The Effectiveness of Using Incentives in Spatial Zones to Promote Renewable Energy

A Case Study: New York City's Solar Empowerment Zone Program

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Table of Contents

1. ABSTRACT

Urban planning utilizes regulations and incentives such as FAR bonuses to spatially target changes in the built form. This concept can be employed formally through the zoning resolution or more informally through special economic development districts. Recently, however, this same concept has also been employed to promote renewable energy, by targeting limited resources in locations where they might be most cost-effective. While this idea- in ways an antecedent for formal renewable energy districts or zones- is innovative, it remains to be seen if targeting incentives spatially in such a manner is effective in terms of actual renewable energy deployment. To analyze this issue, this paper explores New York City's recent Solar Empowerment Zone Program. Its purpose is twofold: to both analyze whether the program is effective and, on a larger level, to determine if spatially targeting incentives and resources such as education and streamlined permitting can effectively promote solar energy. To accomplish this, both a GIS and statistical analysis were conducted to ascertain whether the number of planned and existing solar installations within the zones were different from those outside the zones. Additionally, approximately 20 stakeholder interviews were conducted to determine what aspects of the zones were working well, what needed further improvement, and what over-arching lessons could be offered regarding using zoning to promote solar energy. The main findings were that education within the zones was not as effective as hoped in terms of increasing solar deployment and that the concept of solar zones should only be pursued when the correct balance of stakeholder interests exists. Finally, incentives within the zones need to be different enough from locations outside the zones if they are to drive the decision making process.

2. INTRODUCTION

Urban planning utilizes regulations and incentives such as FAR bonuses to spatially target changes in the built form. This concept can be employed formally through the zoning resolution or more informally through special economic development districts. Recently, however, this same concept has also been employed to promote renewable energy by targeting limited resources in locations where they might be most cost-effective. While this idea- in ways an antecedent for formal renewable energy districts or zones- is innovative, it remains to be seen if targeting incentives spatially in such a manner is effective in terms of actual renewable energy deployment. To analyze this issue, this paper explores New York City's recent Solar Empowerment Zone Program. Its purpose is twofold: to both analyze whether the program is effective and, on a larger level, to determine if spatially targeting incentives and resources such as education and streamlined permitting can effectively promote solar energy.

3. BACKGROUND

With growing concerns over global climate change, and how the scarcity of fossil fuels may affect national security, there is increasing interest in renewable energy- particularly in solar. However, because the term, "solar energy," can encompass such a large number of technologies, before continuing, it is important to differentiate the nuances of this overarching term.

Solar Energy

Solar energy can be broken down into two main categories: *passive solar energy* and *active solar energy (*Bradford, 2006). Passive solar energy refers to the concept of using the sun's heat and light as is; that is, it is not converted into another form of energy (Bradford, 2006). A good example of this is orientating and elongating a building on its east-west axis, thereby allowing the building to capitalize on available sunlight and heat (Sustainable Sources, 2012). Contrasting *passive solar energy* is *active solar energy*, in which the sun's energy is captured and converted to be used in other applications (Bradford, 2006). Active solar energy can be broken down still further into the categories of *thermal* or *photovoltaic* applications (Bradford, 2006). *Thermal* uses the heat of the sun in applications such as in solar hot water heaters (Heller, 2008), solar cooking, or at an industry scale, using solar energy to superheat water, convert it to steam and to power a steam engine(Bradford, 2006). Photovoltaic applications, however, utilize the photons from sunlight to generate an electrical current[1] (Bradford, 2006). For simplicity's sake, this last meaning will be the particular type of application meant when using the term, "solar energy," for the remainder of this paper.

There is increasing interest in solar energy because it offers a number of benefits over conventional forms of energy and even over other forms of renewable energy. It is clean, readily available in limitless supply, does not require additional fuel, and has low maintenance costs due to its lack of moving parts (Bradford, 2006). Also, photovoltaic panels are scalable, meaning that they can be used in settings as large as utility-size operations or in settings as small as residential rooftops (Bradford, 2006). From a utility's perspective this is beneficial because in a utility-scale operation, it allows solar panels to be added as needed. This thereby allows for appropriately sized operations (which thereby eliminates larger than needed up-front capital costs) and allows electricity to be generated much sooner than would occur with traditional power plants given their long lags in construction schedules (Bradford, 2006). The application of solar panels on residential homes is also beneficial given that as electricity is transported across the grid[2], losses of up to 7.5% can occur (Amin and Stringer, 2008). Thus, if electricity can be produced closer to where it is consumed, it becomes more cost-effective.

Finally, solar is advantageous because it produces *intermediate-load* electricity that is compatible with the electricity demands of customers (Bradford, 2006). *Intermediate-load electricity* refers to the fact that the electricity is needed only part of the time whereas *base-load electricity* is needed twenty-four hours a day (Bradford, 2006). Since intermediate- load electricity is produced by generators that run only a portion of the day, the electricity these generators produce is more expensive (Bradford, 2006) and tends to be dirtier (since it comes from dirtier, older generators). Solar, however, is produced at times when customer demand is highest: at peak day times, also known as peak load times (Bradford, 2006). This is beneficial from the utilities' perspective because it allows them to avoid bringing generators online to serve short-term electricity demands (Bradford, 2006). And since utilities must be prepared at all times to supply energy demands which may only exist for 50 to 100 hours of the year , solar energy therefore has the potential to offset the cost of installing costly infrastructure which may in reality only be needed less than 1 percent of the hours in a year (Enernoc, 2009).

The main criticism of solar, is of course, that it is too expensive (Cambell, 2008). While undoubtedly a hurdle, costs are dropping; especially when one calculates costs through using the Levelized Cost of Electricity rather than traditional methods. The Levelized Cost of Energy is a financial tool which

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[1] Note: energy and electricity are not interchangeable terms. Electricity is a temporary and portable form of energy which is able to transported across the grid and ultimately used for number of consumer applications such as heat or light (Amin and Stringer, 2008).

[2] The electric grid can be defined as, "the entire apparatus of wires and machines that connects the sources of electricity (i.e. the power plants) with customers and their myriad of needs" (Amin and Stringer, 2008).

provides a true, “apples to apples,” comparison of different forms of energy (Cambell, 2008). This equation allows one to compare alternative technologies even when different scales of operation, investment, or operating time periods exist and provides an evaluation of the life cycle energy costs and energy production (Cambell, 2008). Thus, it is more accurate than traditional methods in that it does not overlook the hidden costs and benefits of different sources of energy. Due to its increased precision, it is utilized by both the Department of Energy and financial companies.

