



Will Solar Power Have a Home in California?

**Ending Net Energy Metering Would Put
the Residential Solar Market at Risk**



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Executive Summary

California is building a clean energy future based on the efficient use of renewable resources that will never run out, like the sun. As of July 2013, the state has more than 1,600 megawatts of solar power capacity installed on or near buildings. At the peak of the sunniest days, these solar panels produce more electricity than a large nuclear reactor. If the state were a nation unto itself, it would rank 10th in the world in terms of its ability to generate electricity from rooftop solar panels.

California's progress is due to forward-looking policies that are helping the state reduce its contribution to global warming, expand its use of local renewable energy sources, increase the reliability of electricity service, and control energy costs. In particular, net energy metering has been instrumental in the growth of California's rooftop solar market. Net energy metering enables solar panel owners to earn fair compensation for benefits that they provide to other users of the electricity grid. Net energy metering is especially important for the residential solar market – and thus a key part of developing a more localized, reliable and efficient electricity system.

However, California regulators are now deciding whether or not to close the net energy metering program after the end of 2014. For some homeowners, **ending net energy metering would reduce available cash flow from a solar energy system by about 20 percent over the lifetime of the panels, dissuading many from going solar.** Ending net energy metering would cut against the momentum that California residents and businesses have invested billions of dollars since 2006 to create. Instead, regulators should widen access to net energy metering and eliminate regulatory barriers to the expansion of solar energy.

Net energy metering plays a critical role in providing access to solar energy.

- Traditionally, power companies have generated electricity at central power plants and distributed it to passive consumers over long-distance power lines. However, with the rise of rooftop solar technology, consumers can also be electricity producers.
- Electricity rate plans were not originally set up to accommodate self-generation. Net energy metering works to correct this by ensuring that solar panel owners are fairly compensated for the power that they supply to other users of the electricity grid.

Net energy metering is an important part of a healthy residential solar market.

- Practically every residential solar energy system in California takes advantage of net energy metering, which allows the customer's power meter to "spin backwards" at times when solar power production exceeds on-site needs.
- With net energy metering, on-site demand for power and the availability of solar energy do not have to happen at exactly the same time in order for the solar panels to provide value. This is particularly important for residential customers, because homes tend to use the most energy in the afternoon and early evening, while solar panels produce the most power at mid-day.

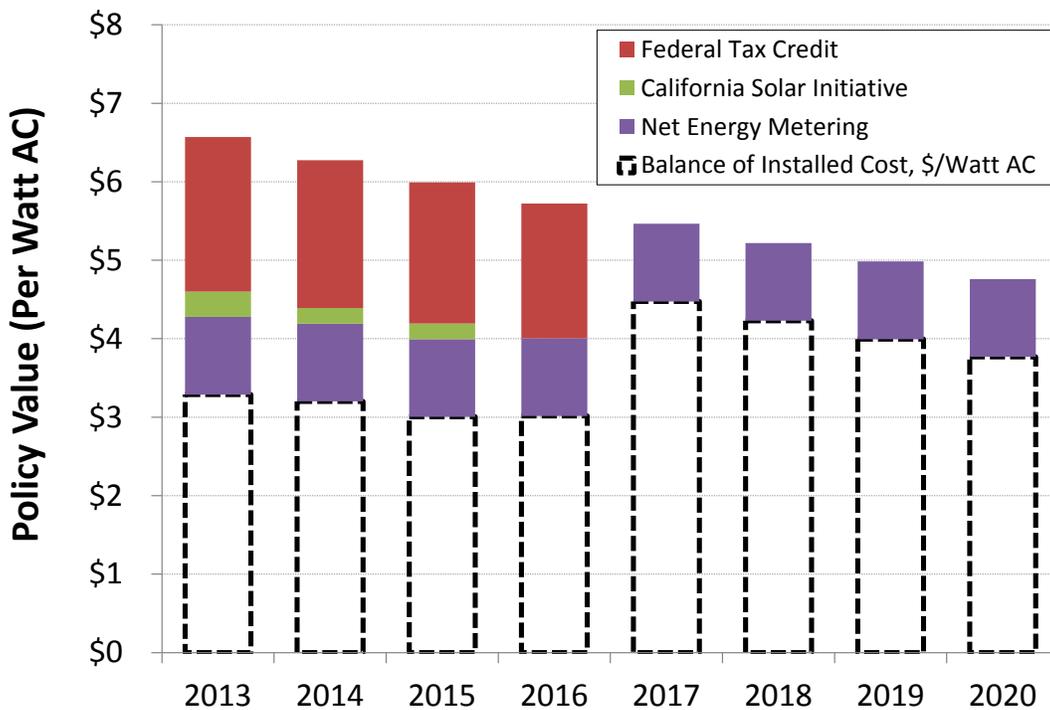
Net energy metering improves the cost-benefit calculation for homeowners considering the addition of a solar power system, encouraging more people to adopt the technology.

- Net metering requires utilities to credit solar panel owners for providing excess power at the same price as delivered electricity, rather than a much lower wholesale rate. For an example homeowner in San Diego, a 2.8 kilowatt solar energy system under net energy metering would deliver 25 percent more electricity bill savings over 25 years – about \$2,800 in net-present-value dollars – compared to the same system without net energy metering.
- Net energy metering makes solar energy a better deal. With net energy metering, an example homeowner installing solar panels in 2015 would be able to pay back the initial cost in about 9 years. Without net energy metering, time required to pay back the initial investment would extend to about 12 years.
- In addition, net energy metering enables homeowners to install solar systems capable of zeroing out a large part of their monthly energy bill. Without this policy, homeowners would have an incentive to undersize a solar system so that it never produced more electricity than could be used on-site at any given time. Such undersized systems might only be able to offset half to three-quarters of a home's annual electricity consumption, wasting otherwise useful rooftop space.

Net energy metering is fair, providing economic and social benefits for both solar panel owners and other users of the electricity grid.

- All kinds of people have solar energy systems and therefore benefit from net energy metering, including low-income families. More than 2,800 low-income homeowners and multi-family dwellings in California have solar energy systems.
- Net energy metering provides broad benefits to all electricity customers, not just those who own solar panels. Studies by the California Public Utilities Commission and third-party energy analysts show that solar electricity helps prevent costs associated with generating and transmitting that power from other sources. Investing in rooftop solar technology reduces and delays the need to invest in new power generation and transmission infrastructure. It also reduces loads on long distance transmission lines and improves the overall efficiency of the electricity system. Increased solar power can lead to more reliable and less expensive electricity service. Studies show that these financial benefits of net energy metering roughly balance out the cost of the policy to ratepayers.
- By facilitating the growth of the solar energy market, net energy metering provides additional benefits to all of society, including increased energy security, reduced pollution, better public health, water conservation and the creation of local jobs that cannot be outsourced.

Figure ES-1: Schedule of Expiration for Solar Policies. Scenario A – Net Energy Metering Continues



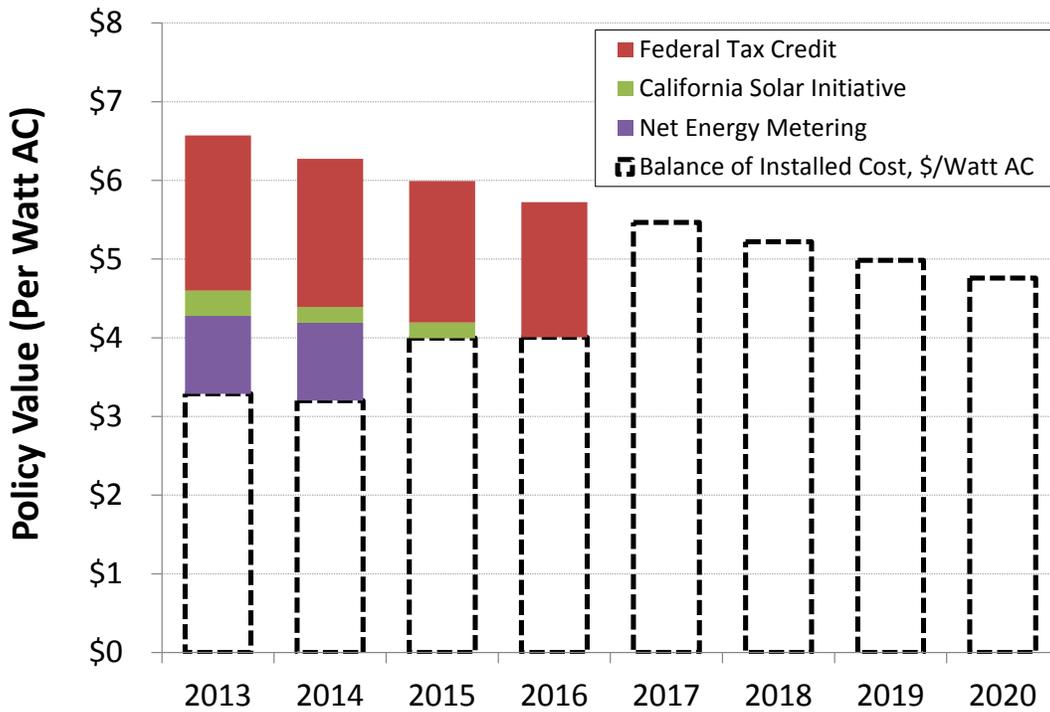
The expiration of solar incentive programs and approaching limits to net energy metering would slow the future growth of the solar market.

- A major 30 percent federal tax credit for solar energy systems is set to expire in 2016. Moreover, the incentive payments offered under the California Solar Initiative and related programs will expire sometime in 2015 or 2016, when utilities reach their share of the state’s goal of 3,000 megawatts of distributed solar power capacity.
- Limits to net energy metering are also approaching. The California Public Utilities Commission is now considering ending the net energy metering program after the end of 2014. Additionally, California has capped net energy metering participation at 5 percent of aggregate customer peak demand, which is roughly equivalent to 5,000 megawatts of solar power capacity state-

wide. At current rates of growth, this cap would limit the expansion of the state’s distributed solar energy market, especially the residential market, sometime after 2016.

