# The Effect of Financial Incentives on Solar Installations

Mimi Kornfeld

Spring 2016

Department of Economics: Honors Thesis

Faculty Adviser: Professor Sprick Schuster

**Abstract:**

Over the last decade there has been a rapid increase in solar capacity, potentially fueled by falling costs and effective solar policies. Detailed examination of dynamic effects and effects depending on state context is important knowledge to help state legislatures spend funding effectively going forward. Using a county level panel dataset from years 2007 – 2014, this paper examines the effects of financial incentives on residential and commercial solar installations. To fully capture the effects of the size and scope of different financial incentives, I calculate a dataset of all statewide residential and commercial financial incentives. Consistent with previous work, I find that cash incentives are the most efficient at increasing incentives. I also find that rebates and grants exhibit different trends after enactment and different effects depending on previous policies passed. This paper contributes to the literature on state solar incentives by examining both residential and commercial dynamic trends and effects depending on policy context.

## I. Introduction

Scientists believe that climate change is one of the largest threats to our society and that greenhouse gas emissions heavily contribute to climate change. Solar energy has long been thought of as a potential solution to greenhouse gas emissions and climate change. The traditional, power plant electricity sector is responsible for approximately a third of greenhouse gas emissions, the most out of all sectors. Solar Photovoltaic (PV) technology creates emission free electricity not only for the owner, but also that can be sold back to the grid in many states (SEIA 2013). Increasing solar penetration in the United States would decrease dependence on traditional electricity sources and reduce greenhouse gas emissions. Similarly, increasing demand for solar will help improve technology and lead to more efficient cells that decrease dependency even further.

In the past decade, there has been a drastic increase in solar capacity for all sectors, including residential and commercial as seen in Figure 1. Prices have also been decreasing during this time period as a result of many different factors, including technology improvements. In 2010, solar was a fairly small portion of capacity additions at only 4%. In 2014, solar surpassed multiple other electricity sectors at 24% of capacity additions. Despite these large increases, the solar market is extremely concentrated with only 10 states accounting for 87% of all PV installations in 2015 (SEIA 2016). Other states' solar markets still have high growth potential. This also indicates that there were drastic differences in where the solar market grew across states. It is unclear whether this increase in capacity comes from decreases in price, improvements in technology, policy changes, or another exogenous factor.

Many legislators agree that reducing greenhouse gas emissions is important. The externality caused by greenhouse gas emissions serves as a motivation for government intervention. There are a variety of ways that governments can encourage renewable energy production, particularly from solar energy. States can pass foundational policies such as net metering, interconnection, and renewable portfolio standards to create a solar market. These foundational policies make up the "policy context" within a state. Financial incentives, such as rebates and income tax credits, aim to expand this solar market. Financial incentives attempt to decrease either the upfront cost or the overall cost because the high costs are a large deterrent for buyers. As prices decrease, governments may feel less motivation to intervene as legislators may believe lower prices will be enough incentive for individuals to install solar panels. Similarly, funding may decrease as law makers believe that the lower cost of solar make financial incentives unnecessary. Whether or not this is the case, it is important to know which financial incentives are effective at promoting solar installations. With limited budgets, it is important for the state governments to efficiently deploy their funds. Previous studies have attempted to determine the effectiveness of solar policy suites, but they mainly focused on low-cost, foundational policies (Krasko & Doris 2012; Steward & Doris 2014; Steward et al 2014). Financial incentives are often expensive and thus may be more important for states to know their benefit, given the high cost. States should be enacting the most dollar-for-dollar effective policies.

There are a few areas where previous literature over simplifies the situation leading to broad, inconclusive policy analysis and recommendations. This paper attempts to fill these holes in the literature and provide more detailed analysis of effects for more accurate policy recommendations. Incentives greatly vary in size, structure, and context. For this reason, a one size fits all model is not sufficient. Previous literature on financial incentives either did not take into account the size of the incentive or the policy context of the incentive (Sarzynski 2012; Stanford 2015). An incentive may have a large effect because the size is greater or a difference in the structure leads to a different behavioral response. Similarly, the most effective financial incentive in one state may not be the same as in another state depending on the policy context in that state. Beyond efficiency, if states are giving financial incentives to people who would have installed solar panels regardless, it can be seen as a wealth transfer. This wealth transfer could be a regressive wealth transfer if wealthier people would install solar panels anyways. A regressive wealth transfer could be contradictory to a government's redistributive goals.

This paper also explores the effect of policies on residential and commercial installations. Previous papers either lumped together all installations or only examined residential installations. Residential solar has been growing at a rate above 50% since 2012 (SEIA 2016). Commercial installations are a large part of the market and need to be explored separately. States have separate incentives for commercial and residential installations. By not examining both of these markets or not separating them, policy analysis is incomplete and authors may be misidentifying the effects. The last major sector for solar installations is utility scale. This paper does not explore utility scale incentives and installations for a few reasons. Utility installations are very different from residential and commercial in nature. They are extremely correlated with the federal income tax credit versus state level incentives. Residential and commercial are large parts of the entire solar market with growth potential to be explored.

For residential and commercial installations, the results suggest that cash incentives are the most effective at promoting solar installations in states with and without strong foundational policies. In most situations, tax incentives are ineffective and may be a regressive wealth transfer. Property tax exemptions, however, are somewhat effective for residential installations in states with strong foundational policies. These results detail the effects of financial incentives and provide analysis for more accurate policy recommendations than previous literature.

Overall, from both an environmental perspective as well as from a public policy perspective, detailed evaluation of the effectiveness of financial incentives adds an important component to the growing literature on solar policies. The paper is organized as follows: section 2 details previous literature on solar incentives and where this analysis adds insight. Section 3 describes my data sources and methodology for creating my own data set. Section 4 discusses my empirical model and varied specifications. Section 5 analyzes and discusses my results from the various empirical specifications. Section 6 describes the robustness checks. Lastly, section 7 contains my conclusions and policy recommendations.

## II. Literature Review

The literature on the effect of state policies on solar installations includes papers that focus on foundational policies and ones that focus on financial incentives. The overwhelming majority find that state policies influence solar markets and cause solar installations. Krasko & Doris (2012), Steward & Doris (2014), and Steward et al (2014) agree that foundational policies have a significant effect on solar installations. The studies emphasize the importance of foundational policies and their quality. Specifically, Krasko & Doris (2012) find that the quality of foundational policies is an important factor attributing 70% of variation in solar capacity to foundational policies and population. To account for the difference in quality of net metering and interconnection, the authors use "Freeing the Grid" scores. I also use these scores in my research.

While they find that quality of net metering and interconnection to be significant, they conclude that the size of the RPS does not matter. Krasko & Doris' findings emphasize the importance of the quality, not just the presence, of net metering and interconnection. Steward et al. (2014) add to this finding by asserting that the effect of foundational policies differs depending on the demographic context. If the effect of policies can differ depending on demographic context, it is plausible that the effect would also differ depending on policy context. Steward et al. demonstrate the importance of including demographic variables and electricity price. Their findings further assert the importance of the quality of net metering and interconnection.

Two main studies, Sarzynski et al. (2012) and Stanford (2015) discuss the impact of financial incentives on solar installations. Despite the amount of literature demonstrating the importance of the quality of foundational policies, neither paper takes the quality of foundational policies into account. Nor do they explore the policy context that the financial incentives are functioning within. Given the proven importance of foundational policies, particularly net metering, this appears to be a major hole in analysis of financial incentives. Both papers' regressions include net metering, but do not emphasize the quality or examine how it interacts with the financial incentives. While they provide a good framework, in many areas the analysis is too simplified and missing key details important when evaluating policies.

Sarzynski et al. (2012) provides a very high level, early analysis of financial incentives. The time frame of this study is from 1997 – 2009. As seen in figure 1, in 2009 the total solar capacity was 298MW. In 2014, total solar capacity was 6,247MW. From 2009 – 2014 there is a drastic increase in solar capacity that is not included in Sarzynski's study. Sarzynski's timeframe was exploring much smaller increases in capacity. The causes of the drastic increase may be different than the causes of the smaller increase that Sarzynski examined. Another shortcoming of her findings is her treatment of the financial incentive variables as dummy variables. She admits the approach may exclude important aspects of these incentives such as size and scope. By using a one size fits all method for the financial incentives, the detail and richness of the incentives is lost. Sarzynski also does not distinguish between different sectors and therefore lumps residential, commercial, and others together. The policy recommendations that result from this type of analysis are therefore oversimplified. Her results indicate that if a state offers cash incentives, it leads to 23% more capacity per year. This result is fairly broad and leads to different policy implications than my results. While I find cash incentives to be the most effective, there are some circumstances where they are not advisable.

Stanford recognizes and addresses some of Sarzynski's shortcomings, particularly by calculating the amount of each financial incentive using a similar method to my treatment. This allows him to find more detailed results. However, Stanford does not use a net present value and therefore underestimates some of the incentives. Stanford uses and defends data from the OpenPV Project, which I also utilize. He attempts to separate the solar installations to only look at residential installations. However, the size distinction that he chooses is 25kW. As I discuss in the data section of this paper, the median for commercial installations is 21kW. Therefore, Stanford is including perhaps more commercial installations than he believed. Lastly, Stanford does not look at the trends of the installations after an incentive. The effect in the years following an incentive may not be the same, it may increase or decrease with time. Dynamic effects are an important component to policy recommendations. Stanford's work greatly improves on

Sarzynski's study but still excludes important aspects of financial incentives that I explore in this study.

## III. Data

Solar installation data comes from the OpenPV project which is a collaborative effort to create a comprehensive dataset of solar panel installations. They receive data on installations from different sources such as utilities, installers, and individuals. Their dataset is extremely detailed and includes factors of the installation such as date, county, cost per watt, zip code, and more. Some of the observations included a designation for installer type. In these cases, residential and commercial were distinguished by these labels. However, these labels do not cover all residential and commercial installation observations, particularly in later years. For observations where the installer type was not available, the residential and commercial distinction was made through size. These installations were split at 10kW. Stanford splits his data at 25kW. The mean size of observations indicated to be commercial is 21kW. Given the distributions for observations that are known to be residential and commercial, a 25kW cut off would designate over 50% of commercial installations as residential. 10kW is approximately the $90^{th}$ percentile for residential installations and the $25^{th}$ percentile for commercial installations. Using this cut off assumes the distribution of the labeled observations is reflective of the true distribution of all residential installations. There are a few reasons this seems plausible. Many of the unknown observations are from later years, yet in the available years the size does not vary greatly. Also, the distribution of residential labeled observations is very similar to the distribution of unlabeled observations. It is important to recognize that there is a chance this could lead to a misinterpretation of the results or a bias. The results could be misidentified if the residential incentive has an indirect effect on commercial installations. It could lead to bias if the residential incentive does not have an effect but there is a commercial incentive that does have an effect and is implemented in the same year. Changing this cut off does not fundamentally change the results; therefore I do not believe misinterpretation or biases are present. Given the availability of county level data, each observation is the sum of capacity added in a given year in a given county. As seen in tables 1.1 and 1.2, at the county-year level, the average amount of residential capacity added is 95.39kW. For commercial, the average amount of capacity added is 167.4kW. The average size of a residential installation is 5.5kW while the average size of a commercial installation is 84kW.

The independent variables of interest are a matrix of policy variables: net metering, interconnection, renewable portfolio standards, solar carve-outs, rebates, grants, loans, sales tax exemptions, property tax exemptions, and income tax credits. The data for most of these variables comes from the Database of State Incentives for Renewables and Efficiency (DSIRE). Table 1 lists the number of states that offer each incentive.

