RENEWABLE PORTFOLIO STANDARDS: STATE LEVEL EFFECTIVENESS

By

Michael Hecker

Submitted to

Central European University

Department of Economics

In partial fulfillment of the requirements for the degree of Master of Arts in Economic Policy & Global Markets

Supervisor: Robert P. Lieli

Budapest, Hungary

ABSTRACT

This thesis investigates the relationship between U.S. renewable energy policy and the amount of renewable energy generation and capacity within the country. Specifically, this thesis examines state Renewable Portfolio Standards and the levels of renewable electricity generation and capacity within a state. In addition the paper attempts to address the recently proposed topic regarding a national Renewable Portfolio.

The literature up to date has not been conclusive, or used data sets spanning a significant amount of years. The Data for the empirical estimation mostly comes from the Energy Information Administration, and was obtained for 1990-2012, for each state. Applied to this larger dataset, the fixed effects estimation procedure can account for a large set of state and year characteristics, as well as looking for a differential effect across states.

This study finds that, on average, RPS programs were not effective over the time period examines. However, the potential reasons for this non-effect vary, and the author argues in favor that the non-effect could be caused by federal level programs which were in place during the time period in question. Overall, the paper finds evidence that a national Renewable Portfolio Standard is not an advisable policy solution to increase renewable energy generation and capacity in the future and that lawmakers should instead focus on federal level tax incentives.

ACKNOWLEDGEMENTS

First, I would like to thank Professor Lieli for his astute guidance on this thesis. Second, I would like to thank the Central European University Economics Department, and especially Professor Kezdi for providing me with fantastic opportunities to learn and develop over the past two years. I would like to thank my family, who has always been supportive of me and my decisions, even when they did not understand them. Finally, I am thankful to all of my friends and classmates at CEU- it would not have been the same experience without them.

Table of Contents

List of Abbreviations

BEA- Bureau of Economic Analysis

DSIRE- Database of State Incentives for Renewable Energy

EIA- Energy Information Administration

ITC- Investment Tax Credit

Mwh- Megawatt Hours

MW- Megawatts

NREL- National Renewable Energy Laboratory

PTC- Production Tax Credit

REC- Renewable Energy Credit

RPS- Renewable Portfolio Standard

USCB- United States Census Bureau

Introduction

Energy is what literally moves our world and without sources of energy such as coal, oil, and gas, our current way of life would be impossible. However, “fossil fuels” have come under attack since the 1970s as harmful to the environment.[1] Furthermore, the distribution of fossil fuel resources is uneven across countries forcing many countries to be dependent upon others with large natural endowments of fossil fuels. Given these two reasons, many countries in the world have been creating policies which incentivize and support renewable energy.

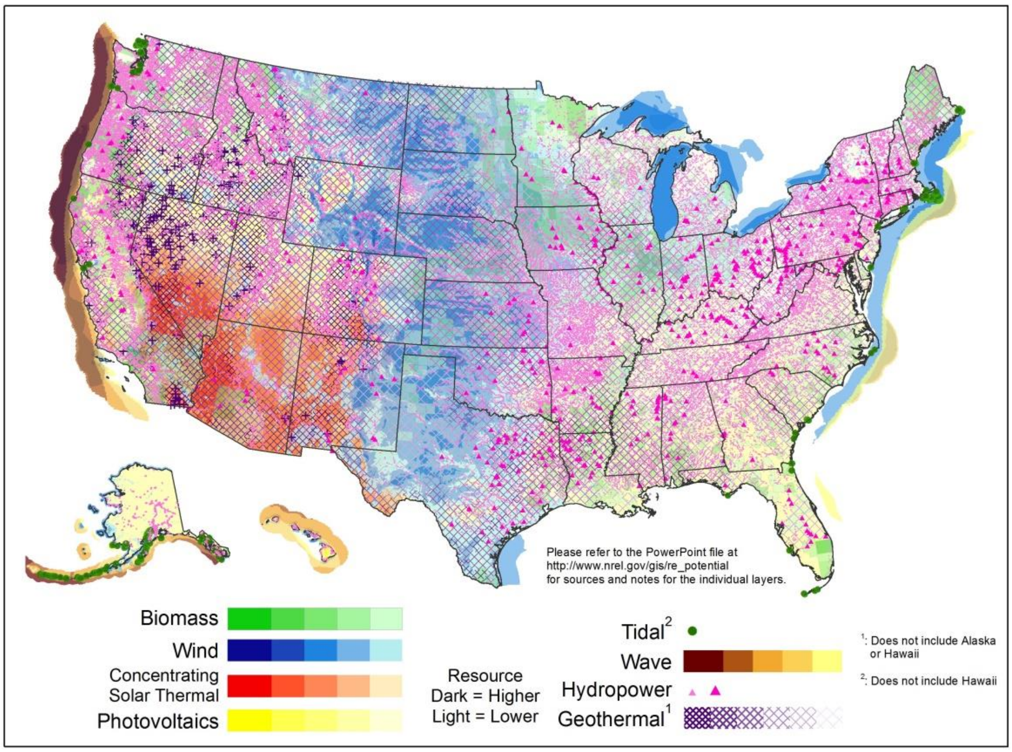
As renewable energy is “energy from a source that is not depleted when used,”[2] countries can avoid both damaging the environment and depending on foreign nations for energy if they increase their renewable energy generation and capacity. Germany is perhaps the best known example of a country successfully beginning the transformation to renewable energy. After passing the “Directive on Electricity Production from Renewable Energy Sources” in 1997, Germany set a goal of 12% of electricity to be generated from renewable energy sources by 2010, though the country surpassed this goal in 2007.[3] In 2010, even more ambitious goals were defined for the future, such as 45% by 2025, 60% by 2035, and 8% by 2050.[4] Germany has proven that it is possible to transition away from conventional energy with strong national level policies. However, one country which has not defined a national renewable energy policy is the U.S.

The United States, given its geographic size and varied climate, has a large renewable energy potential. According to a study conducted by the National Renewable Energy

[1] "Fossil Fuels." Environmental and Energy Study Institute. 2014. Accessed May 31, 2015.
[2] Renewable Energy. Dictionary.com. Dictionary.com Unabridged. Random House, Inc. http://dictionary.reference.com/browse/Renewable Energy (accessed: May 31, 2015).
[3] Morris, Craig, and Martin Pehnt. "German Energy Transition." The German Energiewende. 2014. Accessed May 31, 2015.
[4] Ibid

Laboratory in 2014, “renewable electricity generation from technologies that are commercially available today […] is more than adequate to supply 80% of total U.S. electricity generation in 2050”.[5] The report also stated that the variety of renewable energy sources across the U.S. would be able to support multiple combinations of renewable energy.[6] Therefore, the U.S. has the potential to become much less dependent on conventional fuels; the question is rather how can it harness this potential?

Figure 1- Renewable Energy Potential[7]



Renewable energy is an important political point in the United States- chiefly because it can help limit the U.S. dependence on foreign oil imports. Former President George W. Bush, in his state of the Union address in 2006, even took it so far as to say that “America is

[5] "Renewable Electricity Futures Study." National Renewable Energy Laboratory. 2014. Accessed May 31, 2015.
[6] Ibid
[7] "MapSearch." National Renewable Energy Laboratory. 2014. Accessed April 17, 2015.

addicted to oil, which is often imported from unstable parts of the world".[8] Current President Barack Obama's energy strategy has "reducing our dependence on foreign oil" as its first goal.[9] Most recently in 2009 Senators Jeff Bingaman and Tom Udall and Representative Edward Markey all designed national level Renewable Portfolio Standards (RPS) programs, which generally specified a target of 25% of energy in the US to be made by renewable resources by 2025.[10] Nonetheless, none of these proposed systems were ever put into place. The sentiment to create a national level policy has not subsided and is still the topic of fierce debate. Senator Udall has vowed to continue to fight for a national Renewable Portfolio Standard, stating that "It's a proven fact: these kinds of renewable electricity standards work- and they are good for both the U.S. economy and our environment".[11]

In the absence of a strong national renewable energy policy such as the one Senator Udall suggests, the United States relies on an amalgamation of state policies and federal level tax breaks making up a decentralized renewable energy policy framework. These policies can be split into two categories: regulations, such as setting energy efficiency standards, and incentives, such as providing tax breaks to renewable energy producers. Perhaps the most visible US renewable energy policy is the state level RPS programs. Briefly, an RPS program is a regulatory policy which mandates that a certain percentage of the electricity generated by public utilities must come from renewable resources, by a set date.[12] Federal policies come in the form of tax breaks. Take for example the Federal Production Tax Credit (PTC) which

[8] "President Bush's State of the Union Address." Washington Post. January 31, 2006.
[9] "Advancing American Energy." The White House. November 14, 2013. Accessed May 13, 2015.
[10] "Senator Udall Introduces Renewable Electricity Standard Bill." Renewable Energy World. February 17, 2009. Accessed May 31, 2015.
[11] Brandt, Jaclyn. "Is It Finally the Year for a National Renewable Electricity Standard?" Fierce Energy. May 18, 2015. Accessed May 31, 2015.
[12] "Renewable Portfolio Standards." National Renewable Energy Laboratory. September 8, 2014. Accessed May 20, 2015.

stated that companies which generate electricity from renewable sources qualified for a .01-.02$ per kilowatt hour tax break for the first ten years of operation.[13]

Senator Udall is not the only individual within the U.S. government that would like the U.S. to have a stronger national renewable energy policy, in order to decrease the dependence on foreign oil. Since 1997, Congress has considered a national RPS four times, with the Senate passing legislation three times and the House passing legislation once, though none of these measures was ultimately successful.[14] The sentiment that the U.S. should become more energy independent has been a policy goal of every President since the Carter administration (not only in the past two administrations as previously mentioned). However, before any national level legislation is implemented, the effectiveness of current programs should be analyzed. This research will focus on measuring the effectiveness of the current RPS programs across U.S. states in increasing the renewable percentage of net electricity generation and nameplate capacity. It will be interesting to see whether or not Senator Udall is correct in claiming "these kinds of renewable energy standards work".[15]

[13] "Production Tax Credit for Renewable Energy." Union of Concerned Scientists. December 1, 2014. Accessed May 31, 2015.

[14] Sullivan, Logan, Bird and Walter Short, *Comparative Analysis of Three Proposed Federal Renewable Electricity Standards* (Colorado: National renewable Energy Laboratory:2009), 1.

[15] Brandt, Jaclyn. "Is It Finally the Year for a National Renewable Electricity Standard?" Fierce Energy. May 18, 2015. Accessed May 31, 2015.