- Suspending net energy metering would reduce a potential customer’s rate of return on an investment in solar power. The impact would be comparable to increasing the net cost of a solar energy system for an example solar customer by one-third in 2015. (See Figures ES-1 and ES-2.)
- Small changes in rates of return on investment in rooftop solar energy systems can have large effects on both the speed and the overall extent of market development. For example, researchers at the National Renewable Energy Laboratory estimate that valuing all electricity generated by residential solar panels at the wholesale cost of natural gas generation would reduce projected residential solar energy development through 2030 by 80 percent.

Figure ES-2: Schedule of Expiration for Solar Policies. Scenario B – Net Energy Metering Suspended After 2014



Data in Figures ES-1 and 2 are for an example homeowner in San Diego installing a 2.8 kilowatt (AC) solar energy system, ignoring potential financing costs. These charts assume that solar energy systems will decline in price at a rate of 4.5 percent per year, per the residential solar reference scenario of the U.S. Department of Energy report SunShot Vision Study, February 2012. For the purposes of illustration, net energy metering is included in these figures as the net present value of 25 years worth of electricity supplied to the grid credited at delivered value rather than a much lower short term avoided cost rate. In real-world operation, net energy metering largely does not affect the up-front cost for a solar energy system.

Extending net energy metering beyond 2014 would help ensure that the solar energy market continues to grow in an orderly fashion.

- Net energy metering is a necessary part of a healthy solar energy market. The California Public Utilities Commission (CPUC) should allow new participants to join the net energy metering program after 2014. Additionally, it should lift the current 5 percent cap on participation in the

program, ensuring that customers who go solar continue to receive fair financial value for the clean energy they feed back onto the grid.

- In addition, policymakers should eliminate regulatory barriers to the expansion of solar energy, provide access to more financing options for would-be solar customers, and require new buildings to meet net-zero energy performance standards.

Introduction

Decades ago, California's leaders took action to capture a promising and important opportunity: solar energy.

Solar power offers a vast array of benefits for California's environment, for users of California's electricity system and for society at large. Environmentally, solar energy reduces the air pollution caused by burning coal, gas or oil to generate electricity – including pollution that contributes to global warming. Economically, solar energy helps break our costly dependence on fossil fuels and plays into California's economic strength as the nation's capital of high-tech innovation. And solar energy takes advantage of a resource that is clean, safe and ubiquitous, and which California has in virtually limitless abundance: sunlight. California's rooftops alone could hold enough solar panels to generate the equivalent of more than 40 percent of the electricity we use in a year, statewide.¹

California's leaders understood that the main hurdle facing solar power was the same hurdle facing any new energy technology – making it cost-competitive with established forms of energy generation that have benefited from decades of government, business and consumer investment. In the mid-1990s, policymakers began to craft and implement programs designed to push the solar energy market past this hurdle by offering rebates to consumers who install solar energy systems, facilitating the integration of solar power into the grid and ensuring that customers earn fair compensation for power supplied to the grid through net energy metering. In the 10 years leading up to 2006, these programs resulted in the installation of nearly 200 megawatts

(MW) of solar generation capacity in California and established the state as one of the world's leading solar markets.

In 2006, the California Legislature took these efforts to scale, making solar power a commonplace and affordable energy resource for average citizens. Policymakers decided to invest \$3.3 billion in small-scale solar electric power systems, with the goal of increasing the state's solar generation capacity by 3,000 MW within a decade.² The effort aimed to cut the cost of solar power in half and create a mainstream market for solar power. At the same time, the program was designed to increase the stability of California's energy supply, reduce the state's contribution to global warming, make the state's air cleaner, and launch an industry that will be an economic engine for the state in decades to come.³

These efforts are working as designed. California's solar energy market is significant on the international stage. The solar industry has built a great deal of momentum, now employing more than 43,000 people statewide.⁴ Solar panels are becoming a common sight on rooftops across the state.

The success of California's solar energy policies have led us to the point where it is likely that the solar energy market will become self-sustaining within the decade. The main question facing policymakers now is how to manage the transition to a mature solar market without undermining the momentum that the state and its citizens have invested billions to create.

California's major electric utilities are asking the state to suspend net energy metering, at the same time that federal tax credits and state incentive payments are scheduled to expire.⁵ The California Public Utilities Commission has announced a review of the policy, which could potentially result in the suspension of net energy metering for new customers after 2014. If enacted, these changes would slow California's progress toward a clean energy future, while also introducing new obstacles to participation in the solar energy market for residential customers and making it more difficult to achieve Governor Brown's goal of installing 12,000 megawatts of clean distributed energy by the end of the decade.⁶

This report takes a closer look at net energy metering policy from the point of view of the residential electricity market, which involves many small-scale installations spread over a wide area. The residential market is a key component of the transformation of our electricity system from the traditional centralized structure to a more flexible, adaptable and distributed structure, where homeowners can also be power generators.

We conclude that net energy metering is a necessary part of a healthy solar energy market. This policy serves a crucial role by ensuring that solar technology owners earn fair compensation for the electricity they provide to other users of the electricity grid. Extending and expanding net energy metering, in concert with other policy support, will be critical to ensure that California realizes the potential for solar power to transform our economy, generate local jobs, protect our health, and secure our future for generations to come.



Net energy metering is a necessary part of a healthy residential solar energy market.

California Is a World Leader in Solar Energy

California is building a clean energy future based on the efficient use of renewable sources that will never run out, like the sun. California is a world leader in the deployment of solar energy technology – in particular, rooftop solar photovoltaic panels.

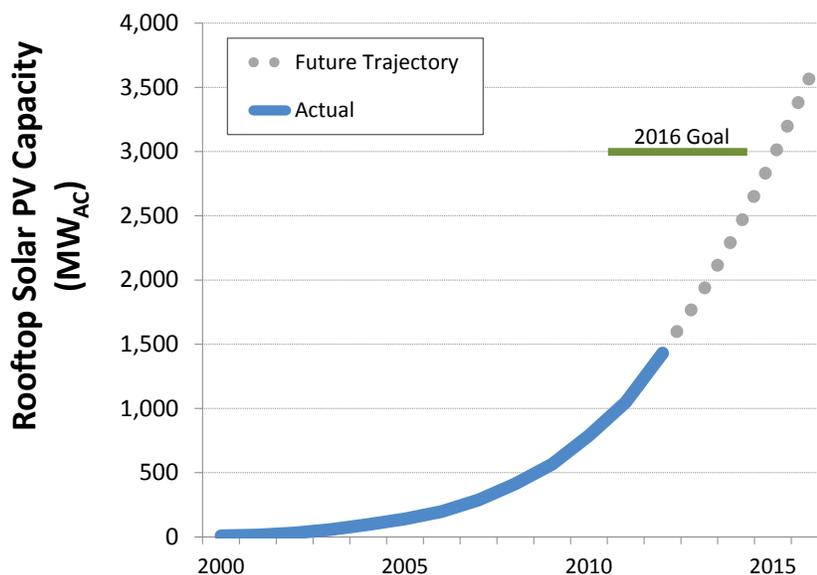
Fifteen years ago, solar panels atop roofs were a rarity. Today, solar energy is taking hold in cities across the state, from coastal metropolises to agricultural and industrial hubs in the Central Valley. In mid-March 2013, California officials announced that the state reached the milestone of having more than 1,500 megawatts (MW) of solar photovoltaic capacity installed on or near rooftops around the state.⁷ By July 2013, California passed 1,600 MW.⁸

At the peak of the sunniest days, those solar panels produce more electricity than a large nuclear reactor. If California were a nation unto itself, it would rank 10th in the world in terms of its ability to generate electricity from rooftop solar panels.⁹

California's Solar Market Is Growing Rapidly

California's solar market is growing rapidly. Over the past decade, total rooftop solar installations have expanded exponentially, growing by an average of 47 percent per year.¹⁰

Figure 1: Rooftop Solar Capacity in California Is Growing Exponentially (Showing Actual Growth through 2012, then Assumed 25 Percent Annual Growth Through 2016)¹²



The state is well on track to meet its goal of reaching 3,000 megawatts (MW) of rooftop solar power generation capacity by 2016, established by the 2006 Million Solar Roofs Bill, SB1.¹¹ Just as policymakers envisioned, solar power is becoming a commonplace and affordable energy resource for average citizens across the state. In fact, solar market growth is ahead of pace. If the market continues growing at more than 25 percent per year, the state will reach its goal almost a year ahead of schedule. (See Figure 1.)

California Is Building a Strong and Healthy Solar Industry

The growth of California's solar market has launched an industry that is likely to be an economic engine for the state in decades to come. Solar power has created thousands of installation jobs that can't be outsourced.

The solar industry is growing at a rate that eclipses most other sectors of the economy. In 2012, a year in which the overall national economy grew at a rate of 2.3 percent, employment in the U.S. solar industry grew by 13.2 percent.¹³ At the end of 2012, more than 43,000 Californians worked in the solar industry – accounting for more than one-third of all solar industry jobs in the nation.¹⁴

Solar power creates more jobs than fossil energy. More of the money for solar energy goes towards hiring and paying workers who design, build and install solar panels, as opposed to paying for imported fuel. Generating electricity from the sun creates at least 10 times more jobs overall than generating the same amount of electricity from coal or natural gas.¹⁵

California's consistent support for clean energy makes it a magnet for clean energy technology



Solar power has created thousands of installation jobs in California that can't be outsourced.

venture capital. California companies lead the world in clean energy investments and technology patents.¹⁶ Since 2006, approximately one-third of global clean technology-oriented venture capital has come to California.¹⁷ California has received more than \$25 billion of this cleantech funding in the past seven years, supporting solar power as well as other clean energy technologies from energy efficiency to transportation. This financial support is part of the reason that researchers and entrepreneurs in California hold a large share of the nation's green technology patents. In 2010 and 2011, nearly 40 percent of the nation's solar energy patents were registered in California.¹⁸

The solar industry predicts continued explosive growth. If, as industry analysts expect, California were to install more than 1 million residential solar projects by 2020, it would add on the order of \$30 billion to the economy and create more than 20,000 new jobs.¹⁹

California's Progress Is Due to Forward-Thinking Policies, such as Net Energy Metering

California has become a clean energy leader thanks to forward-looking policies that have helped to level the playing field between traditional fossil-fired power plants and local, renewable power technologies. In particular, net energy metering is part of a healthy, self-sustaining solar energy market. Net energy metering allows the customer's power meter to "spin backwards" at times when solar power production exceeds on-site needs. In other words, it enables solar panel owners to earn fair compensation for the power that they provide to other users of the electricity grid.

