# U.S. GREEN EMPLOYMENT: HOW CARBON CRAZY STATES ARE HURTING THE GREEN REVOLUTION

---

A THESIS

Presented to

The Faculty of the Department of Economics and Business

The Colorado College

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Arts

By

Sarah Tarika

May 2014

U.S. GREEN EMPLOYMENT: HOW CARBON CRAZY STATES ARE HURTING THE GREEN REVOLUTION

Sarah Tarika

May 2014

Economics

**Abstract**

This study looks at the determinants of green goods and services (GGS) employment in the U.S. and specifically how high levels of carbon dioxide (CO2) emissions negatively affects green job growth. Previous studies on political, economic, and social factors were reviewed to generate the two-year (2010-2011) empirical model. The significant results found from the OLS regression include a negative effect of CO2 emissions on GGS employment. This paper indicates significant variables that can help researchers and policy makers understand what comprises green employment.

KEYWORDS: (GGS employment, CO2 emissions, OLS regression)

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
UNAUTHORIZED AID ON THIS THESIS

_____

Signature

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

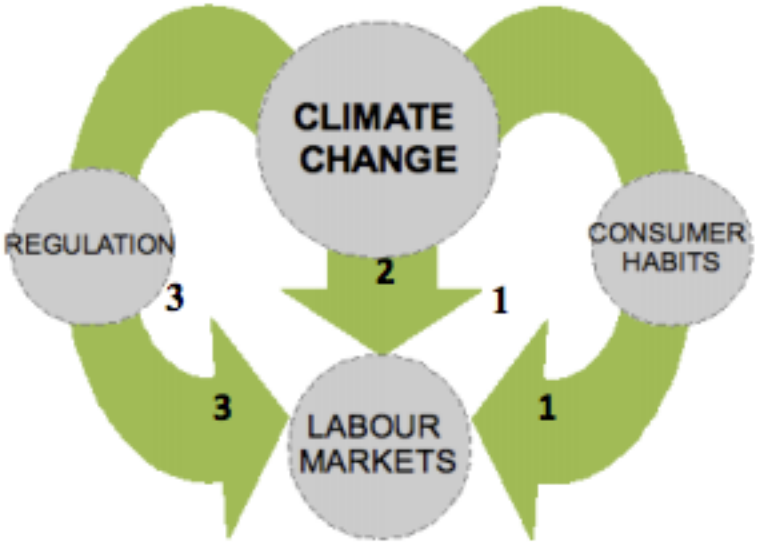
# CHAPTER I

# INTRODUCTION

Climate change concerns and fears have resulted in global action adapting and mitigating to this phenomenon. The United States of America has been criticized in its action to this crisis and in taking initiative in moderating human impact on the environment. U.S. states and cities will be impacted differently depending on their geographic location, climate, population, accessibility to resources etc. Although climate change policy should be on the forefront of U.S. governmental issues there are political, economic, and social pressures or constraints in adjusting to this looming catastrophic issue. In recent years there has been a worldwide drive to decrease carbon dioxide (CO2) emissions and reduce consumption of fossil fuels (Martinez-Fernandez, Hinojosa, & Miranda, 2010; United Nations Environment Programme, 2008). As a result there is motivation to invest in renewable energy resources and initiative in the creation of green jobs. Figure 1.1 below shows how climate change will affect labor markets and therefore employment in three ways: (1) changes in consumer habits, (2) direct impacts on environments, and (3) effects from policies (Martinez-Fernandez et al., 2010).

FIGURE 1.1

Impacts of Climate Change on Labor Markets




Source: Martinez-Fernandez, C., Hinojosa, C. & Miranda, G. (2010). *Green jobs and skills: The local labour market implications of addressing climate change.* Retrieved 4/2, 2014, from www.oecd.org/dataoecd/54/43/44683169.pdf?conte

This green employment movement is inspired by the hope that environmental improvement and conservation can happen simultaneously with economic growth and revenue (Hill, 2013). There is strong understanding that decreasing the national carbon footprint by investment in energy efficient industries and development of environmental policies will have positive contributions to economic development and employment (Yi, 2013; Wei, Patadia, & Kammen, 2010; Bezdek, Wendling, & DiPerna, 2008).

The meaning of green jobs is broad, ambiguous, and interpreted differently depending on the corporation, institution, or organization. The United States Bureau of

Labor Statistics (BLS) defines green jobs using two separate components, a process-based approach and an output-based approach (Bureau of Labor Statistics, 2012). The output occupations are ones "associated with producing goods or providing services that benefit the environment or conserve natural resources" while the process jobs are ones "in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources" (Bureau of Labor Statistics, 2012, p. 4). Both job descriptions fall into at least one of the four categories: energy from renewable sources; energy efficiency; pollution reduction and removal, greenhouse gas reduction, and recycling and reuse; and natural resources conservation (as well as environmental compliance, education and training, and public awareness for the jobs that produce green goods) (Bureau of Labor Statistics, 2012). United States companies commonly use the BLS expansive definition of green jobs; however the United Nations Environment Programme (UNEP) definition is even broader. The UNEP defines green jobs as "positions in agriculture, manufacturing, R&D, administrative, and service activities aimed at alleviating the myriad environmental threats face by humanity" (United Nations Environment Programme, 2008, p. 7). Ultimately there are inconsistencies in defining green employment, and therefore confusion on how it should be measured.

This paper discovers what contributes to the growth of green jobs in the U.S. and specifically what is incentivizing the states to create green goods and services employment. Two main questions concerning global growth of green jobs I address throughout my research and in this paper are:

1. What are the economic, political, and social factors contributing to green

goods and services employment in the 50 U.S. states?

2. Do states with higher carbon dioxide emissions levels have a lower percentage of green employment?

I hypothesize that states that emit high levels of CO2 have a lower percentage of GGS employment. Therefore a decrease in CO2 emissions would cause an increase in GGS employment. It is my assumption that U.S. states that emit higher levels of greenhouse gases (GHG) usually have little concern for climate change efforts, which will hopefully been seen in the results.

To address these questions and test the hypothesis, this paper first will discuss how a green job is measured and then will review the relevant literature on the variables contributing to green employment. Next, the data and methodology used will be discussed and a simple ordinary least squares (OLS) regression will be run to determine which factors have the largest impact on GGS employment across the 50 U.S. states. The regression analysis and results will be presented, followed by concluding remarks and recommendations for future studies on the topic.

