2012

An Analysis of Ohio's Alternative Energy Portfolio Standard

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Abstract:

I performed quantitative analyses and qualitative interpretation of energy policy data, energy production and consumption data, and political data. I collected data on state Renewable Portfolio Standards from the Database for State Incentives for Renewable Energy (DSIRE), energy production and consumption data for the 50 states and Washington D.C. from the Energy Information Agency (EIA), and 1992 presidential election data from the internet. I identify relationships that exist between these different types of variables, and where Ohio fits in the national context of existing energy patterns and policies. There are several conclusions found in the literature that are independently tested with the data I have collected. I hypothesize that enactment of Renewable Portfolio Standard (RPS) policies and geographic location in the United States are not robust indicators of the proportion of energy generation in states that comes from renewable sources, and that the strength of RPS policies is not based upon location (Carley 2009). Furthermore, I predict that states that are politically left leaning have larger proportions of their energy generation coming from renewable sources and have stronger RPS policies (Carley 2009). Finally, I postulate that Ohio's energy policy will be weaker relative to some policies based upon descriptive statistics of the RPS policies. Tests utilized include correlations, T-tests, and multiple linear regressions for geographic variables.

I also performed a spatial analysis of renewable energy potential and unemployment rates in the state of Ohio. I found National Renewable Energy Laboratory maps of average wind speed, solar radiation, biomass yield, and a Bureau of Labor Statistics map of unemployment rates at the county level. I calculated correlation coefficients between unemployment rate and renewable resource abundance according to a 24-section grid I overlaid on the state. No positive statistically significant results occurred, with the highest unemployment in the Southeast and greatest wind potential in the Northwest. There was insufficient variation of solar radiation across the state to perform a meaningful correlation.

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Introduction

Energy policy is at the forefront of ensuring energy security and reducing greenhouse gas emissions that contribute to climate change (Lokey 2007). Global non-OPEC oil production has been relatively stable since 2004, and according to the IEA's 2010 World Energy Outlook, total conventional oil production reached its highest level in 2006; this level of output has not been exceeded in spite of increasing demand from developing countries (Kerr 2011, Heinberg 2009, Rudolf 2010). Climate change threatens humanity in multiple ways, and must be addressed to prevent its worst effects (Hansen et al. 2011). Ohio has taken a small but concrete step towards confronting these issues through the enactment of its Alternative Energy Portfolio Standard (AEPS) policy. However, the goals of the AEPS are modest in comparison to James Hansen's call for rapid reductions in fossil fuel consumption and emissions, especially since most of Ohio's energy is derived from coal (Hansen et al. 2011, U.S. Energy Information Administration 2011). This standard, and others like it, is one possible policy approach towards maintaining stable energy supplies and climate. By conducting an analysis of Ohio's policy and the spatial distribution of renewable resources relative to unemployment, I hope to elucidate how the state can progress towards a renewable energy future.

First, I will review academic studies of state and national portfolio standard policies and analyses of the impacts of renewable energy development. Next, I will perform quantitative analyses and qualitative interpretations of energy policy data, energy production and consumption data, and political data. This section will identify relationships that exist between these different types of variables, and where Ohio fits in the national context of existing energy patterns and policies. Then, I will examine Ohio's AEPS, and conduct a spatial analysis of renewable energy potential and unemployment in the state. I will discuss the history, merits, and weaknesses of a federal renewable energy standard. I will subsequently explore what impacts may result in Ohio from the enforcement of a federal policy. Lastly, I will discuss the importance of pursuing a more aggressive policy than currently exists in Ohio.

Literature Review

A number of researchers have explored and modeled the economic and environmental impacts of different state and national energy and climate change policies. Some studies have emphasized economic outcomes for different renewable energy and efficiency policies in the Midwest; McCarron's "Job Jolt" estimated the effects of different energy policies in the state of

Ohio (McCarron 2002). Others have evaluated the empirical effectiveness of Renewable Portfolio Standards (RPS) in terms of their ability to catalyze development of renewable energy above the status quo rate of investment (Carley 2009, Haitao and Powers 2010). Comparative analyses between state and national scale RPS, Mandatory Green Power Options (MGPOs), Renewable Energy Production Credits (REPCs), and Cap and Trade programs have measured the efficacy of these different policies in terms of new renewable energy development, carbon emission reductions, and secondary impacts (Delmas and Montes-Sancho 2011, Bird et al. 2011, Palmer and Burtraw 2005). One analyst has recommended the implementation of a national Fossil Energy Reduction Standard (FERS) to improve environmental outcomes with energy policy (Casten 2009). The aforementioned analyses represent a sample of the ongoing discussions in the literature relevant to the formulation of future U.S. energy policy.

The Regional Applications Laboratory (REAL) for the Environmental Law and Policy Center conducted an analysis in 2002 that projected the impacts of aggressive development of renewable energy and electricity efficiency in what the report dubs the "Repowering the Midwest Clean Energy Development Plan" (McCarron 2002). REAL created econometric input-output models, which incorporated U.S. Census data, employment, income, and economic output data from fifty-three industrial sectors, to predict the economic impacts of the plan. Thirteen demand variables, including consumption, investment, government expenditures, and eight demographic variables, such as age, sex, and migration all factored into the dynamic models REAL utilized. The plan calls for the installation of cost-effective energy efficiency technologies, including lighting, appliances, industrial equipment etc. These technologies would cost 2.3 cents per kWh or less, which is lower than the cost of generating, transmitting and distributing electricity from coal, gas, and nuclear power plants. The other major component of the plan was to increase development of renewable energy sources, including wind, solar, and biomass from agricultural crops (switchgrass and corn husks).

Under this plan, the ten state region that comprises the Midwest would create 214,600 jobs, generate $5.5 billion in increased worker income, and produce $20 billion in additional economic activity by 2020 (McCarron 2002). Ohio, a highly industrialized state, would benefit disproportionately from this plan. Net new employment would increase by 39,000, and $4.4 billion in increased economic output would result from energy efficiency and renewable energy development under this plan. The two goals of the plan are to reduce power demand from energy consumers across all sectors below the projected business-as-usual scenario by 28% by 2020 through efficiency improvements, and to increase the electricity supplied by utilities from renewable sources by 22% by 2020. Implementation of the plan will reduce the emission of sulfur dioxide by 56%, nitrogen oxide by 71%, and greenhouse gases by 51% over their business as usual scenario that is 95% coal and nuclear energy-based. Improved health outcomes and electrical grid reliability will result from its enactment. The authors of the study envision state lawmakers creating and enforcing “Renewable Energy Standards” and Energy Efficiency and Renewable Energy Investment Funds. Third party and independent administrators, whose boards would include environmental and consumer representatives, would manage these groups and facilitate the plan. The projections and analysis behind the “Repowering the Midwest Clean Energy Development Plan” highlight the economic and environmental benefits of increased energy efficiency and renewable energy deployment.

One of the most prevalent state-level policy instruments for encouraging renewable energy deployment and greenhouse gas emission reductions in the U.S. is a statewide RPS: a policy approach that mandates an increase in the share of renewable energy supplied to the electricity market (Carley 2009). One study evaluated the empirical effectiveness of state RPS policies through exploration of the connection between state RPS policy implementation and the percentage of renewable energy electricity generation across states. The authors utilized a variant of a standard fixed effects model called a fixed effects vector decomposition, with state-level data from 1998 to 2006. The results of the analysis suggested that RPS implementation was not a robust predictor of renewable energy generation percentage out of a total generation mix; however, every additional year a state had an RPS the total amount of renewable energy generation increased (Carley 2009). Significantly influential factors included "political institutions, natural resource endowments, deregulation, gross state product per capita, electricity use per person, electricity price, and the presence of regional RPS policies."

The empirical efficacy of RPS policies is contested in the literature. According to the authors of one study, existing research on the effectiveness of RPS policies utilizes cross-sectional approaches and ignores unique characteristics of different RPS policies (Haitao and Powers 2010). The authors of the paper, "Do state renewable portfolio standards promote in-state renewable generation?" investigate the effects of RPS policies on renewable electricity development within states. The authors created a model to address their research question, which incorporated the percentage of generating capacity excluding hydropower, other state policies that encourage renewable energy investment, social and economic variables that might impact renewable energy development, and a measure of RPS policies that accounts for differences within and between states. Their results indicate that RPS policies have significant and positive effects on in-state renewable energy development: a conclusion missed when differences between policies are ignored (Haitao and Powers 2010). Another important finding of this study is that the interstate trade of Renewable Energy Credits (RECs), without preferential treatment for instate RECs can significantly weaken the effectiveness of an RPS in increasing the development of non-hydro renewable energy. RECs represent the reduced carbon or carbon neutral electrons fed into the electricity grid, and the environmental benefits associated with the generation of cleaner energy. Each REC is typically one Megawatt hour (MWh) of energy generated from eligible renewable or alternative energy sources. At the end of a compliance year, utilities in states that trade RECs have a certain amount of time to buy the RECs from other utilities that have exceeded their minimum required generation. Utilities will purchase the RECS needed to satisfy the required amount of renewable or alternative energy generation if they have failed to meet the requirement on their own. Thus, the debate over the effectiveness of RPS policies continues.

One study comparing existing RPS and Mandatory Green Power Option (MGPO) policies found that these policies were mixed in terms of their effectiveness post-implementation (Delmas and Montes-Sancho 2011). MGPO policies require electricity suppliers to provide options for their customers to buy eligible green sources of energy either directly from the utilities covered by the policy or from another provider capable of supplying the green energy. Electricity companies can also purchase RECs from their state's public utilities commission to satisfy the requirements of the MGPO policy, depending on pre-existing state laws with regards to RECs. The authors assert that the natural resource abundance, economic indicators, political alignments, and energy policies context for the adoption of these policies are among the essential factors to measure their true efficacy. In addition to this argument, the authors put forward three hypotheses: RPS policies do not effectively increase renewable energy capacity investment, MGPO policies are effective at increasing renewable energy investment, and that investor-owned utilities will respond more to renewable energy policies than publicly owned utilities. The test used to investigate the effectiveness of these two policies was a two-stage binary logit model that calculated the likelihood of adoption of a state-level RPS and a firm's decision to invest in renewable energy capacity. The authors found that RPS policies had a negative impact on investment in renewable capacity when context is controlled (Delmas and Montes-Sancho 2011). However, investor-owned utilities did respond more positively to RPS mandates than publicly owned utilities, and MGPO policies apparently had a significant positive impact on the installed renewable energy capacity for all utilities irrespective of their context.

Another paper examined the impacts on the US electricity sector of various RPS and cap-and-trade policies with models simulating their individual and simultaneous implementation (Bird et al. 2011). Cap-and-trade strategy, with the purpose minimizing climate change, consists of the government enforcing a mandatory cap on greenhouse gas emissions, while giving utilities the flexibility to determine how they comply (US Environmental Protection Agency). Allowances, or limited authorizations to emit, are distributed to utilities either for free or through auction up to the limit of the cap. Utilities are then allowed to reduce their emissions and either purchase or sell allowances to meet the cap or bank their allowances to use in future years if they have already met the cap with surplus allowances. The effects studied in the models used in this paper include the US electric generation mix, electricity price, and carbon emissions (Bird et al. 2011). The study is based on the National Renewable Energy Laboratory's (NREL) Regional Energy Deployment System (ReEDS) model that simulates least-cost expansion of electricity generation capacity and transmission in the US. ReEDS is a complex and comprehensive "multiregional, multitime-period, geographic information system (GIS), and linear programming model" (National Renewable Energy Laboratory). This model employed different parameters to simulate the U.S. electricity generation mix under various RPS and carbon emission cap scenarios (Bird et al. 2011). In this study, the projected greenhouse gas (GHG) emission levels through 2050 come from the U.S. Environmental Protection Agency (EPA) analysis of the Waxman-Markey bill, which reflects domestic and international offsets, banking, and borrowing of allowances. The base cap is a 17% reduction of 2005 GHG emissions by 2020 and 42% reduction of 2005 GHG by 2030 with offsets and banking, consistent with the Waxman-Markey bill. The results indicated that a base cap alone did encourage significant renewable energy generation, but at higher electricity prices than scenarios that included load reduction from energy efficiency. A 25% RPS policy led to similar emission reductions as the base cap in the near term at a similar electricity price. A 25% RPS, in addition to efficiency measures, would allow the electricity sector to meet the base emission cap levels in the 2020 timeframe at a similar electricity price. The results of the study also indicated that a RPS policy did not send a carbon price signal significant enough to affect longer-term investment decisions based on carbon emissions, nor does it provide the same level of certainty of emissions reductions, especially if demand increases. The authors found that simultaneous enforcement of RPS and emissions caps could drive renewable energy generation beyond that achieved by emissions caps alone, particularly in the short run. According to the study's model, an RPS combined with a base cap did not lead to substantially greater electricity prices, while the addition of an RPS and efficiency to a base cap resulted in a reduction in carbon dioxide allowance prices.

