CONSUMER ENERGY ALLIANCE
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Incentivizing Solar Energy:
An In-Depth Analysis of U.S. Solar Incentives

2018
UPDATE

REPORT PREPARED BY:
ScottMadden, Inc. *June 2018*

About Consumer Energy Alliance

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Consumer Energy Alliance (CEA) brings together energy consumers, producers and manufacturers to engage in a meaningful dialogue about America's energy future. With more than 300 member organizations and 500,000 family and individual members nationwide, our mission is to help ensure stable prices for consumers and energy security. We believe energy development is something that touches everyone in our nation, and thus it is necessary for all consumers to actively engage in the conversation about how we develop and diversify our energy resources and energy's importance to the economy. CEA promotes a thoughtful dialogue to help produce our abundant energy supply, and balance our energy needs with our nation's environmental and conservation goals.

Learn more at **ConsumerEnergyAlliance.org**.

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Executive Summary

As part of Consumer Energy Alliance's all-of-the-above approach to meeting our nation's growing energy needs, we strongly support the expanded use of solar power. Diversifying our energy portfolio and improving options for families and small businesses will help further reduce energy prices, improve our individual and national energy security, and expand the U.S. energy revolution.

Solar technology is currently reshaping modern electricity generation, and the number of large-scale, community, and residential rooftop solar systems in the United States have been growing rapidly. In addition to the declining cost of solar photovoltaic (PV) systems over the past several years, federal and state tax credits, state rebates, utility rebates, and other indirect incentives from net energy metering programs have led to the significant expansion of solar power across the country.

The combination of these incentives has reduced the net costs of installing solar PV systems significantly. In fact, many states have total incentives that exceed the lifetime costs of a rooftop solar PV system. Given current solar PV market dynamics and technological maturity, many states are now reviewing their policies to find an appropriate level of financial incentives.

In 2016, Consumer Energy Alliance released a report entitled *Incentivizing Solar Energy: An In-Depth Analysis of U.S. Solar Incentives* report. The 2016 report provided a comparison of the incentives available in 15 selected states: Arizona, California, Connecticut, Florida, Georgia, Illinois, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, and North Carolina.

Because of the rapid transformations in both the economics of solar PV systems and the policy dialogue over solar incentives in the states, CEA has commissioned ScottMadden, Inc. to update its 2016 report and provide additional analysis of the total incentives available to customers installing rooftop solar PV systems in an additional 10 states. Like our 2016 report, this analysis is intended to aid policy and decision makers by quantifying current incentives provided for solar PV systems.

In order to accelerate the installation of solar PV systems, local, state and federal governments have provided several incentive programs for rooftop solar owners. The combination of these incentives – along with the declining cost of PV systems over the past several years – has led to significant increases in the use of rooftop PV systems across the country.

This report is designed to inform policymakers who are evaluating state solar incentives by quantifying the total incentives available to residential PV users as a percentage of the installed cost of a typical residential solar facility. This analysis covers 25 selected states, including: Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oregon, Rhode Island, South Carolina, Texas, and Utah. These states were selected to capture diversity in location, state incentive policies, retail tariff designs and wholesale electricity prices.

Direct Incentives

A variety of direct incentives are available for consumers who install residential solar PV systems or third-party owners who lease systems to consumers. This report compares five categories of these incentives: 1) federal tax incentives, 2) state tax credits, 3) state rebates, 4) utility programs, and 5) Renewable Energy Certificates. While there are additional direct incentives one could consider, such as county and city tax credits, state and local sales and property tax credits, and other public utility commission programs, these five categories are considered the most common. To simplify the analysis, this report only includes these five areas of direct incentives; consequently, the results of the analysis can be considered conservative estimates of the total incentives that residential customers with solar PV might receive.

Net Energy Metering Incentives

Forty-four states and the District of Columbia offer Net Energy Metering (NEM) programs for their residential customers with solar PV. These programs bill the customer for the net amount of electricity consumed (what the customer consumes less the amount the customer produces onsite) and provide a credit for any excess energy which flows back to the utility which is applied to future bills.

Net energy metering incentives occur, in general terms, when PV owners receive credit at the retail rate instead of the lower avoided cost rate for the energy their PV system produces. In more specific terms, the analysis calculates the amount a residential consumer would save by using a solar PV system rather than using electricity from the representative utility in their state. The amount of the incentive varies by the amount of energy that the system is able to produce (which varies by state) and the applicable tariff for electricity (which varies by state), less the utility's avoided costs (which also varies by state).

Residential solar PV systems rely on the use of the utility's distribution system to "buy" power when household energy consumption exceeds solar system production (e.g., at night) or "sell" power when solar system production exceeds household energy consumption (e.g., during the day). However, current utility rate structures do not separately charge distribution costs to solar system owners. Such costs include capital expenditures for the poles, conductor, transformers, switches, and metering devices, as well as additional operation and maintenance expense to operate the system safely and reliably. To the extent utilities are not allowed to recover these costs directly from residential solar system owners, utilities may seek to recover these costs from other consumers through increased rates.

It is also possible to generate additional incentives if the total solar energy put onto the grid by a residential system exceeds total energy usage for the home. However, the average residential consumer typically consumes more energy than is produced by the average residential solar PV system, so these additional

benefits were not included in this analysis.[1] The analysis assumes that the residential rooftop solar PV installation is appropriately sized to meet the homeowner's energy needs.

Analytical Approach

In this analysis, the total incentives available for owning and installing a solar PV system are calculated based on the median 6.1 kilowatt sized system on a present value basis over the 25-year economic life of the residential solar PV facility. The analysis employed a Microsoft Excel model to calculate the present value of total incentives for direct-owned and third-party-owned (TPO) solar PV systems. The Excel model calculates the annual streams of incentives over the 25-year life of the system, then discounts them to obtain their respective present value as of January 1, 2017. The analysis starts by calculating energy production and net energy metering incentives on an hourly basis, then aggregates these amounts on an annual basis over the life of the system.

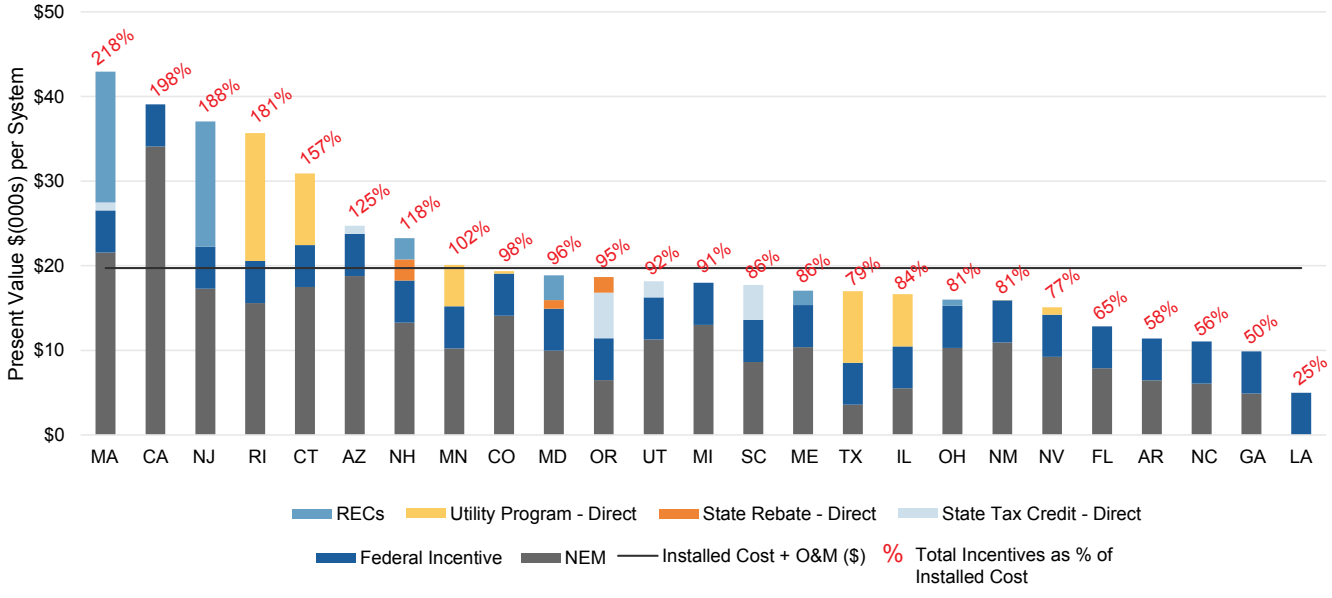
New to this year's analysis is the inclusion of system operation and maintenance (O&M) expense in total system costs. Multiplying the average installation cost by the median system size results in an average installation cost. To calculate total installed cost, ScottMadden added the annual stream of O&M expense, inflated annually over the 25-year life of the system, to the average installation cost, and then discounted the sum to the present value using a discount rate. The full methodology can be found in Appendix A.

Note that this report also does not attempt to put a total value on distributed solar energy as there are many societal and political considerations which have not been evaluated. Rather, this analysis focuses solely on the available incentives related to installing a residential solar PV system.

Total Incentives for Residential Direct-Owned Solar Systems

The total incentives available for installing a direct-owned solar PV system under standard electricity rates by selected state are depicted in Figure 1.

Figure 1. Total Incentives for a Direct-Owned Solar PV System[2] (6.1 kW System) (Standard Rate)

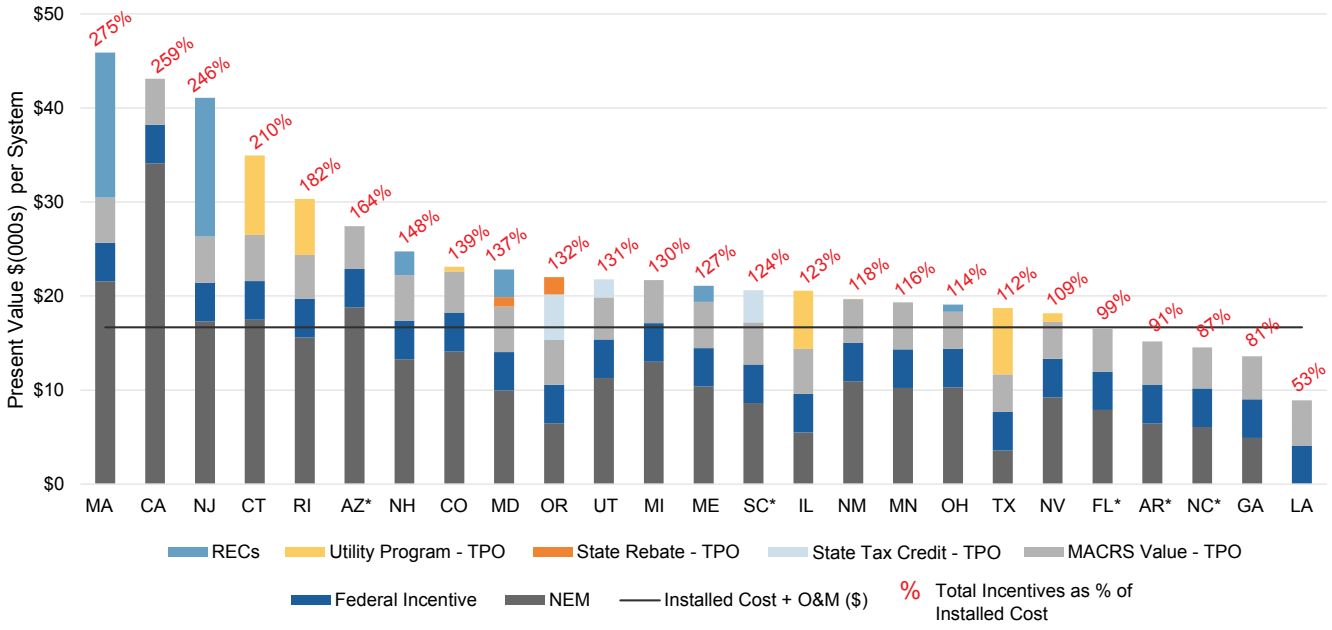


1 ScottMadden analysis; typical household energy consumption was compared to typical solar PV system output, by state.
2 ScottMadden analysis.

Total Incentives for Residential Third-Party-Owned Solar Systems

Figure 2 below provides an illustration of total incentives compared to average installed cost for third-party-owned solar systems.

Figure 2. Total Incentives for a Third-Party-Owned Solar PV System[3] (6.1 kW System) (Standard Rate)



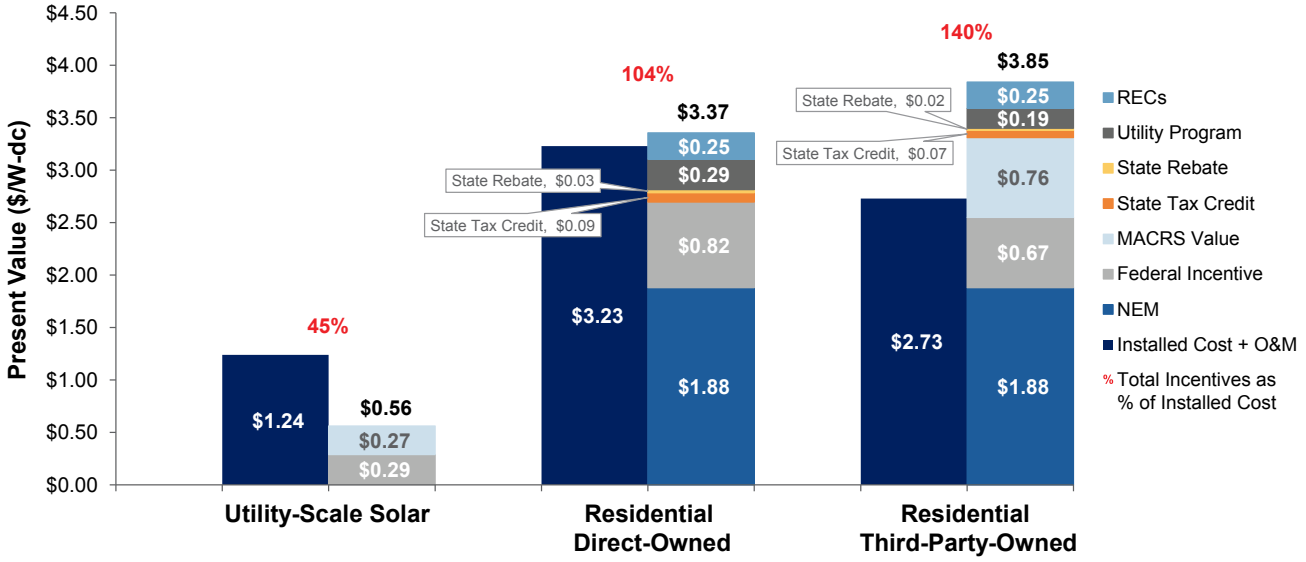
**Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[4]*

Comparison to Utility-Scale Solar

While this report primarily focuses on residential rooftop solar PV, it is also important to compare the total incentives available to residential solar PV systems to those available to utility-scale solar. Figure 3 shows that the total cost of utility-scale solar is less than half of the total cost of residential solar PV systems. Residential solar PV systems receive, on average, between 104% and 140% of total system costs in incentives. Utility-scale solar installations only receive about 45% of total system costs in incentives.

3 Ibid.
4 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

Figure 3. Residential Solar Versus Utility-Scale Solar[5]
($ per watt-dc)



Policy Implications for Solar Incentives

In considering the policy implications of current solar incentives, one must also understand which constituent groups bear the true costs of installing residential solar PV systems. The report analyzes the percentage of the cost of a residential solar system which is borne by taxpayers and consumers in addition to the system owner.

Through the 30% federal tax credit, various state tax credits, state rebates, and the additional tax deductions provided by the depreciation of the solar assets for third-party-owned systems, taxpayers, as a whole, are covering a significant portion of the cost of an individual's residential solar PV system in the United States. Depending on the state, the share of incentives funded by taxpayers varies from approximately 10% to 65% under standard tariffs (excluding Louisiana). Through utility programs and utility purchases in renewable energy certificate (REC) markets, utility ratepayers in all customer classes also share the cost of residential solar PV systems. While consumer contributions do not occur in every state, in at least five states, such as Massachusetts, New Jersey, Rhode Island, Texas and Illinois, consumers pay approximately 30% of the costs of residential solar PV systems.

Figures 4 and 5 show the percentage of incentives to solar system owners borne by each group. The indirect consumer impact shown in this analysis represents the net energy metering incentive (or bill savings minus utility avoided costs).

