable energy generation used to fulfil Massachusetts RPS compliance requirements were generated in two states: Maine and Massachusetts. (See Table 4). Only 34% of the renewable energy generated for compliance in 2004 was generated in the state of Massachusetts itself. (MA DOER, 2006)

[17] 61,147 MW of this total was credited from banked generation created in 2003.

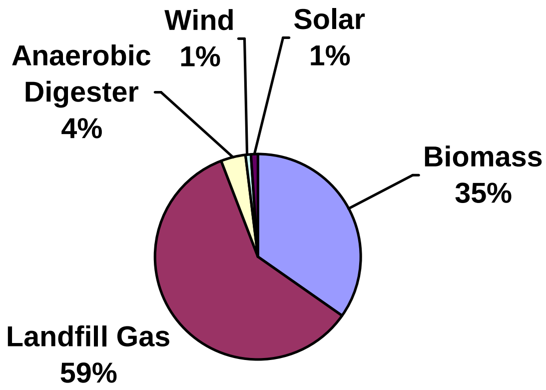


Figure 9 Percentage of Massachusetts RPS Compliance Credit Fulfilment by Industry in 2004. Landfill gas accounted for a majority of compliance credits, while wind and solar each accounted for only 1%.

Source: (MA DOER, 2006)

Table 5 Compliance for Massachusetts RPS Fulfilment by State in 2004. As Massachusetts has allowed compliance credits from generation outside of state boundaries, only 34% of compliance renewable energy was generated within state boundaries. Maine and New York accounted for significant generation credits in the Massachusetts RPS.

State	Percentage of Compliance Generation	Primary Renewable Resource
Maine	34%	Biomass
Massachusetts	34%	Landfill Methane, Anaerobic
New York	14%	Landfill Methane, Wind
New Hampshire	9%	Landfill Methane
Rhode Island	6%	Landfill Methane
Connecticut	3%	Landfill Methane

Source: (MA DOER, 2006)

6.3 Applicability of Case Studies

Taken by example, the states of Texas and Massachusetts clearly exhibit the distributional variation that results from the implementation of RPS policies. The renewable energy generation capacity development in Texas, a Western state of significant size (695,622 km^2) with boundary definitions which limit eligibility to renewable energy generation facilities which lie in the state, has been disproportionately that of wind. Moreover, development has been concentrated in the areas of the state with the most significant wind resources; the plateaus of West Texas and the panhandle of North Texas. Texas TRECs trade for an average of $10-15/MWh. Conversely, the renewable energy generation capacity development in Massachusetts, a small New England state (27,360 km^2) only 1/25th of the size of Texas, with boundary definitions with allow out-of-state renewable energy generation facilities to qualify for compliance, has primarily land fill gas. More importantly, a significant percentage of the development that has resulted from the Massachusetts RPS has not been in the state of Massachusetts. That renewable energy generation capacity rather, has been in the states of Maine, New York, New Hampshire, Rhode Island, and Connecticut. Massachusetts TRECs have traded for an average of $40-49/MWh. The cost difference in TRECs sold in Texas and in Massachusetts may be influenced by the differences in installed technology (wind as opposed to landfill methane), indigenous renewable energy resources, as well as banking and trading rules in the respective states.

Therefore, the in-state development which results from the implementation of RPS policies is shown to be influenced by the definition of TREC compliance markets boundaries in these case studies. Texas, in not allowing any renewable energy generation outside of the state boundaries, fulfils its entire TREC obligation by means of renewable energy generation facilities installed in the state. Massachusetts, in extending its eligibility definitions outside of state boundaries, fulfils only a proportion of its RPS requirements by means of renewable energy generation facilities installed in the state. Rather, a significant percentage of the renewable energy generation which qualifies for its annual RPS requirements is generated in neighbouring states. As such, these case studies clearly exhibit the correlation between in-state, regional renewable energy generation and the definition of TREC compliance market boundaries.

7 Projections for an Extended TREC Compliance Market

RPS policies have been shown in Chapters 5 and 6 to have varied considerably in the resulting distribution of new renewable energy generation capacity installed. This Chapter addresses the question of distributional equity to the projected effects of a federal RPS. Based on analysis by the United States EIA, the likely result of such a policy (which includes a national-scale TREC compliance market) are presented by industry and by the adjunct geographic distribution of that development.

7.1 Projections by Industry on the Effect of a Federal RPS

In 2003 the EIA published a report, *"Analysis of a 10-percent Renewable Portfolio Standard"*, in which the effects of a national RPS were projected similarly based on the NEMS model. This study compared the developmental effects of a Federal RPS requiring 10% renewables by 2025[18] against a reference situation in which all policies remained static. The report projected that wind and biomass co-firing would account for the majority of new renewable development implemented to fulfil the obligations of a Federal RPS. See Figure 10. Geothermal and landfill gas would also benefit from a Federal RPS, but not to the extent of wind and biomass co-firing. Wind energy is projected to make the most significant contribution, increasing to four times the levels it would otherwise reach in the reference case.

Biomass co-firing is projected to increase significantly early after the policy is implemented as it is possible to utilize existing coal-fired plants, and thus, it offers a quick compliance solution with modest new capital expenditure. However, as wind is more economical in the long-term, biomass co-firing is likely to decline as wind plants are brought into service and produce at lower cost TRECs. (Beamon and Namowicz, 2006)

[18] Projections made in this report assume a fixed sun-set clause which may impact specific renewable energy installations, particularly in later dates.

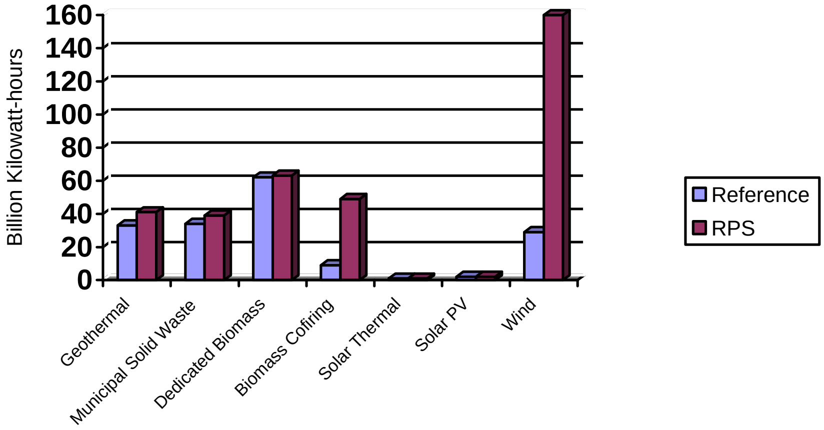


Figure 10 Generation of Non-Hydro Renewables Under a 10% National RPS. As compared to a reference case of no change in renewable policy, the NEMS generation projected new renewable energy development to increase significantly as a result of a Federal RPS, however, there will be a disproportionate development of the wind energy industry. Biomass co-firing was also projected to benefit significantly from a national RPS. Other renewable energy industries were projected to increase only slightly in comparison.

Source: (EIA, 2003, Addendum, p.2)

In each of these examples, both solar thermal and solar photovoltaic installations are not projected to increase significantly. As Renewable Portfolio Standards favour least-cost-options, it follows that the high cost of these solar-based technologies inhibits their benefit from the policy.

7.2 Projections on the Geographic Distribution Effects of a Federal RPS

On account of the comparatively low cost of wind energy technology and its established manufacturing industry, projections for the domination of an extended TREC market by wind energy generation are well substantiated. There are more indigenous wind energy resources in the upper Great Plains than in the remaining United States. (See Figure 11.) Based on the assumption that the development of new renewable energy installations is most cost-efficient around areas of maximal resource and that TREC compliance markets favor the least-cost development option, it follows that most renewable energy capacity development would occur in those areas of abundant resource, the Middle American States if TREC markets were extended to a super-market scale.

