ISSN 1933-8147

Fall 2009

ECONOMICS WORKING PAPERS

No. 21

THE AYES & NOES OF RENEWABLE ENERGY LEGISLATION: AN INVESTIGATION INTO THE POLITICAL DETERMINANTS OF CALIFORNIA'S RENEWABLE PORTFOLIO STANDARD

Wynne Auld

WHITMAN COLLEGE

Wynne Auld

The Ayes & Noes of Renewable Energy Legislation: An Investigation into the Political Determinants of California's Renewable Portfolio Standard

WORKING PAPER No. 21

The Ayes & Noes of Renewable Energy Legislation:

An investigation into the political determinants of California's Renewable Portfolio Standard

Wynne Auld

Whitman College

An Introduction to Energy Policy

Electric generation and transmission is the largest U.S. industry as measured by investment and revenues (Heiman, 2006). It is also conclusively linked to the nation's productivity: an economic analysis of G7 countries, including the U.S., concluded that a 1% increase in electricity consumption yields a 0.12–0.39% increase in real GDP (Sadorsky, 2009). Unfortunately, this cornerstone of the U.S. economy is also responsible for 66% of the nation's sulfur dioxide emissions, 25% of nitrogen oxides, and is the preeminent source of CO_2 emissions (Heiman, 2006). The link between atmospheric quality and energy is so compelling that environmental policy scholar Walter A. Rosenbaum predicted "for the first decade of the 21st century [the nation's environmental agenda] will become energy policy by another name" (252). Between the contrasting environmental and industry concerns, any energy policy can be controversial.

Renewable energy, however, sparks both environmental and industrial interests by posing an alternative to conventional fuel sources in the *lingua franca* of economic growth. Renewable energy has zero direct emissions and is a promising industry for the 21st century: it is expected to grow, create green-collar jobs, and provide hedging against volatile fossil fuel prices (www.cpuc.ca.gov). As a result of these social boons, state and federal policy makers have increasingly considered renewable energy policies. One of the most popular state policies is the Renewable Portfolio Standard (RPS). Twenty-four states to date have implemented an RPS, which require a certain percentage of a state's electricity be derived from renewable resources by a certain date. California's RPS regulates the largest U.S. state-economy and is among the most ambitious in the nation, proposing that 33% of the state's electricity be generated from renewable sources by 2020. A federal RPS has yet to gain any significant legislative traction, and other federal renewable energy policies have been temporary.

In the absence of a federal RPS or enduring federal incentives for renewable energy, the determinants of political support for RPS by state counties are particularly revealing as to the nation's energy future. This paper is aimed at quantitatively explaining state legislators' votes for California's RPS on the county level. Drawing on California legislators' voting records for the initial RPS vote in 2001 and the acceleration RPS vote in 2006, we employ different econometric strategies. First, we run cross-sectional models referring to California Assembly and Senate votes for each of the two years. We find that RPS voting mostly occurs along party lines. Counties that voted for George W. Bush in the 2000 and 2004 presidential elections, respectively, tended to vote against the RPS scheme. Second, we estimate a "difference-in-differences model" for California Assembly and Senate votes which yields similar findings suggesting that the voting behavior at U.S. presidential elections is also an excellent proxy variable for environment-related attitudes. We, therefore, also run a difference-in-differences model on the presidential votes in 2000 and 2004. We find that the following factors significantly decreased the fraction of votes for George W. Bush in the presidential elections and thus increased the votes for the RPS: (1) increasing unemployment, (2) increasing levels of college degrees, (3) decreasing median incomes and (4) a decline in air quality.

This paper will lay the foundation for the regression analyses by first exploring qualitative aspects of the energy industry. First, a brief history of energy policy, especially deregulation, will provide context for current legislation, including the RPS. Next, a theory section will explain theoretical motivation of policy makers when enacting renewable energy legislation. The theory will then be grounded by a discussion of empirical considerations facing Californian policy makers. Next, there is a review of the existing literature that contributed to building the regression models employed in this paper. Finally, the outcome of the regression analysis will be discussed.

A Brief History of Energy Policy

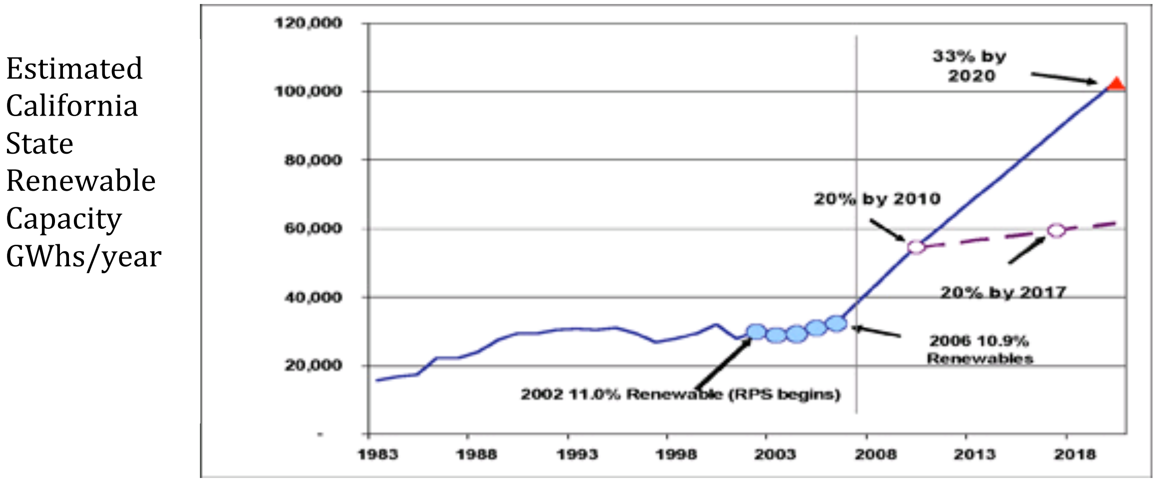
This brief history is meant to describe an industry that is often described by economists as the classic natural monopoly and a producer of the classic externality of pollution. Despite these exemplary characteristics, the electric utility industry is anything but textbook. The complex interweaving of state and federal power, regulation and deregulation, and industrial and environmental concerns make it a complex industry for which even slight nuances in policy have are highly contentious and have widespread effects.

The 1992 Energy Policy Act laid the foundation for the deregulation of one of the most enduring natural monopolies in the United States: the electricity industry. Historically, electric utilities had accepted government control of prices and an agreement to serve all customers in exchange for the exclusive right to service specific geographic areas (Tietenberg, 2006). In the 1970s and 1980s, a surge of technological advances, in addition to changing political sentiment under the Reagan and Thatcher administrations, eliminated or reduced the natural monopoly condition of many industries, including trucking, airline, natural gas, and telecommunications (Heiman, 2006). The 1992 Energy Policy Act represented a switch in the political paradigm of federal policy makers, one that both recognized technological advances that had altered the cost-curves upon which the former electric utility industry had been regulated and put greater trust in competitive markets to deliver efficiency (Heiman, 2006). Specifically, it became clear that although electric distribution had important characteristics of a natural monopoly, electric generation did not (Tietenberg, 2006). As a result, states' deregulation legislations enacted varying combinations of "unbundling" of electric generation from electric distribution (i.e. dismantling vertically-integrated electric providers) and "retail wheeling," which allowed customers to choose separate providers of wholesale power, transmission services, and local distribution.