Incentives for Solar

Given the numerous benefits that solar offers, it is unsurprising that this form of energy is actively being promoted by states, the federal government, and by local municipalities. To accomplish this there are a plethora of different types of incentives to encourage solar including: installer training and certification, manufacturing and economic development, changing permitting and inspection requirements, changing utility policies and processes, etc. While an in depth discussion of all these different incentives is outside the scope of this paper, some of the more applicable programs as they relate to this study include: educational outreach; financing and incentives; and planning and zoning.

Education Outreach

Education can occur in a variety of ways including media campaigns, workshops, educational displays, events, competitions, highly visible demonstration projects, and/ or online mapping tools such as NYCSolarmap.com (DOE, 2011). The premise of educational campaigns is that citizens who are more educated about solar are more likely to be interested in purchasing and installing solar. However, there is a lack of data proving that this premise is true.

Financial Incentives

Financial incentives are another popular method to encourage solar deployment and can occur in the form of tax-credits, loan and loan guarantees, research and development, buy- down programs which provide rebates or cash incentives to reduce initial equipment costs, or through feed-in-tariffs which are long-term contracts for electricity at a pre-determined rate based on the cost of generation. Yet another method, however, is to create Renewable Portfolio Standards which require the increased production of energy from renewable energy sources as created by Colorado in 2004.

These incentives may occur at either the state and/ or federal level. For example, New York State’s tax incentives include: Residential Solar Tax Credit, Residential Solar Sales Tax Exemption, Residential Solar Sales Tax Exemption, and Property Tax Abatement for Photovoltaic Equipment Expenditures

Planning and Zoning

Finally, another way in which municipalities have been able to promote solar adoption is through zoning. For example, changing zoning ordinances to orient subdivisions or street grids to take advantage of solar conditions; using zoning to mandate roof pitch and color (Town of Truckee,2011) to take advantage of solar conditions; or through enacting solar rights ordinances. The later, as passed by the City of Ashland in Oregon contains solar setback provisions to ensure that shadows of the north property line do not exceed a certain heights so as, “to preserve the economic value of solar radiation” and to preserve options for future uses of solar energy (City of Ashland, 2011). Finally, it can mean removing zoning impediments to ensure that panels can be installed on rooftops and that permitting applications can be streamlined to reduce the amount of time and difficulty involved in installation.

Given the variety of these different incentives, the question remains: can these incentives be effective when targeted spatially? To better understand this, New York City's Solar Empowerment Zone Program was analyzed.

New York City's Solar Empowerment Zone Program

New York City's Solar Empowerment Zone Program was a byproduct of the U.S. Department of Energy's Solar America Cities Program (now called Solar American Communities) in 2007. This top- down program designated a total of 25 U.S. cities between 2007 and 2008 as Solar American Cities (USDOE, 2011). Not only does the program encourage the sharing of knowledge through a peer- to- peer network, but it provides financial and technical assistance to these cities.

New York City joined the program on June 20, 2007; an action which dovetailed well with PlaNYC2030. PlaNYC 2030's sustainability goals include reducing citywide carbon emissions by 30% below 2006 base levels by 2017 for city operations, and reducing citywide greenhouse gas emissions by 30% by 2030 below 2005 base year levels (NYC Climate Protection Act, 2008), and to ensure cleaner, more reliable, more affordable fuel for New York City (PlaNYC 2030, 2011). Solar energy meets these goals through providing solar power at peak load times- the same time that older, dirtier, less efficient power plants would otherwise need to run in order to provide energy (US DOE, 2011).

To encourage solar, the city set an overall installation goal of 8.1 MW of solar photo voltaic panels by 2015 (USDOE, 2011). Additionally, using their funding from the Department of Energy Solar American Communities Program, New York City undertook three main initiatives to address technical, political and financial barriers to PV in New York City (USDOE, 2011). These initiatives included: conducting a study on interconnecting photovoltaics to a network grid, studying solar in emergency preparedness planning, and through creating Solar Empowerment Zones (USDOE, 2011).

Towards this end, the city worked with multiple stakeholders to create New York City's Solar Empowerment Zones. These stakeholders included: The City University of New York's Center for Sustainable Energy, Con Edison, NYSERDA, the Mayor's Office of Long Term Planning and Sustainability (USDOE, 2011), and the Public Service Commission. The three zones are located in Downtown Brooklyn, Greenpoint- Gateway and Staten Island were decided upon through assessing which areas of the city were most viable and beneficial from a technical standpoint (USDOE, 2011). Or, said another way, these zones were chosen based on where Con Edison foresaw increased population and energy trends and anticipated needing to make network infrastructure grid upgrades in the next several years (USDOE, 2011). Likewise, they were chosen because customers in these zones had "day peaking" energy demand profiles which, conforms to the production of solar and because each of these zones had a significant amount of rooftop spaces which was well suited for solar installations (USDOE, 2011). When drawing the particular boundaries, they drew them at the network level (Con Edison's grid is broken down into 62 networks and when they need to be expanded they expand it at the network level).

The goal of the Solar Empowerment Zones was to target efforts to reduce peak electricity demand, potentially deferring or eliminating the need for costly infrastructure upgrades or substations which would otherwise increase electricity rates (USDOE, 2011). The Solar Empowerment Zones also offer an opportunity to test out policies and incentives which could be rolled out elsewhere in New York City (USDOE, 2011).

To incentivize the installation of solar within these zones, the program designated that building owners within these zones be offered technical assistance, given additional guidance regarding financial incentives available for solar panels, receive data monitoring systems to inform users of system performance, the opportunity to take advantage of streamlined permitting during installation, experience additional community outreach support, and assistance with developing applications for state renewable portfolio standards (USDOE, 2011). Through these incentives, this program worked to target education and streamlining efforts within these zones. However, as mentioned previously there is a shortage of academic literature analyzing if this is an effective method.

4. LITERATURE REVIEW

New York City's organized efforts to encourage solar energy arguably began with the Million Solar Roofs Initiative in 2005. This program provided the impetus to assess New York City's solar energy market and resulted in the publication of two reports: **New *York City's Solar Energy Future*** by **Rickerson, 2006 and Rickerson et al 2007** (Meister Consultants, 2011)**.** These reports concluded that although solar energy held great potential, for New York City to meet its energy needs in an effective and clean manner, complex barriers first needed to be overcome (Rickerson, 2006 and 2007). These barriers included: insufficient solar funding and investment, the high costs of installing PV in New York City, technical and administrative barriers, and inadequate state policies for the New York City market.

