Incentivizing Green Single-Family Construction:

Identifying Effective Government Policies and Their Features

Shaun A. Bond and Avis Devine[1]

University of Cincinnati and University of Guelph

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Abstract:

For more than a decade, governments have been incentivizing, and now requiring, private developers to construct energy efficient, sustainable projects. We examine the effectiveness of green single-family construction incentive programs. A cross-sectional comparison of municipalities with and without green private residential incentive programs indicates which government levels of policy issuance and which types of certification programs prove most successful, and when those impacts should be expected. Findings indicate that only municipalities experience success with construction-related policies, which may be tailored to their local market's construction demands. Business-related policies, however, prove effective at all levels of government implementation, with particular success at the state level. Lastly, event studies and multiyear window data indicates that green incentive policies elicit the greatest change two to three years after their implementation.

Key words: Energy Efficiency, Sustainability, Policy, Residential

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The construction of single-family homes utilizing sustainability and energy efficiency techniques has been proven to make financial sense. Pricing premiums have been confirmed for green residential properties, both multifamily (Bond and Devine, 2015) and single family (Aroul and Hansz, 2011; Kok and Kahn, 2012; Deng, Li, and Quigley, 2012), and evidence indicates that home buyers are willing to pay a reasonable premium (one that may be offset by the long-term savings on utility costs associated with the investment) for green home improvements (Sadler, 2003; Kwak, Yoo, and Kwak, 2010; Banfi et al, 2008; Dinan and Miranowski, 1989; Horowitz and Haeri, 1990; Dastrup et at, 2012). Simultaneously, evidence supports that the additional costs associated with energy efficient construction are negligible, especially if green characteristics are incorporated from the design stage.[2] Despite this evidence, several government bodies have enacted policies which incentivize energy efficient or sustainable construction on private construction projects, using a green-rating program as a guideline. Through year-end 2013, 105 energy efficiency incentive policies were enacted by state, county, and municipal bodies in the United States regarding market-rate single-family residential construction and governed by the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating program.[3]

Such incentive programs may seem unnecessary, given the substantiated pricing premiums and limited additional costs associated with green construction. Yet while the importance of sustainability and energy efficiency has been adopted by some asset classes such as office properties, other asset classes (such as single-family residential) are still trying to convince the innovators and early adopters of the importance of sustainability in real estate. Although the benefits of green office space may also be experienced by green residential space, developers and users will not realize such benefits until the role of sustainability has been established. Government policy is one tactic to encourage and diffuse new ideas such as

[2] World Green Building Council, "The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants," 2013.
http://www.worldgbc.org/files/8313/6324/2676/Business_Case_For_Green_Building_Report_WEB_2013-03-13.pdf

[3] There are several rating systems in the United States, many created by the state or local governments specifically to address their own needs. We focus on LEED as it is the most commonly used rating tool. 23 of the listed policies allow for other ratings tools to be used as well as LEED.

sustainability and energy efficiency. Government intervention may spur investment through artificial benefits (incentives). Examples of such real estate policy incentive tools are code departure (allowed deviations from building code), expedited permitting, density bonuses, fee reduction and feebate (the rebating of fees) programs, grants, tax credits, and tax abatements.

The research on governmental policies with environmental requirements is largely descriptive (McCrudden 2004, Coggburn and Rahm 2005, May and Koski 2007), examining barriers and solutions to government green building procurement policies (Michelson and de Boer 2009, Sourani and Sohail 2011) and the potential impacts of green government policies (Marron 1997, 2003). Of the few empirical works that address these matters, Simcoe and Toffel (2013) studies the effects of policy on government space with reference to the spillover effects of public purchasing policies on the private sector. The research finds that green government purchasing policies stimulate green private construction. All of this work focuses on the effects of government policies regarding government space, whereas this research is among the first to conduct a detailed examination of the effects of government policies directed at private construction.

By examining the geographies in which sustainable and energy efficient residential construction has been encouraged, we observe the change, if any, in the number of LEED homes built. Using a variety of econometric modeling techniques, we compare these areas with other markets that have not provided green incentive programs, measuring the effect of government incentive policies while controlling for economic and demographic drivers of construction. Through cross-regional analysis, we examine the effectiveness of the different policy categories and of different governing bodies' policy issuances and find drastic differences in success rates.

Despite all government levels enacting incentive programs of varying types, our research indicates that certain incentives and certain government levels of policy enactment prove more effective. In general, municipalities and states have the greatest success with incentive policies. Specifically, municipalities are the only level to experience success with construction-related policies. The ability to tailor incentives to the local development/construction process makes municipalities the optimal level from which to implement construction-related incentive policies such as expedited permitting and code departure. Meanwhile, states attain their desired outcomes more frequently through business-related policies. Incentive categories with definite economic benefit, such as grants and tax credits, prove to be more successful overall, but their greater cost makes them the best fitted for larger governments (states). This economies-of-scale result is due to both the state's larger budget and the developer's ability to seek incentives across their projects statewide, rather than in just one municipality. Lastly, there is a discussion of the government power-related issues that may be impacting county-level policy effectiveness, and suggest ways county governments can address these issues in order to encourage sustainable and energy efficiency residential construction.

Sustainable and Energy Efficient Real Estate

The intention behind government incentive policies is to encourage green construction. In the United States, buildings are the largest energy-using sector, consuming 41 percent of all energy (followed by industrial activities and transportation at 30 percent and 29 percent, respectively) and 73 percent of electricity.[4,5] Additionally, United States' real estate construction accounts for 38 percent of the country's CO_2 gas emissions and is one of the heaviest users of natural resources, representing 40 percent of the country's consumed natural resources.[6,7] Energy efficient buildings consume fewer natural resources (and create less waste), use less power, and put off fewer emissions. Given the significant role

[4] National Trust for Historic Preservation (2011). *The Greenest Building: Quantifying the Environmental Value of Building Reuse*, Accessed Jan. 26, 2012 via http://www.preservationnation.org/issues/sustainability/green-lab/usefulfacts-about-greenest-buildings.html

[5] Department of Energy (2011). *Buildings Energy Data Book. Buildings Share of Electricity Consumption/Sales*. Accessed October 26, 2011 via http://buildingsdatabook.eren.doe.gov/docs/xls_pdf/6.1.1.pdf

[6] Energy Information Administration (2008). *Assumptions to the Annual Energy Outlook*.

[7] Lenssen and Roodman (1995). *Worldwatch Paper 124: A Building Revolution: How Ecology and Health Concerns are Transforming Construction*. Worldwatch Institute.

of buildings in resource and waste management for the world, governing bodies have begun to encourage or require more energy efficient and sustainable construction by enacting policy.

Green housing generally refers to homes constructed and/or operated in a sustainable manner. These homes incorporate environmental considerations and resource efficiencies into many steps of the building and development process to minimize environmental impact. The design, construction, and operation of a home can focus on energy, water, and resource efficiency, building design and materials, indoor environment quality, and the home's overall impact on the environment. There are two major players in U.S. sustainable certification: the Environmental Protection Agency's (EPA) Energy Star; and, the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED). There are several other rating programs available (many being state–specific), but due to the limited use of Energy Star and other ratings programs, this research focuses on LEED-related incentive policies.

