# The Effect of Renewable Portfolio Standards on State-Level Employment: An Ex Post Analysis[1]

April 28, 2016

Richard Boampong*, Colin Knapp**, and Michelle Phillips***

**Abstract**

Renewable Portfolio Standards (RPSs), programs which propose target levels of energy production or consumption that must come from renewable sources, have become a popular policy in state capitals across the United States. As of 2010, 29 states and the District of Columbia had adopted programs which fall under the RPS umbrella. RPS are often times seen as a tool to foster economic development through job growth. This paper analyzes the effects of RPSs on state level employment in the whole economy. While various studies have estimated the employment effects of RPS policies, the analyses in these papers are done ex-ante and rely on forecasting models with different choices of assumptions to predict the expected number of jobs. We use an ex-post approach which compares the actual employment of RPS states to Non-RPS states. We first test for factors that affect state adoption of RPS policies and find that a state's RPS adoption is not random and depends on characteristics such as the educational attainment of its residents, state gross product and state political party dominance. We then examine the employment effects and find that RPS adoption does not lead to a statistically significant effect on overall employment.

**Keywords:** Renewable Portfolio Standards, employment, energy production

* Economics Department, University of Florida
** Economics Department, Pennsylvania State University
*** Public Utility Research Center, University of Florida

[1] This work was supported by the Florida Energy Systems Consortium Project #0077818. The views expressed herein are solely those of the authors. They do not reflect the opinions of the University of Florida, the Public Utility Research Center, or the Florida Energy Systems Consortium. The authors would like to thank Sandy Berg, Lynne Holt, Mark Jamison, Ted Kury and participants at the 2011 FESC Summit for helpful comments on an earlier draft. All remaining errors belong to the authors.

## I. Introduction

Renewable Portfolio Standards (RPSs), programs which propose target levels of energy production or consumption that must come from renewable sources, have become a popular policy choice in many parts of the world. As of 2010, 29 states and the District of Columbia have adopted policies which fall under the RPS classification. Additional states and the federal government are continuing to consider the adoption of RPS policies. Around the world, renewable resource targets of 15 percent by 2020 and 20 percent by 2020 have been set in China and the European Union respectively[2].

The reasons often cited for the adoption of these policies include increasing the share of electricity generation from renewable sources, reducing greenhouse gas emissions and the effects of global climate change (Byrne et al., 2007; Engel, 2006; Palmer and Burtraw, 2005), increasing energy security by moving toward national energy independence[3] (Nogee et al., 2007; Haddad and Jefferiss, 1999), and creating job growth by dedicating expenditures towards industries or technologies not represented within a state's current mix of employment opportunities[4].

In this paper, we focus on the job creation claim made by RPS studies. We analyze states' RPS adoption and employment data to determine if compared to Non-RPS states, states with RPS policies have increased levels of employment. We also investigate whether a state's level of employment increases significantly after adopting RPS policies. A growing number of studies have reported positive employment effects of RPS. Chen et al. (2009) review 28 studies of state-level RPS policies and find that they all project positive employment effects. A criticism of these general studies is that they are done ex-ante, and the employment claims are projections which might be different from the actual employment effects. Kammen et al. (2004) reviewed 13 independent reports that analyze the economic and employment impacts of the clean energy industry in the United States and Europe. The authors concluded that "the renewable energy sector generates more jobs than the fossil fuel based energy sector per unit of energy delivered" (n.p). The authors also found that employment rates in the fossil fuel-related industries have been declining steadily for reasons that have little to do with environmental regulation. Thus, analysis of the employment

[2] See Martinot and Junfeng (2010) and EurActive (2011).
[3] Although a national RPS was removed prior to passage, the U.S. Congress even passed a law titled The Energy Independence and Security Act of 2007 (P.L. 110-140, H.R. 6)
[4] See Center for Energy and Environmental Policy (2005), Union of Concerned Scientists (2006), and Elles and Beck (2007). Chrissy and Beck (2007) references 10 studies with the word "Jobs" in the title.

effects of RPS policies by comparing jobs generated in the renewable energy sector to those in the fossil fuel energy sector may overstate the employment effects of RPS policies.

This study seeks to fill a gap in the existing literature by performing an ex-post analysis of the employment impacts of state-level RPS policies in the United States. Unlike the previous studies reviewed by Chen et al. (2009) and Kammen et al. (2004) which use an ex-ante analysis with employment effects generated under different assumptions and several future energy scenarios, this paper analyzes the employment effects of RPS policies by comparing the employment levels of states with RPS policies to those without RPS policies. To the best of our knowledge, this is the first paper to undertake such an ex-post analysis. Instead of estimating the employment effects of the policies on only jobs related to the renewable energy industry, we examine the employment effects on the whole economy. We are, thus, able to quantify the net employment effects of RPS policies across all sectors of the state economy. While jobs directly related to the renewable energy industry are expected to increase after the adoption of RPS policies, there are other positive multiplier effects on other sectors such as retail and food industries. There is also the loss of employment in the fossil fuel industry which ought to be taken into account. Considering employment effects in the economy instead of only the renewable energy sector therefore allows us to quantify the full employment effects of RPS policies. Further, by comparing RPS states to non-RPS states, we are able to control for changes in employment that are unrelated to RPS policies.