Foundational policies are those which do not explicitly provide financial funding to those who install solar panels. Net Metering is the main foundational policy focused on in previous literature and by lobbyists. The law allows for individuals to sell excess power back to the grid when they do not use all of it. As of 2014, 41 states have laws that allow net metering (DSIRE), yet the quality of these laws varies. Some states only cover certain utilities; others have capacity limits on panels. Another major foundational law is interconnection laws. These are the guidelines for how to connect to the grid. These also have a large range of quality. Poor interconnection laws make it difficult, costly, and time consuming to install solar panels. For both net metering and interconnection, given previous research on the importance of quality, it is important to include the quality of the laws instead of just a dummy variable. Freeing the Grid publishes grades for the quality of net metering and interconnection in each state from 2007 to 2014. The grades range from A to E, which are encoded in the data as 0 to 5. These scores are determined by a points system where different parts of the law are given points depending on the quality. These parts include individual system capacity limits, total program capacity limits, rollover restrictions, metering issues, renewable energy credit ownership, eligible technologies, eligible customers, policy coverage, and third party ownership. Freeing the Grid breaks down each score given to the states by looking at these components. These scores were used in previous literature to measure the quality of foundational laws (Doris & Krasko 2012, Steward et al 2014). In some regressions the time frame is extended to 1997. Freeing the Grid scores start in 2007, therefore in those regressions, net metering is treated as a dummy variable using data from DSIRE and interconnection is not included.

Renewable Portfolio Standards (RPS) mandate a certain amount of electricity is produced by renewable energy sources. There are 34 states that have RPS in place of which 13 have solar carve-outs. The solar carve-out within that designates that a certain portion of electricity produced be from solar energy sources. Both RPS and carve-outs are treated as dummy variables. Of the RPS that were enacted during this timeframe, one third have carve-outs. The data on RPS and carve outs was obtained from the Database of State Incentives for Renewables and Efficiency (DSIRE). Previous literature found that the amount of the RPS does not influence solar installations, therefore the treatment as a dummy variable is justified (Krasko & Doris 2012).

There are six main financial incentives that I focus on: rebates, grants, loans, income tax credits, sales tax exemptions and property tax exemptions. Rebates and grants can be categorized as cash incentives. Income tax credits, sales tax exemptions and property tax exemptions can be categorized as tax incentives. The information used to calculate each incentive was found using DSIRE, supplemental state agency sites provided by DSIRE, and contact with state administrators.

I use two specifications to treat the financial incentive data. First, is a dummy variable regarding whether the state has a statewide incentive. Second, and preferred, is the estimate the incentive for an average system. For all incentives except for loans, the estimate is the net present value of installing a solar panel in that year. This takes into account credits that extend over different years and repeated incentives. This is irrelevant for some variables like sales tax exemptions or grants where it is a one-time incentive so the net present value is equal to the value in the first year. For rebates, income tax credits, and property tax exemptions, some states have incentives that continue over multiple years. Therefore the amounts are calculated as net present values with a discount rate of 7%. The discount rate was chosen because it is the average return of the market (Maverick 2015). The net present value calculation is different from Stanford who calculated the value only in the first year, which may be underestimating the size of the incentives.

To determine the size and cost of an average system, the data from OpenPV was used to find the average cost per watt in each year and the average size (kW) across the years. The cost per watt and size determined from the OpenPV data is consistent with previous literature. To calculate the total cost of an average incentive, the cost per kW was multiplied with the average size. The cost was varied each year but the average size was kept constant. Since the commercial installations had a heavy right skew, I calculated the cost for both the mean cost and median cost. I run my regressions on the values calculated with the median costs. Given that cost per watt has decreased over this time period, the incentives that are based off of total cost actually are decreasing after the initial increase at law creation. For residential installations, the average cost over the seven years is approximately $50,000 versus $500,000 for commercial installations. Summary statistics of the mean and standard deviation of the incentives and incentive variables can be found in table 2.1 and 2.2.

Rebates are an incentive that gives individual cash back very quickly after installation usually within 90 days (Sarzynski 2012). Rebates are often designed as a certain percentage of the total cost with a maximum cash amount. Therefore, my rebate variable was calculated as the minimum of that percentage and the maximum amount of rebate allowed. For residential owners, five states offer statewide rebate incentives counted in my dataset. Rebates are more commonly issued by utilities or non-profits than state wide, which are not included in my dataset. There are also two state incentives that had negligible amounts and were excluded from the dataset[1]. From the summary statistics in table 1.1, the mean size of the rebate variable is 342.2. However, given there are only five rebates, this is far lower than the actual average size of a rebate which is $6,065.2. Of the five rebates, three vary during my time frame. For commercial installers, four states offer rebate incentives. The average size of the rebate variable is 1,127.5, but the average size of the rebates is $21,224.4. The size of the rebates is greater for commercial in part because of a higher total cost, but also because of higher maximums.

Grants are similar to rebates but cash is given before installation. Grants are far more common for commercial installations. For residential installations, there are only two states that offer grant incentives. For commercial, there are eight. The average sizes of residential and commercial grants are $2,997 and $214,237 respectively. Grants usually have both a maximum numerical amount as well as a maximum percentage of costs. Grants were treated as the minimum between the maximum amount and the maximum percentage.

Loans vary widely in amount, tenure, qualifications, and a number of other characteristics. Many loans are low interest loans, but not all. Unfortunately, loans were too varied to determine a consistent way to calculate them and therefore are counted as a dummy variable. This is consistent with Stanford's treatment of loans.

Income tax credits are where installers get a credit of a certain amount depending on installation costs, capacity, or production. Twelve states offer income tax incentives for residential owners and fifteen offer the incentive for commercial owners. These are not necessarily the same states. The most common form of this is a credit of a certain percentage of cost with a maximum amount; therefore the credit is equal to a minimum of those. Often states allowed for a roll over for credits that exceeded the maximum account. In these cases, it was treated as the net present value. Certain income tax credits and rebates are based on the amount of electricity that the solar panel produces in kWh. In most cases, this is treated as a NPV of the incentive per kWh multiplied by the average kWh/year produced in that state.

---

[1] In Maryland, the amount was approximately $50 and, in Nebraska, the amount was approximately $5, both for $50,000 panels

Sales tax exemptions allow the installer to forgo paying sales tax on the purchase of the solar panel. Fourteen states offer sales tax exemptions for residential owners and sixteen states offer the exemption for commercial owners. To treat these, the sales tax over time was multiplied by the total cost in each year. Since this is a onetime exemption at purchase, the value is not discounted to find net present value. The sales tax percentages were obtained from The Tax Foundation.

Property tax exemptions mean that the value added by the solar panel is not taken into account when assessing home value. 26 states offer property tax exemption for residential owners and 23 states offer the exemption for commercial owners. While there are a few ways to assess valued added by a solar panel, in the calculation of this incentive, it was assumed that the assessment office used the cost method. Logically, the cost method uses the cost paid to determine the value added. Given that property taxes are paid every year but not necessarily reassessed every year, the property tax exemption applies in perpetuity, unless specified. The majority of property tax exemptions are treated as the perpetuity of the cost, multiplied by the property tax rate. In some cases the state specifies that the installer is only exempt for five or ten years and therefore the incentive is treated as an annuity. The effective property tax rates were also obtained from the tax foundation. Given time constraints, when the time frame is extended, all property tax exemptions are treated as perpetuities.

In figure 2, the overall trends for states with law changes in specific years were mapped. Each line represents the summed capacity for a group of states that added a financial incentive in that year. The 'never passed' group means the states did not pass a financial incentive law in this time period. While this graph is messy and not completely clear, there are general themes to take away from it. In the first few years, the trends appear to be the same then they veer off depending on the years. Since this is the aggregate of all laws and not just the effective ones the trends are not completely clear. However, there are certain peaks and patterns that hint that some laws may have an effect.

For more detailed calculations, in Appendix B, I outlined each incentive offered, why it was or was not included, and how it was calculated if it was included.

## IV. Empirical Strategy

Using a panel dataset at the county-year level, I employed a difference-in-difference model as my basic empirical specification. The time frame for my data is 2007 - 2014. The dependent variable is the solar installations in each county each year. My independent variables of interest are the in the policy vector. I employ a full set of state and year fixed effects.

$$\text{Ln(kw\_installed)} = \beta_0 + \boldsymbol{\beta}\mathbf{policy}_{S,T} + \boldsymbol{\delta}\mathbf{controls}_{S,T} + \gamma_S + \lambda_T + e_{S,T}$$

Policy is a matrix of incentive variables including foundational policies and financial incentives. In the policy matrix, net metering and interconnection are intensity dummies ranging from 0 – 5, RPS, solar carve-outs and loans are dummy variables, and the rest of the financial incentives are the natural log of calculated amounts. Controls is a matrix that includes total population, unemployment, median age, median income, percent high school graduates, percent BA degree, percent poverty, home ownership, electricity prices, and percent democrat. The control variables were obtained from a number of different sources. Population, age, income, poverty, homeownership, and education were all obtained from the US census. Electricity prices were obtained from the Energy Information Administration (EIA). Voting behavior came from the Federal Elections Commission (FEC). Unemployment rate was downloaded from the Bureau of Labor Statistics. To convert both kw_installed and various policy variables to the natural log, one is added to the variables. Given the scale of the installations and incentives, adding one should not change the results. In the equation above, $\gamma$ are the state FE and $\lambda$ are the year FE.

This basic regression is run two ways depending on the treatment of financial incentives. One regression uses the financial incentives treated as calculations based on total cost. The other uses the dummy variables if a financial incentive is present. The basic regressions give information on the general effects of financial incentives. These regressions do not indicate the trends following enactment but rather an average effect. Incentives may have different effects in the years following enactment. Some may have an immediate effect that dies out or the effect may grow stronger with the amount of time. Knowing the dynamic effects is extremely important for policy recommendations. Assuming linear effects could lead to drastically different recommendations if the effects are not linear. To determine the dynamic effects, significant incentives are interacted with year since dummy variables.

Financial incentives are not enacted in a policy vacuum. Their effect may differ depending on what policies have been passed before and their quality. Other papers discuss how financial incentives may have different effects in different demographic contexts (NREL, Stanford). However, given previous literature finds foundational policies to be effective, I believe the policy context is an important factor. Because of the extensive background literature on its importance, I chose net metering as the variable to indicate the policy context. While it does not come up as statistically significant in my regressions, previous literature finds it to be a very important policy. I define good net metering as greater than or equal to a C score in freeing the grid. I interact all financial incentives with the dummy of whether the state has good net metering and, in a different regression, with the number of foundational policies in the state. It may be the case that the foundational policies in the state may move people closer to the margin and a financial incentive can boost them over. If the state does not have that foundational policy, the financial incentive may not be enough boosts to bring them over the margin and therefore would be inefficient. On the other hand, if the effect of financial incentives does not differ depending on foundational policies, a different decision may be more effective. For these reasons, knowing the different effects depending on previous policies in place is important in policy evaluation.

To more directly compare with Sarzynski's results, I run regressions bringing my timeframe back to 1997 for residential. Since Freeing the Grid does not report before 2007, net metering is counted as a dummy variable. These regressions do not include control variables. When running the basic specification excluding the controls, the results do not fundamentally change. While these results are not complete, they do illustrate the patterns of the full time period.