In 1995, California legislators unanimously passed their state electricity deregulation bill, A.B. 1890. Notorious as a regulatory failure, A.B. 1890 partially deregulated the state's electric utility industry by setting a price ceiling on retail rates while allowing wholesale prices to fluctuate on the state's electricity trading floor, the California Power Exchange (CALPX). The problem arose in June 2000, when the wholesale price of electricity on the CALPX spiked sharply yet retail prices were capped at $65 per megawatt hour. Viscusi, Harrington, and Vernon (2006) estimate that at the peak of wholesale prices, retail electricity providers were collectively losing $50 million dollars per day. Unable to pay, utilities stopped buying electricity on the wholesale market and blackouts ensued.

The failure of deregulation was a shameful reality amidst political idealism. Californian policy-makers had high hopes for deregulation, especially with regard to state retail rates that were 50% higher than the national average (Tietenberg, 2006). Deregulation was not just about prices, though. It also opened up the possibilities of electricity generation from renewable sources. Heiman (2006) writes that many analysts predicted the dawn of a new energy era: "renewable energy would take off [… when] consumers could *choose* their power provider and utilities would no longer be enticed to build large central power plants under guaranteed rates of return" (emphasis added, 1052). Some policy makers have seen competition in the electric utility industry and development of renewable energy as complementary, and many RPS policies have been enacted in tandem with deregulation or market "restructuring" legislation (Cleveland, 2004).

Figure 1: California's Electric Capacity from Renewable Sources, 1983-2008



(http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF)

Despite policy makers' high hopes, renewable energy did not "take off," electricity prices did not fall, and the market power of California's Investor-Owned Utilities lingered. As seen in Figure 1, renewable energy capacity changed very little between the deregulation legislation in 1995 and the RPS legislation in 2001. Meanwhile, electricity prices climbed higher; rates in 2005 were 40% higher than those prior to deregulation (Viscusi, 2005). Finally, scholars blame some of California's fiasco on the market power of wholesale electric utilities, which likely withheld some power from the market to raise prices and capture monopoly profits (Puller, 2007; Tietenberg, 173).

Subsequent academic papers have concluded that the aims of deregulation related to renewable electricity may have been misled. The natural monopoly electric utility industry wasn't necessarily hostile to renewables[1]; in fact, California's renewable electric capacity increased at a greater rate under the regulated industry than the restructured scheme (Figure 1).

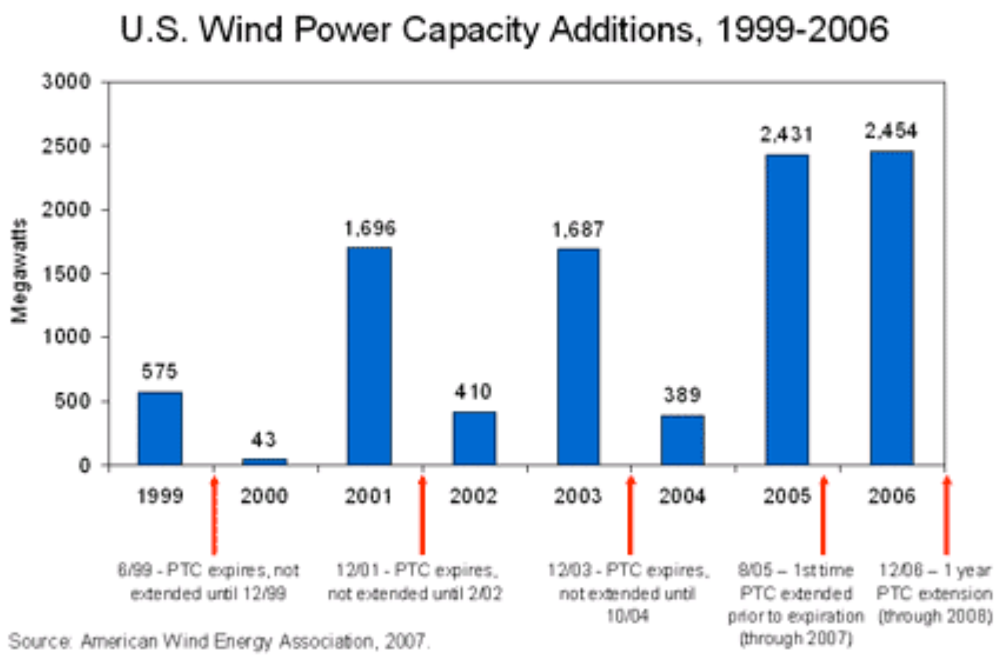
[1] Bohn and Lant (2009) conduct a regression study on the determinants of installed wind capacity by state, concluding a negative relationship between state utility restructuring and installed wind capacity. Bohn and Lant conclude regulated natural monopolies utilities can better maneuver barriers to entry such as price distortions, lack of storage capability, and transmission access.

Although the debacle of deregulation culminated in 2000-2001, when rolling blackouts hit millions of Californians (Tietenberg, 2006), deregulation's fundamental failures to lower prices, stimulate the rate of renewable energy production, and significantly open the market to competition prove its most salient ones.

In 2002, seven years after the deregulation legislation, California legislators passed the Renewable Portfolio Standard Bill, S.B. 1078 (RPS). The policy required that 20% of utilities' power be generated from renewable sources by 2017, according to a schedule of annual increases of the percentage of electricity from renewable sources. Subsequent legislation in 2006 accelerated that goal to 20% by 2010. Most recently, Governor Arnold Schwarzenegger issued Executive Order S-14-08, which set a goal, rather than a mandate, that 33% of utilities' power be generated from renewable sources by 2020 (http://www.cpuc.ca.gov). Electricity eligible for the RPS includes biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal, or tidal current-derived electricity (California's Public Utilities Code Section 383.5).

On a national level, federal legislators' support for renewable energy wavered since the first landmark renewable energy legislation, the Public Utilities Regulatory Power Act (PURPA, 1978). PURPA required IOUs to purchase renewable electricity at the avoided cost of self-generation. At the time, that cost was very high, and renewable generators flooded the market. PURPA propelled California into a world leader of renewable energy technologies, a hub for photovoltaic cell manufacturing, and bearer of a lion's share of the U.S.'s installed wind capacity within 5 years (Heiman, 2006). Although PURPA had notable success in stimulating the renewable energy industry, Reagan allowed most PURPA policies to expire during his term

Figure 2:

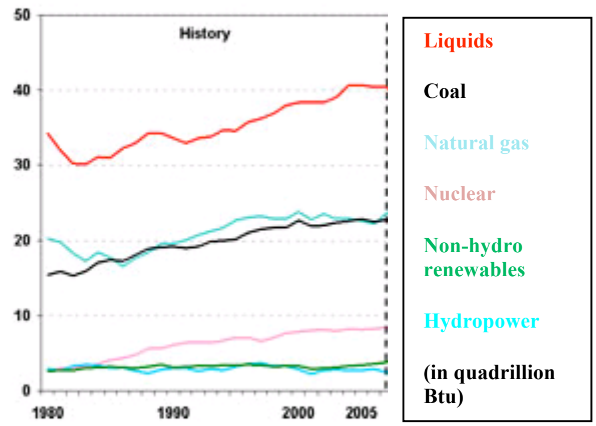


(Bohn and Lant, 2006)

(Heiman, 2006). Since then, federal support for renewable energy has continued to wax and wane. Most recently, Barack Obama promised to "harness the sun and the wind," whereas George W. Bush, his predecessor, commandeered a "fossil-fueled, production-driven vision" of energy from American sources (Rosenbaum, 2005). Inconsistent federal support has tempered growth of the renewable energy industry. Figure 2 shows expiring federal production tax credits resulting in slumps of wind power capacity additions. This inconsistent federal support does not necessarily follow party lines or particular administrations. Figure 2 spans much of George W. Bush's administration between 2000-2008, during which the Federal Production Tax Credit expired 4 times.