Chapter 1 – Renewable Energy Context

1.1 Renewable Energy

The U.S. Energy Information Administration (EIA) defines renewable energy as "energy produced by sources which regenerate or are infinite". The five most commonly used renewable energy sources are Biomass (such as wood or municipal solid waste), Hydropower, Geothermal, Wind, and Solar. Interestingly, according to the EIA, Nuclear power is regarded as non-renewable as the Uranium-235 used to generate fission is finite. A full list of the EIA definitions and descriptions of conventional and renewable energy sources can be found in Table 2 in Appendix A, but Table 1 below gives a brief overview of the category of each type of energy:

Table 1- Energy Types

Conventional	Coal, Natural Gas, Nuclear, Other Gases, Petroleum
Renewable	Pumped storage, Geothermal, Hydroelectric, Biomass & Municipal Waste, Solar, Wind, Wood

The amount of renewable energy generation from these sources is measured in two ways- net electricity generation and total nameplate capacity. In essence, net generation is a flow variable of the energy produced, and nameplate capacity is a stock variable of the installed capacity of power plants making the energy. Net Generation is defined as "the amount of gross generation a generator produces less the electricity used to operate the power plant" and is measured in Megawatt Hours (Mwh).[16] To contextualize this measure, an average American home in 2013 used about .909 Mwh per month, or 10.9 Mwh per year of electricity. Nameplate Capacity is defined as the "maximum electric output a generator can

[16] 1 Mwh is equal to 1,000 Kilowatts (KW) or 1 million watts used nonstop for one hour

produce under specific conditions […] without exceeding specified thermal limits" and is measured in Megawatts (MW).[17]

As can be seen in Figure 2 (Appendix A), the United States generates a large amount of electricity- in 2012 its net generation was about 4 billion Mwh of electricity. The overall trend of the data also shows that the U.S. has been generally producing more electricity over time. Figure 3 (Appendix A) shows the percentage of the total US net electricity generation by conventional versus renewable methods. From 1990-2012, renewables have consistently accounted for about 10% of electricity generation in the U.S. However, closer examination of Figure 2 and Figure 3 shows that the U.S. renewable sector is generating much more electricity than in the past; the only reason this jump is not reflected in the graphs is due to similar growth in electricity production within the conventional energy sector.

It is also interesting to understand what energy type is driving this increase in renewable generation. Figure 4 (Appendix A) shows the generation of electricity from different renewable sources from 1990-2012. It is easily seen that hydroelectric power is the dominant force in the U.S. renewable energy generation sector; however, since 2007 wind has steadily been increasing as a generation source. Since 2010 wind has generated more electricity than all of the other sources combined (while dropping hydroelectric).[18]

In order to generate the massive amounts of energy seen in Figure 2, the U.S. needs an equally large nameplate electric generation capacity. Figure 5 (Appendix A) shows that the nameplate electric capacity of the US has been growing since 1990, in step with the increased net generation. However, the type of capacity which has been installed has changed. In Figure 6 (Appendix A), which shows the percentage of installed nameplate capacity by energy type, it is apparent that between 2011 and 2012 renewables gained a

[17] 1 MW is equivalent to 1,000 kilowatts, or 1 million watts.
[18] Author's calculation

significant percentage, 1.2% of total capacity, over conventional energy.[19] In 2012 renewables were the highest percentage of the U.S. total nameplate capacity they have ever been—about 13%.[20]

Figure 7 (Appendix A) shows the installed renewable capacity by energy type. Again, it is interesting to note the dominance of hydroelectricity, as well as the recent emergence of wind energy. It is readily apparent that no other renewable energy has experienced the same growth as wind energy in the past decade. In 2012, wind energy accounted for 33% of all installed renewable capacity.[21]

Generally, the growth of the renewable energy sector in the U.S. over the past two decades has been attributed to a variety of state and federal level policies. These policies, as mentioned, are not clear directives from the federal government, but rather an amalgamation of renewable energy policies adopted on a state by state basis, as well as a few federal level tax incentives.

1.2 Renewable Energy Policy History

Renewable energy policy in the United States stretches back to the late 1970s. The 70s was a tumultuous decade in regards to energy. The 1973 oil crisis triggered a price increase of 400% in oil.[22] This shock had immediate effects on consumers, and the U.S. Congress responded in the form of the National Energy Act of 1978.[23] The National Energy Act was an umbrella law that covered many different topics such as energy taxes and conservation policies, but most interestingly regulated electricity generating Public Utilities.

---

[19] Author's calculation
[20] Ibid
[21] Ibid
[22] Hinsdale, Jeremy. "Extreme Oil - 1930-1974." PBS. 2004. Accessed May 31, 2015.
[23] *National Energy Act, 1978*, Pub. L. 95-617, 95th Congress, 1st session. (Nov. 9) U.S. Government Publishing Office

The act which regulated the Public utilities is known as the Public Utilities Regulatory Policies Act, or PURPA.

PURPA encouraged “creating a market for power from non-utility power producers, increased efficiency by making use of cogeneration, ending promotional rate structures, encouraging the development of hydroelectric power, and the conservation of electric energy and natural gas”.[24] In effect, PURPA broke down the natural monopoly structure of the U.S. electricity generation sector. Before PURPA, utilities were established with vertically integrated structure- as it was assumed that one company could provide electricity at a lower cost than many competing companies. With PURPA’s allowance of non-utility generators to produce power for use by customers attached to a utilities grid, the previous monopoly in the generation sector was broken.

As a direct result of the de-monopolization of the generation sector, the U.S. power system is serviced by three types of entities: public utilities, non-utility generators (NUG), and retail non-utility suppliers of power.[25] Public utilities are publicly owned entities “with distribution facilities for delivery of electric energy for use primarily by the public”.[26] Most citizens in the U.S. receive their electricity from public utilities.[27] NUGs are privately owned “entities which generate, transmit, or sell electricity”.[28] NUGs may sell their electricity to public utilities, or any number of market actors, but do not provide retail service- that is they do not sell directly to consumers. Retail non-utility suppliers are entities that may or may not generate electricity, but buy and sell electricity as a commodity.[29] Retail non-utility suppliers

[24] *National Energy Act, 1978,* Pub. L. 95-617, 95th Congress, 1st session. (Nov. 9) U.S. Government Publishing Office
[25] Regulatory Assistance Program. *Electricity Regulation in the US: A Guide* (Vermont: RAP, 2011), 9-11.
[26] "Glossary." Energy Information Administration. 2015.
[27] Ibid
[28] Ibid
[29] Ibid

may buy excess electricity from public utilities or NUGs, and sell them to any number of market actors, including individual consumers.[30]

PURPA also set the stage for the current electricity generation regulation in the U.S. by leaving the implementation of the law up to each state. States have variations in their ability to regulate the entities acting in the electric power generation sector, but all states can regulate public utilities.[31] PURPA was flexible enough to fit each state's peculiarities in the types of entities each allows to operate in the electric generation sector. As a consequence of PURPA, Renewable Portfolio Standards are possible- as states can regulate public utilities to generate certain percentages of their electricity through renewable resources.[32]

1.3 Renewable Portfolio Standards

Renewable Portfolio Standards are state level regulatory mandates aimed at increasing the production of energy from renewable sources as alternatives to fossil and nuclear electric generation.[33] The designs of RPSs vary across states, but there are a few common themes. An RPS requires public utilities to create a certain percentage of their electricity from renewable sources measured in terms of absolute levels (MW or Mwh) or in percentages of the total energy produced. RPS requirements increase over time and electricity suppliers can meet their yearly requirements in three ways:

1. Build enough renewable capacity, and use this capacity to generate the yearly requirement of renewable electricity
2. Make a monetary compliance payment to the RPS regulator, instead of obtaining the yearly requirement

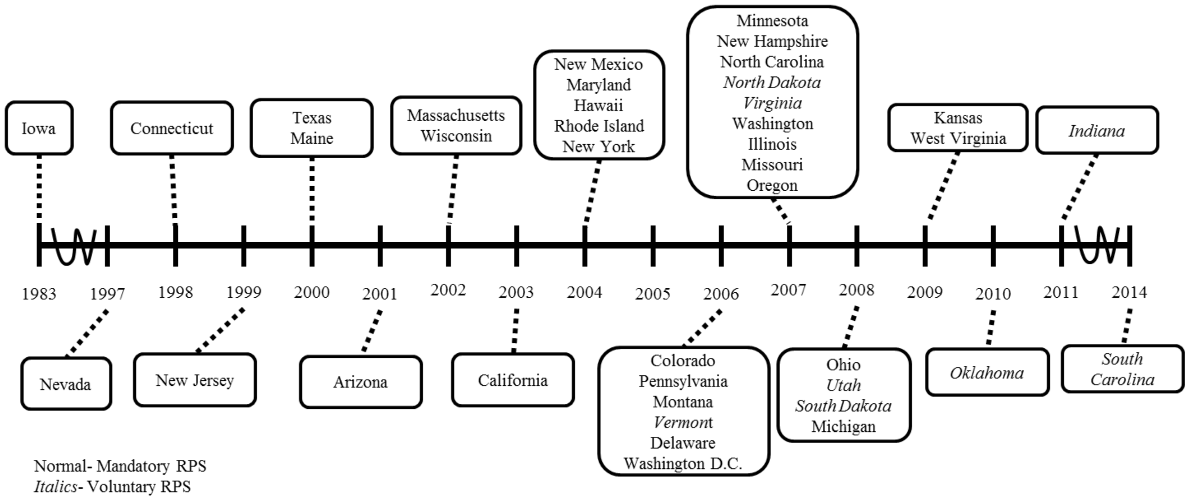
[30] Regulatory Assistance Program. *Electricity Regulation in the US: A Guide* (Vermont: RAP, 2011), 9-11.
[31] *National Energy Act*, *1978*, Pub. L. 95-617, 95th Congress, 1st session. (Nov. 9) U.S. Government Publishing Office
[32] Regulatory Assistance Program. *Electricity Regulation in the US: A Guide* (Vermont: RAP, 2011), 9-11.
[33] Ibid

3. Purchase Renewable Energy Credits (REC) from a renewable resource electricity generator (normally a NUG or Retail provider); RECs can come bundled, when both the energy and the REC are bought, or unbundled when only the REC is purchased

RECs are credits, awarded to any type of renewable energy electricity producers. For example, a NUG windfarm might (depending on the state) receive a REC for every 1 Mwh of electricity it produces. Then public utilities not within their RPS compliance percentages can purchase RECs from the windfarm, and apply the REC to their electricity generation percentage, until they are within the RPS compliance limits. The REC system allows RPSs to be more effective across large geographical distances; if a producer is in an area with few renewable resources available, the producer can "transfer" the resources from an area with abundant renewable resources by buying REC. RECs also permit RPS programs to be market driven, by allowing independent producers to enter the market as they see fit. One potential drawback of RECs is that they encourage independent producers to create power plants with the lowest cost options- in practice this means that most renewable producers tend to only develop one type of renewable generation rather than a diversified portfolio.[34] Finally, some states allow RECs to be transferred across state boundaries- this helps RPS programs in states with limited renewable potential still be flexible enough to be effective.

[34] Center for Climate and Energy Solutions, *Clean Energy Standards* (Vermont, 2011), 16.

