Do Policy Incentives Promote Green Building?

Shaun A. Bond and Avis Devine

Department of Finance and Real Estate

University of Cincinnati

January 2014

(Draft in progress – do not cite without the permission of the authors)

Abstract:

For more than a decade, governments have been incentivizing, and now requiring, private developers to construct energy efficient, sustainable projects. We examine the types of incentive programs governing single family market-rate residential construction and determine whether or not these programs have successfully encouraged energy efficient construction. A cross-sectional comparison of municipalities with and without green private residential incentive programs indicates which type of certification program is most popular, which types of incentive programs prove most successful, and which government levels of policy issuance prove most effective.

Key words: Energy Efficiency, Sustainability, Policy, Residential

JEL Codes: R11, R52, R58, E61

Since 1999, several municipalities, counties, and states have enacted policies which incentivize energy efficient or sustainable construction on private construction projects using the LEED, Energy Star, or other green-rating programs as a guideline. Examples of policy incentive tools which can shape supply and design are tax abatement, density bonuses, grant or loan programs, expedited permitting, and permitting/zoning fee reductions or feebate (the rebating of fees) programs. Additionally, several governing bodies have gone beyond incentivizing sustainable development, now requiring some level of sustainability in all new construction.

The intention behind such 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)[1] and 73 percent of electricity.[2] Additionally, the construction process in the United States accounts for 38 percent of all CO_2 gas emissions[3] and is one of the heaviest users of natural resources, consuming 40 percent of the world's natural resources.[4] Energy efficient buildings consume fewer natural resources (and create less waste), use less power, and put off fewer emissions. Given the significant role 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.

Through year-end 2009, 65 energy efficiency policies were enacted by state, county, and municipal bodies in the United States governing private residential (both multifamily and single family) construction and governed by the United States Green Building Council's (USGBC) Leadership in Energy and

---

[1] 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

[2] 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

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

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

Environmental Design (LEED) rating program.[5] Additionally, there is one private residential construction policy tied solely to the Environmental Protection Agency's (EPA) Energy Star program, and there may be other programs linked exclusively to other green building programs such as Green Globes, Earthcraft, etc.[6] While many of the LEED-related policies allow for other rating programs such as these to be used in place of LEED, few exclude LEED from the list of accepted rating systems. This indicates LEED's status as the energy efficiency benchmark of choice for government single family construction incentive programs.

Focusing on these areas in which environmentally efficient residential construction has been encouraged, we look to see if there has been an increase in the number of LEED homes built. Using a variety of econometric modeling techniques, we compare these areas cross-sectionally with other markets that have not provided green incentive programs to measure the effect of the policies, while controlling for economic and demographic drivers of construction. Through this, we examine the effectiveness of the different policy categories and of different governing bodies' policy issuances and find drastic differences in their success rates. Municipalities have the greatest success with incentive policies, followed closely by state-level policies, while county-level policies prove less effective. Additionally, incentive categories which have definite economic benefit prove to be more successful in encouraging green construction than their counterparts which may or may not prove economically beneficial. Lastly, we identify which incentive categories have the less consistent track record and postulate what may be driving these results.

[5] There are also numerous policies governing public construction for both residential and commercial use and private commercial use; this research focuses on private residential uses and their related policies.

[6] 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 the national (or international) programs which government bodies frequently accept in lieu of their own rating systems.

Literature Review

To date there has been little research completed on residential buildings and sustainability, with the majority of the focus placed on commercial buildings, specifically office space. This body of literature provides evidence of rental and sale price premiums and superior occupancy rates associated with green commercial buildings, basing the green definition on the Energy Star, LEED, or other national equivalent labeling systems (Miller, Spivey, and Florance, 2008; Wiley, Benefield, and Johnson, 2010, Eichholtz, Kok, and Quigley 2010, Kok and Jennen, 2011, Kok, McGraw, and Quigley 2011, Ciochetti and McGowan 2010; Fuerst and McAllister 2009, 2011).

A comparatively limited amount of research examines sustainability and residential properties. Aroul and Hansz (2011) examines Frisco, Texas, the nation's first municipality to mandate a sustainable green building program, and Costa and Kahn (2009) focuses on Sacramento, California. Both studies examine house transaction prices and find premiums for green construction. Kok and Kahn (2012) examines single family home sales in California from 2007 through 2012 and finds those with energy efficiency certification transact at a sales premium minimum of nine percent; Deng, Li, and Quigley (2012) finds a similar (albeit smaller magnitude) result in Singapore. Bond and Devine (2013, working paper) measures the rental rate premium associated with multifamily properties identifying themselves as green and as being LEED certified, finding both to be positive and significant, and that the LEED certification premium is greater than the premium associated with uncertified green properties. Brounen and Kok (2011) examines Dutch residences and finds that energy labels create transparency in the energy efficiency of dwellings. The authors also find that the adoption rate of energy labels on housing is positively correlated with the location of Green party voters in the 2006 national election, and that consumers capitalize the energy label information into the pricing of homes.

In peripheral research, Brounen, Kok, and Quigley (2011) examines the extent to which utility usage is determined by technical specifications of a residence as opposed to demographic characteristics of the residents. Based on a sample of more than 300,000 Dutch residents, gas usage is determined by technology but electricity usage varies more directly with income and family composition. However, Sadler (2003) finds that residents exhibit a strong preference for energy efficient renovations and Kwak, Yoo, and Kwak (2010) finds a high consumer willingness to pay for energy-saving measures in Korean buildings. Additionally, Banfi et al. (2008) shows Swiss residents value energy-saving construction features. In contrast, Brounen, Kok, and Quigley (working paper, 2011) examines awareness and behavior of households regarding their residential energy usage. They find that "energy literacy" is quite low, indicating that while consumers may value energy efficiency in theory, few people would be able to identify such energy efficiency in their own lives.

Additionally, some studies focus on specific energy-saving residential construction features. Cameron (1985) analyzes the impact of energy efficient retrofitting, such as the inclusion of storm windows and insulation, and Dinan and Miranowski (1989) was the first to find that energy efficiency improvements are capitalized into housing transaction prices, with similar results found by Horowitz and Haeri (1990) regarding thermal performance improvements. Bollinger and Gillingham (2010) study the diffusion of solar panels across communities and Dastrup et al. (2010) examines San Diego single-family residential resale transactions involving solar panels and finds a price premium.

There is also a young and growing body of work on governmental policies with environmental requirements. Much of the work to-date is 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). One of the first contributions to empirical analysis of these questions is provided by Simcoe and Toffel (2011, working paper), which finds that green government purchasing policies can spill over into the private sector construction, stimulating additional green construction. All of this work focuses on the effects of government policies regarding government space, whereas our research is among the first to examine the effects of government policies directed at private construction.

Pricing premiums have been verified in both commercial and single family residential sustainable construction in a variety of locations, both within the United States and internationally. Additionally, consumers appear interested in sustainable options in their housing and are willing to pay a reasonable premium (i.e. – a premium which may be offset by the long-term utility savings associated with the investment) for such improvements. Having verified that pricing premiums may be achieved on sustainable construction, government policies implemented to encourage energy efficient construction could sufficiently incentivize developers to pursue sustainable construction. We could find no research completed to-date addressing the success of such programs in encouraging green construction, making our efforts some of the first in this field.

Certification Programs

Green housing generally refers to homes constructed and/or operable 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 U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED).[7] While there are several other rating programs available and no evidence to indicate that Energy Star and LEED are better programs than the others, these two programs are the most widely used and accepted in the United States.

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

Energy Star

The Energy Star program was created in the early 1990s by the United States Environmental Protection Agency (the EPA) in an attempt to reduce energy consumption and greenhouse gas emission by power plants. The program was intended to be part of a series of voluntary programs that would demonstrate the potential for profit in reducing greenhouse gases and facilitate further steps to reducing global warming gases. The initial program was a labeling campaign for computer and printer products, expanded to include labels for residential heating and cooling systems. More than 1.3 million homes have been Energy Star certified since the home labeling program began in 1995.

To earn Energy Star certification, a home must meet guidelines for energy efficiency set by the EPA. These homes are at least fifteen percent more energy efficient than homes built to the 2004 International Residential Code (IRC), and include additional energy-saving features that typically make them 20–30 percent more efficient than standard homes. In addition to the environmental benefits associated with construction and use of an Energy Star home, other benefits include mortgage closing cost credits, specialized mortgage products, and utility firm cost offsets to help encourage Energy Star upgrades. Any home three stories or less can earn the Energy Star label if it has been verified to meet the EPA's guidelines, including both new and existing construction. Energy Star qualified homes can include a variety of energy-efficient features that contribute to improved home quality and homeowner comfort, and to lower energy demand and reduced air pollution. These features include effective insulation, high-performance windows, tight construction and ducts, efficient heating and cooling equipment, equipping the home with Energy Star qualified products, and using Energy Star’s third party independent Home Energy Raters to verify successful inclusion of these features.

However, the Energy Star program’s rigor has been questioned. In 2008, the EPA Office of the Inspector General released its report on the Energy Star program, finding the program’s claims regarding greenhouse gas reductions were inaccurate and based on faulty data. Additionally, the Inspector General found that

Energy Star program's reported energy savings were unreliable, and that many of the touted benefits could not be verified.[8] The EPA released reports in 2007 and 2008 claiming Energy Star labels were misleading.[9] In March 2010, a report by the Government Accountability Office stated that the Energy Star program had accepted fifteen of 20 bogus products submitted for approval. The Energy Star program had also qualified four businesses as Energy Star partners, failing to identify the fact that information on the companies, products, and staff were all fictitious.[10]

LEED

Developed by the U.S. Green Building Council (USGBC) in 1998, Leadership in Energy and Environmental Design (LEED) is intended to provide building owners and operators with a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. LEED is a transparent process where the technical criteria proposed by USGBC members are publicly reviewed for approval by the almost 20,000 member organizations that constitute the USGBC. LEED certified buildings are intended to use resources more efficiently when compared to built-to-code properties. Often, when a LEED rating is pursued, the cost of initial design and construction rises. However, these higher initial costs can be effectively mitigated by the savings incurred over time due to the lower-than-industry-standard operational costs typical of a LEED certified building, and recent findings suggest that if green strategies are instituted from the beginning of the planning process, those added costs may be avoided. Additionally, this construction cost premium is shrinking as green construction methods and materials become less the exception and more the norm.[11]

[8] Environmental News Service, “Energy Star Climate Change Claims Misleading, Audit Finds,” Washington, D.C., December 2008. http://www.ens-newswire.com/ens/dec2008/2008-12-31-092.asp
[9] Becker, B., “Why Obama’s Energy Savings Estimate May Be Skewed,” *The New York Times*, February 6th, 2009. http://www.nytimes.com/2009/02/07/washington/07energy.html?_r=0
[10] United States Government Accountability Office, “Energy Star Program: Covert Testing Shows the Energy Star Program Certification Process Is Vulnerable to Fraud and Abuse” (GAO-10-470), Washington, D.C., March 2010. http://www.gao.gov/new.items/d10470.pdf
[11] 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

The LEED program may be applied to any sustainably constructed building. The LEED for Homes program was subsequently developed to lower the cost of certification on small scale projects, and is available exclusively for residential construction less than six stories in height. This certification product is often used for low-rise multifamily buildings, but is most commonly used for single-family housing, the focus of this analysis. Through year-end 2011, there were approximately 14,000 LEED and LEED for Homes certified homes constructed. To pursue any type of LEED certification, each project must begin by meeting the Energy Star requirements and then improve its sustainability substantially over that level; this provides a concise relative comparison of the two certification products. To meet LEED requirements, a home must meet sustainability requirements in the categories of energy use, water use, indoor air quality, material use (including the minimization of waste), land use, and education of the homebuilder and end user.