## V. Results

### *i. Residential Results*

The results of the basic and dynamic residential specifications are listed in table 3.1. Consistent with previous literature, I find that cash incentives, rebates and grants, are the most effective at causing solar installations for residential installations. In the basic specification, the results suggest that a 1% increase in rebates leads to a 0.14% increase in kW of capacity and a 1% increase in grants leads to a 0.30% increase in kW of capacity. This finding demonstrates that rebates and grants on a whole are more effective than tax incentives for residential installers. Given that grants are smaller in size than income tax incentives and property tax incentives, it is clear that this effect is not based on size. However, since rebates are the largest, the size cannot be completely ruled out in their effect. Given the way the variables were treated, the size was taken into account more than in previous literature and it is possible to compare the effects on a dollar for dollar basis. A 1% increase in the actual rebates equates to roughly an increase of $61 given the average size of the rebate incentive is $6065. Thus a $61 dollar increase led to a 0.14% increase in capacity. A 1% increase in the actual grants equates to roughly an increase of $30 given the average size of the grant incentive is $2997. Thus a $30 dollar increase in grants led to an increase in capacity of 0.31%. Comparatively, an increase of $100 for rebates versus grants leads to an increase in capacity of 0.22% versus 1.0% increase. Given a mean size in a county year of 86.15kW, a $100 increase in rebates would lead to a 0.189kW increase in capacity in the counties that enacted a rebate. When comparing these results with regressions run with dummy variable treatment for financial incentives found in table 1.2, the significance is the same, but the coefficients change. In the dummy regression, the presence of a rebate leads to a 213% increase in solar capacity. This percent change is equal to 100*e^(1.14-1). Relatively, grants are more productive than rebates; however the very nature of grants is more of a purchase by the government rather than a government incentive.

Overall, cash incentives are more effective than tax incentives given their lack of significance. With 95% confidence, an effect larger than 0.03% can be ruled out for both income tax credits and property tax exemptions. An effect larger than 0.08% can be ruled out for sales tax credits with the same confidence. An increase of $100 for income tax incentive will lead to no more than 0.05kW increase in installations. The same increase in property tax and sales tax exemptions would lead to no more than 0.06kW and 0.47kW respectively. This type of calculation does not entirely make sense for property tax and sales tax exemptions because their size is more dependent on the tax rates. The size of sales tax exemptions may be an indication of why they are not effective given the dollar for dollar conversion is actually higher than cash incentives. Income tax incentives are the most directly comparable to rebates given their similarities in size and general structure. They are not exemptions from an extra cost as property tax and sales tax exemptions are, but rather a benefit to installing a solar panel. Therefore comparing a $100 increase in rebates and income tax credits reveals major differences. A test of whether ln(rebate) equals ln(incometax) reveals a p-value of 0.002, further demonstrating that the coefficients for these incentives are not equal.

There are a few reasons that cash incentives have a larger effect than tax incentives. Cash incentives tend to be simpler to understand than tax incentives, particularly income tax incentives. Another reason is the timing of incentives. Solar installations have a very high upfront cost making it difficult for people to install them. While in the long run the upfront costs may be paid off through savings on power bills and net metering, most people do not have large amounts of disposable income. Grants give the installer money before the installation and rebates give cash shortly after installation. With income tax incentives, the installer may have to wait to redeem their credit.

As evidenced by the figures 3.1 and 3.2, grants and rebates have different effects that are not necessarily linear. To account for this, rebates are interacted with dummy variables of the year since enacted. The results of this regression can be found in the third specification of table 3.1. Sarzynski briefly looks at the effects in the years following an incentive by including a year-since variable. While rebates are statistically insignificant in their first year, grants are significant. In the year of enactment, a 1% increase in grants leads to a 0.232% increase in capacity. The effectiveness of grants peaks in year two but greatly drops off in year four. At their most effective, in year two, a 1% increase in grants leads to a 0.46% increase in capacity. Rebates become increasingly more effective depending on the number of years. They are not effective in year zero, perhaps due to low knowledge of the policies. At the most effective point, year five, a 1% increase in rebates leads to a 0.37% increase in capacity. Looking at the difference in the effectiveness of cash incentives depending on the year enacted bolsters the idea that the installations after cash incentives do not follow a linear trend. Previous literature has treated the effects of incentives as linear; however this clearly shows that it is not the case. Non-linear effects have very different policy consequences.

Previous literature has found that net metering and other foundational policies heavily influence solar markets. It seems intuitive that in order for financial incentives to be effective there needs to be some foundation in place. To test this assumption, the financial incentives are interacted with a dummy variable for if the state has good net metering. The results for this regression are presented in table 3.2. In a different regression, the financial incentives are interacted with a variable that counts the number of foundational variables present, found in the second specification of table 3.2. These two results give insight into how financial incentives react to policy context. The interaction term for rebates and good net metering is positive but insignificant. The non-interaction term remains positive and significant at the 1% level. This indicates that regardless of net metering, rebates are still effective. The results with total foundational laws also indicate that rebates are still effective regardless of if there are policies in place. The rebate interaction term, however, is positive and significant for this regression. The magnitude is small, but this indicates that rebates are slightly more effective in states with more foundational policies. Unfortunately given the low number of grant incentives, the interaction term for grants and net metering is omitted due to collinearity. The grant interaction term is not omitted for collinearity in the second specification and it is positive and significant. The grant non-interaction term is negative and significant. This indicates that grants are only effective when states have foundational policies. In both policy regressions, the interaction term for loans is significant and negative. While this is a somewhat surprising result, it is not new. Stanford found loans to be negative in some of his regressions. This could be due to expectations for a financial incentive, but disappointment due to the incentive being a loan. The property tax interaction term is positive and slightly significant. While it is not a large coefficient, it is interesting to note especially given the results of the regressions with an extended time period.

The extended time frame reveals interesting results. Rebates and grants are still positive and significant at the 1% level despite lower magnitude coefficients. The variation in grants does not change with the extension because the grant incentives were enacted after 2007, but the variation in the rebate variable does increase because there one rebate was enacted after 1997 but before 2007. The difference in the magnitude of the rebate variables in the different time frames could indicate that rebates have gotten more effective in more recent years. The dynamic regressions do not provide insight into this given the same patterns for rebates and grants persist.

When sales tax is interacted with the net metering dummy term, it is positive and significant. The non-interaction term is not significant. This indicates that property tax exemptions and net metering are complements since the variable is only significant when there is net metering. The fact that in the normal time frame the property tax interaction term is significant and in the extended time frame in sales tax interaction term is significant indicates that policy context has some positive effect on tax exemptions. Extending the time frame and increasing the variation did not fundamentally change my results. It added insight to the effect of tax exemptions and a potential difference in effectiveness of rebates over time.

*ii. Commercial Results*

The regressions on commercial installations demonstrate the same general patterns as the residential regressions. Sarzynski does not separate out the installations or incentives into different sectors and Stanford only looks at residential. Commercial installations are a large part of the solar market and therefore important to examine for the same reasons as residential. Commercial and residential installers have different incentives offered in states and therefore cannot be treated as the same.

In table 4.1 the results for basic and dynamic regressions are shown. The basic regressions for commercial installations show some the same patterns as residential. A 1% increase in rebates leads to a 0.20% increase in installations. Given the size of the commercial rebate incentives are larger, this means a $212 increase leads to an increase of 0.33kW per county year. The years after enactment for rebates follow the same pattern as residential installations. The year of enactment for commercial rebates is slightly significant, whereas it was not for residential rebates. Unlike for residential installations, grants are not significant for commercial. Interestingly, commercial grants only become significant and positive when they are interacted with the policy context variables. This indicates that grants are mildly effective but only in states with positive policy context. Commercial rebates do not change depending on net metering. These results are consistent when incentives are interacted with the number of foundational laws. Another difference is that the RPS variable is significant and negative in some commercial regressions. This result could be driven by the time frame. Most of the renewable portfolio standards put into place during this period did not have carve-outs. Therefore, solar may be relatively more expensive than other renewable technologies specifically covered in the RPS. Overall, commercial incentive effects are similar to residential with a few significant differences.

## VI. Robustness Checks and shortcomings

For both residential and commercial results, there are multiple areas where robustness checks are necessary. To check the robustness of the insignificance of tax incentives, the dynamic effects regressions are expanded to include year since variables for tax incentives as well. It plausible that there are effects in the first years of these incentives but they are not seen in the average effect. For residential and commercial incentives, this is not the case overall. A few year interactions randomly pop up as significant, however, they are small in size and significance. Another way to check the robustness of the insignificance is by lumping all insignificant incentives into an ‘other incentive’ dummy variable that takes the value of one if any of these variables are present. The result for these regressions for both residential and commercial are that the originally significant cash incentives remain significant, but the other incentive variable is insignificant. Lastly, to determine the effect of the policy enactment versus the size of the incentive, I included both the dummy treatment of the financial incentives as well as the ln of the calculated treatment in the same regression. The results are not very indicative, however, given that total cost is decreasing and therefore the size of incentives is decreasing over time. This gives a negative value to the coefficient of the calculated value because it is picking up on the decreasing incentive.

In a few ways these results may be difficult to assert decisively. Given the lack of variation in the residential grant variable, the results may be driven by one state in particular, Pennsylvania. In the same incentive Pennsylvania created loan and grant options. This is the state's main incentive and therefore may have been heavily advertised. Another shortcoming of the data is in the solar installation data. In the later years, a large amount of the installations had to be split based on size. This means that some installations are mislabeled. However, given the distributions, the size cut off of 10kW is the most logical. Changing this cut off does not fundamentally change the results.

## VII. Conclusion

When examining solar policy, it is important to look at these findings both individually and holistically. From an environmental perspective, it is important to find effective policies to continue the drastic increase of solar installations. There are a limited amount of funds for state governments to spend, therefore from a public policy perspective, the effectiveness of the incentives is important so funds are not wasted. Basic regressions show the relative effectiveness of different financial incentives. More detailed regressions reveal the dynamic effects of incentives and the effects in different policy contexts.

Consistent with previous literature, cash incentives are the most effective overall at increasing incentives. It seems that if there is a limited amount of funding to be allocated to solar incentives, rebates or grants would be the best options. Similarly, given the difference in response patterns for rebates and grants there are different times to enact each policy. If a short term push over a threshold is necessary, a grant that is offered for only a couple years could be implemented here. Grants could be implemented and then retracted after a couple years given they lose effectiveness after a certain point. For more long term growth, rebates seem like a more consistent incentive. Given that rebates are not effective in their first year, this could also indicate to governments that people are unaware of these policies at first and preemptive advertisements could be useful in promoting installations in the year of enactment. Lastly, policy context is an important factor to examine when implementing a policy. Tax Exemptions are only effective in states with positive policy context. While loans are never effective, they have a negative effect in states with good net metering therefore it is not advisable to implement a loan incentive in these situations. If a state is debating what incentive or policy to put into place, this adds insight. In some states it may help to improve their net metering before implementing rebates. Yet if the state does not have the ability to put good net metering and a rebate in place, enacting a rebate will still be productive. The presence of ineffective tax incentives can be seen as a wealth transfer. People who would have already installed a solar panel simply are receiving a benefit from doing so. This could be problematic if the burden of this credit shifts to other taxes. These results can help inform policy makers of the consequences of their policies and advise them how to best utilize their limited funding.

Cash incentives can be extremely helpful in expanding solar markets in the US and bringing the market closer to solar parity. By utilizing the most efficient financial incentives, solar installations will continue to grow drastically leading to more reductions in greenhouse gas emissions. Further research is needed to examine commercial, agricultural, industrial and utility installations. Another way this research can be used is to create a demand curve by utilizing data on incentives that are actually used.

## VIII. Works Cited

*Solar energy and climate change: a solution to reducing greenhouse gas emissions* 2013. SEIA.

*Solar Market Insight 2015 Q4* 2016. SEIA.