5 ScottMadden analysis.

Figure 4. Taxpayer and Consumer Contributions – Direct-Owned Systems[6] (6.1 kW System) (Standard Rate)

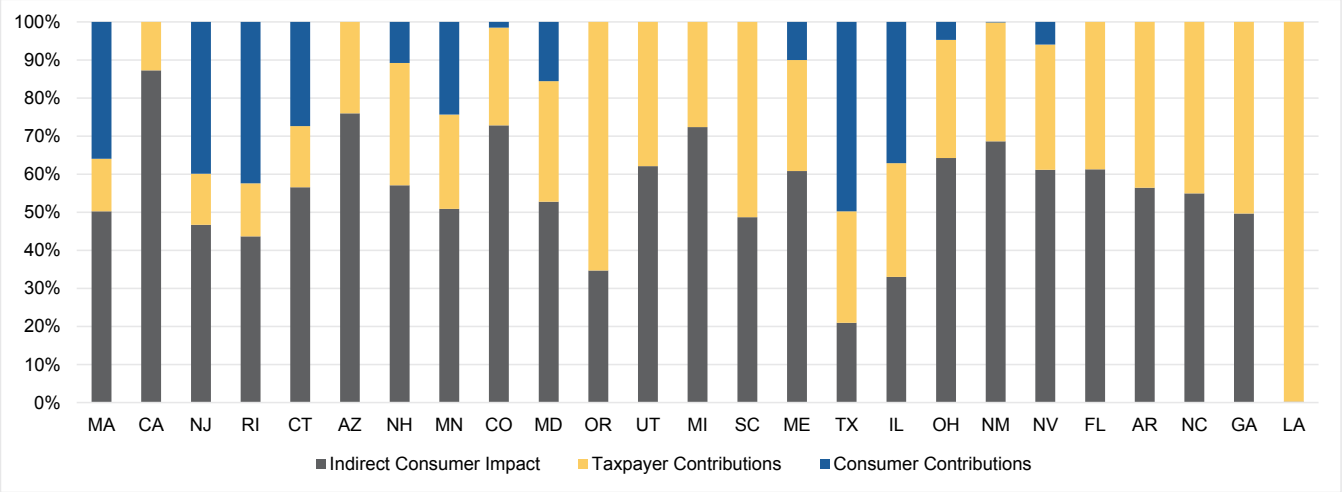
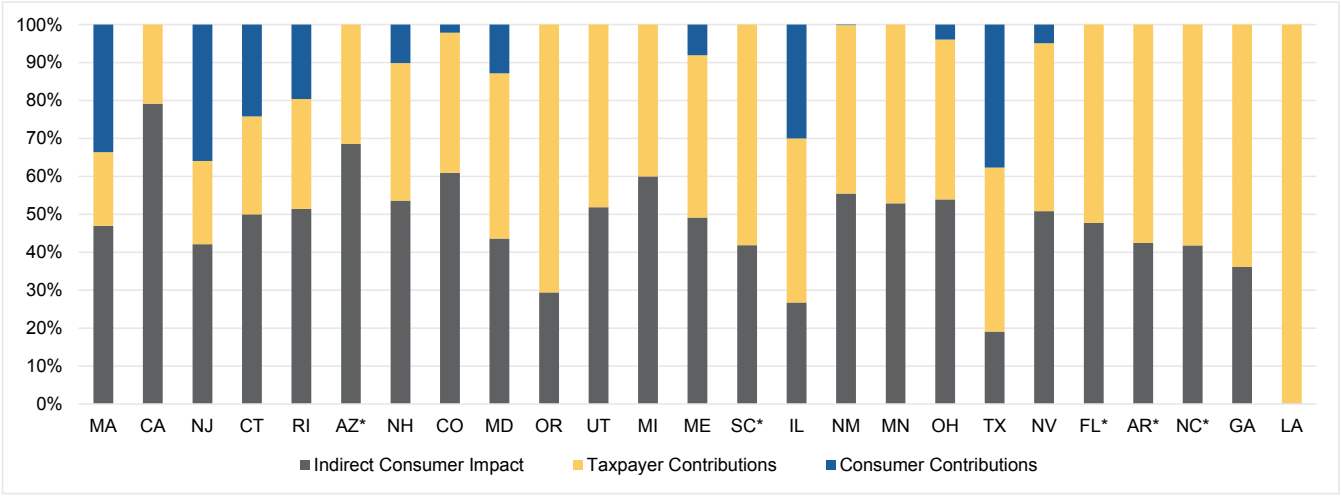


Figure 5. Taxpayer and Consumer Contributions – Third-Party-Owned Systems[7] (6.1 kW System) (Standard Rate)



***Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[8]*

Taxpayer Contributions

Through the 30% federal tax credit, various state tax credits and state rebates ranging between 10% and 65%, and the additional tax deductions provided by the depreciation of the solar assets for third-party-owned systems, taxpayers as a whole are covering a significant portion of the cost of an individual's residential solar PV system in the United States.

6 Ibid.
7 Ibid.
8 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

Electric Customer Contributions

Through utility programs and utility purchases in REC markets, utility customers in all customer classes share the cost of residential solar PV systems. Customers currently contribute directly in about half of the states analyzed and, in at least five states, customers pay approximately 30% of the costs of residential solar PV systems.

Indirect Customer Impact

Residential solar PV systems rely on the use of the utility's distribution system to "buy" and "sell" power from the grid. In the majority of jurisdictions, utility rate structures currently do not separately charge distribution costs to solar system owners. Such costs include capital expenditures for the poles, conductor, transformers, switches, and metering devices, as well as additional operation and maintenance expense to operate the system safely and reliably. If these costs are not paid for by solar PV system owners, they may be passed on to other customers through increased rates.

Conclusions

This report provides a foundation and context for policymakers to make well-informed, well-reasoned decisions regarding solar policy within their jurisdiction, and a better understanding of who is paying the installed cost of rooftop solar PV. The various incentives and certificates at the federal, state, and local levels offered to solar PV rooftop users demonstrate the following conclusions:

- Existing Incentives for Residential Solar PV are Significant

Based on this analysis of total available incentives, in many of the states studied, residential solar remains incentivized in amounts that exceed the installed cost of a solar PV system. In eight states examined, direct owners receive more than the total system costs in total incentives under a standard rate structure. In all but five states, direct owners receive at least 75% of total system costs in total incentives under a standard rate structure.

- Utility-Scale Solar Installations are Incentivized at Lower Rates Per Watt Than Rooftop Solar PV Systems and are Less Expensive to Install

Although the total incentives for residential solar PV systems exceed the incentives available for utility-scale solar, utility-scale solar installations have significantly lower total costs (installed cost plus operation and maintenance expense) than residential PV systems. Residential solar PV systems receive, on average, between 104% and 140% of total system costs in incentives. Utility-scale solar installations only receive about 45% of total system costs in incentives; therefore, the ratio of absolute incentives for utility-scale to rooftop is greater than 5-to-1.

- Third-Party-Owned Solar PV Owners Receive the Most Significant Incentives

In contrast to direct-owned solar, third-party solar owners are able to utilize accelerated depreciation, which generates additional tax benefits for the third-party system owner. In all but five states (Florida, Arkansas, North Carolina, Georgia, and Louisiana), total incentives exceed total system costs under standard rate structures. Under TOU rates, total incentives also exceed total system costs in all but six states Georgia, New Mexico, Nevada, Florida, Arkansas, and North Carolina). In other words, while the non-economic value of rooftop solar is identical for direct-owned and third-party-owned, the third-party-owned systems receive considerably greater incentives.

- Solar PV Installation Incentives May Shift Costs to Other Customers

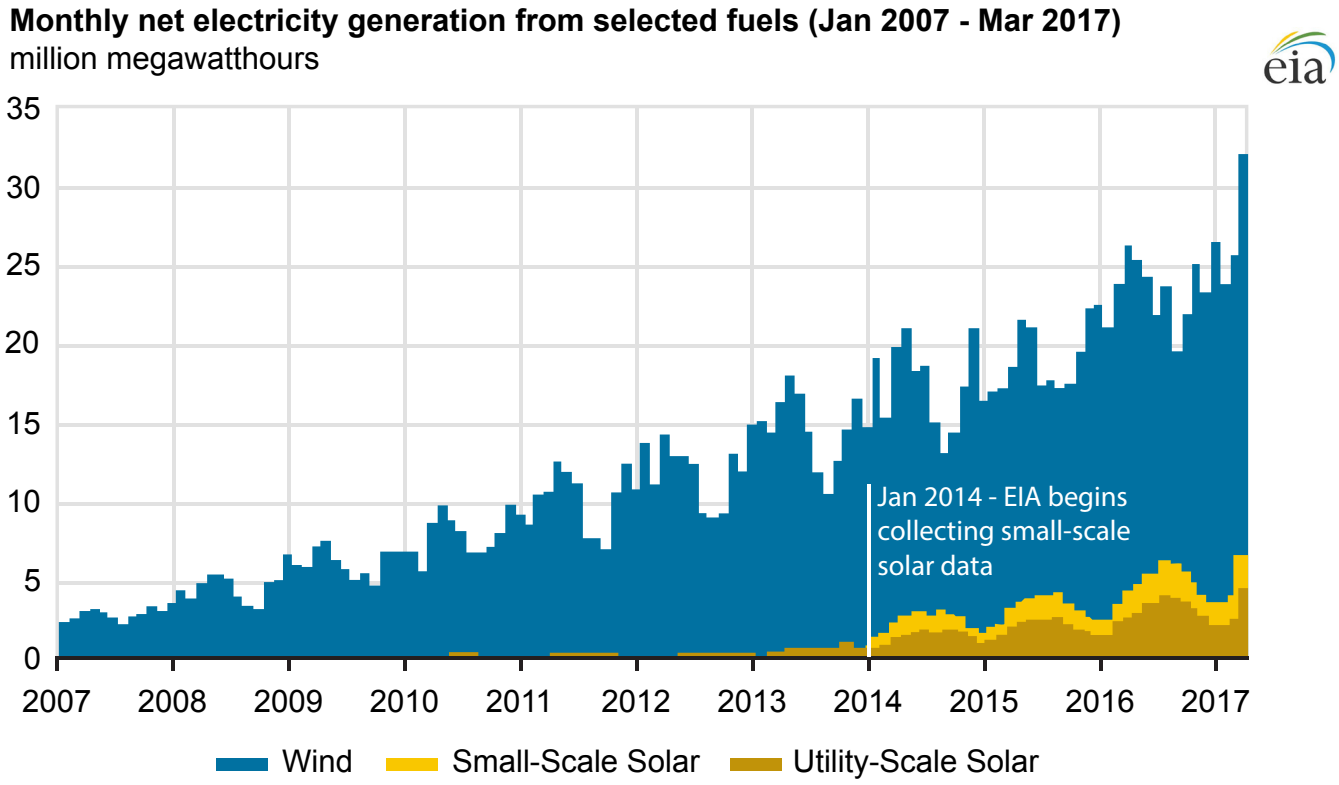
Some net metering programs, which pay residential PV solar customers full retail rates for their excess electricity production, may shift fixed utility infrastructure costs onto non-solar customers. As a result, CEA remains concerned that these net metering incentives may also shift costs onto less-affluent customers.

Introduction

As part of Consumer Energy Alliance's all-of-the-above approach to meeting our nation's growing energy needs, we strongly support the expanded use of solar power. Diversifying our energy portfolio and improving options for families and small businesses will help further reduce energy prices, improve our individual and national energy security, and expand the U.S. energy revolution.

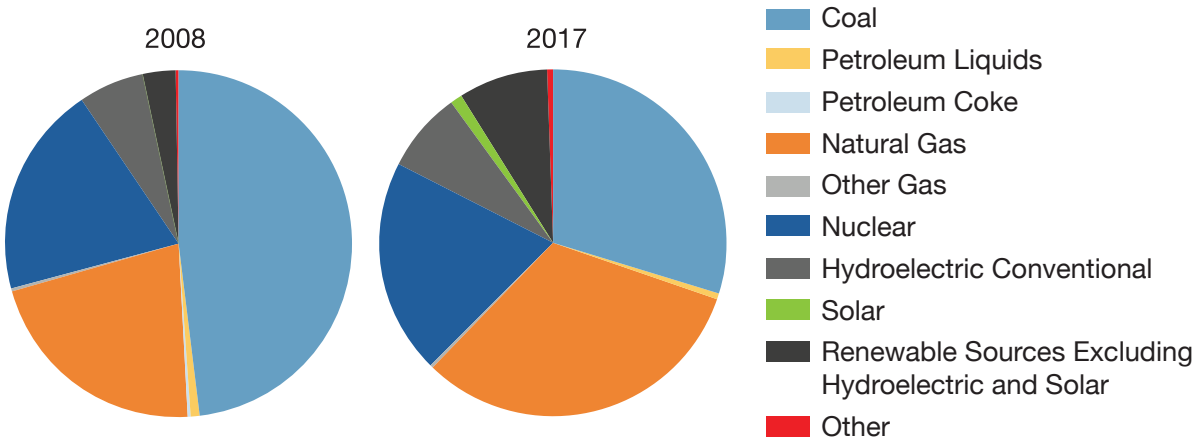
Solar energy technology is changing the electricity market in the United States. The declining costs of residential, community, and utility-scale projects are allowing consumers and utilities alike to rapidly deploy solar generation technology. Over the last ten years, there has been a substantial increase in both solar electricity generation and solar generating capacity (see Figures 6 and 7 below). In March 2017, monthly electricity generation from solar (including utility-scale plants and small-scale systems) exceeded 10% of total electricity generation in the United States.

Figure 6. Monthly Electricity Generation (2007-2017)[9]



9 U.S. Energy Information Administration; EIA began collecting small-scale solar PV data in January 2014.

Figure 7. U.S. Utility-Scale Electric Generating Capacity[10]



While much of this solar power comes from utility-scale projects, smaller-scale solar installations, including residential rooftop solar photovoltaic (PV) systems, are increasingly installed. This report focuses on these residential rooftop solar PV installations.

Trends in Residential Solar PV

Recently, there has been considerable growth in the residential solar PV market. For example, 2016 saw a 20% increase in residential solar PV capacity over the previous year.[11] Over 371,000 residential solar projects were installed in 2016, which is a 19% increase over the number of installations in 2015.[12] In addition, the installed cost of residential solar has dropped significantly in recent years. The average installed cost of residential solar PV systems in the United States declined 21% from $3.59 per watt-dc in the first quarter of 2015 to $2.84 per watt-dc in the first quarter of 2017.[13]

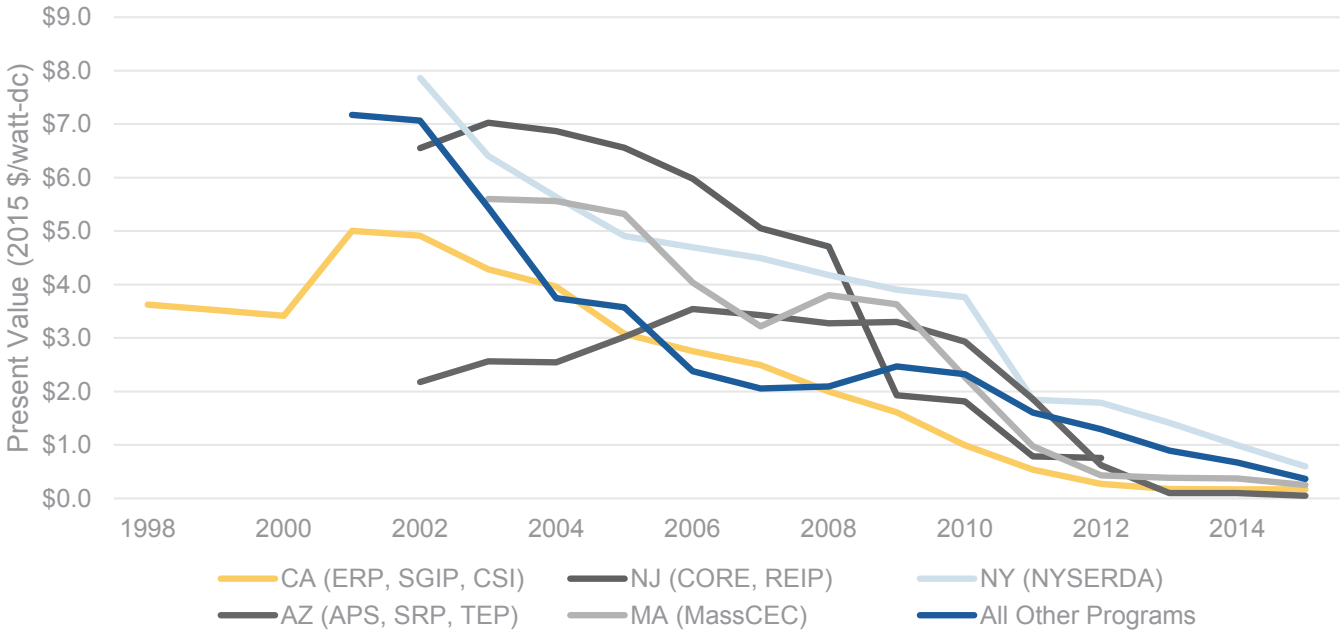
To help the residential solar market grow and reach maturity, federal, state, and local governments developed incentives to reduce consumer out-of-pocket costs for installing residential solar PV systems. At the federal level, individuals can use the Residential Renewable Energy Tax Credit to claim a personal tax credit equal to 30% of the costs of a residential solar installation.[14] Commercial businesses, including third-party owners of residential solar installations, can use the Business Energy Investment Tax Credit to claim a corporate tax credit equal to 30% of installed cost.[15] Commercial enterprises can also take advantage of accelerated depreciation and bonus depreciation deductions. At the utility level, net energy metering programs are another benefit. These programs bill the customer for the net amount of electricity consumed, or the amount of energy the customer consumes less the amount the customer produces onsite. In billing periods when the solar PV facility produces more energy than the customer consumes, the excess energy flows back to the utility and the customer receives a bill credit (expressed either in kilowatt-hours or dollars) that is carried forward and applied to future bills.[16] The monetary bill credits are based on the energy prices in the customer's retail tariff.