Our dataset contains information on RPS policies and monthly employment data in the United States for all 50 states and the District of Columbia from 1990 to 2009. First we show that a state's RPS adoption is not random and depends on characteristics such as the educational attainment of its residents, state gross product and state political party dominance. Using both a linear regression and IV estimation, we then show that there is no statistically significant employment effect of RPS policies. These findings are robust to several alternative definitions of RPS implementation and model specifications. Our results, therefore, suggest that jobs created by the policy are fully offset by job losses somewhere else in the state-level economy. This result, however, does not imply that RPS policies are ineffective. The employment claims of RPS policies are normally given as peripheral effects of RPS policies. The central reasons for the adoption of RPS policies such as reductions in greenhouse gas emissions and its effects on global climate change are still achieved with RPS policies.

The rest of this paper is organized as follows. Section II discusses the existing literature and attempts that have been made to empirically review RPS policies. Section III explains our

conceptual framework and describes the data. In section IV we examine factors that affect state adoption of RPS, while in section V we discuss the methodology and results of our study of employment effects of RPS policies. Section VI concludes.

## II. The Existing Literature

The literature covering the effect of RPS policies on employment spans both academic papers and advocacy pieces. The number of peer-reviewed, academic papers is small. Advocacy pieces are numerous and have different assumptions and conclusions on the magnitude of the employment effects of RPS. The analyses in most research papers are performed ex-ante, and conclusions are projected employment impacts instead of actual impacts. A few studies, listed below, analyze RPS effects ex-post, after the implementation of RPS policies.

### II.1. The Ex-Post Literature

The ex-post literature is limited with no papers on the effects of RPS on employment. The few papers on the ex-post effects of renewable energy policies mainly investigate cost effectiveness and program effectiveness on renewable energy generation other than employment ( e.g.,. Shrimali and Kniefel (2011) and Menz and Vachon (2006)). Menz and Vachon (2006) find that RPS adoption positively impacts wind power availability. Shrimali and Kniefel (2011) find that an RPS will increase renewable generation, but only if implemented with specific generation targets rather than a percentage of sales requirements. Several studies explore the political economy of RPS policies to identify the characteristics associated with adoption. Woerman (2009) and Lyon and Yin (2010) use multiyear, state-level demographic, political and energy market characteristics to estimate the likelihood that a state has adopted an RPS. Woerman (2009) suggests that high retail energy prices, the percentage of electricity generation from coal and Democrat-leaning state governments are positively correlated with RPS adoption while state-level unemployment and per-capita income are negatively correlated. Lyon and Yin (2010) concur with the effect of a Democrat-leaning legislature, but find no concrete evidence that unemployment affects the probability of adoption. Lyon and Yin (2010) conclude that high unemployment states are no more likely to adopt an RPS than low unemployment states, although many politicians say they support RPS policies as a way to stimulate job growth. The authors further explore the effects of poor air quality, renewable

energy potential, and organization within the renewable energy industry on adoption and find that all are positively correlated with adoption.

## II.2. The Ex-Ante Literature

The ex-ante literature focuses on forecasting the potential macroeconomic effects of an RPS, and is much larger than the ex-post literature. Ex-ante studies typically use a forecasting methodology to predict outcomes based on a series of assumptions. The typical outcome of interest is the identification of an overall effect of the policy which is stated in terms of jobs created or increased economic activity. Kammen et al. (2004) review ex-ante reports and studies that analyze the economic and employment impacts of the clean energy industry in the United States and Europe. While these studies employ a broad range of methods, they all project positive employment effects of the clean energy industry. Although the studies use different methodologies which make comparisons of the employment effects difficult, the positive effects obtained using the different methods add credence to the common finding and conclusion that the renewable energy industry leads to more jobs (Kammen et al., 2004). However, most of these studies model only one idealized scenario. Sometimes seemingly small changes to the assumptions or even small deviations from the stylized models can generate significantly different predicted effects.

Kammen et al. (2004) grouped the ex-ante studies on the employment impacts of the renewable energy industry into two main types: Analytical spreadsheet-based models and Input-Output (I-O) models. Analytical spreadsheet-based models normally calculate direct employment effects (according to Wei et al (2010), direct employment includes jobs created mainly in the renewable energy sector and jobs created in manufacturing, delivery, construction, installation, project management and operation and maintenance of the different components of the technology, or power plant under consideration). The I-O models, on the other hand, calculate both direct and indirect employment impacts. The indirect impacts measure the effects of jobs in other industries such as the fossil fuel industry and a multiplier effect on other industries such as food or department stores since the increase in income in the renewable sector allows increased spending on food and retail and helps create more jobs in the whole economy.