Net energy metering is especially important for residential solar customers. The policy is easy for customers to understand and improves the cost-benefit calculation for homeowners considering the purchase of a solar energy system by requiring utilities to credit solar panel owners for any excess electricity not consumed on-site at delivered, rather than wholesale, electricity prices. Net energy metering helps homeowners to earn a modest return on their solar investment. At the same time, net energy metering makes it possible for homeowners to size solar energy systems large enough to offset most of their annual electricity consumption.

A healthy residential solar market is an important part of making California more energy secure and developing a more localized, reliable and efficient electricity system.

Net Energy Metering Plays a Critical Role in Providing Access to Solar Energy

Traditionally, power companies have generated electricity at central power plants and distributed it to passive consumers over long-distance power lines. For example, approximately 40 percent of Los Angeles' electricity supply comes from coal-fired power plants, such as the Navajo Generating Station on the border between Arizona and Utah.²⁰ Power generated at the Navajo Generating Station must travel more than 500 miles on high-voltage power lines through the desert before reaching Los Angeles, where it is distributed to businesses and neighborhoods across the city.

The relationship between power generators and consumers has traditionally been a one-way street. Utilities generated the power and customers bought it. Utilities simply sent customers a monthly bill for the amount of power they consumed. The price of the power was set at a level designed to ensure that the utility could earn a reasonable profit on its investments in power plants, power lines and related infrastructure and services.

Rooftop solar power introduces a new and different dynamic to the electricity system. With the rise of solar photovoltaic technology, electricity consumers can also be electricity producers.



Net energy metering helps to encourage more people to invest in solar energy. It works to ensure that solar panel owners are fairly compensated for the power that they produce and feed to the grid for others to use.

However, utility rate plans were not originally set up to accommodate small-scale self-generation, especially for customers who could not use all of the power they generated on-site.

That's where net energy metering comes into play.²¹ Net energy metering policy works to ensure that solar panel owners are fairly compensated for the power that they produce and feed to the grid for others to use. In so doing, net energy metering helps to encourage more people to invest in solar energy.

Net Energy Metering Is an Especially Important Part of a Healthy Residential Solar Market

Net energy metering is particularly important for a healthy residential solar energy market. That is because home power use is not perfectly synchronized with the power output of a rooftop solar energy system. Homes tend to use the most energy in the afternoon and early evening, while solar panels produce the most power at mid-day.

Figure 2 shows how this might look over the course of a warm summer day at an example house. At night and in the evening, the house will be consuming electricity from the wider power grid, like a normal retail customer (blue line). As the sun rises in the morning, the home's solar photovoltaic power system will begin producing electricity (orange line). Initially, that power will offset the home's on-site electricity needs, reducing the home's consumption of electricity from the power grid.

As the sun climbs higher in the sky, the sunlight hitting the panels grows more intense and power output rises. Eventually, the solar panels produce more power than the home could use on-site. That power then flows into the local electricity distribution system, providing 100 percent clean,

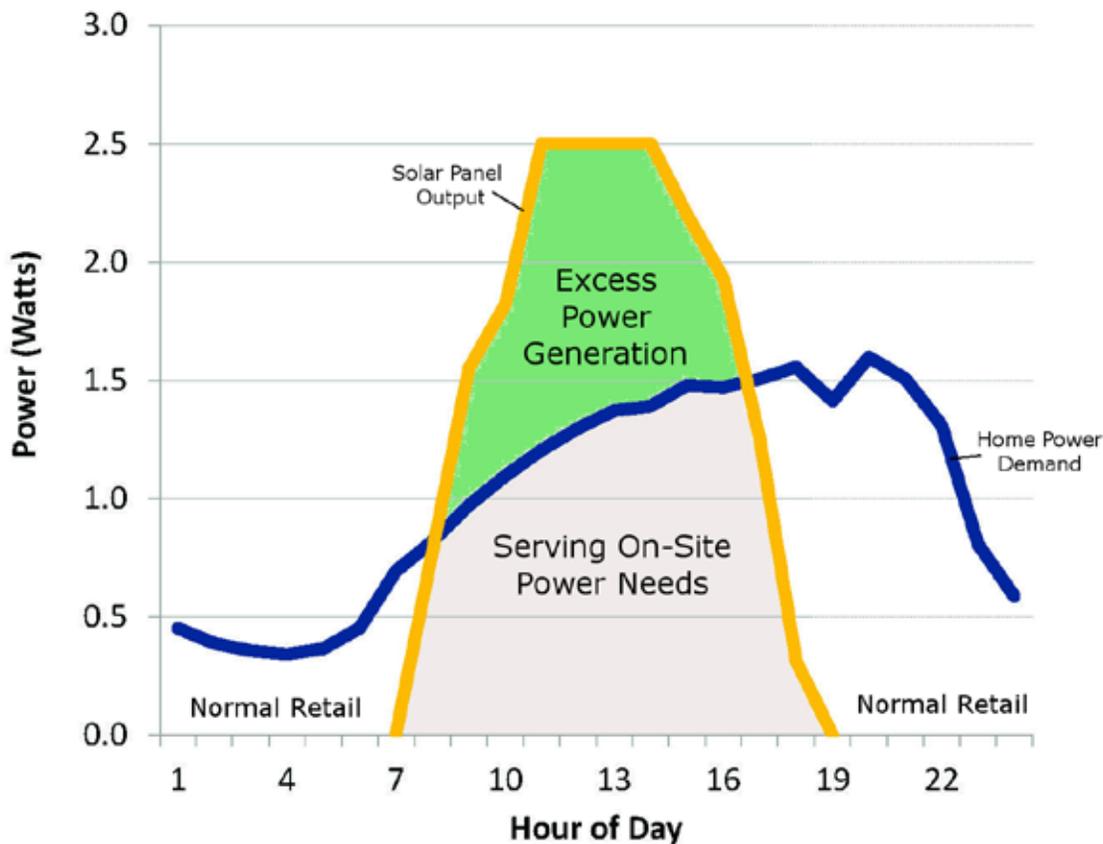
renewable electricity to other nearby power users, such as neighboring office buildings and non-solar homeowners.

As the sun sets, home electricity use will begin to exceed solar electricity production until the home once again draws all of its electricity from the power grid.

Net Energy Metering Allows the Customer's Power Meter to "Spin Backwards"

Federal law already requires utilities to connect customers with solar photovoltaic power systems to the larger electricity grid. It also allows customers to use power generated by a solar photovoltaic system

Figure 2: During the Peak of the Day, Solar PV Systems Can Produce More Electricity than a Home Needs On-Site



to offset their on-site need for electricity.²² When meeting on-site power needs, from the utility's point of view, a solar energy system reduces the amount of power drawn from the grid.

Federal law also requires utilities to purchase any excess power from customer-owned solar photovoltaic systems at a state-regulated rate based on the "avoided cost" of a unit of grid electricity.²³ California utilities individually define short run avoided cost rates and update them on a regular basis, based on guidance from the California Public Utilities Commission.²⁴ Factors considered include the price of natural gas and the time of power use. In June 2013, for example, the Southern California Edison Company calculated that the avoided cost of a kilowatt-hour of electricity provided in the middle of a summer day was 6.6 cents.²⁵ Winter and off-peak avoided cost rates are lower.

Net energy metering policy alters how solar panel owners are compensated for power they supply to other users of the electricity grid. It replaces the default minimum rate with the delivered cost of electricity – the amount that a residential customer would pay to draw a unit of electricity from the grid. Stated simply, net energy metering allows the customer's power meter to "spin backwards" at times when solar power production exceeds on-site needs. As a result, over the course of a year, a customer with a solar photovoltaic system pays for only the net amount of electricity used over a 12-month period (electricity consumed minus electricity produced), plus utility service charges.

In effect, net energy metering makes power supplied to the grid equally as valuable to the solar power owner as power consumed on-site. The difference is significant. At summer peak times, delivered electricity rates can be more than 500 percent higher than the short run avoided cost price for some residential customers.

Net Energy Metering Improves the Cost-Benefit Calculation for Homeowners Considering Solar PV

To get a better sense of how net energy metering works, let's consider how the policy improves the cost-benefit calculation for a hypothetical homeowner in San Diego who is considering the installation of a solar energy system. This system would deliver 25 percent more electricity bill savings over 25 years – about \$2,800 in net present value dollars or \$6,000 in nominal dollars – with net energy metering than without.²⁶

Let's say our hypothetical homeowner lives in a single family residence in the inland area of San Diego and has a relatively efficient home. This homeowner uses about 6,000 kilowatt-hours of electricity per year, similar to the average California residential electricity customer.²⁷ (The homeowner uses San Diego Gas & Electric's tiered residential electricity rate plan for region 2.²⁸)

A 2.8 kilowatt solar photovoltaic system (AC) on the roof of this home would generate about as much electricity as the home consumes over the course of the year on a net annual basis (5,740 kilowatt-hours per year). At prices available in 2013, the up-front cost to purchase and install the panels would be \$18,150, or \$6.45 per Watt AC, ignoring any potential financing costs.²⁹ (See Figure 3.) Incentives available through the California Solar Initiative would reduce the installed cost to \$6.25 per Watt AC.³⁰ Additionally, a 30 percent federal tax credit would reduce the cost to \$4.37 per Watt. After incentives, the price of this solar energy system would be about \$12,300.