The LEED programs also have their drawbacks. LEED is a design tool and not a performance measurement tool. It is also not yet climate-specific, although the newest version is intended to address this weakness. Because of this, designers may make materials or design choices that garner a LEED point, even though they may not be the most site or climate-appropriate choice available. Additionally, LEED is developed and continuously modified by workers in the sustainable building industry, especially in the ten largest metro areas in the U.S.; however, LEED certified buildings have been slower to penetrate small and mid-sized markets. Another complaint is that its sizable certification costs less efficiently allocate project funds that could be used to make the building in question more sustainable. Lastly, many critics have noted that compliance and certification costs have grown faster than staff support from the USGBC.

Data

There were 177 government policies enacted before 2010 which incentivize or require energy efficiency for the private construction; of these, 127 are primarily aimed toward LEED programs and 50 are aimed toward Energy Star programs.[12] Of the 50 Energy Star private programs, 23 are requisite and govern eighteen locales (ten states and eight municipalities, plus four federal agency programs) and 27 are campaigns and incentive programs governing 23 locales (five states, one county, seventeen municipalities, and two regions). Comprising the latter are six policies encouraging energy efficiency, sixteen contests, and five incentive programs. However, none of the five incentive policies are applicable to private *residential* construction. Similarly of the eighteen requisite programs, only one relates to private residential construction.

Of the 127 LEED-aimed private programs, 113 relate to commercial uses and 65 relate to residential uses (with several policies relating to both). Of the 65 private residential-related policies, 61 govern single family construction and the vast majority are incentivizing programs. Several of these programs allow for other rating programs to be used to measure energy efficiency as well, but they all accept LEED as a rating tool. While the LEED rating programs are accepted as a measure of energy efficiency, LEED certification is not always required to receive the incentives (or meet the requirements). 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 (Costa 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.

Of the 61 LEED-related private single family residential policies, four are state-level incentive programs, twelve are county-level incentive programs (with one policy including a requisite feature as well), and the remaining 44 policies are municipal level programs.[13] Of those 44 municipal programs, seven incorporate requisite features. Following is a summary of the LEED-directed programs applicable to single family

[12] The 2010 cut off is selected so that two years of construction data could be collected following the latest policies included in the study.

[13] Some municipalities had more than one policy enacted, and one policy was enacted in a municipality on which little governmental data was collected, so it was suppressed from the later analysis. The final sample included 36 municipalities with policies.

residential construction, broken down by their locale type: state, county, and municipality. Each Panel of Table 1 indicates the number of policies which offer each of the common incentive types, as well as which have required programs, and the level of LEED compliance required to receive that incentive (or required to be met for compliance). In many cases, certification under a program is not required. Instead, the developer is required to prove compliance with the program at specified certification levels; if a specific level of compliance is not given, this is noted as the LEED Registration category. Lastly, several programs only require compliance with general green guidelines, making no mention of a specific registration or completion of a rating program's scorecard. This is noted as the General Green category.

(Insert Table 1 here)

As can be seen from Table 1, the most common level of compliance required for green single family programs is LEED Certified. However, LEED Registered and LEED Silver certification levels are also frequently demanded and in one instance a municipality requires LEED Gold certification in order to receive an incentive. Additionally, expedited permitting, fee reduction and feebate programs, and density bonuses are the most commonly issued incentives to encourage energy efficiency.

All of the policies were enacted between 1999 and 2009, with only one policy enacted prior to 2002. In fact, all but eight of the policies were enacted between 2006 and 2009, indicating that these private single-family incentivizing policies are a recent development. The county and municipal policies affect 421 municipalities total, with twelve county policies affecting 390 municipalities and 36 municipalities enacting policies as well; five municipalities are affect by both a municipal level policy and either a county-level or state-level policy.

Data were collected from HUD regarding the single family building permits issued annually for 2000 and 2005 through 2011. Of the approximately 29,000 municipalities and Census Designated Places in the

United States, data were available and collected for approximately 6,500.[14] These 6,500 municipalities represent approximately 65 percent of the total U.S. population. Figure 1 provides the average annual single family building permit activity for both the full sample and the subsample of municipalities which have experienced any LEED single family construction. Following the housing crisis, there was stabilization in the number of housing permits issued annually for 2009 through 2011; both of these trends can be seen in the full group and the LEED subsample. The average number of housing starts is higher in the LEED subgroup, but this is expected; by definition, all of the LEED subgroup municipalities are active in single family construction, while many of the municipalities in the full sample are not.

(Insert Figure 1 Here)

The LEED programs (predominantly LEED for Homes) have been certifying single family projects since 2006, with some projects initially registering as early as 2003. Between its inception and year-end 2011, the commercially-focused LEED programs, including LEED New Construction, LEED Neighborhood Development, LEED Existing Buildings, LEED Core and Shell and others, registered 92 projects which involved a single family housing aspect. Of those 92, 73 are situated in the United States, and sixteen of those completed the LEED certification process (the balance only registering for the program to-date). Fourteen of the sixteen are projects of local or state governments or non-profit organizations such as schools, leaving two certified projects completed by private developers.

The LEED for Homes program is tailored to single family construction and is a less expensive and involved process, making it the more widely used option when pursuing LEED standards on single family construction. There were 6,977 projects totaling 16,444 units (both single and multi-family) certified

[14] While 6,500 municipalities were selected for their construction-active nature as well as availability of all data, the subgroup is a good representation of the full sample of U.S. municipalities. The smaller sample has exactly the same average scaled number of single family building permits for 2006-2011 (26), roughly the same average 2005-2011 population (22,796 vs. 21,148), and roughly the same percent of municipalities are situated in the Top 100 MSAs (39% vs. 32%).

between the program's inception in 2006 and year-end 2011. Of that, 6,365 projects (6,690 units) are single family construction, and 6,133 of those projects (6,458 units) are situated in the United States. Government-related (example: military) and other non-profit development (example: affordable housing) comprise over half of these projects, leaving 2,818 units constructed by private developers. One of the LEED for Homes projects is confidential. Therefore, there were approximately 2,800 non-confidential LEED certified for-profit single family homes constructed in the United States between 2006 and year-end 2011. Given the extremely limited number of usable observations under the original LEED program (only two), those observations have been thrown out. A summary of the two programs and the breakdown of units can be seen in Panel A of Table 2.

(Insert Table 2 here)

Panel B of Table 2 provides counts of the LEED single family construction at the municipal level. Since the inception of the LEED programs, 521 municipalities in the United State experienced the private construction of 2,818 LEED for Homes single family homes. Of those 521 municipalities, only 218 had more than one LEED single family home constructed during that six-year period, and only 59 municipalities had at least ten LEED single family homes constructed. The table provides a year-by-year breakdown of the LEED single family home private construction activity. 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 and 2011. Additionally, there is an increase each year in the number of municipalities that see more than one LEED single family home privately constructed. The number of municipalities seeing the construction of at least ten LEED single family homes increased, but has generally leveled off since 2009.

To begin to understand the relationship between LEED incentivizing policies and LEED construction, the last column of Table 2's Panel B shows the number of municipalities which experienced LEED construction during each year and had an incentivizing policy in-place (through the end of the prior year). For example, of the thirteen municipalities which experienced private construction of LEED single family homes in 2006, only one had a LEED incentivizing policy in-place prior to year-end 2005. Toward the end of the time period, more municipalities that were experiencing LEED construction had incentivizing policies in place. However, the portion of municipalities experiencing LEED construction that had incentivizing policies in-place did not rise very much. More generally, of the 421 municipalities which are affected by a LEED-related policy, only 36 experienced LEED single family private construction, and only 24 municipalities experienced private construction of at least two LEED single family homes. Additionally, of the 36 municipalities which had municipal-level incentivizing policies, half did not experience any LEED single family private construction, and of the 390 municipalities affected by a county-level incentivizing policy, 368 did not experience any LEED single family private construction. This indicates many LEED incentive policies may be proving ineffective.

To complete this baseline analysis, we examined how much of the policy development and LEED construction takes place in our country's most populous areas. Of the over 29,000 municipalities and census designated places in the United States, approximately 9,000 are situated in the 100 most populous MSAs (metropolitan statistical areas) based on 2003 definitions.[15] Of the twelve county-level incentive policies, eight are situated within the 100 most populous MSAs, and 28 of the 36 municipalities with incentive policies are situated within these areas. Approximately three-fourths of incentive policies are occurring in the areas which are home to 65 percent of the U.S. population. However, of the 521 municipalities which experienced private LEED single family home construction, only 57 percent are situated within the most populous MSAs, and those municipalities experienced 65 percent of the LEED single family private construction. Further examination shows that 128 municipalities in these MSAs experienced construction of at least two LEED single family privately developed homes, and 40 of the 59 municipalities which are

[15] MSA definitions are updated regularly, with the most extensive updates coming from the decennial census analysis. The June 2003 MSA definitions appear to be those based on the 2000 Census, and the 2010 Census updates have not yet been made available.

homes to at least ten LEED single family privately developed homes are situated in these 100 most populous MSAs. Therefore, the most populous areas of the country are not home to the vast majority of the incentivizing policies or the LEED construction, but rather a representative percent of each.