# CHAPTER II

# LITERATURE REVIEW

Through the studies examined, I determine what factors are contributing to green employment throughout the 50 U.S. states. The literature pertaining to green goods and services employment within the U.S. is mainly addressed by government efforts, concerned researchers, and environmental protection agencies. There is disconnect in defining a green job and, therefore, the reports associated with U.S. green employment lack concrete conclusions. Due to increased levels of greenhouse gases in past years, there is initiative to create a green economy and therefore measure the number of U.S. green jobs. Also, a study on global environmental competitiveness and innovation shows that because of the wide range of green innovation across eight developed nations, "green growth concerns most, if not all, parts of a modern economy" (Fankhauser, Bowen, Calel, Dechezlepretre, Grover, Ridge, & Sato 2013, p. 907). Green jobs are a globally important topic being discussed in economic, political, and educational forums (Griswold, 2013). Since switching to a green economy is inevitable, there is need to discover what forces are contributing to this growth and employment.

The literature mainly looks at the economic and political opportunities of green jobs and has been broken down into defining green jobs, economic impacts and job opportunities from energy conservation, and government policies' potentials and

concerns. Since "policy makers increasingly place economic growth at the centre of discussions over environmental management" and perceive environmental policy to generate jobs, there is much overlap between the economic and political factors literature (Fankhauser et al., 2013, p. 902). This chapter begins by giving a background of the government efforts to define green employment. It reviews the different methods of defining a green job both domestically and internationally. The second section examines the economic benefits of renewable energy consumption and other potential contributors to green job growth. It focuses on Yi's study uncovering the main social and economic interests that are contributing to U.S. green employment. The final chapter component discusses the political factors that could determine green job growth in the states. The studies analyzed in this section primarily look at the incentives for states to adopt energy conservation policies, and then those regulations impact on green employment. Ultimately through examining this literature, I reveal what motivates the U.S. government and organizations to measure and increase green jobs, and specifically what factors determine green goods and services employment.

## Background

**Defining green jobs**. The first obstacle in determining what factors contribute to green goods and services employment, is defining a green occupation. Established government institutions, scientists, non-profit organizations, scholars, and economists have different interpretations of what a green job is. The United States Environmental Protection Agency (EPA) acknowledges that 'there is no commonly shared definition of "green jobs"' (Byrnett, 2010). This has prevented any type of movement forward in creating a clean society and in acknowledging that a green economy exists.

It is a common theme throughout the green employment literature that green jobs embody two main climate change reactions: adaptation and mitigation (Martinez-Fernandez et al., 2010; United Nations Environment Programme, 2008; Bureau of Labor Statistics, 2012). The Organisation for Economic Co-operation and Development (OECD) paper "Green jobs and skills: the local labour market implications of addressing climate change" describes green jobs as positions that "contribute to protecting the environment and reducing the harmful effects human activity has on it (mitigation), or helping to better cope with current climate change conditions (adaptation)" (Martinez-Fernandez et al., 2010, p. 21). Some literature also discusses green employment in the context of specific industry processes or products. For example the United Nations Environment Program (UNEP) describes green jobs similarly to the OECD but includes particular industries where green employment exists. The UNEP's "Background Paper on Green Jobs" defines green jobs as:

> Positions in agriculture, manufacturing, R&D, administrative, and service activities aimed at alleviating the myriad environmental threats faced by humanity. This includes jobs that help to protect and restore ecosystems and biodiversity, reduce energy consumption, decarbonize the economy, and minimize or altogether avoid the generation of all forms of waste and pollution (United Nations Environment Programme, 2008, p. 7).

These two interpretations have been accepted internationally, and are commonly used when dealing with global climate change action and policy.

When looking specifically at the United States, the Bureau of Labor Statistics (BLS) has made impressive strides to define and measure green employment. In 2010 the BLS developed a two-part definition articulating that "green jobs are either:

A. Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources.

B. Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources." (Bureau of Labor Statistics, 2012, p. 2)

The first definition covers employment in industries that generate green goods and services while the second identifies jobs related to green technologies and practices used in the industry (Bureau of Labor Statistics, 2012). These two categories both cover the output and process approach while addressing the four, main, globally acknowledged green behaviors: producing energy from renewable sources, improving energy efficiency, preventing and reducing pollution and greenhouse gases, conserving natural resources (Bureau of Labor Statistics, 2012).

After reviewing a wide range of academic, government, and business studies and coming to a conclusion in defining green jobs, the BLS constructed a survey to measure green goods and services employment. Although the survey only includes jobs in the output approach, it is the first U.S. federal system in place for measuring green jobs. The following parts of this chapter deal with the literature and empirical studies determining what political, economic, and social factors explain green goods and services employment in the U.S.

**Economic Factors**

As the U.S. continues to pull out of the recession of 2008 there is motive to increase employment rates and decrease the exploding federal debt. Consequently, "the U.S. government looked to the green economy as a source of innovation, economic growth, and skilled job creation" (Scully-Russ, 2013, p. 6). This section discusses the economic incentives and limitations for states to increase their green employment.

Reliance on the electricity industry, education level, and personal income are possible important economic determinants of green employment.

The main paper that addresses many economic explanatory variables is Hongtao Yi's study on the effect of clean energy policies on green employment in U.S. Metropolitan Areas (MSA). Some important contributors Yi examines are: population in the metropolitan area, the local carbon intensive industry, average education level, per capita income, and per capita green house gas emissions in the electricity sector (Yi, 2013). The results show that some independent variables are not significant (per capita GHG emissions and per capita income) but this could be a result of collinearity, and they should not be disregarded for future analyses. Important variables that he finds statistically significant in determining green employment in U.S. cities are population, average educational attainment, per capita GDP, unemployment and the state clean energy policy index discussed later in the policy section (Yi, 2013). As a result each of these variables is taken into account for my study, giving more attention to the empirically significant factors.

**Electricity industry.** It is a reality that current U.S. energy consumption is excessive. In 2011, U.S. electricity consumption totaled 3,856 billion Kilowatt-hours which was more than 13 times greater than the electricity used in 1950 (U.S. Energy Information Administration, 2012). Since fossil fuels will eventually be depleted, there is need for renewable energy growth, starting with employment. Some states current carbon intensive industries can have a negative impact on their innovation and advancement in alternative energies. This occurs because states that rely on carbon intensive industries are "trapped in a economic development model that is difficult to change" and therefore

"clean energy industries would find it difficult to develop" (Yi, 2013, p. 647). Therefore, state reliance on the fossil fuel industry might have a negative impact on green job creation and growth.

An analysis of the state factors driving adoption of green energy policies discusses the impact of state's energy resource industry (Vachon & Menz, 2006). The study uses economic determinants including: state production of coal and proportion of electricity in a state that is generated from fossil fuels. Although the literature reviewed supported otherwise, they find that the proportion of electricity generated from fossil fuels is positively linked with the adoption of renewable portfolio standards (Vachon & Menz, 2006). This result is unexpected but the significance of the variable is noteworthy in determining economic interests for my paper.