With net energy metering, the homeowner would be able to run his or her meter backwards when the solar panels produced more electricity than the home needed. With the addition of the solar energy system, the homeowner's monthly electricity bill would fall by about 94 percent. Over the 25 year life of the system, the average savings would work out

to about \$100 per month, or a total of \$30,200 in nominal dollars.³¹

Altogether, the homeowner would earn a return on investment of about 7.3 percent over the 25-year warranty of the system. In other words, the system would pay for itself after about 12 years of operation, and provide net income for the rest of its operational life.

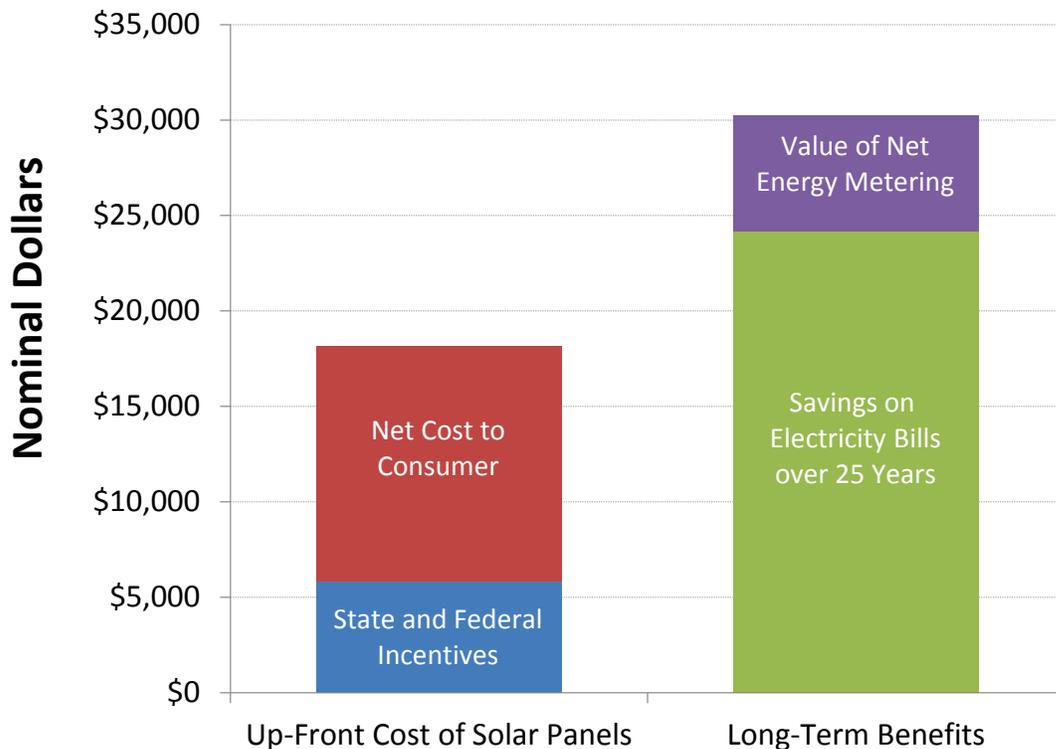
Without net energy metering, however, installing the solar energy system would look a little less attractive. Let's say that 67 percent of the energy produced by the solar energy system would serve local needs at the home, and 33 percent of the energy would serve the larger grid. (This varies from customer to customer, but is roughly typical of residential solar energy systems in California.³²)

That means that over the course of the first year of operation, the solar energy system would produce about 1,900 excess kilowatt-hours of electricity.³³ This is the fraction of electricity generation affected by net energy metering.

Without net energy metering, San Diego Gas & Electric would compensate the homeowner for this electricity at the "short run avoided cost rate," which in June 2013 was 6.53 cents per kilowatt hour for summer peak hours, and less at off-peak times.³⁴ This wholesale rate is significantly less than the retail cost of electricity in San Diego, which starts at about 15 cents per kilowatt-hour, and goes up to as much as 29 cents per kilowatt-hour with increasing usage.³⁵

In the first year, the difference between the net energy metering price for electricity supplied to

Figure 3: A Comparison of the Costs and Benefits of Installing a 2.8 kW (AC) Rooftop Solar Energy System for an Example San Diego Homeowner in 2013





Net energy metering improves the cost-benefit calculation for homeowners considering the purchase of a solar photovoltaic system.

the grid and the wholesale cost would be \$230.³⁶ However, as utility rates increase over time, the difference becomes even more significant.³⁷ On average, over the 25-year life of the solar energy system, net energy metering would be worth about \$240 per year in nominal dollars. Expressed in net present value terms, net energy metering would be worth about \$2,780 for this homeowner, or about \$0.99 per Watt AC.³⁸ Eliminating net energy metering would reduce the cash flow from the solar system by about 20 percent over the lifetime of the solar panels, and thereby reduce the homeowner's overall return on investment.³⁹

The only way a homeowner could preserve the rate of return offered by net energy metering without

actually having the policy in place would be to undersize their solar energy system so that it never produced more electricity than could be used on-site at any given time. Such undersized systems might be able to offset only half to three-quarters of a home's annual electricity consumption.⁴⁰ This would slow the rate of solar development in California and waste otherwise useful rooftop space.

In 2010, the California Public Utilities Commission calculated that the average net present value of net energy metering for residential customers in San Diego was \$1.18 per Watt (in 2013 dollars).⁴¹ This value is in the same region as the example above, although it is not directly comparable. The PUC report was done with a 20-year period of analysis,

whereas the example above takes 25 years into account. Moreover, the purpose of the PUC report was to calculate the costs and benefits of net energy metering, not to analyze what would happen if net energy metering were suspended.⁴²

The Value of Net Energy Metering Varies from Customer to Customer

The value of net energy metering will not be exactly the same for every homeowner. It is tied to the solar panel owner's electricity rate structure, which varies from utility to utility, and from customer to customer depending on when and how much power is used.

Researchers at Lawrence Berkeley National Laboratory calculated in 2010 that net energy metering was worth in the range of 20 to 25 cents per kilowatt-hour supplied to the grid, based on retail rate plans available at the time, again depending on the utility and how much electricity the customer used and when.⁴³

The California Public Utilities Commission regularly adjusts residential electricity rate plans offered by the utilities, and the utilities regularly adjust their short run avoided cost rates. Future rate changes will affect the absolute value of net energy metering, but not the character of its effect – which is to encourage people to choose solar energy by making solar energy a more attractive investment.

Net Energy Metering Is Fair as well as Effective

Net energy metering is fair, providing economic benefits for both solar panel owners and other users of the electricity grid. The policy works to level the playing field between traditional fossil-fired power plants and solar or other localized sources of electricity.

Localized energy technologies offer important benefits for society. They reduce the need to build large power plants, lessen the need to drill for oil and gas, reduce the need to upgrade transmission line infrastructure, and increase the overall efficiency of our electricity system. Localized energy systems can be installed much more quickly than traditional power stations and they can be tailored to suit the needs of individual buildings, institutions or communities.

Many of these benefits have concrete monetary value, which balance out the cost of the policy to ratepayers. Net energy metering also helps California achieve important social goals by encouraging the growth of the solar market.

Net Energy Metering Benefits All Kinds of Solar Energy Customers

Net energy metering provides benefits for all customers who choose to install a solar energy system, by making solar energy a better deal.

These benefits also apply to low-income families living in either single-family homes or multi-family dwellings. More than 2,750 low-income homeowners in California have installed solar energy systems through the state's Single-family Affordable Solar Housing program.⁴⁴ In addition, more than 100 larger multi-family buildings have installed solar energy systems through the Multifamily Affordable Solar Housing program, with hundreds more applications pending.⁴⁵

For example, the photo on page 19 shows solar panels installed on a multi-family housing complex in the Hayes Valley neighborhood of San Francisco. The solar panels at this complex generate enough electricity to power nearly 50 typical California homes and prevent global warming pollution equivalent to that produced by burning 16,000 gallons of gasoline per year.⁴⁶

Net energy metering helps to reduce the economic barriers that can stand in the way of low income residents, landlords or housing authorities choosing to invest in solar energy. By expanding the solar energy market, it also helps to provide important employment and community development opportunities across the state.

Photo: SunWheel Energy Partners / McCormack Baron Salazar



Net energy metering benefits all kinds of solar energy customers, including the residents of this multi-family housing complex in the Hayes Valley neighborhood of San Francisco.

Net Energy Metering Also Benefits Other Users of the Electricity Grid

Net energy metering provides direct financial benefits to all users of the electricity grid, not just to those who choose to install solar panels. These benefits balance well against the costs that all ratepayers pay to support the net energy metering program.

In 2009, the California Public Utilities Commission hired Energy and Environmental Economics, Inc., to perform a financial analysis of net energy metering payments.⁴⁷ This study compared net energy metering payments and billing costs to the benefit for utilities in terms of concrete avoided costs. The study concluded that:

- Solar electricity benefits all consumers by preventing the need to generate and transmit that power from other sources. Investing in rooftop solar technology reduces and delays the need to invest in new power generation and transmission infrastructure. It also reduces loads on long distance transmission lines and improves the overall efficiency of the electricity system.
- The cost of net energy metering payments was about the same as the monetary benefit to the electricity system. When California reaches about 3,000 MW of rooftop solar, the study predicted that customers overall would be paying less than a tenth of a cent extra per kilowatt-hour to support net energy metering. In 2010, a small amount of cost-shifting from some customers to others existed, largely because of some PG&E solar customers that had used large amounts of electricity at the highest tier rates, and because PG&E charged relatively large administrative fees for billing customers on net energy metering rate plans.

Since then, the California Public Utilities Commission has required utilities to adjust their residential electricity rate plans, lowering the upper tier rates and increasing the lower tier rates, altering the costs and benefits of net energy metering.⁴⁸ The Commission again hired Energy and Environmental Economics, Inc., to update its study on the cost-effectiveness of net energy metering, which should be complete by October 2013.⁴⁹

However, a 2013 analysis by Crossborder Energy for the Vote Solar Initiative provides an early look at how the latest residential rate changes have altered the cost-effectiveness equation for net energy metering.⁵⁰ Crossborder Energy also found that net energy metering provides benefits that balance well with its costs. According to this study, net energy metering participants (residential, commercial and industrial) in the investor-owned utility markets will provide on the order of almost \$100 million per year in net benefits to other electricity consumers when solar power reaches the current cap on net energy metering, or 5 percent of aggregate customer peak demand.⁵¹

Net Energy Metering Provides Social Benefits with Real Value

In addition, solar energy provides additional social benefits that have real value, even if they are not often accounted for in terms of dollars and cents or in rate plans created by utility companies. Neither of the net energy metering cost effectiveness studies discussed above attempted to account for the social benefits of increasing the market penetration of solar power.