Developed by the USGBC in 1998, LEED is intended to provide building owners and operators with a concise framework for identifying and implementing green building design, construction, operations, and maintenance solutions. Certification is issued at four levels of increasing stringency: Certified, Silver, Gold and Platinum. LEED is a transparent process in which the technical criteria proposed by USGBC members are publicly reviewed for approval by the almost 20,000 member organizations that constitute the USGBC. While LEED may be applied to any sustainably-constructed building, LEED for Homes was developed to lower the cost of certification on small scale projects, and is available exclusively for residential construction less than six stories in height. The most prominent complaint regarding LEED is that pursuing a rating can cause the initial design and construction cost to rise. However, higher initial costs are offset by the savings incurred over time due to the lower-than-industry-standard operational costs typical of a LEED certified building. Recent findings suggest that if green strategies are instituted from the beginning of the planning process, additional costs may be avoided altogether.[8] Moreover, construction cost premiums are shrinking as green construction methods and materials become more the norm rather than outhe exception. Other complaints include: the design-only focus (not operations) of most LEED programs (including LEED for Homes); and, the lack of climate-specificity incorporated in the programs (which is being addressed in the newest versions).[9]

Data and Methodology

There were 105 government policies enacted before year-end 2013 which incentivize energy efficiency in market-rate single family home construction using the LEED rating tools. A few of the LEED-related policies allow for other rating programs to be used in place of LEED. Energy Star and the Build It Green programs were common second-named rating tools, as were some state-specific rating tools. However, the number of incentive policies utilizing these tools was a fraction of the total LEED-related policies. This indicates LEED's status as the energy efficiency benchmark of choice for government single family construction incentive programs. LEED certification is not always required to receive the incentives. Instead, compliance with the LEED standards is required, but certification is sometimes optional. However, given the pricing premium associated with LEED-certified single family homes (Kok and Kahn 2009, Aroul and Hansz 2011), it is reasonable to assume that, having already met all the LEED guidelines, most builders will complete the process with certification, especially under the less-onerous LEED for Homes program.

[8] World Green Building Council, "The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants," 2013. http://www.worldgbc.org/files/8313/6324/2676/Business_Case_For_Green_Building_Report_WEB_2013-03-13.pdf

[9] Much of the data are taken from each program's respective website: www.energystar.gov and www.usgbc.org.

Of the 105 LEED-related, market-rate, single-family residential policies, five are state-level incentive programs, ten are county-level incentive programs, and the remaining 90 are municipal-level programs.[10] Table 1 provides a summary of the LEED-directed programs applicable to single family residential construction, broken down by their enacted level: state, county, and municipality (Panels A, B, and C). Each Panel indicates the number of policies which offer each of the incentive types, and the level of LEED compliance required to receive that incentive. Lastly, a correlation analysis, shown in Panel D of Table 1, indicates that the policies are generally highly uncorrelated with each other. Only expedited permitting and fee reduction policies are more than 25 percent correlated, with the vast majority of the policies less than ten percent correlated.

(Insert Table 1 here)

The most common level of compliance required is LEED Certified. LEED Silver certification levels are also frequently demanded and in a few instances LEED Gold or Platinum certification is required. Expedited permitting, fee reduction (including feebate programs), and density bonuses are the most common incentives to encourage energy efficiency. All of the policies were enacted between 2002 and 2013, with the majority enacted since 2007. The policies affect approximately 1,500 municipalities, with 1,220 treated municipalities compromising our sample.[11] Of those, most are impacted by five state-level policies (CT, NV, NM, NY, and OR), with 62 and 86 municipalities impacted by county and municipal-level policies, respectively.[12] Seventeen municipalities are affected by both a municipal level policy and either a county-level or state-level policy.

[10] Some municipalities had more than one policy enacted.

[11] The balance of impacted municipalities are suppressed from the analysis due to data limitations, the most commonly being insufficient levels of single-family construction (less than five single-family building permits over the nine-year period).

[12] Due to confounding state-level policies in AZ and CO, both those policies and all affected municipalities were dropped from this analysis.

The LEED programs have been certifying single family projects since 2006.[13] Between its inception and year-end 2014, the commercially-focused LEED programs registered 92 projects which involved a single family housing aspect. Of those 92, only two are certified, market-rate, private development homes in the US. Given this extremely limited number of usable observations under the original LEED program, those observations are discarded.

The LEED for Homes program, an easier and less expensive process tailored to single family construction, certified over 70,000 units through year-end 2014. Of that, nearly 9,000 are single-family market-rate construction in the United States, with government-related, non-profit (affordable housing), specialty (student and senior housing), and confidential developments (for which property details are not available) comprising the balance. Figure 1 shows the total LEED for Homes private single-family construction annually since 2006, broken down by certification level achieved. Certification of homes increased year over year consistently, peaking in 2013 before falling back a bit in 2014. However, more than 1,000 homes have been certified under the program annually since 2010.

(Insert Figure 1 here)

Since its inception, over 962 municipalities in all 50 states and DC have experienced private construction of LEED for Homes single family homes. Of those, 41 percent had more than one LEED single family home constructed, and fourteen percent (136 municipalities) had at least ten constructed. From 2006 through 2010, there is a continual increase in the number of municipalities seeing LEED single family home construction, from thirteen municipalities in 2006 to over 200 in 2010. Since that time, the level of municipalities experiencing LEED single-family construction each year has leveled out, and decreased slightly in 2014.

[13] Certification was available prior to that, but was not pursued for single-family market-rate homes until 2006.

In order to control for the sample selection bias of areas which are not constructing new homes at all (and would therefore not be constructing LEED homes), municipalities with less than five single family building permits issued over the 2006 through 2014 time period are dropped. Additionally, municipalities with confounding policy implications were also cut from the sample. This included municipalities with requisite LEED policies and those with green incentive policies not tied to LEED.

Recent papers have examined factors which impact green real estate policy adoption and usage. Economic, political, and climate-related features of a geography may predict green building policy adoption (Kontokosta, 2011), including property market fundamentals, market size, economic growth, higher levels of education, and prevalence of the Democratic party (Kok et al, 2011; Fuerst et al, 2011; Dippold et al, 2014; Prum and Kobayashi, 2014). This research, along with the existing research on sustainable real estate, is used to inform the selection of the following control variables used in this analysis.

It is possible that some geographic areas may be more predisposed to green construction than others. This poses an endogeneity concern, which is addressed in the analysis through two control variable categories. First there are the heating degree day (HDD) and cooling degree day (CDD) variables. HDD and CDD provide measures of how climate may drive an area to pursue green construction. One of the most significant benefits to green construction is energy savings related to indoor temperature.[14] Therefore, areas with extreme climates requiring significant amounts of heating and/or cooling would be extraordinarily incentivized to pursue green construction and policies. A baseline temperature is set (say, 65 degrees Fahrenheit). If on a certain day the average temperature was 80 degrees, a building would need to cool 15 degrees that day to reach the 65 degree temperature. If the same temperature persisted for 10 days, that would total 150 degrees of cooling required for those 10 days. Total degrees needed to heat

[14] Ibid. World Green Building Council, "The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants."

and cool, respectively, an area for one year are totaled, creating the HDD and CDD variables. This information is based on annual averages taken from 2006 through 2014 National Climate Data Center data.

In addition to a response to local climate, there is an environmental ideology which makes some people more likely than the average consumer to demand green products and practices. In the literature to-date, the common method for measuring this ideology is to measure the Green Party votes or to measure the percent of hybrid and electric car sales or registrations in an area (Kahn & Vaughn, 2009). However, given the U.S.'s prevailing two-party system, analysis based on the Green Party vote count is not as accurate a measure of ideology as it is in other countries. Additionally, the data regarding hybrid and electric car registrations is limited to either a small geographic area or a much larger unit of measure (such as a metropolitan statistical area, as opposed to a municipality).[15] Collecting data on hybrid and electric car registrations nationally at the municipal level is quite difficult and cost prohibitive. Instead, a related measure of green ideology is posed: clean fuel stations. Clean fuel stations are counterparts to gas stations and provide a variety of clean fuel options (electric car charging stations, ethanol, etc.). The idea behind this relationship is simple: a clean fuel station will only be operated where it is demanded. Since people usually refuel their automobiles near their homes, a clean fuel station is a strong proxy for the local presence of alternative fuel vehicles. Alternative fuel vehicles are an already-accepted proxy for green ideology in the sustainability literature, so this proxy should prove as successful as hybrid and electric vehicle registrations.[16] The U.S Department of Energy provides a continuously-updated database of every clean fuel station in the U.S. As an example of coverage, Figure 2 provides a map of the clean fuel stations in the U.S. as of 2012, indicating that clean fuel stations permeate the country, generally following the overall population distribution. While not visible in Figure 2, a more in-depth analysis

[15] Additionally, controlling for hybrid and electric car sales seems poor because the location of a car's sale has more to do with the supply of this car type than the demand. Someone that lives in rural ND would need to drive to a more cosmopolitan area to purchase a hybrid or electric car, invalidating that measure.