Until recently, most of the ex-ante literature examining the effects of RPS on employment predicted positive employment effects. The magnitude of the estimated effects, however, varied widely from study to study. For example, Nogee et al. (2007) evaluated several versions of a national RPS of 20

percent by 2020 and predicted the creation of 355,000 jobs over the status quo (no RPS). This finding equates to about 23,600 additional jobs per year. English et al. (2006) performed a similar analysis using a 25 percent RPS by 2025 assumption. Their prediction forecasts the creation of nearly 255,000 additional jobs every year for a total positive effect of 5.1 million additional jobs. Two recent studies by the same authors, Tuerck et al. (2011a) and Tuerck et al. (2011b) predict job losses. The studies analyze the adoption of RPS policies in Montana and Oregon and predict losses in each state of nearly 1,800 and 17,500 jobs, respectively.

## II.3. The "Green" Jobs Literature

Yi (2013) examines the effects of green job policies on employment using data from 361 Metropolitan areas in the United States from 2006 and finds that clean energy policies at the state level are associated with increases in green jobs. Our study differs from Yi's in that we focus solely on RPS, while Yi's study includes policies in the renewable energy[5], energy efficiency and emission sectors. Our study also examines the employment effects in the entire economy, rather than just the green energy sector. While other studies of green jobs and employment exist, they all tend to focus on forecasts or scenarios[6].

Furchtgott-Roth (2012) describes the costs associated with the creation of green jobs. The author argues that green jobs are an example of how industrial policy can be used to promote certain industries and mentions how these initiatives can result in higher costs of energy which can lead to both industries and firms moving abroad (and taking their jobs with them). Similarly, Lesser (2010) argues that RPS studies tend to ignore how mandates for purchasing electricity at above-market cost can result in a transfer of dollars from electricity consumers to the developers of renewable energy generation. Furchtgott-Roth (2012) also suggests that there may be cheaper and more effective ways of reducing man-made greenhouse gas emissions than through the promotion of green jobs.

[5] Including RPS, tax incentives, industry support, and other policies.
[6] Lehr et al (2012) contains a review of this literature.

## III. Conceptual Framework, Methodology, and Data

Conceptually we follow the ex-ante I-O model of estimating the employment effects of the renewable energy sector. Our study differs from previous studies in that we perform an ex-post analysis. When a state adopts an RPS policy, it sets a target for the amount or percentage of state generation that should come from renewable energy. Utilities set yearly objectives to increase their use of renewables. The greater use of renewable energy systems leads to innovations and jobs within the renewable energy industry, especially in manufacturing, construction and installation. This increase in employment within the renewable energy sector is termed the direct employment effect of RPS policies. The increased employment in the renewable energy sector also has a multiplier effect (the indirect effect) on other industries. First, since renewable energy is a substitute for fossil fuel energy, an increase in the use of renewable energy would reduce the use of fossil fuel and thus reduce employment in the fossil fuel industry. Further, an increase in jobs in the renewable energy industry also impacts employment in other non-energy-related industries. For example increases in employment in the renewable energy sector increase income in the renewable energy sector and people in this industry are able to spend more on food, entertainment, and hospitality, hence increasing jobs in these sectors of the economy. Some industries might experience net employment losses while other areas might experience net employment expansions. Considering the employment effects on only a select group of industries (e.g., the particular effects on the renewable energy sector) might underestimate or overestimate the employment effects of the policy. We, therefore, estimate a total employment impact of the RPS policies which includes a direct employment effect of jobs in the renewable energy sector as well as the indirect effect of RPS on other areas of the economy. We, however, do not distinguish between the type of employment or the quality of the job.

### III.1. Data

We use data on the number of people employed during each month for all states and the District of Columbia from January 1990 to December 2009. Data were also collected on each state's RPS adoption within this period and before 1990. The state-level employment data was collected from the Bureau of Labor Statistic's Local Area Unemployment Statistics (LAUS) program while the RPS adoption and other state renewable policy variables were collected from the Database of State

Incentives for Renewables & Efficiency (DSIRE) maintained by North Carolina State University[7]. The database contains detailed information on each state's renewable and energy efficiency policies. These include RPS policies, Public Benefit Funds (PBF), Green Power Purchasing Plans (GPPP), Mandatory Green Power Options (MGPO), and net metering requirements. The DSIRE database lists two dates associated with the RPS policy adoption: the date the legislature became law and the date the legislation became effective. For the purposes of this study we used the effective date.

As a means of controlling for heterogeneity in the electricity market of each state over time, we collected data on the generation mix in each state. Net generation data comes from the EIA. From 1990 to 2000, generation data by source are only available for each state on an annual basis while monthly data exists from 2001 onwards. This requires that the annual observations be replicated to fill in the missing values for the initial ten years. Generation shares were calculated using data on coal, hydroelectric, natural gas, nuclear, petroleum, and renewable energy generation sources[8]. Wei et al. (2010) calculate average job-years per gigawatt of energy produced over the expected lifespan of different types of facilities. According to their calculations, having natural gas in the portfolio, compared to other energy sources, produces the lowest number of jobs per gigawatt.