10 U.S. Energy Information Administration, Utility-scale solar has grown rapidly over the past 5 years, May 4, 2017.
11 GTM Research and SEIA, U.S. Solar Market Insight Q2 2017.
12 Ibid.
13 Ibid.
14 Energy Star, Federal Income Tax Credits for Energy Efficiency, https://www.energystar.gov/about/federal_tax_credits.
15 DSIRE, Business Energy Investment Tax Credit (ITC), http://programs.dsireusa.org/system/program/detail/658.
16 Most state net energy metering programs only allow bill credits to be carried forward for 12 months, at which time the credits expire or the utility buys them at a price that approximates the utility's avoided cost of wholesale energy. The buyback price is generally much lower than the energy prices in the customer's retail tariff, which discourages customers from oversizing their solar PV facilities.

Currently, 40 states have mandatory net energy metering rules, six states have distributed generation compensation rules other than net metering, and two states have no statewide mandatory rules, but some of the utilities in these two states allow net metering.[17]

State and utility rebates and incentives have also contributed to the growth in the residential solar PV market. State direct cash incentives (i.e., rebates and performance-based incentives) were as high as $8 per watt-dc in 2002 (in 2015 dollars).[18] However, these incentives have been declining over time. By 2015, direct cash incentives had been removed from several major markets (e.g., California, Arizona, and New Jersey), and fell below $1 per watt-dc elsewhere in the country.[19] The decline of these rebates over time is shown in Figure 10 below. Other incentive structures, such as the REC markets and the SMART program in Massachusetts have also been declining in recent years, although some still provide substantial incentives.

Figure 8. State and Utility Rebates and Performance-Based Incentives[20]



Objectives of the Study

With the available federal, state, and utility direct and indirect incentives, and with declining installed costs, in several of the states analyzed, the net costs of solar PV have declined to historically low levels. In eight of the states examined, total incentives exceed the total costs of a rooftop solar PV system. In light of this, many states are reviewing their policies and reevaluating the need for and amount of incentives going forward. To help inform policy makers considering such changes, CEA commissioned ScottMadden, Inc. to update the 2016 *Incentivizing Solar Energy: An In-Depth Analysis of U.S. Solar Incentives* report developed by Borlick Associates, LLC.

17 For a map of affected states, see Database of State Incentives for Renewables & Efficiency, Net Metering, April 2017.
18 Lawrence Berkeley National Laboratory, Tracking the Sun IX: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States, August 2016.
19 Ibid.
20 Ibid.

The 2016 report provided a comparison of the incentives available in 15 selected states: Arizona, California, Connecticut, Florida, Georgia, Illinois, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, and North Carolina. In this 2017 update, the analysis has been expanded to include a comparison of the incentives available in 25 selected states: Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oregon, Rhode Island, South Carolina, Texas, and Utah.

Analytical Approach

This report estimates the total incentives available to consumers installing rooftop solar PV systems. The results include the total incentives available for the 25 selected states as a percentage of the cost of installing and maintaining a solar PV system over the life of the system. The results incorporate state and federal tax credits, state rebates, utility programs, renewable energy credits (also referred to as renewable energy certificates or RECs), and net energy metering incentives in effect on January 1, 2017 over the estimated 25-year life of the system. The full methodology can be found in Appendix A.

It should be noted that since January 1, 2017, some of the state incentive programs have changed, as described below:

- In March 2017, Maine replaced its net metering program with a “buy-all, sell-all” program which will steadily decrease the credit for produced solar energy from retail rates to avoided costs
- In late 2016, Arizona decided to replace net metering with an avoided cost payment schedule for solar customers. These rates were set to go into effect in July 2017
- In the past few years Nevada has been busy adjusting net metering laws. In 2015, the state made changes to the monthly fixed charge, energy rates, and the net metering tariff. Monthly fixed charges increased, energy rates decreased, and the net metering tariff decreased. In 2017, the state passed a law that will credit new rooftop solar customers at 95% of the retail electricity rate for energy sold back to the grid
- Georgia does not require utilities to offer net metering tariffs. Through the Renewable and Nonrenewable Resources Schedule, Georgia Power Company offers customers the option of selling produced energy. Effective with bills rendered for August 2017, Georgia Power now offers the RNR-9 schedule which pays customers $0.035 per kilowatt-hour. This analysis uses the previous RNR-8 schedule, which pays customers $0.0401 per kilowatt-hour

Note that this report also does not attempt to put a total value on distributed solar energy as there are many societal and political considerations which have not been evaluated. Rather, this analysis focuses solely on the available incentives related to installing a residential solar PV system.

Total System Costs

This report estimates the installed cost of a residential solar PV system by using the median system size of 6.1 kilowatts and the national average installation cost. New to this year’s report is the inclusion of PV system O&M expense in total system costs over the life of the system.

Direct Incentives

This report estimates the total incentives available for residential solar PV systems installed on January 1, 2017. The analysis compares the initial installation costs and ongoing operation and maintenance expense to available incentives. The available direct incentives include federal and state tax credits, state rebates, utility programs, and the sale of Renewable Energy Credits.

Indirect Incentives

To calculate the net energy metering incentive, the analysis calculates the amount a residential consumer would save by using solar energy from a solar PV system rather than using electricity from the representative utility in their state. The amount of the incentive varies by the amount of energy that the system is able to produce (which varies by state) and the applicable tariff for electricity (which varies by state), less the utility avoided costs (which also varies by state).

Available Direct Incentives for Residential Solar PV Systems

A variety of direct incentives are available for consumers who install residential solar PV systems or who lease systems from third-party owners. This report compares five categories of these incentives: 1) federal tax incentives, 2) state tax credits, 3) state rebates, 4) utility programs, and 5) Renewable Energy Certificates. While there are additional direct incentives one could consider, such as county and city tax credits, state and local sales and property tax credits, and other public utility commission programs, these five categories are considered the most common.

To simplify the analysis, this report only includes these five areas of direct incentives; consequently, the results of the analysis can be considered conservative estimates of the total incentives that residential customers with solar PV might receive. A comprehensive description of all federal, state, and local incentives, including those offered by electric utilities, is available at www.dsireusa.org.

It is important to note that some of the incentives included may vary depending on whether the system is owned directly by the consumer or leased from a third-party owner. Therefore, this report is divided into an analysis for residential customer-owned solar and an analysis for third-party-owned solar installations.

Federal Tax Incentives

The federal tax credit for residential customer-owned solar PV is the Residential Renewable Energy Tax Credit (RETC).[21] The RETC allows individuals to deduct 30% of the solar PV facility's installed cost from federal taxes. The RETC was extended in December 2015 and is scheduled to be phased out by 2022.

While the RETC is available only to customer-owned systems, commercial businesses (e.g., third-party owners of residential solar) are eligible for the Business Energy Investment Tax Credit (ITC) which allows companies to claim a corporate tax credit equal to 30% of installed cost.[22] Like the RETC, the 30 percent ITC was also recently extended but is scheduled to step down to 10 percent by 2022.

21 DSIRE, Residential Renewable Energy Credit (RETC), http://programs.dsireusa.org/system/program/detail/1235.

22 DSIRE, Business Energy Investment Tax Credit (ITC), http://programs.dsireusa.org/system/program/detail/658.

Third-party owners can also take advantage of additional depreciation deductions. Under the Modified Accelerated Cost Recovery System (MACRS) in the United States, third-party owners are able to deduct the depreciation of the solar PV system from federal taxes on an accelerated basis. Our analysis accounts for the present value of these depreciation deductions over the 25-year life of the solar PV system by including a "MACRS value" for third-party owned systems. In addition, third-party owners can base the depreciation deductions and the federal credits on the facility's fair market value, which is higher than the installed cost and increases the incentive.

State Tax Credits

Several of the states included in this analysis offer tax credits for residential customer-owned and third-party-owned solar PV systems. These credits range from 15% to 50% of installed cost. Specific tax credits by state are provided in Table 1 below.

Table 1. State Tax Credits by State[23]

State	Customer- Owned Rate	Customer- Owned Maximum Payment	Third-Party-Owned Rate	Third-Party- Owned Maximum Payment	Notes
AZ	25% of installed cost	$1,000	N/A	N/A	▪ Personal tax credit; not applicable to third-party owners
LA	Lesser of $2 per watt or 50% of installed cost	$10,000	38% of the first $20,000 of the cost of purchase	$7,600	▪ Program currently out of money ▪ 6 kilowatt maximum for leased systems
MA	15% of installed cost	$1,000	N/A	N/A	▪ Personal tax credit; not applicable to third-party owners
OR	$1.30 per watt	Lesser of $6,000 or 50% of net costs	$1.30 per watt	Lesser of $6,000 or 50% of net costs	▪ Maximum incentive: $1,500 per year ▪ Third-party owners eligible to pass-through tax credits
RI	N/A	N/A	25% of installed cost	$3,750	▪ Commercial tax credit; not applicable to direct-owned systems ▪ Program exists, but not currently functioning
SC	25% of installed cost	In a given tax year, $3,500 or 50% of taxpayer's tax liability for that taxable year	25% of installed cost	In a given tax year, $3,500 or 50% of taxpayer's tax liability for that taxable year	▪ If credit amount exceeds $3,500, excess may be carried forward for up to 10 years
UT	25% of installed cost	$2,000	25% of installed cost	$2,000	▪ Maximum payment phases out beginning in 2018

23 Database of State Incentives for Renewables & Efficiency; net metering policies in effect on January 1, 2017.

State Rebates

Additionally, several states offer rebates for installing residential customer-owned and third-party-owned solar PV systems. Currently, residential customers can get a rebate of as much as $10,000. The specific rebates offered in 2017 for the selected states are listed below in Table 2.

Table 2. State Rebates by State[24]

State	Customer- Owned Rate	Customer- Owned Maximum Payment	Third-Party-Owned Rate	Third-Party- Owned Maximum Payment	Notes
CT	$0.487 per watt		$0.039 per kilowatt-hour		▪ The incentive for third-party-owned systems is paid over twenty-four calendar quarters
MD	Flat rate: $1,000	$1,000	Flat rate: $1,000	$1,000	
NH	$0.50 per watt	Lesser of $2,500 or 30% of installed cost	N/A	N/A	▪ 2017 rebates are fully subscribed, and a waitlist has been established
OR	$0.30 per watt	$2,100	$0.30 per watt	$2,100	
RI	$1.05 per watt	$10,000	$0.70 per watt	$5,000	

For this analysis, the existing rebate program in Connecticut is not included in the incentive calculations. Under that program, if a system owner accepts payment from the Residential Solar Investment Program, the RECs (discussed below) generated by the operation of their PV system go the Connecticut Green Bank. The applicable utility program in Connecticut, through Eversource Energy in this analysis pays a higher price for the RECs. The analysis assumes the customer will choose the higher incentive option. The analysis also assumes the system owner is selected to be a part of the Eversource Energy program, which is based on random selection.

Similarly, the existing program in Rhode Island is not included in the incentive calculations. If a system owner accepts payment from National Grid's RE Growth Program they cannot participate in the Rhode Island Small Scale Solar Grants program. The National Grid program offers a higher incentive and the analysis assumes the customer will choose the higher incentive option.

Utility Programs

In several of the selected states, utility programs also incentivize residential solar PV systems. These programs pay customers a set amount based on the amount of solar energy the solar PV systems produce or the size of the solar PV system. Specific utility programs by state are shown in Table 3 below.

24 Ibid.

Table 3. Utility Programs by State[25]

State	Customer- Owned Rate	Customer- Owned Maximum Payment	Third-Party-Owned Rate	Third-Party-Owned Maximum Payment	Notes
CO	$0.005 per kilowatt-hour		$0.005 per kilowatt-hour		▪ Customer-owned system payments are made for 10 years ▪ Third-party-owned system payments are made for 20 years ▪ Utility owns RECs
CT	$103.07 per Megawatt-hour		$103.07 per Megawatt-hour		▪ First-come, first-served basis ▪ 15-year contract ▪ Utility owns RECs
IL	$176.46 per Megawatt-hour		$176.46 per Megawatt-hour		▪ 5-year contract ▪ Incentive paid quarterly ▪ Utility owns RECs
MN	$0.08 per kilowatt-hour		N/A		▪ 10-year contract ▪ Utility owns RECs
NM	$0.0025 per kilowatt-hour		$0.0025 per kilowatt-hour		▪ 8-year contract ▪ Utility owns RECs
NV	$0.1475 per watt	$13,816.50	$0.1475 per watt	$13,816.50	▪ Incentive payment may not exceed 50% of the average installation cost per watt of 25 kilowatt and smaller solar systems installed in the SolarGenerations Program in the quarter prior to application
RI	$0.3345 per kilowatt-hour		$0.247 per kilowatt-hour		▪ Payments are made for 20 years ▪ Utility owns RECs
TX	$0.54 per watt and $0.2519 per kilowatt-hour	50% of installed cost	$0.54 per watt and $0.2519 per kilowatt-hour	50% of installed cost	

Most of the utility programs transfer the REC ownership from the customer to the utility. There is an exception: In Texas, Oncor Electric's program allows customers to retain ownership of RECs, but reserves the right to claim produced RECs at a later date. Unlike REC market prices, which are determined by the competitive market (though some markets have fixed prices), the prices paid for RECs through these programs are determined by the utility or by a competitive solicitation process.

The differences in incentives between direct customer ownership and third-party ownership seen in state tax credit and state rebate programs is also seen in utility programs. Direct owners in Colorado receive payments for 10 years, while third-party owners receive payments for 20 years. Additionally, in Minnesota, third-party owners are not eligible for Xcel Energy's Solar*Rewards Program. In Rhode Island, National Grid's Renewable Energy Growth Program offers different contracts to the two ownership types.

Renewable Energy Certificates

In a few of the states analyzed in this report, customer owners of residential solar PV systems are able to sell RECs. A REC represents one MWh of electricity generated from a renewable energy resource. In the United States, RECs act as tradable commodities because electric suppliers in 30 states must procure them as part of the state renewable portfolio standards (RPS). If electric suppliers do not secure enough

25 Ibid.

RECs to comply with a state's RPS, suppliers must pay the alternative compliance payment (ACP) set by the state. ACPs are penalty payments which essentially set a price cap on RECs in that state. For the selected states, Table 4 below depicts the average price of RECs in 2016. If a state is not listed in the table, the average REC price in 2016 was zero, and therefore was not included in the analysis. In addition, the average REC prices in 2016 were so low in California and Texas that these incentives were excluded from the analysis.

Table 4. Renewable Energy Certificates by State[26]

State	Average 2016 Price ($ per Megawatt-hour)	REC Type
CA	$0.97	CA RPS Bucket 3
MA	$274.38	MA Solar II
MD	$51.26	MD Solar
ME	$29.84	ME Class I
NH	$49.76	NH Class II
NJ	$265.91	NJ Solar
OH	$14.37	OH In-State Solar
RI	$35.37	RI New
TX	$0.32	TX REC

26 SNL Financial, Weekly REC Index.

Total Incentives for Residential Direct-Owned Solar Systems

This section of the report provides an analysis of the costs and total incentives available for residential direct-owned solar PV systems. This section addresses the installation costs of the average residential solar PV system. In addition, this section will provide an analysis of the various incentives available in each state within the scope of this report. This includes the net energy metering incentive for residential electricity customers who install solar PV systems.

Total System Costs

In 2017, the average residential solar system in the United States is estimated to cost $19,722. This includes the cost of equipment, installation of the system, and operation and maintenance expense over the system's expected 25-year life. This cost is for a system size of 6.1 kilowatts, which is the median size of residential solar PV systems in the United States.

Direct Incentives

As described earlier in the section entitled Available Direct Incentives for Residential Solar PV Systems, several incentive types are available for direct customer-owned systems.

Indirect Incentives

Direct system owners (i.e., consumers) are credited for the energy produced by the installed solar PV system via bill savings. To calculate bill savings by state, our analysis forecasted the energy production of an average solar PV system in each of the selected states and multiplied it by the applicable utility's residential rate for electricity. This amount was then forecast over the 25-year life of the system. Energy production depends on the amount of sunlight available in each state, with states such as California producing more and Maine producing less.

There are two types of electricity rate structures commonly used in the United States for residential customers: standard and time of use (TOU). In a standard rate structure, consumers pay the same rate for electricity regardless of the hour of the day it is used (although prices may still change from season to season). In a TOU rate structure, consumers pay more for electricity in peak hours versus off-peak hours of the day. In both structures,

rates can be tiered by total consumption (i.e., the more energy consumed, the higher the price). In addition, in both structures there are generally additional fixed charges, for example the monthly customer charge.

Because of the nature of residential solar production, most solar energy is produced during hours of the day when lights are typically turned off at home and many residential customers are away at work. Further, peak versus off-peak hours and the differential between peak and off-peak rates can vary by utility and by season.

As one might expect, in addition to the energy output of the solar PV system, the average retail price of electricity plays a large role in bill savings. In states where the price of electricity is high, such as in Massachusetts and Connecticut, direct owners will receive a higher bill credit relative to system output. In states where the price of electricity is low, such as in Texas and Louisiana, direct owners will receive a lower bill credit for the same system output.

It is also possible to generate additional incentives if the total solar output of the residential system exceeds total energy usage for the home. However, the average residential consumer typically consumes more energy than is produced by the average residential solar PV system, so these additional benefits were not included in this analysis.[27] The analysis assumes that the residential rooftop solar PV installation is appropriately sized to meet the homeowner's energy needs.

This report defines the net energy metering incentive as the present value of the customer's bill savings, less the present value of the energy and capacity costs the utility avoids due to the customer's onsite generation, over the 25-year life of the solar PV system. Note that this report also does not attempt to put a total value on distributed solar energy as there are other utility (e.g., transmission and distribution expense) and societal (e.g., environmental) cost considerations which have not been evaluated. Rather, this analysis focuses solely on the available incentives related to installing a residential solar PV system. Figure 9 compares the average retail prices by state with the total incentives available to the solar system owner. Incentives are described in more detail below.