The effectiveness of RPS and cap-and-trade policies has also been compared to Renewable Energy Production Credits (REPCs) (Palmer and Burtraw 2005). REPC policies require the federal government to give tax credits to utilities for the production of certain types of renewable energy. Palmer and Burtraw evaluate which of the three policies is the most cost-effective in terms of economic impacts, renewable energy generation, and greenhouse gas emission reduction. The scenarios used to illustrate the efficacy of each policy into the future were calculated with the Haiku electricity market model, which simulates equilibrium in regional electricity markets in the United States. The authors' model calculates: the demand for electricity, electricity prices, sources of the electricity supply, inter-regional electricity trade, and emissions of certain pollutants including NO_x, SO_2, CO_2, and mercury. Generation of electricity from 13 regions for four time periods in three seasons is considered in the model.

> For each of these 156 segments of the electricity market, demand is aggregated from price-responsive demand schedules for three customer classes: residential, industrial, and commercial. Supply is aggregated from the complete set of electricity plants in the United States, which for modeling purposes are aggregated into 48 representative plants in each region. Investment in new generation capacity and retirement of existing facilities are determined in a dynamic framework, based on capacity-related costs of providing service in the future. Generator dispatch in the model is based on the minimization of short-run variable costs of generation (876).

Their study revealed that RPS policies raised electricity prices and mainly reduces gas-fired generation (Palmer and Burtraw 2005). "A knee of the cost curve exists between 15% and 20% goals for 2020 in our central case," meaning the cost of electricity significantly increased between 15% and 20% RPS targets. Furthermore, "higher natural gas prices lower the cost of greater reliance on renewables." Lower electricity prices, at the expense of taxpayers, could come from a renewable energy production tax credit. However, shifting the cost of the policy onto taxpayers limited its effectiveness as a means to reduce carbon emissions. A renewable energy production tax credit was also less cost-effective at increasing renewable energy than an RPS, and neither of the two aforementioned policies was as cost-effective as a cap-and-trade policy for achieving carbon emission reductions.

Another study recommends a different approach to energy policy in the form of a Fossil Energy Reduction Standard (FERS) (Casten 2009). The author of the paper claims that if there is a universal goal behind renewable energy policy, it is the reduction in use of non-renewable fossil fuels. The FERS would be a single incentive paid to power plants to reduce demand for fossil fuel resources in proportion to reductions in fossil energy consumption. The principles of FERS are that all clean energy credits are equal, and that the number of credits available should be based on the amount of fossil energy reduced. The targets for fossil fuel demand and consumption reduction should be difficult, but not impossible. Furthermore, clean energy credits should only go to new generation installed after the commencement of the FERS. FERS strikes a balance between carbon dioxide policies that penalize emissions and RPS policies that incentivize clean energy sources with no penalty for dirty ones.

There is diversity within the literature regarding different types and aspects of energy policy. Some papers analyze the economic impacts of different policies in the Midwest and Ohio (McCarron 2002). The empirical effectiveness of Renewable Portfolio Standards (RPS) in encouraging new renewable energy development is another subject of interest for researchers (Carley 2009, Haitao and Powers 2010). Comparative studies of different scales of RPS, MGPOs, REPTCs, and cap-and-trade policies project the effectiveness and impacts of these different policies (Delmas et al. 2011, Bird et al. 2011, Palmer and Burtraw 2005). The implementation of a FERS provides another possible policy option towards a more sustainable energy future (Casten 2009). These energy policies offer many possible pathways towards sustainable energy provision: the key to success is in their design.

Data Analysis Introduction

Much of the literature on energy policies focuses on the empirical efficacy of certain policies in achieving their goals. While these goals vary widely across policies, it is important to take into account the unique context that applies to each policy. I have created a database that serves as an inventory for those states that have an energy policy, what the content of each policy is, the energy flows of each state (in terms of production, consumption, and importation), and two contextual variables. The two contextual variables, geographic location and political alignment, provide important data points to compare and draw out possible relationships between these two factors and the energy situation and existing policies of each state.

There are several conclusions found in the literature that are independently tested with the data I have collected. I hypothesize that enactment of RPS policies and geographic location in the United States are not robust indicators of the proportion of energy generation in states that comes from renewable sources, and that the strength of RPS policies is not based upon location (Carley 2009). Furthermore, I predict that states that are politically left leaning have larger proportions of their energy generation coming from renewable sources and have stronger RPS policies (Carley 2009). Finally, I postulate that Ohio's energy policy will be weaker relative to some policies based upon descriptive statistics of the RPS policies.

Data Analysis Methods

The data utilized in the spreadsheet came from several different sources. The majority of the RPS data came from the online Database of State Incentives for Renewables and Efficiency (DSIRE). The database included: the year of enactment, year effective, baseline year, energy targets, trading of Renewable Energy Credits (RECs), solar carve-outs, and eligible technologies for each energy policy. The technologies addressed included nuclear, natural gas, landfill gas, coal, and ethanol. Additional supplementary RPS data came from the Federal Energy Regulatory Commission's website, which included a map of the United States that was color-coded with different state policies and their respective goals. The 1980 and 2009 energy data came from the Energy Information Administration's (EIA) State Energy Data System on their website. The data used from the EIA included production, consumption, and net import of energy from the power sector from different energy sources across the 50 states and Washington, D.C. The 1992 election data in the spreadsheet came from an online election atlas. The election data included Electoral College and popular vote data for both the Democratic and Republican candidates in each state and nationally.

The data, and calculations based on the data, have been compiled in an Excel spreadsheet. For most yes or no (Y/N) variables, 0=no and 1=yes. The exceptions are the three presidential election columns. The "1992 Presidential Election EC Vote" column represents the Electoral College vote, specifically, 1=state where college voted for George Bush, 0=state where college voted for Bill Clinton. The "1992 Presidential Election Pop Vote (D)" column represents the percentage of people in each state that voted for Bill Clinton, and the "1992 Presidential Election Pop Vote (R)" column represents the percentage of people who voted for George Bush in each state. The "Capacity in Final Year (MW)" column represents the installed capacity required to comply with policies that measured compliance in terms of installed capacity instead of or in addition to percent of sales. The operational definition of "conventional energy" used in the spreadsheet is the combination of coal, natural gas, and crude oil. The "2009 % Other Renewable Energy" refers to all non-ethanol biofuel renewable energy production. All negative variables in reference to "Net Import" and "% Net Import" represent net exportation, while positive values from either of these two categories represents net importation. Furthermore, there are 24 million tons of coal coke imported into the US in 2009 not attributed to any of the states in the net importation variables due to a lack of appropriate allocation methodology. The correlations were calculated with the CORREL function in Excel 2008 for Mac; the multiple regression analyses and tests of significance for the regressions were calculated using the

Analysis ToolPak in Excel 2007 for PC. The statistical significance of the correlations was determined through comparison of the correlation coefficients with a table of critical r-values for a two-tailed test at the .05 alpha level (Price 2000). T-tests comparing the means of different regions according to certain variables with the alpha level set at .05 were performed in Excel 2008 for Mac.

Regions of the country were defined according to the U.S. Census Bureau's definition of regions: Northeast, South, Midwest, and West (U.S. Census Bureau). The Northeast consists of: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, and Pennsylvania. The Midwest is comprised of: Indiana, Illinois, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota. The South includes: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, and Texas. The West is composed of: Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, Wyoming, Alaska, California, Hawaii, Oregon, and Washington.

Table 1: Energy Policy and 1992 Election Data Summary Statistics

Category	Mean	Sum	Median	Mode	Min	Max	Standard Deviation	Range	Source of Data
RPS (Y/N)	0.78	40.00	1.00	1.00	0.00	1.00	0.44	1.00	DSIRE
Binding (Y/N)	0.74	29.00	1.00	1.00	0.00	1.00	5.18	1.00	DSIRE
Year First Enacted	2004.33	78169.00	2006.00	2007.00	1983.00	2011.00	4.49	28.00	DSIRE
Final Year	2020.35	80814.00	2020.00	2025.00	2010.00	2030.00	9.16	20.00	DSIRE
% in Final Year	20.98	776.30	20.00	15.00	10.00	50.00	6.65	40.00	DSIRE
% by 2020	16.81	588.30	16.00	10.00	7.00	33.00	3263.58	26.00	DSIRE
Capacity in Final Year (MW)	2905.83	17435.00	1550.00	#N/A	105.00	8000.00	1.29	7895.00	DSIRE
Solar Carve-Out % by Final Year	1.48	17.80	1.25	1.50	0.20	4.00	0.23	3.80	DSIRE
Nuclear (Y/N)	0.05	2.00	0.00	0.00	0.00	1.00	0.31	1.00	DSIRE
Natural Gas (Y/N)	0.11	4.00	0.00	0.00	0.00	1.00	0.00	1.00	DSIRE
Landfill Gas (Y/N)	1.00	38.00	1.00	1.00	1.00	1.00	0.00	0.00	DSIRE
"Clean Coal" (CCS) (Y/N)	0.11	4.00	0.00	0.00	0.00	1.00	0.31	1.00	DSIRE
Ethanol (Y/N)	0.08	3.00	0.00	0.00	0.00	1.00	0.27	1.00	DSIRE
REC Trading (Y/N)	0.84	32.00	1.00	1.00	0.00	1.00	0.37	1.00	DSIRE
1992 Presidential Election EC Vote	0.35	18.00	0.00	1.00	0.00	1.00	0.48	1.00	US Election Atlas
1992 Presidential Election Pop Vote (D)	42.01	2142.40	42.50	43.50	24.70	84.60	8.51	59.90	US Election Atlas
1992 Presidential Election Pop Vote (R)	37.67	1921.30	37.30	42.90	9.10	49.70	6.42	40.60	US Election Atlas

[1]

40 states have at least some form of a renewable or alternative energy policy. 29 of these states have a legally binding standard. The first RPS policy was enacted in Iowa in 1983, and one policy was enacted as recently as 2011 in Indiana. The mean year of RPS enactment is approximately 2004. While final target years range between 2010 and 2030, the mean final target year is approximately 2020. The percent of the states' energy sales from renewable energy by the final policy year ranges from 10% to 50%, with a mean of approximately 21%. By 2020, the mean percent of states' energy sales from renewable energy required by RPS policies is approximately 17%. For those policies that include a minimum carve-out for photovoltaic energy, the mean solar carve-out is approximately 1.5%. Most policies do not consider natural gas, coal, nuclear, or ethanol as eligible sources for policy compliance. 32 of the 40 policies

[1] Cells in the "Mode" column, that are labeled as "#N/A," indicate that no mode was found because all data points were unique and without repetition for that variable.

have provisions that accepted Renewable Energy Credit trading as a mechanism for policy compliance. Since Bill Clinton won the 1992 Presidential Election, the Electoral College and popular vote columns reflect his victory over George Bush.

Table 2: 1980 and 2009 Energy Production and Consumption Data Summary Statistics

Category	Mean	Median	Mode	Min	Max	Standard Deviation	Range	Source of Data
2009 % Coal Consumption	0.45	0.47	0.00	0.00	0.97	0.30	0.97	EIA
2009 % Natural Gas Consumption	0.18	0.11	0.00	0.00	0.93	0.20	0.93	EIA
2009 % Petroleum Consumption	0.04	0.00	0.00	0.00	1.00	0.17	1.00	EIA
2009 % Nuclear Consumption	0.18	0.16	0.00	0.00	0.66	0.19	0.66	EIA
2009 % Hydroelectric Consumption	0.10	0.02	0.00	0.00	0.85	0.19	0.85	EIA
2009 % Biomass Wood and Waste Consumption	0.02	0.00	0.00	0.00	0.26	0.04	0.26	EIA
2009 % Geothermal Consumption	0.00	0.00	0.00	0.00	0.07	0.01	0.07	EIA
2009 % Solar/PV Consumption	0.00	0.00	0.00	0.00	0.01	0.00	0.01	EIA
2009% Wind Consumption	0.02	0.00	0.00	0.00	0.14	0.03	0.14	EIA
2009 % Total Conventional Energy Consumption	0.67	0.71	#N/A	0.00	1.00	0.25	1.00	EIA
2009 % Total Renewable Energy Consumption	0.14	0.06	0.00	0.00	0.89	0.21	0.89	EIA
2009 Total Energy Consumption (Trillion Btus)	746.95	543.00	508.00	0.50	3556.80	668.26	3556.30	EIA
2009 % Coal Production	0.17	0.00	0.00	0.00	0.93	0.27	0.93	EIA
2009 % Natural Gas Production	0.14	0.01	0.00	0.00	0.81	0.23	0.81	EIA
2009 % Crude Oil Production	0.08	0.00	0.00	0.00	0.74	0.16	0.74	EIA
2009 % Nuclear Production	0.26	0.13	0.00	0.00	0.94	0.29	0.94	EIA
2009 % Ethanol Biofuel Production	0.06	0.00	0.00	0.00	0.73	0.16	0.73	EIA
2009 % Other Renewable Energy Production	0.28	0.16	1.00	0.00	1.00	0.33	1.00	EIA
2009 % Total Renewable Energy Production	0.34	0.16	1.00	0.00	1.00	0.35	1.00	EIA
2009 % Total Conventional Energy Production	0.38	0.11	0.00	0.00	1.00	0.41	1.00	EIA
2009 Total Production (Trillion Btus)	1424.31	575.26	#N/A	0.04	11915.00	2354.30	11914.95	EIA
2009 Total Consumption (Trillion Btus)	1852.37	1429.35	#N/A	158.14	11297.41	1966.40	11139.27	EIA
2009 Net Import (Trillion Btus)	428.06	588.12	#N/A	-9816.41	5400.20	2118.59	15216.61	EIA
2009 % Net Import	-0.16	0.61	#N/A	-18.87	1.00	2.86	19.87	EIA
1980 % Coal Production	0.23	0.00	0.00	0.00	0.96	0.33	0.96	EIA
1980 % Natural Gas Production	0.11	0.00	0.00	0.00	0.73	0.20	0.73	EIA
1980 % Crude Oil Production	0.13	0.01	0.00	0.00	0.88	0.20	0.88	EIA
1980 % Nuclear Production	0.16	0.01	0.00	0.00	0.75	0.23	0.75	EIA
1980 % Other Renewable Energy (Non-Fuel Ethanol) Production	0.36	0.19	1.00	0.00	1.00	0.36	1.00	EIA
1980 % Total Renewable Energy Production	0.36	0.19	1.00	0.00	1.00	0.36	1.00	EIA
1980 % Total Conventional Energy Production	0.47	0.58	0.00	0.00	1.00	0.43	1.00	EIA

The table above represents summary statistics calculated on energy consumption and production data from 2009 and production data from 1980. According to the calculations above, the U.S. consumes more energy than it exported in 2009. However, the values for "2009 % Net Import" across the different states are skewed because a small handful of states exported vast quantities of energy above their own intrastate consumption. Most of the energy the U.S. consumed in 2009 was from fossil fuel energy, particularly coal. These sources were followed by nuclear power in terms of electricity production and consumption, and renewable energy was only a tiny fraction of the total energy consumed and produced; the majority of the renewable energy consumed was hydroelectric. The proportion of both conventional energy and other energy produced decreased between 1980 and 2009, while the proportion of nuclear and renewable energy increased during the same period.