Figure 8- Timeline of RPS Adoption



As more states have adopted RPSs, there has been more variation in their stipulations within goals, compliance requirements, and what types of utilities are targeted. Iowa was the first state to adopt an RPS in 1983 in the form of the Iowa Alternative Energy Production law. The law required all utilities within the state to contract for a total of 105 megawatts of electricity generation from renewable sources.[35] This initial RPS only set a target deadline for the same year of 1983. The initial Iowa RPS program was rather primitive when compared to the goals other contemporary policies, such as California's goal of 33% by 2020. In Colorado, different utility types have different obligations: public utilities have a goal of 30%, while cooperative utilities have a goal of 20% by 2020. By 2015, 38 of the 51 states (including Washington D.C.) have adopted Renewable Portfolio standards; however, in 7 of the states the RPS is a voluntary regulation. There are also differences in the types of energy covered under the RPS. For example, Hawaii allows for Solar Heat, while Delaware does not. The differences between states are quite numerous. A summary table of the differences in states' RPS policies can be seen in Table 2 in Appendix B. The differences between state programs will not be analyzed, as this research focuses on the effect of RPS programs in increasing renewable energy as a whole- whether that comes from Solar or Wind or is created

[35] "Iowa RPS." Center for Climate and Energy Solutions. 2014. Accessed March 31, 2015.

by public or private institutions is irrelevant. One difference between states, however, will be highlighted: the difference between compulsory RPS programs and Voluntary RPS programs. As compulsory RPS programs carry real monetary penalties for non-compliance, compulsory programs are expected to be more effective than their voluntary counterparts.

Recently RPS policies have come under attack. In 2014 Ohio froze its Renewable Portfolio Standard- meaning that annual compliance percentages are held at 2014 levels until further research is completed to advise lawmakers if they should repeal, modify or continue the RPS.[36] In 2015 West Virginia completely repealed its RPS.[37] Both States have cited economic reasons for the suspension of the RPS as their economies are heavily reliant on the coal industry. Both governments believed the RPS placed an unfair burden on the economy to force electricity generators to spend money on higher cost renewable energy capacity rather than relying on cheap coal fired power plants.[38]

1.4 Federal Tax Credit Programs

In addition to the state level RPS programs there have been two federal tax credit programs put in place to encourage the production and usage of renewable energy sources. Both tax credit programs operate in broadly the same way- they are dollar for dollar reduction in income taxes based on the installation and generation of qualifying renewable energy resources. They do differ, however, in the definition of incentives, target populations, and dates of effectiveness.

[36] Funk, John. "Ohio Renewable Energy and Efficiency Rules Frozen for Two Years as Gov. John Kasich Signs Legislation." Cleveland.com. June 14, 2014. Accessed May 1, 2015.
[37] Light, John. "Score One for ALEC: West Virginia Is First State to Repeal a Renewable Energy Standard." Grist. February 5, 2015. Accessed March 23, 2015.
[38] "West Virginia Becomes First State to Repeal RPS - American Legislator." American Legislative Exchange Council. February 4, 2015. Accessed May 14, 2015.

1.4.1 Production Tax Credit

The Production Tax Credit (PTC) was enacted as part of the Energy Policy Act of 1992, but was allowed to expire in January of 2015.[39] The PTC provided commercial and industrial energy producers tax breaks based on the amount of renewable electricity generated. These tax breaks were introduced in order to help renewable energy generation compete with cheaper conventional generation.[40] There were varying levels of incentives, which were based on the type of renewable used. Geothermal and Wind energy had the highest incentives, with a $0.02 per KWh generated tax credit for 10 years. Hydroelectric, Municipal Solid Waste, Landfill gas, Tidal, Wave, Ocenaic Thermal, and small Hydroelectric had the second highest incentives, with a $0.01 per KWh generated tax credit, for 10 years. Biomass had the lowest incentive, with a $0.01 per KWh generated tax credit for 5 years. Given this incentive structure, the PTC favored both geothermal and wind energy development.

The effectiveness of the PTC has been estimated across a broad range of empirical studies, and has consistently proven to be quite effective. Most of these studies have focused on the PTC impacts on wind energy as the PTC most greatly affected the wind market. Xi Lu et al., in their paper titled *The impact of Production Tax Credits on the profitable production of electricity from wind in the U.S.* published in Energy Policy in 2011, estimated that with the PTC in place, the quantity of wind energy that could be generated profitably would be about 28 billion Mwh (much greater than the total demand for electricity in the U.S. in 2015).[41] Without the PTC in place, the authors estimated that the wind energy which could be

[39] Cohen, Boner. "Senate Rejects Wind PTC Extension." Heartland. March 11, 2015. Accessed May 13, 2015.
[40] National Renewable Energy Laboratory, *Implications of a PTC Extension on U.S. Wind Deployment* (Colorado, 2014), iv
[41] Lu, Xi, Jeremy Tchou, Michael B. Mcelroy, and Chris P. Nielsen. "The Impact of Production Tax Credits on the Profitable Production of Electricity from Wind in the U.S." Energy Policy 39, no. 7 (2011): 4212.

generated profitably would drop to almost 0 Mwh.[42] The Congressional Research Service also conducted studies and found the PTC to be effective. By 2010, $1.7 billion in tax credits were claimed under the program which implies that 85 billion Mwh of renewable electricity was produced under the program from 1992-2010.[43] As prior research has proven, the PTC was an extremely effective program at increasing the amount of renewable electricity generation and capacity, though most of this increase was driven through a single resource: wind.

As the PTC was in place during almost entire time period that RPS programs have been implemented, this research will not attempt to estimate the effectiveness of RPS programs separately from the PTC. Rather, the results presented will show the estimated effectiveness of RPS programs, within a PTC scheme. As the PTC was a national policy while RPS policies were state policies, it is possible the PTC could have spurred renewable development country wide which will overshadow any effects of state RPS programs. However, it is also possible that the PTC could help to amplify the effectiveness of state RPS programs. As RPS programs create new "demand" for renewable energy, states with RPS programs could have experienced higher levels of renewable development.

1.4.2 Investment Tax Credit

The Investment Tax Credit (ITC) was first brought into legislation in 2008; however, it was not enacted or effective until 2013.[44] The ITC is a policy designed to replace the PTC, and it provides tax credits for eligible renewable energy capacity placed into service on or before December 31, 2016. For Solar, small Wind (<100.00 kW capacity), and Fuel Cell

[42] Ibid
[43] Sherlock, Molly. "The Renewable Electricity Production Tax Credit: In Brief." Congressional Research Service, 7-5700, 2014, 10.
[44] "Investment Tax Credit." Database for State Incentives for Renewables & Efficiency. 2015. Accessed April 31, 2015.

power plants the investing individual/company can claim 30% of their expenditures on the facility as tax deductible.[45] The ITC did not affect RPS programs over the time period in question, as it became effective in 2013; however, the ITC is significantly different from the PTC. Whereas the PTC emphasized Geothermal and Wind energy, the ITC is emphasizing Solar, small Wind, and fuel cells. If the ITC is as successful as the PTC, the landscape of the U.S. renewable sector may change dramatically in the future.

[45] "Programs." Database for State Incentives for Renewables & Efficiency. 2015. Accessed April 14, 2015.

Chapter 2- Literature Review

Analysis of RPS programs is quite varied- both in terms of time periods researched and results obtained. There have been many anecdotal studies of effectiveness in specific states, as well as large empirical studies attempting to isolate the key drivers and issues of renewable development. Unfortunately there has been very little research into the effectiveness of programs across the United States, and what research exists suffers from the small availability of data during the period in which it was written.

A large bulk of the literature focuses on consumer cost-impact studies of state level RPS programs. Cliff Chen, in a literature review published by the Lawrence Berkely National Laboratory, reviews 31 pervious state RPS cost-benefit projects to compare the forecasted impacts across the studies.[46] The reviewed studies not only focused on cost impacts, but also forecasted the mix of renewable technologies most likely to be used to meet state RPS requirements.[47] Because wind is favored by the PTC and boasts relatively low costs with high generation potential, Chen concludes that wind will become the dominant technology helping states meet their RPS goals.[48] He also found that state level RPS consumer impacts would be rather modest- less than a $2.00 increase in monthly electric costs for an average household.[49] Chen's findings are widely accepted and there is little debate concerning his estimations.

Another branch of literate focuses solely on RECs and their price fluctuations. Marc Chupka, in his piece *Designing Effective Renewable Markets* for the Energy Journal in 2003, noted that RECs need to be banked over time in order to be effective.[50] He argued that if

[46] Chen, Cliff, Ryan Wiser, and Mark Bolinger. "Weighing the Costs and Benefits of Renewables Portfolio Standards:A Comparative Analysis of State-Level Policy Impact Projections." Lawrence Berkely National Laboratory, no. LBNL-61580 (2007): i. Accessed April 12, 2015.
[47] Ibid Page 8
[48] Ibid
[49] Ibid Page 9
[50] Chupka, Marc W. "Designing Effective Renewable Markets." The Electricity Journal 16, no. 4 (2003): 46-57.

producers were not able to transfer the benefits of renewable production from one year to the next, then the REC market would become extremely volatile, which would disincentivize investment in renewable energy- achieving exactly the opposite effect than what is hoped for. Glen Barbose, in a 2012 presentation created for the Lawrence Berkely National Laboratory, proved Chupka's previous hypothesis, showing that REC prices have been volatile throughout the history of state RPSs, and that as a result REC market prices dropped substantially in 2009 and 2010. However, Barbose also mentions that states have implemented different measures to ensure REC markets stay viable. These measures include "increasing or decreasing RPS targets" and long term contracting programs wherein large users of electricity can create contracts with renewable generators, setting a price for electricity itself (or RECs) which helps to stabilize market price.[51] Currently the prevailing literature on the topic suggests there is little risk of REC markets becoming unviable.

Nevertheless, research into the effectiveness of RPS programs in increasing actual renewable capacity and generation presents some controversy. Some studies have found RPS programs to be beneficial and effective at increasing renewable capacity and generation, while others have found them to be ineffective. In 2007, Robert Michaels found RPS programs to be ineffective in his paper *Intermittent Currents: the Failure of Renewable Electricity Requirements*.[52] Michaels found that in many states compliance measures are not well defined, meaning that utilities can strategically game the system and avoid penalties. Michaels uses the example of California, which in 2002 enacted an RPS to achieve 20% renewable power by 2010. In 2003, the California Public Utilities Commission estimated that to reach the 2010 goal, 4,200 MW of new renewable capacity would have to come on line by 2010. In response California's public utilities contracted with renewable developers and

[51] Barbose, Galen. "Renewables Portfolio Standards in the United States: A Status Update ." Lecture, 2012 National Summit on RPS from Clean Energy States Alliance, Washington, D.C., December 3, 2012.
[52] Michaels, Robert J., Intermittent Currents: The Failure of Renewable Electricity Requirements (October 30, 2007). Accessed April 19, 2015.

claimed that their contracts, whether or not they had started producing renewable electricity, counted towards their renewable generation requirements. As a result, the author estimated that 44% of claimed compliance capacity in California was completely speculative.[53] Conversely, in the 2012 Berkely National Laboratory presentation, Barbose showed that renewable targets under RPS schemes have generally been met- though some states (Massachusetts, New Hampshire, and New York) have struggled to meet their targets. Barbose does not address the issues that Michaels brings up- whether or not the targets are being met by speculative contracts, or by actual power plants producing electricity from renewable energy.