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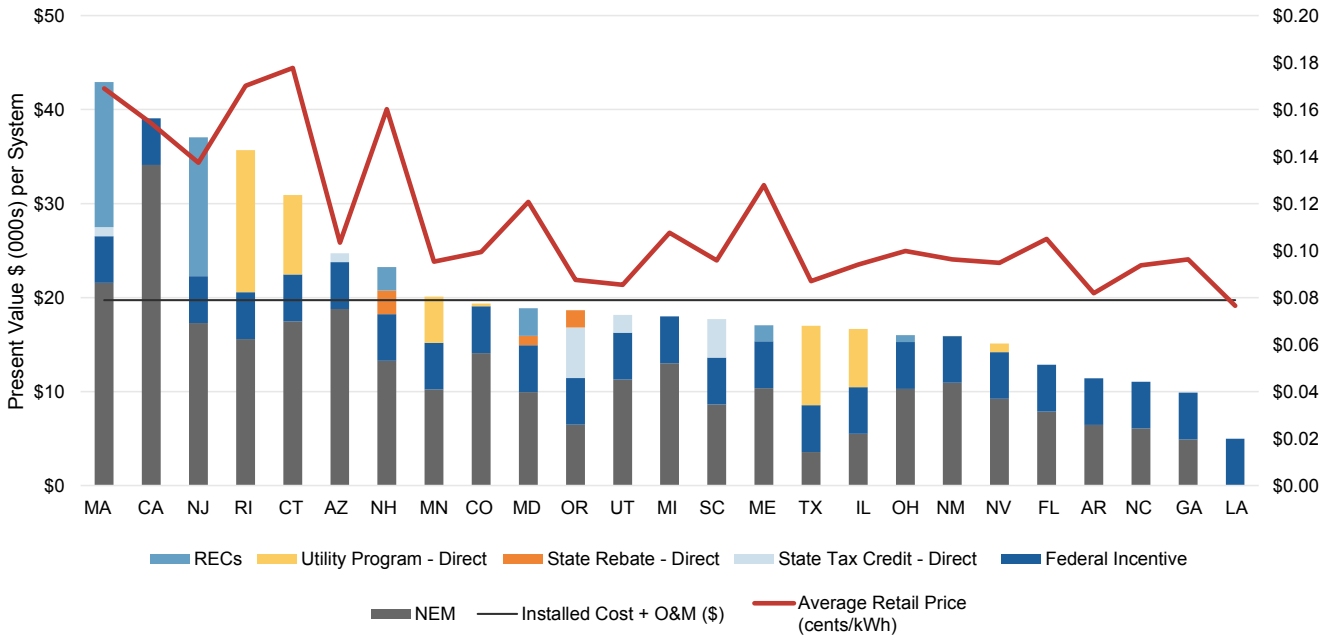
27 ScottMadden analysis; typical household energy consumption was compared to typical solar PV system output, by state.

Figure 9. Average Residential Retail Price[28] and Total Incentives[29] (Direct-Owned, Standard Rate)



Total Incentives

Given total available incentives, based on this updated analysis, in many of the states studied, on a present value basis, residential solar is substantially incentivized for direct-owners of PV systems. In eight states analyzed, direct owners would receive more than the total system costs in total incentives under a standard rate structure. In all but five states states examined, direct owners would receive at least 75% of total system costs in total incentives under a standard rate structure.

The total incentives available for installing a direct-owned solar PV system under standard electricity rates and TOU rates by selected state are depicted in Figures 10 and 11. Note that not all utilities offer TOU rates, so Rhode Island, New Jersey, Texas, Utah, South Carolina, Illinois, Ohio, and Louisiana are not included in the TOU analysis. Total incentives range from 218% of total costs in Massachusetts to 25% of costs in Louisiana under standard tariffs. Total incentives range from 228% of total costs in Massachusetts to 29% of costs in North Carolina under TOU tariffs (see Figures 10 and 11).

28 Ibid.
29 Ibid.

Figure 10. Total Incentives for a Direct-Owned Solar PV System[30] (6.1 kW System) (Standard Rate)

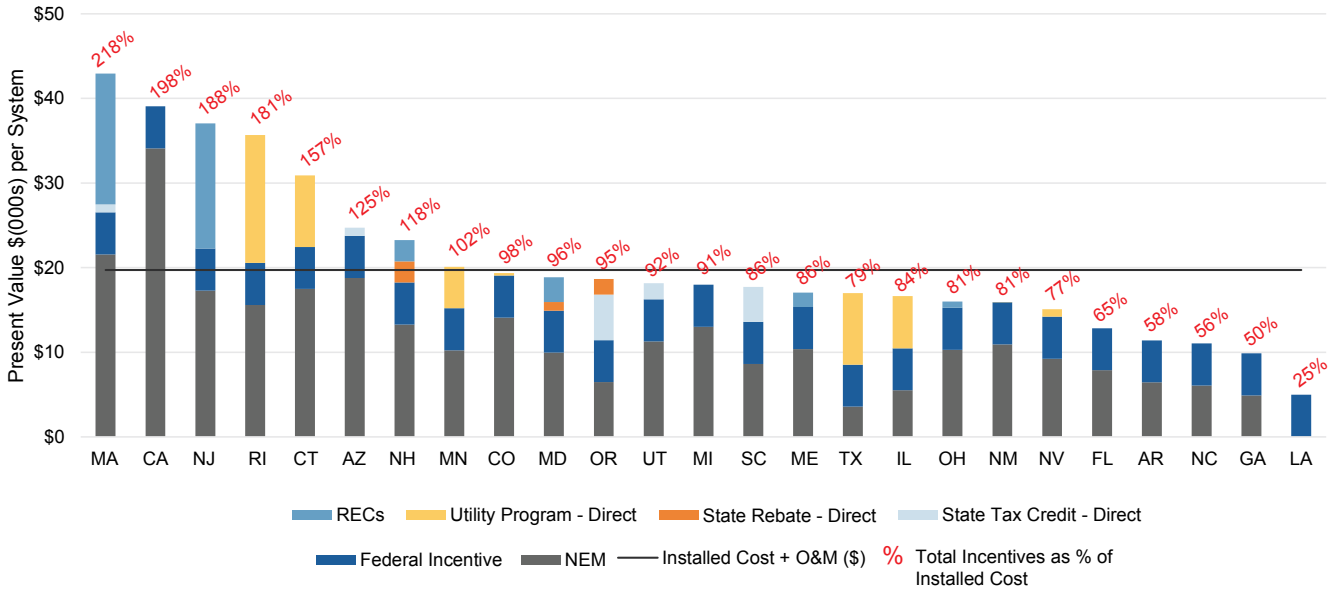
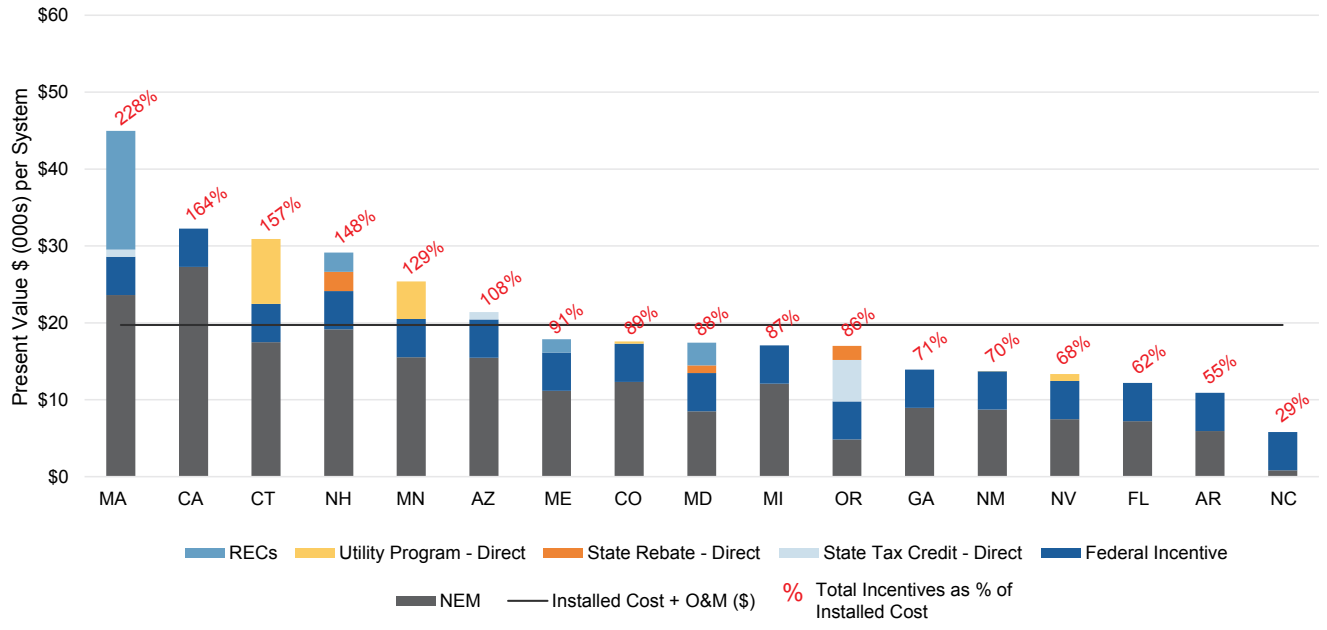


Figure 11. Total Incentives for a Direct-Owned Solar PV System[31] (6.1kW System) (Time-of-Use Rate)



30 ScottMadden analysis.
31 Ibid.

Total Incentives for Residential Third-Party-Owned Solar Systems

ScottMadden also analyzed the installed cost and total incentives for third-party-owned solar PV systems. While this analysis assumes that third-party ownership is legal in all of the selected states for comparison purposes, it is important to note that this is not the case. Of the states studied, as of April 2017, third-party solar power purchase agreements are not legal in Arizona, Arkansas, Florida, North Carolina, and South Carolina for residential customers.[32] Where third-party ownership is not currently allowed, these states are noted as such in the figures and tables below.

Total System Costs

This report assumes that third-party-owned systems will have a lower installed cost than residential direct-owned systems due to economies of scale. According to Lawrence Berkeley National Laboratory's Tracking the Sun IX report[33], third-party-owned systems have an average price which is $0.50 per watt lower than residential direct-owned systems. Our estimated total costs for a third-party-owned system is $16,672. This includes the cost of equipment, installation of the system, and operation and maintenance expense over the system's expected 25-year life. This cost is for a system size of 6.1 kilowatts, which is the median size of residential solar PV systems in the United States. Note this cost may not represent the fair market value of the system, used by third-party owners for federal income tax credit and depreciation purposes. Instead, this is the estimated out-of-pocket cost. For a further discussion of fair market value, please see the section entitled Fair Market Value in Appendix A.

Direct Incentives

As described earlier in the section entitled Available Direct Incentives for Residential Solar PV Systems, several incentive types are available for third-party-owned systems. In general, these incentives are the same or less than those offered for direct-owned systems. For example, some state tax credits are not available for third-party-owned systems. Similarly, some state rebates offered to direct owners are not available for third-party-owned systems or are available at a reduced amount. In five of the selected states, residential consumers with third-party-owned systems are still eligible for a utility rebate. However, in New Mexico,

32 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA) (April 2017), http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2017/04/DSIRE_3rd-Party-PPA_April_2017.pdf.

33 TBD. Tracking the Sun IX: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States, https://emp.lbl.gov/publications/tracking-sun-ix-installed-price.

third-party-owned systems do not qualify for rebates while direct-owned systems do. Lastly, as with direct-owned systems, third-party-owned systems qualify consumers for RECs in nine of the 25 selected states.

Indirect Incentives

Residential customers will receive electricity bill savings from producing solar energy through third-party-owned systems in the same manner as direct-owned systems. These savings were calculated in the same way as the direct-owned systems above. Bill savings are derived by multiplying the energy production of the average solar PV system in each of the selected states by the applicable utility's residential rate for electricity. The utility's avoided energy and capacity costs are then subtracted from bill savings to calculate the net energy metering incentive. This amount was then forecast over the 25-year life of the system.

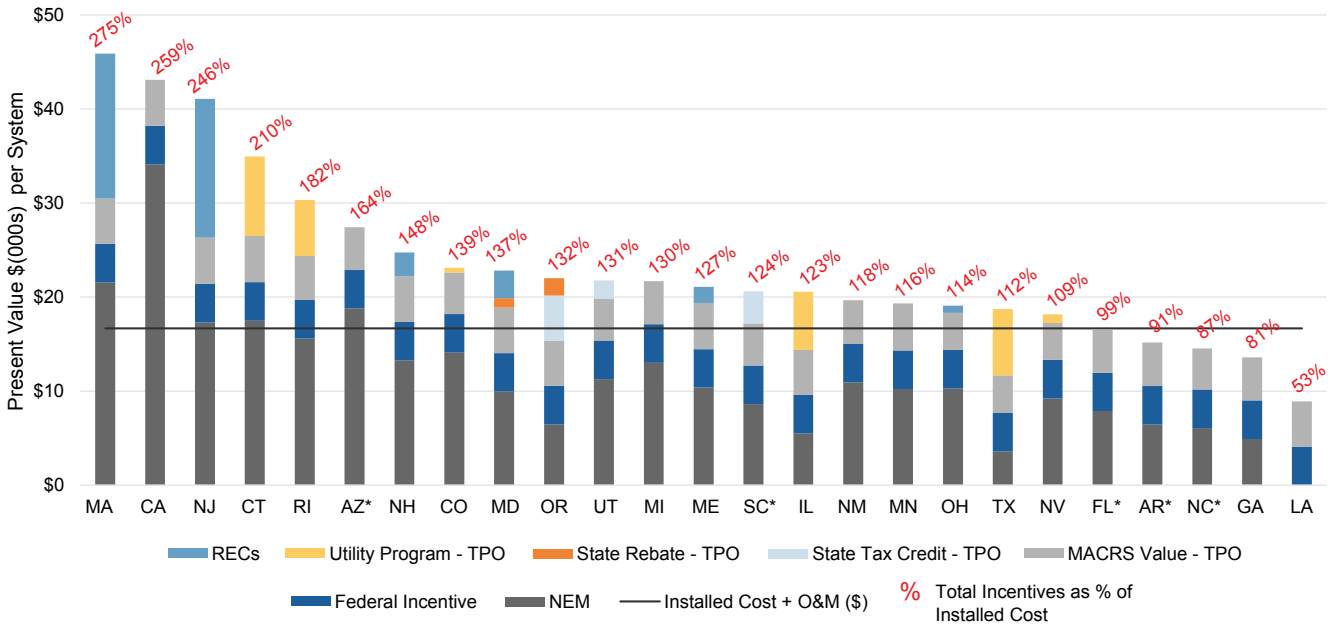
Total Incentives

Figures 12 and 13 below provide an illustration of total incentives compared to total system costs for third-party-owned solar systems. In contrast to direct-owned solar, third-party-owned solar also benefits from accelerated depreciation (under MACRS), which generates additional tax benefits for the third-party system owner. In all but five states (Florida, Arkansas, North Carolina, Georgia, and Louisiana), total incentives exceed total system costs under standard rate structures. Under TOU rates, total incentives also exceed total system costs in all but four states (Nevada, Florida, Arkansas, and North Carolina). Note that not all utilities offer TOU rates, so Rhode Island, New Jersey, Texas, Utah, South Carolina, Illinois, Ohio, and Louisiana are not included in the TOU analysis.

Total incentives range from 275% of total costs in Massachusetts to 53% of costs in Louisiana under standard tariffs. Total incentives range from 288% of total costs in Massachusetts to 56% of costs in North Carolina under TOU tariffs (see Figures 12 and 13).

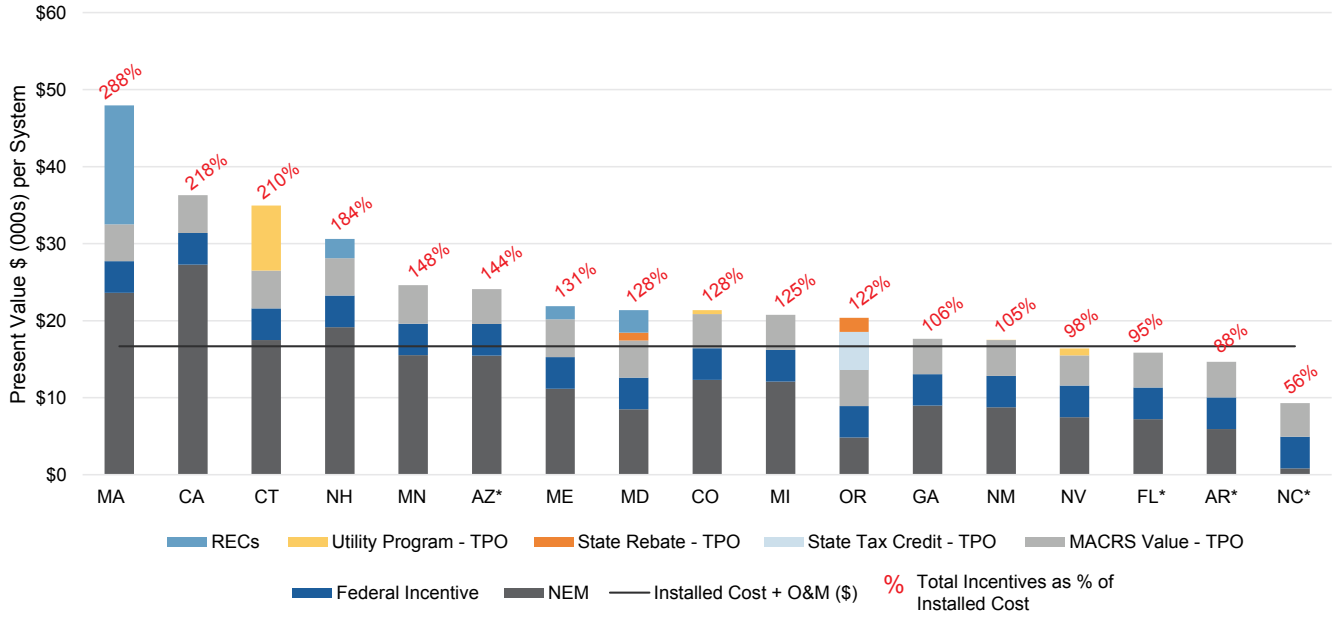
It is also important to note that the total cost included in this analysis does not take into account any contract premiums consumers might pay under the power purchase agreements. Thus, this analysis may not reflect the true out-of-pocket cost for consumers wishing to install third-party-owned solar systems.