Finding that green policies are popular in higher-density areas while green construction is more evenly distributed across the country, the question arises: do some municipalities have a predisposition to green? This question poses an endogeneity concern which we will address in our analysis though three control variables. 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 air temperature.[16] Therefore, areas with extreme climates requiring significant amounts of heating and/or cooling would be extraordinarily incentivized to pursue green construction and policies. In each variable's case, 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 that temperature persisted for 10 days, that would be 150 degrees of cooling required for those 10 days. Total degrees needed to heat and cool, respectively, an area for one year are totaled, creating the HDD and CDD variables. This information is taken from the National Climate Data Center based on 2009 data.

The third green variable captures the predisposition of the residents of an area to desire or require green construction. 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. Unfortunately, given the U.S.'s strong two-party system, relying on

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

the Green Party vote count does not work for U.S. analysis as well as it does in the analysis of other countries. While the percent of hybrid and electric car registrations is a strong measure of green ideology, most of the research using that data is working in either a small geographic region or at a larger unit of measure (such as an MSA, as opposed to municipality).[17] Collecting data on hybrid and electric car registrations nationally at the municipal level is quite difficult and cost prohibitive. Instead, we pose a new measure of green ideology: 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 the vast majority of the time we refuel our automobiles near our homes, a clean fuel station is a strong proxy for the local presence of alternative fuel vehicles. Since alternative fuel vehicles are an already-accepted proxy for green ideology, this proxy should prove as successful as hybrid and electric vehicle registrations. The advantage is the U.S Department of Energy provides a continuously updated database of every clean fuel station in the U.S. As of April 18, 2013, there were 11,597 clean fuel stations nationwide, including 5,734 electric stations (predominantly situated on the east and west coasts), 2,339 ethanol stations (predominantly situated in the Midwest), and 2,586 propane stations (scattered evenly across the country). Figure 2 is a map of the clean fuel stations in the U.S. as of that date, including all seven types of tracked clean fuel stations.

(Insert Figure 2 Here)

In addition to the focus on building permits and green policies, predispositions, and construction, there are a variety of control variables utilized in our analysis. 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

[17] 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).

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).

(Insert Table 3 Here)

Table 3 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 those municipalities with and without any LEED incentivizing policies; in our analysis, transformations of these values are occasionally used as well. Municipalities with LEED construction and with LEED policies are more likely to be situated in the Top 100 MSAs of the U.S., and those municipalities have higher populations and per capita incomes. These municipalities also appear to have fewer building permits on average, but that may reflect the effect of a few outliers. Looking at the green variables, both HDD and CDD are relatively similar across all categories except for the policy group. This group has approximately half as many cooling days and almost 50 percent more heating days, indicating that policies may be most prevalent in the north. This is largely driven by the fact that Minnesota has a state-wide policy (one of only four states to do so) and a large number of municipalities. This result is mirrored in the geographic breakdown analysis, with 65 percent of the policy subgroup situated in Division 4, which includes Minnesota. Other notable results in the geographic analysis include heavy LEED construction in the Pacific and Mountain Divisions (areas having a reputation for being more environmentally conscious), and the greatest concentration of LEED construction occurring in the South Atlantic Division. One in five LEED homes are constructed in this area which includes both the Washington, D.C. MSA (the most liberal region in the country and an environmentally sensitive area) and the southeast states (which would benefit more than the average U.S. area from lower energy costs associated with indoor air temperature).

(Insert Figure 3 Here)

Lastly, Figure 3 graphs the political persuasion of the sample and each subsample. The full sample indicates that the U.S. as a whole is skewed slightly more conservative than liberal (46 percent versus 37 percent), with just over one-fifth of the country identifying as moderate. This finding matches that put forth in the Gallup poll from which this data was taken, indicating that the full sample correctly represent the nation's political ideology. Turning to the subsamples, there is a substantial skewness towards liberal and very liberal in areas with LEED construction. In contrast, the areas with LEED incentivizing policies are not necessarily strongly liberal, but rather strongly moderate. Of note is the fact that each of the five political categories are represented in every subsample with the exception of no 'very conservative' municipalities (or, more specifically municipalities in very conservative states) associated with the LEED incentivizing policy subset.

Methodology

A variety of econometric techniques are used to investigate our question. Probit models are used to determine how energy efficient incentive policy influences construction of green single-family residential properties. First, we examine if these policies affect the choice to construct green rated or traditional nonrated single family homes. To do this, we model the binary choice of constructing green vs. traditional properties at the municipal level, seeing if there is a relationship between the green incentive programs and the construction of sustainable or energy efficient properties. 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 1 if at least one LEED certified single family residential property has been constructed by a private developer in the ith municipality over the 2006 through 2011 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 ith municipality, the definition of which will be modeled differently in a variety of equations throughout our analysis. 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, β, γ, and δ are each coefficient estimates and *v* is an error term.

In addition to the probit model described above, we also use a negative binomial regression to analyze a model similar to the one posed in Equation 1, but this time the dependent variable is the number of single family LEED homes constructed; the explanatory variables are the same. This model is shown in Equation 2, in which L_i represents the count of LEED single family homes and q 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, 2008). The primary difference between this method and common propensity score matching is that the balance between the control and treatment groups is selected ex ante rather than discovered through trial and error of model estimations. 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). Some of the benefits of CEM include: the adjustment of one variable's imbalance does not affect the maximum imbalance on other variables; a guarantee of common empirical support (without specific restriction of the data); results which are robust to measurement error; and, a process that is more transparent than propensity score matching. Lastly, CEM has been found to outperform other matching methods in Monte Carlo tests.

An econometric concern facing our question is one of sample selection bias. When examining the count of homes that are LEED constructed, those municipalities which make that list have first met the threshold of having any LEED construction at all. While we model the answer to these two questions separately (Does an incentive policy encourage any LEED construction? How much green construction does an incentive policy encourage?), to capitalize on the information in our data, we consider a model which addresses these two questions concurrently. That is to say, we must simultaneously answer the following questions:

1. Does the municipality have a LEED incentive policy?
2. Does the municipality have any LEED construction?
3. If the municipality has LEED construction, how much?

By only answering these questions individually or in sets of two, we are ignoring the complexity of the data and the possible sample selection issues which may arise. To address that, we employ an endogenous participation and endogenous treatment model (Bratti and Miranda, 2010). In this Poisson model, three equations answering the three questions above are estimated, as described in Equations 1, 2 and 3.

$$S_i = \alpha'_i + \sum \gamma_i X_i + \sum \delta_i P_i + \varepsilon_i \qquad \text{(Equation 3)}$$

In order to close the model, all of the covariates are assumed exogenous (with the exception of the treatment variable, the incentive policy) and each of the equations' distributions is assumed $N(0,\sigma^2)$. It is the measures of correlation between the equations which are of interest in testing the effectiveness of this model. Correlations between the three dependent variables are functions of factor loadings on the residuals of the treatment and participation equations.

$$v = \lambda_1 \eta + \zeta \qquad q = \lambda_2 \eta + \xi \qquad \text{(Equation 4)}$$

Equation 4 provides examples of the factor loadings (λ_1 and λ_2) from the equations' errors (v and q); ζ and ξ are idiosyncratic errors terms. λ_1 and λ_2 have no distributional requirements (aside from being real numbers). However, to close the model, the following distributional conditions are required.

$$\text{Condition 1:} \quad D(\eta|\mathrm{S},\mathrm{X},\mathrm{P},\zeta,\xi) = D(\eta)$$

$$\text{Condition 2:} \quad D(\zeta|\mathrm{S},\mathrm{X},\mathrm{P},\eta) = D(\zeta|\eta)$$

$$\text{Condition 3:} \quad D(\xi|\mathrm{S},\mathrm{X},\mathrm{P},\eta) = D(\xi|\eta)$$

$$\text{Condition 4:} \quad \zeta \perp \xi \mid \eta \qquad \text{(Equation 5)}$$

Condition 1 requires random effects, with unobserved individual heterogeneity term η being independent of all explanatory variables and error terms ζ and ξ. Conditions 2 and 3 are conditional independence assumptions which, instead of requiring ζ and ξ to be independent, allows for limited dependence between the idiosyncratic error terms and the control variables. However, Condition 4 requires ζ and ξ be independent of eachother, conditional on η. Therefore, ζ and ξ are not necessarily independent of eachother, but conditional on η they are both distributed as independent standard normal variates (Bratti and Miranda, 2010). Considering these structural controls of the model, the correlations between the dependent variables are functions of these factor loadings:

$$\rho_{\eta,v} = \frac{\lambda_1 \sigma_\eta^2}{\sqrt{\sigma_\eta^2(\lambda_1^2 \sigma_\eta^2 + 1)}} \qquad \text{(Equation 6)}$$

$$\rho_{\eta,q} = \frac{\lambda_2 \sigma_\eta^2}{\sqrt{\sigma_\eta^2(\lambda_2^2 \sigma_\eta^2 + 1)}} \qquad \text{(Equation 7)}$$

$$\rho_{v,q} = \frac{\lambda_1 \lambda_2 \sigma_\eta^2}{\sqrt{(\lambda_1^2 \sigma_\eta^2 + 1)(\lambda_2^2 \sigma_\eta^2 + 1)}} \qquad \text{(Equation 8)}$$

The model is estimated using maximum simulated likelihood (MSL), and there can be differences in the independent variables in each of the three equations. Additionally, given the nature of the model, CEM weights cannot be used in association with this MSL estimation method. It is recommended that the MSL model be estimated using a minimum of 1,000 Halton draws to perform the integration.

Results

Using Equations 1 and 2, we begin to explore the relationship between private construction of green single family housing and government green housing incentivizing policies. The dependent variable in Equation 1 is binary, taking a value of one if there has been at least one LEED single family home certified in the municipality through year-end 2011. Equation 2's dependent variable is similar in content, but instead measures the count of LEED single family homes certified in a municipality through year-end 2011. As previously noted, the majority of LEED homes construction has occurred since 2006. The loading on these explanatory variables (and their statistical strength) gives a basic indication if green construction incentive policies have a positive effect on green single family residential (LEED) construction.