As acknowledged above, Yi's regression analysis uses per capita greenhouse gas emissions in the electricity sector as a proxy for measuring the local carbon intensive industries. Yi finds in both the OLS regression model and the Two Stage Probit Least Squares model that in 2005 per capita GHG emissions are not statistically significant in determining green jobs in the metropolitan areas selected. But another study shows that as the employment in the fossil fuel industry increases, Republicans support for PACE and RPS laws decreases (Coley & Hess, 2012). Although the dependent variable in Coley and Hess's (2012) paper is not green employment, the policy section of this chapter will explain the indirect relationships between these important factors.

**Population characteristics.** Although this part of the Literature Review discusses the economic components of green employment, U.S. states' population, income level, and educational attainment are included in this section. There is much discussion on what

demographic factors are important in measuring green industry employment and specifically where education for green employment should be focused. These social determinants directly affect the U.S. economy and therefore are incorporated into my analysis as part of the economic factors.

Vachon and Menz (2006) study on "The role of social, political, and economic interests in promoting state green electricity policies" argues that education level matters in a states decision to adopt a pro-environment policy. They find that "states with higher social interests are more likely to have adopted measures promoting green electricity" (Vachon & Menz, 2006, p. 659). The statistically significant social factors that they describe are states' median income, the percentage of the state's population with a college degree (proxy for level of education), and state participation in environmental organizations. Since the variables have significant explanatory power, education and other social interests are important support for environmental policies that potentially promote green employment.

The empirical evidence found in Yi's study also suggests that educational level is statistically significant in determining green employment. Yi argues that "clean energy industries need different levels of specialized and well train professionals" and that it is necessary to take education into account to understand green employment (Yi, 2013, p. 648). In his study the education level in each metropolitan area is measured by percent of people with high school diplomas. Since this variable shows a strong (was statistically significant on the 99% level) positive relationship with the number of existing green jobs, education must be taken into account as an important factor in determining green job creation (Yi, 2013). Yi also describes per capita income and population change as

additional explanatory factors to green employment. Although neither is found to be statistically significant, all three variables are recognized as potential factors for my study. The next section of Chapter II discusses the political interests in determining green employment.

**Policy Factors**

As a developed economic powerhouse, the U.S. has fallen short of national expectations in terms of combatting climate change and therefore state legislature is the leading force in addressing the issue. On the national level, there has been much talk of climate action but little federal legislation and commitment. As a result, U.S. cities and states have been the main drivers in the battle against climate change (Cohen & Miller, 2011). In recent years U.S. states have developed policies cutting greenhouse gas emissions, promoting renewable energy consumption, installing education programs for green job employment and investing in energy efficiency technology. As a result the economic and political factors of green employment are very intertwined, since policy implications fund and allow the growth of green industry.

**Renewable Portfolio Standards.** Progressive U.S. states main commitment to sustainability and climate change mitigation is shown by their adoption Renewable Portfolio Standards (RPS). A RPS is a regulation that promotes renewable electricity generation by setting individual state goals for percentage of energy produced from alternative energy sources. The standards require a certain amount of renewable energy to be included in the state's portfolio of electric generating resources to promote technological innovation and cleaner air (Lyon & Yin, 2010). This section discusses the

development of RPS and addresses the environmental and economic benefits of a state having RPS.

Yin and Lyon's (2010) empirical study discovers what incentives states have to adopt RPS. It uses independent variables including: emissions from electric generation, unemployment rate, renewable energy capacity, electricity price, median income, citizens environmental preferences, republican governorship, percentage of Democrats in the state legislature as well as several more. Although of the determinants suggested by public interest theory, most are not statistically significant, they find that the percentage of Democrats in the state legislature "is an important factor driving RPS adoption" (Lyon & Yin, 2010, p. 154). Also their paper shows that states with lower unemployment, strong renewable potential, and better air quality are more likely to adopt RPS (Lyon & Yin, 2010). Another similar study on state's likelihood to adopt green energy policies by Vachon and Menz (2006) was discussed above in the economic variables section. As well as many other variables, this analysis finds that political interests, measured by legislators voting history, has a positive effect on peoples' support for most environment-friendly policies (Vachon & Menz, 2006). These two studies, discussing what motivates a state to adopt energy policies, are important to look at before examining how RPS standards have an effect on green employment.

Yi's paper uses a state's clean energy policy tool variable to understand the number of green jobs in selected metropolitan areas. The index identifies 21 policy tools that impact green job creation and provides a range of 0-17 (Yi, 2013). The empirical model originally included a RPS dummy variable, but was dropped when collinearity with the state clean energy index was identified. The OLS regression analysis shows that

"for every additional state clean energy policy tool adopted, around 1.7% more green jobs are expected in the metropolitan area" (Yi, 2013, p. 649). Although this variable is not specifically cities' RPS adoption, RPS is included as policy tool in the index he uses. Overall as a method of economically feasible adaption and mitigation policy to climate change, states' RPS has been very successful. RPS are the most prominent policy tool states use but the policies' effectiveness is still uncertain and will be shown once each state reaches their individual goals.

With the adoption of RPS other climate change laws have become established on the state government level. By 2008 nine states acknowledged the Regional Greenhouse Gas Initiative, the first cap-n-trade program for reduction of CO2 emissions (Greenwald & Gray, 2009). These state regulations have been powerful in targeting green house gas emissions but there is also need for political party action and federal legislation.

**Democratic support.** Studies show that Democrats are the leading force of green legislation as well as adoption of RPS standards (Coley & Hess, 2012; Lyon & Yin, 2010; Chandler, 2009). Democrats have attempted to push federal climate legislation but have shown their success on the state level. Two empirical analyses reveal the contributors to green climate policy and therefore determine the significant factors to state climate legislation. Coley and Hess's paper "Green energy laws and Republican legislators in the U.S." examines what impacts Republicans votes on green energy laws. The results of their binary logistic regression can support that as the level of fossil-fuel industry employment in a state increases, Republican support for green energy laws decreases (Coley & Hess, 2012). They also find that median household income has a significant, negative effect on Republican support for green legislation, which agrees

with the notion that "education and income have commonly been associated with more progressive attitudes towards environmental legislation" (Coley & Hess, 2012). These two variables were empirically significant on the impact of Republicans opinions on green energy law (as well as used in studies discussed before) and therefore are considered for determining green employment (Coley & Hess, 2012). As reviewed in the last section, Lyon and Yin's (2010) quantitative empirical analysis determines what influences states to adopt RPS standards. Their study shows that the adoption of RPS is more likely in states with a strong Democratic presence in the state legislature (Lyon & Yin, 2010). It also notes that Republicans have been hesitant in believing that climate change is occurring, and therefore refute policies towards adaptation. As a result it is apparent that government party association is key in determining energy policies and potentially green employment.

Ultimately, the literature reveals that there are repetitive variables in determining contributors to green employment. Since energy efficiency policies are proven to have an effect on green employment, the variables used to determine RPS could possibly have an impact as well. Also some important state determinants Yi's (2013) paper discusses and that are incorporated into my study include: population, average education attainment, per capita GDP (or income), and greenhouse gas emissions. Yi also finds that the state clean energy policy index impacts green employment in metropolitan areas.