Figure 12. Total Incentives for a Third-Party-Owned Solar PV System[34] (6.1 kW System) (Standard Rate)



**Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[35]*

Figure 13. Total Incentives for a Third-Party-Owned Solar PV System[36] (6.1 kW System) (Time-of-Use Rate)



**Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[37]*

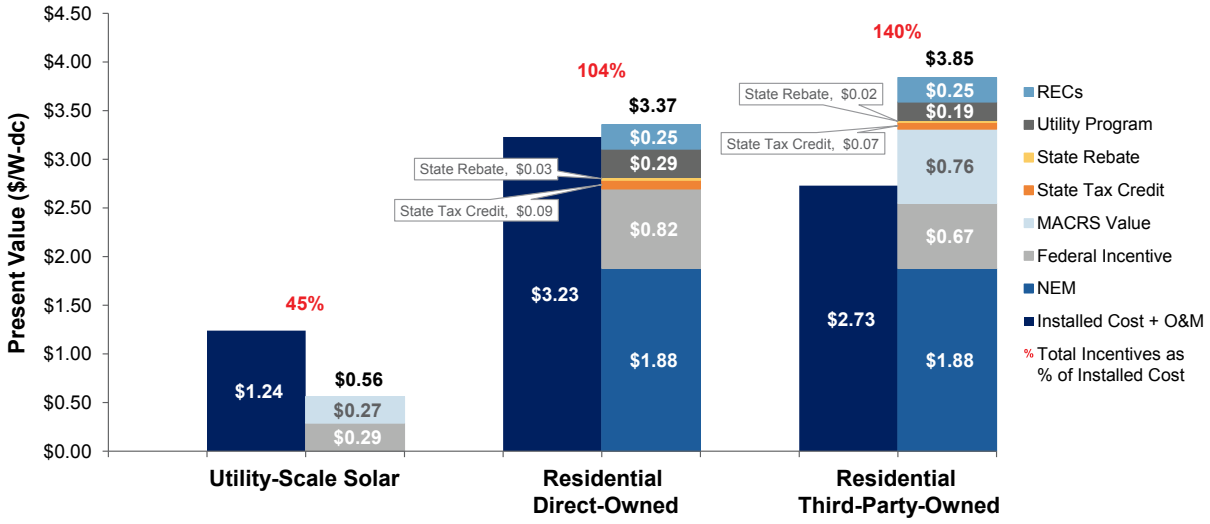
34 ScottMadden analysis.
35 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.
36 Ibid.
37 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

Comparison to Utility-Scale Solar

While this report primarily focuses on residential rooftop solar PV, it is also important to compare the total incentives available to residential solar PV systems to those available to utility-scale solar. Although the total incentives for residential solar PV systems exceed the incentives available to the electric utility, utility-scale solar installations have lower total costs (installed cost plus operation and maintenance expense) than residential PV systems. Figure 14 shows that the total cost of utility-scale solar is less than 50% of the total cost of residential (direct-owned) solar PV systems. Residential solar PV systems receive, on average, between 104% and 140% of total system costs in incentives. Utility-scale solar installations only receive about 45% of total system costs in incentives.

The results shown for direct-owned and third-party-owned residential solar PV systems are simple averages of the 25-state analyses.

Figure 14. Residential Solar Versus Utility-Scale Solar[38] ($ per watt-dc)



For fixed-tilt utility-scale systems, our analysis used an installation cost of $0.99 per watt-dc which is the modeled national average turnkey price in the first quarter of 2017. This price is sourced from the U.S. Solar Market Insight report published by GTM Research and the Solar Energy Industries Association. National Renewable Energy Laboratory's 2017 Annual Technology Baseline estimates annual O&M expense for utility-scale PV systems at $13 per kilowatt ($0.013 per watt-dc) per year. In this analysis, the total cost of utility-scale solar equals the net present value of the installed cost and operation and maintenance expense over the 25-year life of the system. Although RECs are not included in the analysis for utility-scale solar, in some states, additional incentives including RECs may apply.

38 Ibid.

Conclusions: Policy Implications for Solar Incentives

This report provides a foundation and context for policymakers to make well-informed, well-reasoned decisions regarding solar policy within their jurisdiction, and a better understanding of who is paying the installed cost of rooftop solar PV. The various incentives and certificates at the federal, state, and local levels offered to solar PV rooftop users demonstrate the following conclusions:

- Existing Incentives for Residential Solar PV are Significant

Based on this analysis of total available incentives, in many of the states studied, residential solar remains incentivized in amounts that exceed the installed cost of a solar PV system. In eight states examined, direct owners receive more than the total system costs in total incentives under a standard rate structure. In all but five states, direct owners receive at least 75% of total system costs in total incentives under a standard rate structure.

- Utility-Scale Solar Installations are Incentivized at Lower Rates Per Watt Than Rooftop Solar PV Systems and are Less Expensive to Install

Although the total incentives for residential solar PV systems exceed the incentives available for utility-scale solar, utility-scale solar installations have significantly lower total costs (installed cost plus operation and maintenance expense) than residential PV systems. Residential solar PV systems receive, on average, between 104% and 140% of total system costs in incentives. Utility-scale solar installations only receive about 45% of total system costs in incentives; therefore, the ratio of absolute incentives for utility-scale to rooftop is greater than 5-to-1.

- Third-Party-Owned Solar PV Owners Receive the Most Significant Incentives

In contrast to direct-owned solar, third-party solar owners are able to utilize accelerated depreciation, which generates additional tax benefits for the third-party system owner. In all but five states (Florida, Arkansas, North Carolina, Georgia, and Louisiana), total incentives exceed total system costs under standard rate structures. Under TOU rates, total incentives also exceed total system costs in all but six states Georgia, New Mexico, Nevada, Florida, Arkansas, and North Carolina). In other words, while the non-economic value of

rooftop solar is identical for direct-owned and third-party-owned, the third-party-owned systems receive considerably greater incentives.

- Solar PV Installation Incentives May Shift Costs to Other Customers

Some net metering programs, which pay residential PV solar customers full retail rates for their excess electricity production, can shift fixed utility infrastructure costs onto non-solar customers. This net metering incentive may shift costs onto less-affluent customers.

Taxpayer Contributions

Through the 30% federal tax credit, various state tax credits, state rebates ranging between 10% and 65%, and the additional tax deductions provided by the depreciation of the solar assets for third-party-owned systems, taxpayers as a whole are covering a significant portion of the cost of an individual's residential solar PV system in the United States. Figures 15 and 16 below show the percentage of the total incentives to solar system owners paid by group. Depending on the state, the share of incentives funded by taxpayers varies from approximately 10% to 65% under standard tariffs (excluding Louisiana).

Electric Customer Contributions

Through utility programs and utility purchases in REC markets, utility customers in all customer classes share the cost of residential solar PV systems. Customers currently contribute directly in about half of the states analyzed and, in at least five states, customers pay approximately 30% of the costs of residential solar PV systems.

Indirect Customer Impact

Residential solar PV systems rely on the use of the utility's distribution system to "buy" power when household energy consumption exceeds solar system production (e.g., at night) or "sell" power when solar system production exceeds household energy consumption (e.g., during the day). In the majority of jurisdictions, utility rate structures currently do not separately charge distribution costs to solar system owners. Such costs include capital expenditures for the poles, conductor, transformers, switches, and metering devices, as well as additional operation and maintenance expense to operate the system safely and reliably. To the extent utilities are not allowed to recover these costs directly from residential solar system owners, utilities may seek to recover these costs from other customers through increased rates. This indirectly impacts those customers who do not have residential solar PV systems.

Figure 15 and 16 show the percentage of incentives to solar system owners borne by each group. The indirect customer impact shown in this analysis represents the net energy metering incentive (or bill savings minus utility avoided costs).

- Incentives for Residential Solar PV Vary Widely Among the States

The total incentives for customer-owned residential solar PV facilities vary substantially among the states. Four factors create these disparities: (1) different state direct and REC incentives for residential solar energy, (2) different residential retail tariff designs, (3) different avoided utility costs and, (4) (for third party-owned facilities) different tax benefits. Still, on a dollar per-kW basis, in almost all states the package of

total incentives exceeds the average incentives provided to utility-scale solar PV projects. (Louisiana is the one exception, where rooftop solar owners only receive 25% of total costs through incentives.)

Figure 15. Taxpayer and Consumer Contributions – Direct-Owned Systems[39] (6.1 kW System) (Standard Rate)

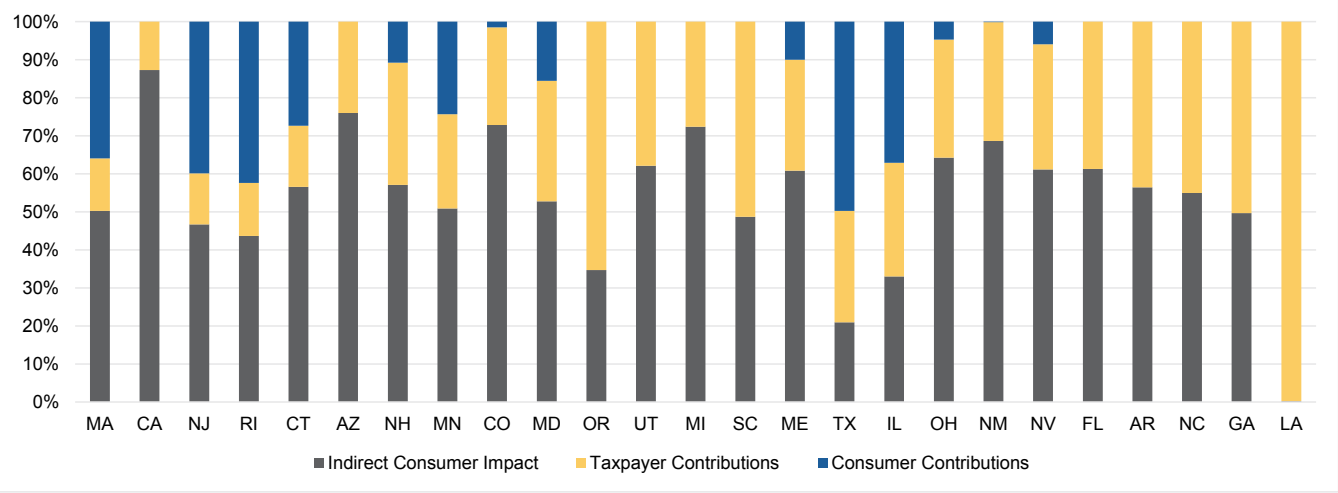
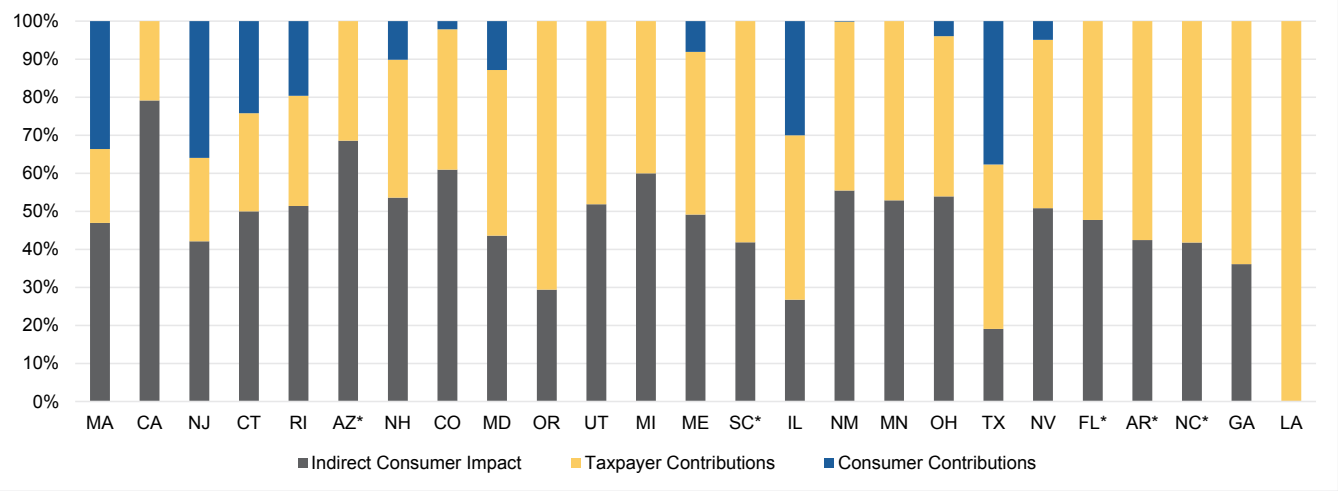


Figure 16. Taxpayer and Consumer Contributions – Third-Party-Owned Systems[40] (6.1 kW System) (Standard Rate)



**Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[41]*

39 Ibid.
40 Ibid.
41 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

Appendix A – Model Methodology and Required Inputs

This Appendix describes the sources, methodology and inputs ScottMadden used to estimate the installation costs, available incentives, bill savings, and avoided costs for residential solar PV systems in the United States. In this report, the total incentives available for owning and installing a solar PV system are calculated on a present value basis over the 25-year economic life of the residential solar PV facility. The analysis assumes a 25-year economic life for rooftop solar PV facilities consistent with the performance warranties of solar panel manufacturers.[42]

The analysis employed a Microsoft Excel model to calculate the present value of total incentives for direct-owned and third-party-owned solar PV systems. The Excel model calculates the annual streams of incentives over the 25-year life of the system, then discounts them to obtain their respective present value as of January 1, 2017. The analysis starts by calculating energy production and net energy metering incentives on an hourly basis, then aggregates these amounts on an annual basis over the life of the system.

Residential Rooftop Solar PV System Installation Costs

For residential rooftop solar PV systems, the analysis used an installation cost of $2.84 per watt-dc, which was the modeled national average turnkey) price in the first quarter of 2017. This price is sourced from the U.S. Solar Market Insight report published by GTM Research and the Solar Energy Industries Association.

The analysis also used a residential solar PV system size of 6.1 kilowatts, which is the median size of residential solar PV systems in the United States according to Lawrence Berkeley National Laboratory's Tracking the Sun IX report. New to this year's analysis is the inclusion of system O&M expense in total system costs. National Renewable Energy Laboratory's 2016 Annual Technology Baseline quantifies the fixed operation and maintenance expense for distributed residential PV systems at $20 per kilowatt per year.

Multiplying the average installation cost by the median system size results in an average installation cost of $17,324. To calculate total installed cost, ScottMadden added the annual

42 SunPower, High Performance, Excellent Durability https://global.sunpower.com/high-efficiency-solar-technology/solar-panels/ (accessed August 2017).

stream of O&M expense, inflated by 2.2 percent per year over the 25-year life of the system, to the average installation cost, and then discounted the sum to the present value using a discount rate of 4.5 percent (the resulting total cost was $19,722).

Available Direct Incentives

Available direct incentives by state were sourced from the Database of State Incentives for Renewables & Efficiency (DSIRE) managed by the North Carolina Clean Energy Technology Center. RECs were sourced from the Weekly REC Index from SNL Financial. Where incentives were given as a percentage of system cost, or as a factor of system production or size, ScottMadden converted these incentives using ScottMadden estimates of cost, system production, and system size to calculate the total incentives available. Table 5 below summarizes the available direct incentives by state.

It is important to note that some of the incentives included may vary depending on whether the system is owned directly by the consumer or leased from a third-party owner.

Table 5. Available Direct Incentives by State[43]
(Excluding Federal Tax Incentives)

State	State Tax Credits		State Rebates		Utility Programs		RECs	
	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned
AR*								
AZ*	$957	N/A						
CA								
CO					$292	$499		
CT			(4)	(4)	$8,450	$8,450		
FL*								
GA								
IL					$6,174	$6,174		
LA	(1)	(2)						
MA	$957	N/A					$15,434	$15,434
MD			$1,000	$1,000			$2,940	$2,940
ME							$1,711	$1,711
MI								
MN					$4,890	N/A		
NC*								
NH			$2,500	N/A			$2,515	$2,515
NJ							$14,770	$14,770
NM					$28	$28		
NV					$900	$900		
OH							$754	$754

43 Database of State Incentives for Renewables & Efficiency; ScottMadden Analysis. States with an asterisk disallow or otherwise restrict by law third-party solar power purchase agreements for residential installations. DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

State	State Tax Credits		State Rebates		Utility Programs		RECs	
	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned	Direct-Owned	Third-Party-Owned
OR	$5,381	$4,843	$1,830	$1,830				
RI	N/A	(3)	(4)	(4)	$15,126	$5,948		
SC*	$4,110	$4,110						
TX					$8,452	$8,452		
UT	$1,914	$1,914						

**Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.*

1. *Program out of money.*
2. *Program maximum system size of 6 kW, analysis uses a system size of 6.1 kW*
3. *Program exists, but not currently functioning.*
4. *Program exists, but customers receive higher incentives from the utility program and cannot participate in both the state rebate and utility program.*

State Tax Credits

In the 25 states included in the report, there are seven state tax credit programs currently available to rooftop PV systems. For purposes of the net present value analysis, these tax credits are assigned to the year after the PV system is installed. The analysis assumes the system is installed on January 1, 2017, and the owner will file their tax return in the spring of the following year. The present value of the tax credit incentives was determined by using a risk-adjusted discount rate.