Upon becoming a solar city, the report, "**Solar Policy Environment: New York**," established a baseline for New York City's solar conditions. It examined policies in New York state and New York City between July and September 2007 which affected solar deployment. The report provided a benchmarking and tracking matrix for various policies and activities affecting solar deployment. It also reviewed the categories of financing and incentives, market analysis, permitting and inspection processes, and finally, planning, zoning and utility policies and processes. However, because this document only assessed the baseline from which the city developed its solar program- and did not include new programs such as the solar empowerment zones- it is of little help in currently determining how effective the zones (or any other programs are for that matter) are in New York City.

The publication, "**Photovoltaic Systems Interconnected onto Secondary Network Distribution Systems-Success Stores**" was a turning point in the city's pursuit of solar. Prior to this April 2009 report, Con Edison had required an electrical assessment for each new PV panel to ensure that the installations wouldn't damage the grid. However, these evaluations were expensive and often delayed projects. This study conducted by the National Renewable Energy Laboratory in collaboration with New York City Solar America City team and Con Edison, alleviated this concern. The four part study assessed the maximum technical potential deployment of the PV system in New York City and evaluated what the impacts of this maximum solar generation might be on the grid. Ultimately, Con Edison determined that low levels of PV power were generally acceptable. Consequentially, Con Edison now allows PV systems of less than 200 kilowatts to connect to the grid without requiring an engineering review. This change in policy removed a major impediment in the solar installation process and made solar PV a realistic pursuit in New York City.

The Department of Energy more recently released two important solar reports. The first was ***Challenges and Successes on the Path toward a Solar-Powered Community: Solar in Action***. This report summarized New York City's programs as per the American Solar Cities programs. However, it did not assess the effectiveness of these programs nor did it focus substantially on the challenges that these programs faced. Conversely, the ***Department of Energy's New York City's Solar Energy Future 2011 Update*** was much more comprehensive. It provided forecasts for New York City's future solar energy markets, benchmarked NYC's current solar production, outlined current solar barriers and provided recommendations to overcome these barriers. Finally, it described new solar initiatives that the city was pursuing including solar empowerment zones, community solar roadmap and pilot programs, and a solar thermal pilot program. However, although this report tracked NYC's current solar production and compared this to its potential, it did not review how successful *each* solar programs had been in terms of facilitating solar production.

Using lessons learned from Sacramento, New York City, as well as the other 23 DOE Solar America Cities, program, the DOE published, "**Solar Powering Your Community: A Guide for Local Governments,**" a resource to assist local governments and stakeholders to implement successful solar strategies. This resource describes various solar policies and programs, describes the benefits of these policies or programs, gives tips for designing and implementing the suggested policy or program, provides case studies and provides additional tools. In particular, the report offers tips on designating a local solar coordinator, streamlined permitting, and consumer outreach and education programs. Notably however, this otherwise comprehensive report did not examine the effectiveness of using solar overlays or "zones" to promote solar deployment even though solar cities such as Sacramento and New York City used such techniques.

Around the same time that the New York Bar Association released their report, Urban Green Council released **Green Codes Task Force Report** (September 2010). This report recommended changes to laws and regulations in order to create greener buildings. The report outlined 111 recommendations, offered statutory language changes, an explanation for why these codes should be changed, an analysis of the costs and savings, precedents from other jurisdictions or LEED credits, and information on implementation. With regards to solar, it once again reiterated that changes to the zoning code were needed. The Task Force proposed three specific changes related to solar energy (#EF13-#EF16) including: to clarify standards for attaching rooftop solar panels, to allow large solar rooftop installations, to remove zoning impediments to alternative energy, and to remove landmark impediments to alternative energy.

Perhaps in response to the Green Codes Task Force, in December of 2011, the New York City Department of City Planning proposed **Zone Green**, a citywide zoning text amendment, "to remove zoning impediments to the construction and retrofitting of green buildings (DCP, 2011)." This text amendment was approved by the City Council on May 1st 2012 and features provisions for more energy-efficient building walls, sun control devices, and rooftop greenhouses. Additionally, in terms of renewable energy, it also allows wind turbines of a height up to 55 feet to be assembled on rooftops of buildings taller than 100 feet- provided they are set back 10 feet from the property line. Finally, the Zone Green Text Amendment also included an amendment to allow solar panels on flat roofs anywhere below the parapet regardless of building height. Taller installations are subject to limits on roof coverage and on sloping roofs, panels are allowed if they are flat-mounted (less than 18 inches high).

While breaking down barriers through zoning changes is one important way to increase solar deployment, as discussed previously, two other important methods are through financial incentives or through increased educational outreach. Unfortunately, the effectiveness of both these types of incentives are not entirely understood.

One comprehensive report which sought to tackle this issue was published by the National Renewable Energy Laboratory entitled, "**Case Studies on the Effectiveness of State Financial Incentives for Renewable Energy.**" This report examined ten state financial-incentive programs as case studies in six different states to identify key factors which influenced effectiveness in stimulating deployment of renewable energy technologies. These credit programs included Tax Credit Programs, Buy-Down programs and loan programs. Interestingly the report concluded that program participants tended to be strongly motivated by *noneconomic* factors such as an interest in the environment, a desire to reduce dependence on utilities, power reliability, and security threats. Many participants in the buy- down program had a long standing interest in renewable and the incentive merely inspired them to make the purchase. Perhaps for this, among other reasons, the report frequently referenced the importance of education in combination with financial incentives. For example, "A more comprehensive renewable energy education campaign may be necessary to increase deployment of renewable. An inadequate understanding of the types and benefits of renewable in general is still considered a major barrier to technology adoption."

Unfortunately, other studies question education's ability to act as a panacea and to actually generate changes. For example the article, "**Cajolery or Command: Are Education Campaigns an Adequate Substitute for Regulation"** discussed that there is little analysis following educational campaigns to determine their effectiveness. This study in particular studied three highly prominent health and safety campaigns and found that it was difficult to implement behavioral changes in citizens. The author stated that, "to avoid wasteful spending, government policymakers should insist that proposed education campaigns be subject to the same scrutiny as proposed regulatory measures." This finding was apt considering little analysis has been undertaken to determine if educational campaigns for renewable energy are working.

Another study which further corroborates these findings was the National Renewable Energy Lab study **Analysis of Web-Based Solar Photovoltaic Mapping Tools** which explained that although 3,700 people visited San Francisco's Solar Mapping Website, the number of installed solar PV systems resulting from this tool remained unknown. The study concluded that "in the future, as cites and private entities make tough decisions about how to make the largest impact toward renewable energy technology adoption with minimum funds, they will need to weigh the costs associated with map development against the benefits many of which are known."