We also collected data on each state's population and gross state product from the Bureau of Economic Analysis. The state's population data contains both the actual census population figures for the years 1990 and 2000 and estimates for the other years. Since our employment data is at a monthly level, the population figures from a particular year were used as the population for each month in the year. We also collected data on state political party composition for the years 1990 through 2010 from the National Conference of State Legislatures website. This data contains information on the number of Democratic and Republican legislators in the House of Representatives and in the Senate. A variable Democratic Party dominance was calculated as a dummy variable equal to one if Democrats dominate the combined House and Senate and zero if Republicans dominate.

Finally, we collected data on educational attainment from the Census Bureau from the 1990 and the 2000 Census of Population and yearly estimates of educational attainment from the American Community Survey for the years 2006 through 2009. Specifically, we collected data on the percent of persons over 25 who have completed a Bachelor's degree or an Advanced degree. The 1990 data

[7] The database can be assessed at www.dsireusa.org
[8] Renewable is defined to include energy derived from biomass, geothermal, solid state gases, solar, wind, and wood pulp.

were imputed for the years 1991 through 1999 for which there is no information on educational attainment. Also the 2000 educational attainment information was imputed for the years 2001 through 2005. Summary statistics for the data used in this paper are available in Tables 1 through 4.

## IV. Factors that affect a state's adoption of RPS policies

Our first empirical methodology tests factors that affect a state's adoption of RPS policies. Let $RPS_i$ be a binary indicator variable of whether a state has ever participated in an RPS policy. $RPS_i = 1$ if a state has ever had an RPS policy and $RPS_i = 0$ for states with no RPS policies. Based on the different effects found in the RPS adoption literature, we expect RPS adoption to depend on socio-economic factors, political factors, and environmental factors. The equation we seek to estimate is therefore of the form:

$$RPS_i = \beta X_{it} + d_t + \varepsilon_i \qquad (1)$$

Where $X_{it}$ is a vector of state characteristics at time t. These include the state population, Gross State Product (GSP), percentage of residents with at least a Bachelor's degree, percent of coal in the electricity generation mix and others. We also include state Democratic party dominance, as a dummy variable equal to 1 if Democrats dominate the combined Senate and House of Representatives and zero otherwise. $d_t$ is a vector of year fixed effects while $\varepsilon_i$ is the independent and identically distributed idiosyncratic error which is assumed to have a logistic distribution. $\beta$ is a vector of coefficients of interest representing the effects of each factor on the probability of participating in an RPS policy. Table 5 presents the results of the regression from equation (1).

Column (I) shows the values of the coefficients obtained in the logistic regression while the values in column (II) show the average marginal effects of the regression. The table shows that all the variables in the regression have statistically significant effects on RPS adoption. Gross State Product (GSP), Democratic party dominance, percent of a state's populace with a Bachelor's degree, and the percentage of coal in the state's generation mix all increase RPS adoption. Percentage of natural gas and the percentage of hydroelectric in the generation mix, on the other hand, reduce the probability of RPS adoption. Presumably, a state with a high proportion of coal in its generation mix is driven by environmental concerns to adopt RPS policies while states with high percentages of natural gas or hydroelectric already have a high percentage of renewable energy resources in their energy

generation mix which may deem RPS policies unnecessary. Our results also show that bigger states, as defined by gross state product, are more likely to adopt RPS policies. This finding supports the results of several papers in the literature in which a state residents' preferences for environmental quality is found to be positively correlated with societal affluence (Huang et al., 2007; Verbeke and De Clercq, 2006).

## V. Employment Effects of RPS Policies

In section V.1 we examine the effects of RPS policies on employment using a graphical analysis, followed by an OLS regression in section V.2. and an Instrumental Variable (IV) estimate to account for the possibility of endogeneity in section V.3.

## V.1. Graphical Analysis of the Employment Effects of RPS policies

Figure 1 provides a graphical analysis of the effects of RPS policies on state level employment. The figure shows the average employment for all states that have participated in RPS policies against states that have never participated in RPS policies. Irrespective of when a state adopted RPS, a state is considered an RPS state if it had ever participated in an RPS policy and a Non-RPS state if it had never participated in an RPS policy. The figure compares the trend of monthly employment for RPS states and non-RPS states. The two lines seem parallel with no significant differences. Particularly, there is no significant difference in employment between the two types of states even after the year 2004 (vertical dotted line in the graph) which is both the median year and the modal year of RPS adoption.

The graph, therefore, suggests that there is no or little employment effects of RPS policies. This suggestion is contrary to the conclusion of most of the ex-ante literature which predicts positive and often high employment effects.