In general, there are two different state tax credit incentive types: $ per watt and a percentage of installed cost. All six state tax credit programs included in ScottMadden report cap the incentive amount available to each customer. Incentive caps range from $1,000 to $10,000.

Louisiana offers tax credits for both customer-owned and third-party owned solar energy systems. The third-party owned incentive only applies to systems smaller than 6 kilowatts, so ScottMadden modeled system would not have qualified for this tax credit. In July 2016, Louisiana announced that the state has run out of money for the program, which was originally set to expire on December 31, 2017.

Rhode Island's residential customer-owned tax credit has been inactive since 2010, but a corporate third-party-owner tax credit still exists. However, according to state officials there is currently no guidance or functional way to leverage the tax credit for third-party owners.

State Rebates

In the 25 states included in the report, there are five state rebate programs currently available to rooftop PV systems. These incentives are rebates and not tax credits, therefore the incentives are assigned to the year the PV system was installed. The exception to this is Connecticut, which is discussed below.

All but one of the state rebate incentive programs are calculated on a dollar per watt basis. Connecticut's Residential Solar Investment program, which lasts six years, calculates incentives for third-party owners on a dollar per kilowatt-hour basis. Thus, for the six years of payments, a risk-adjusted discount rate was used to determine the present value of the rebate payments.

Connecticut's Residential Solar Investment program and Rhode Island's Small Scale Solar Grants program have different incentive amounts for direct owners and third-party owners. New Hampshire's Residential Small Renewable Energy Rebate Program is fully subscribed and a waitlist has been established.

Utility Programs

In the 25 states included in the report, there are eight utility programs currently available to rooftop PV systems. Because these incentives are credited to customer's electricity bills, incentive payments are assigned on a year-by-year basis. Again, a risk-adjusted discount rate is used to determine the present value of the utility program incentive payments. Unlike tax credit and rebate programs, which generally have either a maximum incentive amount or are calculated on a $ per watt basis, the maximum incentive amounts for utility programs are usually determined by program length. In addition to modeling the incentives offered by each utility, any applicable connection fees were also incorporated into the calculation of incentive payments. The connection fee can range from $100 to $250.

All of the utility programs transfer the REC ownership from the customer to the utility. (In Texas, Oncor Electric's program allows the customer to retain ownership of RECs, but reserves the right to claim the produced RECs at a later date.) Unlike REC market prices, which are determined by the competitive market, prices paid for RECs through these programs are determined by the utility or by a competitive solicitation process.

The difference in incentives between direct ownership and third-party ownership seen in state tax credit and state rebate programs is also see in utility programs. For example, in Colorado direct owners can receive program payments for 10 years, while Public Service Company of Colorado (PSCo) owns the RECs for 20 years. However, third-party owners can enter into a 20-year agreement with PSCo, and receive payments over the life of the agreement.

In Connecticut, Eversource Energy's Small ZREC program conducts a random selection process to choose customers for the tariff program. ScottMadden analysis assumes that the modeled customer is selected in the random selection process and receives the incentive for the life of the 15-year program. The price of the Small REC incentive is determined each year by adding 10% to the weighted average of the Medium ZREC price. The Medium ZREC price is determined through a competitive solicitation process.

Illinois's DG REC Procurement program pays incentives quarterly, unlike other programs where incentives are directly credited to the customer's utility bill.

In Nevada, NV Energy's SolarGenerations Rebate Program determines the program's maximum incentive payment based on PV systems installed in the SolarGenerations Program in the quarter prior to installation. For systems smaller than 25 kilowatts, incentive payments cannot exceed 50% of the average installation cost per watt. This average is published quarterly by NV Energy on the SolarGenerations website. Following a recent regulatory proceeding, NV Energy increased the incentives available through their SolarGenerations program. ScottMadden analysis uses the incentives available on January 1, 2017.

In Rhode Island, National Grid's solar PV system owners fall under a "buy-all, sell-all" program. The Renewable Energy Growth Program calculates the incentive based on the standard performance of the system. The homeowner receives the same incentive for the entire duration of the program. During the program, the solar PV system's production flows directly into National Grid's grid and the customer buys electricity from National Grid at the residential tariff price. For bill savings, ScottMadden analysis uses the System Advisor Model calculation which assumes net metering. However, in Rhode Island, the system owner will not see a direct reduction in their electricity utility bill as they are still buying the same amount

of electricity from National Grid. ScottMadden analysis corrects for this by subtracting the calculated bill savings from the utility incentive. Once the contract is completed, the system owner has the option of entering into a 15-year or 20-year net metering agreement with National Grid. National Grid offers higher incentive rates for the 15-year contracts. However, ScottMadden analysis assumes the system owner will choose a 20-year contract, as it has a higher present value than the 15-year contract.

In Texas, Oncor Electric's Solar Photovoltaic Standard Offer Program pays customers for both installed capacity ($ per watt) and production ($ per kilowatt-hour). Unlike other incentive programs, which determine the installed capacity incentive on a kilowatt-dc basis, Oncor Electric's program determines the one-time installation payment on a kilowatt-ac basis. In order to calculate the incentive, this analysis converts the 6.1 kilowatt-dc installed capacity to kilowatt-ac.

If there is net surplus energy at the end of the year, Southern California Edison offers customers a Net Surplus Compensation Rate (NSCR) which will buy the RECs from customers. ScottMadden analysis assumes there is no surplus energy available at the end of the year, so customers would not receive any incentive payments under this program.

Renewable Energy Certificates

Renewable Energy Certificates (RECs) represent one Megawatt-hour (or 1,000 kilowatt-hours) of electricity generated from a renewable energy resource. In the United States, RECs act as tradable commodities because electric suppliers serving customers in 30 states must procure them as part of state renewable portfolio standards (RPS). If electric suppliers do not secure enough RECs to comply with a state's RPS, the suppliers must pay the alternative compliance payment (ACP) set by the state. ACPs are penalty payments, which essentially set price caps on RECs.

It is important to track the ownership of RECs to ensure there is no double counting of REC incentives. In 18 of the 25 states analyzed, the owner of the system receives the produced RECs. In six of the 25 states the RECs were unassigned, and in North Carolina the utility owns all produced RECs from a net-metered system. For the six states with unassigned RECs, ScottMadden analysis assumed that the system owner would own the produced RECs.

Not all states have a RPS, so RECs in those states may not have the same value as they would in a state with a RPS. In addition, some states require that RECs must be generated from inside the state, while other states do not have this restriction. Customers with systems in states without a RPS can sell their RECs into states with no generation-location restrictions. However, the REC markets in these states are typically flooded with parties wishing to sell RECs, often pushing the price of RECs to close to $0. In theory, all RECs have potential economic value, but in today's REC markets many RECs hold little or no value.

For the 24 states where the system owner owns the RECs, ScottMadden analysis modeled the approach which would provide the owner the highest incentives over the lifetime of the PV system. There are two approaches for receiving an incentive for RECs: utility REC purchase programs (explained above in utility programs) or state REC markets. As mentioned earlier, not all states have REC markets as these markets are generally driven by state renewable portfolio standards. In some cases, carve-outs within the RPS drive the price of RECs even higher. For example, Massachusetts's Solar Carve-Out program provides additional incentives to foster the development of 400 megawatts of solar PV across Massachusetts.

REC market prices in this analysis are determined by using the average of 2016 REC prices. Direct owners and third-party owners are treated the same when calculating the incentives for selling RECs in state markets.

The analysis assumes that REC payments will only last for 10 years due to market uncertainty. System owners receive the full price of RECs for the first seven years. In the next three years (years 7 through 9), ScottMadden analysis modeled REC incentive payments such that REC prices trended to $0 in year 10. (Note: the solar PV system is assumed to have been installed on January 1, 2017, so 2017 is Year 0 and 2018 is Year 1 in this analysis.) In calculating REC payments, ScottMadden analysis uses a simplifying approach that also avoids carrying fractional shares to the following year. The analysis assumes that it is possible to sell fractional shares (e.g., 9,500 kWh produced at the end of the year is 9.5 RECs).

Where multiple incentives were available in exchange for REC ownership, the incentive with the higher value to the system owner was used. For example, Connecticut residents have two programs which will buy their RECs. If a system owner accepts payment from CT's Residential Solar Investment Program their generated RECs go the CT Green Bank. The utility program, through Eversource Energy, currently pays a higher price for the RECs. The model assumes the customer will choose the higher incentive option. The model also assumes the system owner is selected to be a part of the Eversource Energy program, which is based on random selection.

Table 6. Renewable Energy Certificate (REC) Owner

State	Renewable Energy Certificate (REC) Owner
AR	Customer
AZ	Customer
CA	Customer*
CO	Customer
CT	Customer
FL	Customer
GA	Unassigned
IL	Customer
LA	Unassigned
MA	Customer
MD	Customer
ME	Customer
MI	Customer
MN	Customer
NC	Utility
NH	Customer
NJ	Customer
NM	Customer
NV	Customer
OH	Unassigned
OR	Customer

State	Renewable Energy Certificate (REC) Owner
RI	Unassigned
SC	Unassigned
TX	Unassigned
UT	Customer

**If a customer receives payment for net excess generation at the end of a 12-month billing cycle, the resulting RECs belong to the utility.*
Note: The analysis assumes there is no net excess generation.

Federal Tax Incentives

The federal tax credit for residential solar PV is the residential Renewable Energy Tax Credit (RETC), which is equal to 30% of the solar PV facility's installed cost. Commercial businesses (third-party owners) receive an equivalent 30% Business Energy Investment Tax Credit on their investments in solar facilities.

Legality of Third-Party Ownership

Third-party ownership of solar PV systems is not allowed in all states. However, for the purposes of this analysis, ScottMadden assumes that all states allow third-party ownership. There are currently five states in which third-party solar power purchase agreements with residential customers are not allowed: Arizona, Arkansas, Florida, North Carolina, and South Carolina. However, in July 2017, North Carolina passed a law which legalizes third-party solar leases to residential homeowners. Because the third-party-ownership model in this analysis is most like a power purchase agreement (PPA), it is worth noting that South Carolina allows solar leases but not PPAs.[44] Arizona limits third-party ownership to schools, governments and other non-profit organizations.[45] The states in which third-party ownership is not allowed have been noted throughout the report.

Of the six state tax credit programs, Arizona's and Massachusetts's programs do not allow third-party-owned systems to receive the tax credit. In these two programs only homeowners who directly purchase the system are eligible for the personal tax credit incentive payment. Similar to Arizona's and Massachusetts's state tax credit programs, New Hampshire's state rebate program does not allow third-party-owned systems to receive the state rebate incentive payment.

Net Energy Metering

Net energy metering, where available, allows direct owners to sell net excess generated energy to the utility in return for a bill credit. The bill savings calculation in the System Advisor Model (SAM) utilized by ScottMadden for this analysis takes into account state and utility net metering guidelines. However, net energy metering is not allowed in all states. Of the 25 states selected for analysis in this report, only Texas does not allow net energy metering. To accurately forecast the bill savings in Texas, ScottMadden analysis uses a different "monthly accounting of excess generation" option in SAM. For the states that do allow net metering, ScottMadden analysis uses the "monthly total excess rolled over to the next month bill in kWh" approach. For Texas, ScottMadden analysis used "cumulative hourly (sub-hourly) excess credited to current month bill in $ at sell rate(s)." In order to properly calculate no net metering, the sell price is set to $0, so the customer receives nothing for any energy sent back to the grid.

44 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.
45 Ibid.

Standard Versus TOU Rates

This analysis uses the U.S. Utility Rate Database, developed and maintained by the National Renewable Energy Laboratory (NREL), to identify standard and time-of-use tariffs for each of the 25 selected utilities. The bill savings incentive, calculated by the System Advisor Model, uses the selected tariffs to quantify 25 years of savings. Because SAM and the U.S. Utility Rate Database are both developed by NREL, the SAM model pulls tariff information directly from the U.S. Utility Rate Database. SAM and the U.S. Utility Rate Database are also able to account for other fixed fees, seasonal charges, and consumption tiers.

To find a representative utility within the newly selected states, ScottMadden chose the utility that serves the largest metropolitan statistical area (MSA) in each state. Where the primary city within the largest MSA was in a neighboring state, the next largest MSA was selected. It is important to note that ScottMadden analysis does not include demand charges. Where multiple standard tariffs are available to a homeowner, the single-phase, above-ground tariff is chosen. If a utility had multiple TOU tariffs, the tariff which would generate the largest bill savings was chosen.

Table 7. Selected Tariffs

State	Utility	Standard Tariff	Time-of-Use Tariff
AR	Arizona Public Service (APS)	General Purpose Residential Service (RS) Single Phase	Optional Residential Time-Of-Use (RT) Single Phase
AZ	Entergy Arkansas	Residential Service Standard (E-12)	Residential Service TOU Time Advantage 7PM-Noon (ET-2)
CA	Southern California Edison	Domestic Service: D - Baseline Region 6	Time-of-use Tiered Domestic: TOU-D-T - Region 6
CO	Public Service Company of Colorado (Xcel Energy)	Residential Service (Schedule R)	Residential Time of Use (Schedule R-TOU)
CT	Connecticut Light & Power Company (Eversource Energy)	Residential Electric Service	Rate 7 - Residential Time-Of-Day Electric Service
FL	Florida Power & Light Company (FPL)	RS-1 Residential Service	RTR-1 Residential TOU Rate (RS-1 w/ TOU Rider)
GA	Georgia Power Company (Southern Company)	Schedule R-22 Residential Service	Schedule TOU-REO-10 Time of Use - Residential Energy Only
IL	Commonwealth Edison Company (Exelon)	BES - Residential Single Family with Electric Space Heat Delivery Class	N/A
LA	Entergy Gulf States Louisiana	Residential Service (RS-G)	N/A
MA	Central Maine Power Company (Avangrid)	Greater Boston Residential R-1 (A1)	Greater Boston Optional Residential Time-of-Use R-4 (A5)
MD	Baltimore Gas & Electric Company (Exelon)	Residential Service (Schedule R)	Residential Optional Time of Use (Schedule RL)
ME	NSTAR Electric Company (Eversource Energy)	A Residential Standard Offer Service (Bundled)	A-TOU-OPTS Residential Service - Optional Time-Of-Use (Super Saver)
MI	DTE Energy	Residential Service Rate-(Full Service)-D1	Residential Time of Day Full Service
MN	Northern States Power Company (Xcel Energy)	Residential Service - Overhead Standard (A01)	Residential TOD Overhead Standard (A02)
NC	Duke Energy Carolinas	RS (Residential Service)	RT (Residential Service Time of Use)
NH	Public Service Company of NH (Eversource Energy)	Residential Service	Residential Time-of-Day

State	Utility	Standard Tariff	Time-of-Use Tariff
NJ	Public Service Electric & Gas Company	RS - Residential Service	N/A
NM	Public Service Company of New Mexico	1A (Residential Service)	1B (Residential Service Time-Of-Use)
NV	Nevada Power Company (NV Energy)	RS - NEM	ORS-TOU Optional Residential Service Time of Use (Option A)
OH	Cleveland Electric Illuminating	RS (Residential Service)	N/A
OR	Portland General Electric (PGE)	Residential Service (Rate 7)	Residential Time-Of-Use Service (Rate 7-TOU)
RI	National Grid	A-16 (Residential Service)	N/A
SC	Duke Energy Carolinas, LLC (South Carolina)	Residential - RS	N/A
TX	Oncor Electric Delivery Company	Residential LSP POLR	N/A
UT	Rocky Mountain Power (PacifiCorp)	Schedule 1 (Residential Service - Single Phase)	N/A

Bill Savings

The SAM model developed by the National Renewable Energy Laboratory simulates hourly production from the solar PV system and calculates bill savings. This report calculated 25 years of bill savings for both standard and time-of-use tariffs (where applicable). ScottMadden report intentionally simplified the SAM calculation. The only inputs needed for the bill savings calculation in SAM include location of installed PV system, utility tariff, household consumption, PV system degradation rate (0.5% per year), and inflation rate (2.2% per year). The SAM model then simulates the solar facility's hour-by-hour energy output (for 8,760 hours) during the study year (2016). The PV system degradation rate is based on a report by the National Renewable Energy Laboratory.[46] The annual inflation rate is the 30-year Treasury Bond Yield, 2024-2028 Consensus published in the Blue Chip Financial Forecast on June 1, 2017.

PV system locations are determined by the largest metropolitan area in each state (see Appendix C). Note that the second largest metropolitan area was selected in states where the largest metropolitan area crosses state borders, such as Washington D.C., for Maryland and Cincinnati, Ohio.[47] For each utility, the standard and time-of-use (TOU) tariffs were selected.[48] The Energy Information's (EIA) annual average electricity consumption for a U.S. residential utility customer was used in the calculation of bill savings.

