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Tax Credit Incentives for Residential Solar Photovoltaic in Hawai'i

FEBRUARY 11, 2013

The typical residential solar PV investment has an internal rate of return of 9% even without state tax credits. With the current state tax credit rules, the internal rate of return is as high as 14%. If most of Hawaii's households choose to take advantage of these high rates of return, state tax credit expenditures could reach $1.4 billion for residential units alone.

Solar photovoltaic (PV) tax credits are at the center of a public debate in Hawai'i. The controversy stems largely from unforeseen budgetary impacts, driven in part by the difference between the legislative intent and implementation of the PV tax credits. HRS 235-12.5 allows individual and corporate taxpayers to claim a 35% tax credit against Hawaii state individual or corporate net income tax for eligible renewable energy technology, including PV. The policy imposes a $5,000 cap per system, and excess credit amounts can be carried forward to future tax years. Because the law did not clearly define what constitutes a system or restrict the number of systems per roof, homeowners have claimed tax credits for multiple systems on a single property. In an attempt to address this issue, in November 2012, temporary administrative rules define a PV system as an installation with output capacity of at least 5 kW for a single-family residential property. The new rule does not constrain the total number of systems per roof, but rather defines system size and permits tax credits for no more than one sub-5 kW system. In other words, it is possible to install multiple 5 kW systems and claim credits capped at $5,000 for each system. There is an additional 30% tax credit for PV capital costs at the federal level. There is no cap for the federal tax credit and excess credits can be rolled over to subsequent years.

This study assesses 1) the household "payback" as a result of investing in PV, and 2) the maximum amount of PV capacity that might be installed on owner-occupied single-family homes based on household size and income. We provide estimates of the upper bound in state tax expenditures for PV tax credits, under both the previous and current rules.

Model Framework and Study Assumptions

We use data from the American Community Survey (2007 – 2011), prepared by the U.S. Census Bureau, to develop a simple model linking household size, gross household income, federal and state tax liability, and estimated electricity demand. This baseline data is used to estimate household payback periods and state tax credit costs under three policy rules: 1) "old rule" – effectively unlimited state tax credits for PV; 2) "current rules," where a system is defined as an installation with total output capacity of 5 kW; and 3) "no state credit" where we assume no state tax credit.

There are two main elements of the model. The first is that state and federal tax brackets are used to estimate the maximum income tax liability for households.[1] Second, from the census data, we use household size and income to estimate household electricity demand. We assume that all households will install a PV system that will net out their annual electricity usage.[2] The system is paid for either through personal saving, one of the many "green loans" available in the market, or through a lease arrangement. Note that no matter how a household installs a PV system, it imposes a tax credit cost on the state.

Calculating the "Payback" Period

The payback period is an estimate of the time it takes for the household to "break even" on their investment, taking into account the opportunity cost of the upfront capital investment and the electricity cost savings that are returned on a monthly basis. For this calculation, we use a range of discount rates—2% and 5%. We use the 2% lower bound discount rate because that is the current yield on 10-year treasury bonds. However, in better economic times, we should expect a higher rate of discount, so we also use a more typical 5% rate to show how varying the "opportunity cost" of the private investment decision affects the payback period.

For simplicity, we assume a constant electricity cost based on current rates as well as constant technology costs. Over the past two decades, the statewide residential electricity rates have increased by more than 6% per year, while PV costs have fallen by more 3% per year since 1998 (NREL, 2012). This makes our analysis of payback periods more conservative and based solely on today's pricing.[3]

Calculating Total PV Capacity

To estimate total residential PV installations, we focus on households likely to install PV under the current set of incentives: owner occupied, single family homes. We look at single-family homes (using census tract level data) because this represents the current lion's share of installations.[4] In addition, we only consider owner-occupied units because of the disconnected incentive for landlords to install PV in rental units.[5] Due to the difficulty in estimating which households will qualify for a bank loan or solar leasing agreement, we estimate PV installations for the range of household income types. We make the starting assumption that all homeowners will eventually take advantage of the state PV credits such that they are net-zero users of electricity under the net metering framework for PV. This simplifying assumption leads us to overestimate the total installed capacity. If only half of eligible households install PV, for example, our estimates of total installed capacity and tax credit costs will be reduced by approximately the same fraction.[6,7]

1 We assume that a one-person household files a single return while a two person households files jointly, married. All additional household members are treated as dependents.