The only research that can disprove Michaels's supposition that utilities can avoid their compliance requirements by creating speculative contracts is research analyzing the actual generation and capacity levels of renewable electricity in states. Perhaps the most comprehensive empirical study of state RPS effectiveness was conducted in 2008 by Sanya Carley, in her article *State renewable energy electricity policies: An empirical evaluation of effectiveness*, published in Energy Policy. The author estimated the effect of the implemented RPS policies at the time (27 states), with data spanning nine years- 1998 through 2006. The data used was compiled from a variety of different state sources, which the author readily admits are "rarely comprehensive".[54] The analysis resulted with "no strong evidence that RPS policies are, to date, obtaining their overarching objective of increasing the percentage of [renewable energy] generation".[55] The author theorizes that this result could be caused by

[53] Ibid
[54] Carley, Sanya. "State Renewable Energy Electricity Policies: An Empirical Evaluation Of Effectiveness." Energy Policy 37, no. 8 (2009): 3078.
[55] Ibid

poorly structured RPSs, as well as the fact that renewable energy growth could be overwhelmed by "the rate of overall electricity demand growth", so no effect is shown.[56]

Given the current literature, there only seems to be one open question for debate in the study of RPS programs: are they effective? The cost of RPSs has proven to be marginal, and the REC markets have not collapsed. Michaels and Carley both present arguments that RPSs are not very effective, yet the current research suffers from a brief time window and little amounts of data. In order to test state RPS programs effectiveness at actually increasing the renewable capacity and generation of electricity, it is beneficial to use new data sources that span longer time periods. Additionally many states have continually tweaked and improved their RPS programs, so the programs might prove to be effective after they have matured. The EIA now provides databases of electricity data, by state and year for all types of producers and energy types. These databases only measure the amount of capacity that was actually installed in a state year, as well as the actual generation of electricity by energy source in a state year. By using this data to test the effectiveness of state RPS programs, one can ignore the speculative capacity increases which Michaels mentions, and see the effect on the actual generation and capacity. By using a larger dataset, which expands both into the future and the past from Carley's data, one may be able to find differing results.

[56] Ibid

Chapter 3- Data

The data used in the analysis comes from a variety of sources; however, the end result is a balanced panel dataset covering all of the variables from the years 1990-2012. When percentage changes are mentioned, the dataset will only cover years 1991-2012, as 1990 must necessarily be dropped in this operation, because the previous year (1989) is not contained in the dataset.

3.1 Dependent Variables: Nameplate Capacity & Net Generation

Both dependent variables, net electricity generation and existing nameplate capacity, were collected from the Energy Information Agency (EIA).[57] The EIA composes these datasets by collecting data from trade journals, company reports, and governmental energy offices as well as conducting surveys with any power plants with a capacity greater than 1 MW. The datasets span from 1990-2012 and contain both the net generation per state by energy type, and the nameplate capacity per state by energy type. Again, the detailed energy types used by EIA can be found in Table 2 in Appendix A.

In some of the models, the dependent variables were further transformed, in order to control for different levels of exploitable renewable energy resources, as well as varying levels of pre-installed capacity prior to the target time period (1990). The renewable values for net generation by state were added together in each year and were then divided by the total net electricity generation by state in the same year. This resulted in the renewable percentage of total net generation by state and year. These values were then used to calculate the change in the renewable percentage of total net generation by state, from year to year. The

[57] "Electric Power Detailed State Data." Energy Information Administration. February 3, 2015. Accessed May 31, 2015.

same process was undertaken with the total capacity variable, resulting in a variable showing the change in the renewable percentage of total capacity by state, from year to year. The following equation was used to transform the data:

$$\frac{X_{st+1}}{Y_{st+1}} - \frac{X_{st}}{Y_{st}} = \Delta\frac{X_{st+1}}{Y_{st+1}}$$

Where:
X= Total Renewable Generation (Capacity)
Y= Total Generation (Capacity)

3.2 Independent Variables: Mandatory RPS & Voluntary RPS

The independent variables, Mandatory RPS & Voluntary RPS are dummy variables, containing the value of 1 if a state has a mandatory/voluntary RPS in place in time *t*, and 0 if otherwise (respectively). The data summarizing each state's RPS, including effective adoption date and eligible renewable technologies was gathered from the Database of State Incentives for Renewable Energy (DSIRE), which is operated by NC State University, and funded by the U.S. Department of Energy.[58] If a state implemented the policy in the last quarter of the year (September, October, November, December), then the state only changed from a 1 to 0 in the following year. The information is summarized in Table 2 in Appendix B, but as previously noted the minute differences between state RPS policies are negligible in this analysis. The goal of the analysis is to see if the presence of RPS programs correlates with an increase in the percentage of renewables in total net generation and capacity- not to isolate the different renewable technologies RPSs may or may not affect.

[58] "Programs." Database for State Incentives for Renewables & Efficiency. 2015. Accessed April 14, 2015.

3.3 Control Variables: GDP & Population

The control variables, state GDP and population, were collected from the Bureau of Economic Analysis (BEA)[59] and U.S. Census Bureau (USCB)[60][61][62] respectively for the same time period as the Dependent and Independent variables: 1990-2012. State GDP is defined as the "compensation of employees, taxes on production and imports (less subsidies), and gross operating surplus"[63] per state and year and is measured in current U.S. Dollars (USD).

Population is defined as "all persons who are 'usually resident' in a [state]", and is measured in a count of all people within the state, within the year. The USCB only conducts a census survey every ten years, but estimates the population in inter-years by utilizing "current data on births, deaths, and migration".[64] For the target time period, the census was conducted in 1990, 2000, and 2010- all other yearly population data are USCB estimates rather than survey results.[65]

These measures are included in the analysis as it is hypothesized that wealthier states may be able to invest more in (relatively more expensive) renewable energy technology. States with a larger population may have higher electricity demands- implying that they may build (relatively more expensive) renewable capacity, or increase their capacity of cheaper conventional energy sources to meet these demands thereby decreasing the percentage of renewable energy in their total energy portfolio.

59 "Regional Data." Bureau of Economic Analysis. February 3, 2015. Accessed May 31, 2015.
60 "Population Estimates- 1990s: State Tables". U.S. Census Bureau. January 2014. Accessed May 20, 2015
61 "Population Estimates- 2000s:State Tables" U.S. Census Bureau, January 2014. Accessed May 20, 2015
62 "Population Estimates – 2010s:State Tables: U.S. Census Bureau, January 2014. Accessed ma 20,2015
63 "Gross Domestic Product by Industry." Bureau of Economic Analysis. April 22, 2014. Accessed May 31, 2015.
64 "About Population Estimates." U.S. Census Bureau. March 23, 2013. Accessed May 31, 2015.
65 Ibid

Chapter 4- Methodology & Results

4.1 Methodology

In order to estimate the effect of state RPS programs on the renewable percentage of total electricity net generation and capacity, a fixed-effect model was used, with standard errors clustered on the state, for the time period 1990-2012:

$$Y_{st} = \lambda_s + \theta_t + \beta_1 Mandatory_{st} + \beta_2 Voluntary_{st} + \beta_3 GDP_{st} + \beta_4 Population_{st} + \varepsilon_{st}$$

Where:
Y= Renewable percentage of total electricity net generation/capacity
Mandatory/Voluntary= Dichotomous variable, 1 if state has a Mandatory/Voluntary RPS in year t

The model was run twice, once with year dummies, for two sets of data: the renewable percentage of total electricity generation and capacity from 1990-2012, and the year to year change (first difference) of the renewable percentage of total electricity generation and capacity from 1991-2012. Within the first differenced fixed effects model, state fixed effects were maintained, as there are state specific time trends. As mentioned, RPS regulations are living policies, which are often tweaked and changed during their lifespan- not only do states differ slightly in their implementation of an RPS, but the implementation itself changes over time per state.

4.2 Results

Table 4 presents the results from the models which were run with the renewable percentage of total generation and capacity as the dependent variables.

Table 4- Generation & Capacity Percentage of Total

	Renewable Generation as % of Total	Renewable Generation as % of Total	Renewable Capacity as % of Total	Renewable Capacity as % of Total
Mandatory RPS	0.009	-0.000	0.002	-0.008
	(1.35)	(0.02)	(0.20)	(0.67)
Voluntary RPS	0.033	0.018	0.032	0.017
	(1.98)	(1.21)	(1.16)	(0.64)
GDP	-0.000	0.000	0.000	0.000
	(1.86)	(1.58)	(0.03)	(1.27)
Population	-0.000	-0.000	-0.000	-0.000
	(0.68)	(0.15)	(1.00)	(0.78)
Year Dummies	N	Y	N	Y
Constant	0.161	0.125	0.172	0.143
	(14.26)**	(7.67)**	(11.10)**	(5.40)**
R^2	0.03	0.18	0.03	0.13
N	1,173	1,173	1,173	1,173

* p<0.05; ** p<0.01

Both regression results uphold the prevailing research by Carley- namely that there is no statistically significant relationship between a state having an RPS (whether mandatory or voluntary) in place in time *t*, and on average having a greater percentage of its generation or capacity coming from renewable energy than a state without an RPS policy.

Although this result is in line with previous research, it is somewhat surprising. Given that this analysis has a longer time horizon, it was expected that the presence of an RPS program would positively correlate with higher levels of renewable generation and capacity as percentages of their respective state totals. One explanation for this result is that RPS programs simply do not effectively increase renewable generation and capacity relative to states without RPS programs. Another explanation for the lack of significance could be the PTC. If the PTC was effective at increasing renewable generation and capacity across all states, regardless of whether or not an RPS was in place, then an insignificant result could be expected. From these results, it seems the earlier supposition was incorrect- the PTC certainly does not boost the effectiveness of state RPS programs.

Another question, however, is whether RPS programs correlate with a yearly change in the renewable percentage of total electricity generation and capacity, relative to states without such programs. Table 5 shows the results of the models which were run with the yearly change of the renewable percentage of total electricity generation and capacity by state- once with and once without year dummies included.