However, certain areas may be pre-disposed to encourage green construction. In order to capture and measure this effect, we consider a variety of variables posed in the existing green construction literature. Tested in in different model specifications are the total heating days, the total cooling days, the average and average change in the residential cost of electricity, the average and average change in the residential cost of natural gas, and the scaled number of clean fuel stations per 1,000 residents. We found these measures to be highly correlated with both state and geographic division fixed effects and the variables controlling for political ideology. Upon review, this seemed logical given the physical location of states highly affects the area's need for heating, cooling, and fuel for that temperature management. The most informative combination of these variables proves to be HDD, CDD, scaled clean fuel stations, and the political ideology variables; we omit heating fuel and electricity costs as well as state and geographic controls as the information they provide is redundant.

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, we include variables measuring the natural log of average annual population change and of the average annual per capita income change from 2006 through 2011. Additionally, we also frequently divide these two measures into quintiles and use those categorical variables instead. Lastly, we control for construction activity with a measure of the average total number of single family building permits issued (per 1,000 people) from 2006 through 2011. All of the data for these variables are taken from the one-year American Community Survey. Lastly, 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 no single family building permits issued over the 2006 through 2011 time period are dropped.

Table 4 highlights the regression results utilizing Equations 1 and 2 and our complied data. Columns 1 and 3 present estimations of Equation 1 with and without CEM weighting, and Columns 2 and 4 present estimations of Equation 2 with and without CEM weighting, respectively. In all of the equations in Table 4, 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). The CEM weights used in Columns 3 and 4 are developed around the treatment variable and based on a comparison of clean fuel stations, income, population, and building permits. The addition of the weights results in only a small decrease in sample size and a strengthening of the pseudo R squared when compared with the non-weighted equation.

(Insert Table 4 Here)

Results of note in Table 4 begin with the treatment variable. Columns 1, 2, and 4 all return statistically significant results, indicating that the introduction of any LEED government incentive policy will increase LEED construction. While the findings regarding the probit are mixed, the unweighted Column 1 results indicate the marginal effect of having any LEED incentive policy increases the probability of LEED construction by approximately 2.4 percent; the weighted results show no statistical significance and a counterintuitive sign on the coefficient. However, when evaluating the number of LEED homes constructed, the results are much more consistent. Both the weighted and unweighted equations (Columns 2 and 4) return highly statistically significant results with the anticipated sign and a notable coefficient magnitude.

There are several other important results highlighted in Table 4 and seen throughout our analysis. First is the statistically strong and consistent role political ideology plays in every estimated equation. Across our analysis, we find that at least one category proves statistically significant in each estimation, and all ideological subcateorgies generally return negative coefficients with the exception of Very Liberal. The dummy variable used to define municipalities situated within the 100 most populous MSAs in the U.S. has inconsistent results, indicating that LEED–related policies may not merely be an activity for big city areas (or may not merely be successful in those areas). The green variables – the log of total HDD and CDD, and clean fuel stations – also have mixed success, but more often than not at least one of these variables proves statistically significant in each estimation. Population and income variables consistently prove to be very important drivers in our equations. This is likely due to the important role these variables play in the related topics of housing growth and demand. However, it should be noted that the higher income quintiles are often the ones which prove most significant. This could reflect that private market-rate housing construction occurs in richer areas. Additionally, higher income is often considered a proxy for higher education, which could indicate that the higher educated areas are demanding more green products. Lastly, two variables which have inconsistent results are the total single family building permits and the dummy controlling for municipalities with multiple LEED policies.

(Insert Table 5 Here)

Focusing more specifically on the municipality-level nature of the data, we re-estimate all of the equations from Table 4, but this time the treatment variable represents only municipal-level policies (excluding county and state-level policies which are available to a municipality); the results are shown in Table 5. Given the reduced treatment group, the CEM matching pared down the sample substantially for the estimations described in Columns 3 and 4. The treatment variable experienced a similar level of success in this subgroup. This time, both of the unweighted models returned statistically and economically significant results, with the expected sign and sizable magnitudes. In this probit model, the marginal effect of having a municipal-level policy is a 29 percent increase in the likelihood of having LEED construction. The weighted regressions returned statistically insignificant results on the treatment variable. The control variables remained quite strong and returned signs consistent with the findings in Table 4. Lastly, comparing the pseudo R-squareds from similar equations in Tables 4 and 5 indicates relatively similar model strength for both definitions of the treatment variable.

(Insert Tables 6 & 7 Here)

Tables 6 and 7 provide analyses similar to those found in Table 5, this time for county-level and state-level policies, respectively. All of the general results found in the municipal-level analysis hold for county and state-level analysis (the smaller R squareds in the weighted equations, the highly significant and consistent results relating to the control variables, etc.). However, the loadings on the county treatment dummies in Table 6, while strongly significant in some cases, are also consistently negative, indicating that the incentive policy would actually be discouraging green construction. This is contrary to the goal of the incentivizing policies and may instead indicate that county-level policies are an ineffective way to encourage green construction. However, the state-level treatment variables all have positive loadings and are economically and statistically significant. Based on these findings, it appears that state and municipal-level green incentive policies are most effective in encouraging LEED single family construction.

Categorical Policy Analysis

In order to better understand the impact green incentive policies have on green single family green construction, we replace the single dummy policy variable with individual dummy variables for seven popular categories of incentive types. By doing this, we are able to examine if certain types of incentive policies are more effective at encouraging green construction than others. The seven incentive categories are: expedited permitting; fee reduction (including feebate); density bonuses; real estate tax abatement; tax credits; grants; and, other programs. Other is a catch-all for less common incentives including technical assistance, expedited sewer and water line installation, etc. It should be noted that several policies include incentives from more than one of these categories. A correlation analysis was completed for these policies and is shown in Table 8. 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 8 Here)

Table 9 describes the results of re-estimating Column 1 and 2's equations from Tables 4, 5, 6 and 7 with the treatment variable broken into seven treatment variables. Since there is no longer one treatment variable, weighting is not utilized. In Panel A, the first two columns examine the broken-out categories for any policy available to a municipality (municipal, county, and state level), in the probit and negative binomial regression models, respectively. The control variable loadings remain consistent with the finding from the earlier tables so those results are suppressed. The probit model indicates Fee Reduction and Tax Credit categories have a statistically significant positive relationship with the presence of LEED construction. Specifically, the marginal effect of having any type of tax credit policies is a 26 percent increase in the probability of a municipality experiencing LEED construction. The count equation in Column 2 provides differing results, reporting the positive statistically significant relationship for Expedited Permitting, Tax Credit and Grant policies. Other policies also returns statistically significant results, but with a negative sign, indicating the opposite relationship from the desired effect.

(Insert Table 9 Here)

Columns 3 and 4 of Panel A represent the same analysis, but with the treatment variables restricted to only municipal-level policies. Here, the success rate appears much lower. Only Expedited Permitting returns statistically significant results in both the probit and the count models. However, these results are strong, with the expected sign and a notable coefficient magnitude. Aside from that, the only other incentive categories with a statistically significant relationship are Tax Abatement and Other; in the probit model, Other policies prove strongly economically and statistically significant with the expected sign, as does Tax Abatement in the count model. This divergence from the results regarding Other policies in Columns 1 and 2 may indicate that Other incentive policies (or the types of Other policies pursued by municipalities vs. counties and states) may be an incentive model that works well at the municipal level, while being less effective at the county and state level.

Panel B provides the same analysis for the county (Columns 1 and 2) and state (Columns 3 and 4) level. Even once broken out into different policy categories, the county-level policy dummies predominantly have negative loadings and only the Other category has statistical significance. This further supports the concept that county-level incentive policies may not be an effective tool to encourage green construction. The state-level results are mixed. The probit model proves to be a total loss, with no economically or statistically significant treatments, and half of the treatments omitted in order to complete the analysis. However, in the count-driven model (Column 4), Tax Abatement is the only category which does not return statistically significant results. While the Tax Credit and Grant categories return significant results with the expected sign, the Other category again carries a negative sign, indicating that these non-traditional types of incentive policies may not effectively encourage green single family construction.

These multinomial regressions provide the benefit of controlling for all of the policy categories simultaneously. However, given the limited number of certain types of policies at different government levels, these models have their limitations. In particular, these limitations are visible in the probit models. For example, in the state-level probit (Panel B, Column 3), two of the four policy categories are omitted in order to obtain results. While the balance of the results are informative, we lose insight into Tax Credit and Grant policies in the probit, which is especially disappointing given those two policy types' strong results in the state-level count equation (Panel B, Column 4).

To amplify our categorical results further, we re-define and estimate these equations once more. Utilizing the same probit and count models, we can once again estimate both weighted and unweighted scenarios (all with robust standard errors) as these models each have only one treatment variable. In this set of equations, the treatment variables are defined by policy category. By identifying all municipalities which are affected by a specific category of policy at any government level (municipal, county, or state), our samples become more robust, reducing the likelihood that certain policy category results would be suppressed.

Therefore, for each of the seven policy categories, an analysis is completed similar to that found in Tables 4 through 7. Table 10 provides a summary of this set of regressions. As is seen in Tables 4 through 7, the control variables remain very consistent and strong in these categorical models. Similar results were found in the parsimonious estimations developed for Table 10. Additionally, the pseudo R-squareds for the probit models fall within the range of those found in Table 4 through 7. Given the lack of new information in these controls, those results are suppressed. Instead, Table 10 includes each equation's treatment variable coefficient, its statistical significance, and the associated standard errors.

(Insert Table 10 Here)

In this analysis, Tax Credit surfaces as the strongest incentive policy category. In all four models, Tax Credit returns positive, highly significant results (both economically and statistically). Grant comes in as a close second, followed by Expedited Permitting, Fee Reduction, and Tax Abatement. Density Bonus results mostly have the expected sign, but have limited economic impact and low statistical strength, and Other suffers from the same mixed and weak results seen in the earlier analysis. All together, the categorical analysis indicates that Tax Credit is the most effective incentive policy type, and Other may produce unreliable and unexpected results. The balance of the categories vary in their strength and effectiveness, but Grant and Expedited Permitting also prove to be effective incentivizing tools.

Multiple Equation Models

While control variables are used to address endogeneity concerns in the single equation models described thus far, the endogenous participation endogenous treatment model is also utilized to examine endogeneity concerns.[18] Here, the endogeneity extends beyond the two questions outlined above to additionally address the different between having or not having LEED construction, and how much LEED construction there is. These two variables are obviously highly correlated, but each is also correlated with the decision to have an incentive policy as well. Effectively, here we are combining the probit and the negative binomial equations together and simultaneously estimating them. Unfortunately, the simulation process associated with this modeling precludes the use of weights and can also provide noisy results. However, as a check of our earlier results rather than a stand-alone estimation technique, the EPET model proves helpful.