As of 2005, renewable energy had no meaningful share of the national energy pie (Figure 3, 4) (Heiman, 2006). Although wind and solar capacity both had double-digit annual growth between 1994-2004, together they contributed less than one-half of 1% of the nation's electricity

Figure 3: **The upward trend of all energy sectors 1980-2005** **Figure 4:** **Sources of Electricity, 2007**



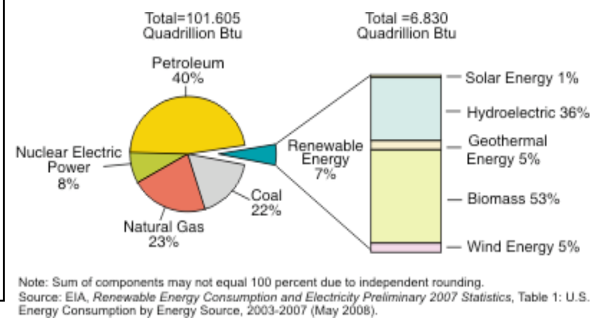


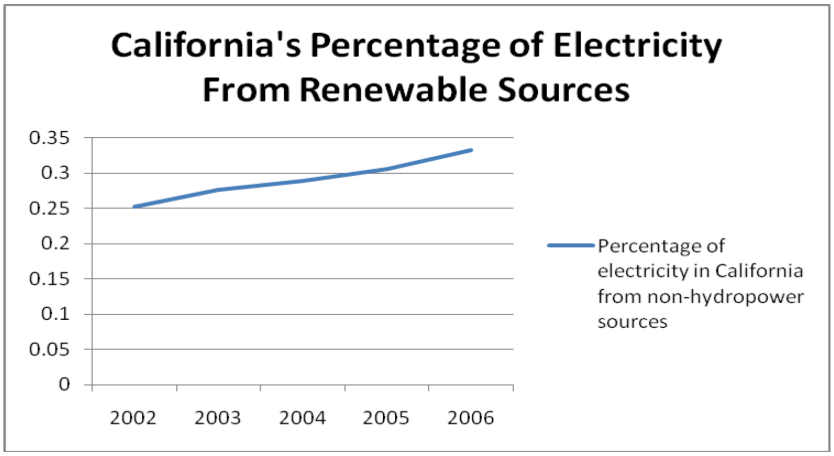
Figure 3: (http://www.eia.doe.gov/oiaf/forecasting.html)

Figure 4: (http://www.eia.doe.gov/kids/energyfacts/sources/renewable/renewable.html)

mix in 2004. Three decades of progress of renewable energy development had been outpaced by the nation's growing appetite for energy.

Breakthrough for renewables on the federal level came in 2005. The 2005 Energy Policy Act encouraged the approval of at least 10,000 megawatts of renewable energy projects on federal public lands within the next ten years. At more than 100 megawatts and 500 acres of land per plant, this proposal would be realized on 50,000 acres of public land (http://www.epa.gov/oust/fedlaws/publ_109-058.pdf). To accompany the proposal, the Bush Administration streamlined the permit process on public land; later, the California Public Utilities Commission (CPUC) would work with state and federal agencies to enact a similar process in their state. The Administration also implemented the Federal Energy Corridor, which significantly decreased barriers to entry for new energy development by designating continuous swathes of federal land for the construction of new transmission lines and natural gas pipelines.

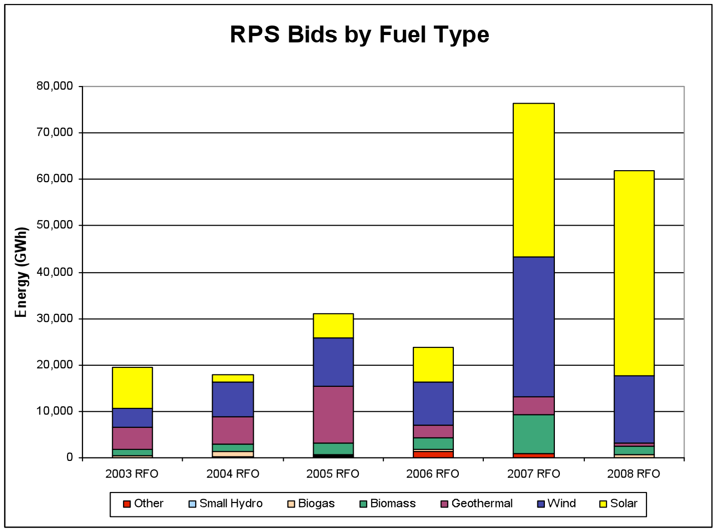
Figure 5: California's Growth in Renewable Electricity



(http://www.eia.doe.gov/emeu/states/_seds_tech_notes.html)

Although the 2005 Energy Policy Act stimulated the development of both fossil fuel and renewable energy alike, federal favor was particularly effective for renewable energy development. The 2005 Energy Policy Act was like a flipped switch in California. Riding the wave of federal support, California aimed to increase in-state renewable production as well as renewable imports from neighboring states. In 2006, California accelerated its RPS to 20% by 2010, established the Renewable Energy Transmission Initiative (a state version of the Federal Energy Corridor), and established eligibility requirements for out-of-state renewable electricity production. In the half-decade between 2001, when the RPS was first enacted, and 2006, when the RPS was accelerated, the percentage of electricity from renewable sources jumped by 24% (Figure 5). However, bids for solar energy development, mostly on the federal lands outlined in the 2005 Energy Policy Act, increased at an even greater rate between 2006-2008 (Figure 6).

Figure 6: California Renewable Energy Portfolio Bids



The 2005 Energy Policy Act and subsequent California state legislations present a classic dichotomy of state versus federal regulation. The 2005 Energy Policy Act opened up a myriad of renewable energy development opportunities for California: its most cost-effective development opportunities are on public lands in the Mojave and Colorado deserts and western Nevada (www.cpuc.ca.gov). Nevertheless, the state of California was still the "regulator," while the federal government encouraged, but did not enforce, renewable energy development. In the absence of strong and consistent federal renewable energy regulations, states have been the de-facto regulators. There are some advantages to state regulation: states can to tailor their standard to their state's particular needs and design innovative regulatory schemes to minimize the cost and maximize the effectiveness of a given regulation.