Table 5-Yearly Change of Renewable Percentage of Total Generation and Capacity

	Renewable Generation as a % of total, year to year change	Renewable Generation as a % of total, year to year change	Renewable Capacity as a % of total, year to year change	Renewable Capacity as a % of total, year to year change
Mandatory RPS	**0.007**	-0.002	0.004	-0.003
	(3.60)**	(0.75)	(1.82)	(1.00)
Voluntary RPS	0.014	0.005	**0.011**	0.004
	(1.57)	(0.62)	**(2.70)****	(1.11)
GDP	-0.000	0.000	0.000	0.000
	(1.43)	(0.87)	(0.44)	(0.79)
Population	0.000	-0.000	-0.000	-0.000
	(0.57)	(0.55)	(0.29)	(1.50)
Year Dummies	N	Y	N	Y
Constant	0.001	-0.005	-0.000	0.001
	(0.32)	(0.87)	(0.19)	(0.29)
R^2	0.01	0.10	0.03	0.10
N	1,122	1,122	1,122	1,122

* p<0.05; ** p<0.01

Although Tables 4 showed that states which have RPSs in place do not have statistically significant differences in terms of percentage of renewable generate and renewable capacity, the models in Table 5 run without year dummies show some significance. States with Mandatory RPS programs are on average expected to increase their renewable electricity generation as a percentage of total generation by .07%, compared to states with voluntary RPS programs and states without any RPS program. States with Voluntary RPS programs are expected to on average increase their renewable capacity as a percentage of total capacity by 1.1% compared to states with Mandatory RPS programs or no RPS programs in place. Both of these results have statistical significant at the 10% level.

However, when year fixed effects are included, all significance is lost. Time fixed effects were included as a robustness check, as part of the variation in the dependent variables could be explained by overall time trends- since hydroelectric power is a significant renewable energy source, season patterns of rainfall could have a large impact on states' generation of renewable energy, as well as the choice to install renewable capacity. As a result, Table 5 is interpreted as showing that there is no statistically significant relationship between a state having an RPS (whether mandatory or voluntary) in place in time *t*, and on average yearly increasing its renewable electricity generation and capacity as a percentage of total generation.

Again, this result is in line with previous research. The same reasoning from the results in Table 4 can be applied to the results for Table 5. Namely, that either RPS programs are ineffective at increasing renewable generation and capacity, or that during the time period the PTC was preeminent in increasing renewable generation and capacity.

Conclusion

The findings of this research have supported the findings of prior research in that state RPS programs have proven to be ineffective at their stated goals of increasing renewable energy generation and capacity. There are different explanations for why these results seem to be recurring. One option is that RPS policies are ineffective, and another option is that the PTC was much more effective over the same time period.

Michaels research discussed that control mechanisms within state RPS policies are rarely stringent, for a host of reasons. This oversight can lead to many utilities being able to "game the system" and avoid either paying non-compliance penalties or buying RECs in order to become compliant. By not being stringent enough, some states could be setting themselves up for failure regarding their RPS programs. However, given the data presented by Barbose it is unlikely that all states have such inefficient compliance measures as to lead to these insignificant results. One reason why states would adopt and RPS program with little stringency is in order to win easy political points from voters concerned about the environment or national security. Nevertheless, this supposition is quite illogical, given that states are often tweaking and modifying their RPS programs. If states were unconcerned with creating effective RPS programs, there would be no incentive to modify the existing RPS program.

A far more likely scenario which explains the non-effect of state RPS programs is the presence of the PTC. As mentioned, the PTC has been proven to have been an extremely effective policy tool to increase renewable energy generation and capacity. Therefore it is possible that state RPS programs effectiveness cannot be measured over the time period because the PTC helped to increase renewable energy generation and capacity country wide during the same time period. If this is the case, then the comparison group (states without

RPS programs) would have had large increases in renewable generation and capacity, and this fact would diminish any effect that RPS programs may have had. This scenario seems much more probable. Given the massive increase in wind generation and capacity shown in Figures 4 and 7, it seems that the PTC could easily be washing out any effect state RPS programs could have had during the time period.

Unfortunately, it is beyond the scope of this research if separate the effects of the PTC and state Renewable Portfolio Standards. Perhaps future research with longer time horizons will be able to take advantage of the discontinuity point in 2015, when the PTC was allowed to expire. After this point, it may be possible to isolate the effect of RPS policies. Currently, the literature and this research conclude that there was no measureable effect of state Renewable Portfolio Standards on renewable generation or capacity from 1990-2012.

Policy Implications

Given the conclusions of this research, Senator Udall seems to have been mistaken when he stated that “these kinds of renewable energy standards work”. The statement is untrue for U.S. states during the time period studied. However, the debate surrounding U.S. renewable energy policy is still ongoing- many members of the government would like to become more energy independent. It is possible that state RPS programs will prove to be effective in the coming decades.

Since the PTC has expired, the national increase in renewable electricity generation and capacity could slow down significantly: as Lu et. al pointed out, without the PTC renewable energy sources will have a much harder time being profitable.[66] If the result of the PTC expiration is a turndown in the renewable energy sector, I would expect that states with

[66] Lu, Xi, Jeremy Tchou, Michael B. Mcelroy, and Chris P. Nielsen. "The Impact of Production Tax Credits on the Profitable Production of Electricity from Wind in the U.S." Energy Policy 39, no. 7 (2011): 4212.

RPS programs will surge ahead of states without them; even if the cost of renewable generation and capacity has increased, RPS programs induce increased demand for renewable energy. States without this increased demand will have no reason to build renewable capacity and generation facilities, so they may fall behind their counterparts.

Also, RPS programs could prove to be more effective in the future because the law which is replacing the PTC is significantly different from its predecessor. The ITC favors small Wind and Solar power, as compared to Geothermal and Wind power. Small wind potential is not great enough to allow electricity suppliers to rely on the technology to meet their RPS requirements.[67] Although solar energy has come a long way in the past decade, it is still proven to be uneconomical: solar PV panels produce electricity at roughly 3-6 times higher than current (2015) market prices.[68] Also the ITC only subsidizes the initial capital cost of building a renewable energy power plant- it does not subsidize the electricity which is generated from that plant as the PTC did. Given this host of reasons, it is supposed that the ITC will have a significantly smaller impact on the renewable energy sector then the PTC did. Therefore the potential effect of RPS programs could become even more pronounced.

Given that the PTC was not extended, and the ITC is expected to be less effective, a national RPS program could be a viable solution for increasing renewable energy generation & capacity in the U.S. However, this policy would be a double edged sword, as forcing utilities to use or create more renewable energy power plants without the presence of subsidies (such as the PTC) could easily lead to an increase in the cost of electricity across the United States. Therefore, even though a national RPS program might be effective in increasing renewable energy generation and capacity, the results of this analysis show that the U.S. has already had a policy which effectively increased renewable energy even more so

---

[67] Wilson, Alex. "Wind Power: Why It Doesn't Make Sense Everywhere." Building Green. February 6, 2013. Accessed March 10, 2015.
[68] "Make Solar Energy Economical." National Academy of Engineering. 2015. Accessed April 12, 2015.

than state RPS programs could- the PTC. Therefore, decision makers such as Sentaor Udall should focus on a policy that has been proven to be effective- namely a large dollar for dollar tax incentive such as the PTC, instead of focusing on an RPS scheme which has not proven to be effective in the United States.

Bibliography

"About Population Estimates." U.S. Census Bureau. March 23, 2013. Accessed May 31, 2015.

"Advancing American Energy." The White House. November 14, 2013. Accessed May 13, 2015.

Barbose, Galen. "Renewables Portfolio Standards in the United States: A Status Update ." Lecture, 2012 National Summit on RPS from Clean Energy States Alliance, Washington, D.C., December 3, 2012.

Brandt, Jaclyn. "Is It Finally the Year for a National Renewable Electricity Standard?" FierceEnergy. May 18, 2015. Accessed May 31, 2015.

Carley, Sanya. "State Renewable Energy Electricity Policies: An Empirical Evaluation Of Effectiveness." Energy Policy 37, no. 8 (2009): 3078.

Chen, Cliff, Ryan Wiser, and Mark Bolinger. "Weighing the Costs and Benefits of Renewables Portfolio Standards:A Comparative Analysis of State-Level Policy Impact Projections." Lawrence Berkely National Laboratory, no. LBNL-61580 (2007) Accessed April 12, 2015.

Chupka, Marc W. "Designing Effective Renewable Markets." The Electricity Journal 16, no. 4 (2003): 46-57.

Center for Climate and Energy Solutions, *Clean Energy Standards.* Vermont, 2011.

"Electric Power Detailed State Data." Energy Information Administration. February 3, 2015. Accessed May 31, 2015.

"FAQ- Electricity." Energy Information Administration. February 20, 2015. Accessed May 31, 2015.

"FAQ- Capacity." Energy Information Administration. March 30, 2015. Accessed April 15, 2015.

"FAQ- Capacity & Generation." Energy Information Administration. March 30, 2015. Accessed May 31, 2015.

"Fossil Fuels." Environmental and Energy Study Institute. 2014. Accessed May 31, 2015.

"Glossary." Energy Information Administration. 2015.

"Gross Domestic Product by Industry." Bureau of Economic Analysis. April 22, 2014. Accessed May 31, 2015.

Hinsdale, Jeremy. "Extreme Oil - 1930-1974." PBS. 2004. Accessed May 31, 2015.

Lu, Xi, Jeremy Tchou, Michael B. Mcelroy, and Chris P. Nielsen. "The Impact of Production Tax Credits on the Profitable Production of Electricity from Wind in the U.S." Energy Policy 39, no. 7 (2011). Accessed May 15, 2015.

"Make Solar Energy Economical." National Academy of Engineering. 2015. Accessed April 12, 2015.

"MapSearch." National Renewable Energy Laboratory. 2014. Accessed April 17, 2015.

Morris, Craig, and Martin Pehnt. "German Energy Transition." The German Energiewende. 2014. Accessed May 31, 2015.

Michaels, Robert J., Intermittent Currents: The Failure of Renewable Electricity Requirements (October 30, 2007). Accessed April 19, 2015.

National Energy Act, *1978*, Pub. L. 95-617, 95th Congress, 1st session. (Nov. 9) U.S. Government Publishing Office

“Population Estimates- 1990s: State Tables”. U.S. Census Bureau. January 2014. Accessed May 20, 2015.

“Population Estimates- 2000s:State Tables” U.S. Census Bureau, January 2014. Accessed May 20, 2015.

“Population Estimates – 2010s: State Tables: U.S. Census Bureau, January 2014. Accessed May 20, 2015.

"President Bush's State of the Union Address." Washington Post. January 31, 2006.

"Production Tax Credit for Renewable Energy." Union of Concerned Scientists. December 1, 2014. Accessed May 31, 2015.

“Programs." Database for State Incentives for Renewables & Efficiency. 2015. Accessed April 14, 2015.

"Regional Data." Bureau of Economic Analysis. February 3, 2015. Accessed May 31, 2015.

Regulatory Assistance Program. *Electricity Regulation in the US: A Guide*. Vermont: RAP, 2011.

"Renewable Electricity Futures Study." National Renewable Energy Laboratory. 2014. Accessed May 31, 2015.

"Renewable Energy Sources - Energy Explained." Energy Information Administration. March 27, 2015. Accessed April 16, 2015.