Barbose, Galen, Samantha Weaver, and Naim Darghouth. 2014. *Tracking the sun VII: An historical summary of the installed price of photovoltaics in the united states from 1998 to 2013.* Lawrence Berkeley National Laboratory, .

Krasko, V., and E. Doris. 2013. State distributed PV policies: Can low cost (to government) policies have a market impact? *Energy Policy* 59 : 172.

Maverik, JB. What is the average annual return for the S&P 500? 2015]. Available from http://www.investopedia.com/ask/answers/042415/what-average-annual-return-sp-500.asp.

Sarzynski, Andrea, Jeremy Larrieub, and Gireesh Shrimalic. 2012. The impact of state financial incentives on market deployment of solar technology. *Energy Policy* 46 (July 2012): 550-557.

Stanford, Virgil Ian. 2014. Rooftop revolution? the comparative effectiveness of state policy incentives for solar photovoltaic adoption in the residential sector Doctorate of Philosophy Public Policy., George Mason University.

Steward, D., and E. Doris. 2014. *The effect of state policy suites on the development of solar markets* National Renewable Energy Laboratory, NREL/TP- 7A40-62506.

Steward, D., E. Doris, V. Krasko, and D. Hillman. 2014. *The effectiveness of state-level policies on solar market development in different state contexts* National Renewable Energy Laboratory, NREL/TP-7A40-61029.

# IX. Appendix A

Figure 1: Solar Capacity Additions

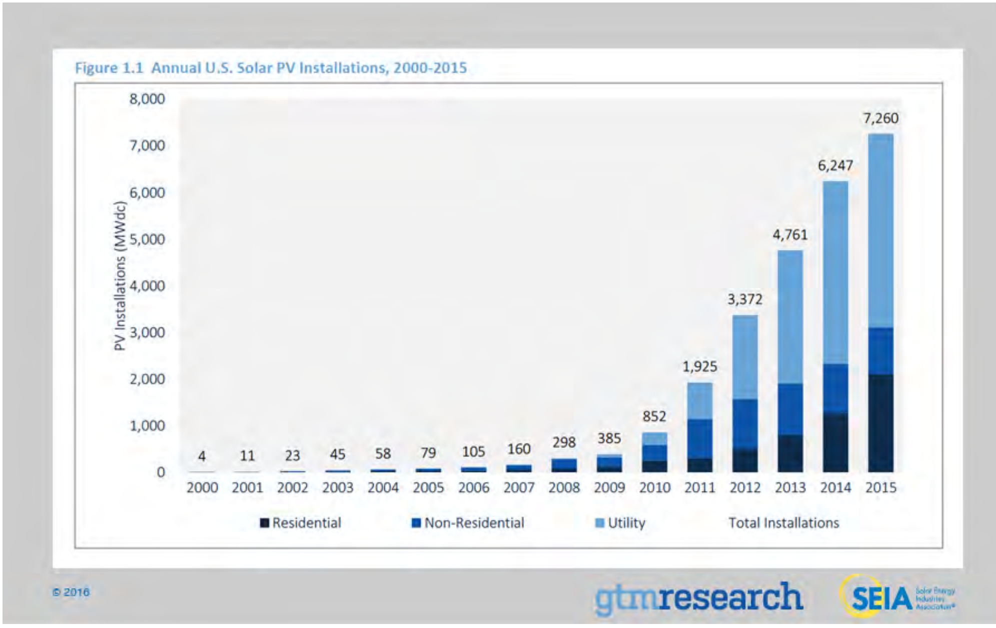


Table 1: Number of state incentives

| VARIABLES | (1)<br>number of states<br>residential | (2)<br>number of states<br>commercial |
|---|---|---|
| rebate | 5 | 4 |
| grant | 2 | 8 |
| loan | 13 | 15 |
| sales tax | 14 | 16 |
| prop tax | 26 | 23 |
| income tax | 12 | 15 |
| net metering | 41 | 41 |
| rps | 34 | 34 |
| carve | 13 | 13 |

Table 2.1: Residential Summary Statistics

| VARIABLES | (1) mean | (2) sd | (3) mean no zeros | (4) sd no zeros |
|---|---|---|---|---|
| rebate | 342.2 | 1,604 | 6,065 | 3,299 |
| grant | 49.71 | 397.5 | 2,997 | 833 |
| sales tax | 320.3 | 717.2 | 1,732 | 579 |
| prop tax | 1,952 | 3,111 | 4,706 | 3,220 |
| income tax | 1,170 | 3,223 | 5,935 | 4,939 |
| **VARIABLES** | **(1) mean** | **(2) sd** | **(3) mean per install** | **(4) sd per install** |
| kW installed | 95.39 | 1,105 | 5.51 | 8.26 |

Figure 2: Residential Trends

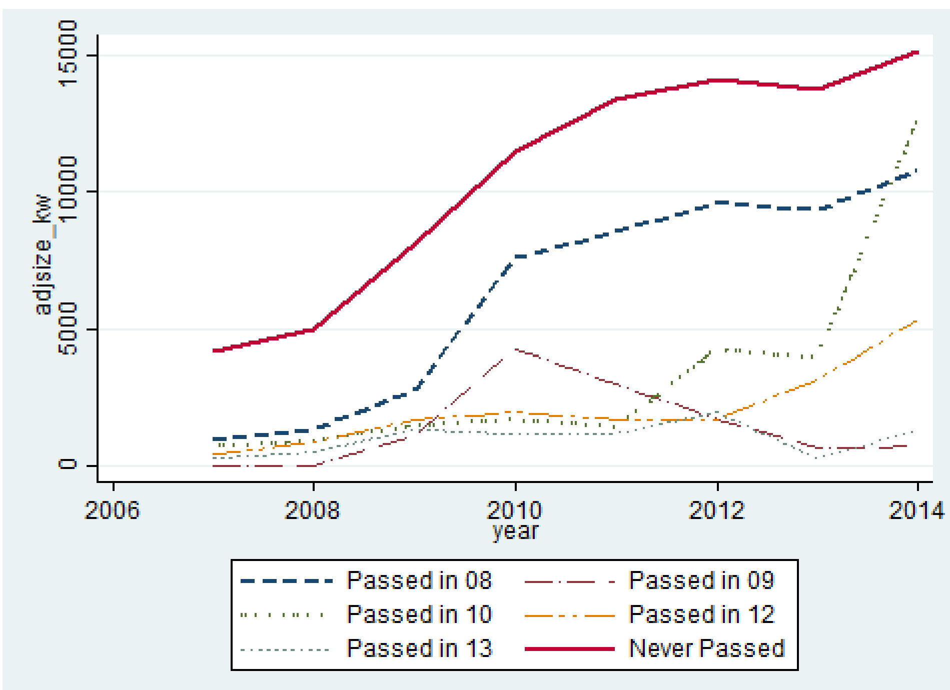

Table 2.2: Commercial Summary Statistics

| VARIABLES | (1) mean | (2) sd | (3) mean no zeros | (4) sd no zeros |
|---|---|---|---|---|
| rebate | 1,127 | 5,204 | 21,224 | 9,127 |
| grant | 3,251 | 14,987 | 47,973 | 34,201 |
| sales tax | 1,792 | 3,641 | 8,209 | 2,837 |
| prop tax | 7,897 | 13,848 | 20,705 | 15,414 |
| income tax | 5,373 | 13,051 | 17,965 | 18,529 |

| VARIABLES | (1) mean | (2) sd | (3) mean per install | (4) sd per install |
|---|---|---|---|---|
| kW installed | 167.42 | 1,654 | 84.86 | 365.5 |

Figure 3.1: Year Since Residential Rebate

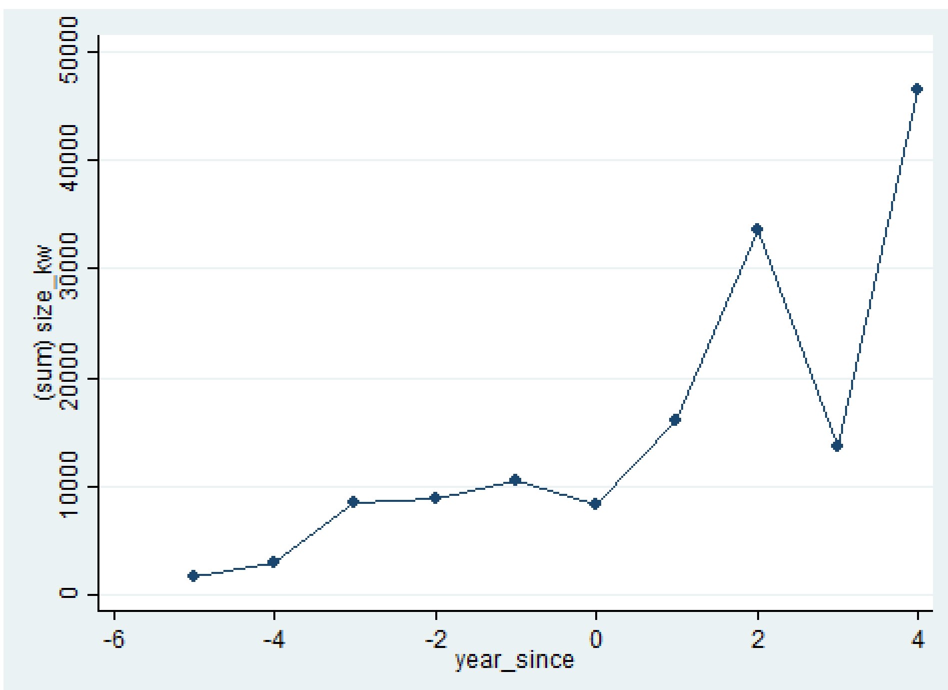

Figure 3.2: Year Since Residential Grant

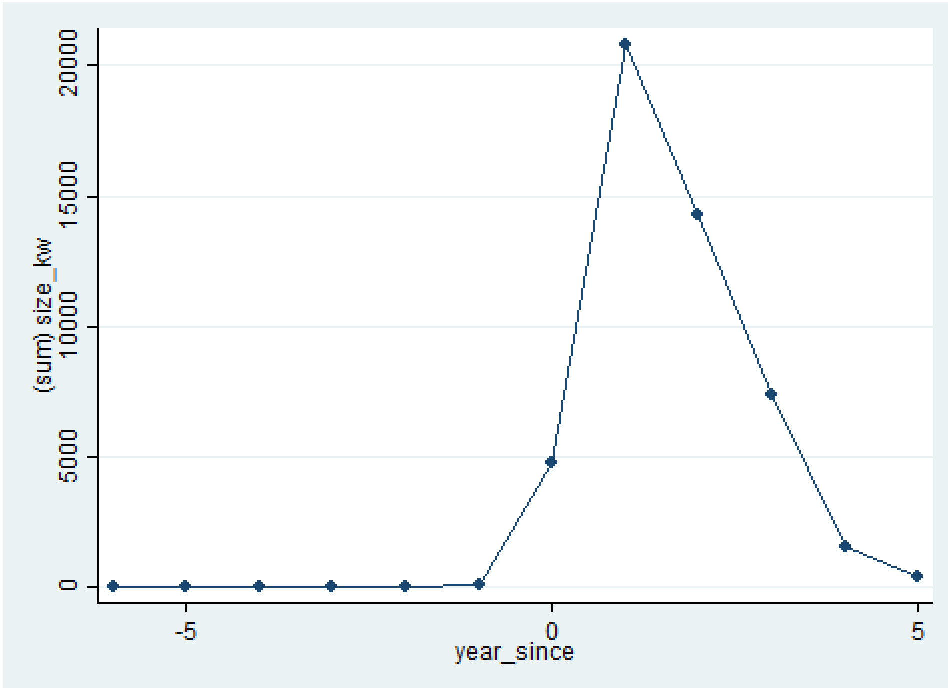


Table 3.1: Basic and Dynamic Residential Regressions

| VARIABLES | (1)<br>lnsize_kw | (2)<br>lnsize_kw | (3)<br>lnsize_kw |
|---|---|---|---|
| Ln(rebate) | 0.144***<br>(0.0411) | | |
| Rebate Dummy | | 1.140***<br>(0.330) | |
| Ln(rebate)*year0 | | | 0.0313<br>(0.0462) |
| Ln(rebate)*year1 | | | 0.0746<br>(0.0536) |
| Ln(rebate)*year2 | | | 0.191***<br>(0.0226) |
| Ln(rebate)*year3 | | | 0.187***<br>(0.0324) |
| Ln(rebate)*year4 | | | 0.251***<br>(0.0360) |
| Ln(rebate)*year5 | | | 0.364***<br>(0.0335) |
| Ln(grant) | 0.306***<br>(0.0275) | | |
| Grant Dummy | | 2.341***<br>(0.185) | |
| Ln(grant)*year0 | | | 0.232***<br>(0.0396) |
| Ln(grant)*year1 | | | 0.429***<br>(0.0254) |