Figure 1

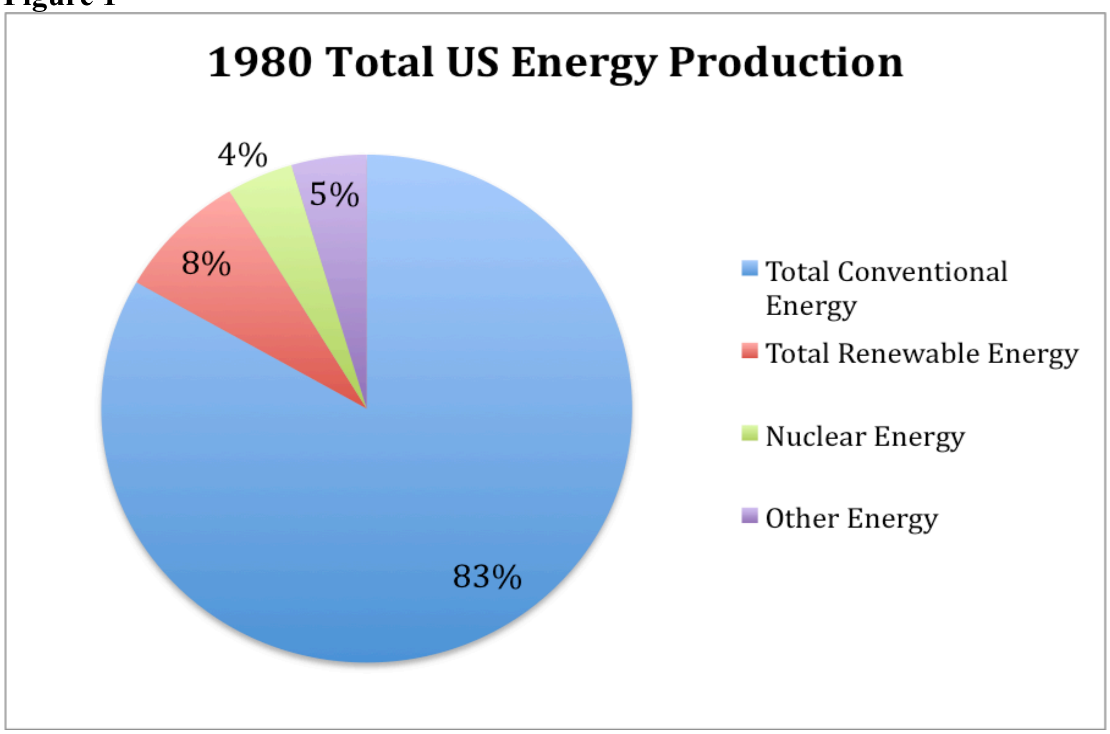
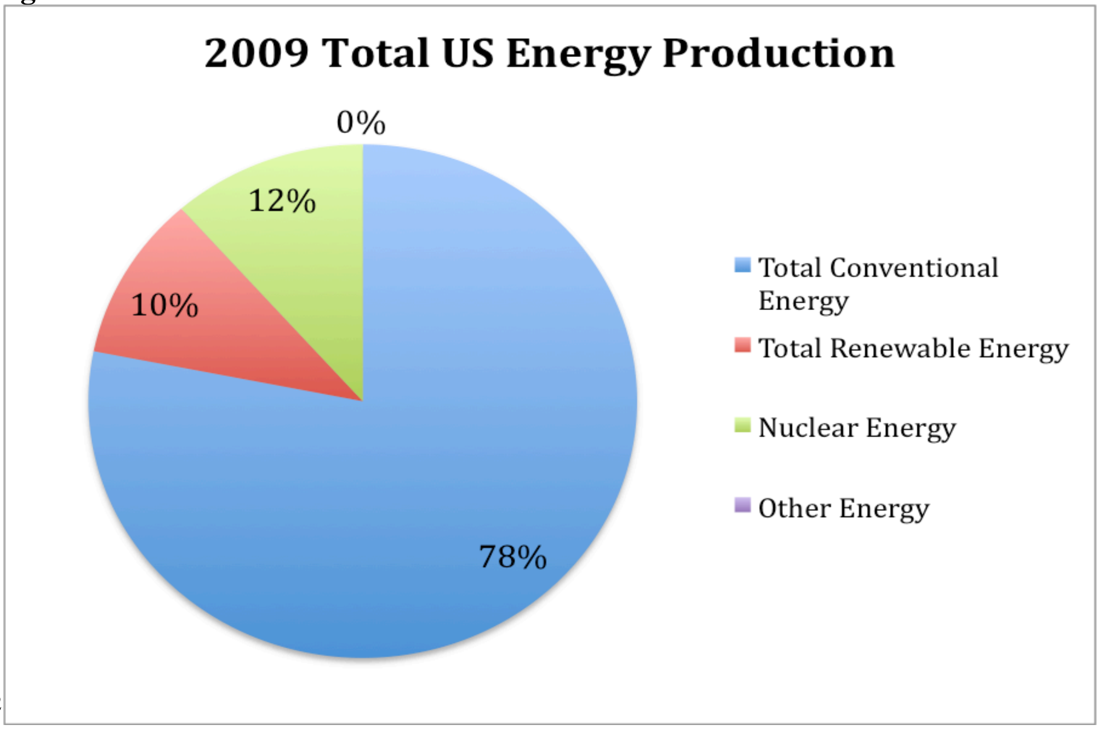


Figure 2



[2]

Discussion of Results

The correlation matrix provided some interesting outcomes, leaving room for interpretation of the results. The percentage of renewable energy by 2020 has a statistically significant -0.35 correlation with year the RPS passed ($p < 0.05$), which could mean that early adopters of RPS policies had more aggressive targets for 2020 than states that enacted them later. However, the correlation between "Year Passed" and "% by Final Year" was not statistically significant. "2009 % Conventional Energy Production" has a .41 correlation with "Year Passed," and "1980 % Conventional Energy Production" has a .42 correlation with "Year Passed": both correlations were statistically significant. These values might suggest that states having a higher proportion of their energy production from fossil fuels adopted policies later than states with lower fossil fuel production. This is corroborated by negative correlations for both

[2] 1980 and 2009 Other Energy was calculated by subtracting conventional, renewable, and nuclear energy source production totals from the total energy produced from all sources.

2009 and 1980 % total renewable energy production with "Year Passed", -.36 and -.29 respectively. However, only the former correlation was statistically significant. Thus, states with higher proportions of renewable energy production adopted policies earlier.

The "1992 EC Vote" has a statistically significant correlation of -.40 with "% by 2020," which could suggest that states in the 1992 Electoral College that voted for the democratic candidate tended to have higher RPS targets by 2020. There were no statistically significant correlations between "Solar Carve-Out" and any of the other variables. This could have been in part due to the small sample size of nine states with solar carve outs measured as a percent of sales in the final year of the standard. Both 2009 and 1980 % total conventional energy production have a positive and statistically significant correlation of .39 with "RPS Natural Gas," which indicates that states that have elevated proportions of their energy production coming from conventional sources were more likely to include natural gas as an eligible energy source for their RPS. In addition, "RPS Natural Gas" has statistically significant correlations of .68 and .85 with "RPS Nuclear" and "RPS Coal" respectively, which is reflected in the data that the majority of states that included natural gas as an eligible energy source in their standard also included other finite resources. 1980 % conventional energy production has a statistically significant correlation of .28 with "1992 EC Vote," suggesting that states with higher conventional energy production were more likely to have voted for the republican presidential candidate in 1992.

Both the 2009 and 1980 % conventional energy production categories have positive and statistically significant correlations with "1992 Pop Vote (R)," .29 and .35 respectively, providing evidence that conventional energy production is a larger share of the energy production mix in states that voted for the republican candidate in the popular vote of the 1992 presidential election. The conventional energy production correlations are inversely related to renewable energy production: "1992 Pop Vote (R)" has a -.44 correlation with "1980 Total Renewable Energy Production". An interesting correlation is -.45 between "2009 % Net Import" and "2009 % Conventional Energy Production," which shows that states with a higher proportion of conventional energy production export more conventional energy. Furthermore, "2009 % Net Import" has positive correlations of .28 and .30 with 2009 and 1980 total renewable energy production respectively, indicating that states that import more energy also have higher shares of renewable energy and lower percentages of conventional energy within the in-state mix of energy production. The data supports these calculations, as states that exported large quantities of energy were typically big oil-producing states, such as Wyoming and Texas (US Energy Information Administration 2011).

Multiple regression analyses yielded results based upon the relationship of geographic factors to other variables. Latitude and longitude were not statistically significantly related to either conventional or renewable energy production in 1980 or 2009. Furthermore, "2009 % Net Import" and "2009 % Conventional Energy Consumption" were not statistically significantly related to latitude or longitude. However, latitude and longitude were statistically significantly related to "2009 % Renewable Energy Consumption" with p values of .0006 and .003 respectively. This suggests that northeastern states consumed more renewable energy proportionally than other regions of the country. However, this explanation contradicts the mean 2009 % Total Renewable Energy consumption for the northeast, which shows that states in the west consume nearly double the percentage of renewable electricity in each state as compared to northeastern states.

The T-tests show that the Midwest, which includes Ohio, is statistically significantly different from the Northeast according to several variables. The Midwest voted on average less for the democratic candidate (39%) and more for the republican candidate (38%) in the 1992 presidential election than the Northeast (44% and 33% respectively), with calculated p-values of .043 and .019. The Midwest, in 1980, on average produced more conventional energy as a percent of the total energy produced in the region (53%) and less renewable energy (28%) than the Northeast (10% and 57% respectively), with p-values of approximately .015 and .043 respectively. The Midwest also consumed more conventional energy in 2009, as a proportion of total energy consumed in the region (73%), than the Northeast (45%), with a p-value of approximately .008. T-tests ran comparing the South and the West with the Midwest were not statistically different from zero at the .05 alpha level.

Data Analysis Conclusion

Based upon the analyses conducted, some conclusions can be drawn. The negative correlations between renewable energy production and republican voting and positive correlations between conventional energy production and republican voting suggest that states in which a larger proportion of the population voted for the republican candidate favor the use of fossil fuels for energy production and downplay renewable energy production. The results of correlations regarding voting for the democratic candidate are unable to demonstrate statistically that states which voted proportionally more for the democratic candidate produce proportionally more renewable energy and less fossil fuels in terms of the mix of state level production, even though all of the correlations that utilize those variables point toward that conclusion. Although there are states that in the popular vote voted democratic in the 1992 presidential election, and have large proportions of their energy production from renewable sources, there is no statistically significant relationship between these two variables across all states. Unfortunately, an analysis of this kind with consumption data from 1980 was not possible due to the lack this information.

There is limited evidence to suggest that a relationship exists between political preference and RPS policy strength. There is a statistically significant correlation between the percent of sales from renewable energy required by 2020 and the Electoral College vote that indicates the percentages are higher in states that voted for the democratic candidate in the presidential election in 1992. While both democratic and republican states have positive and negative correlations respectively with both the "% by 2020" and "% by Final Year," none of these relationships are statistically significant. The correlations that tested the relationship between Electoral College vote, popular democratic and republican voting in 1992 and the presence of a solar carve-out suggest that democratic states are more likely to enforce a solar carve-out as part of their RPS, but none of these correlations are statistically significant. None of the three voter variables have statistically significant relationships with "RPS REC Trading;" thus, it is difficult to claim that the presence of REC trading is the product of partisan efforts. The lack of statistically significant correlations between political preference and variables that measure the strength of an RPS policy make it difficult to draw any conclusions about these relationships.