Renewable Energy. Dictionary.com. Dictionary.com Unabridged. Random House, Inc. http://dictionary.reference.com/browse/Renewable Energy (accessed: May 31, 2015).

"Renewable Portfolio Standards." National Renewable Energy Laboratory. September 8, 2014. Accessed May 20, 2015.

"Senator Udall Introduces Renewable Electricity Standard Bill." Renewable Energy World. February 17, 2009. Accessed May 31, 2015.

Sherlock, Molly. "The Renewable Electricity Production Tax Credit: In Brief." Congressional Research Service, 7-5700, 2014, 1-12.

Sullivan, Logan, Bird and Walter Short, *Comparative Analysis of Three Proposed Federal Renewable Electricity Standards*. Colorado: National Renewable Energy Laboratory 2009.

"U.S. Renewable Energy Potential." Rocky Mountain Institute. 2011. Accessed May 31, 2015.

Wilson, Alex. "Wind Power: Why It Doesn't Make Sense Everywhere." Building Green. February 6, 2013. Accessed March 10, 2015.

Appendix A- Figures & Tables

Figure 2 - Total Net Electricity Generation (million Mwh)

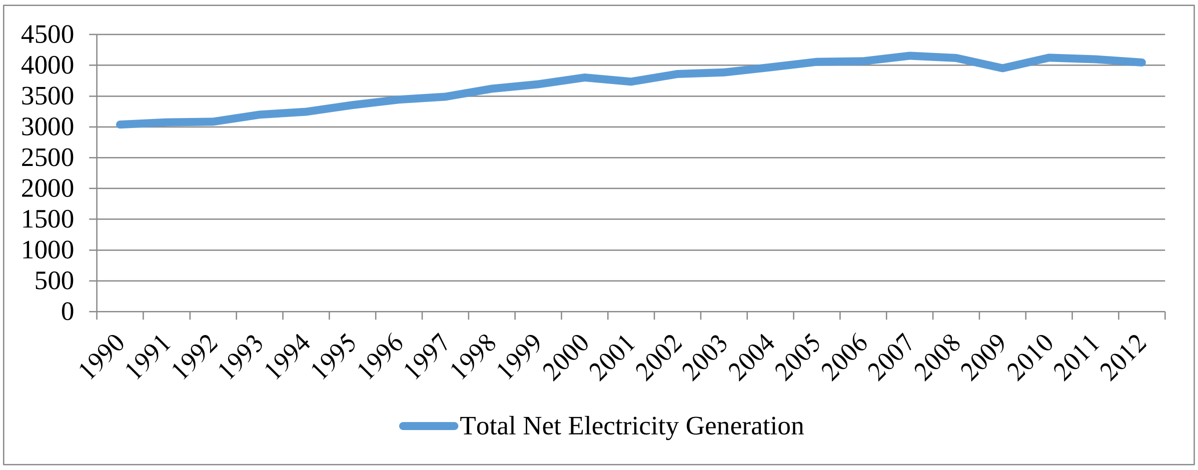


Figure 3- Net Generation by Type (%)

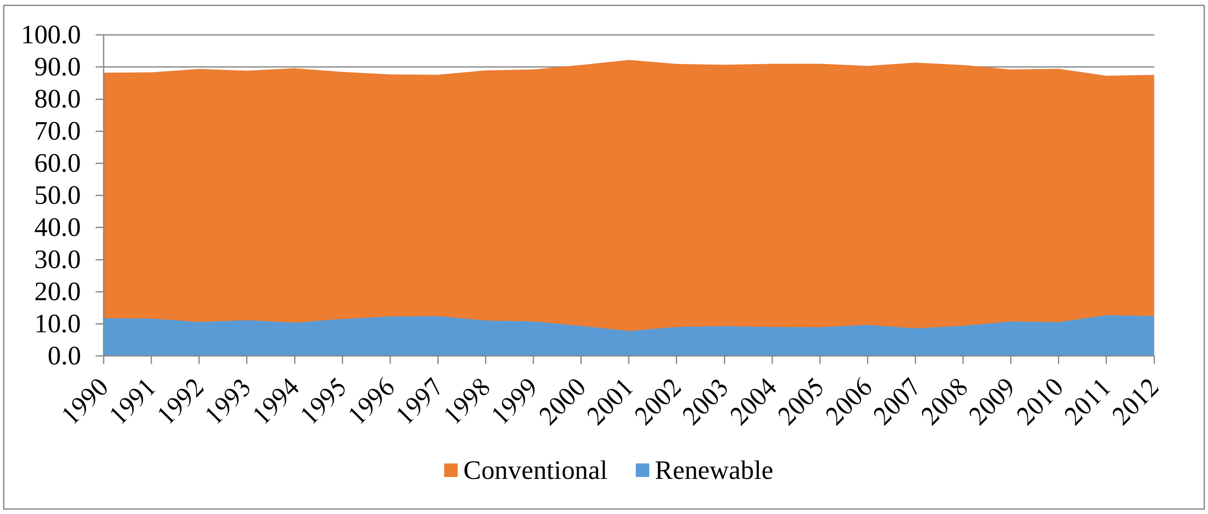


Figure 4- Net Generation (100,000 Mwh)

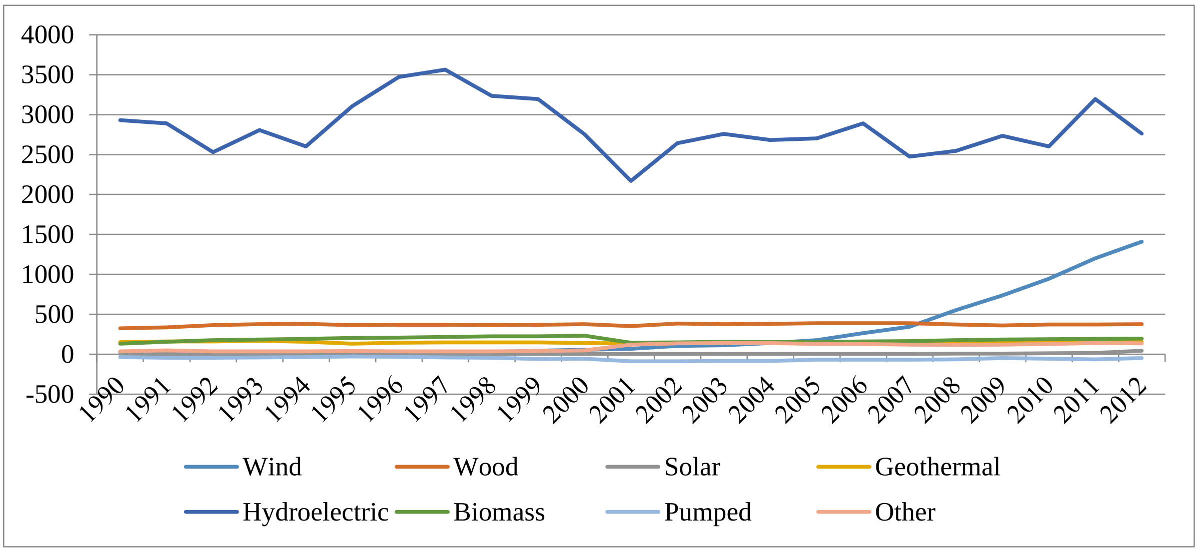


Figure 5- Total Nameplate Capacity

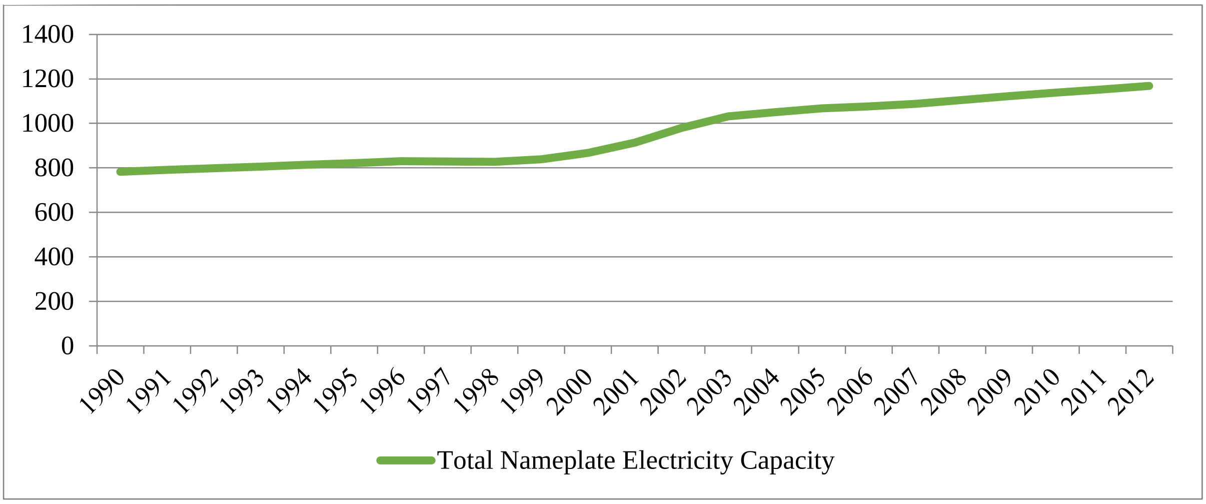


Figure 6 - Capacity by Type (%)

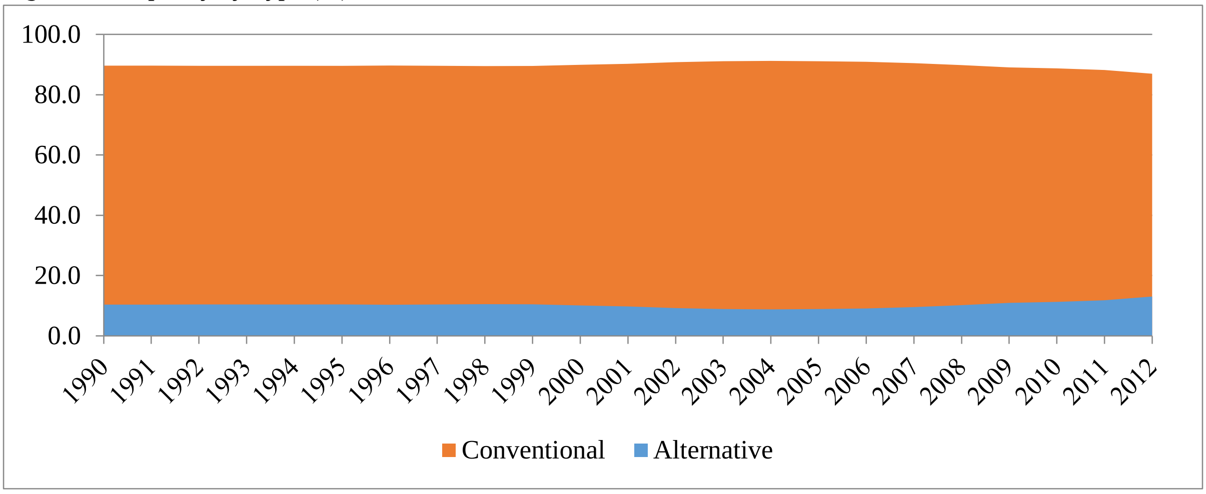


Figure 7 - Capacity (1,000 MW)