| | | | |
|---|---|---|---|
| Ln(grant)*year2 | | | 0.421*** |
| | | | (0.0240) |
| Ln(grant)*year3 | | | 0.405*** |
| | | | (0.0253) |
| Ln(grant)*year4 | | | 0.172*** |
| | | | (0.0261) |
| Ln(grant)*year5 | | | 0.0497* |
| | | | (0.0278) |
| Loan | -0.185 | -0.156 | -0.153 |
| | (0.170) | (0.168) | (0.157) |
| Ln(sales tax exemption) | 0.00416 | | 0.0103 |
| | (0.0380) | | (0.0389) |
| Salestax Dummy | | 0.0811 | |
| | | (0.265) | |
| Ln(prop tax exemption) | 0.00122 | | 0.000995 |
| | (0.0133) | | (0.0132) |
| Proptax Dummy | | 0.0272 | |
| | | (0.109) | |
| Ln(income tax credit) | 0.0105 | | 0.0118 |
| | (0.0122) | | (0.0121) |
| Incometax Dummy | | 0.0747 | |
| | | (0.108) | |
| Net Metering | 0.0373 | 0.0364 | 0.0278 |
| | (0.0362) | (0.0365) | (0.0328) |
| Carve | -0.0859 | -0.0923 | -0.0959 |
| | (0.141) | (0.139) | (0.132) |
| RPS | -0.118 | -0.121 | -0.106 |
| | (0.0897) | (0.0892) | (0.0850) |
| Interconnection | 0.0308 | 0.0317 | 0.0339 |
| | (0.0386) | (0.0385) | (0.0391) |
| Observations | 24,848 | 24,848 | 24,848 |
| R-squared | 0.691 | 0.690 | 0.701 |

Demographic controls included; Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.2: Policy Context Residential Regressions

| VARIABLES | (1)<br>lnsize_kw | (2)<br>lnsize_kw |
|---|---|---|
| Net Metering dummy | 0.0336 | -0.0534 |
| | (0.0921) | (0.0939) |
| Carve | -0.0727 | -0.0919 |
| | (0.151) | (0.124) |
| Rps | -0.165* | -0.137 |
| | (0.0850) | (0.0995) |
| Interconnection dummy | 0.121 | |
| | (0.112) | |
| Ln(rebate) | 0.133*** | 0.0982** |
| | (0.0425) | (0.0388) |
| Net metering*ln(rebate) | 0.0134 | |
| | (0.0118) | |

| | | |
|---|---|---|
| Number foundational laws*ln(rebate) | | 0.0147* |
| | | (0.00764) |
| Ln(grant) | 0.302*** | -0.304** |
| | (0.0252) | (0.119) |
| Number foundational laws*ln(grant) | | 0.160*** |
| | | (0.0339) |
| Loan | 0.305 | 0.769 |
| | (0.211) | (0.475) |
| Netmeter*loan | -0.515*** | |
| | (0.161) | |
| Number foundational laws*loan | | -0.289** |
| | | (0.115) |
| Ln(sales tax) | -0.000314 | -0.0707 |
| | (0.0320) | (0.0487) |
| Netmeter*ln(sales tax) | 0.0362 | |
| | (0.0258) | |
| Number foundational laws*ln(sales tax) | | 0.0241 |
| | | (0.0174) |
| Ln(prop tax) | -0.0105 | -0.0307 |
| | (0.0112) | (0.0216) |
| Netmeter*ln(prop tax) | 0.0233 | |
| | (0.0160) | |
| Number foundational laws*ln(prop tax) | | 0.0134* |
| | | (0.00791) |
| Ln(income tax) | 0.0240 | 0.00710 |
| | (0.0199) | (0.0243) |
| Netmeter*ln(income tax) | -0.0121 | |
| | (0.0205) | |
| Number foundational laws*ln(income tax) | | 0.00100 |
| | | (0.00945) |
| Observations | 24,848 | 24,848 |
| R-squared | 0.692 | 0.692 |

Demographic Variables included; Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## Table 3.3: Basic and Dynamic Extended Time Period Regressions

| VARIABLES | (1)<br>lnsize_kw | (2)<br>lnsize_kw | (3)<br>lnsize_kw |
|---|---|---|---|
| Ln(rebate) | 0.0899*** | | |
| | (0.0215) | | |
| Rebate Dummy | | 0.671*** | |
| | | (0.174) | |
| Ln(rebate)*year0 | | | 0.00346 |
| | | | (0.0228) |
| Ln(rebate)*year1 | | | 0.0295 |

| | | | |
|---|---|---|---|
| | | | (0.0283) |
| Ln(rebate)*year2 | | | 0.0746*** |
| | | | (0.0201) |
| Ln(rebate)*year3 | | | 0.0749*** |
| | | | (0.0272) |
| Ln(rebate)*year4 | | | 0.130*** |
| | | | (0.0274) |
| Ln(rebate)*year5 | | | 0.110*** |
| | | | (0.0338) |
| Ln(grant) | 0.201*** | | |
| | (0.0347) | | |
| Grant Dummy | | 1.595*** | |
| | | (0.272) | |
| Ln(grant)*year0 | | | 0.181*** |
| | | | (0.0395) |
| Ln(grant)*year1 | | | 0.235*** |
| | | | (0.0369) |
| Ln(grant)*year2 | | | 0.196*** |
| | | | (0.0360) |
| Ln(grant)*year3 | | | 0.180*** |
| | | | (0.0393) |
| Ln(grant)*year4 | | | 0.0857** |
| | | | (0.0404) |
| Ln(grant)*year5 | | | -0.0145 |
| | | | (0.0463) |
| Loan | -0.234 | -0.221 | -0.172 |
| | (0.261) | (0.250) | (0.274) |
| Ln(sales tax) | 0.0513 | | 0.0548 |
| | (0.0437) | | (0.0443) |
| Salestax Dummy | | 0.454 | |
| | | (0.339) | |
| Ln(prop tax) | 0.0283 | | 0.0294 |
| | (0.0226) | | (0.0222) |
| Proptax Dummy | | 0.270 | |
| | | (0.192) | |
| Ln(income tax) | -0.00131 | | -0.00171 |
| | (0.0259) | | (0.0257) |
| Incometax Dummy | | -0.0396 | |
| | | (0.216) | |
| Net Metering | -0.159 | -0.149 | -0.164 |
| | (0.224) | (0.221) | (0.223) |
| Carve | 0.204 | 0.196 | 0.212 |
| | (0.288) | (0.285) | (0.288) |
| RPS | -0.0840 | -0.0920 | -0.0855 |
| | (0.165) | (0.163) | (0.165) |
| Constant | 0.808*** | 0.792*** | 0.823*** |
| | (0.115) | (0.115) | (0.118) |
| Observations | 89,767 | 89,767 | 89,767 |
| R-squared | 0.654 | 0.655 | 0.657 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Policy Context Extended Time Period Regressions

| VARIABLES | (1)<br>lnsize_kw | (2)<br>lnsize_kw |
|---|---|---|
| Net Metering dummy | -0.503** | -0.328* |
| | (0.244) | (0.189) |
| Carve | 0.217 | -0.221 |
| | (0.292) | (0.208) |
| Rps | -0.341* | -0.0708 |
| | (0.201) | (0.136) |
| netmeter_rps | 0.425 | |
| | (0.328) | |
| Ln(rebate) | 0.0826*** | 0.0551** |
| | (0.0260) | (0.0232) |
| Net metering*ln(rebate) | 0.00354 | |
| | (0.0173) | |
| Number foundational laws*ln(rebate) | | 0.00739 |
| | | (0.00693) |
| Ln(grant) | 0.208*** | -0.401*** |
| | (0.0387) | (0.128) |
| o.netmeter*ln(grant) | - | |
| Number foundational laws*ln(grant) | | 0.224*** |
| | | (0.0480) |
| Loan | -0.174 | 0.405 |
| | (0.292) | (0.438) |
| Netmeter*loan | -0.0764 | |
| | (0.178) | |
| Number foundational laws*loan | | -0.236 |
| | | (0.190) |
| Ln(sales tax) | -0.120* | -0.190** |
| | (0.0652) | (0.0831) |
| Netmeter*ln(sales tax) | 0.163*** | |
| | (0.0444) | |
| Number foundational laws*ln(sales tax) | | 0.114*** |
| | | (0.0355) |
| Ln(prop tax) | -0.000777 | -0.0280 |
| | (0.0224) | (0.0379) |
| Netmeter*ln(prop tax) | 0.0346 | |
| | (0.0251) | |
| Number foundational laws*ln(prop tax) | | 0.0318 |
| | | (0.0215) |
| Ln(income tax) | -0.00878 | -0.0193 |
| | (0.0338) | (0.0315) |
| Netmeter*ln(income tax) | 0.0175 | |
| | (0.0376) | |
| Number foundational laws*ln(income tax) | | 0.00828 |

| | | |
|---|---|---|
| | | (0.0241) |
| Observations | 89,767 | 89,767 |
| R-squared | 0.661 | 0.663 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 4: Year Since Commercial Rebates