Avoided Energy Costs

SAM's simulation of the solar facility's hour-by-hour energy output (8,760 hours) during the study year (2016) is used to calculate the utility's avoided energy costs. The PV system's hourly production simulated by SAM is increased hour-by-hour by each utility's reported line losses to calculate total avoided energy. Line losses are added because utilities would have to generate more than the PV system's production at a generating power plant to equal the solar PV system output at the home. Utility-specific line losses are gathered from FERC Form 1 data. Energy Information Administration (EIA) state-level data is used for utilities that did not report line losses in the FERC Form 1.

46 National Renewable Energy Laboratory, Photovoltaic Degradation Rates — An Analytical Review (June 2012), http://www.nrel.gov/docs/fy12osti/51664.pdf.
47 U.S. Census Bureau.
48 NREL, U.S. Utility Rate Database.

To calculate the costs of avoided energy, the hourly total avoided energy is multiplied by either the appropriate locational marginal price (LMP) or the system lambda. LMP is the marginal cost of supply of the next increment of electric demand. LMPs were collected for the corresponding market hub for each utility. For states where no LMP is available, ScottMadden analysis uses the supply curve and historical hourly loads of the respective utility to generate the system lambda. System lambda is the cost of the last unit of energy produced.

All hourly avoided energy costs are summed for the year to create the avoided cost of energy for the study year. The model then calculates the avoided energy over the 25-year life of the system by decreasing the PV system's production by 0.5% per year for solar panel degradation, and inflating the total avoided cost of energy by the inflation rate (2.2%).

Avoided Capacity Costs

One potential benefit of solar PV capacity is the potential for lower capacity needs for the utility providing generation service to that customer. There are several ways to estimate the potential capacity value, and hence capacity benefit, of a solar PV resource. These methods have been summarized and studied by a number of different institutions.[49]

ScottMadden's model estimates the utility's avoided cost of generating capacity purchases from the wholesale market or avoided generating capacity needs for the system. The capacity value of the PV system reflects its ability to reliably meet load or reduce the need for conventional capacity. This can occur if the PV system reduces the peak demand for electricity and thus reduces the need for peaking capacity.

ScottMadden used a capacity factor approximation approach to estimating avoided capacity from an installed solar PV system. The amount of avoided generating capacity depends on how much energy is produced by the residential PV system. The approach used considered the output of a generator (capacity factor) over a subset of periods during which the system faces a high risk of an outage event. These periods generally correspond to periods of highest net load. Thus, the capacity factor approximation using net load approach simply examines the average capacity factor of the PV system over a set of the highest net-load hours. To find a reasonable estimate of solar energy production, the solar capacity factor of the highest 30% of power system loads in the year is multiplied by the installed capacity of the solar system (6.1 kilowatts). Note, the "power system loads" refer to those of the balancing authority (e.g., ISO-NE), not necessarily the utility's load.

The PV system's capacity is given a monetary value by comparing it to the value of capacity for an assumed marginal generating resource. A standard proxy for the marginal generating resource for valuing capacity is the cost of new entry (or CONE). This is typically represented by a natural gas-fired combustion turbine unit. In estimating a proxy for capacity value, ScottMadden used the cost of an advanced gas-fired combustion turbine generator (or CT). ScottMadden calculated the CT's capacity by multiplying its summer capacity by its summer availability – assumed to be 95 percent. The estimated solar PV capacity value (adjusted to

49 See for example, North American Electric Reliability Corp., Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning (Mar. 2011); National Renewable Energy Laboratory (NREL), Solar Energy and Capacity Value (Sept. 2013); C. Bothwell & B. Hobbs, System Adequacy with Intermittent Resources: Capacity Value and Economic Distortions, presentation at ISO-New England LOLEWG (Jul. 22, 2016), available at https://www.iso-ne.com/static-assets/documents/2016/09/PSPC09222016_A4_Cindy-Bothwell-Johns-Hopkins-University-System-Adequacy-with-Intermittent-Resources-Capacity-Value-and-Economic-Distortions.pdf; NREL, Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generation to the U.S. Electric Utility System, Technical Report NREL/TP-6A20-62447 (Sept. 2014).

account for the lower CT capacity value) was then multiplied by the levelized, present value annual cost of the CONE resource (the CT). This estimate was repeated over each year of the analysis, valuing capacity at the levelized cost of a new resource built for service in that year.

The value of a new CT is calculated based on the generic overnight construction cost and fixed operation and maintenance expense published by the Energy Information Administration in 2016. These costs are adjusted by region to reflect differences in plant temperatures and humidity levels which affect the capacity of a CT. Table 8 shows the regional adjustments made to overnight construction costs. In addition to the adjustments made in Table 8, ScottMadden factored in financing charges for the construction period, depreciation, income taxes, property taxes, insurance and O&M expense for the 20-year life of the CT.

In the table below, EMM regions refers to the various supply regions for electricity in the United States developed by the EIA. The After-Tax WACC refers to the after-tax weighted average cost of capital. This figure is calculated by multiplying the cost of capital by its weight and applying the federal and state tax rate. This analysis uses a debt cost of 7.75%, equity cost of 12%, and debt-to-equity ratio of 60%.[50] For state tax rates, this report relies on the rates reported by the Tax Foundation.[51]

Table 8. Regional CT Adjustments[52]

State	EMM Region	Generic Overnight Cost (2016 $/kW)	Regional Capacity Adjustment (2016)	Regional Cost Adjustment (2016)	Fixed O&M (2016 $/kW)	After-Tax WACC	Adjusted Overnight Cost (2016 $/kW)
AR	SRDA	$678	0.98	0.96	$6.80	7.52%	$637.86
AZ	AZNM	$678	0.91	1.04	$6.80	7.57%	$641.66
CA	CAMX	$678	0.98	1.29	$6.80	7.41%	$857.13
CO	RMPA	$678	0.86	1.05	$6.80	7.61%	$612.23
CT	NEWE	$678	1.03	1.20	$6.80	7.40%	$838.01
FL	FRCC	$678	0.95	0.93	$6.80	7.57%	$599.01
GA	SRSE	$678	0.96	0.97	$6.80	7.54%	$631.35
IL	RFCW	$678	1.02	1.06	$6.80	7.46%	$733.05
LA	SRDA	$678	0.96	0.96	$6.80	7.45%	$624.84
MA	NEWE	$678	1.03	1.20	$6.80	7.45%	$838.01
MD	RFCE	$678	1.01	1.25	$6.80	7.44%	$855.98
ME	NEWE	$678	1.05	1.20	$6.80	7.41%	$854.28
MI	RFCM	$678	1.02	1.02	$6.80	7.54%	$705.39
MN	MROW	$678	1.02	1.00	$6.80	7.37%	$691.56
NC	SRVC	$678	0.97	0.93	$6.80	7.64%	$611.62
NH	NEWE	$678	1.04	1.20	$6.80	7.43%	$846.14
NJ	RFCE	$678	1.02	1.25	$6.80	7.40%	$864.45
NM	AZNM	$678	0.84	1.04	$6.80	7.52%	$592.30
NV	NWPP	$678	0.9	1.03	$6.80	7.82%	$628.51
OH	RFCW	$678	1.02	1.06	$6.80	7.81%	$733.05

50 ISO-NE, ISO-NE CONE and ORTP Analysis (Dec. 2, 2016), Section 3.E and Tables 27-29.

51 Tax Foundation; State Corporate Income Tax Rates and Brackets for 2016 (Excel Spreadsheet). In states that do not have state corporate income taxes, marginal gross receipts taxes were used.

52 U.S. Energy Information Administration, Capital Cost Estimates for Utility Scale Electricity Generating Plants, November 2017; ScottMadden analysis.

State	EMM Region	Generic Overnight Cost (2016 $/kW)	Regional Capacity Adjustment (2016)	Regional Cost Adjustment (2016)	Fixed O&M (2016 $/kW)	After-Tax WACC	Adjusted Overnight Cost (2016 $/kW)
OR	NWPP	$678	1.02	1.03	$6.80	7.47%	$712.31
RI	NEWE	$678	1.03	1.20	$6.80	7.50%	$838.01
SC	SRVC	$678	0.97	0.93	$6.80	7.59%	$611.62
TX	ERCT	$678	0.96	0.95	$6.80	7.79%	$618.34
UT	SPSO	$678	0.89	1.01	$6.80	7.59%	$609.45

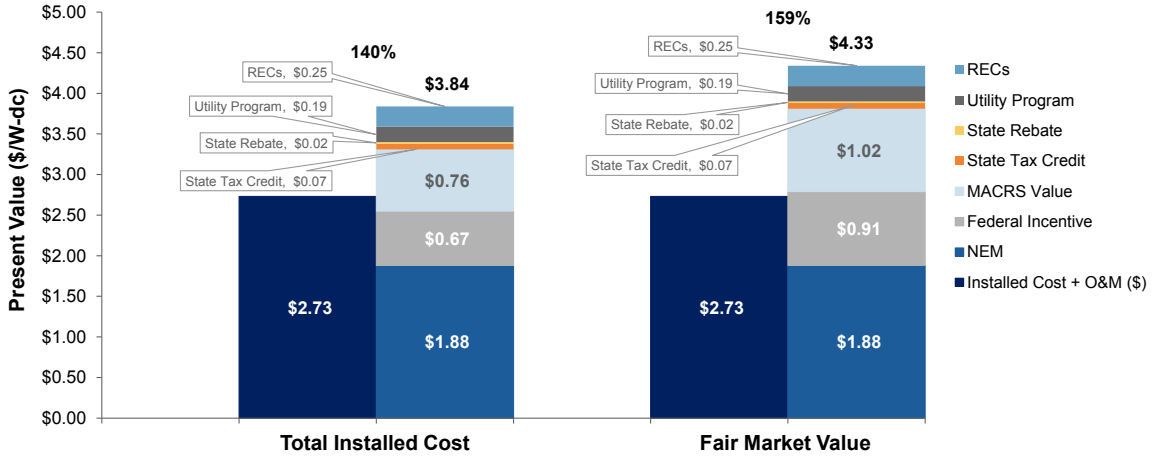
Net Energy Metering Incentives

As described above, SAM was utilized in part to calculate net energy metering incentives as it takes into account different seasonal charges. Also, unlike last year's report, this analysis takes into account different consumption tariff tiers to calculate a more accurate net energy metering incentive. SAM was also used to bring transparency to the report, as analysis results can be replicated with easily accessible information. To calculate the net energy metering incentive for each state, the present value of utility avoided energy and capacity costs were subtracted from the present value of estimated customer bill savings over the 25-year life of the solar PV system.

Fair Market Value of Third-Party-Owned Systems

Third-party owners are able to generate additional incentives because they are able to depreciate the solar PV system as a business asset. ScottMadden analysis assumes that third-party owners will use the installed cost to calculate MACRS deductions and the federal tax credit. However, third-party owners commonly base MACRS depreciation and the federal tax credit on the PV system's fair market value. Third-party owners use an income approach to calculate fair market value, which will produce a higher value than installed cost. ScottMadden didn't include the fair market value in ScottMadden state-by-state analysis because the markup value can vary widely company to company. To illustrate the incentives gained by third-party owners using fair market value, ScottMadden modeled an average third-party-owned system with a 35% markup, resulting from the income approach to fair market value.[53]

Figure 17. Impact of Fair Market Value on Incentives[54]



53 Navigant, Solar Project Return Analysis for Third Party Owned Solar Systems (Feb. 19, 2016) pg. 16.
54 ScottMadden analysis.

Appendix B – Alternative Analysis and Results

For a consumer who is investigating the ownership or lease of a solar PV system, a comparison of the direct out-of-pocket costs, available direct incentives, and bill savings associated with the installation of a solar PV system may be a more appropriate analysis. From the consumer's perspective, whether a utility is able to offset some of the bill savings by avoiding energy and capacity costs for the alternative generation source should not impact this cost-benefit analysis. Therefore, for this alterative analysis, total incentives include customer bill savings instead of the net metering incentive found in the earlier analysis.

The results of the cost-benefit analysis for direct-owned and third-party-owned solar PV systems are shown below.

Total Incentives for Residential Direct-Owned Solar Systems

Given total available incentives, based on a simple cost-benefit analysis, it is clear that in most of the states studied, residential solar is economical for direct-owners of PV systems. In a few states, direct owners would receive more than double the total system costs in total incentives under a standard rate structure over the lifetime of the system. Only in Florida, North Carolina, Arkansas, and Louisiana do the present value of total system costs exceed total incentives under existing federal and state policies and applicable utility programs. The total incentives available for installing a direct-owned solar PV system under standard electricity rates and TOU rates by selected state are depicted in Figures 18 and 19. Note that not all utilities offer TOU rates, so Rhode Island, New Jersey, Texas, Utah, South Carolina, Illinois, Ohio, and Louisiana are not included in the TOU analysis. Total incentives range from 260% of total costs in Massachusetts to 59% of costs in Louisiana under standard tariffs. Total incentives range from 271% of total costs in Massachusetts to 70% of costs in North Carolina under TOU tariffs (see Tables 9 and 10).

Figure 18. Total Incentives for a Direct-Owned Solar PV System[55] (6.1 kW System) (Standard Rate)

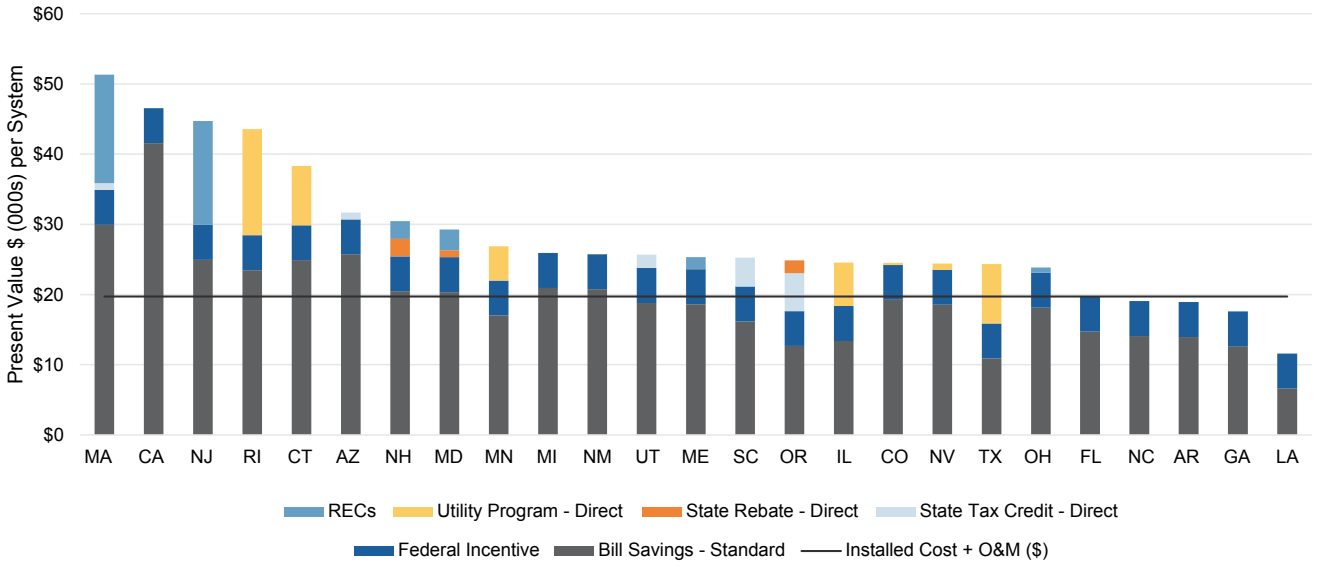
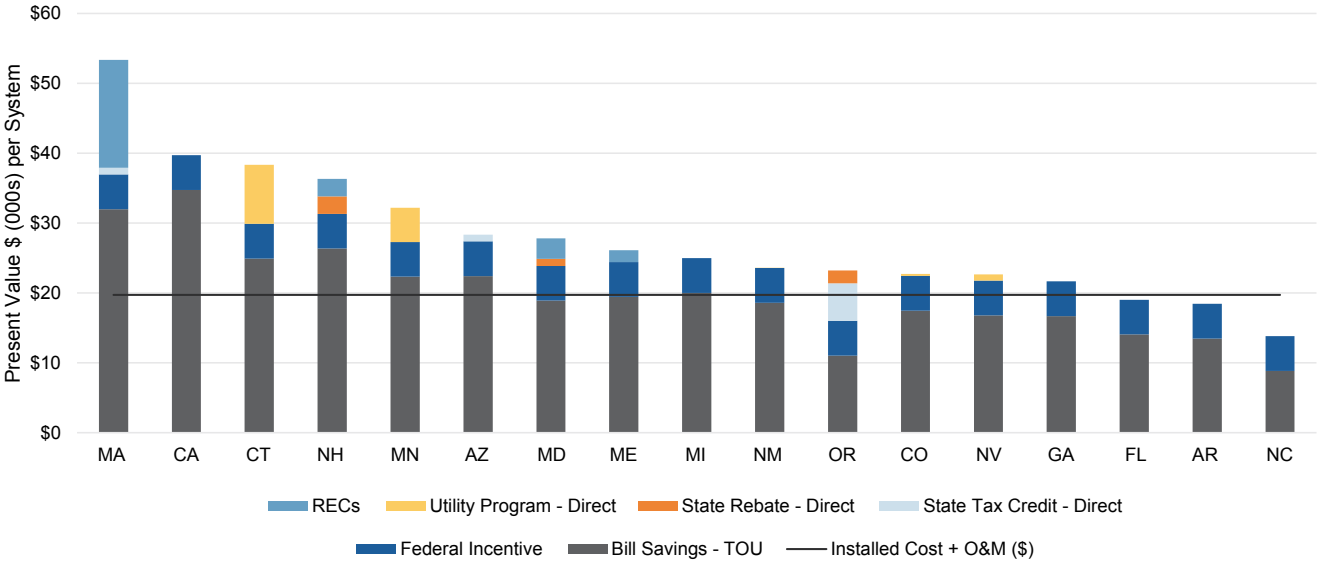