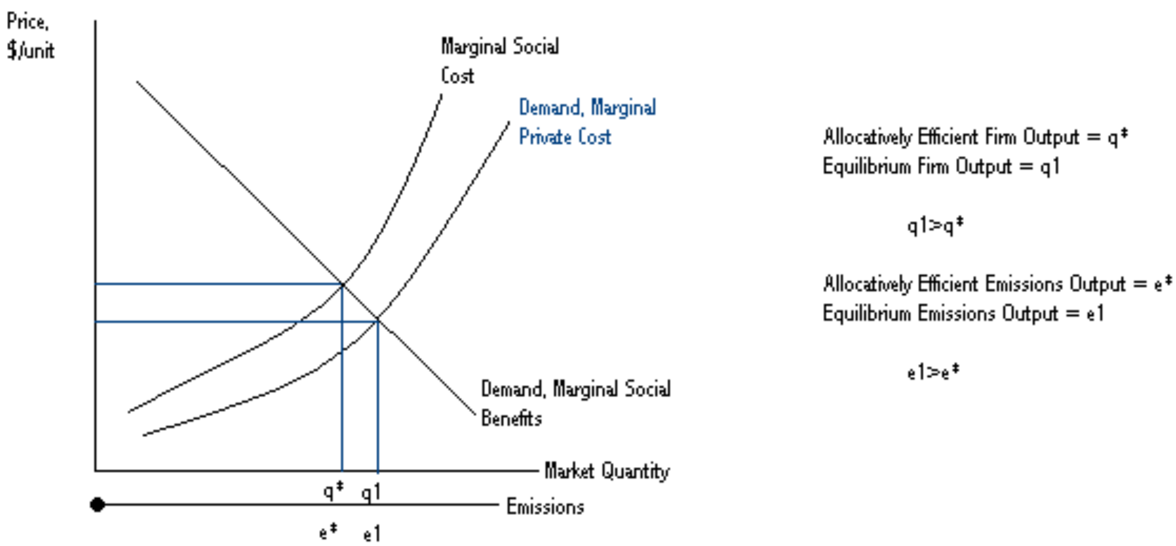
Despite these advantages, the trans-boundary nature of carbon dioxide, sulfur dioxide, and nitrogen oxide emissions makes a strong case for regulation at the federal level. Progress of emissions reductions in regulated states can be undermined by increased emissions in non-regulated states. Non-regulated states tend to attract polluters, who can produce electricity at less private costs. This can trigger a “race-to-the-bottom,” where electric generators that would otherwise be subject to regulation relocate to non-regulated states. Ultimately, the atmospheric consequences of limited national participation in emissions reductions will materialize. Without full participation by the United States, international climate policies are unlikely to have any significant impact on global climate change (Nordhaus, 2001). Although California’s energy policy is ambitious, it is effective in terms of climate change only insofar as it compels a broader change in national policy. Nevertheless, California’s policy will have far-reaching effects within state borders, including constructing new transmission lines, developing open space, stimulating “green” industry, reducing particulate emissions, and more. These particular considerations fit into the following discussion on the theory of environmental regulation.

Theory

The theoretical basis of regulatory intervention is to correct a market failure. Lawmakers may implement an RPS because they perceive that the social benefits of renewable energy and/or the social costs of fossil fuel energy are unaccounted for by the market. These costs, known as externalities, describe any social benefits or costs that that are not borne directly by the producers of the good or service. For example, if coal-fired power plants do not pay for releasing their emissions to the atmosphere (either by reducing emissions or by compensating victims of pollution) and society at large suffers from the emissions, then the coal plant is externalizing some of the cost of coal production onto society. These negative externalities result in overproduction of the good: because the private cost of producing the good or service is lower than the social cost of producing the good or service, the equilibrium market output is higher than the socially efficient output (Graph A). If the full costs of production were borne by the firm, society's net social benefits, or the sum of individuals' net benefits, would increase.

Externalities are just one example of market failure; markets also fail when there is imperfect information, market power, or government failure. When policy makers intervene to correct a market failure, they may implement some combination of taxes, regulations, subsidies, or tax-credits. Taxes and regulations are the most direct way to internalize negative externalities. Subsidies and tax-credits, on the other hand, are meant to stimulate production of a good or service that has positive externalities; they increase government spending or decrease government tax revenues. The monikers of these forms of government intervention reveal policy makers' general perception of them: taxes and regulation are characterized as "sticks," while subsidies and tax-credits are known as "carrots."

Graph A: An Externality



The focus of this paper is the policy tool of environmental regulation. Environmental regulation had its first landmark legislations in the 1960's, but its "political ascension" stretched into the early 1980's (Rosenbaum, 2005: 7). According to Rosenbaum, the years 1960-1970 were critical to "establishing the legal, political, and institutional foundations of the nation's environmental policies" (7). In the early 1980's, however, the Reagan Administration rolled back many of the environmental regulations produced by the Carter Administration in the name of "regulatory relief for the U.S. economy" (7). Perhaps Reagan was the initiator of the perceived antagonism between environmental regulation and the economy that exists today. When he took residence in the White House, he even symbolically removed a solar heater from the rooftop (Heiman, 2006).

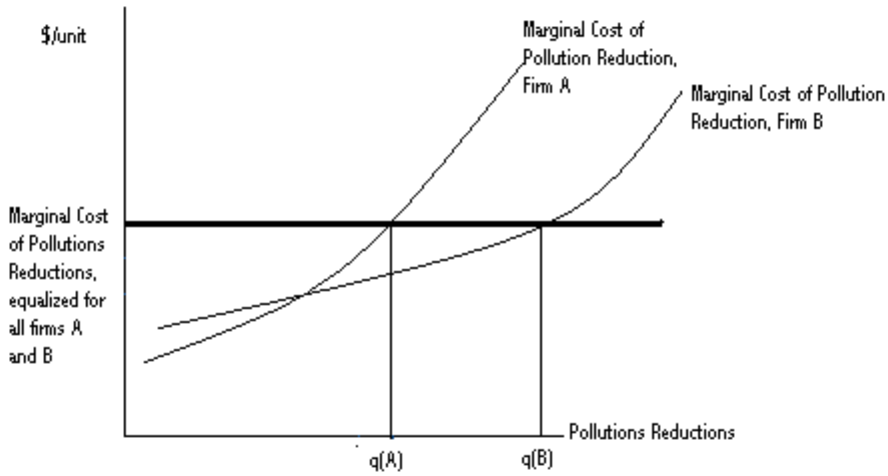
Although public acceptance of environmental regulations has fluctuated over time, the RPS represents a solid commitment to renewable energy development. The RPS is what is known as an Across-the-Board Regulation. Economists point to Across-the-Board regulations such as the RPS as inefficient, albeit politically popular, forms of market intervention. Across-the-Board regulations impose the same standard on all producers regardless of their respective marginal cost situations. The RPS, for example, requires that all producers increase their renewable electricity by 1% of their total electricity per year. Across-the-Board Standards contain inherent inefficiencies because producers are unable to exploit comparative advantages in meeting the standard. Using the example of the RPS, this means that electricity distributors with access to higher-cost units of renewable energy are required to achieve the same portfolio mix as those with lower-cost access. Because this standard does not achieve its outcome at the least-cost, it is economically inefficient. However, it is politically attractive: RPS mandate a hard number of renewable energy by a certain date, with legal and financial means of enforcement.