2 The net metering agreement itself is a form of subsidy to solar PV usage. On an annual basis, the customer is effectively given retail electricity rates for their unused PV-generated electricity. This is a form of subsidy because of issues of grid stability and potential curtailment. How large of a subsidy this actually is depends on potential grid upgrades to better manage intermittent sources of electricity as well as total installation.

3 We should also note that we are not considering degradation of the system over time.

4 There is greater restriction in attaining "net-zero" electricity consumption using PV in an apartment or condominium setting, given the more limited rooftop area.

5 Although alternative policy mechanisms could certainly change this incentive.

6 The actual reduction depends on the mix of households that opt out of installations.

7 Other study assumptions are that 1) a "house" is identified as a dwelling with four or more rooms, and otherwise it is deemed an apartment or condominium unit, and 2) the income elasticity of demand for electricity is 0.5. Other major assumptions are identified in Table 1.

Key Findings

Household Payback Calculation

Table 1 summarizes the estimated payback period for a representative 3-person household with gross income of $75K for each county under the three policy scenarios and two discount rate assumptions. Our accounting model considers a much wider range of household types.

Table 1.
Estimated Payback for the Representative Household by County
Representative Household ($75K Household Income, 3-Person Household)

	OAHU	MAUI	HAWAII	KAUAI
Electric Rate	32 ¢/kwh	36 ¢/kwh	42 ¢/kwh	44 ¢/kwh
Monthly Electric Bill	$170	$190	$220	$230
Payback Period with 2% Discount Rate (years)				
Old Rule	4.5	4.0	3.4	3.3
New Rule ($5000/system)	6.6	5.8	4.9	4.8
No State Credit	9.5	8.4	7.1	6.8
Payback Period with 5% Discount Rate (years)				
Old Rule	5.0	4.4	3.7	3.5
New Rule ($5000/system)	7.5	6.6	5.5	5.3
No State Credit	11.6	10.0	8.2	7.8

We estimate that a representative household demands a PV system that costs $24,900. This is based on the following assumptions: 1) that there is 5.2 solar hours per day, 2) that PV units operate at 75% efficiency, 3) that PV costs $5.50 per watt, and 4) the average person consumes 6kWh of electricity per day. We estimate annual tax credits based on an estimated State tax liability of $4,600 and Federal tax liability of $10,800.

The expected payback period for PV installation varies widely by county (and island), because of the variation in electric rates. The payback is longest on Oahu where electricity rates are lowest, and shortest on Kauai where electricity costs are the highest.

Policy plays a very large role in determining the payback period. Under the previous interpretation of the law ("old rule"), with a 2% rate of discount, the payback period on Oahu is 4.5 years. Under the new rules, it is 6.6 years. Without the state tax incentive, the payback ranges between 6.8 and 9.5 years.

Residential PV Installation

Based on the assumptions laid out above, we estimate that PV installations on single family, owner-occupied housing could eventually reach 1,100 MW of installed capacity.[8] Figure 1 shows the potential PV capacity by household income type.

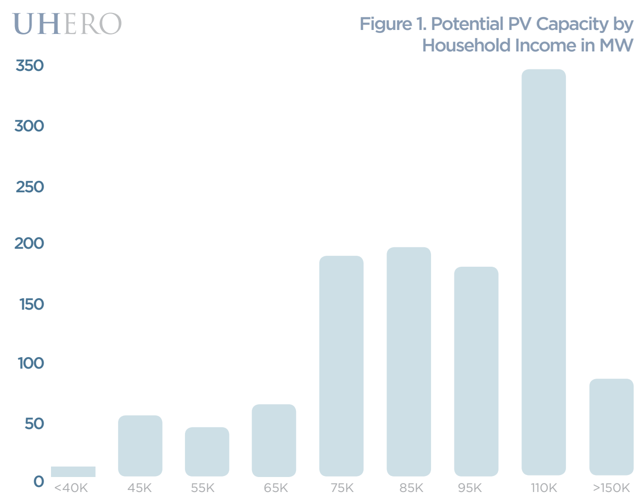

Figure 1 shows that the vast majority of capacity will be installed on the rooftops of households with annual income greater than $75K. This is simply because there are more owner-occupied single-family dwellings with households in this demographic. Because lower income households may not have access to credit or lease agreements, we repeat our calculations excluding

8 Our focus on owner-occupied dwellings likely mitigates the overestimation of PV capacity as home-owners are more likely to have assets and thus to qualify for either financing or a lease agreement. Moreover, we are neither considering income growth over time or new home construction, which are ways in which we underestimate total potential capacity.

all households with median income below $75K, and estimate a total of 980 MW of installed PV capacity. It seems that the vast majority of potential PV capacity occurs in households who would most likely qualify for financing, particularly given they also own single family homes.