Table 9. Total Incentives as a Percentage of Total Costs[56] (6.1kW System) (Standard Rate)

State	MA	CA	NJ	RI	CT	TX	AZ	NH	MD	MN	MI	NM
%	260%	236%	227%	221%	194%	180%	161%	154%	148%	136%	131%	131%

UT	ME	SC	OR	IL	CO	OH	FL	NC	AR	GA	NV	LA
130%	128%	128%	126%	124%	124%	121%	100%	97%	96%	72%	71%	59%

Figure 19. Total Incentives for a Direct-Owned Solar PV System[57] (6.1kW System) (Time-of-Use Rate)



55 Ibid.
56 Ibid.
57 Ibid.

Table 10. Total Incentives as a Percentage of Total Costs[58] (6.1kW System) (Time-of-Use Rate)

State	MA	CA	CT	NH	MN	AZ	MD	ME
%	271%	201%	194%	184%	163%	144%	141%	132%

MI	NM	OR	CO	FL	AR	NV	GA	NC
127%	120%	118%	115%	96%	93%	76%	71%	70%

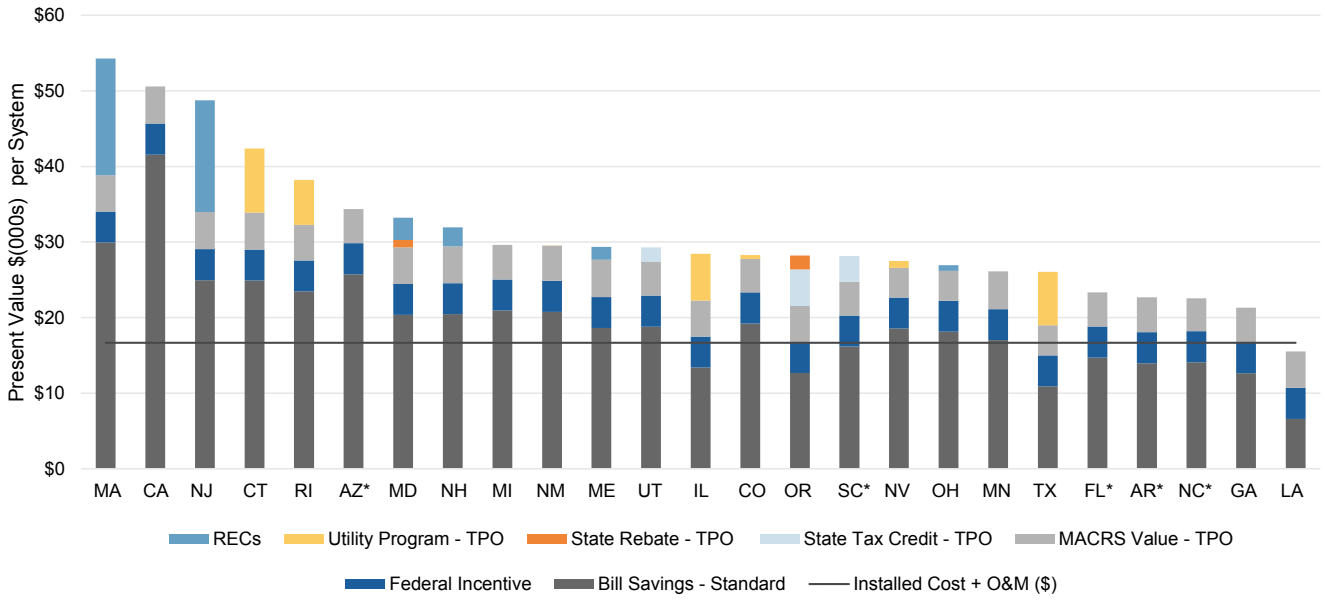
Total Incentives for Residential Third-Party-Owned Solar Systems

Figures 20 and 21 below provide an illustration of total incentives compared to average installed cost for third-party-owned solar systems. In contrast to direct-owned solar, third-party-owned solar also benefits from accelerated depreciation (under MACRS) which generates additional tax benefits for the third-party system owner. In all but one state (Louisiana), total incentives exceed total system costs under standard rate structures. Under TOU rates, total incentives exceed total system costs in all states but North Carolina. Note that not all utilities offer TOU rates, so Rhode Island, New Jersey, Texas, Utah, South Carolina, Illinois, Ohio, and Louisiana are not included in the TOU analysis.

Total incentives range from 285% of total costs in Massachusetts to 88% of costs in Louisiana under standard tariffs. Total incentives range from 295% of total costs in Massachusetts to 97% of costs in North Carolina under TOU tariffs (see Tables 11 and 12).

It is also important to note that the total cost included in this analysis does not take into account any contract premiums consumers might pay under power purchase agreements. Thus, this analysis may not reflect the true out-of-pocket cost for consumers wishing to install third-party-owned solar systems.

Figure 20. Total Incentives for a Third-Party-Owned Solar PV System[59] (6.1 kW System) (Standard Rate)



Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers[60]

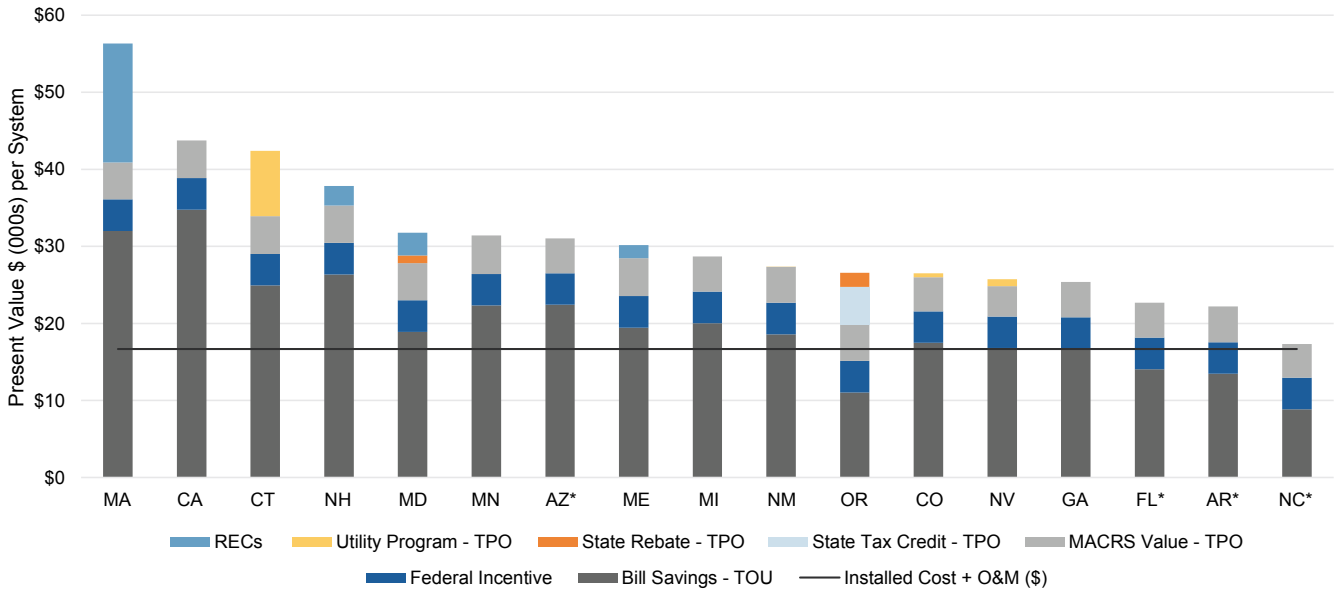
58 Ibid.
59 Ibid.
60 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.

Table 11. Total Incentives as a Percentage of Total Costs[61] (6.1 kW System) (Standard Rate)

State	MA	CA	NJ	CT	RI	AZ	MD	NH	MI	NM	ME	UT
%	326%	303%	292%	254%	229%	206%	199%	192%	178%	177%	176%	176%

IL	CO	OR	SC	NV	OH	MN	TX	FL	AR	NC	GA	LA
171%	170%	169%	169%	165%	162%	157%	156%	140%	136%	135%	128%	93%

Figure 21. Total Incentives for a Third-Party-Owned Solar PV System[62] (6.1 kW System) (Time-of-Use Rate)



Third-party solar power purchase agreements disallowed or otherwise restricted by law for residential customers.[63]

Table 12. Total Incentives as a Percentage of Total Costs[64] (6.1 kW System) (Time-of-Use Rate)

State	MA	CA	CT	NH	MD	MN	AZ	ME
%	338%	262%	254%	227%	191%	189%	186%	181%

MI	NM	OR	CO	GA	FL	AR	NV	NC
172%	164%	159%	159%	152%	136%	133%	154%	104%

61 ScottMadden analysis.
62 Ibid.
63 DSIRE, 3rd Party Solar PV Power Purchase Agreement (PPA); April 2017.
64 ScottMadden analysis.

Appendix C – Selected States and Representative Utilities

To expand on last year's report, an additional 10 states were selected for analysis. To find a representative utility within the newly selected states, ScottMadden chose the utility that serves the largest metropolitan statistical area (MSA) in each state. Where the primary city within the largest MSA was in a neighboring state, the next largest MSA was selected. For example, Baltimore was selected for Maryland rather than Washington, D.C. which is the largest MSA in Maryland. The table below shows the selected states, primary city within the largest MSA in these states, and the representative utility selected.

Table 13. Metropolitan Statistical Area and Representative Utility in Each State[65]

State	Primary City Within Largest Metropolitan Statistical Area	Representative Utility (Parent Company)
Arizona	Phoenix	Arizona Public Service (APS)
Arkansas*	Little Rock	Entergy Arkansas
California	Los Angeles	Southern California Edison
Colorado*	Denver	Public Service Company of Colorado (Xcel Energy)
Connecticut	Hartford	Connecticut Light & Power Company (Eversource Energy)
Florida	Miami	Florida Power & Light Company (FPL)
Georgia	Atlanta	Georgia Power Company (Southern Company)
Illinois	Chicago	Commonwealth Edison Company (Exelon)
Louisiana	Baton Rouge	Entergy Gulf States Louisiana
Maine	Portland	Central Maine Power Company (Avangrid)
Maryland*	Baltimore	Baltimore Gas & Electric Company (Exelon)
Massachusetts	Boston	NSTAR Electric Company (Eversource Energy)
Michigan	Detroit	DTE Energy
Minnesota	Minneapolis	Northern States Power Company (Xcel Energy)
Nevada	Las Vegas	Duke Energy Carolinas
New Hampshire	Manchester	Public Service Company of NH (Eversource Energy)
New Jersey	Newark	Public Service Electric & Gas Company
New Mexico*	Albuquerque	Public Service Company of New Mexico
North Carolina	Charlotte	Nevada Power Company (NV Energy)
Ohio*	Cleveland	Cleveland Electric Illuminating
Oregon*	Portland	Portland General Electric (PGE)
Rhode Island*	Providence	National Grid
South Carolina*	Greenville	Duke Energy Carolinas, LLC (South Carolina)
Texas*	Dallas-Fort Worth	Oncor Electric Delivery Company
Utah*	Salt Lake City	Rocky Mountain Power (PacifiCorp)

**Denotes states which are new for the 2017 report.*

65 U.S. Census Bureau, Metropolitan and Micropolitan Statistical Area Tables, 2016; ScottMadden analysis.

Appendix D – Glossary

- **ACP** – stands for alternative compliance payment, which are payments that electric suppliers must pay if they do not secure enough RECs to comply with a state's renewable portfolio standard
- **After-Tax WACC** – stands for the after-tax weighted average cost of capital. This figure is created by multiplying the cost of capital by its weight and applying the federal and state tax rate
- **Avoided Capacity Cost** – is the marginal cost for a public utility to produce one more unit of energy. The report measures this by calculating the cost of a building a new, state-of-the-art, gas-fired combustion turbine
- **Avoided Energy Cost** – the cost the utility company saves by not producing one more unit of energy
- **Bill Savings** – the annual savings a customer can expect from their utility bill. It is a product of solar PV generation and the electricity prices in the customer's retail tariff
- **Capacity Payment** – An expected cash flow from the power generation of a new power plant. The capacity payment must equal or exceed the cost of investment for the project to be undertaken
- **CONE** – stands for cost of new entry and refers to the capital cost of constructing a new power plant
- **CT** – refers to a natural gas combustion turbine
- **DSIRE** – stands for Database of State Incentives for Renewables & Efficiency

- **EIA** – refers to the U.S. Energy Information Administration
- **ELCC** – refers to the Effective Load-Carrying Capability of a solar PV resource, which is defined as the amount of additional load a power system can serve, with the same ex ante level of reliability, after the resource is added to the system
- **EMM** – stands for Electricity Market Module. The EMM was developed to represent capacity planning, dispatching, and pricing of electricity. Based on fuel prices and electricity demands, the EMM determines the most economical way to supply electricity within environmental and operational constraints

- **EMM Region** – EMM regions were developed by the EIA and represent the various supply regions for electricity in the United States. These regions correspond to the NERC regions
- **FERC** – stands for the Federal Energy Regulatory Commission
- **Fixed O&M Expense** – means the operation and maintenance expense that occurs regardless of the use of the system
- **FMV** – stands for fair market value
- **Installed Cost** – the cost of installation includes equipment, labor and materials, fixed O&M expense, and financing costs
- **ISO-NE** – is an independent regional transmission organization serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
- **ITC** – stands for investment tax credit
- **kWh** – is a unit of energy which is commonly used by electric utilities as a metric for energy delivered to consumers
- **Line Loss** – is the inherent loss of electrical energy due to inefficiencies in the distribution or transmission system
- **LMP** – stands for locational marginal price and reflects the value of energy at the specific time and location it is delivered
- **MACRS** – stands for the Modified Accelerated Cost Recovery System and is one of the tax depreciation methods used in the United States
- **MSA** – stands for Metropolitan Statistical Area
- **NERC** – North American Reliability Corporation
- **NEM** – stands for Net Energy Metering, which credits solar PV system owners when they sell generated energy to the utility. Most net energy metering payments take the form of a bill credit
- **NEM Incentive** – for comparability with last year's report, calculated as bill savings minus utility avoided costs over the life of the solar PV system
- **NREL** – National Renewable Energy Laboratory
- **O&M** – stands for operations and maintenance
- **Overnight Construction Cost** – The overnight construction cost refers to the cost of the project as if no interest accrued during its construction. This cost includes construction and supply costs, mechanical equipment and installation, electrical instrumentation systems, engineering and labor costs, and other development costs during the construction period
- **PPA** – refers to a solar power purchase agreement. Under this type of financial agreement, a third-party owner installs a solar system on a customer's property at little or no cost. In exchange, the third-party sells the energy the system produces back to the customer

- **PV** – stands for photovoltaic. This is a specific type of solar generating system which converts sunlight into usable energy by way of solar cells
- **Retail Tariffs** – refers to the rates that customers pay to the electric utility for electricity
- **REC** – stands for renewable energy certificate, which certifies that of one MWh of electricity was generated from a renewable energy resource
- **RETC** – stands for the residential Renewable Energy Tax Credit. This is a federal tax credit for residential energy consumers that own solar PV systems equal to 30 percent of the solar PV facility's installed cost
- **RPS** – stands for Renewable Portfolio Standard which is a federal or state regulation that requires an increase in the generation of energy from renewable energy sources to meet customer load
- **SAM** – stands for System Advisor Model. SAM was developed by the National Renewable Energy Laboratory to model performance and costs for grid-connected power projects
- **SEIA** – stands for the Solar Energy Industries Association, a non-profit trade association focused on building the solar industry in the United States
- **Solar PV** – refers to a solar photovoltaic system which generates power by converting sunlight into electricity
- **Standard Tariff** – the rate that consumers pay utilities for electricity. Unlike time-of-use tariffs, standard tariffs have a single rate which the consumer pays year round
- **State Direct Subsidies** – payments solar PV system owners can receive from their state of residency. Incentives can take the form of an installation payment or a production payment
- **System Lambda** – is the cost of the last unit of energy produced in a load control area
- **System Load** – the total electric power delivered and consumed in a load control area
- **Tariff** – the rate that consumers pay utilities for energy
- **TOU Tariff** – stands for time-of-use tariff. With a TOU tariff, the rate will change with the time the energy is used (i.e., during peak and non-peak hours). Daily, weekly and monthly rate differences can be included in TOU tariffs
- **TPO** – stands for third-party-owned, a financial alternative to a homeowner purchasing the solar PV system outright. The third-party ownership can take two different forms. A homeowner can enter into a power purchase agreement (PPA) with the business to buy the electric output from the system ($ per kilowatt-hour). A homeowner can also lease the solar system from the business ($ per month)
- **Utility-Scale Solar** – a solar facility that generates solar power and directly supplies the energy to the grid
- **ZREC** – stands for zero emission renewable energy credits

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