For example, in the enabling legislation for the California Solar Initiative, legislative leaders wrote: “The Legislature finds and declares that a program to provide net energy metering for eligible customer-generators is one way to encourage substantial

private investment in renewable energy resources, stimulate in-state economic growth, reduce demand for electricity during peak consumption periods, help stabilize California’s energy supply infrastructure, enhance the continued diversification of California’s energy resource mix, and reduce interconnection and administrative costs for electricity suppliers.”⁵²

The unique characteristics of solar power make it a valuable source of energy:

- Sunlight is free and widely available. Capturing solar power increases California’s energy security.
- Solar energy is clean and safe. It is a powerful solution to reduce the environmental and public health damage caused by our dependence on fossil fuels. Solar power can dramatically reduce emissions of global warming pollutants compared with fossil fuels. It also reduces pollution that can cause or trigger asthma and allergies, contribute to lung disease, harm agricultural output and reduce visibility.
- Rooftop solar energy helps to conserve land. Solar energy is one of the few power-generating technologies that is a good fit for urban areas. Rooftop solar panels require no additional land beyond that already occupied by buildings, parking lots or other developed areas. In addition to being clean, solar energy can be installed on buildings, over parking lots and on top of other developed areas without interfering with human activities.
- Solar energy helps to conserve limited water supplies. Solar photovoltaic panels generate power with very little need for water beyond that required for occasional washing, replacing power that would otherwise come from traditional power plants – which use vast amounts of water for cooling and steam.⁵³ This is especially important given that one of the projected impacts of global

warming is increased drought, especially in the already dry Southwest.⁵⁴ Spring 2013 provided a taste of what drought conditions may be like, with Sierra Nevada snowpack measuring at 50 percent below average.⁵⁵

- Solar panels generate the greatest amount of electricity at the times when it is most needed, particularly hot, sunny summer days. This enhances the reliability of the state's electricity system and reduces our vulnerability to blackouts.
- Solar electricity saves consumers money. The U.S. Department of Energy estimates that increased deployment of solar power could save consumers on the order of \$30 billion by 2030, or about

\$6 per month for the average homeowner.⁵⁶ Solar energy helps utilities avoid the cost of generating and transmitting power using traditional fossil fuel power plants and transmission infrastructure.

- Moreover, expanding the solar energy market will ensure the continued growth of an industry that is likely to be an economic engine for the state in decades to come. Solar power requires local workers to transport and install the panels, and these jobs cannot be outsourced.

Suspending Net Energy Metering Would Slow the Growth of the Solar Market

California's solar energy market is facing a transition in the next three years. The federal individual tax credit for residential solar purchases – which shaves 30 percent off of the price of a solar energy system – is due to expire at the end of 2016.⁵⁷ The California Solar Initiative has mostly reached the final, smallest step in its incentive payment schedule. This program is likely to reach its goal and complete spending all of its funding sometime in 2015 or 2016.

In this context, net energy metering will become all the more important as part of maintaining momentum in the distributed solar electricity market. However, the California Public Utilities Commission is now deciding whether or not to allow new customers to participate in the state's net energy metering program after the end of 2014, pending the outcome of a policy review.⁵⁸ Additionally, California has capped net energy metering participation at 5 percent of aggregate customer peak demand, which is roughly equivalent to 5,000 megawatts of solar power capacity statewide.⁵⁹ At current rates of growth, this cap will limit the expansion of the residential solar energy market sometime after 2016.

Small changes in rates of return on investment in residential solar energy systems can have large effects on both the speed and the overall extent of market development. According to the National Renewable Energy Laboratory, the price paid for solar electricity is second only to the availability of favorable financing options for driving growth in the residential PV market.

Ending Net Energy Metering Would Make Solar Power a Less Attractive Investment

Solar incentive policies, like the California Solar Initiative and the federal tax credit, have helped to stimulate market development by making solar power increasingly cost competitive with other forms of electricity. The policies work by making the investment more attractive for potential customers, therefore increasing the amount of solar panels manufactured and installed. The more people install solar panels, the greater the level of experience and economies of scale that solar energy companies achieve, which brings prices down. This process makes solar investments more affordable, creating a virtuous circle.

California and the federal government chose to stimulate the solar energy market now precisely to create these effects down the road. And these policies are working as planned. The installed cost of residential solar electricity systems in California has been falling at an average rate of about 10 percent per year since 2007.⁶⁰

However, suspending net energy metering for new customers would have the opposite effect. It would make solar power a less attractive investment by making power supplied to the grid less valuable, reducing a potential customer's rate of return and increasing the time it would take to recoup the up-front cost of purchasing the solar panels.

Figures 4 and 5 show how the installed cost of solar for our example San Diego homeowner might change over time. The change in the overall height of the bars over time represents a steady 4.5 percent annual decline in the cost of solar energy before any incentives, based on the residential solar reference scenario of the U.S. Department of Energy report *SunShot Vision Study*.⁶¹ The red bar represents the value of the 30 percent federal tax credit. The green bar represents the final step of incentive payments available under the California Solar Initiative, assuming completion late in 2015 or early in 2016. And the purple bar represents the net present value of net energy metering for the example San Diego homeowner. Although net energy metering would not affect the up-front cost of solar, we include it here as if the revenue stream from net energy metering were paid to the homeowner up-front in net present value terms, or about \$0.99 per Watt AC, in order to illustrate how important it is to the overall value proposition for solar energy.

With net energy metering, in 2015 a homeowner installing solar would be able to pay back the initial cost in about 9 years, for a return on investment of about 10.5 percent. The impact of suspending net energy

Figure 4: Schedule of Expiration for Solar Policies. Scenario A – Net Energy Metering Continues

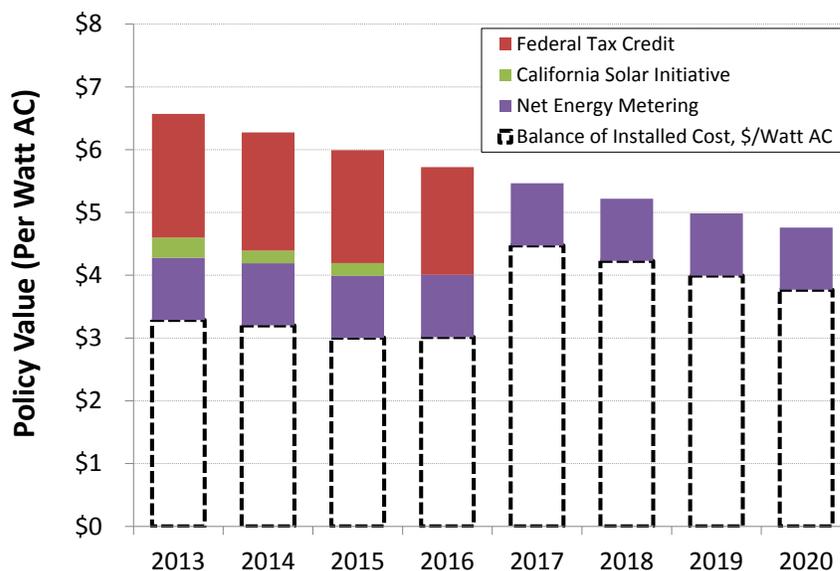
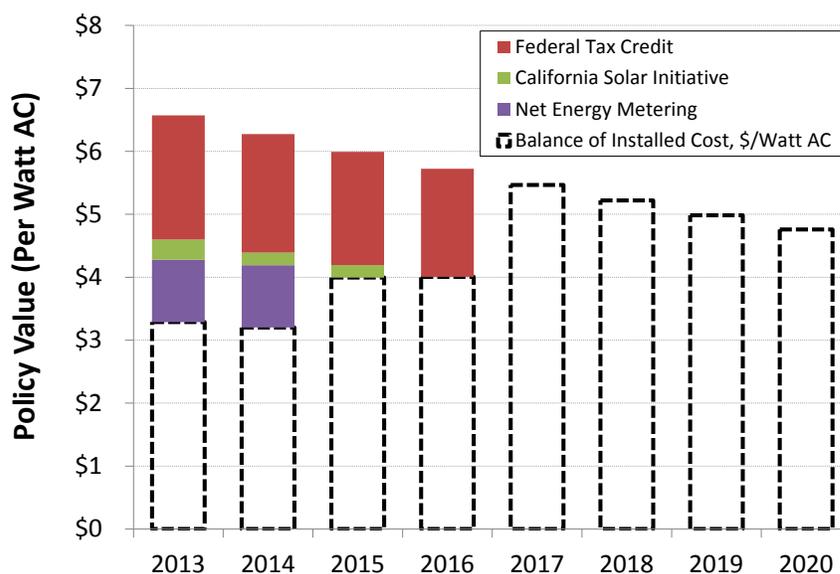


Figure 5: Schedule of Expiration for Solar Policies. Scenario B – Net Energy Metering Suspended After 2014