Given that both financial incentives and educational outreach are not entirely understood, to better allocate limited education and financial incentives, New York City created the Solar Empowerment Zones so that "pilot processes, policies, and incentives could be rolled out throughout New York City." And while this concept of spatially targeting incentives is still relatively new, it has been gaining prominence with examples not only in New York City but also in Arizona, and California.

In New York City, the idea of using zoning to promote renewable energy was arguably first proposed in May of 2010, when the New York Panel on Climate Change released their ***Climate Change Adaptation Plan***. In this report, the Panel on Climate Change identified risks and vulnerabilities associated with climate change and offered guidelines to address these concerns. In Chapter Five, "Law and Regulation," they identified the zoning resolution as a main barrier to implementing renewable energy in New York City and proposed the idea of, "heat reduction districts." They argued these districts would allow for wide-spread renewable energy rather than requiring that permits be applied for on a case by case basis.

The idea of energy districts was also discussed in the New York Bar Association's September 2011 discussion paper, "**Further Utilizing the Zoning Resolution to Create a More Sustainable New York City, Better Prepared to Adapt to Climate Change**." This paper's purpose was to "advance the dialogue of how the Zoning Resolution can be amended to shape a more sustainable New York City, better prepared to adopt to climate change." In particular, the paper discussed amending the zoning resolution to allow for a "block-by- block or neighborhood approach" to energy, in which one building can serve as a platform providing energy to neighboring buildings. It also highlighted the idea of special energy overly districts in which the permitting process could be streamlined.

Spatial zoning is also gaining acceptance elsewhere in the country. For example, In December of 2010, the US Department of the Interior Bureau of Land Management (BLM) and the US Department of Energy (DOE) acting as joint lead agencies released a **Draft Environmental Impact Statement for Solar Energy Development.** This draft Environmental Impact Statement reviews a federal plan to facilitate utility-scale solar development on public lands located in the six western states of Arizona, California, Colorado, Nevada, New Mexico and Utah. The proposed federal program was developed to target limited human resources to respond in a more efficient and effective manner to interest surrounding siting utility-scale solar on public lands, and to consistently apply measures to mitigate adverse impacts of such development. The proposed program would establish solar energy zones chosen based on criteria explicitly stated in the EIS. These parameters include, among many, the physical conditions of the land and its ability to support solar, avoidance of cultural, social or environmental features, and transmission availability. Within these solar zones, incentives would be spatially targeted and would include: facilitating faster and easier permitting, improving and facilitating mitigation, facilitating the permitting of needed transmission to solar zones and providing economic incentives for development. Given that this program is still going through the approval process (a final draft EIS will not be released until Summer of 2012), no information is available regarding how well this program might work in the future.

Another program which spatially targets incentives is Sacramento's Clean/ Green Technology Zones which was assessed in the July 2010 CH2MHill report, "**Growing a Solar Industry in the Sacramento Clean Tech Zone."** This report explains that the zones were not formally incorporated into the zoning resolution but instead existed informally as an economic development zone. Within these zones, financial incentives were targeted in the form of sales tax credits, wage tax credits for five years after hiring eligible employees, 100% net operating loss carryovers available for 15 years, and rapid depreciation of equipment.

Overall, stakeholders interviewed by CH2MHill were generally optimistic regarding the zones and felt that they could be successful given their: location, widespread support and availability of land buildings, ongoing improvement efforts, and the involvement of Saremento State and SMUD. In practice, however, it is unclear how successful the zones have actually been; especially considering that since the CH2MHill report was published, the city changed their approach. Now, the program incorporates all clean technology rather than just clean renewable energy, indicating that the zones did not appear to be working as they were.

As identified in the report, key challenges identified with the zones included that they did not have many unique advantages, that they did not have a unified identity, conflicting land uses such as recycling centers discouraged potential tenants, and that no large cash incentives were available. Furthermore, while monetary incentives were beneficial, they were either not unique monetary incentives or were not as significant or aggressive as those being offered through other state programs. Suggested improvements included: improving the area to meet the needs and requirements of the solar industry, and better marketing techniques to target potential companies.

Finally, another program which relied on targeting incentives is Gila Bend, Arizona's Solar Field Overlay Zones, which use the incentive of streamlined permitting to spatially target solar development. As discussed in **Gila Bend Zoning Ordinance (16-4-18)**, this program has the stated purpose to act as, "a holding overlay zone by which it allows for future development of property to occur in an organized and sustainable pattern." These zones can only be utilized for the use of Solar Energy, must be 100 acres, and site plans must be submitted at the time of application. Furthermore, development of the solar field must begin within one year. Through creating overlay zones rather than formal zones, the town was able to bypass General Plan requirements which state that a general plan amendment must be passed when, "a request for the introduction of a new land use category or a change to the intensities or densities of existing land use categories (Gila Bend General Plan, p26)," occurs.

Gila Bend's program was discussed in a Department of Energy article, "**Could Gila Bend, Arizona, Become the Solar Capital of the World."** As discussed in this piece, processes that had previously taken solar companies at least a year or more could now gain approval in as little as four weeks while still going through all the necessary public hearings, citizen review sessions, planning and zoning commissions hearings, publication in newspapers and council. This four week approval process led one solar company Vice President to remark, "Gila Bend has set a world record in utility scale solar plant construction. Right now, we can't build solar power faster anywhere in the world." According to Rick Buss, this was extremely beneficial to solar executives given that, "what matters most to them is the elimination of risk.. they know they won't get half way through a year-long approval process and then have the rug pulled out from under them, which happens to them in a lot of other towns." This explains why just four to six months after the overlays were created, two solar companies constructed power plants, converting over four square miles that have previously been cotton and alfalfa fields to solar facilities. Not only did this create 2,300 new jobs for the 2,000 residents, but it reduced water usage by 75% to 90% since it removed the land from water-heavy agricultural production.

As demonstrated, the concept of spatially targeting incentives has been gaining acceptance. However, as a relatively new usage, it is unclear if incentives can be targeted spatially. This study will analyze this issue through examining the case study of New York City's Solar Empowerment Zone program.