Other forms of regulation can provide a similar production outcome at a lower cost to society. The least-cost regulation imposes an equal marginal cost on all firms. Incentive-based policies such as taxes and tradable permits allow producers, rather than policy makers, to choose achieve efficiency in a way minimizes their particular marginal costs. In a tax scenario, the theory of the profit maximizing firm says that firms will choose the quantity of production, in this case pollution reduction, where the marginal costs of pollution reduction equal the marginal benefits of pollution reduction (in this case, the avoided cost). In a perfectly competitive market, a flat tax per unit of pollution will result in equal marginal costs of pollution reduction for every firm (Graph B). Similarly, in a transferrable credit system producers will choose a profit-maximizing mix of renewable energy production and renewable energy credits. Some producers will become specialists in renewable electricity production and sell renewable energy credits; others will buy excess renewable energy credits from the aforementioned specialist firms (Mankiw, 2004). The economic rent associated with renewable energy credits would add a cost to the production of conventionally generated electricity, which would internalize the social costs of electricity generated from fossil fuels. Renewable energy credits are a powerful economic tool for policy makers; according to Tietenberg, tradable renewable energy credits make "economic growth a vehicle for improving air quality, not for degrading it" (573).

The efficiency of tradable permits or emission taxes relies on establishing the proper amount of renewable energy credits or setting the tax at the proper level. That means legislators must craft the policy to accurately reflect social benefits and social costs. While theoretically attractive, this is a tall order for policy-makers facing imperfect information and pressure from special-interest groups.

Although in title California's system represents a Command-and-Control regulation, in reality, California's RPS is more like a hybrid. First, utilities do not have to produce renewable electricity themselves, but can buy it from other firms that can produce it at lower costs; this allows firms to exploit their cost advantages in emissions reductions or renewable technologies. Renewable generators compete with each other to supply the Investor Owned Utilities (IOUs) (http://www.nrel.gov/docs/fy04osti/35947.pdf).

Graph B: The Least-Cost Pollution-Reduction Regulation



Second, California has taken several measures to enhance flexibility and reduce the cost of compliance, including expanding RPS eligible electricity to include that produced out-of-state; renewable electricity generators in bordering states Nevada and Arizona may produce lower cost renewable megawatts. Additionally, renewable electricity in excess of minimum targets roll over to the next compliance term. Finally, the CPUC is considering Renewable Energy Credits to enhance compliance flexibility and efficiency.

Some Considerations Facing Californian Policy-makers

State RPS buck a well-established trend of environmental regulation at the federal, rather than state, level. According to environmental-policy expert Judith Layzer (2002), state-level environmental regulation is sparse because state officials “tend to be concerned, above all, with economic development and are much more constrained than federal officials by the need to attract and retain industry” (Layzer, 12). Particularly where they induce financial consequences on industry, environmental regulations are often viewed as competition for other interests, especially employment (Kirchgassner and Schneider, 2003).

However, the RPS challenges the identity of the financially punitive environmental regulation. It strikes a balance between environmental and industrial interests by curbing greenhouse gas emissions while stimulating industry. Vajjhala (2006) emphasizes that the “recent surge of interest in renewable energy has been motivated to no small degree by anticipated local economic benefits” (11). The CPUC, which enforces the RPS, emphasizes the economic boons: an RPS stimulates jobs -- an economic study by the University of California Berkeley reports that the state’s renewable energy policies would create up to 403,000 green jobs in the next 12 years (CPUC Press Release, 11/17/2008). An RPS stimulates renewable energy production and infrastructure that provide hedging against volatile fossil fuel prices. Additionally, the CPUC proposes that the RPS would mitigate some barriers to entry that renewables face: larger economies of scale would push down the cost of electricity from renewables to make it more cost-competitive with fossil fuel electricity. Finally, prices of electricity from renewables would be pushed down due to increased competition (www.cpuc.ca.gov).

The politically-possible resides within socially-acceptable forms of regulation. Empirically, this means that inefficient regulations may be politically favorable to more efficient regulations. For example, although cap-and-trade systems, which limit emissions and use a tradable permit system, are more effective at reducing greenhouse gas emissions than an RPS[2], cap-and-trade systems are less prevalent (Fischer and Newell. 2004). In the United States, participation in the only carbon emissions trading floor at the Chicago Climate Exchange is voluntary. However, participation is mandatory for producers of SO_x and NO_x.

Nuances in the implementation of the RPS leave room for potentially rent-seeking politicians to have their sway. "The theory of economic regulation proposes that such powerful industry groups [coal and natural gas lobby] can influence the outcome of a [green] policy to their advantage" (Stigler, 1971). Nowhere is this argument more heated than the debate between Concentrating Solar Thermal and Photovoltaic technologies, both of which harvest solar energy. Concentrating Solar Power (CSP) is an industrial solar power plant that requires developing open space and utilizes conventional transmission methods to transport electricity to load centers. CSP plants are usually owned by a private firm or by an IOU, and water is an important input in CSP energy, both to run a steam turbine as well as to wash the mirror-fields for optimum reflectivity. Critics point out that the Mojave and Colorado deserts, where most CSP proposals are located, have little water to spare, that many of the proposed locations provide habitat for endangered or threatened species, and that Los Angeles could be covered in Photovoltaic cells before the desert. Photovoltaic (PV) solar technology, on the other hand, has a small footprint, is often used at the

[2] Fischer and Newell (2004) find that "an RPS set to achieve a 5.8% reduction in carbon emissions is 7.5 times as costly in terms of social welfare as using an emissions tax (equivalent to a cap-and-trade policy with allowances distributed by auction) to achieve the same emissions reduction".

point of generation, and is often owned by homeowners. PV systems do not use any water or generate any by-products, and therefore have minimal on-site environmental impacts.

While the literature regarding the capture of green policy by the fossil-fuel industry lobby remains inconclusive, some citizen groups are vehement that the RPS legislation is a sell-out to big business at the expense of desert conservation. The history of solar-bids tells their story well: renewable energy bids from concentrating solar-thermal power plants slated for the Mojave and Colorado deserts more than quintupled between RPS enactment in 2001 and 2008 (Figure 5). The CPUC defends CSP and other utility-scale renewable projects as the lowest-cost renewable megawatt. According to the CPUC, "Even optimistic assumptions about implementation of these [photovoltaic and other distributed generation] technologies do not materially reduce the need for largescale renewable generation." (RETI phase 1b report). These accusations and competing interests prompted the research behind this paper, the quantitative investigation of the determinants of political support for renewable energy legislation. Because renewable energy development is occurring so rapidly, it is difficult to perceive the extent of its effects. However, the quantitative analysis posed by this paper can at least investigate what factors contributed to California policy-makers' votes for the RPS.

Review of Existing Literature

This paper used county-level data to analyze California legislators' votes for California's RPS. However, the bulk of empirical studies on renewable energy legislation analyze national data. The studies discussed here use state data.

Bohn and Lant (2006) conduct a regression analysis of data for thirty-seven U.S. states regarding the determinants of states' installed wind capacity. They find that the primary determinants are "human geographic factors of population distribution, and resulting geography of electricity demand and transmission line accessibility, together with state-based energy policies, including electric utility restructuring, renewable portfolio standards, and procedures for siting and permitting wind farms." A state's installed wind capacity is positively correlated with wind production; each year since passage is associated with 29 megawatts of additional installed capacity. As mentioned in the Background section of the paper, utility restructuring has a negative correlation with installed wind capacity. A restructured electricity market inhibits wind energy production by 324 statistical megawatts. However, population as a proxy for transmission infrastructure and proximity to load centers is the most influential factor, with each million people associated with 65.9 installed megawatts. This study indicates that electricity demand and access to transmission infrastructure, for which the population variable is a surrogate, are among the most important drivers of installed wind capacity.