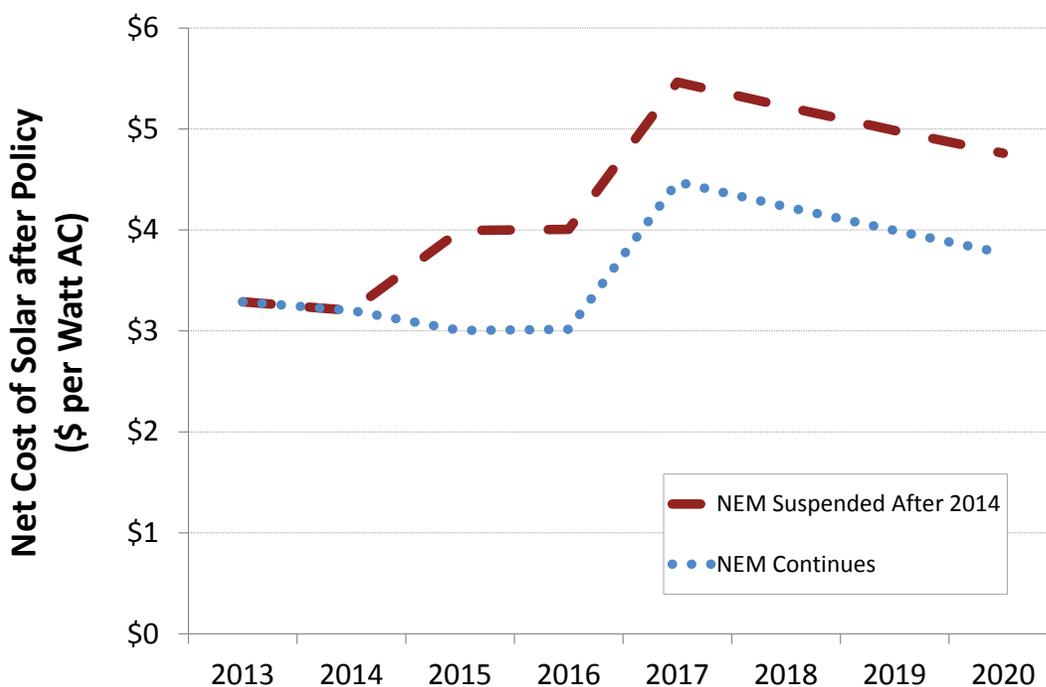
Data are for an example homeowner in San Diego installing a 2.8 kilowatt (AC) solar energy system, ignoring potential financing costs. These charts assume that solar energy systems will decline in price at a rate of 4.5 percent per year, per the residential solar reference scenario of the U.S. Department of Energy report *SunShot Vision Study*, February 2012. For the purposes of illustration, net energy metering is included in these figures as the net present value of 25 years worth of electricity supplied to the grid credited at delivered value rather than the wholesale rate. In real-world operation, net energy metering largely does not affect the up-front cost for a solar energy system.

metering, in terms of overall cash flow, would be comparable to increasing the net cost of this solar energy system by 33 percent.⁶² (See Figure 6.) This would extend the time required to pay back the initial investment to about 12 years, reducing the homeowner's overall rate of return on investment to below 8 percent.

Figure 6 shows a projection for what those costs could look like through the rest of the decade for our example San Diego homeowner. Since 2007, the nominal net installed cost of solar power has been between \$3 and \$4 per watt (AC). Again, although suspending net energy metering would not affect

the up-front cost of solar, it would reduce the solar homeowner's cash flow. If we account for the value of net energy metering as if the money were paid to the homeowner up-front in net present value terms, or about \$0.99 per Watt AC, the net cost of installing a solar energy system for our example homeowner in 2015 would be higher than the average net cost of residential solar energy at any point since California launched its landmark Go Solar California campaign in 2006. The impact of suspending net energy metering will be magnified by the scheduled expiration of the 30 percent federal tax credit at the end of 2016. (See Figure 6.)

Figure 6: Policy Expiration Will Make Investing in Solar Energy Less Attractive for Homeowners



Data are for an example homeowner in San Diego installing a 2.8 kilowatt (AC) solar energy system, ignoring potential financing costs. These charts assume that solar energy systems will decline in price at a rate of 4.5 percent per year, per the residential solar reference scenario of the U.S. Department of Energy report SunShot Vision Study, February 2012. For the purposes of illustration, net energy metering is included in these figures as the net present value of 25 years worth of electricity supplied to the grid credited at delivered value rather than the wholesale rate. In real-world operation, net energy metering largely does not affect the up-front cost for a solar energy system.

The Better the Payoff, the More People Will Adopt Solar Energy

The more that homeowners can have certainty that investing in solar energy is a good deal, the greater the number of homeowners who will choose to install solar energy systems, and the faster they will do it. Small changes in rates of return can have large effects on both the speed and the overall extent of market development.

Studies of rooftop solar photovoltaic market penetration suggest that getting more than a few percent of homeowners to install solar panels requires a return on investment greater than 10 percent (or, said another way, a payback period of less than 10 years). (See the Navigant 2008 curves in Figure 7.⁶³)

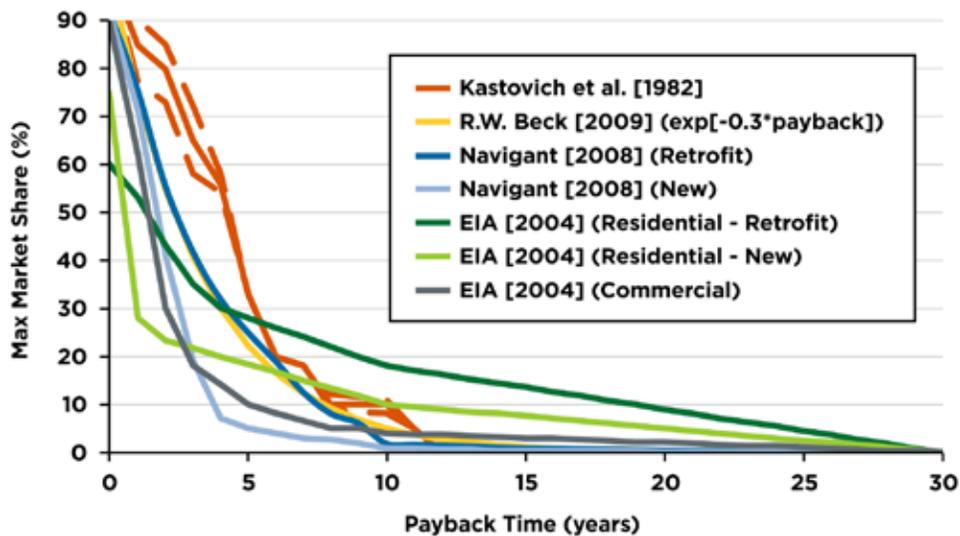
California's solar policies have created a virtuous cycle, where the growth of the market produces economies of scale, which cause prices to decrease, increasing rates of return, which then causes the market to grow further. Suspending net energy metering would have the opposite effect, delaying California's clean energy future.

Ending Net Energy Metering Would Reduce Future Rooftop Solar Energy Development

An analysis of future solar development done by the U.S. Department of Energy, called the *SunShot Vision*, gives a sense for how important net energy metering is for maintaining a healthy future solar energy market, especially in the residential sector.

The *SunShot Vision* report models the impact of price reductions in solar energy technologies on market penetration of those technologies nationwide by 2030 and 2050. In the reference case, the cost of solar energy systems declines by 37 percent from 2010 to 2020.⁶⁵ If America can manage to reduce the installed cost of solar just a little further, to 50 percent, consumers will install triple the amount of solar photovoltaic power capacity by 2030. And if America can manage to reduce the installed cost of solar by 75 percent, consumers will deploy more than eight times as much solar capacity – or about 38 gigawatts of rooftop and utility-scale solar PV in California.⁶⁶

Figure 7: As Solar Panels Become a Better Deal, More Homeowners and Businesses Will Go Solar (Fraction of Customers Likely to Invest in PV Over a Range of Payback Periods)⁶⁴



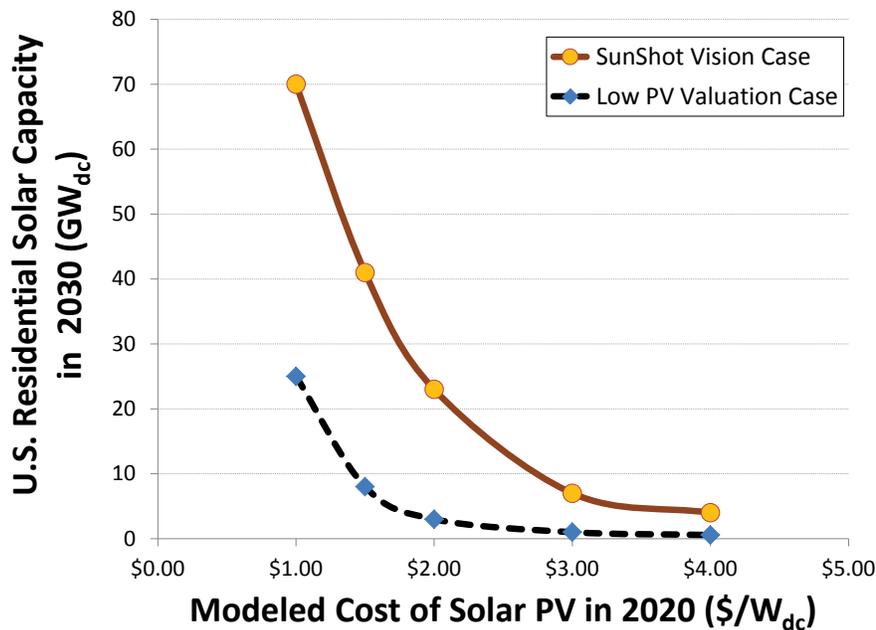
The authors of the report conducted a sensitivity analysis to get a better sense of how other factors could accelerate – or delay – market development.⁶⁷ In the residential market, the most important factor was the availability of favorable financing options. Without financing, all customers would have to pay for the full cost of a solar energy system up-front – in effect buying 25 years-worth of electricity in one lump sum – preventing large numbers of homeowners from going solar.

The second most important factor is how utilities compensate homeowners for electricity generated by solar panels. The report did not explicitly evaluate net energy metering, but it did examine a scenario where all solar PV generation received credit at the avoided cost for natural gas generation as the lowest possible boundary.⁶⁸ Reducing the value of PV

generation to this level would cut the growth of the residential solar market in the *SunShot Vision Study* by three-quarters through 2020, and by 80 percent through 2030.