## V.2. The Employment Effects of RPS: OLS Estimation

The graph above compares the average employment of states with RPS to states without RPS without controlling for any other factors that might affect employment or RPS adoption. In Table 6

we estimate the effects of RPS adoption on employment while controlling for these factors. We apply OLS estimation to the equation below:

$$logy_{it} = \beta_0 + \beta_1 RPS_{it} + \beta_2 X_{it} + \alpha_i + d_t + \varepsilon_{it} \quad (2)$$

where $y_{it}$ is the number of workers employed in state i in month t, $RPS_{it}$ is an indicator variable for whether state i has an RPS policy in month t. $X_{it}$ is a vector of other control variables which includes GSP, population, percent of the population with a Bachelor's degree, percent of state's electricity generation from coal, renewable sources, hydroelectric and nuclear. $\alpha_i$ represents state fixed effects which control for unobservable time-invariant differences in employment that are specific to each state. $d_t$ represents year fixed effects and controls for unobservable differences in employment across years. The results of the OLS estimation of equation (2) are given in column I of Table 6. The results show no statistically significant effects of RPS policies on state level employment.

## V.3. The Employment Effects of RPS: IV Estimation

There is a concern that RPS adoption may be correlated with some unobserved characteristics that also affect the employment level in a state. For example, we would expect big states with high numbers of employed residents to be more likely to adopt RPS policies. Similarly, states with favorable consumer attitudes and perceptions toward green products are expected to be more likely to adopt RPS policies. Green attitudes by consumers are correlated with income levels which may also be related to the employment in a particular state. Therefore, there is reason to believe that RPS adoption may be endogenous. We address this by performing an IV estimation, using Democratic Party dominance, a dummy variable equal to one if Democrats dominate the House and Senate and zero otherwise, as an instrument for RPS adoption.

From both Table 5 and the literature (Huang et al., 2007; Fowler and Breen, 2013), this variable has been found to affect RPS adoption but has little or no effect on employment. Column II of Table 6 shows the IV estimation of the effects of RPS adoption on state level employment using Democratic Party dominance as an instrument for RPS adoption. Similar to the OLS results in column I, the results show no statistically significant effects of RPS adoption on state level employment. Other common estimates from the two columns are the effects of GSP and Population on employment. State's GSP and population, as expected, have positive effects on employment. A 1% increase in GSP

is expected to increase the number of people employed in a state by 0.19% while a 1% increase in the population increases the number of people employed by 0.7%. Also the percent of renewable energy in the electricity generation mix has no statistically significant effect on employment.

## VI. Conclusion

Despite what appears to be a nearly unanimous conclusion in previous studies that RPS policies create jobs over time, this study finds no support for the notion and finds evidence that RPS policies have no statistically significant effects on employment. Two reasons may account for the difference in findings. First, in contrast with this study's ex-post approach, prior studies assessing the impact on job creation are ex-ante in their methodology. As such, they rely on forecast models to predict the employment effects of the policy. The outputs of forecasting models are sensitive to an analyst's choice of assumptions. Second, it is apparent that earlier studies failed to adequately consider the net impacts on employment, namely that creating jobs in one sector draws at least some resources from other sectors, causing a decrease in employment in the latter sectors or that the increased employment in one sector may lead to a multiplier effect of jobs in other sectors as incomes increase. To date, too much of the focus has been on just the creation of green jobs as an added benefit of adopting RPS policies. Costs must come with those benefits. This paper suggests those costs may be in the form of lost "brown" jobs.

There is little evidence to suggest that the overall number of jobs will be positively affected by the adoption of an RPS. Whether this topic should continue to be part of the lexicon used in the debate over RPS policies is a reasonable question. Further research is needed to better inform the decision-making process as it concerns RPS. This will help insure the debate is better framed.

The job dynamics resulting from adoption and implementation of RPS policies are complex. It is undeniable that dedicating more resources to an endeavor will increase the prevalence of that endeavor. This study does not rule out the possibility that increases in green jobs may occur and stimulate job growth in some industries. Identifying growth related industries will require breaking the employment data down into finer detail and balancing these positive effects with the costs. This will require greater detail about the wages, skills, and locations of such jobs. It will also necessitate more robust methods for modeling the variation between state-level RPS policies at the finest level of detail. Both advances will ultimately lead to a better understanding of the trade-offs made clearer

in this paper. From a regulatory perspective, it is important to determine how costly the implementation of new rules will be.

It is often assumed that incentivizing green jobs will promote economic development by creating new jobs. For instance, according to Yi (2013), RPS legislation in Texas emphasized job creation and energy supply diversity, rather than its impact on climate change. The main result of this paper is that the adoption of an RPS policy has no significant effect on employment, suggesting that such claims need to be reevaluated. The increase in green jobs is presumably matched by a decrease in jobs in other sectors so that there is no net employment effect. This does not, however, imply that RPS policies are ineffective. Commonly cited reasons for the adoption of renewable portfolio standards such as increasing the share of electricity generation from renewable sources, reducing greenhouse gas emissions and the effects of global climate change, and increasing energy security, have been found to have an effect in the literature (Byrne et al., 2007; Engel, 2006; Haddad and Jefferiss, 1999 Nogee et al., 2007; Palmer and Burtraw, 2005). However, it is important to note that if a policymaker's goal is to, for example, reduce greenhouse gas emissions, having a better understanding of the costs and benefits of policies such as RPS is important in achieving the desired results using the most cost-effective approach possible.