[16] This is evidenced through the control variable's consistently significant results in both this research and in Bond and Devine (2015).

indicates clean fuel types are regional, with electric stations common on the east and west coasts and ethanol stations common in the Midwest.

(Insert Figure 2 Here)

A variety of other control variables are also utilized in the analysis. Data were collected from HUD regarding the single family building permits issued annually for 2006 through 2014. Population and per capita income data are taken from the American Community Survey, and the former is used in conjunction with the Office of Budget Oversight's metropolitan statistical area definitions to determine the 100 most populous MSAs. Lastly, a recent nationwide Gallup poll is used to quintile states as very conservative, conservative, moderate, liberal, and very liberal (Newport 2013).

Table 2 presents the averages for selected variables described above. These averages are presented for the full sample, as well as two subsets representing those municipalities with and without any LEED single family homes and with and without any LEED incentivizing policies. The presence of an incentive policy is associated with a higher probability of LEED construction, and a greater number of LEED homes. Municipalities with LEED construction are notably larger, have higher per capita incomes, and are more likely to be situated in the Top 100 MSAs of the U.S. However, these three features are correlated. Municipalities with an incentive policy are overwhelmingly more liberal, have slightly higher per capita incomes, and are more likely to be home rule governed. Areas with LEED construction present have substantially higher numbers of clean fuel stations, and electric stations in particular. However, there is not a relationship between ethanol stations and LEED construction or incentive policies. Finally, the political views of municipalities with LEED construction are quite similar to the full sample, as opposed to the areas with incentive policies which are extremely liberal.

(Insert Table 2 Here)

Methodology

A variety of econometric techniques are used to investigate the question. Probit models determine how energy efficient incentive policies influence the probability of LEED single-family residential construction. To examine if there is a relationship between the incentive programs and the construction of sustainable or energy efficient properties, the binary choice to construct green-rated versus traditional nonrated single-family homes is modeled at the municipal level. This model is described as follows.

$$G_i = \alpha_i + \beta_i S_i + \sum \gamma_i X_i + \sum \delta_i P_i + v_i \qquad \text{(Equation 1)}$$

In Equation 1, G_i is a binary variable which takes the value of one if at least one LEED certified single family residential property has been constructed by a private developer in the i^{th} municipality over the considered time period, and a value of zero otherwise. S_i is a dummy variable indicating the presence of energy efficient or sustainable incentive policies in the i^{th} municipality. Both the definitions of the time period and the treatment variable will be modeled differently in a variety of equations. X_i represents a vector of demographic and other economic characteristics used to describe each locale and P_i represents a vector of characteristics which capture the propensity of a locality to experience green construction. α_i, β_i, γ_i, and δ_i are each coefficient estimates and v_i is an error term.

In addition to testing the probability of increased LEED construction associated with an incentive policy, we also use OLS regressions to analyze the extent of the policy's impact on LEED construction. This is an important distinction, as the introduction of one LEED home in a municipality (which may not be the result of an incentive policy, but rather just the result of one green-minded household) can bias the results in the probit model. The LEED dummy and the LEED count variables are only 40 percent correlated, indicating that they are distinct, and understanding each variable's relationship with incentive policies provides a unique answer to the research question.

In the OLS models, the dependent variable is the natural log of the number of single family LEED homes constructed, scaled by total single family building permits. The explanatory variables remain the same in both models. This model is shown in Equation 2, in which L_i represents the natural log of scaled LEED-certified single family homes and q_i is an error term; all other variables are described above.

$$L_i = \alpha_i + \beta_i S_i + \sum \gamma_i X_i + \sum \delta_i P_i + q_i \qquad \text{(Equation 2)}$$

In order to address the substantial differences in municipality characteristics described in the Data section, a matching procedure is utilized and the resulting weights are applied to the regression models. The matching methodology used is Coarsened Exact Matching (CEM), a monotonic imbalance reducing matching method (Iacus, King, and Porro 2011, 2012). The CEM process can be defined in three steps. First, the data is coarsened by discretizing the variables to build a multi-dimensional histogram. Second, any observations from a cell that does not contain at least one control and one treatment observation is discarded. Last, weights are created, with each treatment observation receiving a weight of one, and each control observation receiving a weight of $\text{Treatment}_i/\text{Control}_i$ (a weighted weight).

There are many benefits to CEM. The adjustment of one variable's imbalance does not affect the maximum imbalance on other variables. Additionally, the matching method guarantees common empirical support without specific restriction of the data. Lastly, the results are robust to measurement error. CEM and propensity score matching differ in that the former's process is more transparent, and that the balance between the control and treatment groups is selected ex ante rather than discovered through trial and error of model estimations. Finally, CEM has been found to outperform other matching methods in Monte Carlo tests.[17]

Results

Using Equations 1 and 2, we begin to explore the relationship between private construction of green single family housing and green housing incentivizing policies. The loading on the treatment variables (and their statistical strength) gives a basic indication of if green construction incentive policies have a positive effect on green single family residential (LEED) construction.[18]

Certain areas may be pre-disposed to green construction. In order to capture and measure this effect, a variety of variables posed in the existing green construction literature are considered. The most informative combination of these variables proves to be total heating degree days, scaled electric stations, and political ideology variables. In addition to a propensity for green construction, an area may also have a predisposition for more construction in general, thereby increasing the chances for green construction. To control for such growth and demand factors, population and income control variables are included, as well as a control for municipalities situated in the 100-largest U.S. metropolitan statistical areas. Additionally, construction activity is controlled for with a measure of the total single family building permits issued between 2006 through 2014. This total count of permits over the nine-year period is not scaled, and differs from the annual total single-family building permits used to scale the total LEED construction. The total single family building permits variable is used in CEM weight calculation.

[17] Following the Diamond and Sekhon (2005) method, Iacus, King, and Porro (2012) completes 5,000 Monte Carlo replications. CEM, propensity score matching, nearest neighbor Mahalanobis matching, and genetic matching results are compared in terms of bias, standard deviation, and root mean square error. CEM dominates all three evaluation categories.

[18] All of the following analysis was tested using different structural breaks in the certification levels, but the results were not different from those utilizing all certification levels and are therefore suppressed. Similarly, LEED single family construction began to ramp-up in 2008. However, subsample analysis of this later time period also did not alter the results.

Three government-related variables are included to control for the distribution of power in the different municipalities. A dummy variable captures if the municipality has real estate taxation authority. This is rare in most of the US, but standard in a few Northeastern states. The entity which controls taxation may have a different set of policy incentives available to them, such as tax abatements, tax credits, etc. Similarly, several states operate under Home Rule, allowing the decentralization of a state's power. In these states, the local government has the ability to govern its own administrative area. Finally, a control is included for municipalities in which more than one green incentive policy are available, as this compounded incentivizing may prove a stronger encouragement of LEED construction. Municipal Taxation Authority is used exclusively to determine the CEM weights, and the control for multiple policies proved consistently uninformative, so it was removed from the models.

In Table 3, Eq. 1 and 3 are probits, with the dependent variable taking a value of one if there has been at least one LEED single family home certified in a municipality during the observation year. The dependent variable in Eq. 2 and 4 is similar in content, but instead measures the natural log of the portion of single-family building permits that resulted in LEED-certified single family homes. In all of the equations in Table 3, the treatment variable is a dummy with a value of one if a municipality has any LEED incentive policy available from any level of government (municipal, county, or state). CEM weights are used in all equations, and are based on a comparison of total clean fuel stations (scaled by the population), income, population, municipal taxation authority, and total 2006-2014 building permits.[19] Additionally, all models include controls for Census geographic divisions and year fixed effects.