The effect remains significant across a range of assumptions for future progress in reducing the overall installed cost of a PV system. (See Figure 8.) In the *SunShot Vision* case (which models reaching \$1.50 per Watt DC by 2020), and all cases with slower progress in reducing solar costs, valuing solar generation at the avoided cost of natural gas would cut potential market development by 80 percent or more. Even with progress greater than that envisioned in the *SunShot Vision* scenario (reaching \$1 per Watt DC by 2020), reducing the value of solar electricity would cut potential residential capacity by almost two-thirds.

Figure 8: Net Energy Metering Is Important for a Healthy Residential Solar Market. Compensating Homeowners for Solar Electricity Generated at Low Rates Instead of Retail Rates Would Greatly Slow Future Solar Development across a Range of Possible Installation Costs⁶⁹



The SunShot Vision Case assumed that 90 percent of residential solar electricity generation would be compensated at retail rates, while 10 percent would be compensated at the avoided cost of natural gas generation. The Low PV Valuation Case set the rate of compensation for all solar generation at the avoided cost of natural gas generation. A “No Net Energy Metering Case,” which the National Renewable Energy Laboratory did not model, would fall between the two lines.

Policy Discussion and Recommendations

Despite the development of thriving solar markets in cities across the state, California has only just begun to capture its tremendous potential for solar power. The National Renewable Energy Laboratory estimates that the state could host more than 80,000 MW of rooftop solar capacity in total – enough to generate more than 40 percent as much electricity as California uses in a year.⁷⁰ Vast potential remains to be developed.

The potential benefits of capturing California’s solar energy potential are equally vast. Generating more than 10 percent of our power from the sun could create a cleaner, more reliable and more decentralized electricity system. It would dramatically reduce our dependence on fossil fuels and our emissions of global warming pollution while also creating thousands of installation jobs that can’t be outsourced.

Capturing this opportunity will require action to usher the solar industry into maturity and to ensure that residential customers in particular retain fair access to the solar market. Policymakers should focus on facilitating orderly market growth and avoiding unhelpful boom and bust cycles.

Extend Net Energy Metering to Help Ensure Continued Growth in the Residential Solar Market

Net energy metering is a necessary part of a healthy solar energy market. The California Public Utilities Commission should continue to allow new participants to join the net energy metering

program after 2014 and beyond. Extending this policy would help to maintain orderly growth in the solar marketplace, and particularly the residential marketplace.

The Public Utilities Commission should ensure that solar energy system owners are fairly compensated for all the benefits they deliver. Moreover, all utility ratepayers should contribute funds for this purpose, in the same manner that ratepayers pay for a new power line, a new power plant, or other kinds of infrastructure upgrades that serve the interests of everyone who uses electricity. To the extent that rate structures cause any misalignment between who pays and who benefits, the Public Utilities Commission should re-examine rate structures rather than compromise net energy metering.

Policymakers should also lift the cap on participation in net energy metering above 5 percent of aggregate customer peak demand before that threshold arrives. Technical limits to integrating solar electricity into a properly functioning electricity grid are much larger than 5 percent. For example, the U.S. Department of Energy concludes that solar photovoltaic power could supply close to 20 percent of U.S. electricity needs with no need for energy storage technologies like batteries.⁷¹ Italy already obtains 5 percent of its total electricity needs from solar PV.⁷²

Net Energy Metering Is Necessary to Avoid Tilting the Playing Field Back toward Fossil Fuels

Allowing net energy metering to expire would unfairly shift the playing field toward the dirty and unsustainable energy resources of the past. Net

energy metering is necessary in order to ensure fair treatment for solar panel owners in the marketplace. The purpose of net energy metering is to create a level playing field – to enable distributed energy generation technologies, like solar and small wind, to compete with centralized forms of electricity generation. Its purpose is also to make sure that solar panel owners are fairly compensated for the benefits that they provide to other users of the electricity grid. In this regard, it is fundamentally different than a policy like the California Solar Initiative, which was designed to stimulate the marketplace for solar energy and then wind down. The need for net energy metering will remain after incentive policies with different purposes expire.

In the immediate term, ending net energy metering could slow the solar market, reducing the ability of the industry to provide jobs to Californians, and delaying progress towards the state’s big-picture goals to generate more electricity from renewable sources of energy and to reduce global warming pollution.

California’s experience with solar technology in the 1970s and 1980s provides an example of why boom and bust cycles are best avoided. After the Arab oil embargo, the Carter Administration launched programs designed to promote renewable energy and energy efficiency. The federal government created tax rebates designed to incentivize the purchase of renewable energy systems. California created its own set of incentives. For example, in 1978, Jerry Brown established SolarCal, a government office charged with advancing solar energy in the state, and created a state tax credit for solar energy technology purchases.⁷³

These incentives worked. The American renewable energy industry started to take root. By the early 1980s, the United States had developed dominance in the world market for solar energy, accounting for 80 percent of global installations and 85 percent of global sales.⁷⁴

However, declining oil prices led to a loss of focus. In 1980, oil peaked at more than \$35 per barrel. By 1986, the price had fallen to \$10 per barrel.⁷⁵ Concerns over energy shortages simmered down. Under the Reagan Administration, solar energy became negatively politicized, and decision-makers canceled most government subsidies for solar energy by 1985.⁷⁶

As a result, the solar industry collapsed. A generation of people who had built skills and knowledge in solar energy suddenly found themselves without jobs. It took years to rebuild that human and organizational capital.

California is much further along today. It has created remarkable progress in solar energy development over the past decade, building a strong and healthy solar industry. At the end of 2012, more than 43,000 Californians worked in the solar industry.⁷⁷ California companies lead the world in clean energy investments and technology patents.⁷⁸ This represents a huge investment in human and intellectual resources.

The risk remains, however, that making solar energy less financially attractive could trigger another bust cycle. Suspending net energy metering would reduce the attractiveness of solar power as an investment and create major uncertainty in the solar marketplace. The results of the policy mistakes of the solar “boom” of the 1970s and early 1980s suggest that, instead, policymakers should encourage the orderly growth of the industry over the long term.

Other Policy Options Can Complement Net Energy Metering

Additional policy options could ensure continued growth in the solar marketplace, especially when combined with net energy metering.

Eliminate Regulatory Barriers to the Expansion of Solar Energy

- California policymakers at all levels of government should simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation. Different jurisdictions across the state have varying permitting and interconnection procedures and fees, which can add unnecessary friction to the process of installing solar energy systems. State and local leaders should work to standardize procedures, minimize fees, and streamline the process of installing a new solar energy system and integrating it into the electricity grid. Industry analysts predict that reforming permitting would lead to the installation of an additional 132,000 residential solar power systems through 2020, a 13 percent increase in the pace of solar development – which would contribute \$5.1 billion to the California economy and create 3,900 full-time jobs.⁷⁹

Require Net-Zero Energy Homes

- A net-zero energy building code requirement would increase the use of solar and other local clean energy systems in new construction. Incorporating solar energy technology into new buildings at the time of construction represents an enormous opportunity to grow California's solar market. California should require all new homes to include solar power or other on-site renewable electricity generation by no later than 2020, and all non-residential buildings by no later than 2030, through a net-zero energy building code requirement. Such a requirement would be consistent with the state's overall clean energy goals, as well as with steps that President Obama has ordered for federal buildings.⁸⁰

- This policy can be enacted at the local level as well. For example, Lancaster and Sebastopol have taken steps in this direction by requiring solar energy on new housing developments.⁸¹

Provide Access to More Financing Options

- Policymakers should expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.
- For example, allowing on-bill financing – which would incorporate long-term loan payments into a regular electricity bill – could enable potential solar customers to install systems with no money down and low interest payments. These programs, such as the PAYS America program (Pay As You Save), harness future savings from renewable technologies or efficiency measures to pay the up-front cost of installation. They are especially promising for multi-family dwellings because they allow the payments to be attached to the utility meter, making the program attractive to renters, as well as property owners.
- The Property Assessed Clean Energy (PACE) program, which enables property owners to finance renewable energy and energy efficiency projects through local government loans that are paid back via property tax bills, should be reinstated for residential customers. California leaders can continue to advocate for the program to be restored at the federal level.
- Another option to further diversify California's solar energy consumer base would be to create a community solar program to enable Californians who rent their property, whose roofs are obstructed or who face resource issues to voluntarily participate in the state's clean energy transformation.

Notes

1. Beginning with 80GW of rooftop solar PV potential, per: J. Paidipati et al., Navigant Consulting, Inc. for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*, Subcontract Report NREL/SR-581-42306, February 2008; and assuming that an average 1kW (AC) system generates 1,450 kWh of electricity per year, compared to California's annual usage of about 270 million MWh of electricity, per U.S. Energy Information Administration, *State Electricity Profiles: California*, DOE/EIA-0348(01)/2, April 2011.

2. State of California Legislature, *Senate Bill 1 (Murray)*, Chapter 132, Statutes of 2006.

3. Ibid, Section 25780.

4. The Solar Foundation, *State Solar Jobs*, downloaded from thesolarfoundation.org/solarstates/california on 12 May 2013.

5. Utilities, eg: David R. Baker, "Solar Customers' Net Metering' Challenged," *San Francisco Chronicle*, 30 March 2013.

6. Jeffrey Russell and Steven Weissman, Berkeley Law Center for Law, Energy & the Environment, *California's Transition to Local Renewable Energy: 12,000 Megawatts by 2020*, 7 June 2012.

7. Michelle Kinman, Environment California Research & Policy Center, *California Rooftop Solar Hits 1.5 Gigawatt Milestone* (press release), 14 March 2013. All solar capacity figures in this report are presented in terms of alternating current watts, measured under California Energy Commission PTC test conditions, unless otherwise noted.

8. See www.gosolarcalifornia.ca.gov for current statistics.

9. BP, *Statistical Review of World Energy*, May 2012. Available at www.bp.com/statisticalreview.

10. In 2002, California had 30 MW of distributed solar power. By 2012, the state had 1,430 MW. See Travis Madsen, Frontier Group, and Michelle Kinman and Bernadette Del Chiaro, Environment California Research & Policy Center, *Building a Brighter Future: California's Progress*

Toward a Million Solar Roofs, November 2011 and www.gosolarcalifornia.ca.gov.