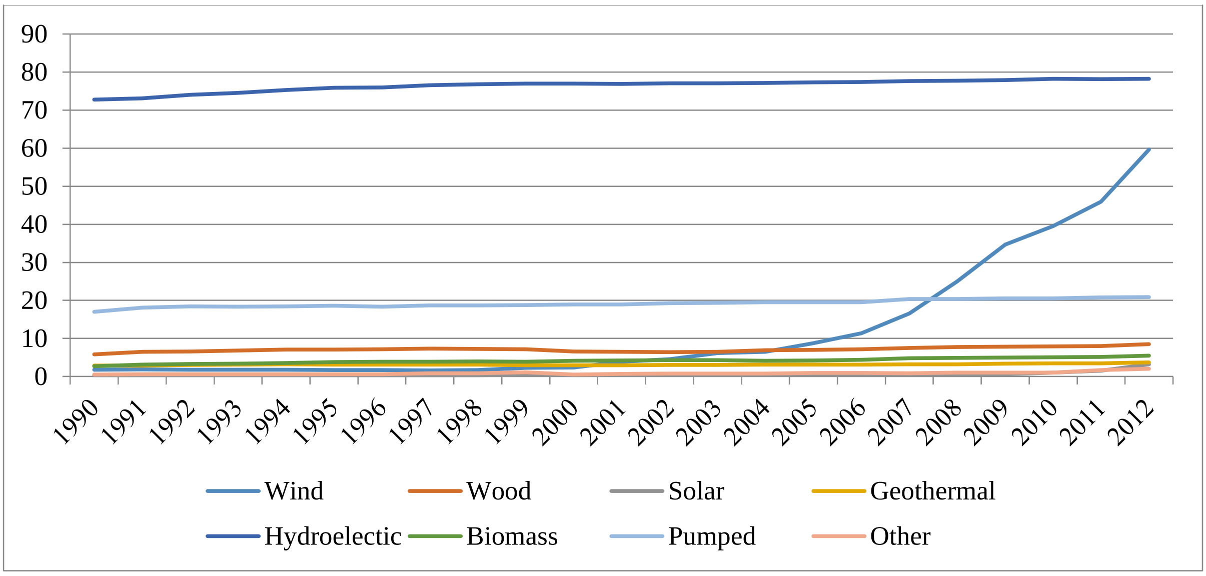


Table 2 - EIA Energy Classification

	Type of Energy	Definition	Generation description
Conventional	Coal	Includes anthracite, bituminous coal, subbituminous coal, lignite, waste coal, and synthetic coal	Coal is burned to convert water to steam, which drives turbines.[69]
	Natural Gas	All natural gas	Natural gas is burned, increasing its pressure which drives turbines. The excess heat is used to convert water to steam, which drives additional turbines.[70]
	Nuclear	All nuclear power	Radioactive elements are allowed to react, generating heat to convert water to steam, driving turbines.[71]
	Other Gasses	Includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels	Gas is burned, increasing its pressure which drives turbines. The excess heat is used to convert water to steam, which drives additional turbines.[72]
	Petroleum	Includes distillate fuel oil, residual fuel oil, jet fuel, kerosene, petroleum coke, and waste oil.	Petroleum is burned, creating heat which converts water to steam and driving turbines.[73]
Renewable	Pumped Storage	All types of pumped storage	A type of hydroelectric power, where water stored in a reservoir is released into a tunnel, driving a turbine to generate. When demand is low, this process is reversed.[74]
	Geothermal	All geothermal power	Generation of electricity by harnessing steam, from reservoirs of hot water below the surface of the earth, to drive turbines[75]
	HydroElectric	All hydroelectric power (small & large)	Generation of electricity by harnessing the kinetic energy of flowing water to spin turbines
	Other	Includes non-biogenic municipal solid waste, batteries, chemical,s hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, and other misc. technologies	Municipal solid waste (garbage) and the variety of other components in this category are burned to create heat, which converts water to steam and drives turbines [76]
	Other Biomass	Includes biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, other biomass solids, other biomass liquids, and other biomass gasses	Municipal solid waste (bio-genic garbage) and the variety of other components in this category are burned to create heat, which converts water to steam and drives turbines. [77]
	Solar	Thermal panels and Photovoltaic panels (PV)	Thermal panels use solar energy to heat water for heating or washing. PV panels use solar energy to knock electrons loose from a charged semiconductor, which is then picked up electrical contacts, creating current.[78]
	Wind	All wind (small & large)	Turbines use the kinetic energy of wind to spin a turbine.[79]
	Wood & Wood products	Includes paper pellets, railroad ties, utility poles, wood chips, bark, red liqueur, sludge wood, spent sulfite liquor, and black liquor, with other wood waste solids and wood-based liquids	The wood is burned, creating heat which converts water to steam, driving turbines.[80]

[69] https://www.edfenergy.com/energyfuture/coal-generation
[70] http://www.edfenergy.com/energyfuture/generation-gas
[71] http://www.edfenergy.com/energyfuture/nuclear
[72] http://www.edfenergy.com/energyfuture/generation-gas
[73] http://www.edfenergy.com/energyfuture/oil-generation
[74] https://www.duke-energy.com/about-energy/generating-electricity/pumped-storage-how.asp
[75] http://www.renewableenergyworld.com/geothermal-energy/tech/geoelectricity.html
[76] http://www.epa.gov/cleanenergy/energy-and-you/affect/municipal-sw.html
[77] http://www.epa.gov/cleanenergy/energy-and-you/affect/municipal-sw.html
[78] http://www.edfenergy.com/energyfuture/solar-generation
[79] http://www.edfenergy.com/energyfuture/generation-wind
[80] http://www.wbdg.org/resources/biomasselectric.php

Table 5 - Generation & Capacity

* $p<0.05$; ** $p<0.01$	Renewable Generation as % of Total	Renewable Generation as % of Total	Renewable Capacity as % of Total	Renewable Capacity as % of Total
Mandatory RPS	0.009	-0.000	0.002	-0.008
	(1.35)	(0.02)	(0.20)	(0.67)
Voluntary RPS	0.033	0.018	0.032	0.017
	(1.98)	(1.21)	(1.16)	(0.64)
GDP	-0.000	0.000	0.000	0.000
	(1.86)	(1.58)	(0.03)	(1.27)
Population	-0.000	-0.000	-0.000	-0.000
	(0.68)	(0.15)	(1.00)	(0.78)
Year1991		-0.002		0.001
		(0.96)		(1.09)
Year1992		-0.008		0.003
		(2.36)*		(1.50)
Year1993		-0.003		0.005
		(0.67)		(1.86)
Year1994		-0.006		0.002
		(1.59)		(0.56)
Year1995		0.005		0.001
		(0.76)		(0.31)
Year1996		0.007		-0.002
		(1.32)		(0.41)
Year1997		0.007		0.000
		(1.13)		(0.01)
Year1998		-0.011		-0.012
		(1.22)		(0.88)
Year1999		-0.018		-0.014
		(2.13)*		(0.99)
Year2000		-0.029		-0.020
		(3.13)**		(1.30)
Year2001		-0.048		-0.025
		(3.99)**		(1.54)
Year2002		-0.033		-0.030
		(3.24)**		(1.79)
Year2003		-0.036		-0.033
		(3.09)**		(1.87)
Year2004		-0.039		-0.035
		(3.13)**		(1.85)
Year2005		-0.039		-0.034
		(2.95)**		(1.68)
Year2006		-0.034		-0.034
		(2.53)*		(1.59)
Year2007		-0.042		-0.030
		(2.93)**		(1.40)
Year2008		-0.036		-0.024
		(2.34)*		(1.08)
Year2009		-0.020		-0.014
		(1.35)		(0.62)
Year2010		-0.020		-0.009
		(1.31)		(0.42)
Year2011		0.002		-0.004
		(0.12)		(0.19)
Year2012		-0.002		0.005
		(0.10)		(0.22)
Constant	0.161	0.127	0.172	0.141
	(14.26)**	(8.05)**	(11.10)**	(5.32)**
R^2	0.03	0.18	0.03	0.13
N	1,173	1,173	1,173	1,173

* *p*<0.05; ** *p*<0.01	Renewable Generation % of total, yearly change	Renewable Capacity % of total, yearly change	Renewable Generation % of total, yearly change	Renewable Capacity % of total, yearly change
Mandatory RPS	0.007	0.004	-0.002	-0.003
	(3.60)**	(1.82)	(0.75)	(1.00)
Voluntary RPS	0.014	0.011	0.005	0.004
	(1.57)	(2.70)**	(0.62)	(1.11)
GDP	-0.000	0.000	0.000	0.000
	(1.43)	(0.44)	(0.87)	(0.79)
Population	0.000	-0.000	-0.000	-0.000
	(0.57)	(0.29)	(0.55)	(1.50)
Year1992			-0.003	0.001
			(0.61)	(0.69)
Year1993			0.008	0.001
			(1.90)	(0.51)
Year1994			-0.000	-0.003
			(0.03)	(1.75)
Year1995			0.014	-0.002
			(2.04)*	(1.00)
Year1996			0.005	-0.003
			(0.86)	(1.80)
Year1997			0.003	0.001
			(0.64)	(0.57)
Year1998			-0.009	-0.002
			(1.42)	(0.58)
Year1999			-0.006	-0.003
			(1.51)	(1.32)
Year2000			-0.010	-0.007
			(1.89)	(1.29)
Year2001			-0.017	-0.007
			(2.32)*	(1.99)
Year2002			0.015	-0.007
			(2.76)**	(2.37)*
Year2003			-0.002	-0.004
			(0.29)	(1.49)
Year2004			-0.003	-0.002
			(0.54)	(0.93)
Year2005			0.001	-0.001
			(0.31)	(0.47)
Year2006			0.006	-0.001
			(1.44)	(0.25)
Year2007			-0.008	0.002
			(1.41)	(0.73)
Year2008			0.007	0.004
			(1.21)	(1.03)
Year2009			0.016	0.007
			(3.50)**	(2.11)*
Year2010			0.000	0.003
			(0.08)	(1.07)
Year2011			0.023	0.004
			(4.17)**	(1.32)
Year2012			-0.002	0.009
			(0.42)	(2.01)
Constant	0.001	-0.000	-0.005	0.001
	(0.32)	(0.19)	(0.87)	(0.29)
R^2	0.01	0.03	0.10	0.10
N	1,122	1,122	1,122	1,122