> "National markets would lead to uneven geographic development of renewable resources, as some regions are better endowed with cost-effective resources than others…Less well-endowed regions would end up paying for renewable energy development elsewhere in order to achieve compliance at the least cost." (Holt and Bird, 2005, p.45)

As such, it is justified to assume that in the event of a TREC market extended beyond state boundaries to encompass the entire United States, it would therefore, be those states in the upper Great Plains which would benefit most readily.

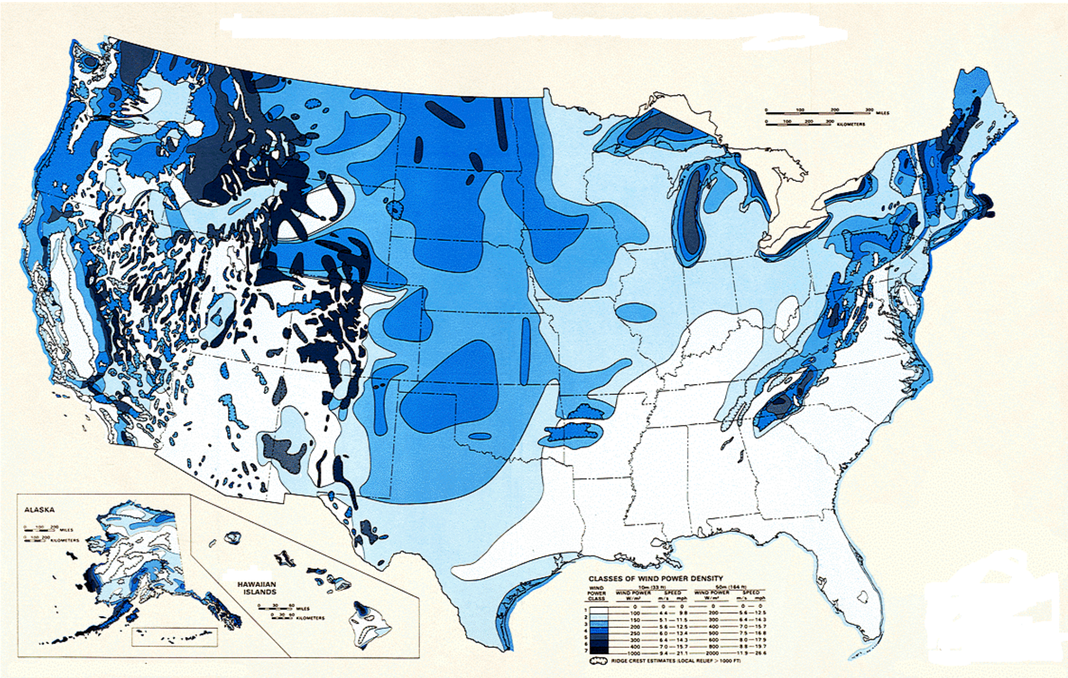


Figure 11 Annual Average Wind Resource in the United States. The darker blue colours, associated with areas of stronger indigenous wind resource are most significant in the Upper Midwest states. As such, assuming an extension of TREC compliance market boundaries to national levels, it is likely that most wind energy development will be in these areas.

Source: (National Renewable Energy Laboratory, 2006)

States in the Southeast would not be likely to experience equal renewable energy development if political priority were based on fulfilling RPS requirements at the least possible cost by means of a national scale TREC compliance market. If political priority in those states were placed upon fulfilling RPS obligations at the least cost, it is likely that those states with less indigenous resource would fulfill their obligation requirements by means of TREC purchase from areas with more significant resource.

However, if priority were placed on regional benefit and economic growth, indigenous resources exist in those areas to provide a significant quantity of renewable development for RPS compliance. For example, Dr. Jack Barkenbus, Executive Director of the Energy Environment and Resources Center in Knoxville, Tennessee has shown that 80% of the renewable energy generation required from a 10% federal RPS may be fulfilled by means of bioenergy in co-fired coal boilers. (Barkenbus et al., 2006) In an interview for this thesis research Dr. Barkenbus emphasized his belief that "pressure may grow to develop renewable resources locally, rather than opt for the otherwise cheapest option of TREC purchase." In this case, while the cost to develop these renewable resources and technologies may incrementally increase the over-all compliance cost of the tool, development would not necessarily occur disproportionately in the Upper Great Plains, due to implementation of a federal RPS.

Therefore, this Chapter has shown that the implementation of a federal RPS policy to include a national-scale TREC compliance market is likely to result in disproportionate support for the wind energy industry. Based on the indigenous wind energy resources by state, it is likely that a majority of the development supported by such a policy will occur in the Upper Midwestern states. However, the actual result of such a policy is dependent on the direction of emphasis chosen by American politicians, either on cost efficiency of the political tool, or on its potential for assisting regional development. As such, trends in American politics in terms of emphasis on cost and regional development and their implications for RPS policies are discussed in depth in Chapter 7.

8 Political Implications for Further Integration of RPS and TREC Compliance Markets

In Chapters 3 and 4 the practical reasons behind the implementation of RPS policies and TREC compliance markets were presented. The effects that they have had on U.S. states and projections of the effects that are likely if there is an extension of TREC boundaries to a national level were addressed in Chapters 5,6, and 7. This Chapter examines the political implications of RPS policies and TREC compliance markets based on trends extracted from interviews conducted in this thesis research.

Often, practical reasoning behind the design of a policy does not necessarily correspond to the political reasoning for its implementation. Moreover, political decisions, particularly on a state level, are often based on perceptions and loose interpretations rather than on in-depth economic analysis. Therefore, in order to define trends in American politics on RPS policies, the political arguments made in favor and against RPS policies on both the state level and federal level are presented in combination with information gathered from the qualitative analysis of stakeholder interviews. General observations are made with regard to trends in American politics at the conclusion of this Chapter.

8.1 Political Arguments Historically Surrounding RPS

On a state level the political reasoning behind the implementation of RPS policies has been closely tied to the desire to promote economic development. Environmental factors, such as carbon dioxide emission mitigation, were considered of lesser priority in decisions to implement RPS policies. (Rabe, 2006) The investment opportunities associated with renewable energy have therefore translated into significant political favour for RPS. The economic impact of new renewable energy installations in a given region includes construction, operations, and maintenance employment opportunities, landowner revenue, and taxes. (Flowers and Kelly, 2005) In addition, according to Leon Lowery with the United States Senate Committee on Energy and Natural Resources, the employment benefits often associated with renewable energy have led labour unions to support RPS policies vocally in politics. (See Box 4 for a summary of employment benefits associated with renewable energy and Appendix III for a more comprehensive explanation.)

Box 4. Employment gains of renewable energy generation capacity development

Employment is generated through the development and installation of renewable energy technologies. As RPS policies are designed to facilitate the development of new renewable energy generation sites, it may be assumed that RPS policies are therefore linked to the generation of new employment. It has been estimated that the average employment generated over the life of a renewable energy facility in jobs/average installed MW (MWa) varies from 2.79 jobs per MWa of wind energy technologies to 10.56 jobs per MWa of solar photovoltaic. These numbers are in comparison with an average employment generation by utilization of coal and gas technologies of 1.01 job/MWa and 0.95 job/MWa respectively. (Kammen, Kapadia, and Fripp, 2004)

The renewable energy industry creates more jobs in manufacturing than in services, operations, and maintenance. Since a majority of the jobs involved in renewable energy are in the manufacture of the plant itself, it may be assumed that most of the employment benefits of RPS policies are associated with the manufacture of new renewable energy installations. As installation sites are typically concentrated in areas of significant renewable energy resources, the employment gains associated with new renewable energy generation capacity development, particularly the manufacture and construction of new facilities, are unlikely to be equally distributed across any given RPS jurisdiction. To complicate the issue, as components for renewable energy are often manufactured in various areas of the nation, the employment benefits are not necessarily limited to the state of implementation, or to the renewable energy facility sites.