The literature I reviewed led to the development of my independent variables and brought many considerable social, economic, and political factors forward. The main independent variables I derived from these analyses are: RPS adoption, state political party affiliation, price of electricity, CO2 emissions, income per capita, education level,

and population. All of this literature motivated the selection of the independent determinants of green goods and services employment in the U.S.

# CHAPTER III

# DATA AND METHOD

This chapter discusses the methodology of the study as well as the data collected and used for the empirical analysis. It is split between the motivation behind the dependent variable and then the derivation of the independent variables used.

## Dependent Variable

To understand the purpose of this study, it must be clear exactly how the dependent variable, green goods and services employment, is measured by the Bureau of Labor Statistics (BLS). My research uses data taken from the BLS 2010 and 2011 Green Goods and Services (GGS) Survey (Bureau of Labor Statistics, 2013). BLS recognized that neither of the standard classification systems currently used, North American Industry Classification System (NAICS) and the Standard Occupational Classification (SOC), identified a green grouping of industries or occupations and therefore came up with a method that is objective and measurable (Bureau of Labor Statistics, 2010). By using the NAICS and SOC, BLS green jobs data can be compared to existing employment measures and many more detailed subcategories.

As reviewed in Chapter II, GGS employment measurements are a recent development and are measured through the BLS Green Goods and Services Survey. Although there is speculation from other government institutions and specifically

environmental protection companies, the GGS Survey is used to attain information and data on U.S. development towards a green economy.

The survey is designed to grasp the scope and size of the U.S. green jobs. The 2011 GGS survey was published in March of 2013 using the 2012 NAICS classification system. Since this impacted the scope of the first GGS survey, the original 2010 GGS employment estimates were revised to be consistent with the 2012 NAICS classification. This resulted in the BLS sampling 325 6-digit NAICS industries covering all private and public establishments (Bureau of Labor Statistics, 2013). Since GGS employment is determined based on the percent of employment or revenue generated by the production of green goods and the providing of green services, a GGS employment scope was created. The in-scope GGS employment covers establishments that produce a mix of green and non-green goods and services.

TABLE 3.1

GGS employment level by green activity, 2010-11 annual averages

| Revenue or Employment from GGS | 2010 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | GGS in-scope employment | GGS Employment | Percent of GGS employment | GGS in-scope employment | GGS employment | Percent of GGS employment |
| 0% | 17,696,984 | 0 | 0 | 17,497,369 | 0 | 0 |
| 0%<GGS<100% | 6,207,622 | 1,416,620 | 43.7 | 6,637,244 | 1,478,029 | 43.5<br>56.5 |
| 100% | 1,826,913 | 1,826,913 | 56.3 | 1,923,251 | 1,923,251 | |
| Total | 25,731,519 3 | 3,243,533 | 100.0 | 26,057,864 | 3,401,279 | 100.0 |

Source: Bureau of Labor Statistics. (3/19/2013). *Employment in green goods and services - 2011.* Retrieved 4/2, 2014, from http://www.bls.gov/news.release/archives/ggqcew_03222012.htm
Note: GGS in-scope employment is the total employment within industries that potentially produce green goods or provide green services, based on the Quarterly Census of Employment and Wages.

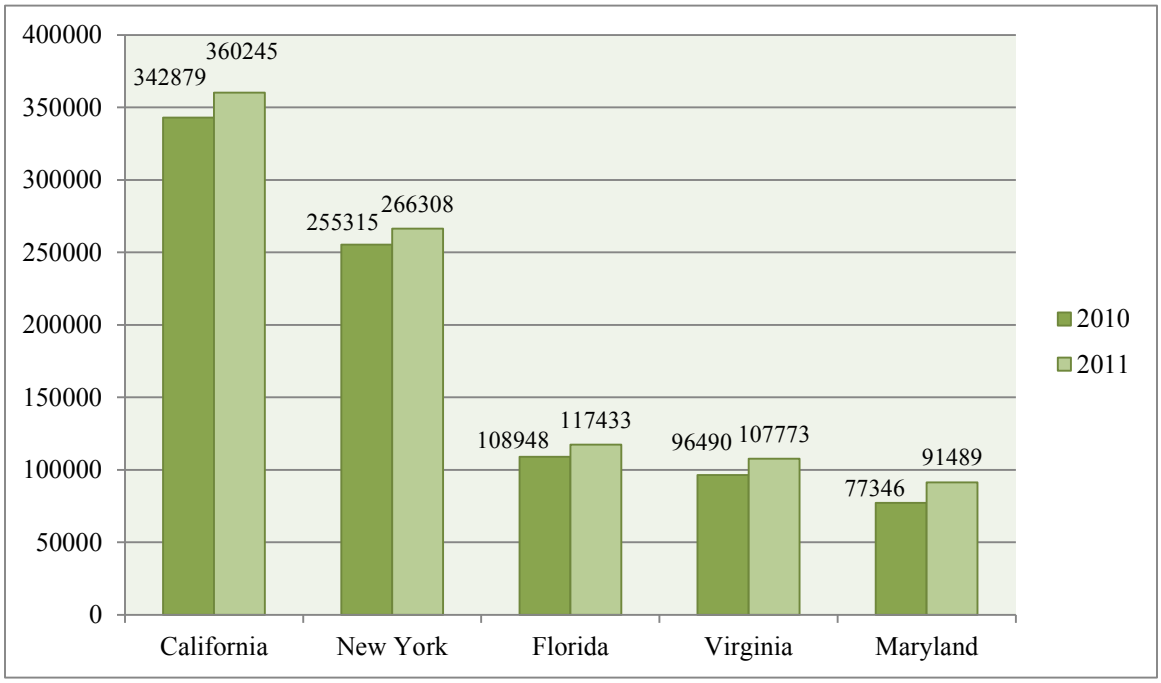
In both 2010 and 2011, the majority of GGS employment is found in establishments that produce exclusively green goods and services, both at about 56 percent. Since there is much speculation on how "green" a green job truly is, Table 3.1 is necessary to understand how the BLS took this concern into account. This table also shows that there was a slight increase in total GGS employment from 2010 to 2011 of about 157,746 jobs (or by 0.1 percentage point). Although this is a small increase, when analyzed across states and industries, some have extreme growth while others show significant decrease.

For the purpose of my study, the literature I reviewed, and the data I could generate on other contributing variables, I decided to focus on state GGS employment instead of individual industries' GGS employment. I am curious on how the distribution of the social, political, and economic factors varied between states. There are many notable findings from the BLS GGS survey. Below are separate tables showing the change in GGS employment across the U.S. in specific individual states.