(Insert Table 3 Here)

Results of note in Table 3 begin with the treatment variable. Both Eq. 1 and 2 (the probit and the OLS) return statistically and economically significant results, indicating that the introduction of a LEED incentive policy has increased LEED construction. For the probit results (Eq. 1), the marginal effect of

[19] The addition of CEM weights results in only a small decrease in sample size and a strengthening of the model when compared to unweighted estimations of the same equations.

having any LEED incentive policy increases the probability of LEED construction by two percent in any given year. The OLS results (Eq. 2) indicates an incentive policy is associated with a 25 percent increase in the portion of new home construction that is LEED certified in any given year.

There are several other notable results highlighted in Table 3 and supported throughout the analysis. First, there is the significant role of the home rule variable. In nearly all model estimations, this control proves to be statistically significant at the one percent level and carries a positive sign. This indicates a strong relationship between local governance control and enhanced policy effectiveness, which is intuitive. Localities which self-govern are best able to incentivize construction. Nearly all municipalities individually govern the construction approval process, but home rule communities are also governing many additional processes which would otherwise be handled separately, by higher levels of government. Second, there is a consistent inverse relationship between the dependent variable and Top 100 MSA variable. This is likely a partial offset for the population and geographic controls. Lastly, green-predisposition controls all proved to be important, both economically and statistically. It is plausible then that the location of clean fuel stations and the extreme climate areas are heavily associated with LEED construction.[20]

Event Study Analysis

Eq. 3 and 4 in Table 3 take an event study approach to the question, examining the impact of a policy on the municipality's LEED construction both in the event year (the year of policy implementation), and for each of the subsequent three years. All other aspects of the models mirror those of Eq. 1 and 2. Both the probit and the OLS models indicate a positive relationship between an incentive policy and LEED home

[20] In addition to the analysis reported, an Endogenous Participation Endogenous Treatment (EPET) model is used to test for sample selection bias. The root of this bias lies in the relationship between answering the two questions posed (Does an incentive policy encourage any LEED construction? How much green construction does an incentive policy encourage?). The EPET model (Bratti and Miranda, 2011) allows for simultaneous testing of both those questions. The multiple equation modeling results indicate that there is a correlation between incentive policies and green construction, with correlations being strongest for municipal-level policies, followed closely by state-level policies. Results are available upon request.

construction. Notably, these findings are highly statistically significant in Lagged Years 2 and 3. This indicates that the adoption of an incentive policy may take a while before the benefits are observed. As with the home rule results, this is also intuitive. Real estate development is a slow and lumpy process. The planning and approval requirements associated with construction may take several months (or years). Therefore, if a policy is implemented this year, the first issued building permits (and subsequent LEED-certified homes) associated with the policy would not be expected in the event year, or even the year following. In fact, a decrease in the level of LEED certified units might be anticipated in the event year. Developments pursuing LEED certification may elect to delay construction long enough to ensure policy guidelines are met, so the benefits from the newly-announced incentive may be obtained.[21]

Government Level Policy Analysis

Having identified the general effectiveness of LEED incentive policies, we examine the policies issued at the three different levels of government: municipal, county, and state. Eq. 1 and 2 from Table 3 are re-estimated with the treatment variable representing only policies issued at each level of government. Table 4 summarizes results for the weighted models, with municipal-level policies only in Eq. 1 and 2, county-level policies in Eq. 3 and 4, and state-level policies in Eq. 4 and 5.[22] In each case, observations impacted by policies from other levels of government are removed from the sample, so as to measure the independent impact of each government level's policies. The treatment variables demonstrate a similar level of success in these subgroup analyses, and the pseudo R-squareds for the comparable equations in Tables 3 and 4 return relatively similar values, although some models prove stronger than others.

(Insert Table 4 Here)

Eq. 1 indicates that the impact of a municipal-level policy is a marginal 2.7 percent increase in the likelihood of LEED construction, and Eq. 2 indicates a policy is associated with a 33 percent increase in

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[21] Event studies were conducted for each government level of policy implementation as well, and the results supported the full sample findings.
[22] Unweighted models were also tested and offered similar results.

the portion of new home construction which is LEED certified. Eq. 3 and 4 indicate that county-level incentive policies are associated with a decrease in LEED single family construction, although it should be noted that the models don't perform well with county-level data. Many of the explanatory variables which perform consistently in all other models fail to return the expected sign and any notable significance level. This weakness in the county-specific results is found throughout the analysis, limiting the insights available into the impact of county-level policies. This may indicate that county-level policies are an ineffective way to encourage green construction, lacking from both the specificity of municipal policies and the breadth of state policies (see Discussion for further investigation). However, the state-level treatment variables have positive loadings and are economically and statistically significant. Eq. 5 and 6 indicate that a state-level policy increases the probability of LEED construction by 2.5 percent, and is associated with a 33 percent increase in the portion of new home construction which is LEED certified.

Multiyear Windows Analysis

Up to this point, all of the analysis is based on annual data – examining the impact of a policy in-place on annual LEED construction. Given the nature of real estate development, results from this format could prove noisy as the temporal relationship is difficult to measure. It is possible that a policy is in place in a municipality, which effectively encourages LEED construction. However, that construction may occur as five LEED homes in the first year after implementation, none the following year, and three the year after that. To better capture the impact of incentive policies, multiyear windows are created. Based on the event study analysis, it is clear that the greatest impact from a policy occurs in the second and third years ex post policy implementation.[23]

For each municipality with a policy, only one window was created, representing Lagged Years 1-3. All other data from those municipalities, including data predating the policy, was suppressed to prevent

[23] A fourth lagged year was also tested, and proved uninformative. This may be due to the limited number of policies which have been in place for at least five years.

confounding results. For the non-treated municipalities, every available three-year window was created. In each case, the related point in time data (population, clean fuel stations, etc.) is taken from the year prior to the beginning of the window, so it matches with the treated observations' data on the year the policy was enacted. The format of the dependent variables, both for the probit and OLS regressions, remains the same. For the probit models, the dependent variable carries a value of one if there is any LEED construction during the three-year window, zero otherwise. For the OLS models, the dependent variable is the natural log of the ratio of total LEED construction over the three years to the total single-family building permits over the three years. These transformations will result in fewer observations, but should provide less noisy data.

(Insert Table 5 Here)

Table 5, Eq. 1 and 2 recreates the results from Table 3, Eq. 1 and 2 with this modification to the data. The results remain quite consistent, both in terms of the treatment and other explanatory variables, and the strength of the model. The probit (Eq. 1) indicates the marginal impact of any policy is a 4.1 percent increase in the likelihood of LEED construction over the three-year horizon, and Eq. 2 indicates a policy is associated with a 34 percent increase in the portion of new home construction which is LEED certified. This proportion is a near-match to the annual proportion increase seen in Table 3, Eq. 2.

Table 5, Eq. 3 through 6 recreate the results from Table 4, using the multiyear dataset and excluding county-specific results. Given the poor performance of the county-specific models, those results have been suppressed.[24] Here as well, the multiyear window results mirror the single-year findings. Municipal-level policies prove more likely to encourage LEED construction with the marginal impact being nine percent versus the state's 5.4 percent. Additionally, the percent increase in the proportion of LEED homes over the three-year window is a substantial 72 percent for municipal policies, versus 34 percent for state policies. While both are strong results, economically and statistically, the municipal

[24] Most county-specific results are suppressed given their poor performance and to save space, but are available upon request.

policy results indicate a near-doubling of the percent of LEED homes constructed over a three-year period, providing strong evidence that municipal policies may be more effective.

Sensitivity Analysis – Model Comparisons

In the analysis thus far, the effectiveness of each policy has been analyzed individually. By employing a "horse race" model format, policy categories can be compared side-by-side. First, municipal, county, and state policies are all controlled for in the same two equations used to date. Table 6, Panel A reports the results on the variables of interest for both the probit (Eq. 1 and 3) and OLS (Eq. 2 and 4), and for both the annual data (Eq. 1 and 2) and the three-year window data (Eq. 3 and 4). All of the previously-utilized controls variables are also included, but suppressed from the table to conserve space. These results support the previous findings, with both the municipal and state-level policies having a positive, statistically and economically significant relationship with the probability and marginal increase in LEED homes, and county policies having a negative relationship. Based on these findings, it appears that state and municipal-level green incentive policies are most effective in encouraging LEED single family construction.