The generation of property taxes by means of increased renewable energy generation capacity development has important economic and therefore, also has significant political impacts. By means of property taxes, renewable installations create important revenues for the state, especially in rural areas.

As cited by a majority of interviewees contacted for this thesis research including Marchant Wentworth with the Union of Concerned Scientists, Leon Lowery with the United States Senate Committee on Energy and Natural Resources, and Jaime Steve with the American Wind Energy Association, it is often utilities and the coal and oil industries which lobby most strongly against RPS policies. Arguments were cited including increased electricity prices, a significant concern to American politicians, and associated employment declines. According to Ray Harry of the Southern Company utility, (a utility cited by a majority of interviewees as a vocal opponent to RPS policies) in accordance with macroeconomic theory, employment would decline if a mandate were to raise the cost of electricity. (Energy intensive manufacturing industries would not have the finances to pay employees should energy prices increase significantly.) Additional arguments against the implementation of RPS policies have been in favor of alternative support policies. These arguments are based on the idea that RPS policies are not the best mechanism by which to support the development of renewable energy generating capacity increases. Tax credits and direct subsidization of research and development programs are often argued as better suited for such purposes.

As presented in Chapter 5.2, several U.S. states have recognized the advantages of an extended TREC compliance market, such as an extended resource base and an associated stabilization of TREC price fluctuation. However, while U.S. states have been willing to extend TREC compliance eligibility to include surrounding states, there has been no instance of integrated RPS policies. States therefore, have been able to retain the requirements established in the policy design which tailor the policy to the goals and resources available in the state. Chris Namovicz and Alan Beamon of the United States Energy Information Administration said, "In some states individual RPS policies have created complex terms of eligibility aimed at the development and support of renewables in their particular state." For example, the state of Pennsylvania has defined their RPS as an "Alternative Energy Portfolio Standard", as due to the significant coal mining in the state it has defined coal mine methane as an eligible resource. (Namovicz and Beamon, 2006, DSIRE, 2006) In addition, in the Southwest, an area with significant solar resource, Arizona created specifications for 50% of the renewable energy requirements to be met by solar thermal or solar photovoltaic technologies. (DSIRE, 2006)

The size, location, and history of individual states may influence their willingness to declare out-of-state renewables eligible for RPS compliance. Smaller states in the Northeast, especially those with a strong history of cross-border cooperation have largely accepted TRECs generated outside of their state boundaries in conjunction with their RPS policies. Conversely, large states with little or no experience collaborating across their borders have been considerably less willing to implement extended TREC markets[19]. Barry Rabe with the University of Michigan said with respect to this topic, "States outside of New England are more likely to be wary of negotiations and brokering with other states. The New England states conversely have a strong history of multi-state collaboration on a variety of issues."

8.2 Movement toward a Federal RPS

A proposal for a federal RPS has been introduced in three separate Congressional sessions; it is therefore not a foreign concept in Washington. Stipulations have been included in the design of the bills which would allow states to apply more aggressive, individual RPS requirements as desired so as not to limit the progression or ambitions of individual states. The Energy Policy Act of 2003 introduced a 10% RPS by 2010. Although it passed in the U.S. Senate, the House of Representatives opposed the measure and it was stalled in conference committee. The Energy Policy Act of 2005, signed into law by George W. Bush, initially included a 10% RPS to be implemented by 2020. This provision for a Federal RPS in the Energy Policy Act of 2005, similarly, passed in the Senate but was dropped from the final version of the law due to House opposition.

Each proposal for a national-level RPS has included a TREC compliance market which extends to national boundaries. This super-TREC market size would ensure that the nation as a whole could fulfill minimum targets at the least possible cost.

> "The society as a whole becomes more efficient in providing renewable energy by extending the TREC market beyond the state boundaries…Integration will provide greater economies of scale in implementing RPS regulation. [Moreover an] integrated TREC system will reduce the price fluctuations of the certificates…[resulting] in a more stable flow of revenue to the investors." (Mozumder et al., 2004)

Conversely, restricting the TREC market by state or by regional power pool would ultimately raise the entire cost of compliance for each individual utility or electricity retailer.

Proponents argue that a national standard would achieve substantially greater benefits in terms of stimulating renewable energy generation development and displaced CO_2 emissions than may be achieved should political responsibility be left to the states. A federal RPS would stimulate those states currently uninvolved in the promotion of renewable energy to initiate development.

[19] The initiation of a Western Renewable Energy Generation Information Tracking System across most Western states, however, may have important implications for the future collaboration among those states

The electric utility industry, with individual exceptions (e.g. PPM Energy, based in Oregon and WE Energies, based in Wisconsin), has been especially vocal against a national RPS. It is often argued by the electric utility industry that a national RPS has the potential to increase electricity prices. Ray Harry with the Southern Company, one of the largest electric utilities in the United States responsible for approximately 40,000 MW of electricity generation and a utility cited by most interviewees as a vocal opponent to a federal RPS, said with respect to RPS "Other policies designed for the promotion of renewable energy are more adequate and better suited to the purpose". As such, common arguments of the electric utility industry in opposition to a national RPS reflect the opposition seen on the state level; increased electricity prices and favour for alternative policies. It is a common argument against an extended RPS that such policies are best left to the states. Mr. Harry of the Southern Company continued, "State policies are more readily tailored to the resources available in a given region, and are better able to make justified comparisons of the regional electric rates and the costs of renewable development for implementation decisions."

Geographic distributional inequities are also regularly used as argument against a federal RPS. As exhibited in Chapter 5.1, although all states have some form of indigenous renewable energy resources, they are unevenly distributed. Critics of federal RPS proposals argue that those states without significant renewable energy resources would not benefit locally and would therefore, be at a disadvantage to those states with abundant resources. Marchant Wentworth with the Union of Concerned Scientists who has lobbied extensively in favor of a federal RPS said in an interview for this thesis research, "Inequity has been used as a key argument against the implementation of a federal RPS from those states perceived to be at a disadvantage with regard to indigenous renewable resources, particularly those states in the Southeast." This argument is countered by proponents who argue that utilities may take advantage of immediate inequity. That is, utilities may purchase TRECs during an introductory period at low cost while they plan their investments in regional renewable energy generating facilities for future periods. By deferring "an investment decision, the utility may be able to get additional information on its investment options or negotiate more favorable contracts to purchase renewable generating equipment." (Berry, 2002, p.371) This effect may act to counteract otherwise disproportionate indigenous natural resources.

Increasing political support for the proposed federal RPS policies exhibits important movement by the federal government towards more concrete sponsorship of renewable energy technologies. Many modifications as to the structure and design specifications of a federal RPS are possible and it is likely that those design features selected for inclusion in such a policy are heavily influenced by political interests. As an increasing number of U.S. states implement individual variations of RPS policies tailored to their state, practical, bureaucratic challenges in the implementation of a national RPS may increase.

8.3 General Observations and Trends

American states have been much more proactive in the implementation of policies aimed at diversifying energy resources and reducing greenhouse gas emissions than the federal government. As such, it has been the states which have assumed a leadership role in the promotion of renewable energy technologies by means of RPS policy implementation. However, the political discussions behind the decisions to implement such policies at both the state and federal level are often complicated by a myriad of interests and influences. For example, in those states which have implemented RPS policies, the belief that RPS promotes economic development has been a key driving factor driving its political success.