The Midwest voted more conservatively in the 1992 presidential election than the Northeast. The Midwest produced and consumed more conventional energy in 1980 and 2009 and produced less conventional energy in 1980 than the Northeast statistically. Ohio is representative of these trends as a Midwestern state. Ohio's energy consumption in 2009 was derived from almost 88% conventional energy sources, with 84% coming from coal alone. Energy production in 1980 was provided by approximately 89% conventional energy, 71% of which was coal. In 2009, about 75% of the state's electricity production came from conventional energy sources, of which nearly 64% was derived from coal. The 14% decline in the production of conventional energy sources between 1980 and 2009, relative to all sources produced, was overwhelmingly due to increased nuclear energy production.

Ohio's Alternative Energy Portfolio Standard

In 2008, Ohio Governor Ted Strickland signed substitute Senate Bill 221 into law. This established an AEPS for the state of Ohio, making Ohio the 27th state to establish a renewable electricity standard (Pew Center on Global Climate Change). It mandates that by 2025 at least 25 percent of all electricity sold in Ohio must come from alternative energy resources. 12.5% of this electricity must be generated by renewable energy sources, including wind, solar, biomass, geothermal, and hydropower. A minimum of .5% of the state's total electricity sold by 2024 must be provided by solar energy. 12.5% of the electricity sold in Ohio by 2025 can come from alternative energy sources, which include third generation nuclear power plants, clean coal, fuel cells, and energy efficiency programs. Half of the state's renewable energy-sourced electricity generated must be generated within state boundaries, and the rest must be capable of being transmitted into Ohio (Ohio Air Quality Development Authority 2009). Utilities must reduce peak demand by 1% by 2009, an additional .75% for each year after 2009 until 2018. Peak demand reductions after 2018 are to be determined by the state legislature.

A system of Renewable Energy Credits (RECs) was instituted; each REC is defined as one megawatt of power with a five-year lifetime (Ohio Department of Development 2010). RECs can be traded between utilities or owners of credits to comply with annual renewable energy sales targets (Holt and Bird 2005). Thus, if Ohio's utilities were to fail to generate and sell enough renewable electricity in a given year to comply with that year's target, the utilities could buy RECs to cover the shortfall of intrastate generation and sales. By the end of 2025, electric utilities must increase energy efficiency by 22.5% through the implementation of energy efficiency programs (Ohio Department of Development 2010). SB 221 includes clauses for cost limitations and allowances for non-compliance for reasons beyond a utility's control or force majeure. Utilities are not required to meet annual benchmarks if it is "reasonably expected" to raise their costs by 3% or more above business as usual without the standard.

The Public Utility Commission of Ohio (PUCO) is responsible on an annual basis for monitoring utilities' level of compliance with renewable and solar energy standards, and imposing penalties if the standards are not met (Ohio Department of Development 2010).

> The alternative compliance payment (ACP) for the renewable portion was initially set at $45/MWh, but will be adjusted annually by PUCO according to the federal Consumer Price Index. The Solar Alternative Compliance Payment (SACP) is set at $450/MWh in 2009, reduced to $400/MWh in 2010 and 2011, and will be reduced by $50 every two years thereafter to a minimum of $50/MWh in 2024.

Compliance payments will be deposited into the Ohio Advanced Energy Fund, whose purpose is to provide financial support to renewable energy and energy efficiency projects in Ohio (Ohio Department of Development 2010). Utilities are not allowed to burden customers with the costs of compliance payments. If PUCO determines that a utility fails to comply with either the energy efficiency or peak demand reduction requirements, the commission must demand from the utility: "An amount, per day per under-compliance or non-compliance, not greater than $10,000 per violation" or "An amount equal to the then existing market value of one renewable energy credit per megawatt hour of under-compliance or noncompliance" (Ohio Department of Development 2010). The revenue generated from non-compliance penalties is deposited into the state's Advanced Energy Fund.

When compared to other states, Ohio's AEPS is relatively weak in several aspects. The percent of renewable energy sales by 2020 and the percent in the final policy year of 2024 are both only half the mean and median values of all RPS policies. Ohio is one of only two states that permit the use of nuclear energy ("advanced" nuclear) in its AEPS. It is also one of four states to permit the use of natural gas (in the form of coalmine methane) and "clean" coal through Carbon Capture and Sequestration (CCS). The use of coalmine methane is meant to prevent methane emissions by combusting the material and releasing carbon dioxide instead; it is an analogous resource to landfill gas ("Coalbed Methane Outreach Program"). Overall, lower than average targets in percentage terms and the eligibility of nonrenewable resources leave this policy lagging behind that of other states like California.

Ohio Energy and Unemployment Spatial Analysis

The National Renewable Energy Laboratory has created visual maps of the abundance of renewable energy sources for Ohio ("Global Solar Radiation at Latitude Tilt-Annual, Ohio," Wind Powering America 2010). Wind speeds at 80 meters elevation are highest in the northwestern half of the state, and lowest in the southeastern half (Wind Powering America 2010). The southwestern border of the state has the highest annual level of solar radiation that could be utilized for photovoltaic panels, with the rest of the state at a slightly lower level of potential ("Global Solar Radiation at Latitude Tilt-Annual, Ohio"). Biomass resources are concentrated in the northwest corner of the state and also near Columbus. The distribution of these resources suggest that efforts to develop these sources for energy production will disproportionately benefit the western half of the state, particularly in the northwestern part of Ohio.

With wind and solar photovoltaic panels as eligible sources of renewable energy under Ohio's AEPS, the possibility for direct benefits for citizens of Ohio in terms of employment and financial incentives is worth exploration (Pew Center on Global Climate Change). Residential and non-residential landowners in Ohio can receive financial incentives for leasing part of their land to utilities to site wind turbines (Windustry). Furthermore, AEP (American Electric Power) Ohio provides financial incentives for both residential and non-residential wind turbines and solar photovoltaic panels that commit their RECs to AEP Ohio (AEP Ohio). Turbines and photovoltaic panels must be installed after July 1st, 2011 and before June 30th, 2013 to be eligible for these incentives. Various size requirements and funding limits apply. The creation of local jobs to install these production facilities and the revenues accrued to Ohio landowners could potentially yield economic benefits for Ohioans. Some companies are even working to create public-private partnerships to revitalize communities in Ohio through reduced energy costs and local job creation (Burger 2012). I performed a spatial analysis to determine whether any win-win investments exist to install renewable energy in resource rich areas that concurrently have high levels of unemployment.

I created a spatial analysis of Ohio with four maps: unemployment by county for December 2011 (not seasonally adjusted), resource potential maps for wind at a height of 80 meters, biomass yield, and solar radiation (Bureau of Labor Statistics, Wind Powering America 2010, "Biomass Resources-Ohio," "Global Solar Radiation at Latitude Tilt-Annual, Ohio"). I divided Ohio on all four maps into a twenty-four-region grid that is 5x5 cells (with cell 25 excluded because no land within Ohio's borders was captured within this region) using tables in PowerPoint, which is included in Appendix D. The numbering convention is one through twenty-four, reading West to East, North to South. For each of these regions, I calculated an average value for percent unemployment, wind speed at 80 meters, biomass yield in thousands of tonnes per year, and average annual kWh/m^2/day of solar radiation. Additional assumptions are included in Appendix C.

Table 3: Spatial Analysis Data

Ohio Region	Average Unemployment (%)	Average Wind Speed at 80m (m/s)	Average kWh/m^2/day Solar Radiation	Biomass Yield (Thousand Tonnes/Year)
1	8.5	5.86	4.25	287.5
2	8.95	5.355	4.25	226.25
3	9.4	6.45	4.25	140
4	8.15	4.595	4.25	162.5
5	6.85	5.515	4.25	70
6	7.3	6.05	4.25	188.75
7	8.44	6.25	4.25	175
8	9.25	6.16	4.25	133.75
9	6.05	5.94	4.25	113.75
10	8.5	5.11	4.25	100
11	7.3	6.075	4.25	155
12	7.5	5.969	4.25	146.5
13	6.45	5.575	4.25	115
14	9.7	4.95	4.25	97.5
15	8.56	4.89	4.25	50
16	8.53	4.625	4.425	111.25
17	10	5.635	4.25	184
18	9.1	5.025	4.25	225
19	10.3	4.545	4.25	61
20	8.8	4.45	4.25	65
21	9.1	4.88	4.255	93.75
22	11.5	4.84	4.3	99.75
23	10.3	4.38	4.25	85.25
24	10.6	4.4	4.25	50

I then performed correlation coefficient calculations using Excel between unemployment and wind speed, and unemployment and biomass yield. Visual inspection indicated there was insufficient variation of solar radiation across the state to calculate meaningful correlation coefficients. The results were approximately -.49 for unemployment and wind and -.17 for unemployment and biomass. The former was significant at ($p<.05$), while the latter was not. The statistically significant negative coefficient reflects the lack of wind in the southeast, where unemployment is highest, and the presence of the best winds in the northwest, where unemployment is lower. However, given the high overall level of unemployment, there is still ample opportunity to improve local communities and help Ohio transition towards renewable sources of energy in spite of the lack of a statistical correlation between renewable resource abundance and unemployment (Bureau of Labor Statistics). Just looking at the unemployment and resource potential maps, one can see that there is overlap between elevated levels of unemployment and higher wind speeds at 80 meters for Ottawa County. While any wind project will require greater resolution data and understanding of realities on the ground in these communities, this may be one possible location where development of wind energy and economic revitalization could go hand in hand. There was also a statistically significant correlation between wind speed at 80m and biomass yield: .51 at ($p<.05$). This reflects the northwestern concentration of renewable energy resources for both biomass and wind.

Federal Renewable Energy Policy vs. State Policies

The debate over a national renewable energy requirement has raged on for over a decade (Davies 2010). More than twenty-five national RPS policy proposals have been introduced on Capitol Hill since 1997, but no policy has passed both chambers (Davies 2010, Nogee et al. 2007). Diversification of energy supplies, reductions in natural gas demand and prices, job creation, economic gains, and environmental benefits have all driven this policy approach to the fore (Nogee et al. 2007). Interest in developing a federal RPS policy also stems from the potential to increase the size of the renewable energy market well beyond what is possible under existing state RPS policies. One estimate asserts that the maximum amount of new renewable energy capacity installation from state standards as of 2007 would be over 46 GW, or approximately 6 percent of total U.S. electricity sales (Nogee et al. 2007). However, a federal RPS that required 20 percent of national electricity sales be derived from renewable electricity by 2020 would support the development of up to four fold more capacity over the status quo. The inclusion of a national floor in all proposed federal RPS policies, and the flexibility of allowing states to exceed this minimum, suggest that a combination of both policies would lead to the greatest increase in renewable energy capacity.

Leveling the playing field by requiring all states and electricity providers to share in the cost of renewable energy investment is equitable and popular, both publicly and politically (Nogee et al. 2007). This would prevent the free riding of states that do not have policies, and could be implemented on a sliding pay scale based upon the wealth of a state. A national RPS would create one set of rules for the most efficient trade of RECs. The uniformity of the legislation has the potential to lower the costs of renewable energy through larger economies of scale and the existence of a nationwide market for the most cost-effective resources. This policy incentivizes development of renewable energy in the most cost-effective and resource-abundant regions of the country. The greater concentration of projects in areas that are most favorable for development will likely reduce transaction costs because suppliers will be able to purchase credits and avoid negotiating numerous smaller contracts with individual renewable energy projects. The EIA and UCS have performed several analyses that estimate the costs and benefits of various RPS proposals (Nogee et al. 2007). These analyses indicate, with a diverse set of assumptions, that a 20 percent national RPS is both feasible and beneficial to consumers through the reduction of natural gas and electricity prices. Furthermore, a federal RPS of 20 percent would diversify the system of electricity provision, encourage local economic development, improve national energy security, and reduce greenhouse gas emissions.

Those that oppose a national RPS policy take issue with its enactment on different grounds (Sovacool and Cooper 2006). Some utilities fear the policy will be too expensive to implement, and threaten that regulatory cost burdens would be imposed upon consumers. Evidence cited for increased costs include the misguided concern that certain renewable energy technologies, which are ill suited for some geographic regions, must be developed in those areas. Thus, the fear is that a national policy may force utilities to choose more expensive sources of renewable energy. On the other hand, developing renewable energy primarily in areas with the greatest abundance of renewable energy could prevent states like Ohio from sharing in the direct benefits of renewable energy development in terms of revenue generation and job creation for installation and maintenance. Lobbyists and analysts from the Edison Electric Institute and the Alliance for Competitive Electricity have voiced concerns that a national RPS would be extraordinarily challenging to design, monitor, and enforce. There are also electricity system operators who have cautioned that a power grid relying largely on intermittent renewable generators would create significant technical challenges and complicate system management. Additionally, they often consider renewable energy as "non-dispatchable" because they are not capable of generating electricity on demand. Some politicians claim such a policy is inequitable to states that have more limited renewable energy resources, and many citizens have verbalized they do not want to see renewable energy installations near their residences: exemplary of the NIMBY (Not In My Back Yard) defense. The mix of opinions regarding a national RPS policy has thus far prevented any from passing into law.