## Tables and Figures

*Table 1: Summary Statistics (combined RPS and Non-RPS states)*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Employed | 12240 | 2603156.00 | 2814112.00 | 222638.0 | 17100000.0 |
| Gross State Product (GPS) | 12240 | 218460.30 | 276205.50 | 12952.00 | 2005756.00 |
| Democratic Party Dominance | 12240 | 0.68 | 0.47 | 0.00 | 1.00 |
| Population | 12240 | 5446826.0 | 6064963.00 | 453589.0 | 37000000.0 |
| Percent of Coal in Electricity Generation | 12240 | 47.84 | 30.93 | -0.12 | 98.73 |
| Percent of Renewables in Electricity Generation | 12240 | 2.98 | 4.23 | 0.00 | 37.20 |
| Percent of Natural Gas in Electricity Generation | 12240 | 14.51 | 20.32 | -0.02 | 99.58 |
| Percent of Hydro in Electricity Generation | 12240 | 10.79 | 20.29 | 0.00 | 94.73 |
| Percent of Nuclear in Electricity Generation | 12240 | 17.36 | 18.62 | -0.71 | 85.31 |
| Percent of Population over 25 with a Bachelor Degree or Higher | 12240 | 22.67 | 5.41 | 12.33 | 48.50 |
| Percent of Population with an Advanced Degree | 12240 | 8.08 | 2.84 | 4.50 | 28.00 |

*Table 2: Summary Statistics (Non-RPS states)*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Employed | 6000 | 1941344.0 | 1633081.0 | 222638.0 | 8730775.00 |
| Gross State Product (GPS) | 6000 | 148542.00 | 140282.70 | 12952.00 | 803205.00 |
| Democratic Party Dominance | 6000 | 0.64 | 0.48 | 0.00 | 1.00 |
| Population | 6000 | 4105146.0 | 3453639.0 | 453589.0 | 18700000.0 |
| Percent of Coal in Electricity Generation | 6000 | 52.61 | 32.08 | -0.12 | 98.73 |
| Percent of Renewables in Electricity Generation | 6000 | 2.19 | 1.98 | 0.00 | 21.12 |
| Percent of Natural Gas in Electricity Generation | 6000 | 11.33 | 16.53 | -0.02 | 64.58 |
| Percent of Hydro in Electricity Generation | 6000 | 15.87 | 26.41 | 0.00 | 94.73 |
| Percent of Nuclear in Electricity Generation | 6000 | 16.17 | 19.27 | -0.18 | 85.31 |
| Percent of Population over 25 with a Bachelor Degree or Higher | 6000 | 20.54 | 4.45 | 12.33 | 34.00 |

| | | | | | |
|---|---|---|---|---|---|
| Percent of Population with an Advanced Degree | 6000 | 7.01 | 1.74 | 4.50 | 14.10 |

*Table 3: Summary Statistics (RPS states)*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Employed | 6240 | 3239513.00 | 3484896.00 | 261297.00 | 17100000.00 |
| Gross State Product (GPS) | 6240 | 285689.50 | 348586.40 | 15355.00 | 2005756.00 |
| Democratic Party Dominance | 6240 | 0.72 | 0.45 | 0.00 | 1.00 |
| Population | 6240 | 6736903.00 | 7569276.00 | 519000.00 | 37000000.00 |
| Percent of Coal in Electricity Generation | 6240 | 43.25 | 29.05 | 0.00 | 98.26 |
| Percent of Renewables in Electricity Generation | 6240 | 3.74 | 5.49 | 0.00 | 37.20 |
| Percent of Natural Gas in Electricity Generation | 6240 | 17.56 | 22.99 | 0.00 | 99.58 |
| Percent of Hydro in Electricity Generation | 6240 | 5.90 | 9.38 | 0.00 | 66.25 |
| Percent of Nuclear in Electricity Generation | 6240 | 18.50 | 17.90 | -0.71 | 66.47 |
| Percent of Population with a Bachelor Degree or Higher | 6240 | 24.72 | 5.47 | 15.28 | 48.50 |
| Percent of Population with an Advanced Degree | 6240 | 9.10 | 3.29 | 5.20 | 28.00 |

*Table 4: RPS adoption years*

| RPS Adoption year | Number of States | Percent | Cum. Percent |
|---|---|---|---|
| 1983 | 1 | 3.85 | 3.85 |
| 1996 | 1 | 3.85 | 7.69 |
| 1997 | 2 | 7.69 | 15.38 |
| 1998 | 1 | 3.85 | 19.23 |
| 1999 | 4 | 15.38 | 34.62 |
| 2002 | 2 | 7.69 | 42.31 |
| 2004 | 6 | 23.08 | 65.38 |
| 2005 | 2 | 7.69 | 73.08 |
| 2006 | 1 | 3.85 | 76.92 |
| 2007 | 4 | 15.38 | 92.31 |
| 2008 | 1 | 3.85 | 96.15 |
| 2009 | 1 | 3.85 | 100 |