Politicians aiming to satisfy the priorities of the American public are also strongly influenced by the convictions of utilities and energy providers. Jaime Steve with the American Wind Energy Association was quick to note that "Often, in American politics, incumbents speak in support of renewable energy, but are vocal in opposition to RPS policies". The view of utilities with regards to RPS policies is considerably divergent. Those utilities in favor of RPS often have an established percentage of their energy generation sourced from renewables. Opposing utilities, in contrast, were described by interviewees including Marchant Wentworth with the Union of Concerned Scientists and Leon Lowery with the United States Senate Committee on Energy and Natural Resources, as perceiving RPS mandates as an unnecessary interference with business decisions such as where to source their energy. As such, politicians and utilities are often seen in unified argument against a federal RPS, making the appeal that such a policy would raise electricity costs for domestic customers, would create inequity among the states in terms of compliance benefits, and is a policy less suited to the aims of promoting renewable energy than the alternatives.

Consideration for regional development and employment is markedly important in American politics. Political decision-making tends to favor regional benefits over national achievements with respect to the implementation of renewable energy generation capacity. Across all interviewed stakeholders in this research, there was consensus that political emphasis is placed upon those policies which encourage regional development in the politicians' home state. Barry Rabe of the University of Michigan believes that the desire to keep economic benefits in-state acts to dissuade interstate collaboration in many cases. Moreover, regional development is often prioritized even should the ultimate compliance cost of the policy increases, as a result. Thus, regional social considerations could be said to take priority over economic considerations.

The disproportionate favor for low cost renewable technologies inherent in the design of RPS policies, and therefore the inequity in terms of support for renewable energy industries, are not as readily considered by American politicians. RPS policies have acted as strong tools of subsidy for investment in the wind energy industry. It relates that in some political circles, RPS policies have been referred to as a 'wind mandate' according to Jaime Steve of the American Wind Energy Association. Although renewable energy industries often work together to lobby American politicians, RPS policies are widely debated in internal renewable energy industry circles. Renewable energy industries that are less cost-competitive, such as solar photovoltaic, frequently lobby for specifications or carve-outs for their respective technology to even the playing-field. A similar phenomenon is seen for small-scale technologies against industrial sized technologies, since small-scale technologies are frequently less cost-competitive. This issue is complicated by the fact that in specifying carve-outs for more expensive technologies, the over-all cost of the political instrument is increased, thus decreasing the original appeal of the tool as a cost-efficient mechanism.

This Chapter has identified American political trends which were extracted from interviews conducted in this thesis research. American states have been much more proactive in the implementation of policies aimed at diversifying energy resources and reducing greenhouse gas emissions than the federal government. In those states which have implemented RPS policies, the belief that RPS promotes economic development has been a key driving factor driving its political success. It was shown that American politicians are strongly influenced by the convictions of utilities and energy providers, which often affect their political stance on RPS. In addition, regional equity effects were shown to be an important consideration by American politicians in their decisions to support expanded RPS and TREC compliance markets. In terms of an extended national-scale TREC compliance market, political support or opposition is strongly influenced by the effect that the policy would have on a politician's home state with respect to its effect on states in other areas of the nation. Issues of equity in terms of geographic development take a higher precedence in the American political decision making process than considerations of inequity by industry, however renewable energy industries especially well-suited to a given geographic area are receiving increasing political attention in the form of carve-outs and quota specifications.

9 Conclusions and Recommendations

This final Chapter of this thesis outlines the conclusions of the preceding Chapters with regards to the distributional equity effects of RPS policies and TREC compliance markets. These conclusions are structured as summary answers to the research questions. Recommendations are made on the design of RPS policies for future expansion and national integration based on the conclusions of the research. Finally, areas of further research are suggested to accompany the final conclusions of this thesis.

9.1 Revisiting the Research Questions

A goal of this thesis research was to examine the effects of existing RPS policies and TREC compliance markets on the distribution of renewable energy installations in terms of developmental equity in the United States. With respect to this goal, the following conclusions were drawn from the applicable research findings:

1) In those American states which have implemented RPS policies, how has the development of new renewable energy generation capacity been geographically dispersed?

The development of new renewable energy generation capacity that has resulted from the implementation of RPS policies in American states has varied significantly. In the years 2004-2005, several small North-eastern states with RPS policies in place experienced no new renewable energy generation capacity development, in-state. Conversely, larger Western states (California and Texas) witnessed more than 500 MW of new renewable energy generation capacity development in-state following the implementation of a RPS. The geographic distribution of the development of new renewable energy generation capacity that has resulted from the implementation of RPS policies may be affected by a number of factors as state RPS policies are inherently different in their design in each state: the boundary definition of TREC compliance markets is one such factor.

2) How has the geographic distribution of new renewable energy generation capacity in those states been influenced by the definition of TREC compliance market boundaries?

According to these research findings, those states that have developed comparatively low levels of new renewable energy generation capacity in-state are typically those which have implemented extended, super-market-scale TREC compliance markets. Conversely, states that have developed more substantial, in-state, renewable energy generation capacity have defined market-scale TREC compliance market boundaries, such that the eligible locations of renewable energy generation facilities is limited to the proximity of state boundaries.

The case studies presented in this thesis research clearly exhibit the correlation between in-state, regional renewable energy generation and the definition of TREC compliance market boundaries. Texas, in limiting the eligibility of renewable energy generation facilities which qualify for its state RPS to state boundaries, has continuously fulfilled its entire TREC obligation from renewable energy generation facilities installed in the state. Massachusetts, in extending its eligibility definitions outside of state boundaries to super-market-scale, fulfils only a proportion of its RPS requirements by means of renewable energy generation facilities installed in the state. Rather, a significant percentage of the renewable energy generation which qualifies for its annual RPS requirements is generated in neighbouring states.

3) Has any renewable energy technology industry exhibited more direct stimulation in its development as the result of RPS implementation?

RPS policies, historically designed to support least cost technologies, have disproportionately favoured the windpower industry. Renewable technologies which are currently less cost-competitive or which are emerging, such as solar photovoltaic or tidal respectively, have not received equal support under RPS policies. As a result, specifications for these less competitive industries, especially those well-suited to a particular region, are becoming increasingly common in RPS policies.

4) What does the geographic and industrial distribution of renewable energy generation capacity development which has resulted from existing state RPS policies, imply for the development that would likely result from a federal RPS with a national-scale TREC compliance market?

As wind energy is currently a renewable energy technology of least comparable cost, its development is projected to dominate the new installations of renewable energy generation capacity that would result from the implementation of a federal RPS. The development of biomass co-firing is also projected to increase as a result of a federal RPS, however to a much lesser degree. TREC compliance markets, by design, favor the least-cost option for new renewable energy generation capacity development. Based on the assumption that in regions of significant indigenous renewable energy resources, the over-all cost of a given renewable installation decreases, it follows that most renewable energy capacity development, wind, would occur in those areas of abundant wind resource, the Middle American States. Those areas with comparatively little indigenous renewable energy resources, the Southeast for example, are not likely to benefit from an extended TREC compliance market to an equal extent as states in regions of excellent renewable energy resources if a national-scale TREC compliance market were included in the design of a federal RPS.