Table 11 summarizes the results of interest from the EPET regressions. We completed the simulations with all of the treatment variables proposed throughout the paper: any policy category at any government level (Column 1); any policy category at the municipal, county, and state government levels (Columns 2, 3, and 4, respectively); and, for six of the seven policy categories at any government level (Columns 5 through

[18] Additionally, biprobit and endogenous switch and sample selection models were used to test for endogeneity. Both models indicate there is an endogenous relationship between the existence of an incentive policy and LEED construction.

10); the model with Density Bonus at the treatment variable would not converge and is excluded. In each column, the treatment variable's loading, statistical significance, and associated standard errors are reported, as they are for the three correlations associated with the model. Finally, there is a Wald test examining the probability that none of the equations are correlated.

(Insert Table 11 Here)

The results in Columns 1 through 4 reinforce the analysis completed thus far. In each of these equations, the Wald test indicates that there is a correlation between incentive policies and green construction. Looking more closely, the municipal-level policy results prove the strongest. The treatment variable loadings are both positive and very strong economically and statistically, and the correlation coefficients are all statistically significant. Similar statistical strength is found in all the reported results regarding county-level policies, but the factor loadings here are both negative. The state factor loadings are not statistically or economically significant, but all of the correlation coefficients are.

Turning to the policy category variables, these results were not as strong. The Wald tests for the Tax Abatement and Other categories question whether there is a correlation between these incentive types and green construction, and none of the treatment variable coefficients or correlation coefficients proved statistically significant. However, the Expedited Permitting, Fee Reduction, Tax Credit, and Grant categories' Wald tests all indicated strong relationships between the incentive types and green construction, and the loadings on the treatment variables and correlations moderately support that finding. None of the incentive category estimations are as strong as the government-level estimations, but that is likely a reflection of the sample, as there are relatively few instances of some of these policy categories. Overall, these results support the findings previously highlighted.

Conclusion

After collecting data on single family, private, green construction incentive policies, and both total and green total single family construction, we examined whether green incentive policies do or do not increase green construction. Our results clearly indicate that there is a correlation between green incentive policies and green construction, however not all government bodies experience the same success with their policies, and not all policy types are equally effective.

Municipal and state-level policies appear to be far more effective than county level policies. This is most likely a reflection of the incentives which these governments offer. The municipality is the government body which issues building permits, providing this group the greatest flexibility in offering construction-related incentives such as expedited permitting, fee reductions, and density bonuses. Additionally, the municipality is the micro-governing body in this scenario. Therefore, the municipality should be 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.

When enacting policies from a higher government level (county or state), the incentives which benefit one community may offer little benefit to another. An example could be 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 very different results across the municipalities it effects. This is a drawback of county-level policy effectiveness, and as seen in the analysis, has resulted in very low success rates for county-level policies overall. However, state policies prove to be quite effective. This is likely due to the nature of the policies being offered.

While every incentive policy is intended to encourage green construction, not all incentives are created equal. Aside from a local government body having greater insight to tailor their incentives to match the local development environment, certain types of policies may garner more attention in general. These are the policies that have a more tangible fiscal benefit. While a density bonus could or could not result in an economic benefit, policies like tax credits and grants nearly always result in economic benefit, and a benefit that should be sizable enough to outweigh the cost of certifying and/or constructing green. These types of policies experienced greater success than the balance of the policy categories, and that is likely because any developer in any community can benefit from definite fiscal incentive such as a grant. Nearly all the state-level incentive policies fall in the more tangible economic benefit categories, with states offering tax abatements, tax credits, and grants to encourage green single family construction. By selecting the more effective types of policies, the state-level government bodies have positioned their programs for greater success.

There are state incentives that fall into the Other category, but those experience the same mixed results seen throughout the analysis regarding this policy category. In fact, if there is one policy type which government bodies should approach cautiously, it is Other. The results indicate that non-traditional incentives may not prove worthwhile. Whether it be because developers respond better to the mainstream incentives types with which they are familiar, or because the unique benefit being offered in the policy is not actually much of an incentive, the Other category of policies proves to be ineffective.

The take away from this research is fourfold: first, municipalities' ability to tailor incentives to the local development/construction process makes them a good place to implement green incentive policies; second, incentives that have definite economic benefit (such as tax credits and grants) prove the most effective in incentivizing green construction; third: broad-based policies may not be as effective as their counterparts, so higher-level governing bodies should be realistic about their incentive policy goals and how to make them most effective; and, last: non-traditional incentive categories do not consistently return the desired results, so their use in lieu of mainstream incentive categories should be carefully scrutinized.

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.

Bollinger, B. and Gillingham, K., 2011. Peer Effects in the Diffusion of Solar Photovoltaic Panels. Working paper.

Bond, S. and Devine, A., 2013. Rental Rate Premiums Associated with Green Multifamily Properties. Working Paper.

Bratti, M. and Miranda, A., 2010. Endogenous Treatment Effects for Count Data Models with Sample Selection or Endogenous Participation. University of London, DoQSS Working Paper No. 1005.

Brounen, D. and Kok, N., 2011. On the economics of energy labels in the housing market. *Journal of Environmental Economics and Management*, 62:166-179.

Brounen, D., Kok, N., and Quigley, J., 2011. Residential Energy Use and Conservation: Economics and Demographics. Working paper.

Brounen, D., Kok, N., and Quigley, J., 2011. Residential Energy Literacy and Capitalization. Working paper.

Cameron, T., 1985. A nested logit model for energy conservation activity by owners of existing single family dwellings. *The Review of Economics and Statistics*, 67 (2):205–211.

Carothers, S. and Hurt, A., 2011. Getting to 55 MPG, Map: Hybrid And Electric Sales Across The County. November 22, 2011, available at: http://www.npr.org/2011/11/22/142476940/map-hybrid-and-electric-sales-across-the-country

Ciochetti B. and McGowan, M., 2010. Energy Efficiency Improvements: Do they Pay? *Journal of Sustainable Real Estate*, 2 (1):305-333.

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.

Costa, D. and Kahn, M., 2009. Towards a Greener California: An Analysis of Household Variation in Residential Electricity Purchases. Working Paper.

Dastrup, S., Zivin, J., Costa, D., and Kahn, M., 2011. Understanding the Solar Home Price Premium: Electricity Generation and "Green" Social Status. Working Paper.

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.

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.

Eichholtz, P., Kok, N., and Quigley, J., 2010. Doing Well by Doing Good: Green Office Buildings. *American Economic Review*, 100:2494-2511.

Eichholtz, P., Kok, N., and Quigley, J., 2011. The Economics of Green Building. IBER working paper #W10-003.

Fuerst, F. and McAllister, P., 2009. An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates, *Journal of Sustainable Real Estate*, 1 (1):49-64.

Fuerst, F. and McAllister, P., 2011. Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values, *Real Estate Economics*, 39 (1): 45-69.

Greene, W., 2012. *Econometric Analysis*, 7th edition. Upper Saddle River, NJ: Prentice Hall.

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., 2009. Causal Inference Without Balance Checking: Coarsened Exact Matching, Working Paper. Available at: http://gking.harvard.edu/files/cem-plus.pdf

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., McGraw, M., and Quigley, J., 2011. The Diffusion of Energy Efficiency in Building. *American Economic Review*, 101 (3):77-82.

Kok, N. and Jennen, M., 2011. The Value of Energy Labels in the European Office Market. Working paper.

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

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.

Miller, N., Spivey, J., and Florance, A., 2008. Does Green Pay Off? *Journal of Real Estate Portfolio Management*, 14 (4): 385-400.

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

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. Harvard Business School Working Paper 13-030, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2142085

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.

Wiley, J., Benefield, J., and Johnson, K., 2010. Green Design and the Market for Commercial Office Space. *Journal of Real Estate Finance and Economics*, 41 (2): 228-243.

Table 1: Summary of Government Policies Incentivizing LEED Single Family Private Construction

The following table summarize the types of policies incentivizing green construction in the private single family market. Panels A, B, and C provide breakdowns by incentive type and required level of certification compliance for the State, County, and Municipal levels, respectively. Not all incentive types are used at each level of government policy, and some policies include multiple incentive programs.

Panel A: State	General Green	LEED Registered	LEED Certified	LEED Silver	LEED Gold	Total
Expedited Permitting						
Fee Reduction/ Feebate						
Density Bonus						
Tax Abatement	1					**1**
Tax Credit				1		**1**
Grant	1					**1**
Other	1					**1**
Requisite						
Total	**3**			**1**		

Panel B: County	General "Green"	LEED Registered	LEED Certified	LEED Silver	LEED Gold	Total
Expedited Permitting		1	2	1		**4**
Fee Reduction/ Feebate			4			**4**
Density Bonus			1			**1**
Tax Abatement			1	1		**2**
Tax Credit			1	1		**2**
Grant						
Other				1		**1**
Requisite			1			**1**
Total		**1**	**10**	**4**		

Panel C: Municipality	General "Green"	LEED Registered	LEED Certified	LEED Silver	LEED Gold	Total
Expedited Permitting	1	8	3	2	1	**15**
Fee Reduction/ Feebate	1	2	3	3		**9**
Density Bonus		2	5	2		**9**
Tax Abatement			1			**1**
Tax Credit						
Grant		1	2	1		**4**
Other		1	2			**3**
Requisite	3		4			**7**
Total	**5**	**14**	**20**	**8**	**1**	

**Some policies include multiple incentives*

Table 2: Residential LEED Summary

The following two tables provide summary information on residential properties which have been LEED certified. Panel A describes the number of LEED, market-rate, single family homes in the United States which have been certified under the two available programs through year-end 2011. Panel B examines that group of certified homes annually at the municipal level. This table highlights the number of LEED homes certified each year from the program's inception through year-end 2011. At the municipal level, breakdowns are provided for the number of communities with any market rate LEED single family construction, and for communities with a notable amount of LEED construction (at least ten homes in a year). Additionally, it is noted now many municipalities with LEED construction during that year had any green incentivizing policies in effect.