| | | |
|---|---|---|
| Total | 26[9] | 100 |

*Table 5: Factors affecting state adoption of RPS*

| RPS | I | II |
|---|---|---|
| log (GSP) | 0.3769*** | 0.0433*** |
| | (17.75) | (18.33) |
| Democratic Party Dominance | 0.2582*** | 0.0296*** |
| | (4.19) | (4.25 ) |
| Percent of Population over 25 with a Bachelor's Degree | 0.1946*** | .0223*** |
| | (33.82) | (40.41) |
| Percent of Coal in Electricity Generation | 0.0125*** | 0.0014*** |
| | (7.45) | (7.56) |
| Percent of Natural Gas in Electricity Generation | 0.0303*** | 0.0035*** |
| | (16.64) | (17.53) |
| Percent of Hydro in Electricity Generation | -0.0123*** | -0.0014*** |
| | (-6.04) | (-6.00) |
| Percent of Nuclear in Electricity Generation | -0.0029 | -0..0003 |
| | (-1.56) | (-1.56) |
| constant | -11.8384*** | |
| | (-34.1517) | |
| N | 12240 | 12240 |

* p<0.05, ** p< 0.01, *** p<0.001. t-statistics are in parenthesis.

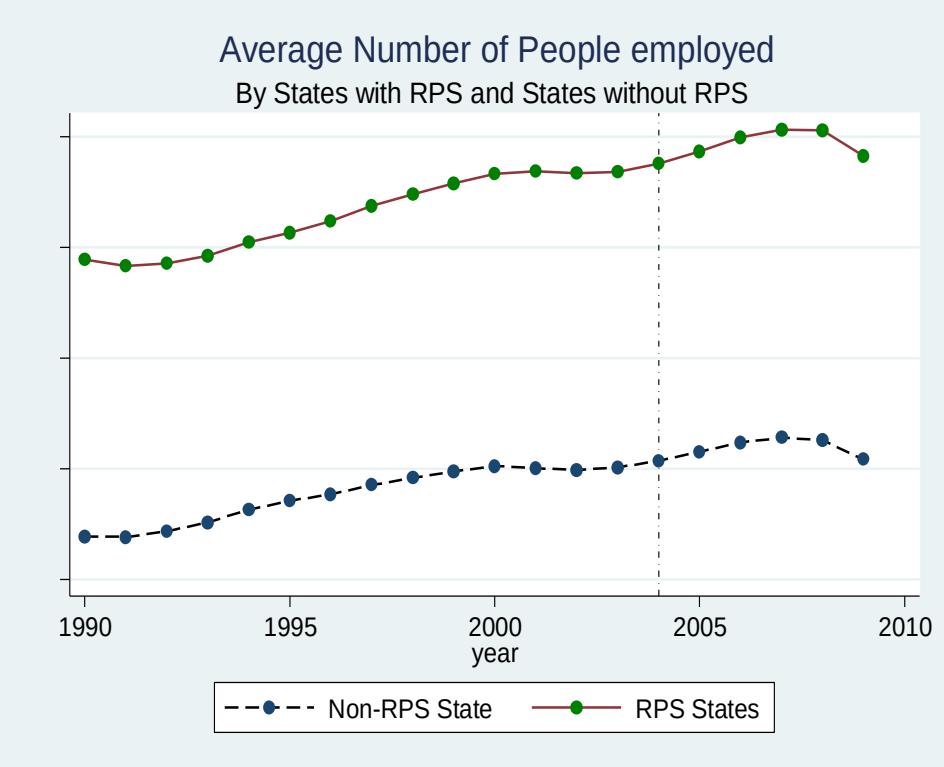
[9] While 29 states and DC had RPS policies as of 2010, Virginia, North Dakota, South Dakota, and Vermont had voluntary programs. These states were coded as not having an RPS policy. Thus, only states with mandatory RPS policies were considered as having an RPS policy.

*Table 6: Employment effects of RPS policies*

| Log(Employed) | I | II |
|---|---|---|
| RPS | 0.0004 | -0.0434 |
| | (0.0658) | (-1.3865) |
| log(GSP) | 0.1858*** | 0.1877*** |
| | (4.1270) | (4.1584) |
| Percent of Population over 25 with a Bachelor Degree | -0.0017 | 0.0016 |
| | (-0.7126) | (0.4615) |
| log(Population) | 0.6776*** | 0.6986*** |
| | (12.8683) | (12.2661) |
| Percent of Renewables in Electricity Generation | -0.0002 | -0.0007 |
| | (-0.3086) | (-0.8058) |
| Percent of Coal in Electricity Generation | 0.0001 | -0.0001 |
| constant | 1.6877** | 1.3155* |
| | (3.3874) | (2.2714) |
| N | 12240 | 12240 |
| r2 | 0.9997 | 0.9996 |

* p<0.05, ** p< 0.01, *** p<0.001. t-statistics are in parenthesis. The year and state fixed-effects are not shown.