Appendix B- State RPS Descriptions

Table 3- Yearly Change of Renewable Percentage of Total

Mandatory RPS							Voluntary RPS			
State	Dsire Page	State Webpage	Year Enacted	Goal Year	Goal %	Investor-Owned Utility	Retail Supplier	Local Government	Cooperative Utilities	Types of Energy Covered
Arizona	http://programs.dsireusa.org/system/program/detail/268	http://www.azcc.gov/divisions/utilities/electric/environmental.asp	2006	2025	15%	x	x			Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Geothermal Heat Pumps, Combined Heat & Power, Landfill Gas, Wind (Small), Hydroelectric (Small), Geothermal Direct-Use, Anaerobic Digestion, Fuel Cells using Renewable Fuels
California	http://programs.dsireusa.org/system/program/detail/840	http://www.cpuc.ca.gov/renewables	2002	2015 2020	20% 30%	x		x		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Colorado	http://programs.dsireusa.org/system/program/detail/133	http://www.dora.state.co.us/PUC/rulemaking/RenewableEnergyStandard.htm	2004	2020	Dependent on type of Utility	x (30%)	>100,000 (20%) <100,000 (10%)	>40,000 (10%)		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels Recycled Energy, Coal Mine Methane (if the PUC determines it is a greenhouse gas neutral technology), Pyrolysis of Municipal Solid Waste (if the Commission determines it is a greenhouse gas neutral technology)
Connecticut	http://programs.dsireusa.org/system/program/detail/195	http://www.ct.gov/dpuc/cwp/view.asp?a=3354&q=415186	2006	2020	27%	x	x	x		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Tidal,

										Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Delaware	http://programs.dsireusa.org/system/program/detail/1231	http://depsc.delaware.gov/electric/delrps.shtml	2005	2025	25%	x	x	x		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Hawaii	http://programs.dsireusa.org/system/program/detail/606	http://energy.hawaii.gov/renewable-energy	2004	2020 2030	25% 40%	x				Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Geothermal Heat Pumps, Municipal Solid Waste, Combined Heat & Power, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Illinois	http://programs.dsireusa.org/system/program/detail/584	http://www.icc.illinois.gov/electricity/procurementprocess2013.aspx	2007	2015	25%	x	x			Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Wind (Small), Anaerobic Digestion Landfill Gas, Anaerobic Digestion, Biodiesel
Iowa	http://programs.dsireusa.org/system/program/detail/265		1983		105 MW	x				Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Anaerobic Digestion
Kansas	http://programs.dsireusa.org/system/program/detail/3401	http://kcc.ks.gov/energy/res.htm	2009	2020	20%	x				Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Wind (Small), Hydroelectric (Small), Fuel Cells using Renewable Fuels
Maine	http://programs.dsireusa.org/system/program/detail/452	http://www.maine.gov/energy/initiatives/efficiency_renewable.html	1999	2017	40%					Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Tidal, Fuel Cells using Renewable Fuels, Other Distributed Generation Technologies

Maryland	http://programs.dsireusa.org/system/program/detail/1085	http://webapp.psc.state.md.us/intranet/ElectricInfo/home_new.cfm	2004	2022	20%	x	x	x		Solar Water Heat, Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Geothermal Heat Pumps, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Geothermal Direct-Use, Anaerobic Digestion, Fuel Cells using Renewable Fuels
Masssachusetts	http://programs.dsireusa.org/system/program/detail/479	http://www.mass.gov/energy/rps	2003	2020	15%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Michigan	http://programs.dsireusa.org/system/program/detail/3094	http://www.michigan.gov/mpsc/0,1607,7-159-16393_53570---,00.html	2008	2015	10%	x	x	x	x	Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Combined Heat & Power, Landfill Gas, Tidal, Wave, Anaerobic Digestion Landfill Gas, Coal Fired with CCS, Gasification, Anaerobic Digestion
Minnesota	http://programs.dsireusa.org/system/program/detail/3094		2007	2020	25%	x		x		Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Municipal Solid Waste, Landfill Gas, Wind (Small), Anaerobic Digestion Landfill Gas, Co-Firing, Anaerobic Digestion
Missouri	http://programs.dsireusa.org/system/program/detail/2622	https://www.efis.psc.mo.gov/mpsc/Filing_Submission/DocketSheet/docket_sheet.asp?caseno=EX-2010-0169&pagename=case_filing_submission_rst.asp	2008	2021	15%	x				Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Montana	http://programs.dsireusa.org/system/program/detail/384		2005	2015	15%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Nevada	http://progra	http://puc.nv.gov	2001	2025	15%	x	x			Solar Water Heat, Solar Space Heat,

	ms.dsireusa.org/system/program/detail/373	/Renewable_Energy/Portfolio_Standard/								Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Solar Pool Heating, Geothermal Direct-Use, Anaerobic Digestion
New Hampshire	http://programs.dsireusa.org/system/program/detail/2523	http://www.puc.state.nh.us/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm	2007	2025	24.80%	x	x			Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Solar Pool Heating, Geothermal Direct-Use, Anaerobic Digestion
New Jersey	http://programs.dsireusa.org/system/program/detail/564	http://www.njcleanenergy.com/renewable-energy/program-activity-and-background-information/rps-background-info	1999	2020	20.45%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
New Mexico	http://programs.dsireusa.org/system/program/detail/720	http://www.nmprc.state.nm.us/utilities/renewable-energy.html	2004	2020	20%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels Zero Emission Technology
New York	http://programs.dsireusa.org/system/program/detail/93	http://www3.dps.ny.gov/W/PSCWeb.nsf/All/1008ED2F934294AE85257687006F38BD?OpenDocument	2005	2015	29%	x				Solar Water Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
North Carolina	http://programs.dsireusa.org/system/program/detail/2660	http://www.ncuc.commerce.state.nc.us/reps/reps.htm	2007	2021	12.50%	x		x	x	Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydrogen, Combined Heat & Power, Landfill Gas, Tidal, Wave, Wind (Small), Hydroelectric (Small), Anaerobic Digestion
Ohio	http://programs.dsireusa.org/system/program/detail	http://www.puco.ohio.gov/PUCO/IndustryTopics/Topic.cfm?id=100	2008	2024	25%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Combined

	/2934	39								Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Anaerobic Digestion, Fuel Cells using Renewable Fuels, Microturbines
Oregon	http://programs.dsireusa.org/system/program/detail/2594	http://www.oregon.gov/ENERGY/RENEW/Pages/RPS_home.aspx	2007	2025	25%	x	x	x		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Municipal Solid Waste, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion
Pennsylvania	http://programs.dsireusa.org/system/program/detail/262	http://www.puc.pa.gov/consumer_info/electricity/alternative_energy.aspx	2004	2020	18%	x	x			Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Geothermal Heat Pumps, Municipal Solid Waste, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels, Other Distributed Generation Technologies
Rhode Island	http://programs.dsireusa.org/system/program/detail/1095	http://www.ripuc.ri.gov/utilityinfo/res.html	2004	2019	16.00%	x	x			Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Texas	http://programs.dsireusa.org/system/program/detail/182	http://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.173/25.173ei.aspx	1999	2025	10,000 MW	x	x			Solar Water Heat, Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Geothermal Heat Pumps, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small)
Washington	http://programs.dsireusa.org/system/program/detail/2350	http://www.commerce.wa.gov/Programs/Energy/Office/EIA/Pages/default.aspx	2006	2020	15%	x		x		Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Anaerobic Digestion
Washington D.C.	http://programs.dsireusa.org/system/program/detail/303	http://www.dcpsc.org/electric/renewable.asp	2005	2020	20%	x	x			Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Fuel Cells using Renewable Fuels

West Virginia	-	-	2009 **(repealed 2015)**	2019 2024 2025	10% 15% 25%					Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Landfill Gas, Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels
Wisconsin	http://programs.dsireusa.org/system/program/detail/190	http://psc.wi.gov/utilityInfo/electric/renewableResource.htm	1999	2015	10%	x	x	x		Solar Water Heat, Geothermal Electric, Solar Thermal Electric, Solar Thermal Process Heat, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Geothermal Heat Pumps, Municipal Solid Waste, Combined Heat & Power, Landfill Gas, Tidal, Wave, Wind (Small), Hydroelectric (Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels Landfill Gas, Geothermal Electric, Solar Light Pipes, Biomass Thermal, Densified Fuel Pellets, Pyrolysis, Synthetic Gas, Biogas, Anaerobic Digestion, biodiesel, Fuel Cells using Renewable Fuels
Indiana	http://programs.dsireusa.org/system/program/detail/4832	http://www.in.gov/oed/2649.htm	2011	2025	10%	x	x	x	x	Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Geothermal Heat Pumps, Municipal Solid Waste, Combined Heat & Power, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Geothermal Direct-Use, Fuel Cells using Renewable Fuels Landfill Gas, Nuclear, Coal Bed Methane, Clean Coal, Fuel Cells using Renewable Fuels, Geothermal Direct-Use
North Dakota	http://programs.dsireusa.org/system/program/detail/2697		2007	2015	10%	x		x	x	Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Landfill Gas, Wind (Small), Anaerobic Digestion Landfill Gas, Geothermal Electric, Electricity from Waste Heat, Anaerobic Digestion
Oklahoma	http://programs.dsireusa.org/system/program/detail/4178	http://www.occeweb.com/pu/puregelectric.htm	2012	2015	15%	x		x	x	Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Municipal Solid Waste, Fuel Cells using Non-Renewable Fuels, Landfill Gas, Wind (Small), Hydroelectric

										(Small), Anaerobic Digestion, Fuel Cells using Renewable Fuels, Other Distributed Generation Technologies
South Carolina	http://programs.dsireusa.org/system/program/detail/5505		2014	2021	2%	x		x	x	Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Geothermal Heat Pumps, Combined Heat & Power, Wave, Geothermal Direct-Use, Fuel Cells using Renewable Fuels
South Dakota	http://programs.dsireusa.org/system/program/detail/2898	https://puc.sd.gov/energy/reo/SDakotaRenewableRecycledConservedReport.aspx	2008	2015	10%	x		x	x	Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Municipal Solid Waste, Combined Heat & Power, Landfill Gas, Wind (Small), Anaerobic Digestion Landfill Gas, Cogeneration, Electricity Produced from Waste Heat, Anaerobic Digestion
Utah	http://programs.dsireusa.org/system/program/detail/2901		2008	2025	20%	x		x	x	Solar Water Heat, Solar Space Heat, Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Hydrogen, Municipal Solid Waste, Combined Heat & Power, Landfill Gas, Tidal, Wave, Ocean Thermal, Wind (Small), Hydroelectric (Small), Anaerobic Digestion
Vermont	http://programs.dsireusa.org/system/program/detail/1141	http://vermontspeed.com	2005	2017	20%	x		x	x	Solar Water Heat, Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Anaerobic Digestion, Fuel Cells using Renewable Fuels
Virgina		https://www.scc.virginia.gov/pue/renew.aspx	2008	2022 2025	12% 15%	x				Geothermal Electric, Solar Thermal Electric, Solar Photovoltaics, Wind (All), Biomass, Hydroelectric, Landfill Gas, Tidal, Wave, Anaerobic Digestion