Panel A

LEED		LEED For Homes	
Total Registered SF Units	92	Total Certified Units	16444
Total SF Certified Units	19	Total SF Certified Units	6690
Other Countries	3	Other Countries	232
United States	16	United States	6458
Non-Profit/Government	14	Non-Profit/Government	3640
Private Development	**2**	**Private Development**	**2818** *

**includes 1 confidential property*

Panel B

Timeframe	# Municipalities	# LEED SF Units	# Municipalities > 1 LEED SF Units	# Municipalities > 9 LEED SF Units	# Municipalities with Policy In-Place
2006-2011	**521**	**2818**	**218**	**59**	
2006	13	24	2	1	1 with pre-2006 policy
2007	46	171	16	3	0 with pre-2007 policy
2008	109	393	47	8	5 with pre-2008 policy
2009	169	669	55	19	12 with pre-2009 policy
2010	218	884	66	14	21 with pre-2010 policy
2011	200	677	73	16	25 with pre-2011 policy

Table 3: Variable Summary Statistics

The following table lists the average of each variable listed for the full sample and subsamples of municipalities with and without LEED construction and with and without green incentivizing policies. It should be noted that in the analysis, transformations of these variables are sometimes used as well.

	Full Sample	LEED	Non-LEED	Policy	No Policy
Top 100 MSA	39%	58%	38%	44%	39%
HDD	4,686	4,274	4,721	6,733	4,357
CDD	1,389	1,382	1,390	752	1,492
Clean Fuel Stations per 1,000 people	0.12	0.28	0.11	0.20	0.11
Total 2006-2011 SF Building Permits per 1,000 people	26	20	27	20	27
Average 2005-2011 Per Capita Income	22,796	31,526	22,185	26,994	22,184
Average 2005-2011 Population	5,154	16,252	4,682	3,494	5,487
Very Conservative	16%	6%	17%	0%	18%
Conservative	28%	19%	28%	4%	31%
Moderate	21%	26%	20%	10%	22%
Liberal	28%	26%	28%	77%	20%
Very Liberal	9%	23%	7%	9%	8%
D1: New England (CT, ME, MA, NH, RI, VT)	2%	10%	2%	0%	3%
D2: Middle Atlantic (NJ, NY, PA)	3%	8%	2%	9%	2%
D3: East North Central (IN, IL, MI OH WI)	15%	13%	15%	0%	17%
D4: West North Central (IA, KS, MN MO, NE, ND, SD)	29%	6%	31%	65%	23%
D5: South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA)	9%	20%	8%	7%	9%
D6: East South Central (AL, KY, MS, TN)	8%	3%	8%	0%	9%
D7: West South Central (AR, LA, OK, TX)	16%	9%	17%	3%	18%
D8: Mountain (AZ, CO, ID, NM, MT, UT, NV, WY)	7%	14%	7%	3%	8%
D9: Pacific (AK, CA, HI, OR, WA)	12%	18%	11%	12%	12%
Observations	6708	518	6190	929	5779

Table 4: Regression Results with Any Policy as Treatment Variable

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 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). Columns 3 & 4 include CEM weights. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

	(1)	(2)	(3)	(4)
Dependent Variable	LEED Dummy	Total LEED	LEED Dummy	Total LEED
Any Policy Dummy	0.2270991 ***	1.095313 ***	-0.014392	1.167783 ***
	(.0873)	(.2737)	(.0906)	(.3202)
Very Conservative	-0.4063256 ***	-0.541248	-0.260916 **	-0.195191
	(.1086)	(.4282)	(.1298)	(.3884)
Conservative	-0.1567365 *	-0.769736 ***	-0.034178	-0.471532 *
	(.0804)	(.2921)	(.1073)	(.2661)
Liberal	-0.3735889 ***	-1.025921 ***		-0.432402 *
	(.0861)	(.2586)		(.2431)
Very Liberal	0.0223669	0.5947375	0.1384935 ***	1.032269 **
	(.1004)	(.4381)	(.1110)	(.5277)
Top 100 MSA Dummy	-0.1006843		-0.025639 ***	
	(.0711)		(.0931)	
Ln(Total HDD & CDD)	-0.0673169	-0.382739	0.0034666	-0.350492
	(.0808)	(.2675)	(.1135)	(.2930)
Scaled Clean Fuel Stations	0.0920189 **			
	(.0404)			
PCI Quintile 2				1.066801 **
				(.4778)
PCI Quintile 3		1.090067 ***		1.698965 ***
		(.3504)		(.4885)
PCI Quintile 4	0.5140318 ***	1.417991 ***	0.5275788 ***	2.270469 ***
	(.0742)	(.2845)	(.0905)	(.4721)
PCI Quintile 5	0.8636932 ***	2.035037 ***	0.8440201 ***	2.72856 ***
	(.0790)	(.2503)	(.0939)	(.4315)
Population Quintile 2	0.5718725 ***	1.136316 **	0.5947732 ***	1.154909 **
	(.1465)	(.5437)	(.2258)	(.4782)
Population Quintile 3	0.6937873 ***	1.168803 **	0.6740132 ***	1.481004 ***
	(.1440)	(.4903)	(.2236)	(.4837)
Population Quintile 4	0.798892 ***	1.834143 ***	0.9575893 ***	2.227874 ***
	(.1434)	(.4947)	(.2287)	(.4613)
Population Quintile 5	1.311143 ***	3.838829 ***	1.41088 ***	4.223419 ***
	(.1405)	(.4890)	(.2274)	(.4702)
Total Scaled Building Permits	0.000033		0.001037	
	(.0000)		(.0008)	
Multiple Policies Dummy				-1.053804 **
				(.4542)
Constant	-2.026093 ***	-1.411533	-2.78158 ***	-2.840407 ***
	(.7299)	(2.4649)	(1.0468)	(2.6911)
Observations	6558	6558	6440	6440
Pseudo R^2	0.1741		0.1955	
CEM Weights	No	No	Yes	Yes

Table 5: Regression Results with Municipal-level Policy as Treatment Variable

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 2 & 4) regressions. In each of these equations, the treatment variable has a value of 1 if there is a municipal-level LEED incentive policy affecting the municipality. Columns 3 & 4 include CEM weights. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

	(1)		(2)		(3)		(4)	
Dependent Variable	LEED Dummy		Total LEED		LEED Dummy		Total LEED	
Municipal Policy Dummy	1.419415	***	2.592124	***	0.5350325		0.4167254	
	(.2855)		(.7213)		(.4382)		(.4142)	
Very Conservative	-0.4106907	***	-0.879919	**	-0.66447	***	-1.62063	***
	(.1092)		(.4346)		(.2372)		(.5574)	
Conservative	-0.1563536	*	-1.033589	***	0.0481144		-0.864268	**
	0806)		(.3017)		(.2365)		(.3957)	
Liberal	-0.3059354	***	-1.16911	***	-0.274993		-1.267887	***
	(.0816)		(.2792)		(.2188)		(.3872)	
Very Liberal	0.0591654		0.722979					
	(.1011)		(.4706)					
Top 100 MSA Dummy	-0.0880692				0.360566	*	0.3053528	
	(.0705)				(.1998)		(.3574)	
Ln(Total HDD & CDD)	-0.069839		-0.152966		0.5313636	**	0.2591894	
	(.0886)		(.2703)		(.2164)		(.4708)	
Scaled Clean Fuel Stations	0.0900339	**			3.026529	***	2.306228	
	(.0401)				(.7868)		(1.6029)	
PCI Quintile 2							2.451634	***
							(.6608)	
PCI Quintile 3			1.097417	***	0.2433135		3.786	***
			(.3765)		(.4856)		(.6830)	
PCI Quintile 4	0.5151178	***	1.36044	***	1.088234	***	4.893954	***
	(.0743)		(.2912)		(.3385)		(.6466)	
PCI Quintile 5	0.8744643	***	1.97112	***	0.720217	**	4.560213	***
	(.0789)		(.2540)		(.3292)		(.6533)	
Population Quintile 2	0.5556866	***	1.174702	**				
	(.1469)		(.5243)					
Population Quintile 3	0.6804346	***	1.247913	***				
	(.1444)		(.4797)					
Population Quintile 4	0.7622872	***	2.060257	***	0.2080708			
	(.1435)		(.5155)		(.3289)			
Population Quintile 5	1.256548	***	3.964604	***	0.8083878	***	2.494463	***
	(.1409)		(.4824)		(.2570)		(.3365)	
Total Scaled Building Permits	0.0000305				-0.001053		-0.003928	
	(.0000)				(.0028)		(.0061)	
Multiple Policies Dummy	-0.3631354	*	-0.849394		-0.078427			
	(.1877)		(.5833)		(.4039)			
Constant	-1.975374	**	-3.132073		-6.575571	***	-7.199806	*
	(.7948)		(2.4923)		(1.9697)		(4.1040)	
Observations	6558		6558		1901		1901	
Pseudo R^2	0.1816				0.1443			
CEM Weights	No		No		Yes		Yes	

Table 6: Regression Results with County-level Policy as Treatment Variable

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 2 & 4) regressions. In each of these equations, the treatment variable has a value of 1 if there is a county-level LEED incentive policy affecting the municipality. Columns 3 & 4 include CEM weights. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

	(1)		(2)		(3)		(4)	
Dependent Variable	LEED Dummy		Total LEED		LEED Dummy		Total LEED	
County Policy Dummy	-1.094297	***	-1.911719	***	-0.7278127		-1.025269	
	(.2815)		(.6874)		(.4956)		(.6800)	
Very Conservative	3981	***	-0.878068	**	-0.5383511	***	-0.823309	**
	(.1091)		(.4358)		(.1672)		(.3958)	
Conservative	-0.1626712	**	-1.072591	***	-0.231458	*	-0.918051	***
	(.0805)		(.3019)		(.1299)		(.2968)	
Liberal	-0.3111645	***	-1.131524	***			-0.330058	
	(.0816)		.2773)				(.2823)	
Very Liberal	0.0522573		0.7265985		-0.0993205			
	(.1009)		(.4734)		(.1911)			
Top 100 MSA Dummy	-0.0897065				-0.1037232			
	(.0704)				(.1506)			
Ln(Total HDD & CDD)	-0.0677822		-0.273929		0.0413709		0.3460446	
	(.0882)		(.2783)		(.1751)		(.2815)	
Scaled Clean Fuel Stations	0.0915938	**			1.113337	***	2.466698	***
	(.0402)				(.2857)		(.9049)	
PCI Quintile 2					0.2375656		1.996762	***
					(.2188)		(.6162)	
PCI Quintile 3			1.110551	***			2.124843	***
			(.3781)				(.6092)	
PCI Quintile 4	0.5181464	***	1.371901	***	0.9251778	***	2.923113	***
	(.0742)		(.2899)		(.2308)		(.4610)	
PCI Quintile 5	0.8748912	***	1.9442	***	0.9910184	***	2.693225	***
	(.0786)		(.2565)		(.1794)		(.4605)	
Population Quintile 2	0.5583681	***	1.173282	**			-0.033782	
	(.1471)		(.5242)				(.3920)	
Population Quintile 3	0.6801432	***	1.229118	***				
	(.1446)		(.4795)					
Population Quintile 4	0.7644088	***	2.032023	***	0.4663536	**	0.9807916	***
	(.1436)		(.5148)		(.1911)		(.3407)	
Population Quintile 5	1.266916	***	3.954208	***	0.7098591	***	2.377355	***
	(.1408)		(.4807)		(.1541)		(.3161)	
Total Scaled Building Permits	0.0000306				0.0025915			
	(.0000)				(.0017)			
Multiple Policies Dummy	0.8972633	***	1.536571	***	0.2871006		0.6421314	
	(.2375)		(.5476)		(.4736)		(.5549)	
Constant	-1.994007	**	-2.073974	***	-2.544025	*	-7.343204	***
	(.7909)		(2.5578)		(1.5211)		(2.4721)	
Observations	6558		6558		4704		4704	
Pseudo R^2	0.1774				0.1024			
CEM Weights	No		No		Yes		Yes	