Ohio is an important state in the context of the national energy policy debate. Ohio has much room for increasing its share of renewable energy production and consumption given that 75% of its energy is produced from conventional sources and 88% of its energy consumption is fossil fuel-based (U.S. Energy Information Administration 2011). Arguments against a national RPS would put Ohio at risk because it lacks abundant renewable resources relative to certain states, which could potentially increase costs to consumers who would bear a disproportionately high burden of renewable energy development costs (Sovacool and Cooper 2006). Others would likely disagree, claiming a well-designed federal RPS policy would reduce electricity costs to consumers by encouraging states with abundant renewable resources to specialize in and export their surplus energy to areas that have less potential for renewables. However, under this scenario, a massive investment in new transmission lines will be necessary to send electricity from areas with high renewable energy potential to population centers, which could add costs to consumers either through increased rates or taxation to pay for this infrastructure (Caperton 2011). A more distributed approach with many state policies may obviate some of the need for significant transmission line overhaul, which could reduce costs. Both national and state RPS policies could reduce costs over business-as-usual (BAU) if a national cap and trade or carbon tax policy is enacted in the future. However, a national RPS policy may be able to develop more and cheaper renewable energy to achieve required reductions in carbon emissions due to the efficiencies of deploying renewable energy in areas with high wind speeds and solar radiation (Davies 2010, Bird et al. 2011). While no study has specifically performed a cost-benefit analysis of a national RPS policy on Ohio across sectors, there are potential costs and benefits to the state of Ohio under either approach.

Concluding Thoughts

The world is nearing critical tipping points, some of which have already past. Oil production has stabilized (Kerr 2011, Heinberg 2009, Rudolf 2010). Renewable energy remains an insignificant proportion of the energy portfolio of this country, no less globally (U.S. Energy Information Administration 2011, Heinberg 2009). Climate change threatens the long-term stability of human societies, and our current energy sources have played an enormous role in creating this state of affairs (Hansen et al. 2011). Climate scientists like James Hansen claim we must reduce atmospheric concentrations of CO_2 to 350ppm or lower to avoid catastrophic climate change. Humanity cannot afford to continue emitting greenhouse gases, and eliminating them from our energy infrastructure is imperative because they contribute up to 40% of total greenhouse gas emissions (Lokey 2007). Ohio's energy profile is one of the dirtiest in the country, and it must be held accountable for utilizing these energy sources (U.S. Energy Information Administration 2011). While national carbon taxes and cap and trade programs aimed at combating climate change have failed to gain political traction in the United States and much of the world, command and control programs on the state level have been enacted into law (Davies 2010). If national leadership on energy and climate policy remains politically elusive, then states like Ohio must continue to lead and dramatically improve their energy standards to address the concerns of climate scientists and energy analysts.

Works Cited

"Biomass Resources-Ohio." Map. *National Renewable Energy Laboratory*. 25 Sept. 2007. Web. 21 Mar. 2012. <http://www.nrel.gov/gis/pdfs/eere_biomass/eere_biomass_h_ohio.pdf>.

Bird, Lori, Caroline Chapman, Jeff Logan, Jenny Sumner, and Walter Short. "Evaluating Renewable Portfolio Standards and Carbon Cap Scenarios in the U.S. Electric Sector." *Energy Policy* 39.5 (2011): 2573-585.

Burger, Andrew. "Groups Look to Locally Grown Solar Power to Revitalize Ohio Communities." *CleanTechnica*. 27 Feb. 2012. Web. 07 Mar. 2012. <http://cleantechnica.com/2012/02/27/groups-look-to-locally-grown-solar-power-to-revitalize-ohio-communities/>.

"Cap and Trade 101." *US Environmental Protection Agency*.

Caperton, Richard W. "FERC Helps Line Up Clean Energy Projects with New Rule." *Center for American Progress*. 28 July 2011. Web. 08 Mar. 2012. <http://www.americanprogress.org/issues/2011/07/ferc_order_1000.html>.

Carley, Sanya. "State Renewable Energy Electricity Policies: An Empirical Evaluation of Effectiveness." *Energy Policy* 37.8 (2009): 3071-081.

Casten, Sean. "A Better Renewable Portfolio Standard." *The Electricity Journal* 22.5 (2009): 29-33.

"Census Regions and Divisions of the United States." *U.S. Census Bureau*. Web. 8 Dec. 2011. <http://www.census.gov/geo/www/us_regdiv.pdf>.

"Coalbed Methane Outreach Program." *US Environmental Protection Agency*. 23 Dec. 2011. Web. 20 Jan. 2012. <http://www.epa.gov/cmop/>.

Davies, Lincoln L. "Power Forward: The Argument for a National RPS." *Connecticut Law Review* 42.5 (2010): 1339-403. *University of Connecticut Law Review Network*. 9 Aug. 2010. Web. 16 Feb. 2012. <http://uconn.lawreviewnetwork.com/files/documents/LincolnL.Davies_000.pdf>.

Delmas, Magali A., and Maria J. Montes-Sancho. "U.S. State Policies for Renewable Energy: Context and Effectiveness." *Energy Policy* 39.5 (2011): 2273-288.

"Global Solar Radiation at Latitude Tilt-Annual, Ohio." Map. *National Renewable Energy Laboratory*. 25 Sept. 2007. Web. 7 Mar. 2012. <http://www.nrel.gov/gis/images/eere_pv/eere_pv_ohio.jpg>.

Haitao, Yin, and Nicholas Powers. "Do State Renewable Portfolio Standards Promote In-State Renewable Generation?" *Energy Policy* 38.2 (2010): 1140-149.

Hansen, J.E., and Mki. Sato, 2011: Paleoclimate implications for human-made climate change. In *Climate Change at the Eve of the Second Decade of the Century: Inferences from Paleoclimate and Regional Aspects: Proceedings of the Milutin Milankovitch 130th Anniversary Symposium*. A. Berger, F. Mesinger, and D. Šijači, Eds. Springer, in press.

Heinberg, Richard. *Searching For A Miracle: "Net Energy" Limits & The Fate Of Industrial Society*. Rep. International Forum on Globalization and the Post-Carbon Institute, 10 Nov. 2009. Web. 4 Oct. 2011. <http://www.ifg.org/pdf/Searching%20for%20a%20Miracle_web10nov09.pdf>.

Holt, Ed, and Lori Bird. *Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges*. Rep. National Renewable Energy Laboratory, Jan. 2005. Web. 4 Mar. 2012. <http://apps3.eere.energy.gov/greenpower/resources/pdfs/37388.pdf>.

Kerr, Richard A. "Peak Oil Production May Already Be Here." *Science* 331.6024 (2011): 1510-511. *Sciencemag.org*. 25 Mar. 2011. Web. 3 Oct. 2011. <http://www.sciencemag.org/content/331/6024/1510.full>.

Klare, Michael. "Hormuz-Mania: Why Closure of the Straits of Hormuz Could Ignite a War and a Global Depression." *Post Carbon Institute: Energy Bulletin*. TomDispatch.com, 31 Jan. 2012. Web. 02 Feb. 2012. <http://www.energybulletin.net/stories/2012-01-31/hormuz-mania-why-closure-straits-hormuz-could-ignite-war-and-global-depression>.

Lokey, Elizabeth. "How The Next US President Should Slow Global Warming." *Energy Policy*

35.11 (2007): 5399-402. *OhioLink*. Elsevier Science. Web. 16 Feb. 2012. <http://journals.ohiolink.edu/ejc/pdf.cgi/Lokey_Elizabeth.pdf?issn=03014215&issue=v35i0011&article=5399_htnupssgw>.

"Ohio-Average Annual Wind Speed at 80m." Map. *Wind Powering America*. National Renewable Energy Laboratory, 20 Oct. 2010. Web. 7 Mar. 2012. <http://www.windpoweringamerica.gov/images/windmaps/oh_80m.jpg>.

"Ohio Adopts Alternative Energy Portfolio Standard." *Pew Center on Global Climate Change*. Web. 1 Feb. 2012. <http://www.pewclimate.org/node/5922>.

"Ohio's Advanced Energy Portfolio Standard." Ohio Air Quality Development Authority. Web. 1 Feb. 2012. <http://development.ohio.gov/wind/Documents/OHIO_AEPS_FINAL_04-22-09.pdf>.

"Leasing Your Land to a Developer." *Windustry*. Web. 07 Mar. 2012. <http://www.windustry.org/leases>.

Leip, David. "1992 Presidential General Election Results." *US Election Atlas*. 2005. Web. 14 Oct. 2011. <http://uselectionatlas.org/RESULTS/national.php?year=1992>.

McCarron, John. *Job Jolt: The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland*. Rep. Horizon Wind, Nov. 2002.

Nogee, A., J. Deyette, and S. Clemmer. "The Projected Impacts of a National Renewable Portfolio Standard." *The Electricity Journal* 20.4 (2007): 33-47. *OhioLink*. Elsevier Science. Web. 16 Feb. 2012. <http://journals.ohiolink.edu/ejc/article.cgi?issn=10406190&issue=v20i0004&article=33_tpioanrps&search_term=%28ohio+renewable+portfolio+standard%29>.

Palmer, Karen, and Dallas Burtraw. "Cost-Effectiveness of Renewable Electricity Policies." *Energy Economics* 27.6 (2005): 873-94.

Price, Ian. "Testing the Significance of Pearson's R." *University of New England*. 2000. Web. 08 Dec. 2011. <http://www.une.edu.au/WebStat/unit_materials/c6_common_statistical_tests/test_signif_pearson.html>.

"Regional Energy Deployment System (ReEDS): Background of Model." *National Renewable Energy Laboratory*.

"Renewables & Energy Efficiency - Generation & Efficiency Standards." Federal Energy Regulatory Commission, 20 Sept. 2011. Web. 14 Oct. 2011. <http://www.ferc.gov/market-oversight/othr-mkts/renew/2011/09-2011-othr-rnw-archive.pdf>.

"RET Incentive Program." *AEP Ohio*. Web. 7 Mar. 2012. <https://www.aepohio.com/save/renewable/RETIncentiveProgram.aspx>.

Rudolf, John Collins. "Is 'Peak Oil' Behind Us?" *NYTimes.com*. 14 Nov. 2010. Web. 02 Oct. 2011. < http://green.blogs.nytimes.com/2010/11/14/is-peak-oil-behind-us/ >.

"Rules, Regulations & Policies for Renewable Energy." *Database of State Incentives for Renewable and Efficiency*. US Department of Energy. Web. 14 Oct. 2011. <http://www.dsireusa.org/summarytables/rrpre.cfm>.

"Senate Bill 221 - Ohio's Commitment to Advanced Energy." *Ohio Department of Development*. 31 Oct. 2010. Web. 1 Feb. 2012. <http://development.ohio.gov/Energy/Tools/AdvancedEnergyPortfolioStandard.htm>.

Sovacool, Benjamin K., and Christopher Cooper. "Green Means 'Go?'—A Colorful Approach to a U.S. National Renewable Portfolio Standard." *The Electricity Journal* 19.7 (2006): 19-32. *OhioLink*. Elsevier Science. Web. 16 Feb. 2012. <http://journals.ohiolink.edu/ejc/pdf.cgi/Sovacool_Benjamin_K.pdf?issn=10406190&issue=v19i0007&article=19_gmcataunrps>.

"State Energy Data System: 1960-2009 Estimates." *U.S. Energy Information Administration (EIA)*. 30 June 2011. Web. 14 Oct. 2011. <http://www.eia.gov/state/seds/seds-data-complete.cfm>.

"Unemployment Rates by County, Not Seasonally Adjusted, Ohio December 2011." Map. *Bureau of Labor Statistics*. United States Department of Labor. Web. 07 Mar. 2012. <http://data.bls.gov/map/MapToolServlet?survey=la>.