(Insert Table 6 Here)

Besides state, county, and municipal, another delineation in the incentive policies is by the type of incentive: construction-related versus business related. Construction-related policies refers to the four incentive categories which provide benefits directly tied to the construction process, including Code Departure, Expedited Permitting, Density Bonus, and Fee Reduction (including Feebate). Business-related policies refer to the three incentive categories which provide a definite economic benefit, regardless of the construction environment: grants; tax credits; and, tax abatements.

A local governing body may have greater insight into how to tailor construction-related incentives to match the local development environment, making a certain incentive very valuable. However, while a density bonus may or may not result in an economic benefit, policies like tax credits and grants nearly always result in economic benefit, and a benefit sizable enough to outweigh the cost of green construction and certification. While only some developers may benefit from expedited permitting, all developers do benefit from a grant. Therefore, business-related policies may experience greater success than construction policies.

Utilizing the same models and datasets as for the government level comparisons, the construction versus business comparison results are shown in Panel B of Table 6. Overwhelmingly, the results indicate the strength of the business-related policies over the construction policies. A construction policy is related to a marginal 0.2 and 0.8 percent increase in the probability of LEED construction over the one-year and multiyear horizon, respectively, with limited statistical significance. However, a business policy is associated with a marginal 3.2 and 6.6 percent increase in the probability of LEED construction over those same time periods, with results significant at the one percent level of analysis. Regarding the OLS models, construction policies are associated with an eight and fourteen percent increase in the portion of LEED new construction over the annual and three-year period, respectively, compared to the business policies' expected increase of 40 and 44 percent over those two timelines. As with the probit models, here too the construction policy results achieve limited statistical strength while the business policy results prove quite strong. These models were also tested for each level of government policy (results suppressed from table), and the strong economic and statistical strength of the business policies persisted. Across all levels of government issuance, a business-related policy offering a definite financial benefit was found to be more successful in encouraging LEED construction than a construction-related incentive.

Furthermore, models comparing each of the seven policy types examined in this research were completed using both datasets and at each level of government issuance. These results provided little additional information over those discovered in the construction versus business policy analysis. The business-related policies (grant, tax credit, and tax abatement) generally returned economically and statistically significant results with the expected sign at both the municipal and state level. Only one construction policy is used at the state level (fee reduction) and those results carried the wrong sign and no statistical significance. At the municipal level, expedited permitting proved the most consistent, with mixed results for code departure and fee reduction, and poor results for density bonus.[25]

While data limitations disallow independent, time-specific analysis of most incentive types, sufficient data is available for investigation of grants and tax credits. Under both datasets (annual and multiyear windows), the treatment variables for grants and tax credits returned significant results, economically and statistically. Grants are associated with a 4.2 and 10.9 percent increase in the probability of LEED construction for the annual and three-year datasets, respectively, and are related to between a 28 and 34 percent increase in the portion of LEED new home construction. Tax credits are associated with a 1.9 and 5.8 percent increase in the probability of LEED construction over the same time periods, and are related to a 33 to 56 percent increase in the portion of LEED new home construction. These findings further support the superior effectiveness of business policies.

Discussion and Conclusion

Using data on private single family LEED construction incentive policies, and on both LEED and total single family construction, the relationship between green incentive policies and green construction is examined. Analysis indicate that there is a correlation, however not all government bodies experience the same success with their policies, and not all policy types proved to be equally effective.

Regression results indicate that there is an economically and statistically significant relationship between LEED single family construction policies and an increase in both the probability of LEED construction and the portion of LEED-certified homes in total new home construction (Table 3, Eq. 1 and 2). Event studies suggest that policy influence is most notable during the second and third years following policy

[25] These results, including county-level results, were suppressed to conserve space and are available upon request.

adoption (Table 3, Eq. 3 and 4). This result is intuitive given the lengthy process of real estate development, from building permit approval through completion of construction.

While LEED policies prove an effective tool to encourage green construction, not all policies are created equal. Table 4 highlights the strength in policies issued by municipal and state governments as compared to county governments. Municipalities are the governing group with the most robust knowledge of what type of incentives would be beneficial to developers working in their community, and the municipal government has the ability to tailor policies to be enticing within their local arena. For example, the municipality is the government body which most frequently issues building permits, providing this group the greatest flexibility in offering construction-related incentives such as expedited permitting, fee reductions, and density bonuses.

At the other end of the government spectrum, states also experience great success in encouraging LEED construction, albeit exclusively through business-related policies (grants, tax credits, and tax abatement). The types of policies provide a definite economic benefit, as opposed to a construction-related policy which may or may not garner that result. Such construction incentives may be alluring in one community yet offer little benefit in another. An example is density bonuses. In San Francisco, an increased density bonus would have massive economic impact on a project. Meanwhile, in other parts of the state, a density bonus could provide little to no economic benefit. Therefore, one incentive policy enacted at a higher government level could produce differing results across the municipalities it affects. This is especially true of construction-related incentives, with market specific benefits, as opposed to business-related incentives. Since the draw of such policies is near-guaranteed economic benefit, that comes with a near-guaranteed economic cost to the state. States utilizing such policies need to examine the impact to ensure the net present value of the total benefits, both at the margin and in terms of mass commercialization of green construction, outweigh the costs.

The results to this point are based on annual data, yet the event study analysis indicates the greatest benefit from incentive policies is realized up to three years after its adoption. Therefore, a second dataset is formed based on the three years lagging policy implementation. Re-estimation of the preceding analyses using this new dataset indicates the previous results both persist and strengthen under the new lengthened time frame (Table 5). Specifically, municipal policies are associated with a notable increase in the portion of LEED new home construction over the three-year window (72 percent, Table 5, Eq. 4).

Lastly, comparison models reinforce the aforementioned independent findings. Table 6, Panel A reinforces the relative strength of municipal and state policies over county policies. Panel B compares construction-related policies (code departure, expedited permitting, density bonus, and fee reduction) and business-related policies (grant, tax credits, tax abatement). Results indicate that business policies are far more successful in encouraging LEED construction, at all levels of government implementation. An in-depth examination of grants and tax credits provides further evidence of these policy types' economic and statistical strength.

The policy implications of this research include areas for continuation, and areas for correction. LEED has become the preferred standard for measuring green single-family construction, so as new policies are enacted, LEED should be included as the measuring stick. This way, new and existing policies (many impacting the same areas) will use the same measuring stick, increasing the ease and frequency of the policies' use.

Business-related policies prove most effective in encouraging LEED construction, so governments interested is encouraging green construction should attempt to offer these first. However, what makes the business-related policies most effective is their guaranteed economic benefit, which means a guaranteed economic cost for the government. Because of this, larger governments, such as state-level governments, may be better-equipped to offer such programs, both in terms of the government's budget and the geographic scope of the policy application to developers (pursuing a grant across hundreds of units in a state versus tens of units in one municipality). Additionally, this allows municipalities to focus on construction-related incentive policies, an area in which local government could excel given their involvement in the development process and local market expertise. Market-tailored policies could be instituted with little to no financial cost to the government, but with great effectiveness – if the correct type of incentive is offered for a given market's demands.

Having identified the strong matches between policy types and government levels, what remains is the question of counties. Counties prove to be a suboptimal fit – too small for big-budget, highly effective business-related policies; too large for market-specific, fine-tuned construction-related policies. The best approach for counties that wish to encourage green construction may lie in two activities. First, based on the findings of Simcoe and Toffel (2013), a county may inspire green construction is through spillover effect. By requiring county space and county-funded projects to meet green construction requirements, the mid-sized government could indirectly spur green construction. Second, if the county does wish to directly encourage green construction, they would do best to examine the limitations on its powers (as impacted by Home Rule and Dillon's Rule), and work to develop a policy that is most effective given those constraints. Lastly, the successful county will execute a market demand analysis to determine the types of construction and business benefits desired by developers, and find a way to satisfy those demands within the constraints of the county's budget and planning guidelines.