Table 7: Regression Results with State-level Policy as Treatment Variable

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 2 & 4) regressions. In each of these equations, the treatment variable has a value of 1 if there is a state-level LEED incentive policy affecting the municipality. Columns 3 & 4 include CEM weights. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

	(1)		(2)		(3)		(4)	
Dependent Variable	LEED Dummy		Total LEED		LEED Dummy		Total LEED	
State Policy Dummy	0.2834962	***	1.282913	***	0.2096625	**	1.289176	***
	(.1099)		(.3194)		(.1070)		(.3595)	
Very Conservative	-0.4142954	***	-0.534693		-0.126942		-0.090285	
	(.1088)		(.4358)		(.1262)		(.4552)	
Conservative	-0.1601485	**	-0.729603	**	-0.031894		-0.728427	**
	(.0806)		(.2900)		(.1160)		(.3261)	
Liberal	-0.3777628	***	-0.968564	***			-0.49603	*
	(.0870)		(.2554)				(.2871)	
Very Liberal	0.0072345		0.5628245		0.230213	**	1.395602	**
	(.1010)		(.4375)		(.1069)		(.6613)	
Top 100 MSA Dummy	-0.0965862				-0.102338			
	(.0706)				(.0908)			
Ln(Total HDD & CDD)			-0.570396	**	-0.197736	*	-1.012814	***
			(.2708)		(.1102)		(.3654)	
Scaled Clean Fuel Stations	0.0922453	**					-0.786629	**
	(.0403)						(.3574)	
PCI Quintile 2								
PCI Quintile 3			1.097179	***	0.0959132			
			(.3498)		(.1175)			
PCI Quintile 4	0.5161276	***	1.512822	***	0.3754375	***	0.8174045	***
	(.0742)		(.2804)		(.0986)		(.2913)	
PCI Quintile 5	0.8659181	***	2.057916	***	0.7886179	***	1.358097	***
	(.0790)		(.2494)		(.1171)		(.2833)	
Population Quintile 2	0.572374	***	1.158425	**	0.5976163	***	1.316945	***
	(.1465)		(.5520)		(.2200)		(.4828)	
Population Quintile 3	0.6948529	***	1.178033	**	0.7432603	***	1.620349	***
	(.1440)		(.4963)		(.2224)		(.4706)	
Population Quintile 4	0.7983415	***	1.791239	***	0.8530252	***	2.160734	***
	(.1433)		(.4955)		(.2236)		(.4543)	
Population Quintile 5	1.314681	***	3.890405	***	1.309299	***	4.153434	***
	(.1405)		(.4968)		(.2299)		(.4856)	
Total Scaled Building Permits	0.0000305				0.001213			
	(.0000)				(.0008)			
Multiple Policies Dummy								
Constant	-1.44366	*	0.1595632	***	-1.037088		4.219105	
	(.1584)	.7925)	(2.4636)		(1.0159)		(3.3587)	
Observations	6558		6558		6145		6145	
Pseudo R^2	0.1741				0.1909			
CEM Weights	No		No		Yes		Yes	

Table 8: Correlation Matrix for Incentive Policy Types

The follow table 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.

	Expedited Permitting	Fee Reduction	Density Bonus	Tax Abatement	Tax Credit	Grant	Other
Expedited Permitting	1.00						
Fee Reduction	0.41	1.00					
Density Bonus	0.22	0.17	1.00				
Tax Abatement	-0.01	0.00	0.01	1.00			
Tax Credit	-0.02	-0.02	-0.01	-0.04	1.00		
Grant	0.09	0.02	0.09	-0.06	0.02	1.00	
Other	0.03	-0.02	0.13	-0.05	-0.02	0.00	1.00

Table 9: Regression Results with Policy Types Broken Out

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 2 & 4) regressions. Only the treatment variable loadings are shown, with the control variable results suppressed. In each of these equations, the policy variables have a value of 1 if that type of LEED incentive policy is affecting the municipality. In Panel A, Columns 1 & 2 examine any policy level affecting the municipality (municipal, county, and state), and Columns 3 & 4 examine only municipal-level policies affecting the municipality. In Panel B, Columns 1 & 2 examine only county-level policies affecting the municipality, and Columns 3 & 4 examine only state-level policies affecting the municipality. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

Panel A

	(1)	(2)	(3)	(4)
Dependent Variable	LEED Dummy	Total LEED	LEED Dummy	Total LEED
Any Expedited Permit Policy	0.294631	1.417212 **		
	(.2396)	(.6473)		
Any Fee Reduction Policy	0.7555522 **	0.7684007		
	(.3634)	(.6441)		
Any Density Bonus Policy	0.4145947	1.057719		
	(.5691)	(.9069)		
Any Tax Abatement Policy	-0.0890281	0.8441376		
	(.2166)	(.5839)		
Any Tax Credit Policy	1.342476 ***	3.991575 ***		
	(.3016)	(.6198)		
Any Grant Policy	0.3419823	3.116847 ***		
	(.2266)	(.7946)		
Any Other Policy	-0.1204965	-1.049783 ***		
	(.1253)	(.3263)		
Muni Expedited Permit Policy			0.8467137 **	1.842148 ***
			(.3719)	(.5982)
Muni Fee Reduction Policy			0.7249853	0.8293264
			(.5284)	(.9238)
Muni Density Bonus Policy			-0.233848	-1.045511
			(.7424)	(.7965)
Muni Tax Abatement Policy				4.560153 ***
				(.2964)
Muni Grant Policy			-0.010042	-0.693546
			(.8141)	(.9660)
Muni Other Policy			1.688981 **	1.76113 *
			(.7349)	(.9795)
Observations	6558	6558	6558	6558
Pseudo R^2	0.1856		0.1779	
CEM Weights	No	No	No	No

Table 9: Regression Results With Municipal-level Policies Broken Out (Continued)

Panel B

	(1)	(2)	(3)	(4)
Dependent Variable	LEED Dummy	Total LEED	LEED Dummy	Total LEED
County Expedited Permit Policy	-0.1632582	-0.798304		
	(.3523)	(1.0270)		
County Fee Reduction Policy	0.2389348	-0.740173		
	(.5645)	(.8644)		
County Density Bonus Policy				
County Tax Abatement Policy	-0.6522649	0.1231271		
	(.4655)	(.8552)		
County Tax Credit Policy	0.4367233	-0.479455		
	(.4283)	(.7352)		
County Other Policy	-0.3885342 *	-0.639968		
	(.2339)	(.7129)		
State Tax Abatement Policy			-0.002349	-0.250759
			(.2719)	(.5857)
State Tax Credit Policy				4.899739 ***
				(.5966)
State Grant Policy				3.221025 ***
				(.7980)
State Other Policy			-0.089712	-0.982453 **
			(.1523)	(.4244)
Observations	6558	6558	6558	6558
Pseudo R^2	0.1735		0.1686	
CEM Weights	No	No	No	No

Table 10: Categorical Treatment Variable Loadings from Probit and Count Regression Results

The following table details the coefficient results for Probit (Columns 1 & 3) and Negative Binomial (Columns 2 & 4) regressions. In each of these equations, the treatment variable has a value of 1 if there is any LEED incentive policy in the category listed affecting the municipality (municipal, county, or state policy). Columns 3 & 4 include CEM weights. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis.

	(1)	(2)	(3)	(4)
	Unweighted		**Weighted**	
	Probit	Count	Probit	Count
Expedited Permitting	0.4758383 **	0.755434 *	-0.0297	-0.111074
	(.2168)	(.4454)	(.2456)	(.4248)
Fee Reduction	0.8939616 ***	0.469915	0.76305 **	0.8408683 *
	(.3274)	(.4388)	(.3257)	(.4847)
Density Bonus	0.6174146	0.002682	0.29213	-0.46018
	(.4673)	(.6867)	(.4940)	(.7685)
Tax Abatement	-0.164464	0.914344	-0.4681 **	0.1592986
	(.2172)	(.6767)	(.2351)	(.5482)
Tax Credit	1.431486 ***	4.014653 ***	1.59644 ***	3.374645 ***
	(.2615)	(.4315)	(.2821)	(.4717)
Grant	0.4870332 ***	2.356436 ***	0.38173 *	2.550782 ***
	(.1874)	(.6533)	(.2100)	(.7849)
Other	-0.1318187	-0.58815 *	-0.227 *	-0.855308 ***
	(.1234)	(.3398)	(.1161)	(.2984)

Table 11: EPET Regression Results Summary

Columns 1 through 10 provide the loadings, statistical significance, and standard errors for the treatment variable in the participation and count equations, and for the correlations between each of the three pairs of equations. At the bottom of each column is the p-value of a Wald Test with the hypothesis that none of the equations are correlated. This analysis is completed for any policy category at any government level (municipal, county, or state) in Column 1, for any policy category at the municipal, county, and state government levels in Columns 2, 3, and 4 (respectively), and for six of the seven policy categories at any government level in Columns 5 through 10; the results for Density Bonus did not converge. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level of analysis, respectively.