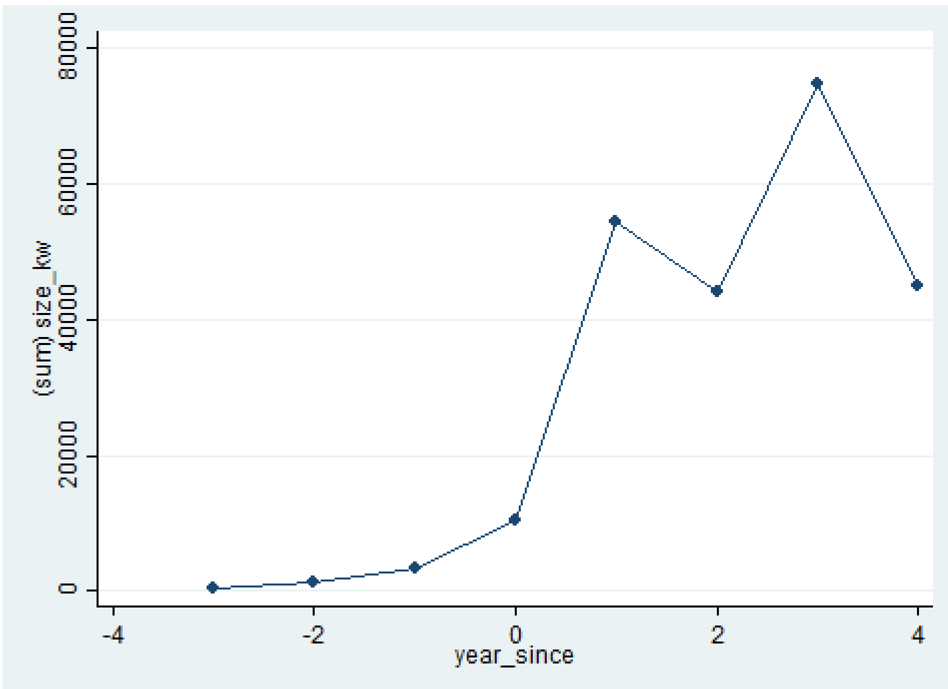


Table 4.1: Basic and Dynamic Commercial Regressions

| VARIABLES | (1)<br>lnsize_kw | (2)<br>lnsize_kw | (3)<br>lnsize_kw |
|---|---|---|---|
| Ln(rebate) | 0.202***<br>(0.0381) | | |
| Rebate Dummy | | 2.012***<br>(0.307) | |
| Ln(rebate)*year0 | | | 0.0503*<br>(0.0290) |
| Ln(rebate)*year1 | | | 0.111***<br>(0.0282) |
| Ln(rebate)*year2 | | | 0.226***<br>(0.0403) |
| Ln(rebate)*year3 | | | 0.307***<br>(0.0420) |
| Ln(rebate)*year4 | | | 0.342***<br>(0.0384) |
| Ln(rebate)*year5 | | | 0.480*** |

| | | | |
|---|---|---|---|
| | | | (0.0318) |
| Ln(grant) | 0.0303 | | |
| | (0.0258) | | |
| Grant Dummy | | 0.326 | |
| | | (0.283) | |
| Ln(grant)*year0 | | | 0.0123 |
| | | | (0.0194) |
| Ln(grant)*year1 | | | 0.0312 |
| | | | (0.0309) |
| Ln(grant)*year2 | | | 0.0489 |
| | | | (0.0427) |
| Ln(grant)*year3 | | | 0.0528* |
| | | | (0.0307) |
| Ln(grant)*year4 | | | -0.0357* |
| | | | (0.0182) |
| Ln(grant)*year5 | | | -0.0643 |
| | | | (0.0460) |
| Loan | 0.377 | 0.389 | 0.429 |
| | (0.293) | (0.284) | (0.319) |
| Ln(sales tax) | -0.00439 | | -0.0346 |
| | (0.0418) | | (0.0284) |
| Salestax Dummy | | -0.00944 | |
| | | (0.394) | |
| Ln(prop tax) | 0.00494 | | 0.00852 |
| | (0.0118) | | (0.0126) |
| Proptax Dummy | | 0.0336 | |
| | | (0.114) | |
| Ln(income tax) | 0.00621 | | 0.00694 |
| | (0.0133) | | (0.0121) |
| Incometax Dummy | | 0.0713 | |
| | | (0.141) | |
| Net Metering | 0.0637 | 0.0654 | 0.0398 |
| | (0.0432) | (0.0430) | (0.0388) |
| Carve | 0.0474 | 0.0466 | -0.00765 |
| | (0.167) | (0.166) | (0.189) |
| RPS | -0.300** | -0.289** | -0.312** |
| | (0.119) | (0.117) | (0.124) |
| Interconnection | -0.0115 | -0.0120 | -0.00554 |
| | (0.0349) | (0.0345) | (0.0363) |
| Observations | 24,848 | 24,848 | 24,848 |
| R-squared | 0.613 | 0.614 | 0.623 |

Demographic Variables included; Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.2: Policy Context Commercial Regressions

| | (1) | (2) |
|---|---|---|
| VARIABLES | lnsize_kw | lnsize_kw |
| Net Metering dummy | -0.107 | 0.119 |
| | (0.153) | (0.0900) |
| Carve | -0.202 | -0.0584 |

| | | |
|---|---|---|
| | (0.129) | (0.222) |
| Rps | -0.249** | -0.109 |
| | (0.120) | (0.103) |
| Interconnection dummy | -0.0245 | -0.0594 |
| | (0.0989) | (0.155) |
| Ln(rebate) | 0.181*** | 0.244*** |
| | (0.0463) | (0.0512) |
| Net metering*ln(rebate) | 0.00993 | |
| | (0.0169) | |
| Number foundational laws*ln(rebate) | | -0.0126 |
| | | (0.00915) |
| Ln(grant) | -0.0339 | -0.238** |
| | (0.0229) | (0.113) |
| Netmeter*ln(grant) | 0.0760** | |
| | (0.0350) | |
| Number foundational laws*ln(grant) | | 0.0791** |
| | | (0.0369) |
| Loan | 0.151 | -0.201 |
| | (0.209) | (0.234) |
| Netmeter*loan | 0.261 | |
| | (0.306) | |
| Number foundational laws*loan | | 0.171 |
| | | (0.127) |
| Ln(sales tax) | -0.0199 | -0.00575 |
| | (0.0401) | (0.0276) |
| Netmeter*ln(sales tax) | 0.0583 | |
| | (0.0425) | |
| Number foundational laws*ln(sales tax) | | 0.00398 |
| | | (0.0167) |
| Ln(prop tax) | 0.00106 | 0.0172 |
| | (0.0117) | (0.0226) |
| Netmeter*ln(prop tax) | 0.00771 | |
| | (0.0148) | |
| Number foundational laws*ln(prop tax) | | -0.00394 |
| | | (0.00816) |
| Ln(income tax) | 0.0184 | 0.0155 |
| | (0.0350) | (0.0227) |
| Netmeter*ln(income tax) | -0.0177 | |
| | (0.0289) | |
| Number foundational laws*ln(income tax) | | -0.00513 |
| | | (0.00722) |
| Observations | 24,848 | 24,848 |
| R-squared | 0.615 | 0.615 |

Demographic Variables included; Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Appendix B

**Financial Incentive Data Guide**

General Treatments:

- Price per watt is calculated from OpenPV data using the Median price for each subset. The price per watt is multiplied by median size also found in OpenPV data. Both the size and price per watt are consistent with previous literature

- kWh/year produced were calculated by multiplying the solar incidence (kWh/m2/day) by 5 (5kW system) then by multiplying 70% to account for loss due to the inverter (DC -> AC) and then multiplying by 365 to get yearly value
  - Solar incidence number was a yearly average
  - Decrease kWh based on number of years installed and a degradation rate of .64% (NREL Jordan 2012)
  - NREL, http://understandsolar.com/calculating-kilowatt-hours-solar-panels-produce/

- Assumed that the system is customer-owned and a household rather than individual

- Industry recruitment incentives, PACE Financing, Performance based incentives, Bond Programs were not included (previous literature and relevance)

**Alabama (AL)**

- Loan Program:
  - Name: AlabamaSAVES Revolving Loan Program
  - Start Year: 2011
  - Applies to: Commercial
  - Amount:
  - Counted as: Counted as a 1 for the loan_c variable
  - Other Notes: Start date from the email
- Loan Program:
  - Name: Local Government Energy Loan Program
  - Start Year:
  - Applies to: Government and schools
  - Amount:
  - Counted as:
  - Other Notes: Not Included

**Arkansas (AR)**

- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Implemented by AEP SWEPCO

**Arizona (AZ)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial
  - Amount: 10% of installed cost with a maximum of 25,000
  - Counted as: In variable incometax_c, took the minimum of 25,000 and 10% of the calculated total cost of the year

  - Other Notes: The corporate renewable energy production tax credit was not included because the minimum size was 5MW; The renewable energy tax credit for manufacturers was not applicable and therefore not included
- Personal Tax Credit:
  - Name:
  - Start Year: 1995
  - Applies to: Residential
  - Amount: 25% with maximum of 1,000
  - Counted as: In variable incometax_r, took the minimum of 1,000 and 25% of the calculated total cost of the year
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial/Residential
  - Amount: 100% of added value
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a perpetuity of the effective tax rate multiplied by the total cost
  - Other Notes:
- Rebate programs:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Implemented by electric cooperatives
- Sales Tax Incentive:
  - Name:
  - Start Year: 1997
  - Applies to: Commercial/Residential
  - Amount: 100% exemption of sales tax
  - Counted as: Salestax_c and salestax_r are both treated by multiplying the sales tax over time to the total cost
  - Other Notes:

**California (CA)**

- Loan Program:
  - Name:
  - Start Year:
  - Applies to: Government, Schools, Institutional
  - Amount:
  - Counted as: Not included
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 1999
  - Applies to: Commercial/Residential
  - Amount: Exemption for 100% of system value
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a perpetuity of the effective tax rate multiplied by the total cost
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year: 2007
  - Applies to: Commercial/Residential
  - Amount: Incentive Levels vary based on 'stage', incentive levels were found here: http://www.csi-trigger.com/.
  - Counted as: Not included
  - Other Notes: Varies based on what utility customer is under, does not cover the entire state.
- Sales Tax Incentive:
  - Name:
  - Start Year:

  - Applies to: Agriculture
  - Amount:
  - Counted as: Not included
  - Other Notes:

**Colorado (CO)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes:
- Grants:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Enacted by city
- Loan Program:
  - Name: Energy Savings Mortgage
  - Start Year: 2013
  - Applies to: Residential owners
  - Amount: Incentive for Existing Homes bases incentive off of improvements to home energy score
  - Counted as: loan_r counted as 1 after 2013
  - Other Notes:
- Property tax incentive:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: Included based on email
  - Other Notes:
- Rebate:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not counted
  - Other Notes: Enacted by utilities
- Sales tax incentive:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as: Salestax_c and salestax_r are both treated by multiplying the sales tax over time to the total cost
  - Other Notes:

**Connecticut (CT)**

- Loan Program:
  - Name: Energy Conservation Loan/Low Interest Loans
  - Start Year: 1979 (Residential) 2006 (Commercial)
  - Applies to: Residential
  - Amount: Maximum 25,000
  - Counted as: loan_r and loan_c counted as 1
  - Other Notes: Dates from email
- Property Tax Exemption:
  - Name:
  - Start Year: 2007 (Residential) 2014 (Commercial)
  - Applies to: Commercial/Residential

  - Amount: 100% exemption
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a perpetuity of the effective tax rate multiplied by the total cost
  - Other Notes:
- Rebate program:
  - Name:
  - Start Year: 2012
  - Applies to: Residential
  - Amount: $0.540/Watt
  - Counted as: in rebate_r, .540 is multiplied bywatts
  - Other Notes: Systems under 20kW
- Sales tax exemption:
  - Name:
  - Start Year: 2007
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as: Salestax_c and salestax_r are both treated by multiplying the sales tax over time to the total cost.
  - Other Notes:
- SREC:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Enacted by utilities, may include

**DC (DC)**

- Property Tax Exemption:
  - Name:
  - Start Year: 2012
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a perpetuity of the effective tax rate multiplied by the total cost
  - Other Notes:
- Rebate:
  - Name: Solar Advantage Plus Program
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2005
  - Applies to:
  - Amount:
  - Counted as: in SREC variable, counted as 1
  - Other Notes:

**Delaware (DE)**

- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Administered by a utility
- Rebate:
  - Name:
  - Start Year:

  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Administered by utilities
- SREC:
  - Name:
  - Start Year: 2012
  - Applies to:
  - Amount:
  - Counted as:  in SREC variable, counted as 1
  - Other Notes:

**Florida (FL)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2006, expired in 2010, reinstated in 2012, expires in 2016
  - Applies to: Commercial
  - Amount: $0.01/kWh
  - Counted as: Incometax_c, NPV of .01*(kWh per year) of an annuity for the expected years of credit.
    - In 2007, NPV of 4 years. In 2008, NPV of 3 years. In 2009, NPV of 2 year. In 2010, NPV of 1 year. In 2012, NPV of 5 years. In 2013, NPV of 4 years. ETC
  - Other Notes:
- Loan Programs:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Administered by utilities/municipalities
- Property Tax Incentive:
  - Name:
  - Start Year: 2013
  - Applies to: Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Enacted by a municipality
- Sales Tax Incentive:
  - Name:
  - Start Year: 1997
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:  Salestax_c and salestax_r are both treated by multiplying the sales tax over time to the total cost.
  - Other Notes:

**Georgia (GA)**

- Loan Program:
  - Name: Georgia Green Loans Save & Sustain Program
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Implemented by non-profit
- Rebate Program:
  - Name:

  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Implemented by utilities

**Iowa (IA)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2012
  - Applies to: Commercial
  - Amount: 18% of total cost maximum of $20,000
  - Counted as:  IncomeTax_C is treated by taking the minimum of 18% of the total cost and 20,000
  - Other Notes: In 2005, there was a corporate tax credit for .015/kWh but my interpretation is the minimum size is 2MW therefore it is not included
- Loan Program:
  - Name: Alternative Energy Revolving Loan Program
  - Start Year: 1996
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as:  loan_c and loan_r counted as 1
  - Other Notes:
- Personal Tax Credit:
  - Name:
  - Start Year: 2012
  - Applies to: Residential
  - Amount: 18% with maximum of $5,000
  - Counted as:  IncomeTax_R is treated by taking the minimum of 18% of the total cost and 5,000.
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 1978
  - Applies to: Commercial/Residential
  - Amount: 100% exemption for 5 years
  - Counted as:  propertyTax_c and propertyTax_r are treated as NPV of an annuity for 5 years of the effective tax rate multiplied by the total cost
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:  SalesTax_C and SalesTax_R are both treated by multiplying the sales tax over time to the total cost.
  - Other Notes:

**Idaho (ID)**

- Loan Program:
  - Name:
  - Start Year: 1987
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as:  in loan_c and loan_r currently not counted
  - Other Notes: Do not know start year, call
- Personal Tax Deduction:
  - Name:
  - Start Year: 2002
  - Applies to: Residential
  - Amount: 40% of cost first year (5,000 max), 20% total cost next three years (20,000 max overall)
  - Counted as:  incometax_r treated as NPV of the above amount over the four years
  - Other Notes:

- Property Tax Incentive:
  - Name:
  - Start Year: 2016
  - Applies to: Residential
  - Amount:
  - Counted as:  Not included
  - Other Notes:

**Illinois (IL)**

- Grant Program:
  - Name:
  - Start Year: 2011
  - Applies to: Commercial
  - Amount: 25% of eligible project costs or 1.25/watt with maximum of 250,000
  - Counted as:  grant_c is counted as the minimum of 250,000 and the maximum of 25% of cost, 1.25*watts
  - Other Notes: Other grant programs exist but are not applicable
- Loan Program:
  - Name: Green Energy Loan
  - Start Year: 2008
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: Rate reduction
- Property Tax Incentive:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included
  - Other Notes: "Special assessment", not quantifiable
- Rebate Program:
  - Name:
  - Start Year: 1997
  - Applies to: Commercial/Residential
  - Amount: $1.5/watt or 25% of cost with a maximum of $10,000 (Residential) and $1.25/watt or 25% of cost with maximum of $20,000 for commercial
  - Counted as: rebate_c and rebate_r are treated as the maximum of the per watt and percentage amounts, then the minimum with the stated maximum amounts
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2007
  - Applies to:
  - Amount:
  - Counted as:  Counted as 1 in SREC variable
  - Other Notes: Not positive on the year, but confident

**Indiana (IN)**

- Grant Program:
  - Name: Community Conservation Program
  - Start Year: 2011
  - Applies to: Commercial
  - Amount: $25,000 - $100,000
  - Counted as:  Minimum of 100,000 and total cost
  - Other Notes: Date from email
- Property Tax Incentive:
  - Name:
  - Start Year: 2012
  - Applies to: Commercial/Residential

  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: only applicable for equipment used to manufacture renewable energy and for industrial owners

**Kansas (KS)**

- Property Tax Incentive:
  - Name:
  - Start Year: 1999
  - Applies to: Commercial/Residential
  - Amount: 100% exemption for 10 taxable years following
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of an annuity for 10 years of the effective tax rate multiplied by the total cost
  - Other Notes:

**Kentucky (KY)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2009
  - Applies to: Commercial/Residential
  - Amount: $3/W with maximum of 500 (residential) and 1000 (commercial)
  - Counted as: Currently counted as minimum of $3/W
  - Other Notes:
- Loan Programs:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Issued by utilities or only for government
- Sales Tax Incentives:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial
  - Amount: 100% exemption
  - Counted as:
  - Other Notes: SalesTax_C is treated by multiplying the sales tax over time to the total cost.

**Louisiana (LA)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: 50% of the first $25,000 of cost with a maximum of 10,000
  - Counted as: if cost < $25,000, 50% of totally cost. If cost > 25,000, taken as the minimum of 50% of 25,000 and 10,000 (10,000)
  - Other Notes:
- Loan Program:
  - Name: HELP
  - Start Year:
  - Applies to: Residential
  - Amount:
  - Counted as: loan_r counted as 1
  - Other Notes: Unsure year treated as before 2007. Call
- Property Tax Incentive:

  - Name:
  - Start Year: 1994
  - Applies to: Residential
  - Amount: 100% exemption
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a perpetuity of the effective tax rate multiplied by the total cost
  - Other Notes:

**Massachusetts (MA)**

- Grant Program:
  - Name:
  - Start Year: 2010
  - Applies to: Local Governments
  - Amount:
  - Counted as: Not included
  - Other Notes:
- Loan Program:
  - Name: Mass Solar Loan Program
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Other loan programs administered by utilities
- Personal tax credit:
  - Name:
  - Start Year: 1979
  - Applies to: Residential
  - Amount: 15% of cost with maximum $1,000
  - Counted as: IncomeTax_R will be treated by taking the minimum of 1000 and 15% of total cost
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 1975
  - Applies to: Commercial/Residential
  - Amount: 100% exemption for value added for 20 years
  - Counted as: propertyTax_c and propertyTax_r are treated as NPV of a 20 year annuity of the effective tax rate multiplied by the total cost
- Rebate:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Offered by different utilities not state wide
- Sales tax incentive:
  - Name:
  - Start Year: 1977
  - Applies to: Residential Owners
  - Amount: 100% exemption
  - Counted as: SalesTax_R is treated by multiplying the sales tax over time to the total cost
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2010
  - Applies to:
  - Amount:
  - Counted as: SREC variable counted as 1
  - Other Notes:

**Maryland (MD)**

- Corporate Tax Credit:

  - Name:
  - Start Year: 2006
  - Applies to: Commercial/Residential
  - Amount: 0.0085/kWh, created a minimum of 1,000$ in 2010
  - Counted as: IncomeTax_C will be treated as 0.0085 multiplied by the average amount of kWh produced by the size of the system. IncomeTax_R will be treated as zero since the amount is negligible.
  - Other Notes: NPV is treated as value 'when installed' so in 2007 it was supposed to expire in 2010, so 2007 was treated as an NPV until 2010 (3 years), but in 2010 when it was extended to 2016, it was treated as an NPV of 6 years
- Grant Program:
  - Name: Game Changer competitive grant program
  - Start Year: 2014
  - Applies to: Commercial
  - Amount: 50,000 – 250,000 or 30% of project costs
  - Counted as:
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not counted, not applicable for commercial/residential
  - Other Notes:
- Property Tax Exemption:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year: 2005
  - Applies to: Residential
  - Amount:$1,000 per installation per household
  - Counted as: $1,000 for rebate_r
  - Other Notes: up to 20kW
- Rebate Program:
  - Name:
  - Start Year: 2009
  - Applies to: Commercial
  - Amount: $30/kWh with a maximum of $6,000 if 100-200 kW. $60/kw if 1-99 kW.
  - Counted as: If 100-200kW, Minimum of $6,000 and 30*kW, if 1-99 kW, minimum of 6,000 and 60*kw
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: 100% sales tax exemption
  - Counted as: SalesTax_R and SalesTax_C are treated by multiplying the sales tax over time to the total cost.
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2008
  - Applies to:
  - Amount:
  - Counted as: Counted as 1 for SREC
  - Other Notes:

**Maine (ME)**

- No financial incentives counted

**Michigan (MI)**

- Grant Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included, only utilities
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not counted, implemented by utilities and non-profits
  - Other Notes:
- Rebate:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not counted, implemented by a utility
  - Other Notes:

**Minnesota (MN)**

- Grant Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included, all by utilities
  - Other Notes:
- Loan Program:
  - Name: Fix-Up Loan
  - Start Year: 1975
  - Applies to: Residential
  - Amount:
  - Counted as:  Counted as a 1 for the loan_r variable
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year:
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Rebate Programs:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:  Not included, implemented by utilities
  - Other Notes:
- Sales Tax Exemption
  - Name:
  - Start Year: 2005
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**Missouri (MO)**

- Loan Program:
    - Name:
    - Start Year: 1989
    - Applies to: Schools/Governments
    - Amount:
    - Counted as: Not included
    - Other Notes:
- Property Tax Exemption:
    - Name:
    - Start Year: 2013
    - Applies to: Commercial/Residential
    - Amount: 100% exemption
    - Counted as:
    - Other Notes:
- Rebate Programs:
    - Name:
    - Start Year:
    - Applies to:
    - Amount:
    - Counted as: Not included, implemented by utility companies
    - Other Notes:

**Mississippi (MS)**

- No Financial Incentives

**Montana (MT)**

- Corporate Tax Credit:
    - Name:
    - Start Year: 2002
    - Applies to: Commercial
    - Amount: 35% of project cost
    - Counted as:
    - Other Notes: Maximum is 50kW, not included in large commercial
- Loan Program:
    - Name:
    - Start Year: 2001
    - Applies to:
    - Amount:
    - Counted as: Counted as a 1 in loan variable
    - Other Notes:
- Personal Tax Credit:
    - Name:
    - Start Year: 2002
    - Applies to: up to $1,000 per incentive
    - Amount:
    - Counted as:
    - Other Notes:
- Property Tax Incentive:
    - Name:
    - Start Year: 2005 (2001)
    - Applies to: Commercial/Residential
    - Amount: Exemption from property taxes for 10 years based on residential investment of 20,000 and commercial investment of 100,000. (OR commercial exemption of 100% for 5 years)
    - Counted as: Second incentive currently entered into PropertyTax_C
    - Other Notes: Check
- Rebate Program:
    - Name:
    - Start Year:
    - Applies to:
    - Amount:
    - Counted as: Not included

- Other Notes: From a utility

**North Carolina (NC)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 1977
  - Applies to: Commercial/Residential
  - Amount: 35% of total cost with a maximum of 10,500 for Residential, maximum of 2.5million
  - Counted as:
  - Other Notes:
- Loan Programs:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not created by a state
- Property Tax Incentive:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: Exempt from 80% of appraised value. In 2011, residential systems were exempt from 100%
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: From a utility

**North Dakota (ND)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2001
  - Applies to: Commercial
  - Amount: 3% of cost per year for 5 years
  - Counted as: NPV of that amount of 5 years
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 2007
  - Applies to: Commercial/Residential
  - Amount: 100% exemption for 5 years
  - Counted as:
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2011
  - Applies to: Commercial
  - Amount: 100% exemption from sales tax
  - Counted as:
  - Other Notes: above 100kW, not counted in small commercial