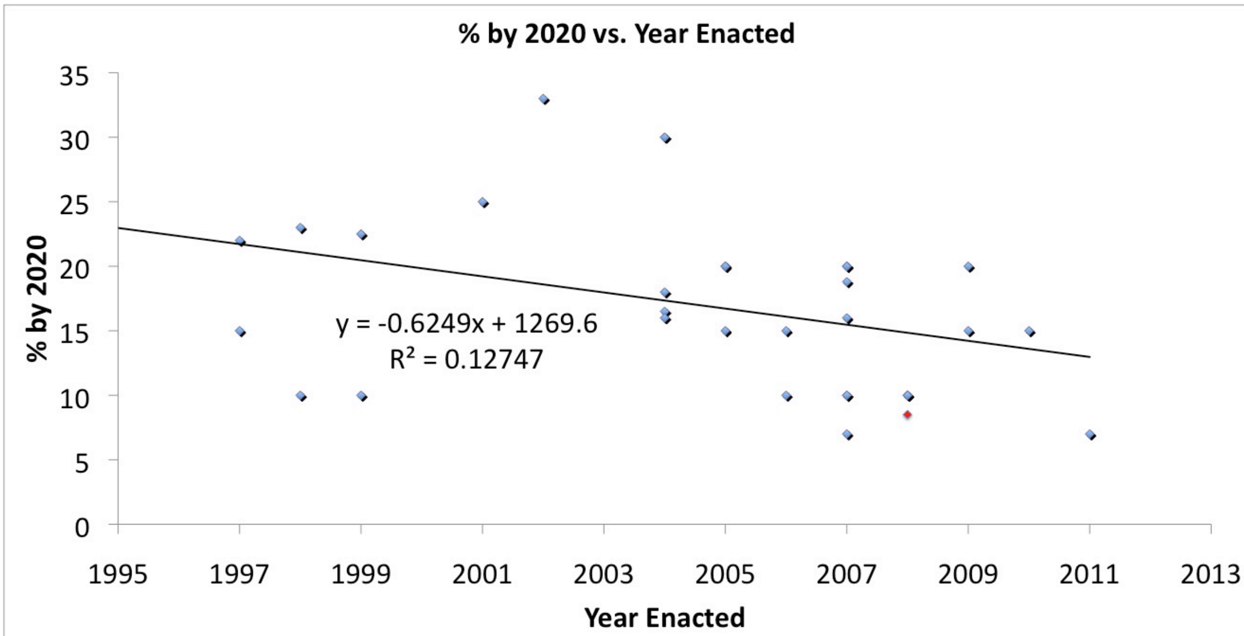
Appendices

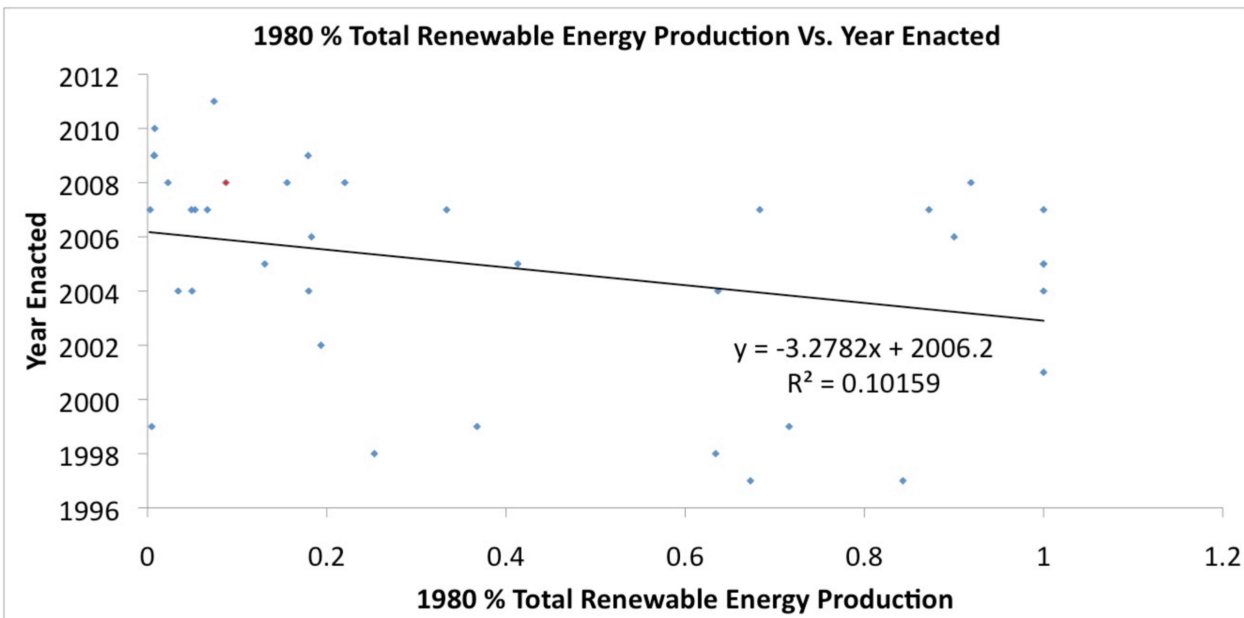
Appendix A: Additional Data Analysis Assumptions

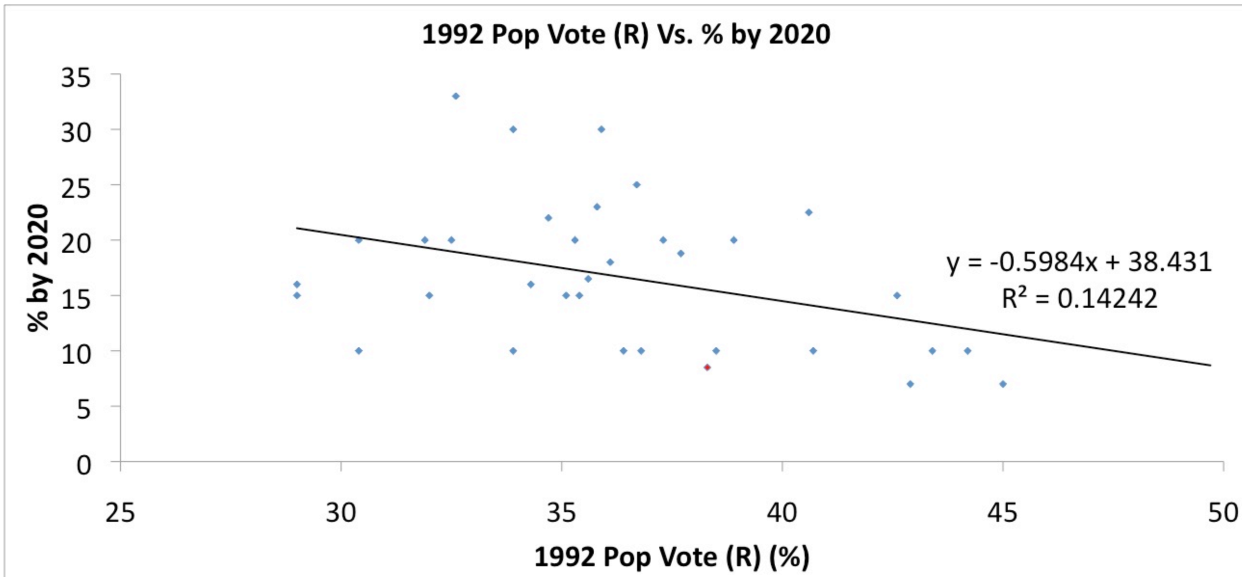
- One set of "2009 Total Consumption in Trillion Btus" data comes from the "sum btu all" spreadsheet that examines power sector consumption only, whereas another set of "2009 Total Consumption in Trillion Btus" examines total electrical consumption of all sectors in the "2009 Energy Production and Consumption Comparison" spreadsheet. The former has much smaller numbers than the latter
- Some zeros in 2009 StateElectricityConsumption sheet actually range between +.05 and -.05, rather than simply being zero.
- 10% out of ME's 40% in "% in Final Year" must come from *new* resources
- *all* 15% of MA's "% in Final Year" must come from *new* resources
- *all* 10% of MI's "% in Final Year" refers to 10% of the MWh *generated*
- MN in "% in Final Year" cell refers to 30% by 2020 for Xcel utility, 25% by 2025 for other MN utilities
- UT's 20% in "% in Final Year" cell represents 20% of *adjusted sales*
- IA's "% by 2020" is actually 105MW installed capacity, thus it is a blank cell in the % by 2020 column
- The 10% in ME's "% by 2020" cell represents the 10% of new resources that must be installed by 2017, since this is the deadline year of the whole policy
- The 20% in MN's "% by 2020" cell represents 20% for non-Xcel utilities by 2020, 30% by 2020 for Xcel: the 20% for non-Xcel utilities was the number entered into the spreadsheet for calculations
- The TX cells in "% in Final Year" and "% by 2020" are blank because their policy is in terms of MW installed: 5,880MW by 2015, 500MW have to come from non-wind sources
- UT's "% by 2020" cell is blank because 2025 is first compliance year, no interim targets before then
- IA "Capacity in Final Year (MW)" cell refers to 105MW installed capacity with a 1 GW wind capacity goal: 105 was the number entered into the spreadsheet for calculations
- TX cell in "Capacity in Final Year (MW)" refers to 5,880MW installed by 2015, but the state also has a 10,000MW total installed renewable energy capacity goal by 2025
- "Solar Carve-Out % by Final Year" is in terms of sales
- DC's "Solar Carve-Out by Final Year" cell, which has "2.5" entered into the spreadsheet, refers to 2.5% of sales by 2023, 3 years after the final year of the policy (2020)
- MA's cell in "Solar Carve-Out by Final Year" column is blank because MA's carve-out is in terms of installed capacity: 400MW of in-state installed capacity by 2020
- MN's "Solar Carve-Out by Final Year" cell refers to: Maximum 1% from solar by 2020 from Xcel, with 24% of sales by 2020 from wind
- NJ's "Solar Carve-Out % by Final Year" is in terms of GWh sold, rather than % of sales (thus the cell is blank in the spreadsheet), and it is 6 years after the policy's final year: 5316 GWh by 2026
- NY's .2% "Solar Carve-Out % by Final Year" is actually due by 2018, 3 years after policy deadline
- OR's "Solar Carve-Out % by Final Year" is actually in terms of MW installed capacity, rather than % sales, thus it is blank in the spreadsheet: 20MW sized between 500kW and 5MW by 2020

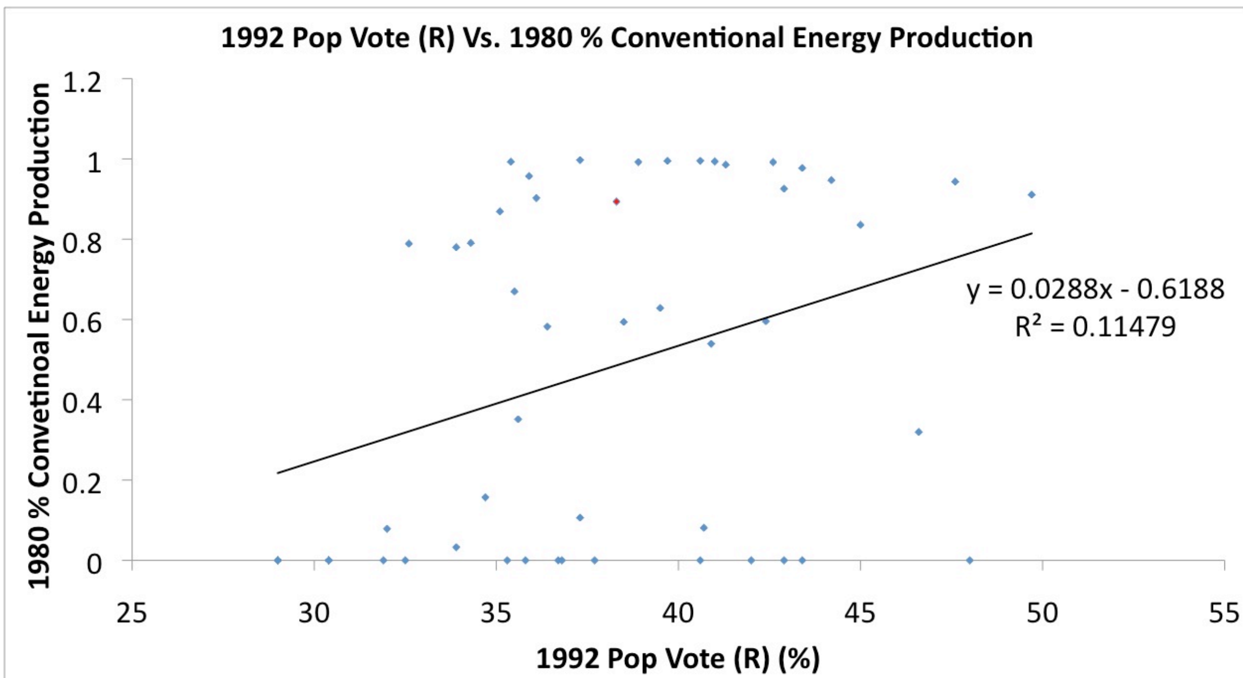
- OH’s “Nuclear (Y/N)” cell is “1” because Ohio considers ‘advanced nuclear’ as eligible for their policy
- IN’s “Natural Gas (Y/N)” cell is “1”, which refers to coal bed methane gas as an eligible energy source in their policy
- OH’s “Natural Gas (Y/N)” cell is “1”, which refers to coal mine methane gas as an eligible energy source in their policy
- PA’s “Natural Gas (Y/N)” cell is “1”, which refers to Coal Mine Methane and Coal Gasification as eligible energy sources in their policy
- WV’s “Natural Gas (Y/N)” cell is “1”, which refers to natural gas, coal bed methane, coal gasification or liquification, and integrated gasification combined cycle technology as eligible energy sources in their policy
- PA’s “Clean Coal (CCS) (Y/N)” cell is “1”, which refers to waste coal without carbon sequestration as an eligible energy source in their policy
- WV’s “Clean Coal (CCS) (Y/N)” cell is “1”, which refers to waste coal without carbon sequestration as an eligible energy source in their policy
- All red data points on charts indicate Ohio’s data point
- All graphs in “gedit” have had outlier points removed
    - On “gedit” sheet, outlier WY and WV data points were removed from “2009 % Total Conventional Energy vs. 2009 2009 % Net Import” because the % Net Import values were very negative (they are big exporters)
    - On “gedit” sheet, outlier NM data point was removed from “2009 % Net Import vs. Solar Carve-Out” because it was the only data point which had a negative 2009 % Net Import value (net exporter), and had a solar carve-out
    - On “gedit” sheet, outlier DC data point was removed from “1992 Pop Vote (R) vs. 1980 % Total Conventional Energy Production” because the Republican vote was exceptionally low
    - On “gedit” sheet, outlier IA data point was removed from “1980 % Total Renewable Energy vs. Year Enacted” because the year enacted was substantially earlier than other data points
    - On “gedit” sheet, outlier IA data point was removed from “Year Enacted vs. 1980 % Total Conventional Energy Production” because the year enacted was substantially earlier than other data points
- Bold correlations on correlation sheet are statistically significant at .05 alpha level
- Regions of country utilized for follow-up analysis for multiple regressions came from this source: "Census Regions and Divisions of the United States." *U.S. Census Bureau*. Web. 8 Dec. 2011. <http://www.census.gov/geo/www/us_regdiv.pdf>.
    - In “Latlon2” sheet, region key is 1=Northeast, 2=Midwest, 3=South, 4=West according to above defined regions, and all data is sorted by region