5. <u>METHODOLOGY</u>

Approximately 10 first- hand interviews were conducted with major stakeholders connected to New York City's Solar Empowerment Zone Program to gain anecdotal evidence regarding what about the zones was working well, what needed further improvement, and what other lessons could be offered in terms of using zoning to promote solar energy. Eight supplementary interviews were also conducted with stakeholders of similar programs such as Sacramento's Clean Green Technology Zone and Gila Bend, Arizona's Solar Overlay Program, or with stakeholders connected to the overarching issues of zoning and renewable energy. Interviews were open ended and conducted either in person, over the phone, or in one case via email, depending on the availability of participants. Depending on the comfort level of the interviewee, conversations were also tape recorded to aid interviewer in later analysis. In all cases, extensive notes were taken during interviews on the interviewer's personal computer and later analyzed to find underlying patterns and themes.

In addition to stakeholder interviews, a quantitative analysis was conducted. For this, NYSERDA's real-time online GIS map, "PowerClerk," (http://nyserda.powerclerkreports.com) was consulted. This map illustrates the location of planned and existing PV installations in New York City and details the size of the installation, the date of installation, and the building typology upon which each installation is built. Using this map, on March 30th 2012, the size of each installation (in terms of kW), the borough, and building typology were recorded. This data was sorted both by those installations that appeared within a solar empowerment zone and those that appeared outside the zones. To determine which installations fell outside the zones, the research referred to the boundaries depicted on the NYCsolarmap.com website. This installation data was then further sorted chronologically to separate those panels that were installed before and after June 8, 2010. June 8, 2010 was the date of the NYC Solar Summit and marks the official start date of the Solar Empowerment Zone program.

Using this data, a significance test was completed using the formula:

$$Z = \frac{\pi 2 - \pi 1}{\sqrt{\pi(1-\pi)\left(\frac{1}{n1}+\frac{1}{n2}\right)}}$$

First a proportion was created looking at the number of panels installed within the Solar Empowerment Zones since the start date of the program and comparing this amount to the number of buildings inside each Solar Empowerment Zone. The number of buildings inside the zone was obtained through using NYCsolarmap.com boundary information and redrawing shapefiles in ArcGIS. Using these created shapefiles, NYC 2011 Pluto data was then clipped to isolate the building information for buildings within each of the total solar empowerment zones.

To determine the total number of buildings inside the zone, the number of buildings categorized as one and two family buildings; multi-family walk-up buildings; multi-family elevator buildings; mixed residential and commercial buildings; and commercial and office buildings was added and recorded. The total number of *all* buildings in the zones was not used as a denominator because the Powerclerk map reflects only those residential and commercial installations which receive NYSERDA funding. To include all building typologies in the denominator would make the analysis less precise[3].

Finally, n1 in the equation was set to represent the total number of commercial and residential buildings outside the zones for the corresponding borough. So for example, for the Staten Island calculation, the total number of residential and commercial buildings outside the Staten Island Solar Empowerment Zone. Likewise, for the Brooklyn and Queens Solar Empowerment Zone, n1 represented the total number of commercial and residential buildings outside the zone for both Brooklyn and Queens (minus those found in the Greenpoint zone). Additionally, n2 was set to represent the total number of commercial and residential buildings within each solar zone.

These proportions correspond to:

$$\text{With } \pi 1 = \frac{\text{The number of panels installed since start date outside zone}}{\text{All commercial and residential buildings outside zones}}$$

[3] Note: there were two outliers on this map for industrial installations but since this was the very rare exception, these points were dropped from the analysis and the denominator was restricted to commercial and residential buildings for the aforementioned reason.

And

With $\pi 2$ = <u>The number of panels installed since start date inside zone</u>
All commercial and residential buildings inside zones

And

Π= <u>total number of panels both inside and outside zone within each borough</u>
total number of commercial and residential buildings within each boroughs

6. DISCUSSIONS OF QUANITATIVE FINDINGS

The resulting amounts for π1 were:

Staten Island	0.000118
Greenpoint	0.000161
Brooklyn- Queens	0.000275

And the resulting amounts for π2 were:

Staten Island Zone	0.000254595
Greenpoint Zone	0.000528709
Brooklyn- Queens Zone	0.000201495

Taken together this correlates to:

	% Inside Zones	% Outside Zones	(%Inside-% Outside)
Staten Island Zone	0.0254595	0.0118	0.01366
Greenpoint Zone	0.0528709	0.0161	0.0367709
Brooklyn- Queens Zone	0.0201495	0.000275	0.0198745

The last column on the right of the table above shows the difference between the percentages of solar panels inside the zones minus the percentages of solar panels outside the zones. The positive values for both Staten Island and Greenpoint indicate that technically the proportion of solar panels inside these zones has increased- albeit by a small percentage. However, to determine if this increase was due to chance or due to the effectiveness of the Solar Empowerment Zone Program, additional analysis was needed.

To determine if this increase can be termed "statistically significant," a significance test was conducted using the formula:

$$Z = \frac{\pi 2 - \pi 1}{\sqrt{\pi(1-\pi)\left(\frac{1}{n1}+\frac{1}{n2}\right)}}$$

The resulting Z scores were:

Staten Island	2.157618
Greenpoint	2.400784
Brooklyn- Queens	-1.10949

Using a Z table, these scores correlate to probability percentages of

Staten Island	1.58%
Greenpoint	0.82%
Brooklyn- Queens	36.43%

Thus, this test indicates that the growth of solar panels in the outer boroughs is statistically significant for both Staten Island and for Greenpoint but not for the zone spanning Brooklyn and Queens. This means that it is extremely unlikely that the increase in solar zones compared to non-solar zones for Staten Island and for Greenpoint was simply due to change whereas it is possible it was due to chance for the Brooklyn and Queens Zone.

Data Limitations

PowerClerk only illustrates those commercial and residential installations which received NYSERDA funding. One concern with this dataset is that a large proportion of solar installations- meaning those not funded by NYSERDA- would be absent from the map. However, because NYSERDA incentives typically cover between 25-35% of residential, commercial and non- profit installations, after speaking with industry experts, it is reasonable to assume that a large proportion of all existing solar panels within these categories of commercial, residential and non- profit installations in New York City are displayed on this map.

Likewise, it can be argued that this map only shows NYSERDA funded installations, which causes a possible bias in the locations where people might have otherwise installed panels. However, since NYSERDA bases their installations on a first come, first- serve basis, reviewing which installations would be most cost-effective and is a state agency, there is no reason to think a specific type of applicant would be favored over another.

Another limitation is that the kW generated by solar panels represents the nameplate capacity- or the normal maximum output generating amount. Nameplate capacity does not represent how much energy these panels actually feed into the grid, however. Finally, since this program is not very old it means there is a limited amount of data which could be analyzed. However, since PowerClerk displays planned installations it also shows future trends. Furthermore, this conclusion in and of itself is still useful because even the limitation of data can indicate to policy makers that these types of programs would take a long time.