Treatment Variable	(1) Any Policy	(2) Municipal Policy	(3) County Policy	(4) State Policy	(5) Expedited Permitting
Treatment Loading in Participation	0.1340998	1.343038 ***	-0.765271 ***	0.0941846	-0.400435
	(.1489)	(.3391)	(.2212)	(.1154)	(.3640)
Treatment Loading in Count	-1.304785 **	4.365087 ***	-2.64656 ***	-0.0977103	0.6148434 ***
	(.6088)	(1.1272)	(.7565)	(.1751)	(.6148)
ρ , Treatment & Count	0.5863438 ***	-0.7342192 ***	0.6868625 ***	0.38235 ***	0.8774949 ***
	(.1174)	(.1986)	(.1447)	(.0704)	(.1029)
ρ , Participation & Count	0.0673835	0.2775926 **	0.3492271 ***	0.3473934 ***	0.3286188 ***
	(.1207)	(.1137)	(.1060)	(.1106)	(.1278)
ρ , Treatment & Participation	0.0395099	-0.2038139 **	0.239871 ***	0.1328259 ***	0.2883613 **
	(.0731)	(.1026)	(.0935)	(.0397)	(.1129)
Wald Test p-value ($\rho = \rho = \rho = 0$)	0.0000	0.0003	0.0000	0.0000	0.0000

Treatment Variable	(6) Fee Reduction	(7) Tax Abatement	(8) Tax Credit	(9) Grant	(10) Other
Treatment Loading in Participation	0.2943566	-0.239526	2.144966	0.5019607 *	0.1338421
	(.5779)	(.4615)	(.6401) ***	(.2955)	(.2032)
Treatment Loading in Count	-30385209 ***	1.158072	-2.706837	1.412583	-2.204748
	(.7681)	(3.0802)	(.6221) ***	(1.5255)	(1.3523)
ρ , Treatment & Count	0.9343571 ***	0.0636283	0.0961173	-0.2589443	0.4335116
	(.1183)	(.8005)	(.0961) ***	(.3186)	(.3201)
ρ , Participation & Count	0.2392795 *	-0.1486656	-0.271812	-0.3943297 **	-0.252487
	(.1427)	(.1936)	(.1509) **	(.1685)	(.1879)
ρ , Treatment & Participation	0.2235725	-0.0094593	-0.232105	0.1021094	-0.109456
	(.1378)	(.1268)	(.1468)	(.1354)	(.1123)
Wald Test p-value ($\rho = \rho = \rho = 0$)	0.0000	0.8753	0.0000	0.0631	0.2313

Figure 1: Mean Single Family Building Permits, 2005 through 2011

This table highlights the average annual single family building permits of the municipalities in the sample. All represents the average single family building permits annually for 2005 through 2011 for all reporting municipalities in the United States (approximately 6,500). LEED represents the same data for the approximately 370 municipalities which are home to at least one LEED certified single family home through year-end 2011. The expected fall off of single family construction during the recent housing crisis is evident in both groups, as is a stabilization of new home starts over the 2009 through 2011 period.

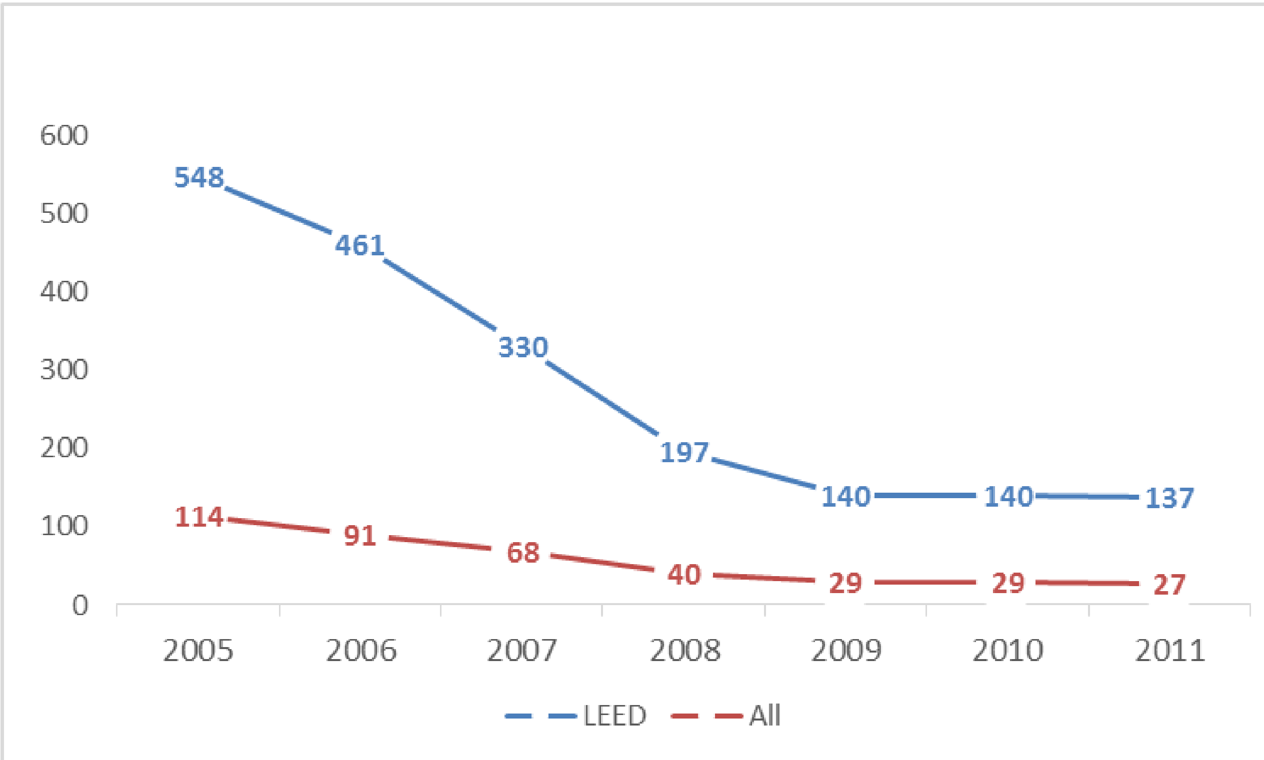
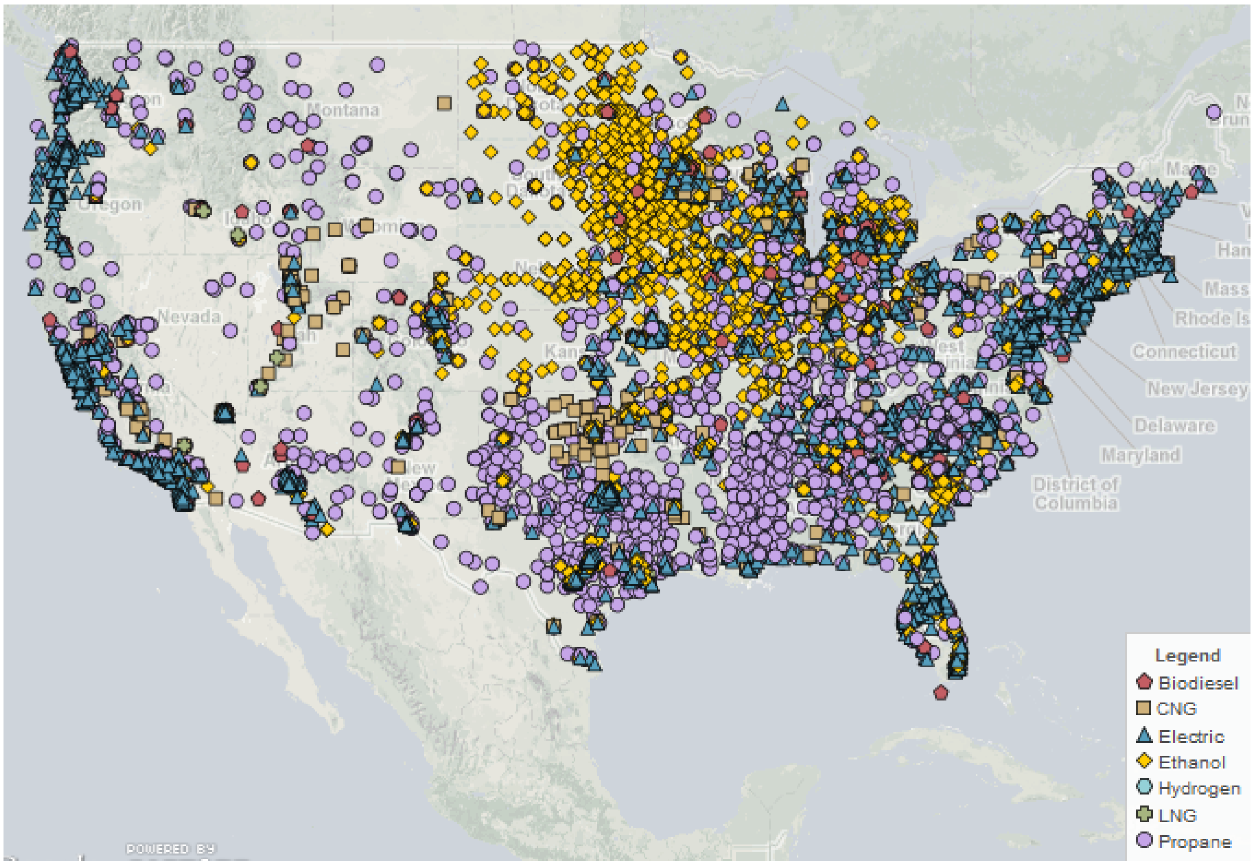


Figure 2: Clean Fuel Station Locations as of April 18th, 2013

The following map notes the mainland locations of the 11,597 clean fuel stations in operation as of April 18th, 2013. 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, ethanol and propane, this map 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.



Source: Department of Energy, available at: http://www.afdc.energy.gov/fuels/electricity_locations.html

Figure 3: Distribution of Political Ideology

This graph highlights the distribution of political ideology in the full sample of municipalities as well as in the two subsets of municipalities: with and without LEED single family construction; with and without LEED incentivizing policy. Each bar is divided into the percent of municipalities whose state identifies as very conservative, conservative, moderate, liberal, or very liberal. This data is based on a year-long Gallup poll in 2012 collecting responses from individuals across the U.S. All five classifications are represented in each sample group with the exception of Policy (there are no very conservative areas in this subsample).