Works Referenced

Aroul, R. and Hansz, J., 2012. The Value of "Green:" Evidence from the First Mandatory Residential Green Building Program. *Journal of Real Estate Research*, 34 (1): 27-49.

Banfi, S., Farsi, M., Filippini, M., and Jakob, M., 2008. Willingness to pay for energy-saving measures in residential buildings. *Energy Economics*, 30: 503-516.

Bond, S. and Devine, A., 2015. Certification Matters: Is Green Talk Cheap Talk? *Journal of Real Estate Finance and Economics*, March 31, 2015. DOI: 10.1007/s11146-015-9499-y.

Bratti, M. and Miranda, A., 2011. Endogenous Treatment Effects for Count Data Models with Endogenous Participation or Sample Selection. *Health Economics*, 20(9): 1090-1109.

Coggburn, J. and Rahm, D., 2005. Environmentally Preferable Purchasing: Who Is Doing What in the United States? *Journal of Public Procurement*, 5(1): 23-53.

Dastrup, S., Zivin, J., Costa, D., and Kahn, M., 2012. Understanding the Solar Home Price Premium: Electricity Generation and “Green” Social Status. *European Economic Review*, 56(5): 961-973.

Deng, Y., Li, Z., and Quigley, J., 2012. Economic returns to energy-efficient investments in the housing market: Evidence from Singapore. *Regional Science and Urban Economics*, 42:506-515.

Diamond, A. and Sekhon, S., 2005. Genetic Matching for Estimating Causal Effects: A General Multivariate Matching Method for Achieving Balance in Observational Studies *The Review of Economics and Statistics*, 95(3): 932-945.

Dinan, T. and Miranowski, J., 1989. Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market, *Journal of Urban Economics*, 25:52-67.

Dippold, T., Mutl, J, and Zietz, J., 2014. Opting for a Green Certificate: The Impact of Local Attitudes and Economic Conditions, *Journal of Real Estate Research*, 36(4): 435-473.

Fuerst, F., Kontokosta, C., and McAllister, P., 2011. Determinants of Green Building Adoption, *Environment and Planning B: Planning and Design*, 41(3): 551-570.

Horowitz, M. and Hossein, H., 1990. Economic efficiency *v* energy efficiency: Do model conservation standards make good sense? *Energy Economics*, 12 (2):122-131.

Iacus, S., King, G., and Porro, G., 2011. Multivariate Matching Methods That are Monotonic Imbalance Bounding. *Journal of the American Statistical Association*, 493:345-361.

Iacus, S., King, G., and Porro, G., 2012. Causal Inference Without Balance Checking: Coarsened Exact Matching. *Political Analysis*, 20(1): 1-24.

Kahn, M. and Vaughn, R., 2009. Green Market Geography: The Spatial Clustering of Hybrid Vehicles and LEED Registered Buildings. *B.E. Journal of Economic Analysis & Policy: Contribution to Economic Analysis & Policy*, 9(2): 1-22.

Kok, N. and Kahn, M., 2012. The Value of Green Labels in the California Housing Market: An Economic Analysis of the Impact of Green Labeling on the Sales Price of a Home, July 2012. Available at: http://issuu.com/nilskok/docs/kk_green_homes_071912/3

Kok, N., McGraw, M., and Quigley, J., 2011. The diffusion of energy efficiency in building, *The American Economic Review*, 101(3): 77-82.

Kontokosta, C., 2011. Greening the Regulatory Landscape: The Spatial and Temporal Diffusion of Green Building Policies in U.S. Cities. *Journal of Sustainable Real Estate*, 3(1).

Kwak, S., Yoo, S., and Kwak, S., 2010. Valuing energy saving measures in residential buildings: A choice experiment study. *Energy Policy*, 38:673-677.

Marron, D., 1997. Buying Green: Government Procurement as an Instrument of Environmental Policy. *Public Finance Review*, 25(3):285-305.

Marron, D., 2003. Greener Public Purchasing as an Environmental Policy Instrument. *OECD Journal on Budgeting*, 3(4): 71-105.

May, P. and Koski, C., 2007. State Environmental Policies: Analyzing Green Building Mandates. *Review of Policy Research*, 24(1):49-65.

McCrudden, C., 2004. Using Public Procurement to Achieve Social Outcomes. *Natural Resources Forum*, 28(4): 257-267.

Michaelsen, O. and de Boer, L., 2009. Green Procurement in Norway: A Survey of Practices at the Municipal and County Level. *Journal of Environmental Management*, 91(1):160-167.

Newport, F., 2013. Alabama, North Dakota, Wyoming Most Conservative States: Americans slightly less conservative, slightly more liberal. *Gallup: State of the States*, February 1, 2013. Available at: http://www.gallup.com/poll/160196/alabama-north-dakota-wyoming-conservative-states.aspx

Prum, D. and Kobayashi, T., 2014. Green Building Geography Across the United States: Does Governmental Incentives or Economic Growth Stimulate Construction? *Real Estate Law Journal*, 43:5-37.

Sadler, M., 2003. Home energy preferences and policy: applying stated choice modeling to a hybrid energy economic model. Report to National Resources Canada, Simon Fraser University, September 2003.

Simcoe, T. and Toffel, M., working paper. Public Procurement and the Private Supply of Green Buildings. NBER Working Paper No. 18385.

Sourani, A. and Sohail, M., 2011. Barriers to Addressing Sustainable Construction in Public Procurement Strategies. *Proceedings of the Institution of Civil Engineers (ICE) – Engineering Sustainability*, 164(4): 229-237.

Table 1: Government Policies Incentivizing LEED Single Family Private Construction

The following table summarizes the types of policies incentivizing market-rate green construction in the single family market. Panels A through C provide breakdowns by incentive type and required level of certification compliance for the State, County, and Municipal levels, respectively. Some policies include multiple incentive programs. Panel D provides the correlation coefficients for the seven categories of incentive programs used in this analysis. Despite many policies or locales offering multiple incentive categories, the correlation between these categories is quite low.

Panel A: State	**LEED Certified**	**LEED Silver**	**LEED Gold**	**LEED Platinum**	**Total**
Fee Reduction/ Feebate			1		**1**
Tax Abatement		1			**1**
Tax Credit		1		1	**2**
Grant	1				**1**
Total	**1**	**2**	**0**	**1**	**5**

Panel B: County	**LEED Certified**	**LEED Silver**	**LEED Gold**	**LEED Platinum**	**Total**
Expedited Permitting	5				**5**
Fee Reduction/ Feebate	4				**4**
Density Bonus	1				**1**
Tax Credit		1			**1**
Code Departure		1			**1**
Total	**10**	**2**	**0**	**0**	**12**

Panel C: Municipality	**LEED Certified**	**LEED Silver**	**LEED Gold**	**LEED Platinum**	**Total**
Expedited Permitting	25	3			**28**
Fee Reduction/ Feebate	21	3			**24**
Density Bonus	26	9	3		**38**
Tax Abatement	4	1			**5**
Tax Credit		1			
Grant	6	1			**7**
Code Departure	4	2			**6**
Total	**86**	**20**	**3**	**0**	**108**

Panel D: Correlation Matrix	**Code Departure**	**Expedited Permitting**	**Density Bonus**	**Fee Reduction**	**Grant**	**Tax Credit**	**Tax Abatement**
Code Departure	1.00						
Expedited Permitting	0.06	1.00					
Density Bonus	0.07	0.06	1.00				
Fee Reduction	0.06	0.25	0.01	1.00			
Grant	-0.01	-0.02	0.01	-0.03	1.00		
Tax Credit	0.00	-0.01	0.01	-0.01	-0.04	1.00	
Tax Abatement	0.00	0.00	0.05	-0.01	-0.01	0.00	1.00

Table 2: Summary Statistics

The following table lists the average of each variable for the full sample and subsamples of municipalities, with and without LEED construction and with and without green incentivizing policies. In the analysis, transformations of these variables are used as well.