First, in 2011 ten states had over 100,000 GGS jobs: California, New York, Texas, Pennsylvania, Ohio, Illinois, Florida, North Carolina, Virginia, and Washington. Of these ten, California, Florida, Virginia, and New York were all states that experienced the largest change in green employment growth from 2010 to 2011. The table below illustrates the five states with the largest increase in number of GGS jobs.

FIGURE 3.1

Green Goods and Services Employment, Five U.S. States with the largest GGS Over-the-year Change in Employment




Source: Bureau of Labor Statistics. (3/19/2013). *Employment in green goods and services - 2011*. Retrieved 4/2, 2014, from http://www.bls.gov/news.release/archives/ggqcew_03222012.htm

Although the District of Colombia had the highest percentage of GGS total employment in both 2010 and 2011, the chart above shows that California had the most people employed. California also saw the largest increase in GGS employment, adding 17,366 GGS jobs in 2011. Overall U.S. GGS employment grew by 157,746 jobs, showing as a nation there has been positive growth. It is also important to look at the states that saw the largest increase in their percentage change of GGS employment, since it accounts for population differences. Of the five states with the highest increase in GGS employment, only Virginia and Maryland were ones with the largest increase of GGS percent employment. Only six states showed an increase above 0.2%, all listed in Table 3.2 below.

TABLE 3.2

Green Goods and Services Employment, Ten U.S. States with the largest GGS Over-the-year Percent Change in Employment

| State | 2010 | | | 2011 | | | Over-the-year change | |
|---|---|---|---|---|---|---|---|---|
| | GGS employment | GGS percent | Total employment | GGS employment | GGS percent | Total employment | GGS employment | GGS Percent |
| Maryland | 77,346 | 3.2 | 2,453,197 | 91,489 | 3.7 | 2,478,505 | 14,143 | 0.5 |
| Oregon | 60,878 | 3.8 | 1,598,173 | 68,709 | 4.3 | 1,616,634 | 7,831 | 0.5 |
| Hawaii | 15,528 | 2.6 | 586,772 | 17,596 | 3 | 593,668 | 2,068 | 0.4 |
| New Hampshire | 14,011 | 2.3 | 600,697 | 16,244 | 2.7 | 605,853 | 2,233 | 0.4 |
| Arizona | 43,161 | 1.8 | 2,356,789 | 48,851 | 2.1 | 2,378,248 | 5,690 | 0.3 |
| Virginia | 96,490 | 2.7 | 3,536,676 | 107,773 | 3 | 3,578,848 | 11,283 | 0.3 |

Source: Bureau of Labor Statistics. (3/19/2013). *Employment in green goods and services - 2011.* Retrieved 4/2, 2014, from http://www.bls.gov/news.release/archives/ggqcew_03222012.htm

Another interesting observation is of the six states that saw the highest over the year change in GGS employment percent, two have not adopted RPS standards. These states, Arizona and Virginia, experienced only a 0.3 percentage change so RPS adoption should not be excluded as a possible explanatory variable for my study. Also besides Virginia, all of the five states had CO2 emissions in 2010 and 2011 below 100 million metric tons (MMT) of carbon dioxide.

Most states increased their GGS employment but there were seven states that recorded a decrease: Texas, Rhode Island, Michigan, Minnesota, Kansas, Montana and Colorado. Michigan and Minnesota had the largest GGS employment percent decrease of -0.2% from 2010 to 2011. But Texas saw the biggest GGS employment decrease of -5,772 jobs. Texas is also the state with the highest CO2 emissions in both 2010 and 2011, increasing its emissions by about 20 MMT of carbon dioxide (from 659.64 MMT in 2010 to 679.72 MMT in 2011). This is not consistent with all the states that saw a decrease in GGS employment, since Rhode Island is one of the bottom three emitters in both years.

This survey produced two years of data before being eliminated in 2013, due to President Obama's across-the-board spending cuts required by the Balanced Budget and Emergency Deficit Control Act (Bureau of Labor Statistics, 2013). The BLS discontinued measuring all green jobs products including: data on the occupations and wages of jobs related to green technologies and practices; data on employment by industry and occupation for business that produce green goods and services; and green career information publications (Bureau of Labor Statistics, 2013). As a result, the U.S. has taken a large step back in their efforts to incentivize building a green economy and today

there is no national system to measure GGS employment. The next section reviews the independent variables I use to explain the dependent variable, GGS employment.

**Independent Variables**

TABLE 3.3

Green Goods and Services Employment Indicators

| Variable | Concept | Description | Source |
|---|---|---|---|
| ELC | Average Price of Electricity | Average Retail Price of Electricity in Total Electric Industry (in cents per kilowatt hour) | U.S. Energy Information Administration |
| POP | Estimates of the Population | Annual Estimates of the Resident Population | U.S. Department of Commerce/United States Census Bureau |
| CO2 | Carbon dioxide emissions from Fossil Fuel Combustion | By end-used sector, in million metric tons of CO2 | United States Environmental Protection Agency |
| MHI | Median Household Income | Median Household Income using Single-year estimates | U.S. Department of Commerce/United States Census Bureau |
| PAF | State Political Affiliation | Governor Political Party Affiliation | National Governors Association |
| RPS | Renewable Portfolio Standards | Adoption of Renewable Portfolio Standard or Alternative Energy Portfolio Standard | Center for Climate and Energy Solutions |
| PHG | Public High School Graduates | State Graduation Rate of All Students in Academic Year 2009-2010; Regulatory Adjusted Cohort Graduation Rate for All Students in academic year 2010-2011 (%) | ED Data Express: Data about elementary and secondary schools in the U.S. |

Table 3.3 gives a descriptive understanding of each variable and the source in which is was acquired. These variables are selected through research and analysis of this topic, deciding what different factors make up GGS employment. Some variables need further explanation. Population and median household income are used as explanatory variables in some studies, and are not focused on for the purpose of my paper (Vachon & Mendez, 2006; Yi, 2013).

**Average Price of Electricity (ELC)**

The price of electricity is used as a determinant for price of fossil fuels. Although in some states fossil fuels are used less in electricity production, overall fossil fuels are burned when generating most U.S. electricity (U.S. Energy Information Administration, 2013). In 2012, coal generated 37% of U.S. electricity and natural gas generated 30% of U.S. electricity (U.S. Energy Information Administration, 2013). Therefore with a higher price of electricity, it is likely there is greater incentive for a state to investment in and use renewable energies. The price of electricity is chosen as a factor because it shows wider variation between states while capturing the price and use of many fossil fuels.

**Carbon Dioxide Emissions from Fossil Fuels (CO2)**

This variable is used to measure how much each state relies and uses the fossil fuel industry. It is similar to and may capture the price of electricity variable, since they represent a similar proxy of state dependence on fossil fuels. It is also imperative to understanding the hypothesis of this study: that states with higher CO2 emissions will have lower GGS employment.