7. DISCUSSION OF QUALITATIVE FINDINGS

Stakeholder Interviews

Several themes and patterns emerged during stakeholder interviews including the effectiveness of the zones, debates on the proper level of incentives in the zones, stakeholder inclusiveness vs. exclusiveness and the potential of future renewable energy zones.

Effectiveness of the Zones

While all stakeholders thought the zones were a good idea in theory, they had mixed opinions regarding how effective the zones were in practice. On the positive side, they felt the zones were helpful in terms of educating building owners about solar energy. Stakeholders also indicated that the program helped to generate public interest in solar, extending to locations even outside of the solar zones. Technical assistance was also cited as being particularly helpful with a few stakeholders expressing appreciation that the zones effectively engaged with Con Edison.

However, in terms of existing challenges, the overall sentiment amongst stakeholders was that the zones were not effective in increasing the number of installations- albeit with the caveat that it was still early in the program. For example, one stakeholder noted that there is, "of course, always more to be done in terms of educating the public and the solar industry on the particulars of the zones." This was corroborated by a solar installer who explained that building owners call them looking for technical advice which likely indicates that there is not enough technical assistance available. Additionally, it was suggested that more assistance needed to be given to solar installers in the form of sales leads (customers who might be interested in installing solar) within the solar empowerment zones. This could occur through allowing individuals who are interested in solar to disclose their information to solar installers, or through making property information more accessible. Stakeholders also indicated that there are probably not enough incentives available in the zones- especially financial incentives. As one stakeholder said, "although there is an enhanced chance to close a deal in that area, it is certainly not a goldrush to those locations." Consequentially, the zones are not necessarily driving the decision making process when it comes to solar installations.

Finding the Proper Level of Incentives within the Zones

Given the fact that the zones are not necessarily driving the decision making process, the next logical question is what amount should solar be incentivized in those locations to reach the program's goals? This is a complex question given that stakeholders *very broadly* have two different motivations: some are interested in solar for its environmental benefits, while others are interested in solar for its financial benefits. Arguably the utilities are on board since the zones have the potential to save them money. Thus, from the utilities perspective, the proper level of incentives is one where the cost of incentivizing solar does not become more expensive than the potential savings of the zones (or the zones will no longer be financially attractive). One stakeholder expressed this quandary commenting, natural gas is currently extremely inexpensive and, "the problem with subsidies is that you can't subsidize any technology forever.. you subsidize to drive down the prices." Likewise, another stakeholder commented, "public dollars [in the form of incentives] need to be spent wisely, so how much is solar worth in these zones?"

This debate can be extended further, not only comparing the zones to greater New York City, but comparing New York City to the greater regional area. For example, as one stakeholder pointed out: it is much cheaper to produce renewable electricity upstate where land is cheap and utilities are unlikely to encounter NIMBY resistance and to then send this electricity back downstate. Thus, from a purely cost-effective standpoint electrical production should occur outside the city, where as many subsidies are not needed. Likewise, one can make the argument that producing electricity upstate is even more environmentally friendly since due to its cheaper price, you can produce more of it (this of course ignores the benefits in producing power close to the location of use as discussed earlier).

Aside from financial incentives, there is an underlying question regarding what other incentives should be used in the zones. For example, as one stakeholder pointed out, " Creating a district for something sounds good but if it's something that you want to promote everywhere then why just do a district?... Coming up with a district should be either why is it more appropriate for this stuff to be here or why is it more important for it to be here?" As this stakeholder pointed out, you might want to allow for more flexibility for solar within the zones, but if this is the case, then why not just allow for more flexible solutions everywhere? These underlying questions align with those posed in the Sacramento case study. As discussed earlier, in that report, they found that incentives within the zones were not unique enough to attract more business than those outside the zones.

Inclusiveness vs. Exclusiveness – Tensions Over the Role of Con Edison

Another reoccurring theme was the tensions between stakeholder inclusiveness and exclusiveness. Due to the nature of this program, Con Edison, NYSERDA and the Public Service Commission were strongly involved in creating and facilitating this program. This was beneficial because these participants are major stakeholders and it was crucial to get their buy-in in order for the program to be successful. As one stakeholder explained, if this buy- in was not achieved, utilities could call for studies, throw up roadblocks or in general, delay projects. However, through obtaining their buy-in, things could be achieved much faster. As another stakeholder explained: there is a certain amount of inertia which needs to be overcome in order to get the staff at utilities to think of solar as a solution instead of thinking of it as a problem (in terms of connecting it to the grid) and since this change in attitude requires retraining of staff, utilities should be able to benefit from solar in some way.

Another benefit from having Con Edison, NYSERDA and the Public Service Commission heavily involved in the process was that it kept the program apolitical. As one stakeholder explained, when these zones were created there was the potential for stakeholder jealousy. That is, councilmen or congressmen would have lobbied for incentives zones to be located within their districts. However, since the zones were largely chosen by Con Edison, and backed up by the Public Service Commission- a state agency- the selection of these zones was able to remain apolitical. This ensured that the zones chosen were most appropriate in terms of technical appropriateness[4] and not chosen for political purposes.

However, Con Edison's prominent role in the project has also been off putting to some stakeholders who question, "to what extent Con Edison really has a monetary incentive to want solar to happen." Likewise, as another stakeholder pointed out this was obviously a top-down program which did not take into account existing social networks. As this stakeholder explained, "the city is interested in big business and there is a role for that but people are passionate about this at a grassroots level." This viewpoint was corroborated by another stakeholder who explained that there are places where residents are already mobilized around solar and environmental issues such as the South Bronx. However, this program fails to tap into those existing networks. Instead it chooses the zones that are most beneficial to Con Edison and then tries to mobilize the communities in those locations around

[4] Interestingly, while the zones were not chosen for political reasons, the greater program developed from political underpinnings. With large amounts of public funds going to the upstate region for wind development, Con Edison and the city petitioned NYSERDA to obtain money for NYC- centric programs with the rationale being NYC customers were paying into this fund but the benefits were going elsewhere.

solar. Finally, as one stakeholder summed up the situation: "it is easy to get Con Edison to something that they want to do, but what about with other sustainable options?"