	Full Sample	LEED	No LEED	Policy	No Policy
LEED (D)	1.6%	100.0%	0.0%	2.5%	1.4%
Total LEED	0.08	5.30	0.00	0.15	0.07
Multiple Policies (D)	0.2%	1.1%	0.2%	1.3%	0.0%
Annual Single-Family Building Permits*	38	129	37	29	40
2006-2014 Single-Family Building Permits	339	1502	320	321	342
Total HDD	1,417	1,293	1,419	1,079	1,484
Total CDD	1,246	1,388	1,243	1,109	1,273
Clean Fuel Stations**	5.76	12.70	5.64	5.56	5.80
Electric Stations**	3.05	10.10	2.94	3.99	2.87
Ethanol Stations**	1.13	0.84	1.13	0.36	1.28
Very Conservative (D)	3%	5%	3%	0%	4%
Conservative (D)	7%	9%	702%	0%	9%
Moderate (D)	27%	28%	27%	7%	31%
Liberal (D)	29%	34%	29%	6%	34%
Very Liberal (D)	33%	24%	34%	87%	23%
Top 100 MSA (D)	59%	62%	59%	48%	62%
Municipal Tax Authority (D)	18%	11%	18%	4%	21%
Home Rule (D)	92%	82%	92%	96%	91%
Population	34,593	167,476	30,593	35,574	34,402
Per Capita Income	$ 27,415	$35,018	$ 27,212	$30,942	$ 26,749
Observations	49,350	791	48,559	8198	41,152

* Scaled, per 10,000 people

**Scaled, per 100,000 people

Table 3: Regression Results with Any Policy as Treatment Variable

The following table details the coefficient results for Probit (Equations 1 & 3) and OLS (Equations 2 & 4) regressions. In each of these equations, the treatment variable has a value of 1 if there is any LEED incentive policy affecting the municipality (municipal, county, or state policy). Equations 3 & 4 represent Event Studies of the policy, tracking the impact of a policy in the year of the event and each of three following years. All models include CEM weights, controls for geographic division, and year fixed effects. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

Dependent Variable	**(1)** LEED Dummy	**(2)** Ln(LEED/ SFBP)	**(3)** LEED Dummy	**(4)** Ln(LEED/ SFBP)
Any Policy (D)	0.33***	0.25***		
	(.068)	(.028)		
Policy Event			0.03	0.04
			(.131)	(.041)
Policy Lag – Year 1			0.14	0.09**
			(.117)	(.042)
Policy Lag – Year 2			0.23**	0.14***
			(.113)	(.042)
Policy Lag – Year 3			0.39***	0.23***
			(.115)	(.046)
Home Rule (D)	0.21**	0.14***	0.20**	0.12***
	(.082)	(.028)	(.081)	(.030)
Very Conservative (D)	-0.45***	-0.58***	-0.60***	-0.66***
	(.152)	(.068)	(.146)	(.067)
Liberal (D)	-0.36***	-0.20***	-0.33***	-0.12***
	(.100)	(.034)	(.099)	(.033)
Very Liberal (D)	-0.29***	-0.27***	-0.19**	-0.15***
	(.103)	(.031)	(.099)	(.027)
Top 100 MSA (D)	-0.24***	-0.10***	-0.25***	-0.10***
	(.048)	(.016)	(.048)	(.016)
Ln(HDD)	0.05***	0.01***	0.05***	0.01***
	(.014)	(.003)	(.013)	(.003)
Scaled Electric Stations	0.01***	0.003***	0.01***	0.003***
	(.000)	(.000)	(.001)	(.000)
Ln (Average Population)	0.31***	0.09***	0.32***	0.09***
	(.016)	(.005)	(.015)	(.005)
Ln(Average PCI)	0.72***	0.22***	0.72***	0.22***
	(.160)	(.017)	(.053)	(.017)
Constant	-13.97***	-3.15***	-14.11***	-3.23***
	(.682)	(.204)	(.684)	(.203)
Geo Division Controls	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes
CEM Weights	Yes	Yes	Yes	Yes
Observations	23,739	23,411	23,739	23,411
Pseudo R^2	0.22	0.07	0.22	0.07

Table 4: Regression Results with Different Government Level Policies as Treatment Variable

The following table details the coefficient results for Probit (Equations 1, 3 & 5) and OLS (Equations 2, 4 & 6) regressions. The dependent variable represents the total LEED over each one-year period. In each of these equations, the treatment variable has a value of 1 if there is a LEED incentive policy issued by the specified level of government affecting the municipality. All models include CEM weights, controls for geographic division, and year fixed effects. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

Dependent Variable	**(1)** LEED Dummy	**(2)** Ln(LEED/ SFBP)	**(3)** LEED Dummy	**(4)** Ln(LEED/ SFBP)	**(5)** LEED Dummy	**(6)** Ln(LEED/ SFBP)
Municipal Policy (D)	0.28***	0.33***				
	(.096)	(.076)				
County Policy (D)			-0.39*	-0.17***		
			(.234)	(.063)		
State Policy (D)					0.70***	0.33***
					(.127)	(.037)
Home Rule (D)	0.23**	0.02	-0.75***	0.47***	0.25**	0.14***
	(.101)	(.049)	(.069)	(.032)	(.100)	(.031)
Very Conservative (D)	1.73	-0.19	2.39	0.20	-0.37*	-0.67***
	(74.891)	(.119)	(167.74)	(.293)	(.194)	(.067)
Liberal (D)	-0.37***	0.00	0.23**	0.26***	-0.38***	-0.21***
	(.133)	(.058)	(.111)	(.044)	(.194)	(.036)
Very Liberal (D)	-0.49***	-0.15**	0.01	0.07	-0.48***	-0.32***
	(.135)	(.058)	(.132)	(.044)	(.143)	(.037)
Top 100 MSA (D)	-0.33***	-0.20***	-0.25***	-0.08***	-0.18***	-0.05***
	(.041)	(.007)	(.053)	(.019)	(.057)	(.016)
Ln(HDD)	-0.01	-0.02***	0.03**	0.01	0.06***	0.01***
	(.013)	(.025)	(.015)	(.004)	(.016)	(.003)
Scaled Electric Stations	-0.03***	0.02***	0.03***	0.01***	0.005***	0.003***
	(.002)	(.007)	(.002)	(.001)	(.001)	(.000)
Ln(Average Population)	0.45***	0.25***	0.32***	0.09***	0.27***	0.06***
	(.016)	(.008)	(.023)	(.008)	(.020)	(.005)
Ln(Average PCI)	0.72***	0.28***	0.19**	0.05	0.68***	0.18***
	(.056)	(.031)	(.098)	(.032)	(.060)	(.017)
Constant	-15.17***	-5.25***	-8.86***	-1.18***	-12.97***	-2.39***
	(.719)	(.345)	(1.072)	(.339)	(.804)	(.206)
Geo Division Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes
CEM Weights	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,530	18,443	12,920	15,107	21,885	20,867
Pseudo R^2	0.25	0.10	0.23	0.06	0.20	0.06

Table 5: Regression Results with Multiyear Windows

The following table details the coefficient results for Probit (Equations 1, 3 & 5) and OLS (Equations 2, 4 & 6) regressions. The dependent variable represents the total LEED over a three-year window. For each treated observation, the three-year window begins the year after the policy is enacted. In each of these equations, the treatment variable has a value of 1 if there is a LEED incentive policy issued by the specified level of government affecting the municipality. All models include CEM weights, controls for geographic division, and year fixed effects. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