**State Political Affiliation (PAF)**

Each state's political affiliation is measured by what party the governor in office was associated with in 2010 and 2011. This dummy variable is used to represent whether a state is generally more liberal or conservative: 0 being a Democratic governor and 1 being a Republican governor. Political impact on green employment can be measured differently as shown in many sources reviewed (Vachon & Menz, 2006; Yi, 2013; Coley & Hess, 2012). Since the governor is representative of state opinion and is voted directly by the people, governor affiliation is selected for this study.

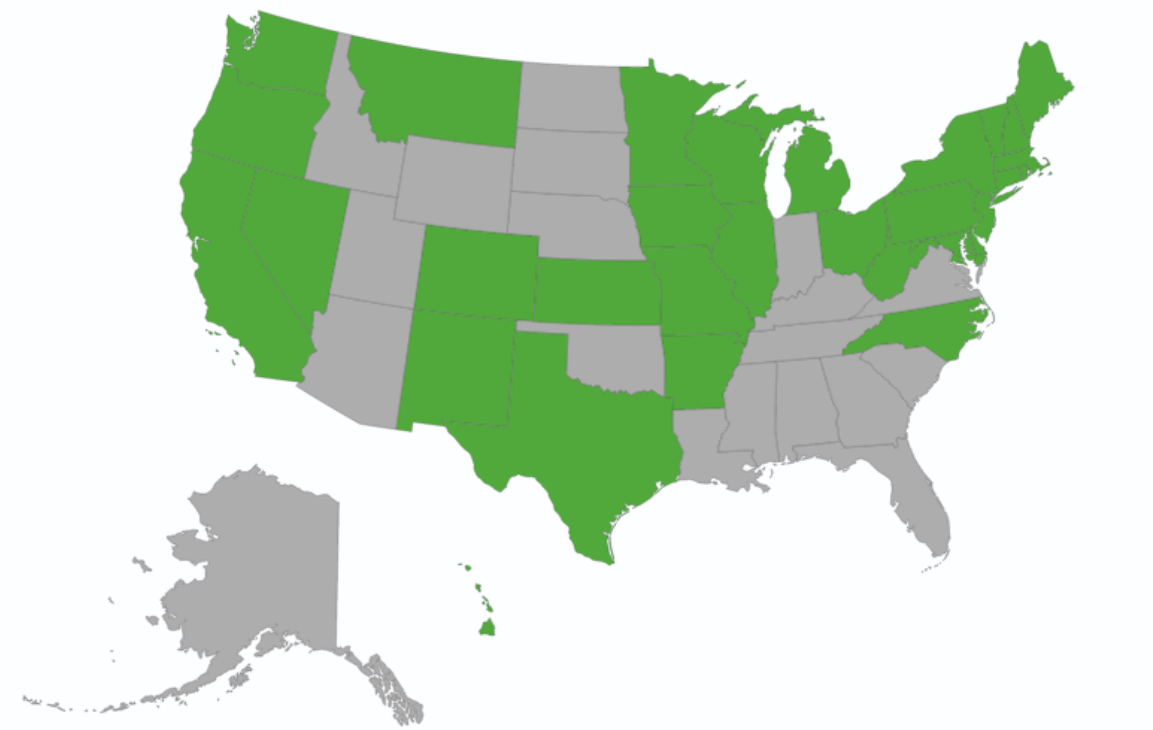
**Renewable Portfolio Standards (RPS)**

The dummy independent variable RPS that is used in the empirical model, is interpreted based on the Center for Climate and Energy Solutions (C2ES) and included all states adopting Renewable Portfolio Standards (RPS) or Alternative Energy Portfolio Standards (AEPS). States with Renewable or Alternative Energy Goals are also listed on the C2ES but were omitted because of their lack of concrete standards. By years 2010 and 2011, 31 states and the District of Columbia had adopted standards: 28 with RPS and four with AEPS. Below is a map (Figure 3.2) showing the distribution of the renewable energy standards; the states that have adopted RPS or AEPS are shown in green. Although this covers many states, they all set standards requiring that electric utilities deliver a specific amount of electricity from alternative or renewable energy sources and set future goals (Center for Climate and Energy Solutions, 2014). Both RPS and AEPS require a certain percentage of a utility's power plant generation or capacity to come from alternative or renewable energy sources in a certain time period. For example, California has adopted RPS to generate 33 percent of the energy through renewable resources by

2020 (Center for Climate and Energy Solutions, 2014). States have different standards depending on their dedication to combating climate change or their motivation based on their renewable potential. This is used as a dummy variable in my data set, 1 being if the state has adopted either standard and 0 if they have not.

FIGURE 3.2

U.S. States Adoption of RPS or AEPS, no change over year 2010-11



Source: Center for Climate and Energy Solutions. (2014). *Energy sector: Renewable and alternative energy portfolio standards.* Retrieved 4/2, 2014, from http://www.c2es.org/node/9340
Note: States who adopted standards are shown in green

**Public High School Graduates (PHG)**

This final statistic is used as an indicator for educational achievement in that state. Education level can be used as a determinant of level of awareness or social responsibility. Yi (2013) argues in his study that green occupations will need skilled and

trained workers. For this reason PHG is used as a proxy for skilled labor. This was measured by using state high school graduates statistics. The data for school year 2009-10 was measured slightly differently than the 2010-11 school year (ED Data Express, 2011). During the 2010-11 school year, graduation statistics were changed to an adjusted cohort graduation rate. As a result of this, the data on the two years of student graduates is potentially slightly different and could affect the results of the study.

After collecting this data set and understanding the scope of each variable, a regression analysis was performed. In the context of cross sectional data, I test what the contributors are to green goods and services employment in the U.S. states.

# CHAPTER IV

# ANALYSIS

Through research and analysis of many previous studies, I deisgned an empirical model that uses the independent variables discussed in the Data and Method Chapter to understand what political, economic, and social factors are contributing to the dependent variable, U.S. green goods and services employment.

**Empirical Model**

$$(\ln)\text{GGS Emp} = \boldsymbol{\beta 0} + \boldsymbol{\beta 1}\text{ELC} + \boldsymbol{\beta 2}\text{POP} + \boldsymbol{\beta 3}\text{CO2} + \boldsymbol{\beta 4}\text{MHI} + \boldsymbol{\beta 5}\text{PAF} + \boldsymbol{\beta 6}\text{RPS} + \boldsymbol{\beta}7 \quad (4.1)$$

Using the model above, I ran an Ordinary Least Squares (OLS) regression to estimate the relationship of each dependent variable to GGS employment over a two-year period.

There was need to transform much of the data since the initial regression seemed to be inconclusive. After running the first set of tests, it was obvious CO2 and POP were highly correlated, above 0.8, and as a result the variable annual estimates of residential population (POP) was eliminated from the data set. It was also necessary to transform GGS employment to the natural log of GGS employment as a percent of total state employment to ensure normality of the residuals. Also due to the heteroskedasticity found in the White Test, a robust option was needed to transform the data to address this issue. With these alterations of the data, an OLS regression was run and results were generated.