Therefore, in response to the first goal of this thesis research it was determined that RPS policies often result in developmental inequity in terms of geography and renewable energy technology sector. Those states which have defined renewable energy generation facilities which lie beyond state borders as eligible for TREC compliance market (thus super-market scale TREC compliance markets) have witnessed a loss in in-state renewable energy generation capacity development to neighbouring states with more indigenous resources, and therefore more cost-efficient development options. Windpower energy has dominated the development which has resulted from the implementation of RPS policies across American states. Finally, a federal RPS proposed to include a national-scale TREC compliance market is likely to result in an extension of the support for windpower energy development. This development is likely to occur in areas of significant wind resource, especially the Upper Midwestern states. The conclusion of this examination of geographic and industrial equity leads to the question of the relation between this inequity and American political trends.

It was a further goal of this research to examine political objectives with respect to RPS policies. With respect to this goal, the following conclusions were drawn from the research results with respect to the final research question:

5) What do trends in American politics, in consideration of the distributional equity of RPS policies, imply for the possible implementation of a federal RPS policy and its design features?

American states have been much more proactive in the implementation of policies aimed at diversifying energy resources and reducing greenhouse gas emissions than the federal government. In those states which have implemented RPS policies, the belief that RPS promotes economic development has been a key driving factor driving its political success. In addition, it was found that American politicians are also strongly influenced by the convictions of utilities and energy providers

According to all interviewees that were a part of this thesis research, the political emphasis is placed on regional development and employment benefits in renewable energy policy design decisions. It relates that regional equity effects are considered by American politicians in their decisions to support an expanded, federal RPS. Political support or opposition is strongly influenced by the effect that a policy would have on a politician's home state with respect to its effect on states in other areas of the nation. This is exhibited by the vocal opposition of politicians from the Southeast states to a federal RPS in response to their perception of potential disadvantage to those states with significant renewable resources. As such, although a federal RPS and extended TREC compliance market would support national objectives, politicians from these regions stand in opposition to them. Issues of equity in terms of geographic development are of higher precedence in American political decision making than considerations of inequity by industry.

In design considerations of state RPS policies, the extent to which geographic equity gains by state are considered in politics is likely influenced by the state's size, geographic location, and history with inter-state collaboration. Smaller, New England states with a strong history of cross-border cooperation have been more willing to extend compliance eligibility across their state borders. Conversely, large states with little or no experience in collaborating across borders may be more likely to place importance on such considerations. The political will to encourage regional economic development has therefore likely acted as dissuasion, thus far, for cooperation in RPS policies across many state boundaries.

Therefore, trends identified through qualitative interviews in this thesis research showed that regional equity is strongly considered by American politicians in their decisions to support expanded RPS and TREC compliance markets, often to the extent that regional development and employment benefits may take precedence over national objectives. The uneven distributional effects of RPS policies have played a role in American politics and the willingness of states to collaborate across borders as well as in decisions to support a federal RPS and national-scale TREC compliance market.

9.2 Recommendations on the Design of RPS Policies for Potential Expansion

Experience with RPS policies has shown the policy to be an effective tool in the promotion of renewable energy. State RPS policies have been increasing, and have been responsible for facilitating the development of notable new renewable energy installations. However, state RPS policies do not exist evenly across the United States as exhibited by the lack of any RPS policy in the Southeast states. Moreover, state RPS policies with unique design characteristics have not resulted in equal new renewable energy generation capacity development. Therefore, in consideration of these issues of inequity, it is unlikely that state RPS policies alone will be capable of creating an evenly distributed portfolio of renewables across the United States to achieve the wider goal of a diversified national energy portfolio.

A federal RPS which established a minimum requirement for renewable energy across every American state has the potential to counter the insufficiency of RPS policies restricted to state governments for significant national targets for renewable energy. Were a federal RPS to include a national TREC compliance market as a tool to promote the development of least-cost renewable energy technologies as has been included in each previous proposal, the data obtained in this research suggest that the resulting development would be dominated by the windpower industry. Furthermore, a significant percentage of that development is likely to be geographically focused in the Upper Midwest and other regions of significant indigenous wind energy resources. The total contribution of renewable energies in the energy portfolio of the United States would grow, but the distribution of that growth would be likely to exhibit inequity by region and by industry. The energy portfolios, by state, would likely vary significantly. For example, states with lesser indigenous natural renewable energy resources would be less likely to fulfil a significant percentage of their energy requirements by means of renewable energy generation. Conversely, energy grids in areas of significant renewable energy resources would provide a considerably higher proportion of their electricity directly from renewable energy generation. As such, were political emphasis to be placed upon cost-efficiency, a federal RPS which included a national TREC compliance market would likely result in new renewable energy generation capacity. However, it is unlikely that the development of new renewable energy generation capacity would be evenly distributed across the nation.

Assuming that one of the most important political goals on the federal level is to encourage a diversification of energy resources, coupled with the simultaneous desire to promote regional economic development, a federal RPS that incorporated a national-scale TREC compliance market may not be an optimal design feature of a federal RPS. Alternatively, a federal RPS which contained stipulations for a minimum renewable requirement, but did not include specifications for a national TREC compliance scheme would allow states to work towards regional development while simultaneously diversifying the resources in their given areas. National goals of renewable requirements could thus be met while satisfying politicians priority for regional benefit. Such design features reflect the EU Directive on Renewable Energy (EU, 2001) which specified requirements for percentages of renewable energy, but left the mechanism by which to do so to the liberty of the individual states. Alternatively, a national-scale TREC compliance market could be designed with many regional market boundaries, or specifications for additional TREC allowances in regions with less indigenous resources. For example, renewable energy generation facilities located in those regions such as the Southeast, could receive additional TRECs per every MW generated, effectually acting to balance the indigenous renewable energy resource inequity.

If it is a goal of the policy makers to include equity in the design of an RPS policy the cost of the instrument is likely to increase. This is applicable to both geographic equity and industry equity. Equity by geography may best be achieved by means of defining limited TREC compliance markets. As such, development will be encouraged in that locale. By extending TREC markets, the cost of RPS compliance is likely to decrease, however regional renewable energy generation development may be lost to adjacent regions. Equity by industry implies specifications by technology type to ensure that currently less cost-competitive technologies receive equal support. As the cost of these technologies is currently higher to implement, installations will raise the over-all cost of compliance, at least at the beginning of such efforts. Therefore, in restricting TREC compliance markets to encourage geographic and industrial equity, the cost of RPS compliance is likely to increase. However, the benefits associated with local regional development of renewable energy generation capacity such as regional energy security, local self-reliance, and reduced air pollution and greenhouse gas contribution are not readily or properly quantifiable in normal cost calculations. The balanced integration of these factors is an important consideration for decision makers at the both the state and the federal level.

Therefore, integrating TREC markets to extend beyond state or national boundaries has the following effects, strengths, and weaknesses in terms of equity in regional renewable energy capacity development: Extended TREC compliance markets may sacrifice in-state development to fulfil compliance quotas with renewable energy generation capacity which has been installed in areas of least cost (those with more readily available indigenous renewable energy resources). The compliance cost of the instrument will depend entirely on the market. Thus, competition will drive down the total compliance cost of a federal RPS with a national-scale TREC compliance market, however the renewable energy generation capacity which is likely to be developed as a result exhibit geographic and industrial inequity.

Smaller TREC compliance markets are associated with an increase in in-state development of new renewable energy capacity. Regional benefits of a locally diversified electricity supply infrastructure associated with small TREC markets include an increase in the reliability of the regional electricity supply and a reduction in local air emissions; benefits not readily quantifiable in cost calculations. Smaller TREC compliance markets may be associated with increased compliance costs as in-state development may not be the most cost-efficient development. However, the regional economic, energy security, and environmental benefits associated with smaller TREC compliance markets accompanied with the political trends in favour of regional development imply that restricted TREC compliance markets may fulfil simultaneous goals of increasing the percentage of renewable energy generation in the national energy portfolio, while encouraging equity in geographic distribution.