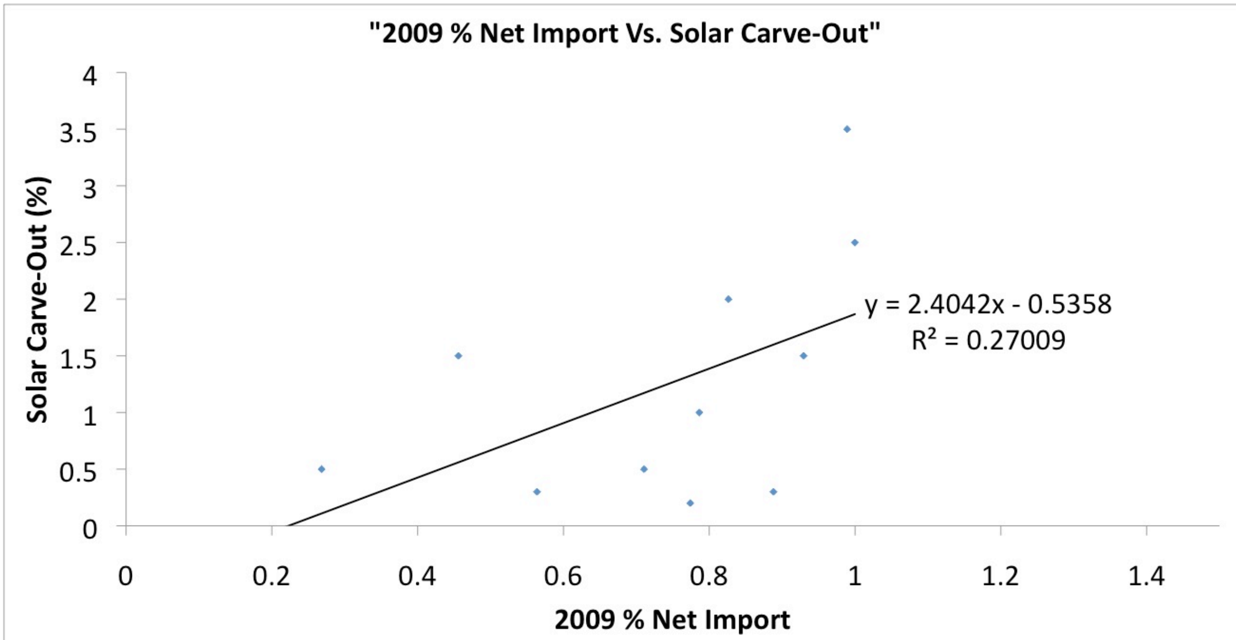
Appendix B: Data Analysis Correlation Graphics

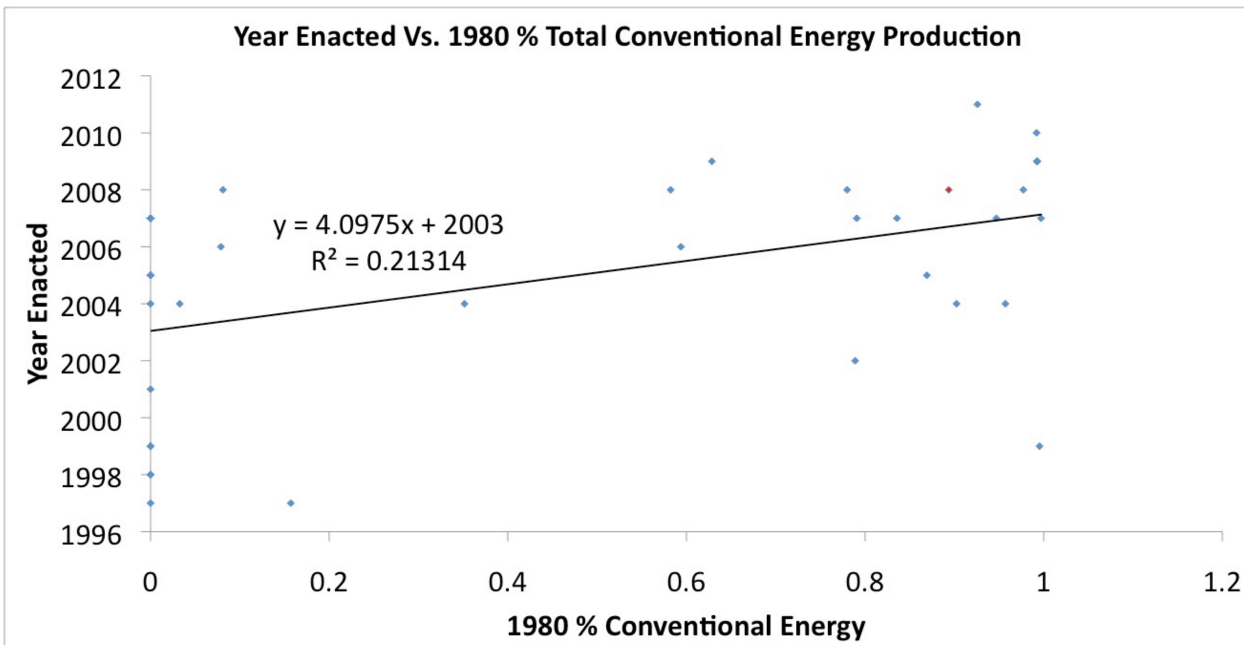





1992 Pop Vote (R) Vs. % by 2020
% by 2020
1992 Pop Vote (R) (%)
y = -0.5984x + 38.431
R² = 0.14242
0
5
10
15
20
25
30
35
25
30
35
40
45
50


1992 Pop Vote (R) Vs. 1980 % Conventional Energy Production
1980 % Convetinoal Energy Production
1992 Pop Vote (R) (%)
y = 0.0288x - 0.6188
R² = 0.11479
0
0.2
0.4
0.6
0.8
1
1.2
25
30
35
40
45
50
55





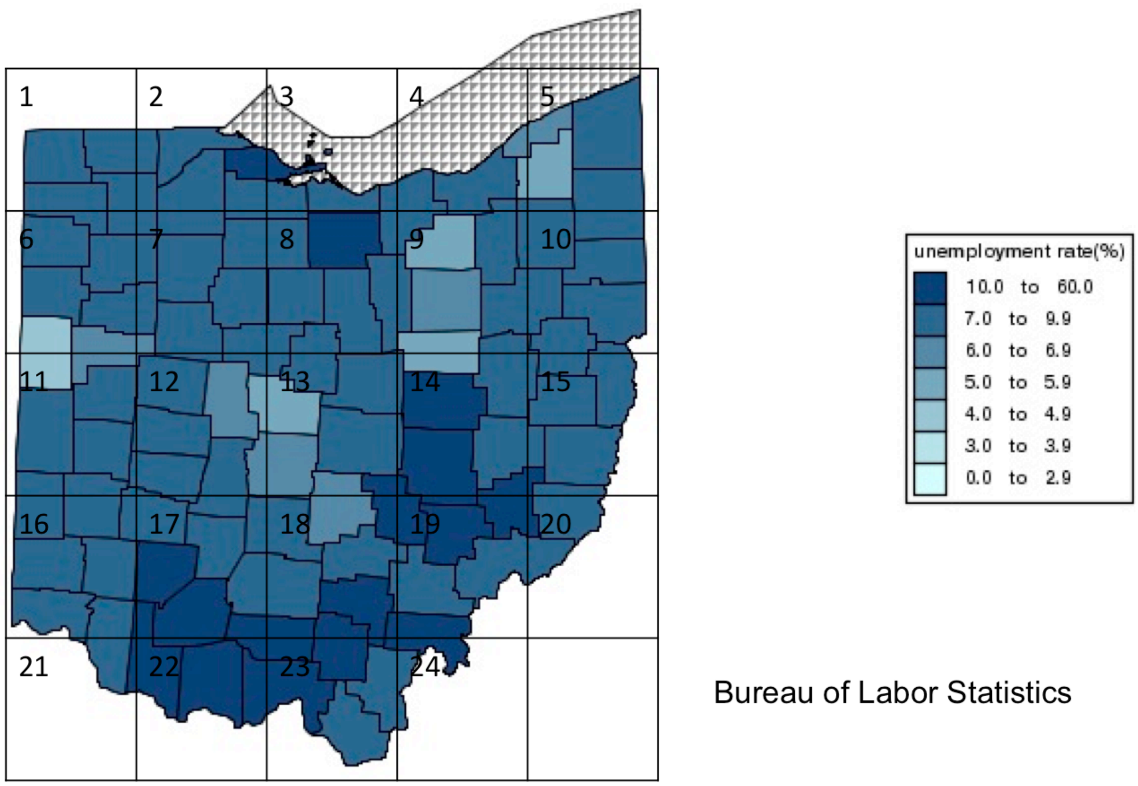
Appendix C: Additional Spatial Analysis Notes

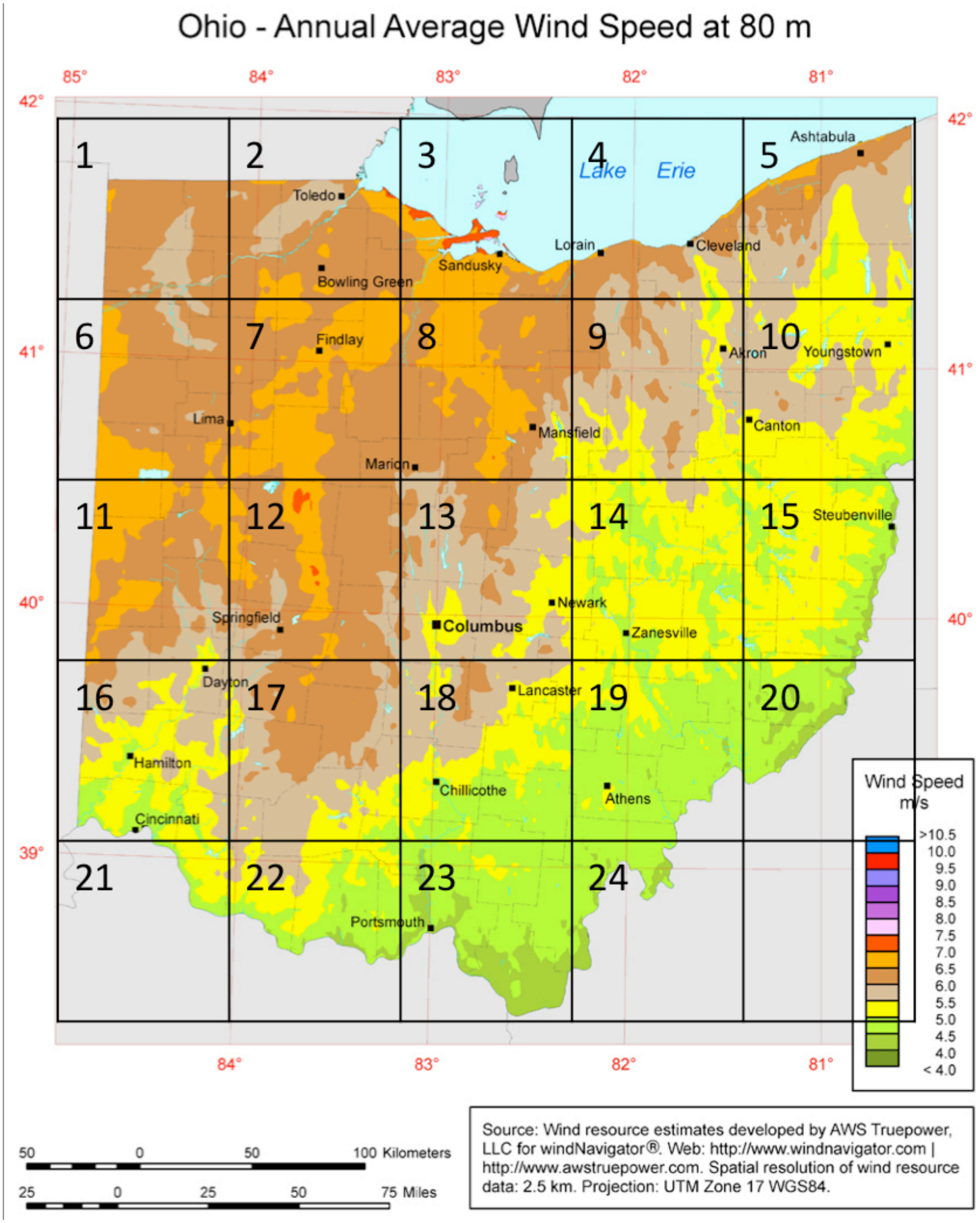
- For increments that were represented in ranges, as was the case with wind speed, biomass yield, and kWh/m^2/day solar energy, I took the average of the range, and used the average to represent the range in my calculations for the regional average. Percentages of land area covered in calculations are based upon land within state boundaries represented in grid lines.
  - One exception to this rule is with the unemployment data. For the highest unemployment level range (10%-60%), I took the average between 10% and 13% (11.5%) and used this number. I chose 13% as the upper bound because