Table 4.1 shows the summary statistics for the variables used. As seen below, some variables have missing observations including: PAF and PHG. For this reason, only 98 observations are used in this study. It is also important to note the two dummy variables present: PAF and RPS. RPS has a mean of 0.627451, meaning that more states have adopted RPS than have not. While, PAF has a mean of 0.5148515 and therefore Democrats and Republicans governors are about equally represented in each state.

TABLE 4.1

Descriptive Statistics

| **Variable** | **Obs.** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| Year | 102 | 2010.5 | .5024692 | 2010 | 2011 |
| GGS Emp | 102 | 2.753922 | .6626786 | 1.5 | 5.1 |
| MHI | 102 | 50352.37 | 7454.926 | 38159.61 | 688876.41 |
| CO2 | 102 | 108.9326 | 110.7677 | 3.17 | 679.72 |
| ELC | 102 | 10.21412 | 3.771946 | 6.2 | 31.59 |
| PAF | 101 | .5148515 | .5022721 | 0 | 1 |
| RPS | 102 | .627451 | .485871 | 0 | 1 |
| PHG | 99 | 80.32323 | 7.232055 | 59 | 95 |

The results of the OLS regression explaining the entirety of the model seem to have some explanatory power. The R-squared value of 0.2223 illustrates that 22.23% of the variation in GGS employment can be explained by the independent variables in the model. This score is not particularly high and therefore must be taken into account when analyzing other values in the results.

The results for the independent variables of the regression indicate only two significant factors as shown below in Table 4.2. The variables with high t-scores, MHI and CO2, give confidence in analyzing the results and interpreting the effect on the dependent variable, GGS employment. It can be said with 99% confidence that these two

variables have a significant impact on GGS employment. This indicates an increase in median household income theoretically causes an increase in GGS employment. The other significant variable, CO2 emissions, coefficient implies the opposite negative relationship: a decrease in state CO2 emissions results in an increase in GGS employment. Specifically, a additional million metric ton of CO2 emissions cause a -0.0004842 percent change in GGS employment.

TABLE 4.2

Green Employment Variable Regression Results

| Variable | Coef. | t-statistic | P > \|t\| |
|---|---|---|---|
| MHI | 7.60e-06 | 2.69 | 0.008 |
| CO2 | -.0004842 | -2.72 | 0.008 |
| ELC | -.0070557 | -1.40 | 0.164 |
| PAF | -.088318 | -1.57 | 0.120 |
| RPS | .0504614 | 0.78 | 0.436 |
| PHG | -.0037543 | -0.99 | 0.324 |

It is interesting that other variables are not significant since the literature supported their contributions. This implies that these variables and their potential effect on GGS employment could be represented by another variable in this regression or an omitted variable. There is high correlation (above 0.5) between ELC and MHI as well between PAF and RPS. Therefore showing that the potential significance of ELC could be represented in MHI and the insignificance of both PAF and RPS could be a consequence of their correlation. An additional regression analysis was run to understand the high correlation found specifically between the variables PAF and RPS. When RPS was run as the dependent variable, the PAF t-statistic was high a negative, -6.11. This could imply that in the initial regression the coefficients for these two variables are

accurate but the significance levels are skewed from correlation. Also since there is limited data available, this is likely a result of omitted variable bias.

# CHAPTER VI

# CONCLUSIONS

This paper attempts to analyze the contributors of green goods and services employment across the 50 U.S. states in 2010 and 2011. The hypothesis that is presented in this paper is that GGS employment increases as a result of the decrease in CO2 emissions. The findings above indicate that the hypothesized results of the study are true. Therefore, states that rely heavily on the fossil fuel industry are having negative impacts on green job creation. This analysis also shows that median household income has positive explanatory power in determining green employment. This indicates that states with wealthier families and higher income levels have a valuable impact on the green industry. Although many variables lacked significance, this study sets a strong framework for future analysis and research on the topic of green employment.

Ultimately, green jobs are an abstract and relative concept, causing there to be much disconnect among surveyors, theorists, politicians, and researchers (Erwin, 2011). There are many ideas of what constitutes a green occupation, but there is no common, universal definition of a green job. As shown in the literature, there have been many government attempts to define green employment and statistically consistently measure it (Martinez-Fernandez et al., 2010; United Nations Environment Programme, 2008; Bureau of Labor Statistics, 2012). The interpretations of green jobs can be inclusive and

exclusive in their definitions, which has led to measurement problems and inconsistencies. The Bureau of Labor Statistics (BLS) was effective in its efforts but due to budget cuts, these recordings have been discontinued and GGS employment has not been measured since 2011 (Bureau of Labor Statistics, 2013).

**Limitations of Study**

Unfortunately some of the findings were inconclusive and therefore there are several limitations in this analysis that must be discussed. First, the biggest restriction I faced in creating the most explanatory model for GGS employment is the number of years of data. It is difficult to assess a growth trend in employment over a two-year period. Before the BLS could measure future GGS employment, they were ordered spending cuts and therefore there is no GGS employment data past 2011. Currently, there is no federal measurement of green jobs so only GGS employment in years 2010 and 2011 could be used in my study.

Also since green employment is such a recent topic and there is limited pertinent literature on what contributes directly to it, this paper exhibits a curse of omitted variable bias. There are multiple variables that I attempted to use, but was prevented by access of information. Non-renewable energy consumption would have been an important explanatory variable to use. It may have had a significant negative effect on green employment, but the EIA will release data on the topic later in 2014 (U.S. Energy Information Administration, 2014). Two independent economic variables that would have been beneficial to include are government investment in green jobs (green technology etc.) and specifically government investment in alternative energies.

Although it is not included in the Yi's study, considerable literature indicates that renewable energy investment has a positive impact on green employment. Wei, Patadia, and Kammen's (2009) study on non-fossil fuel technologies' job opportunities argues that by investing in energy efficient systems, the money spent on energy costs is redirected to job formation. This will assist in stimulating the economy and result in continual innovation hoping to provide the U.S. complete energy independence. In their analysis of employment impacts from various energy supply sources, they find that per unit of energy, the renewable energy and low carbon sectors provide more jobs than the fossil fuel based sector (Wei et al, 2009). The United Nations Environment Programme (UNEP) supports this claim stating that "compared to fossil fuels, renewable energy generates more jobs both per unit of capacity and per dollar invested" (United Nations Environment Programme, 2008, p. 9). They estimate that the total global employment in the renewable energy sector in 2006 was 2,277,000 and could reach over 20 million jobs by 2030 (United Nations Environment Programme, 2008). The UNEP "Background Paper on Green Jobs" concludes with a green investment strategy emphasizing that investment creates employment and without substantial investment, green job creation will suffer.