9.3 Concluding Remarks

The current dependence of the American culture on imported energy sources is an ever-growing concern across both the American citizenry and its political representatives. The diversification of energy resources to include renewable energy sources is an important mechanism in the mitigation of this dependence. Every area of the nation has exploitable indigenous natural resources which could contribute to the diversification of the American energy portfolio. The role of state governments, leading the American movement in the provision of political incentives for the harness of these resources has been substantial in the absence of concrete federal direction and leadership. However, a federal RPS may increase new renewable energy generation capacity in the United States in the support of a nationally diversified energy portfolio where state policies alone are insufficient. In other words, a federal RPS policy would provide proportionately more support for the development of renewable energy generation capacity than if the issue were left to the states.

The design of a federal RPS will greatly affect the geographic and industrial equity that are likely to result from its implementation. The inclusion and definition of a national-scale TREC compliance market as part of a federal RPS is one such key design element. It is recommended by the author of this thesis to investigate the political viability of a federal RPS which includes design features which act to balance the developmental inequity of a national-scale TREC compliance market. Furthermore, assuming the likelihood of an increase in the over-all cost of the policy resulting from such a policy design, an investigation into the cost effects of such a policy design is recommended for further research.

As a low-cost political tool for the implementation of new renewable energy generation capacity development, RPS policies are an excellent option. The geographic distribution of new renewable energy capacity which results from the definition of TREC markets as a compliance mechanism in RPS policies has been shown to have important political implications. It is recommended by this thesis author that a federal RPS should be designed to balance the inequity that may result from a national-scale TREC compliance market. Although the compliance costs of the political instrument may increase should a national-scale TREC compliance market be excluded from the design of a federal RPS, regional benefits that would result, many of which are not currently quantified in normal cost calculations, and which are reflected in the preferences and trends of American politicians, may outweigh the increased compliance costs.

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Chris Namovicz and Allen Beamon, United States Energy Information Administration, July 17th, 2006 (joseph.beamon@eia.doe.gov)

Barry Rabe, University of Michigan, July 18th, 2006 (brabe@umich.edu)

Jaime Steve, American Wind Energy Association, July 10th, 2006 (jsteve@awea.org)

Marchant Wentworth, Union of Concerned Scientists, July 6th, 2006 (mwentworth@ucsusa.org)

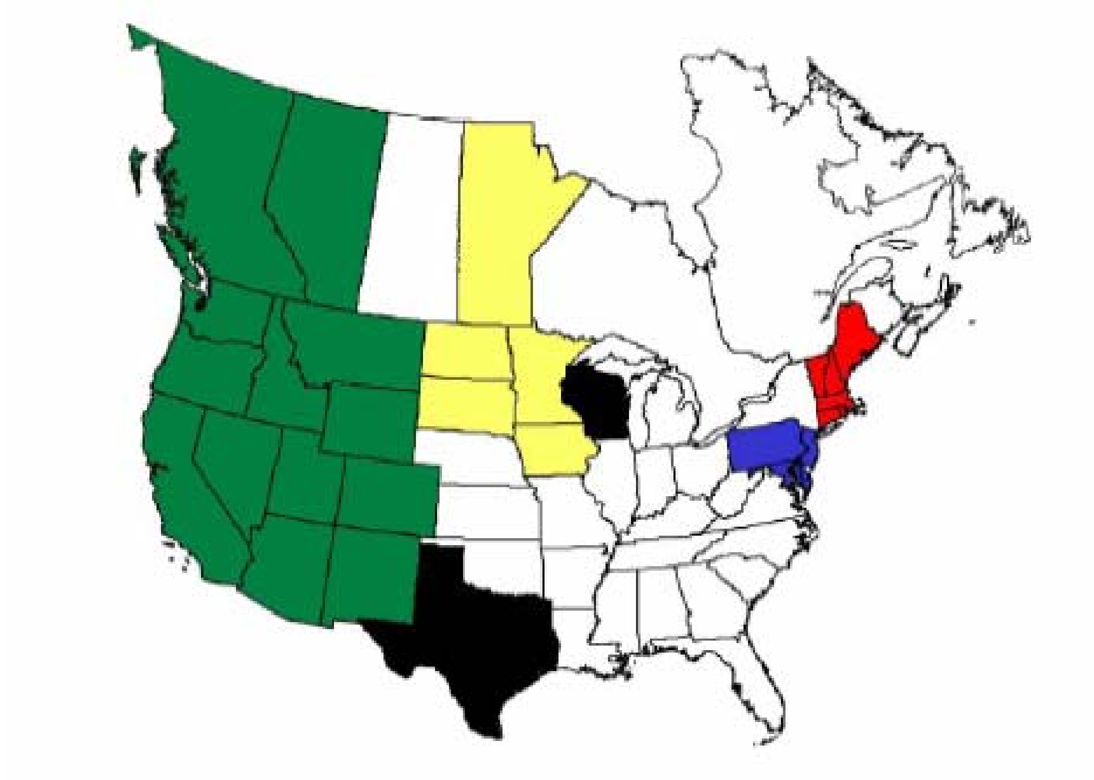
Appendix I. Worldwide Renewable Portfolio Standards

Nation	State/Region	Date Enacted	TREC Market Inclusion	Current Renewable Energy Goal
Australia		2001	Yes	9500 GWh by 2010
Belgium				
	Flanders	2002	Yes	6% in 2010
	Wallonia	2003	Yes	7% in 2007
Italy		2001	Yes	2% annual growth
Japan		2003	Yes	1.4% in 2010
Poland*		2003		
Sweden		2003	Yes	16.9% in 2010
United Kingdom		2002	Yes	15.4% in 2015
United States				
	Arizona	2001	No	15% by 2025
	California	2002	Yes	33% by 2020
	Colorado	2004	Yes	10% by 2015
	Connecticut	1999	Yes	10% by 2010
	Delaware	2005	Yes	10% by 2019
	District of Columbia	2005	Yes	11% by 2022
	Hawaii	2004	No	20% by 2020
	Illinois	2005	No	8% by 2013
	Iowa	1991	No	105 MW
	Maine	1999	Yes	30% by 2000
	Maryland	2004	Yes	7.5% by 2019
	Massachusetts	1997	Yes	4% new by 2009
	Minnesota	2005	No	1250 MW by 2013
	Montana	2005	Yes	15% by 2015
	Nevada	1997	Yes	20% by 2015
	New Jersey	2001	Yes	20% by 2020
	New Mexico	2002	Yes	10% by 2011
	New York	2004	Yes	25% by 2013
	Pennsylvania	2004	Yes	18% by 2020
	Rhode Island	2004	Yes	16% by 2020
	Texas	1999	Yes	5880 MW by 2015
	Vermont	2005	Yes	Load growth by 2012
	Wisconsin	1999	Yes	10% by 2015

**Extensive information at the time of this thesis writing on the RPS in Poland is unavailable.*

Source: (Rabe, 2006, Van der Linden et al., 2005, Kent and Mercer, 2006)

Appendix II. Regions of the U.S. with TREC Tracking Systems in Operation or Development



Source: (Holt and Bird, 2005, p.42)

Appendix III. Employment Development

The employment benefits in the renewable energy industry resulting from the implementation of state RPS policies are an important political consideration. Kammen, Kapadia, and Fripp compiled, established a common denominator for, and analyzed 13 recent studies on the job creation potential of the renewable energy generation industry. The average employment, or jobs[20] per average installed MW (MWa), over the lifetime of a given facility[21] was compared by facility type. The average employment generated over the life of a renewable energy facility was estimated to vary from 2.79 jobs per MWa of wind installations (The American Wind Energy Association estimates that every MW of installed wind energy capacity generates on average 8 jobs per year (indirect and direct). The Danish Wind Turbine Manufacturers Association estimates this number at 22 jobs (indirect and direct) per year/MWa) to 10.56 jobs per MWa of solar photovoltaic. These numbers are compared against the average employment of coal and gas industries, 1.01 job/MWa and 0.95 job/MWa respectively. (Kammen, Kapadia, and Fripp, 2004)

Additionally, the renewable energy industry was shown to create more jobs in manufacturing and installation than in services, operations, and maintenance. As such, it may be assumed that most of the employment benefits of RPS policies are associated with the manufacture of new renewable energy installations. It logically follows that those states that have been object to the most new renewable energy generation capacity development would have experienced more in terms of employment benefits than those states with little or no new development. For those states with no new development, the employment benefits of the RPS policy, if any, would be limited to the manufacture of components.