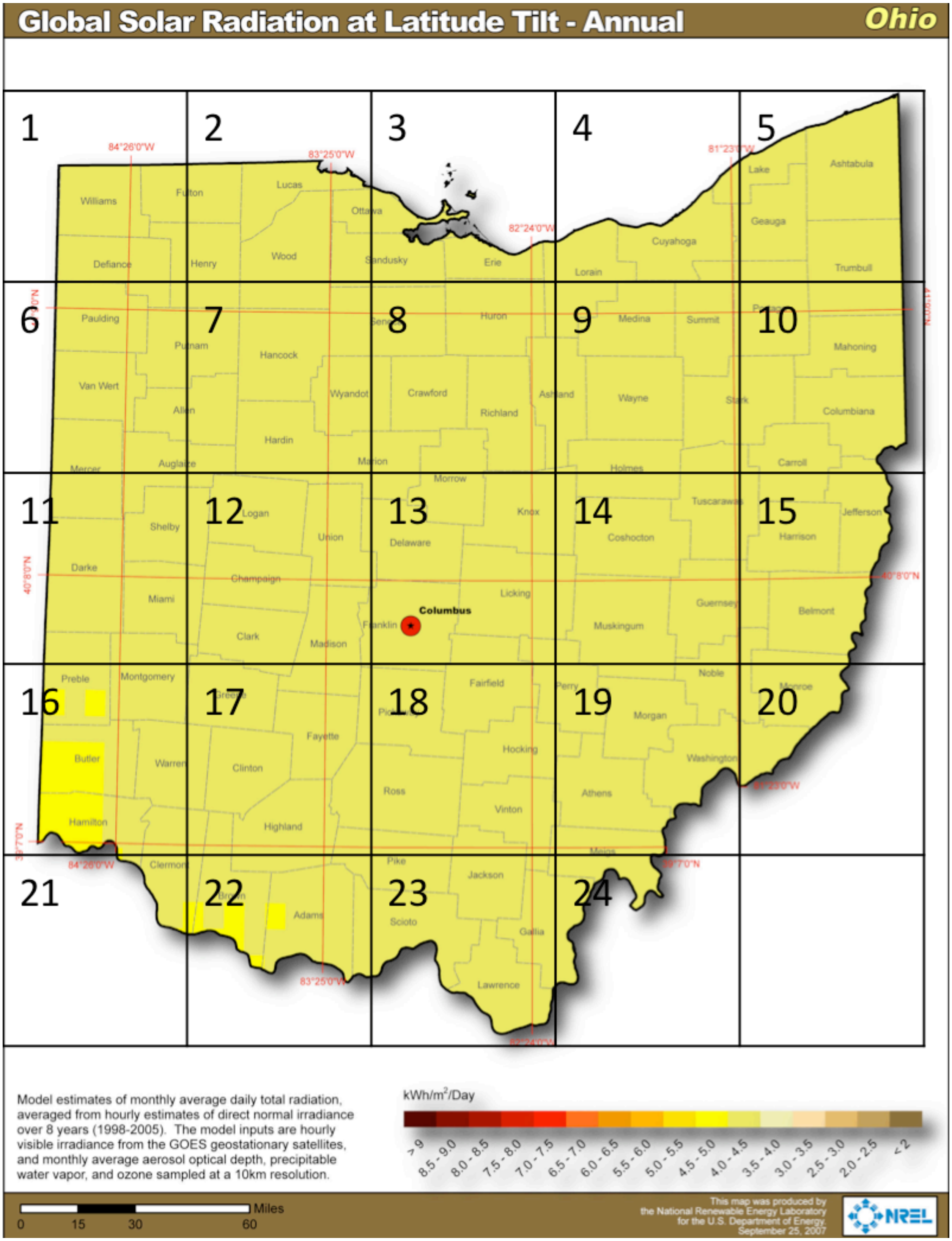
no county in Ohio had unemployment at 14% or greater-all were 13 or below. The other exception is biomass yields measured as “below 50 thousand tonnes per year” were entered into calculations as 25 thousand tonnes because it is an equal increment lower, and for lack of further information on more exact biomass yields.

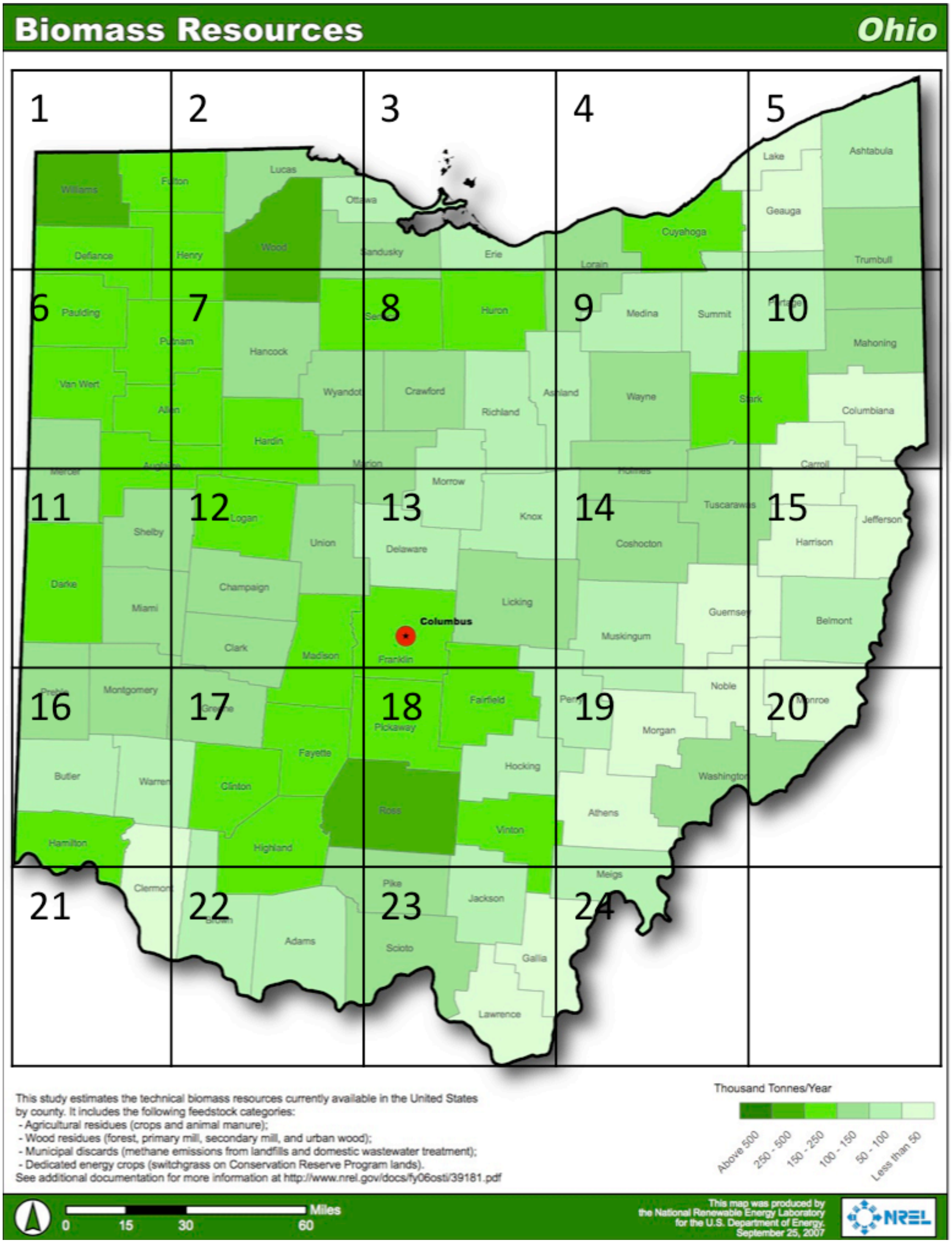
Appendix D: Spatial Analysis Maps

Unemployment rates by county, not seasonally adjusted, Ohio December 2011




Ohio - Annual Average Wind Speed at 80 m
85°
84°
83°
82°
81°
42°
41°
40°
39°
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Lake Erie
Ashtabula
Toledo
Sandusky
Lorain
Cleveland
Bowling Green
Findlay
Akron
Youngstown
Lima
Mansfield
Canton
Marion
Steubenville
Newark
Springfield
Columbus
Zanesville
Dayton
Lancaster
Hamilton
Chillicothe
Athens
Cincinnati
Portsmouth
Wind Speed m/s
>10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
50 0 50 100 Kilometers
25 0 25 50 75 Miles
Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: http://www.windnavigator.com | http://www.awstruepower.com. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 17 WGS84.


Global Solar Radiation at Latitude Tilt - Annual
Ohio
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Columbus
Williams
Fulton
Lucas
Ottawa
Defiance
Henry
Wood
Sandusky
Erie
Lorain
Cuyahoga
Lake
Ashtabula
Geauga
Trumbull
Paulding
Putnam
Hancock
Huron
Medina
Summit
Mahoning
Van Wert
Allen
Wyandot
Crawford
Richland
Ashland
Wayne
Stark
Columbiana
Mercer
Auglaize
Hardin
Marion
Morrow
Holmes
Carroll
Shelby
Logan
Union
Delaware
Knox
Coshocton
Tuscarawas
Harrison
Jefferson
Darke
Champaign
Licking
Guernsey
Belmont
Miami
Clark
Madison
Franklin
Muskingum
Preble
Montgomery
Greene
Fairfield
Perry
Noble
Monroe
Morgan
Fayette
Butler
Warren
Clinton
Hocking
Washington
Ross
Athens
Vinton
Hamilton
Highland
Meigs
Clermont
Pike
Jackson
Brown
Adams
Scioto
Gallia
Lawrence
84°26'0"W
83°25'0"W
82°24'0"W
81°23'0"W
41°9'0"N
40°8'0"N
39°7'0"N
Model estimates of monthly average daily total radiation, averaged from hourly estimates of direct normal irradiance over 8 years (1998-2005). The model inputs are hourly visible irradiance from the GOES geostationary satellites, and monthly average aerosol optical depth, precipitable water vapor, and ozone sampled at a 10km resolution.
kWh/m²/Day
> 9
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2
Miles
0
15
30
60
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy. September 25, 2007
NREL


Biomass Resources
Ohio
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Williams
Fulton
Lucas
Ottawa
Wood
Sandusky
Erie
Lorain
Cuyahoga
Lake
Geauga
Ashtabula
Trumbull
Defiance
Henry
Paulding
Putnam
Hancock
Seneca
Huron
Medina
Summit
Portage
Mahoning
Van Wert
Allen
Wyandot
Crawford
Richland
Ashland
Wayne
Stark
Columbiana
Hardin
Marion
Mercer
Auglaize
Morrow
Holmes
Carroll
Logan
Union
Knox
Tuscarawas
Jefferson
Shelby
Delaware
Coshocton
Harrison
Darke
Miami
Champaign
Licking
Guernsey
Belmont
Columbus
Clark
Madison
Franklin
Muskingum
Noble
Preble
Montgomery
Greene
Pickaway
Fairfield
Perry
Morgan
Monroe
Fayette
Butler
Warren
Clinton
Hocking
Washington
Ross
Athens
Vinton
Hamilton
Highland
Clermont
Brown
Adams
Pike
Jackson
Meigs
Scioto
Gallia
Lawrence
This study estimates the technical biomass resources currently available in the United States by county. It includes the following feedstock categories:
- Agricultural residues (crops and animal manure);
- Wood residues (forest, primary mill, secondary mill, and urban wood);
- Municipal discards (methane emissions from landfills and domestic wastewater treatment);
- Dedicated energy crops (switchgrass on Conservation Reserve Program lands).
See additional documentation for more information at http://www.nrel.gov/docs/fy06osti/39181.pdf
Thousand Tonnes/Year
Above 500
250 - 500
150 - 250
100 - 150
50 - 100
Less than 50
Miles
0
15
30
60
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy. September 25, 2007
NREL