*Figure 1: Effects of RPS on Employment*




## VII. References

Beacon Hill Institute & Cascade Policy Institute Policy Study, page 122, 2011b.

John Byrne, Kristen Hughes, Wilson Rickerson, and Lado Kurdgelashvili. American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. Energy Policy, 35(9):4555–4573, 2007.

Center for Energy and Environmental Policy. (2005) "The Potential Economic Impacts of a Renewable Portfolio Standard in Delaware". University of Delaware. Briefing Paper.

Cliff Chen, Ryan Wiser, Andrew Mills, and Mark Bolinger. Weighing the costs and benefits of state renewables portfolio standards in the united states: A comparative analysis of state-level policy impact projections. Renewable and Sustainable Energy Reviews, 13(3):552–566, 2009.

Elles, Chrissy, and Fredric Beck. (2007) "Jobs from Renewable Energy & Energy Efficiency." Environmental and Energy Studies Institute. Fact Sheet. Last accessed at http://www.eesi.org/files/EEREJobsFactSheet_11-8- 07_0.pdf on August 22, 2011.

Kirsten Engel. State and local climate change initiatives: what is motivating state and local governments to address a global problem and what does this say about federalism and environmental law. Urban Lawyer, 38:1015, 2006.

Burton C. English, Daniel G. De La Torre Ugarte, Kim Jesen, Chad Hellwinckel, Jemey Menard, Brad Wilson, Roland Roberts, and Marie Walsh. 25% renewable energy for the United States by 2025: Agricultural and economic impacts. Working Paper. 2006.

EurActive. EU renewable energy policy. http://www.euractiv.com/energy/eu-renewable-energy-policy-linksdossier-188269, 2011.

Luke Fowler and Joseph Breen. The impact of political factors on states adoption of renewable portfolio standards. The Electricity Journal, 26(2):79–94, 2013.

Diana Furchtgott-Roth. The elusive and expensive green job. Energy Economics, 34: S43-52, 2012.

Brent M Haddad and Paul Jefferiss. Forging consensus on national renewables policy: The renewables portfolio standard and the national public benefits trust fund. The Electricity Journal, 12 (2):68–80, 1999.

Ming-Yuan Huang, Janaki RR Alavalapati, Douglas R Carter, and Matthew H Langholtz. Is the choice of renewable portfolio standards random? Energy Policy, 35(11):5571–5575, 2007.

Daniel M Kammen, Kamal Kapadia, and Matthias Fripp. Putting renewables to work: How many jobs can the clean energy industry generate. RAEL Report, University of California, Berkeley, 13, 2004.

Ulrike Lehr, Christian Lutz, and Dietmar Edler. Green jobs? Economic impacts of renewable energy in Germany. Energy Policy, 358-364, 2012.

Jonathan Lesser. Renewable energy and the fallacy of "green" jobs. The Electricity Journal, pages 45-53, 2010.

Thomas P Lyon and Haitao Yin. Why do states adopt renewable portfolio standards?: An empirical investigation. The Energy Journal, pages 133–157, 2010.

Eric Martinot and Li Junfeng. Renewable energy policy update for china. Renewable Energy World, 21, 2010.

Fredric C Menz and Stephan Vachon. The effectiveness of different policy regimes for promoting wind power: Experiences from the states. Energy policy, 34(14):1786–1796, 2006.

Alan Nogee, Jeff Deyette, and Steve Clemmer. The projected impacts of a national renewable portfolio standard. The Electricity Journal, 20(4):33–47, 2007.

Karen Palmer and Dallas Burtraw. Cost-effectiveness of renewable electricity policies. Energy economics, 27(6):873–894, 2005.

Gireesh Shrimali and Joshua Kniefel. Are government policies effective in promoting deployment of renewable electricity resources? Energy Policy, 39(9):4726–4741, 2011.

D Tuerck, P Bachman, and M Head. The economic impact of montanas renewable portfolio standard. American Tradition Institute: Washington, DC, USA, page 122, 2011a.

D Tuerck, P Bachman, and M Head. The economic impact of oregons renewable portfolio standard.

Union of Concerned Scientists. (2006) "Increasing Wisconsin's Renewable Portfolio Standard Will Create Jobs and Help Stabilize Energy Bills" Fact Sheet. Last accessed August 22, 2011 at

http://www.ucsusa.org/assets/documents/clean_energy/2006-wisconsin-rps-fact-sheet-w-header.pdf

Tom Verbeke and Marc De Clercq. The income–environment relationship: Evidence from a binary response model. Ecological Economics, 59(4):419–428, 2006.

Max Wei, Shana Patadia, and Daniel M Kammen. Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the us? Energy Policy, 38(2): 919–931, 2010.

Matthew Augustine Woerman. An Econometric Analysis of the Adoption and Stringency of State Renewable Portfolio Standards. PhD thesis, The Ohio State University, 2009.

Hongtao Yi. Clean energy policies and green jobs: An evaluation of green jobs in U.S. metropolitan areas. Energy Policy, 56:644-652, 2013.

## VIII. Appendix

*Figure A: Average employment growth rate.*