**Nebraska (NE)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial

  - Amount: 0.001/kWh for electricity generated between October 2007-2010, .00075/kWh for electricity generated between 2010 and 2013, and .005/kWh for electricity generated after 2013
  - Counted as:
  - Other Notes: Amount are negligible counted as zero but the values are in the notes
- Loan Program:
  - Name: Dollar and Energy Savings Loans
  - Start Year: 1990
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: Counted as 1 in both loan variables
  - Other Notes:
- Personal Tax Credit:
  - Name:
  - Start Year: 2006
  - Applies to: Residential
  - Amount: .001/kWh for electricity generated between October 2007-2010, .00075/kWh for electricity generated between 2010 and 2013, and .005/kWh for electricity generated after 2013.
  - Counted as: Negligible, counted as 0
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as:
  - Other Notes: Extended their wind property tax, not included
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: By a utility
- Sales Tax Incentive:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as: Not included
  - Other Notes: ‘Community’ project/C-BED project

**New Hampshire (NH)**

- Grant Program:
  - Name:
  - Start Year: 2011
  - Applies to: Commercial
  - Amount: Minimum award of 150,000
  - Counted as: Minimum of cost and maximum grant
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial
  - Amount:
  - Counted as: Counted as 1 in loan_c variable
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:

- Counted as: Not included
- Other Notes: Local option
- Rebate Program:
  - Name:
  - Start Year: 2009
  - Applies to: Residential owners
  - Amount: $.75/watt with a maximum of 3750 or 50% of costs
  - Counted as:
  - Other Notes: Less than 100kW
- Rebate Program:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial
  - Amount: For <100kW: .75/W AC. For 100-500kW: .65/W AC. Maximum of 25% total cost
  - Counted as:
  - Other Notes:

**New Jersey (NJ)**

- Property Tax Incentives:
  - Name:
  - Start Year: 2008
  - Applies to: Commercial/Residential
  - Amount: 100% exemption from value added
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes:
- Sales Tax Exemption:
  - Name:
  - Start Year: 2007
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2004
  - Applies to:
  - Amount:
  - Counted as: Counted as 1 in SREC variable
  - Other Notes:

**New Mexico (NM)**

- Corporate Tax Credit:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: 1MW minimum
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included

  - Other Notes: Only for local government
- Personal Tax Credit:
  - Name:
  - Start Year: 2009
  - Applies to: Residential
  - Amount: 10% of costs, maximum of $9,000
  - Counted as:
  - Other Notes: 100W minimum (unsure)
- Property Tax Credit:
  - Name:
  - Start Year: 2010
  - Applies to: Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2007
  - Applies to: Residential/Commercial
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**Nevada (NV)**

- Loan Program:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial
  - Amount:
  - Counted as: 1 in loan variable
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 1983
  - Applies to: Commercial
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Utility
- Sales Tax Incentive:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as:
  - Other Notes: Minimum 10MW, not included

**New York (NY)**

- Grant Program:
  - Name:
  - Start Year: 2015
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes:

- Loan Program:
  - Name:
  - Start Year: Unsure
  - Applies to: Residential
  - Amount: Maximum 3,000
  - Counted as: Counted as 1 in loan program
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year: 2009
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: Counted as a 1
  - Other Notes:
- Personal Tax Credit:
  - Name:
  - Start Year: 1998
  - Applies to: Residential
  - Amount: 25% of cost for a 5,000$ system
  - Counted as:
  - Other Notes: 25kW max
- Property Tax Incentive:
  - Name:
  - Start Year: 1977
  - Applies to: Residential
  - Amount: 100% exemption
  - Counted as: Not included, local option
  - Other Notes: Check
- Rebate Programs:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial/Residential
  - Amount: Differs based on region
  - Counted as: Weighted average of amount in regions based on population
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2013/2005
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**Ohio (OH)**

- Loan Program:
  - Name:
  - Start Year: 2011/2009
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: 1 in the loan variable
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial
  - Amount: 100% exemption
  - Counted as:
  - Other Notes: Less than 250kW
- SREC:
  - Name:
  - Start Year: 2009

  - Applies to:
  - Amount:
  - Counted as: Treated as 1 in SREC variable
  - Other Notes:

**Oklahoma (OK)**

- Corporate Tax Credit:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: 1MW minimum
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Schools/Local governments

**Oregon (OR)**

- Grant Program:
  - Name:
  - Start Year: Unsure
  - Applies to: Commercial
  - Amount: $50,000
  - Counted as: Not included right now
  - Other Notes: 25kW to 10MW
- Grant Program:
  - Name:
  - Start Year: 2012
  - Applies to: Commercial
  - Amount: Maximum of 250,000 or 25% of project cost
  - Counted as: Minimum of maximum of 25% of project costs
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year: 1981
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: Treated as 1 in both loan variables
  - Other Notes:
- Personal Tax Credit:
  - Name:
  - Start Year: 2006
  - Applies to: Residential
  - Amount: Lesser of 6,000 over four years (1,500 each year) or 50% of total costs
  - Counted as:
  - Other Notes: Treated as an if statement, "If 6000 < .5* total cost, NPV of 1500 for 4 years, else .5*total cost
- Property Tax Incentive:
  - Name:
  - Start Year: 1976
  - Applies to: Commerical/Residential
  - Amount: 100% of property tax
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year: 2003
  - Applies to:

- Amount:
- Counted as: Not included
- Other Notes: Only for utilities

**Pennsylvania (PA)**

- Grant Program:
  - Name: High Performance Building Incentives
  - Start Year: 2009
  - Applies to: Commercial/Residential
  - Amount: 10% of project costs of 500,000
  - Counted as:
  - Other Notes:
- Loan Program:
  - Name: High Performance Building Incentives
  - Start Year: 2009
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as: Included as a 1 for loan_c and loan_r
  - Other Notes:
- SREC:
  - Name:
  - Start Year: 2004
  - Applies to:
  - Amount:
  - Counted as: Treated as 1
  - Other Notes:

**Rhode Island (RI)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2001 (stops in 2010)
  - Applies to: Commercial/Residential
  - Amount: 25% of costs (based on system cost of 15,000)
  - Counted as:
  - Other Notes:
- Grant Program:
  - Name:
  - Start Year: 2013
  - Applies to: Residential
  - Amount: $1.15/W maximum of 10,000 for up to 10kW
  - Counted as: Minimum of maximum and cost
  - Other Notes:
- Grant Program:
  - Name:
  - Start Year: 2013
  - Applies to: Commercial
  - Amount: 1.15/W for first 0-50kW, 1.00/W for 2$^{nd}$ 50kW, .85 for 3$^{rd}$ kW, .7 for 4$^{th}$ kw (200kW) etc until over 250kW
  - Counted as: Maximum incentive of 350,000
  - Other Notes:
- Property Tax Incentive:
  - Name:
  - Start Year: 2001
  - Applies to: Residential
  - Amount: system is assessed at no more than conventional energy system
  - Counted as: 100% exemption
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2005
  - Applies to: Commercial/Residential

  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**South Carolina (SC)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2006
  - Applies to: Commercial/Residential
  - Amount: 25% of eligible costs with a maximum amount of $3,500 carried over the next 10 years
  - Counted as:
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not for commercial or residential
- Rebate:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: From a utility

**South Dakota (SD)**

- Property Tax Incentive:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial/Residential
  - Amount: 50,000 or 70% of assessed value
  - Counted as: Treated by finding the maximum of these two amounts while using cost method to determine assessed value. Then taking the perpetuity
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2013
  - Applies to:
  - Amount:
  - Counted as:
  - Other Notes: Not included because there is a minimum cost of 2 million

**Tennessee (TN)**

- Property Tax Incentive:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial/Residential
  - Amount: 'ad valorem property tax assessment', may not exceed 12.5% of installed costs for solar
  - Counted as: Counted as 100% exemption
  - Other Notes:
- Sales Tax Incentive:
  - Name:
  - Start Year: 2010
  - Applies to: Commercial
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**Texas (TX)**

- Corporate Tax Deduction:
  - Name:
  - Start Year: 1982
  - Applies to: Commercial
  - Amount: Can deduct 10% of system cost from company's income
  - Counted as:
  - Other Notes: Unsure
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not for commercial/residential
- Property Tax Incentive:
  - Name:
  - Start Year: 2014
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes: Currently counted as 2014
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not state wide

**Utah (UT)**

- Corporate Tax Credit:
  - Name:
  - Start Year: 2007
  - Applies to: Commercial/Residential
  - Amount: 25% of costs with a maximum of 2,000 for Residential. 10% of costs with a maximum of 50,000
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not state wide
- Sales Tax Exemption:
  - Name:
  - Start Year: 2004
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: 2MW minimum

**Virginia (VA)**

- Loan Program:
  - Name:
  - Start Year: 2014
  - Applies to: Commercial
  - Amount:
  - Counted as: Counted as a 1 in loan_c
  - Other Notes:
- Property Tax Exemption:

  - Name:
  - Start Year: 2015
  - Applies to: Commercial
  - Amount:
  - Counted as:  Not included
  - Other Notes:

**Vermont (VT)**

- Loan Program:
  - Name:
  - Start Year: 2011
  - Applies to: Residential
  - Amount:
  - Counted as:  1 for loan_r
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year: 2013
  - Applies to: Commercial
  - Amount:
  - Counted as:  1 for loan_c
  - Other Notes:
- Personal Tax Credit:
  - Name:
  - Start Year: 2009
  - Applies to: Commercial
  - Amount: 7.2% of costs
  - Counted as:
  - Other Notes: Previously 30% state level credit, 'As of 2012 the solar business tax credit has expired and the investment tax credit
- Property Tax Incentive:
  - Name:
  - Start Year: 2013
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes: Systems 50kW or less
- Rebate Program:
  - Name:
  - Start Year: 2003
  - Applies to: Commercial/Residential
  - Amount:
  - Counted as:  Not included, unsure if counts
  - Other Notes: 25kW max
- Sales Tax Incentive:
  - Name:
  - Start Year: 1999
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**Washington (WA)**

- Loan Program:
  - Name:
  - Start Year: Unsure
  - Applies to: Residential
  - Amount: Minimum of 50,000
  - Counted as:  Included as 1 for loan_r
  - Other Notes:
- Rebate Program:

  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not state wide
- Sales Tax Exemption:
  - Name:
  - Start Year: 2009
  - Applies to: Commercial/Residential
  - Amount: Systems under 10kW, 100% exemption. Systems over 10kW 75% exemption
  - Counted as:
  - Other Notes:

**Wisconsin (WI)**

- Grant Program:
  - Name:
  - Start Year: 2012
  - Applies to: Commercial
  - Amount: $0.5kWh with a minimum award of 5,000, maximum incentive of 50% project costs
  - Counted as:
  - Other Notes:
- Loan Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: Not state wide
- Property Tax Incentive:
  - Name:
  - Start Year: 1981
  - Applies to: Commercial/Residential
  - Amount: 100% of value added
  - Counted as:
  - Other Notes:
- Rebate Program:
  - Name:
  - Start Year:
  - Applies to:
  - Amount:
  - Counted as: Not included
  - Other Notes: 4kW maximum
- Sales Tax Incentive:
  - Name:
  - Start Year: 2011
  - Applies to: Commercial/Residential
  - Amount: 100% exemption
  - Counted as:
  - Other Notes:

**West Virginia (WV)**

- No Financial incentives

**Wyoming (WY)**

- No Financial incentives