In a second study, Vachon and Menz (2006) focus on the state determinants of green energy policies, including renewable portfolio standards, net metering rules, public benefits funds, and generation disclosure rules. Vachon and Menz draw on states' population characteristics that are generally considered to be linked to environment-friendly policies, including the level of income, level of education, and participation in environmental groups. They find that education level and income do indeed have a positive correlation with green policies. Vachon and Menz utilize legislators' voting histories under the public-interest assumption of government. Given the theories of regulation discussed in the previous section, this is a significant assumption; however, assuming that industry would not likely lobby for its own regulation, it is an appropriate assumption. This paper exercises the same assumption, that "the voting pattern of elected legislators should reflect different pressures that politicians receive over time from their respective constituencies. These pressures are a function of several factors including proximity to the date of an election, political contributions, and personal beliefs" (Soderbaum, 2000).

One prominent finding of Vachon and Menz (2006) is that industrial groups have no statistical association with various "green" legislation. In fact, this study found a positive link between the proportion of electricity generated from fossil fuels and the adoption of renewable portfolio standards. This suggests that the states that are most dependent on fossil fuels are also most aware of their precarious energy future and that the fossil fuel energy lobby does not significantly affect green legislation.

In a third study, Mastioff (2008) investigates whether states adopt RPS and energy efficiency legislation because of internal determinants (such as citizen ideology, air quality, and important state industries) or because of regional diffusion (emulating neighboring states' policies). At the crux of this study is whether states adopt an RPS for the purpose of internalizing fossil-fueled energy costs to the global community or for the purpose of appeasing internal constituent concerns. Again using regression analysis, Mastioff finds that "citizen ideology" is the driving force behind states' RPS and energy efficiency legislation. The study explains 56 percent of the variation in states' renewable energy and energy efficiency legislations through seven variables: air quality and criteria air pollutants, Gross State Product, Coal and Gas consumption per capita, an index of citizen ideology meant to capture the liberalism of a state's population, CO_2 intensity, solar density, and wind potential. The most surprising finding is that citizen ideology drives state policy decisions more than any other variable; in fact, citizen ideology is the only variable significant at the 0.05 or 0.01 levels. Mastioff concludes that, because a large percentage of variance among states is explained but 6 out of 7 variables are statistically insignificant, collinearity among variables likely masks their significance.

Like Vachon and Menz (2006), this study also takes a cursory glance at the political power of coal and natural gas electricity generators. Because RPS are usually levied on industries, utilities' political power should affect legislators' propensity to adopt an RPS. As predicted, the study finds a negative relationship between these two variables; however, due to collinearity between the fossil fuel industry and CO_2 emissions, it is unclear how much the political influence these industries have.

Finally, Vajjhala considers the siting barriers to renewable energy projects. Siting is the process of designating a specific geographic area to the construction of an energy project. One example is public opposition to construction of new transmission lines and energy fields, as reflected by California utilities' recent battle for regulatory approval of the GreenPath North and Sunrise Powerlink transmission lines. Vajjhala notes that renewable energy facilities arguably face even greater siting difficulties than conventional projects because "renewable resources are highly site specific, [therefore] siting processes often require trade-offs between the highest quality resources locations and proximity to other infrastructure, like power lines" (5).

Vajjhala used GIS analysis to construct a measure of the siting difficulty of renewable energy projects and transmission lines in states that have implemented an RPS. Based on renewable energy potential, proximity to existing transmission, and the degree of public opposition, she finds that siting difficulty is higher for states that have legislated an RPS and states with higher electricity imports. Citing California as an example, which imports 33% of its electricity, she concludes that state importers of electricity have higher-than-average siting difficulty and that an RPS does not necessarily lessen barriers to renewable energy development, because most RPS "focus on structures to promote investment and not on interventions to mitigate siting difficulty" (6-7). California RPS legislation, however, dovetails with legislation to mitigate siting difficulty, namely the Renewable Energy Transmission Initiative (RETI). RETI streamlines permitting processes, opens siting dialogue to the public, and enhances the opportunity for renewable energy firms to share transmission costs (www.cpuc.ca.gov).

These four papers employ state-level data to examine political support for RPS and offer some guidance for the research of this paper, which uses county-level data to analyze political support for California's RPS. The empirical analyses of this paper attempt to incorporate public resistance to the RPS implementation (such as cosmetic concerns about new power plants and transmission lines) and other factors that influence California legislators votes by doing a cross-sectional analysis of the subsequent RPS vote of 2006 as well a difference of differences regression analysis. The next section discusses the relevant variables and the findings of the regression analyses.

Regression Analysis

This analysis makes use of two legislative acts regarding the RPS: first, California Senate Bill 1078 which established the RPS in 2001; second, Senate Bill 107 which accelerated the RPS in 2006. Three groups of regression analyses investigate the political determinants of RPS legislation for each of the bills[3]. For the first group of regressions, the dependent variable is the county representative's vote for the RPS; the independent variables are counties' income per capita, education level, percentage of county votes for George W. Bush, and air quality. The variables of energy consumption, population density, and acres of public land by county are statistically insignificant and not included in the final regression analysis. The variable of proposed megawatts of renewable energy development has an endogeneity problem, meaning that it is unclear whether the RPS instigates new renewable energy projects or whether the benefits of renewable energy projects (like economic stimulus) instigates legislators' vote for the RPS.

The second group of regressions investigates the changes in county-characteristics that contribute to a change in legislative support for the RPS, as measured by the difference between the 2006 and 2001 vote by the Senate and Assembly. This difference-in-differences regression uses cross-sectional data for the two time periods, measuring the sensitivity of political support for the RPS as the determinants of political support shift.

[3] The independent variables are separated into four different votes: the 2001 Senate Vote, the 2001 Assembly Vote, the 2006 Senate Vote, and the 2006 Assembly Vote. Assembly and Senate Districts are geographically distinct from each other.

The final regression explains the determinants of the most influential variable contributing to RPS legislation, namely, the percentage of county votes that went to Bush in 2000 and 2004.

The data are paired, with the first year's data applying to the 2001 RPS vote and the second year's data applying to the 2006 RPS vote. Although the data year varies across variables, the data for any given variable are consistent across counties. Legislative support for the RPS was drawn from Senate and Assembly voting records. Senate and Assembly voting districts are arranged by population and are distinct from both county boundaries and from each other. In some cases, as many as 9 representative votes are cast on behalf of a single county. "Aye" votes for the RPS were recorded as a 1; "No" votes were recorded as a 0. An average of senators and representatives votes was then calculated. (Source: http://info.sen.ca.gov/pub/05-06/bill/sen/sb_0101-0150/sb_107_cfa_ 20060908_114335 _sen_floor.html; http://www.sen.ca.gov/~newsen /senators/districtmaps.HTP; http://www.legislature.ca.gov/legislators_and_districts/ districts/assemblydistricts.html).