State Tax Credit Costs

If the total 1,100 MW of PV are installed, we estimate that under the "old rules," households would claim $2.1 billion in state tax credits. Under the "new rules," households will eventually claim $1.4 billion in tax credits. For comparison, excluding households with income below $75K, under the "old rules" the cost of state tax credits could eventually reach $1.9 billion and under the "new rules," $1.2 billion.

Discussion, Caveats and Conclusions

This study demonstrates the complexity in determining both the role of the state in supporting PV installations from a household decision-making framework as well as consequences to the state's budget.

We estimate that, under the "old rules," the payback period for investing in PV was about 3.6 years (statewide average with a 2% discount rate). Under the "new rules," the payback occurs in 5.1 years. Without the state tax credit, the payback period is 8.0 years with a 2% rate of discount and 9.5 years with a 5% discount rate.

In purely economic terms, and assuming that the net-metering agreement remains unchanged, the rational household decision is to make the PV investment, regardless of tax credit policy. Because systems are warrantied for 25 years or more, a payback period of 10 years or less makes the PV installation a very lucrative investment. Specifically, for a PV installation with no state tax credit, considering electricity savings over the expected 25 year lifespan of the system, the internal rate of return is over 9%. The return under the "new rules" is just under 14%. Of course other factors play a role in the household decision—there are questions of expected house tenure and whether the solar investment adds value to the sale of a home.[9] In addition, some households may choose to wait to see if technological advances lower system costs even further.[10]

We estimate that a total of 1,100 MW could be installed on owner-occupied single-family homes, at a total cost of between $1.4 and $2.1 billion.

Study Limitations

Our analysis is limited by data constraints in a number of ways that merit discussion. The first is our assumption that households invest in enough PV to be net-zero annually. It is more likely that over-installation was and is occurring, under both the old and new rules. Over-building PV has the effect of increasing household electricity usage because, once PV is installed, the electricity becomes a "free" good. Under both sets of rules, the PV system cost is recouped with positive return on investment (assuming the investor benefits from the system over the entire 25 years). Given the transactions cost associated with adding generating capacity at a future date, as well as uncertainty over the availability of tax credits in future years, it is likely that households are installing systems capable of generating more

9 Given the nascent nature of the industry, there is currently little evidence and no studies of which we are aware.

10 On the other hand, expectations about the loss of the federal tax credit, coupled with changing state policy, may lead homeowners to install early-on, regardless of total system cost.

than their current electricity usage. In addition, optimizing system size to maximize tax credits contributes to over installation. This is particularly aggravated by the "new rules," where households have an incentive to build multiple systems, together exceeding 5 kW, to increase the cap level past $5,000.

In addition, our analysis has not constrained PV installation decisions based on circuit capacity issues and therefore overstates the amount of PV that can be installed under current grid limitations. The estimated 1,100 MW would almost certainly result in some neighborhoods exceeding the current 15% circuit limit for intermittent resources.[11] For example, taking a capacity factor for PV of 18% (HNEI, 2010) and 2010 annual electricity demand of 9,960 GWh (DBEDT, 2012), 1,100 MW of PV is about 17% of statewide electricity demand. However, over time, as electricity demand rises and/or grid capabilities improve to accept higher levels of intermittent resources, grid restrictions are less binding.

11 *In particular, as neighborhoods are also income delineated.*

Concluding Remark

This analysis estimates the potential impact to the state's budget if PV tax credit policy "runs its course." Given the magnitude of the estimated taxpayer burden, the relatively short payback periods for household investors, and the large potential for rooftop PV and its subsequent greenhouse gas emission reduction benefits, a more appropriate role for state policy is to facilitate PV deployment rather than make direct payments. One approach to facilitating private decisions to install PV is on-bill financing. This "pay-as-you-save" mechanism is a way to potentially deploy PV to a wider population, while limiting the state's tax credit expenditures.

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