Targeting Other Areas Spatially or by Building Typology/ Possible Future Initiatives

Another theme in interviews was the potential of targeting additional areas for renewable energy generation. This could occur either through creating zoning overlays (similar to the empowerment zones) or through targeting certain building typologies. With regards to the first, one proposal was to install solar on brownfields as is being done with Fresh Kills landfill. Putting solar on Fresh Kills was an idea introduced as early as 2010 (Hammer et al, 2010) and one that is finally gaining traction. The NYCDEC recently sent out a request for proposals seeking proposals, "for the long-term lease of approximately 75 acres of land on and adjacent to the former Fresh Kills landfill ... [for the] ownership, design, construction, and operation of utility-scale installations of solar and wind energy (NYCDEC, 2012)."

In addition to solar energy, stakeholders also suggested using zoning to promote other forms of renewable energy such as combined heat and power. Here, advocates argued that combined heat and power is more cost- effective than solar. Finally, yet another stakeholder offered the idea of creating tidal zones. This idea has merit given that in January the US Federal Energy Regulatory Commission awarded Verdant Power the first license for a tidal energy project (Wingfield, 2012). Likewise, in July of 2010, President Obama issued executive order 13547 by which all U.S. waters should be mapped in order to establish which areas should be set aside for conservation and which for wind and wave energy (Spalding and Brooks, 2011).

Stakeholders also suggested targeting certain building typologies. This idea has precedence given that Scott Stringer's office proposed Rooftop Revolution, a plan which prioritizes installing solar on the rooftops of schools with the hope of eventually extending the plan to other city-owned buildings. This proposal explains that solar panels on the rooftops of 1,094 public schools could host 169.46 megawatts of renewable energy and would increase solar capacity across the five boroughs by over 2,500 percent (Stringer, 2012). Finally, yet another stakeholder suggested targeting college campuses or other large land use holders. This idea was demonstrated at NYU's Washington Square Campus which utilized NYU's Cogeneration (cogeneration is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat) to successfully provide electricity to 22 NYU buildings and to provide hot and chilled water for 37 buildings (NYU, 2011).

Indirect Suggestions

Other ideas inspired by stakeholder interviews- thought not specifically suggested by them- included targeting blighted or industrial areas for renewable energy projects. Precedence exists for this with the Sacramento Army depot project in which the project utilized renewable energy (Forest and Alagozian, 2010) and the EPA Brownfields and Land Revitalization Program. Also the idea of community wide power purchase agreements is particularly promising. In Sacramento's, the Municipal Utility's Solar Shares program allows customers to purchase a portion of solar energy generated from a third-party-owned system (through a Power Purchase Agreement). The program was so wildly successful that it was subscribed to the desired level within six months of program inception without much marketing and has generated a persistent waiting list of approximately 60 customers (USDOE b, 2011).

8. PLANNING IMPLICATIONS/ RECOMMENDATIONS

As discussed, New York City's Solar Empowerment Zone program mirrors the concept of formal renewable energy zones in that it spatially targeting incentives in the form of education to change the urban environment. Examining this program can indicate what would occur if these zones were to formally incorporated. This is a timely issue given the buzz of ecodistricts and similar programs which are attempting to employ zoning. Likewise, this program can be used as a case study to examine if increased educational efforts are effective as an incentive for renewable energy. Taken at the larger level, however, several lessons can be learned:

The motivation of different stakeholder should be determined upfront to ensure that there is a benefit for participation for both top-down and bottom-up stakeholders. Top-down programs without grassroots support are unlikely to be financially sustainable and should be avoided.

In the Solar Empowerment Zone program there were, at times, two competing stakeholder motivations: saving money and improving environmental conditions. Although it was pretty much nonnegotiable to have Con Edison involved in this program (since they control the grid), conceding such a large amount of control to Con Edison required taking control away from other stakeholder such as local communities. Thus, in order to balance this, extra incentives were needed to generate interest among local participants to encourage them to partake in the program or to generate interest. Unfortunately, this ended up being a catch-22. To get the program to work, extra incentives were needed, but the cost of all the extra incentives ultimately detracted for the program's success since it counteracted the economic gains sought by Con Edison.

Thus, such a program should not be used unless it is in a location where participants are already predisposed to install solar- thereby eliminating the need for strong incentives. Or, the interest of the community should be given stronger weight as a parameter when determining zone boundaries. Otherwise, policy makers should anticipate needing to substantially subsidize the program in order to generate interest from the bottom- up and for it to take time. Interest can be generated from education, but as seen in this case study, education may not be as effective as hoped and can take a long time- sometimes several years to develop results. Another method is of course financial incentives, but here too, to justify the use of funds, policy makers should be prepared to answer: why is it more appropriate for this type of business or project to be here?

Metrics for the program should be determined upfront.

Determining metrics upfront not only provides a way to measure the program's eventual success or failure but can assist policy makers in determining if a program has competing objectives. For example, with the solar empowerment zones, a dominating metric was the zone's ability to save money. Thus, a cost benefit analysis should be conducted to ensure that incentives will not cost more than anticipated savings. The fact that this objective might compete with environmental benefits would signal to policy makers this could be problematic.

Incentives need to be unique enough from nearby locations in order to attract additional business

This was demonstrated in both New York City and in Sacramento. If municipalities really want to encourage a change in a particular region, then incentives need to be substantial enough from other locations to drive the decision making process. As discussed above, finding this correct level of incentives can be difficult given that heavy subsidies can negate the program's success.

Government should continue to work with businesses and to streamline regulations

One way to encourage business in locations rather than increasing education efforts or increasing financial incentives is to make installing solar more profitable. This can be achieved either through decreasing regulations thereby making it less expensive to install panels or through allowing installers to increase sales- such as by making it easier for solar companies to target customers. The later could be achieved through assisting solar installers in the generation of leads so they can better penetrate the solar market within these zones.

Education may not be as effective as hoped

Although certainly not meant to be conclusive on the topic in any manner, the findings of this particular study indicate that educational efforts were likely not a cost-effective incentive in terms of solar deployment. That is, while education is always helpful, if it is the only incentive, it can be expensive and can take a long time to generate desired results. Turn- around time can be quickened but to do so will likely require additional financial investments.

9. CONCLUSION

In the case of New York City, while all stakeholders felt the zones were a good idea in theory, there were mixed opinions regarding their actual effectiveness. Preliminary data indicates that this program is not working as hoped and that the Solar Empowerment Zones are not necessarily driving the decision making process. While all constituents agreed that increased education was helpful, and considered statistically effective in Greenpoint, Brooklyn and Staten Island, education was still not necessarily as effective as desired. Likewise, this study demonstrated that crafting zones should only be employed after stakeholders, motives, and metrics are carefully considered. In particular, programs without grassroots support are unlikely to be financially sustainable. At a greater level, however, this study demonstrated that the concept of using zoning to promote renewable energy is difficult and should only be undertaken after substantial preliminary analysis is undertaken to ensure that the right balance of stakeholder interests exists.