As existing and projected examples of RPS compliance have been shown to disproportionately favour new renewable energy generation capacity development by means of wind energy technologies, the manufacture of wind energy was examined as an illustrative example. Ninety companies in 25 states across the United States manufacture wind turbine components. (Sternzinger and Svrcek, 2004) It is not uncommon for the components of the turbines to be manufactured in one location, then transported significant distances to the sites of installation. For example, one of the largest wind farms in Texas, the King Mountain Wind Ranch (200 MW) employs turbines manufactured by the company Bonus (recently acquired by Siemens). (TREIA, 2006) All of the turbines in the King Mountain Wind Ranch were manufactured in Denmark and shipped to the United States[22]. Although the turbines were installed in the state of Texas, the employment generated from the project affected areas outside of the state, and moreover, outside of the country. As such, the employment benefits associated with the manufacture of wind turbines are not necessarily limited to the state of installation.

Therefore, employment is generated by increasing the development of renewable energy technologies, primarily through the manufacture and installation of new renewable energy generation capacity facilities. As RPS policies are designed to facilitate the development of

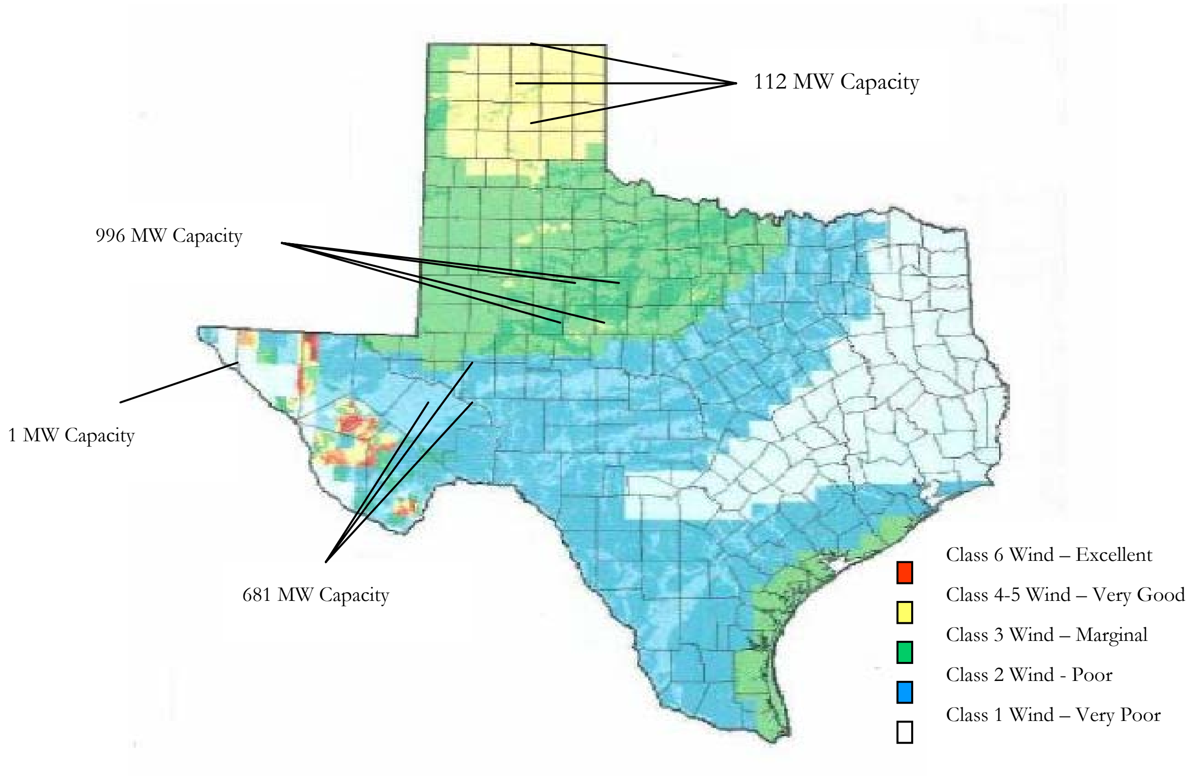
[20] A job was defined as "the number of people who will need to be employed continuously to provide for the ongoing operation of a plant with a maximum output of one megawatt." (Kammen, Kapadia, and Fripp, 2004, p.6)

[21] Including all jobs in manufacturing, construction and installation, operations and maintenance, fuel production, extraction and processing.

[22] According to a Siemens associate, a new facility is currently being constructed in Fort Madison, Iowa for the future manufacture of American bound Siemens wind turbines.

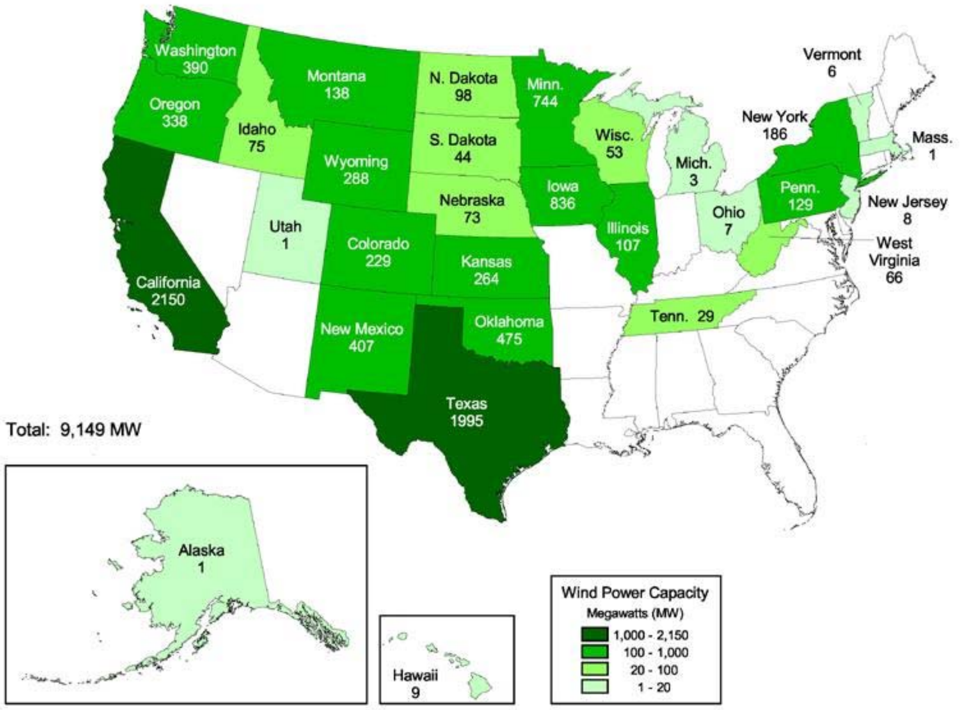
new renewable energy generation sites, it may be assumed that RPS policies are therefore linked to the generation of new employment. However, as components for renewable energy are often manufactured in various areas of the nation, the employment benefits are not necessarily limited to the state of implementation, or the renewable energy facility sites.