One variable that could have assisted in this analysis, but is difficult to measure, is human environmental consciousness and care. Growing environmental awareness has fueled hope for a green labor force (Stevens, 2009). One way of possibly doing this would be to measure the presence of strong environmental groups in areas as done in Coley and Hess's (2012) study. Also Vachon and Menz (2006) use participation in environmental pressure groups including: the Sierra Club, National Wildlife Federation,

and Greenpeace (USA), as a social factor in their study to determine interest in stricter environmental policies. This variable could have benefitted the explanatory power of this study by capturing how demographically environmentally aware populations differ.

**Recommendations**

Political action will occur simultaneously with job creation and therefore must emphasize the amount of jobs a green economy would generate. By determining the contributors of green job growth, researchers and policy makers can implement stronger restrictions and understand how to move forward in creating a green economy. Although the states have taken initiative and been successful in implementing environmental policies there is desire for national attention. To further this study, it is necessary for the federal government to take initiative in continuing the measurement of green employment. There is a need to emphasize the positive economic contributions of green industries and the employment benefits. One way of doing this is through encouraging green energy policies that emphasize the health and financial benefits of a cleaner world. These policies should be directed towards the opportunities a green economy can create and not the restrictions that it might implement. Companies also need to recognize that "green innovation helps businesses stay at the cutting edge and hold down costs by reducing wasteful practices" (United Nations Environment Programme, 2008, p. 8). As a result, the consumer and producer would benefit and the systems would have a less destructive impact on the environment. With the development of a more concrete and explanatory version of this analysis, the economic and social advantages of a green economy could be limitless.

# REFERENCES


Bezdek, R. H., Wendling, R. M., & DiPerna, P. (2008). Environmental protection, the economy, and jobs: National and regional analyses. *Journal of Environmental Management, 86*(1), 63-79.

Bureau of Labor Statistics. (2012). *Measuring green jobs.* Retrieved 4/2, 2014, from http://www.bls.gov/green/home.htm

Bureau of Labor Statistics. (3/19/2013). *Employment in green goods and services - 2011.* Retrieved 4/2, 2014, from http://www.bls.gov/news.release/archives/ggqcew_03222012.htm

Bureau of Labor Statistics. (3/22/2012). *Employment in green goods and services - 2010.* Retrieved 4/2, 2014, from http://www.bls.gov/news.release/ggqcew.toc.htm

Byrnett, D. S. (2010). *Clean energy workforce development: Growing green jobs to achieve climate and energy goals clean energy workforce development: Growing green jobs to achieve climate and energy goals.* Retrieved 4/2, 2014, from http://www.epa.gov/statelocalclimate/documents/pdf/byrnett_presentation_01-26-10.pdf

Center for Climate and Energy Solutions. (2014). *Energy sector: Renewable and alternative energy portfolio standards.* Retrieved 4/2, 2014, from http://www.c2es.org/node/9340

Chandler, J. (2009). Trendy solutions: Why do states adopt sustainable energy portfolio standards? *Energy Policy, 37*(8), 3274-3281.

Cohen, S., & Miller, A. (2012). Climate change 2011: A status report on US policy. *Bulletin of the Atomic Scientists, 68*(1), 39-49.

Coley, J. S., & Hess, D. J. (2012). Green energy laws and republican legislators in the united states. *Energy Policy, 48*(0), 576-583.

ED Data Express: Data about elementary and secondary schools in the U.S. (2012). *State tables report: Achievement data.* Retrieved 4/2, 2014, from http://eddataexpress.ed.gov/state-tables-report.cfm

Erwin, M. (2011). *Demand for green jobs.* Unpublished Public Policy, Georgetown University, Washington, DC.

Fankhauser, S., Bowen, A., Calel, R., Dechezleprêtre, A., Grover, D., Rydge, J., et al. (2013). Who will win the green race? in search of environmental competitiveness and innovation. *Global Environmental Change, 23*(5), 902-913.

Greenwald, S. F., & Gray, J. P. (2009). Feds must deliver on climate change legislation. *Power, 153*(10), 26-26.

Griswoid, W. (2013). Community education and green jobs. *Adult Learning, 24*(1), 30-36.

Hill, R. J. (2013). A deeper shade of green. *Adult Learning, 24*(1), 43-46.

Lyon, T. P., & Yin, H. (2010). Why do states adopt renewable portfolio standards?: An empirical investigation. *Energy Journal, 31*(3), 133-157.

Martinez-Fernandez, C., Hinojosa, C. & Miranda, G. (2010). *Green jobs and skills: The local labour market implications of addressing climate change.* Retrieved 4/2, 2014, from www.oecd.org/dataoecd/54/43/44683169.pdf?conte ntId=44683170

National Governors Association. (2013). *Former governors' bios: Roster.* Retrieved 4/2, 2014, from http://www.nga.org/cms/FormerGovBios

Scully-Russ, E. (2013). Are green jobs career pathways a path to a 21st-century workforce development system? *Adult Learning, 24*(1), 6-13.

Stevens, C. (2009). *Green jobs and women workers: Employment, equity, equality.* Retrieved 4/2, 2014, from http://www.sustainlabour.org/IMG/pdf/women.en.pdf

U.S. Department of Commerce/United States Census Bureau. (2013). *Income: State median income.* Retrieved 4/2, 2014, from http://www.census.gov/hhes/www/income/data/statemedian/

U.S. Department of Commerce/United States Census Bureau. (2014). *Population estimates.* Retrieved 4/2, 2014, from http://www.census.gov/popest/data/index.html

U.S. Energy Information Administration. (2012). *Use of electricity.* Retrieved 4/2, 2014, from http://www.eia.gov/energyexplained/index.cfm?page=electricity_use

U.S. Energy Information Administration. (2014). *Electricity.* Retrieved 4/2, 2014, from http://www.eia.gov/electricity/data.cfm

United Nations Environment Programme. (2008). *UNEP background paper on green jobs.* Retrieved 4/2, 2014, from http://grist.files.wordpress.com/2008/02/green-jobs-background-paper-18-01-08.pdf

United States Environmental Protection Agency. (2014). *State energy CO2 emissions.* Retrieved 4/2, 2014, from http://www.epa.gov/statelocalclimate/resources/state_energyco2inv.html

United States Environmental Protection Agency. (8/6/2013). *Workforce development | state and local | US EPA* Retrieved 4/2, 2014, from http://www.epa.gov/statelocalclimate/state/topics/workforce.html

Vachon, S., & Menz, F. C. (2006). The role of social, political, and economic interests in promoting state green electricity policies. *Environmental Science & Policy, 9*(7–8), 652-662.

Wei, M., Patadia, S., & Kammen, D. M. (2010). 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.

Yi, H. (2013). Clean energy policies and green jobs: An evaluation of green jobs in U.S. metropolitan areas. *Energy Policy, 56*(0), 644-652.