Works Cited

Amin, Massoud and John Stringer. “The Electric Power Grid: Today and Tomorrow.” MRS Bulletin. April 2008, Volume 33 p 399

California Department of Housing and Community Development, 2012= http://www.hcd.ca.gov/fa/ez/EZoverview.html

Cambell, Matt. “The Drivers of Levelized Cost of Electricity of Utility- Scale Photovoltaic.” 2008 Available Online at ussunpowercorp.com

CH2MHill “Growing a Solar Industry in the Sacramento Clean Tech Zone.” Prepared for the City of Sacramento, July 2010. Available online www4.eere.energy.gov/solar

City of Ashland. “18.70 Solar Access” Available Online” <http://www.ashland.or.us/CodePrint.asp?Branch=True&CodeID=3338 > 2011.

Climate Protection Act , Local Law 22 of 2008, available online http://www.nyc.gov/html/nycwasteless/html/laws/local_climateprotection.shtml

CPUC California Solar Initiative 2010 Impact Evaluation Final Report Available Online http://www.cpuc.ca.gov/NR/rdonlyres/E2E189A8-5494-45A1-ACF2-5F48D36A9CA7/0/CSI_2010_Impact_Eval_RevisedFinal.pdf

Department of City Planning “Zone Green Text Amendment” < http://www.nyc.gov/html/dcp/html/greenbuildings/index.shtml > 2011

Department of Energy. Solar Powering Your Community: A Guide for Local Governments” Available Online: < http://solaramericacommunities.energy.gov/pdfs/Solar-Powering-Your-Community-Guide-For-Local-Governments.pdf > January 2011

Department of Interior. “Interior Releases Updated Roadmap for Solar Energy Development.” Office of the Secretary, Us Department of the Interior. October 27,2011 http://solareis.anl.gov/documents/docs/Supplement_to_Draft_PEIS_PressRelease.pdf

Department of Interior. Supplement to the Draft Solar PEIS. < http://solareis.anl.gov/index.cfm >2011

Enernoc, Inc. “Demand Response: A Multi-Purpose Resource For Utilities and Grid Operators.” Enernoc, Inc. < http://www.enernoc.com/our-resources/138-resources/white-papers/294-demand-response-a-multi-purpose-resource-for-utilities-and-grid-operators> 2010

Fitzer, Eric. “January 28, 2010 Citizen Review Session TA-10.01 Solar Field Overlay Zone” Available

Online
<http://www.gilabendaz.org/Gila%20Bend%20Assets/Citizen%20Review%20Session%20SFOZ%201%2028%2010.pdf **>**

Forest, Heather and Alagozian, Lindsey. Report to Council, City of Sacramento. Army Depot Solar Project (P10-028) Public Hearings October 5, 2010

Gila Bend. "Gila Bend Zoning Ordinance." Available Online: http://www.gilabendaz.org/Gila%20Bend%20Assets/16-4-18%20Solar%20Field%20Overlay%20Zone%20_SFOZ_%20Adopted.docx.pdf

Hammer et al. "Large Scale Solar at Fresh kills Park Feasibility Assessment." Columbia University. http://www.sipa.columbia.edu/news_events/announcements/documents/FreshkillsSolarStudyFINAL-June2010.pdf. June 2010

Heller, Erica. "Wind and Solar Production and the Sustainable Developed Code". Denver, CO: Rocky Mountain Land Use Institute, 2008.

HDR. *Town of Gila Bend General Plan.* 2006. Available Online: http://www.gilabendaz.org/Gila%20Bend%20Assets/General%20Plan%20P&Z%20final%2011090 6.pdf

Mark J. Spalding and Hooper Brooks " Sea Science: Marine Spatial Planning is changing the way we deal with oceans and coastlines. " Planning Magazine, American Planning Association. December 2011 p 8-12

Meister Consultants Group Inc. "New York City's Solar Energy Future, 2011 Update." March 2011

New *York City's Solar Energy Future* by Rickerson, 2006 and Rickerson et al 2007

NYCEDC "Fresh kills Renewable Energy RFP" Available Online: http://www.nycedc.com/opportunity/fresh-kills-renewable-energy-rfp 2010

NYSERDA's New York's System Benefits Charge Programs Evaluation and Status Quarterly Report (June 30, 2011). Available online: http://www.nyserda.ny.gov/Publications/~/media/Files/Publications/NYES%20Program/2011/2011q2_nyes_sbcreport.ashx

NYU. "Press Release: NYU Switches on Green CoGen Plant and Powers Up for the Sustainable Future." Available Online < http://www.nyu.edu/about/news-publications/news/2011/01/21/nyu-switches-on-green-cogen-plant-and-powers-up-for-the-sustainable-future.html**>** January 21, 2011

PlaNYC 2030, 2011 Energy Chapter Available Online: http://www.nyc.gov/html/planyc2030/html/theplan/energy.shtml

Scott M. Stringer, Office of the Manhattan Borough President. *Rooftop Revolution: How Solar Panels on Public School Rooftops Can Jumpstart the Local Green Collage Economy and Dramatically Expand*

Renewable Energy in New York City. January 2012. Available Online: http://www.libertycontrol.net/uploads/mbp/RooftopRevolutionFINAL.pdf

Simmons, Ginny. US Department of Energy "Could Gila Bend, Arizona, Become the Solar Capital of the World?" Available online at http://energy.gov/articles/could-gila-bend-arizona-become-solar-capital-world November 15, 2011

Sustainable Sources. "Passive Solar Design" http://passivesolar.sustainablesources.com/ 2012

Town of Truckee. "Title 18 Development Code" Available online: < http://www.townoftruckee.com/index.aspx?page=125 > 2011

USDOE. "Solar in Action NYC Report" September 2011 http://solaramericacommunities.energy.gov/pdfs/new_york_city.pdf

USDOE b. "Solar in Action: Sacramento, California" September 2011 Available Online < http://solaramericacommunities.energy.gov/pdfs/sacramento.pdf >

Wingfield, Brian. "Energy Turbines May be Spinning in New York's East River by 2013." Bloomberg. January 24 2012. < http://www.bloomberg.com/news/print/2012-01-23/tidal-energy-project-in-new-york-s-east-river-wins-license.html >