Explanation of Variables

a. **Percentage of Votes that went to George Bush, 2000, 2004**

As cited by Mastioff (2008), the liberalism of a county is a well-published indicator of environmental regulation. Rather than use an arbitrary scale of a population's liberalism, this analysis utilizes the percentage of county votes that went to George W. Bush in 2000 and 2004. I hypothesize that votes for Bush are a measure of political conservatism and anti-regulatory sentiment by a county. Since the RPS is a regulation, I hypothesize that "yes" votes for the RPS have a correlation with "no" votes for George W. Bush. (Source:

http://www.uselectionatlas.org/RESULTS/datagraph.php?fips=6&year=2000&off=0&elect=0&f=0;

http://www.usatoday.com/news/politicselections/vote2004/PresidentialByCounty.aspx?oi=P&rti=G&tf=l&sp=CA).

b. **Income per capita, 1999, 2006.**

As cited by Vachon and Menz (2006), income level is a well-established indicator of a population's acceptance of "green" policies. I consider the income per capita a relevant explanatory variable for the RPS vote. My working hypothesis is that a high income reflects a higher willingness-to-pay for renewable energies (and higher electricity prices). (Source: http://www.ftb.ca.gov/aboutFTB/press/Archive/ 2008/08_23attach.pdf; http://factfinder.census.gov).

c. **Air Quality Index: number of days for which air quality was "Unhealthy," 2001, 2005**

As cited by Mastioff (2008), poor air quality instigates renewable energy policy. The EPA's Air Quality Index provided data on the number of "Days of Poor Air Quality" by county. I hypothesize that counties' poor air quality drives residents' demands for renewable energy policies, and that poor air quality has a positive correlation with legislators' votes for the RPS. Five rural Californian counties (Alpine, Lassen, Modoc, Sierra, Yuba) without AQI data are omitted from the study. (Source: http://www.epa.gov/air/data/geosel.html).

d. **Percentage of County Population aged 25 or higher with a Bachelors' Degree, 2000, avg. 2005-2007**

As cited by Vachon and Menz (2006), a population's education level is a well-established indicator of a population's support for green policy. My regression analyses use census data on "the percentage of the population aged 25 or higher with a bachelor's degree" as the indicator of education level. I hypothesize that a population's higher education level will have a positive correlation with legislators' vote for the RPS. (Source: http://quickfacts.census.gov/qfd/states/06000.html; http://factfinder.census.gov/home/saff/main.html?_lang=en).

e. **Unemployment Rate 2001, 2006**

As cited by Vajjhala (2006), much of the interest in renewable energy is attributable to promises of economic development and job creation. Therefore, the unemployment rate in the legislation years may be a significant factor in legislators' votes. I hypothesize that unemployment will have a positive correlation with legislators' votes for the RPS. (Source: http://www.bls.gov/LAU/).

f. **Statistically Insignificant Variables:**

i. Acres of public land by county

ii. Sum of online, approved, or pending megawatts of renewable energy projects by county. As of January 2009.

These two variables test sway of cosmetic concerns versus the promise of economic growth. They are intended to test the hypothesis that legislators would respond to the perceived economic potential of RPS for their county by voting for it.

			Table 1		
	Descriptive Statistics of County Characteristics				
Variable	Number of Counties	Minimum	Maximum	Mean	Standard Deviation
Air Quality Index, 2001	53	0	66.00	8.415	17.241
Air Quality Index, 2005	53	0	44.00	4.962	10.243
% Votes for Bush, 2000	58	16.10	72.30	50.027	12.394
% Votes for Bush, 2004	58	15.64	74.01	52.592	13.900
% Residents with Bachelor's Degree, 2000	51	10.30	51.30	21.315	9.979
% Residents with Bachelors's Degree, 2006	51	10.40	53.50	24.027	10.840
% Unemployment, 2001	58	3.50	15.90	6.593	2.538
% Unemployment, 2005	58	3.80	16.10	6.846	2.355
Average Income, 1999	58	13239.00	44962.00	20892.260	6181.531

Likewise, the acres of public land by county may reflect a county's potential for renewable energy development. However, both of these variables suffer from endogeneity, so it is impossible to determine whether the potential for renewable energy development causes the legislation or whether the legislation induces the renewable energy development. This is a shortcoming of this study that calls for further research. Table 1 reports the descriptive statistics of all relevant variables.

Findings

The first set of regressions (Table 2) demonstrates that the primary determinant of political support for the RPS is the county's liberalism, as measured by the percentage of votes that went to Bush in 2000 and 2004. In this set of regressions, political support for the RPS is explained by fewer votes for Bush, more days of poor air quality, and a higher education level. The *Votes for Bush* variable is significant at the 1% level in the 2001 and 2006 Assembly and Senate Votes. *Days of Poor Air Quality* is significant at the 5% level in the 2006 and 2001 Senate votes, *Master's Degree* is significant at the 5% level in the 2006 Assembly vote, and *Unemployment* is significant at the 10% level in the 2006 Assembly vote.

			Table 2	
		Dependent Variable: Vote for RPS		
	(1)	(2)	(3)	(4)
C	1.776	1.317	2.998	1.76
	(4.39)	(-3.11)	(5.50)	(4.08)
Days of Poor Air Quality	-0.000	0.006**	-0.002	0.007**
	(-0.30)	(-2.34)	(-0.46)	(2.07)
Votes for Bush	-0.024***	-0.021***	-0.031***	-0.025***
	(-5.22)	(-4.42)	(-6.05)	(-6.19)
Percentage of Population with Bachelor's Degree	-0.004	0	-0.022**	-0.004
	(-0.61)	(-0.04)	(-2.64)	(-0.63)
Unemployment	0.025	0.017	-0.055*	-0.009
	(1.12)	(-0.72)	(-1.89)	(-0.40)
Income	0.000	0.000	0.000	0.000
	(.05)	(-.07)	(-1.78)	(0.53)
R-squared	0.400	0.390	0.537	0.635
Adjusted R-squared	0.339	0.327	0.483	0.591
Sum squared resid	5.469	5.976	4.635	2.809
F-statistic	6.537	6.256	9.985	14.585
Number of Observations	55	55	49	48
t-statistic in parenthesis. Significant level 1% (***), 5% (**), and 10% (*).				
	1- Dependent Variable: 2001 Assembly Vote for RPS			
	2- Dependent Variable: 2001 Senate Vote for RPS			
	3- Dependent Variable: 2006 Assembly Vote for RPS			

The difference-in-differences regression analysis for the 2006 and 2001 RPS (Table 3) finds only one significant variable: changes in votes for Bush within the Assembly. This implies that national political trends have a significant effect on state legislations.

Having established the importance of the votes for Bush in renewable energy legislation, a final regression analysis investigates the determinants of county-level votes for Bush (Table 4). The following factors significantly decreased the fraction of votes for George W. Bush and thus increased the votes for the RPS: (1) increasing unemployment, (2) increasing levels of college degrees, (3) decreasing median incomes and (4) a decline in air quality. Income was significant at the 1% level; the county's education level and unemployment were significant at the 5% level, and county's air quality was significant at the 10% level.

	Table 3		
Difference in Differences Table for RPS Vote (2006) - RPS Vote (2001)			
	(1)	(2)	
C	0.041	-0.014	
	(-0.53)	(-0.18)	
Δ Days of Poor Air Quality	-0.004	0.002	
	(-0.71)	(-0.25)	
Δ Votes for Bush	-0.07***	-0.024	
	(-3.88)	(-1.25)	
Δ Percentage of Population with Bachelor's Degree	-0.003	0.003	
	(-0.29)	(-0.285)	
Δ Unemployment	-0.081	-0.013	
	(-1.14)	(-0.17)	
Δ Income	0.000	0.000	
	(0.51)	(-1.41)	
R-squared	0.266	0.098	
Adjusted R-squared	0.181	-0.010	
Sum squared resid	4.095	4.107	
F-statistic	3.115	0.909	
Number of Observations	49	48	
t-statistic in parenthesis. Significant level 1% (***), 5% (**), and 10% (*).			
(1) -- Dependent Variable: Assembly RPS Vote 2006 - Assembly RPS Vote 2001			
(2) -- Dependent Variable: Senate RPS Vote 2006 - Senate RPS Vote 2001			

However, the proposed megawatts of renewable energy development and acres of public land per county proved elusive variables in this analysis. It is impossible to determine whether the megawatts are the result or the cause of the legislation, and the acres of public land were statistically insignificant.