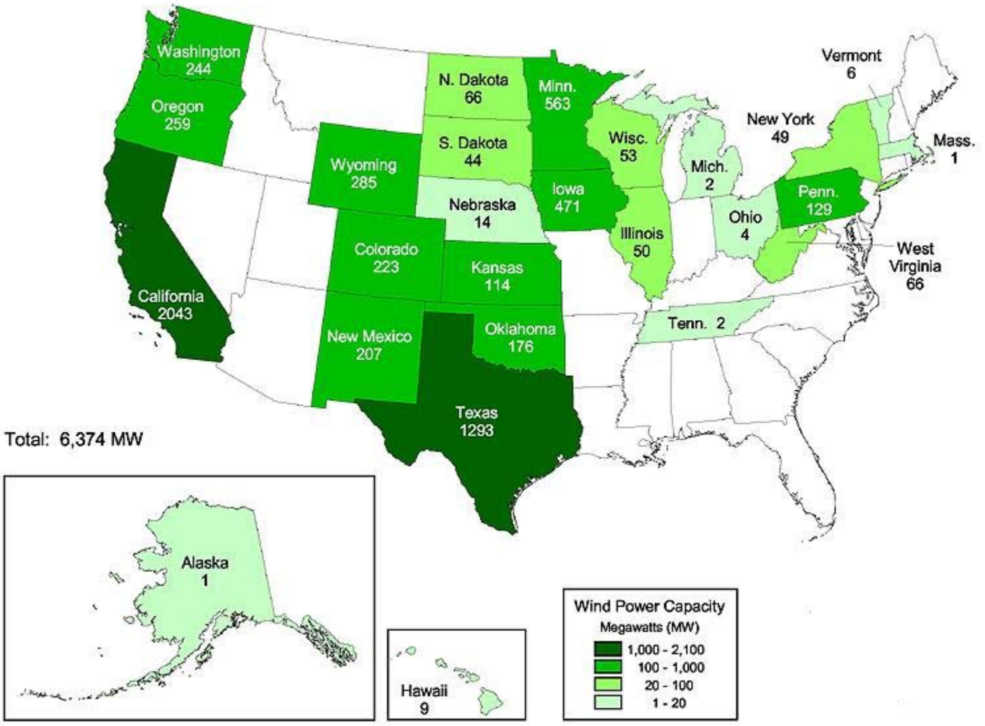
Appendix IV. Map of Texas Wind Energy Generation Potential with overlaid wind turbine installation since the initiation of the State RPS in 1999.



Source: (Virtus Energy Research Associates, 1995, ERCOT, 2006)

Appendix V. Installed Wind Energy Generation Capacity in 2003 and 2005





Source: United States Department of Energy, Office of Energy Efficiency and Renewable Energy

Appendix VI. Considerations for the Harmonization and Integration of RPS and TREC compliance markets

The issue of inter-state collaboration on issues of RPS and TREC compliance markets has been increasingly frequent in political discussions. "As the number of states adopting an RPS and related pro-renewable programs has proliferated they have increasingly begun to confront issues of inter-state collaboration." (Rabe, 2006, p.8) The harmonization of RPS policies is more complex than a simple extension of the definition of geographic eligibility of renewable energy generation facilities for use in a TREC compliance market. Bureaucratic challenges which exist in the coordination of RPS policies in conjunction with expanding TREC compliance markets. Energy policy literature has examined those issues crucial to the coordination of RPS policies and extended TREC markets. These issues include a compatibility of regulation, a concurrence on eligible technologies, and a harmonization of market stabilization mechanisms, penalties, and certificate validity.

Compatibility of Regulation

Policies in support of specific technologies should be synchronized across states to avoid distortion in competition. (Mozumder et al., 2004) For example, subsidies in support of wind energy technologies in a particular state have the potential to disadvantage surrounding states that must also meet RPS requirements, but have no such incentives for renewable supply.

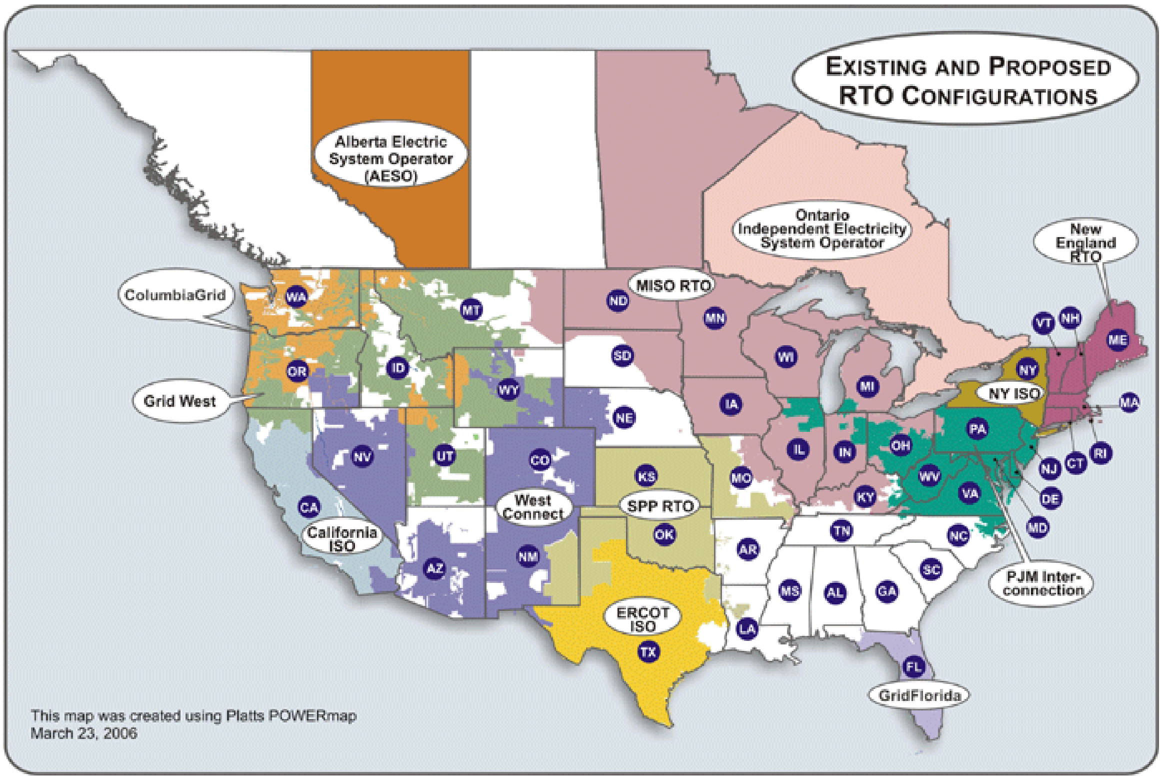
Concurrence for Eligible Technologies

In order to extend an RPS policy and TREC compliance market across national or state boundaries, parties must agree on the type of renewable technologies that are to be considered eligible for certification. Without consensus, trade restrictions are created by the definitions in regulation.

Harmonization of Market Stabilization Mechanisms, Penalties, Certificate Validity

Market stabilization mechanisms for TRECs must be harmonized. This includes coordinating certificate price ceilings and floors, non-compliance penalties, validity time-frame of certificates, and banking and borrowing rules.

Appendix VII. Regional Transmission Organizations



Source: (Federal Energy Regulatory Commission, 2006)