Dependent Variable	**(1)** LEED Dummy	**(2)** Ln(LEED/ SFBP)	**(3)** LEED Dummy	**(4)** Ln(LEED/ SFBP)	**(5)** LEED Dummy	**(6)** Ln(LEED/ SFBP)
Any Policy (D)	0.46***	0.34***				
	(.121)	(.077)				
Municipal Policy (D)			0.59***	0.72***		
			(.193)	(.199)		
State Policy (D)					0.68***	0.34***
					(.204)	(.107)
Home Rule (D)	0.128	0.20***	0.30***	0.12	0.23	0.29***
	(.110)	(.067)	(.105)	(.091)	(.148)	(.080)
Very Conservative (D)	-0.05	-1.41***	3.89	0.90**	-0.61	-2.20***
	(.424)	(.365)	(78.37)	(.374)	(.556)	(.409)
Liberal (D)	-0.430***	-0.29***	-0.30*	-0.15	-.54***	-0.36***
	(.151)	(.083)	(.167)	(.117)	(.199)	(.100)
Very Liberal (D)	-.292*	-0.35***	-0.63***	-0.50***	-0.28	-0.34***
	(.157)	(.082)	(.170)	(.114)	(.220)	(.107)
Top 100 MSA (D)	-.283***	-0.20***	-0.19***	-0.30***	-0.31***	-0.17***
	(.065)	(.036)	(.064)	(.052)	(.084)	(.042)
Ln(HDD)	-.086***	0.02***	0.17***	0.06***	0.08***	0.02***
	(.020)	(.007)	(.030)	(.014)	(.023)	(.007)
Scaled Electric Stations	-0.017***	0.01***	0.04***	0.04***	0.01***	0.01***
	(.002)	(.001)	(.003)	(.003)	(.002)	(.002)
Ln(Average Population)	0.37***	0.14***	0.33***	0.15***	0.37***	0.14***
	(.026)	(.013)	(.032)	(.021)	(.032)	(.015)
Ln(Average PCI)	0.85***	0.47***	0.56***	0.47***	0.88***	0.46***
	(.026)	(.041)	(.098)	(.068)	(.087)	(.046)
Constant	-14.26***	-5.31***	-11.39***	-5.32***	-16.04***	-6.29***
	(1.018)	(.616)	(1.219)	(.810)	(1.122)	(.509)
Geo Division Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes	Yes	Yes
CEM Weights	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,564	7,081	2,081	4,923	5,638	5,033
Pseudo R^2	0.20	0.07	0.17	0.10	0.20	0.07

Table 6: Sensitivity Analysis Regression Results – Model Comparisons

The following tables detail the coefficient results for Probit (Equations 1 and 3) and OLS (Equations 2 and 4) regressions. In Equations 1 and 2 the dependent variable represents the total LEED over each one-year period, and in Equations 3 and 4 the dependent variable represents the total LEED over a three-year window. In each of the equations, the treatment variable has a value of 1 if there is a LEED incentive policy issued by the specified level of government, or under a specified incentive group (construction or business). Panel A compares all government policy levels concurrently. Panel B compares the construction and business related incentive policies. All models include CEM weights, controls for geographic division, and year fixed effects. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

Panel A: Gov't Levels	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable	LEED Dummy	Ln(LEED/ SFBP)	LEED Dummy	Ln(LEED/ SFBP)
Data Format	***Annual***		***3-Year Window***	
Municipal Policy	0.35***	0.45***	0.73***	0.39***
County Policy	-0.36*	-0.19***	-0.90*	-0.42**
State Policy	0.63***	0.30***	0.53***	0.17***
Pop, PCI Controls	Yes	Yes	Yes	Yes
Geo Division Controls	Yes	Yes	Yes	Yes
Time Controls	Yes	Yes	Yes	Yes
CEM Weights	Yes	Yes	Yes	Yes
Observations	23,739	23,411	7,564	7,081
Pseudo R^2	0.23	0.07	0.20	0.07

Panel B: Policy Groups	**(1)**	**(2)**	**(3)**	**(4)**
Dependent Variable	LEED Dummy	Ln(LEED/ SFBP)	LEED Dummy	Ln(LEED/ SFBP)
Data Format	***Annual***		***3-Year Window***	
Construction Policy	0.04	0.08*	0.09	0.14
Business Policy	0.70***	0.40***	0.73***	0.44***
Pop, PCI Controls	Yes		Yes	
Geo Division Controls	Yes		Yes	
Time Controls	Yes		Yes	
CEM Weights	Yes		Yes	
Observations	23,739	23,411	7,564	7,081
Pseudo R^2	0.23	0.07	0.20	0.07

Figure 1: LEED for Homes Private Single-Family Construction

The following chart highlights the total number of LEED for Homes certified, privately-construction single-family units in the United States annually since 2006. Each year's total LEED for Homes certifications is broken down into the different levels of certification achieved.

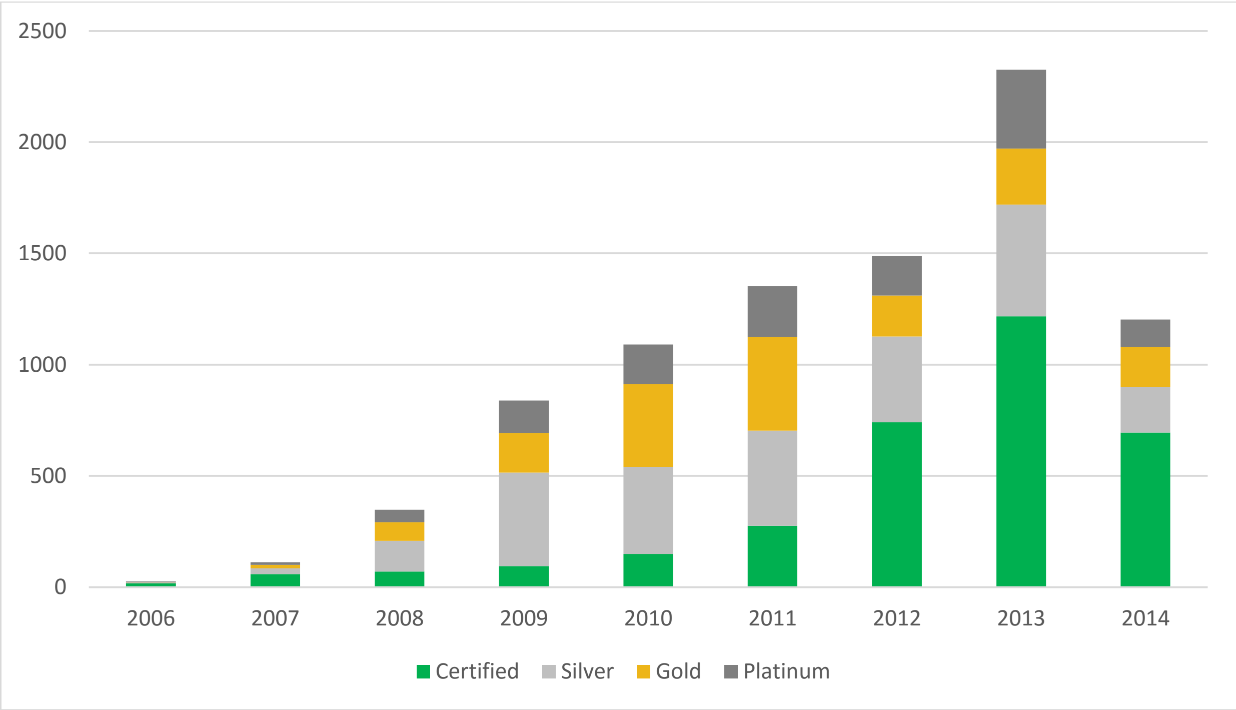

Figure 2: Clean Fuel Station Locations

The following map notes the mainland locations of the 11,597 clean fuel stations in operation as 2012. This data is available from the Department of Energy and is updated in real time. While the most popular types of fueling stations include electric and ethanol, Panel A shows the location of all seven tracked clean fuel station types: biodiesel, CNG (compressed natural gas), electric, ethanol, hydrogen, LNG (liquefied natural gas), and propane.