	Table 4		
	Difference in Differences Table for Bush Vote (2004) - Bush Vote (2000)		
	(1)		
C	-4.075		
	(-2.51)		
Days of Poor Air Quality	-0.074*		
	(-1.92)		
Percentage of Population with Bachelor's Degree	-0.136*		
	(-1.80)		
Unemployment	-1.277**		
	(-2.54)		
Income	0.000***		
	(4.37)		
R-squared	0.450		
Adjusted R-squared	0.400		
Sum squared resid	197.528		
F-statistic	8.997		
Number of Observations	49		
t-statistic in parenthesis. Significant level 1% (***), 5% (**), and 10% (*).			
(1) -- Dependent Variable: Percentage of County Votes for Bush (2004) - Percentage of County Votes for Bush (2000)			

Conclusion

The findings of this paper suggest that voting behavior at U.S. presidential elections is an excellent proxy variable for environment-related attitudes. The most significant determinant of legislators' political support for California's RPS was political orientation, as indicated by county residents' votes for George W. Bush in the U.S. presidential elections. The following county characteristics significantly decreased the fraction of votes for Bush in the presidential elections and thus increased the votes for the RPS: (1) increasing unemployment, (2) increasing levels of college degrees, (3) decreasing median incomes and (4) a decline in air quality.

It is unclear why county representative's RPS votes reflect federal representation more strongly than county characteristics. One hypothesis is that *Votes for Bush* captures a combination of voters' values rather than one single value and that voters' values are consistent for federal and county-level elections. This is a logical hypothesis if voters consistently vote along party lines and if party platforms are consistent at the federal and state levels. However, without the *Votes for Bush* variable, the county characteristics only slightly gain statistical significance. *Votes for Bush* captures something that the other variables do not.

Another hypothesis is that the county-level analysis is inappropriate because Senate and Assembly boundaries are different than county boundaries (as noted in the paper, one Assembly representative may cast a vote on behalf of 6 different counties). If the regression analysis were completed according to Senate and Assembly boundaries, perhaps the characteristics of these geographies would be more strongly represented by legislators.

A final hypothesis is that constituents are less demanding of political representation at the county level than they are of political representation at the national level. Many more people could tell you the name of the U.S. President than those who could tell you the name of their county's representative. Unfortunately, the hypotheses that economic development and constituent concerns such as cosmetic issues drive legislators' RPS votes remain unanswered by this study due to problems of endogeneity. These variables remain intriguing. I started this project with two hypotheses: first, that counties that voted for the RPS would not be the counties where renewable energy was developed; second, that the promises of economic development would entice representatives of low-employment counties to vote for the RPS. The first hypothesis remains unanswered due to endogeneity; the second hypothesis is supported by the 2006 Assembly vote, which was significant at the 10% level.

The significance of the *Votes for Bush* variable does not necessarily color renewable energy development or renewable energy legislation Republican Red or Democrat Blue. In fact, the nation's current leader in installed wind capacity, Texas, has been led by the Republican Party for the last 30 years. Texas has 32% more installed wind capacity than California, the first runner-up. Although the RPS may have emerged as a partisan issue in California, renewable energy legislation may have little to do with party lines in another state. Perhaps California's Republican representatives voted against the structure of the regulation, rather than renewable energy development itself.

Although this paper investigates only one type of renewable energy legislation in one state, the findings do suggest that the RPS as a form of market intervention may be less appealing to the Republican Party than the Democrat Party. Regardless of political orientation, bold, inter-partisan renewable energy policies are critical to the nation's economic and environmental health and to the global atmosphere. Bold policies would directly address the global externality of fossil fuel emissions as well as state-level externalities, such as particulate emissions. As noted earlier in this paper, the RPS stands in the place of more efficient and effective forms of regulation, such as a carbon cap-and-trade. At a time when global climatic collapse and financial prosperity sit on the brink of energy security, constituents and policy makers alike need a different political paradigm.

Works Cited

Bohn, C. and Lant, C. (2009). Welcoming the Wind? Determinants of Wind Power Development Among U.S. States. *The Professional Geographer*, 61: 1. (87-100).

Cleveland, C. J. (2004). Renewable Energy Policies and Barriers. *Encyclopedia of Energy*. (370-372).

California Public Utilities Commission. RETI Phase 1b Report. California Public Utilities Commission Online. Retrieved April 9, 2009 from the World Wide Web: http://www.energy.ca.gov/reti/documents/index.html.

California Public Utilities Commission. CPUC 2009 Quarterly Report. California Public Utilities Commission Online. Retrieved April 9, 2009 from the World Wide Web: http://www.cpuc.ca.gov.

Fischer, C. and Newell, R. (2004). Environmental and Technology Policies for Climate Change and Renewable Energy Discussion Paper, *Resources for the Future*, 4-5.

Heiman, M. K. (2006). Expectations for Renewable Energy Under Market Restructuring: the U.S. Experience. *Energy*, 31, (1052-1066).

Heiman, M. K. and Solomon, B. D. (2004) Power to the people: Utility restructuring and the commitment to renewable energy. *Annals of the Association of American Geographers,* 94:1, (94-116).

Kirchgassner, G. and Schneider, F. (2003) On the political economy of environmental policy. *Public Choice*, 3, (369–396).

Layzer, J. A. (2002). *The Environmental Case: Translating Values Into Policy*. Washington D.C: CQ Press. (12).

Mastioff, D. (2008). The Adoption of State Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants? *Review of Policy Research*, 25: 6. (527-546).

Mankiw, N. G. (2004). *Essentials of Economics, 3rd ed.* Ohio: Thompson. (212-216).

Nordhaus, W.D. (2001). Global Warming Economics, *Science* 294, 5545 (1283–1284).

Puller, S. (2007). Pricing and Firm Conduct in California's Deregulated Electricity market. *Review of Economics and Statistics*, February. (75).

Rosenbaum, W. A. (2005). *Environmental Politics and Policy.* Washington D.C: CQ Press. (255-256).

Soderbaum, P. (2000). *Ecological Economics*. London, UK: EarthScan Publications Ltd.

Tietenberg, T. (2006). *Environmental and Natural Resource Economics, 7th ed*. Boston, San Francisco: Addison Wesley. (173).

Vachon, S. and Menz. F. (2006). The Social, Political, and Economic Role in Promoting State Green Electricity Policies. *Environmental Science and Policy,* 9: 7-8, (652-662).

Vajjhala, S. (2006). Siting Renewable Energy Facilities: a Spatial Analysis of Promises and Pitfalls. *Resources for the Future*, Discussion Paper 06-34. (1-8).

Viscusi, W. Kip, Harrington, Jr., J. E., Vernon, J. M. (2005). *Economics of Regulation and Antitrust, 4th ed.* Cambridge: MIT Press.