11. See note 2; "on track": Energy and Environmental Economics, *CSI Cost-Effectiveness Evaluation*, April 2011, available at ftp://ftp.cpuc.ca.gov/gopherdata/energy_division/csi/CSI%20Report_Complete_E3_Final.pdf; See also note 10.

12. See note 10.

13. The Solar Foundation, *National Solar Jobs Census 2012*, November 2012.

14. See note 4.

15. Generating 1 MW of electricity from coal and natural gas equates to 0.8 and 0.35 jobs respectively, generating this same amount of electricity from solar power provides between 11 and 35 jobs. Job creation estimates obtained from the following sources: California Energy Commission, *California's Clean Energy Future, Preliminary Estimates of Job Creation*, January 2012; Los Angeles Business Council Institute, *Empowering LA's Solar Workforce: New Policies that Deliver Investments and Jobs*, November 2011; Max Wei, Shana Patadia and Daniel M. Kammen, "Putting Renewables and Energy Efficiency To Work: How Many Jobs Can The Clean Energy Industry Generate in the U.S.?" *Energy Policy* 38 (2010) 919-931; Robert Bacon and Masami Kojima, The World Bank, *Issues in Estimating the Employment Generated by Energy Sector Activities*, June 2011.

16. Next Ten and Collaborative Economics, *2013 California Green Innovation Index*, March 2013.

17. Ibid.

18. Ibid.

19. Alexander Quinn, Christine Safriet and Christopher Clement, AECOM, *Economic and Fiscal Impact Analysis of Residential Solar Permitting Reform*, July 2011.

20. Los Angeles Department of Water & Power, *Power Integrated Resources Plan*, December 2012, p. 54 and 55.

21. California's net energy metering law (Senate Bill 656) was enacted in 1995. It applies to utilities in the state of California, except for the Los Angeles Department of Water & Power. (State of California, Public Utilities Code § 2827(b)(3).) However, even without legislative requirement, Los Angeles offers net energy metering to clean energy systems up to one megawatt in size.

22. The Public Utilities Regulatory Policies Act of 1978 (PURPA), which can be found at 18 Code of Federal Regulations §292.303.

23. Ibid.

24. For example, see California Public Utilities Commission, Decision No. 10-12-035, 16 December 2010.

25. Southern California Edison Company, *Short Run Avoided Cost Energy Price Update for Qualifying Facilities, Pursuant to D.10-12-035, June 1, 2013 – June 30, 2013*, Microsoft Excel document, available at www.sce.com/nrc/aboutsCE/regulatory/qualifyingfacilities/srac_price_update.xls.

26. Assuming annual rate inflation of 2.5 percent and a 7 percent discount rate.

27. The average residential electricity customer in California uses 6,700 kWh per year, per: U.S. Department of Energy, Energy Information Administration, *Electric Power Annual*, 30 January 2013.

28. In order to measure the impact of net energy metering, rather than the impact of switching rate plans, we kept our hypothetical solar customer in the same rate plan after solar panel installation. In the real world, many customers choose a "time of use" rate plan, which often provides better value.

29. Calculated using Clean Power Finance CPF Tools software, online interface available at www.cleanpowerfinance.com/. We set the price for installed solar panels at \$5.50 per Watt (DC), based on installed prices in the California Solar Initiative database for residential customers reported from January through June 2013, excluding third-party ownership arrangements to reduce the influence of financing costs. We otherwise used default software settings in the Clean Power Finance software as of June 2013.

30. Assuming residential step 10 incentive levels in the California Solar Initiative.

31. Assuming a 2.5 percent annual increase in the baseline residential electricity rate. Based on Clean Power Finance, *What Is a Realistic Electricity Inflation Rate for my Proposal?* 29 June 2012, available at resources.cleanpowerfinance.com/help/help-articles/determining-an-attractive-but-realistic-electricity-inflation-rate-for-your-proposal/.

32. Overall, NEM customers, including commercial customers, consume 75 percent of the solar electricity they generate and export 25 percent, per California Public Utilities Commission, Energy Division, *Introduction to the Net Energy Metering Cost-Effectiveness Evaluation*, March 2010, page 7. We assume 33 percent export for residential customers, less than shown in representative generation profiles on page 32 of Energy and Environmental Economics, Inc., for California Public Utilities Commission, *Net Energy Metering (NEM) Cost-Effectiveness Evaluation*, January 2010.

33. We assumed, per *Clean Power Finance*, that the output of the solar energy system would decline by one percent per year. We also assumed that the fraction of total generation exported to the grid would decline at the same rate.

34. We modeled the short run avoided cost rate according to the following formula. We assumed that 50 percent of weekday solar exports would happen at peak summer avoided cost rates, and that 50 percent would happen at summer mid-peak rates. Further, we assumed that all weekend solar exports would happen at summer off-peak rates, when peak prices do not apply. Using June 2013 short run avoided cost values from SDG&E (per San Diego Gas and Electric Company, *Energy Price Update for Qualifying Facilities, Pursuant to D.07-09-040, D.10-12-035, D.11-07-010, D.11-10-016 and Resolution E-4246, Effective June 1, 2013 to June 30, 2013*, available at www2.sdge.com/srac/), we calculated the average price at 5.47 cents per kWh. To the extent that winter avoided cost rates, which are lower, ever apply, our estimate for the value of net energy metering is conservative.

35. San Diego Gas and Electric, *Schedule DR – Residential Service*, 1 January 2013, available at www.sdge.com/sites/default/files/regulatory/010113-schedule_dr.pdf

36. For simplicity, we assume that all exported electricity will be credited at the avoided cost rate calculated in note 34 – 5.47 cents per kWh.

37. For simplicity, this calculation assumes that both utility rates and short run avoided cost rates will increase at 2.5 percent per year. (See note 31.) Actual cost increases may differ from this assumption.

38. Assuming a 7 percent discount rate.

39. If the solar panel owner instead consumed 75 percent of electricity on site, the net present value of net energy metering would be \$0.75 per Watt AC. Eliminating NEM would reduce available cash flow by 15 percent in this case.

40. The range of exported power is between 20 and 50 percent, per Energy and Environmental Economics, Inc., for California Public Utilities Commission, *Net Energy Metering (NEM) Cost-Effectiveness Evaluation*, January 2010.

41. See note 32, California Public Utilities Commission and Energy and Environmental Economics, Inc.

42. In other words, the Public Utilities Commission report looked at the value of net energy metering payments without netting out the short run avoided cost payments that would replace the policy were it suspended.

43. Naïm Darghouth, Galen Barbose and Ryan Wiser, Lawrence Berkeley National Laboratory, *The Impact of Rate Design and Net Metering on the Bill Savings from Distributed PV for Residential Customers in California*, April 2010.

44. GRID Alternatives, *Single-family Affordable Solar Homes (SASH) Program: Q1 2013 Program Status Report*, May 2013.

45. Southern California Edison Company, *Multifamily Affordable Solar Housing Semi-Annual Progress Report*, 2 February 2012.

46. Sunwheel Energy, *Sample Projects*, downloaded from sunwheelenergy.com/projects.html on 17 April 2012. Converted kWh to home consumption by comparing reported annual generation with the average annual electricity usage of a residential customer in California per U.S. Department of Energy, Energy Information Administration, *Number of Retail Customers by State by Sector, Back to 1990 (Form EIA-861)*, and *Retail Sales of Electricity by State by Sector by Provider, Back to 1990 (Form EIA-861)*, downloaded from 205.254.135.7/electricity/

data.cfm#sales on 7 March 2012. Electricity generation converted to global warming emissions using the non-baseload emission rate for carbon dioxide pollution in California from 2007, per U.S. Environmental Protection Agency, *eGRID2010 Version 1.1*, 20 May 2011. Gasoline equivalency per U.S. Environmental Protection Agency, *Greenhouse Gas Equivalencies Calculator*, available at www.epa.gov/cleanenergy/energy-resources/calculator.html.

47. See note 32, California Public Utilities Commission and Energy and Environmental Economics, Inc.

48. R. Thomas Beach and Patrick G. McGuire, Crossborder Energy for the Vote Solar Initiative, *Evaluating the Benefits and Costs of Net Energy Metering in California*, January 2013.

49. Energy and Environmental Economics, *Net Energy Metering Cost-Benefit Study: Phase 1 Scope and Method Workshop Update*, 19 December 2012.

50. This study took a similar approach to the earlier Public Utilities Commission study analyzing the cost effectiveness of net energy metering (see Note 32). However, the authors argued that the Public Utilities Commission study missed a few concrete benefits for utilities, especially the value of avoiding purchasing renewable power that would otherwise be needed to comply with California's renewable electricity standard.

51. See note 48.

52. See note 2.

53. Kristin Averyt et al., Union of Concerned Scientists, *Freshwater Use by U.S. Power Plants: Electricity's Thirst for a Precious Resource*, November 2011.

54. Thomas R. Karl, Jerry M. Melillo and Thomas C. Peterson (eds.), U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, Cambridge University Press, 2009. In *Global Climate Change Impacts in the United States*, the U.S. Global Change Research Program notes, "In the future, droughts are likely to become more frequent and severe in some regions. The Southwest, in particular, is expected to experience increasing drought as changes in atmospheric circulation patterns cause the dry zone just outside the tropics to expand farther northward into the United States."

55. Hector Becerra, "Another Dry Year for L.A.," *Los Angeles Times*, 13 April 2013; and Mark Grossi, "Sierra Snowpack Falls Short," *The Fresno Bee*, 26 March 2013.

56. New West Technologies, LLC, Energetics Incorporated, and NREL for the U.S. Department of Energy, *SunShot Vision Study*, February 2012.

57. U.S. Internal Revenue Service, *Credit for Residential Energy Efficient Property*, available at www.irs.gov/pub/irs-drop/n-09-41.pdf.

58. California Public Utilities Commission, *Proposed Decision of Commissioner Peevey Regarding Calculation of the Net Energy Metering Cap*, Rulemaking 10-05-004, 11 April 2012. Available at docs.cpuc.ca.gov/efile/PD/163814.pdf.

59. California Public Utilities Commission, *Decision Regarding Calculation of the Net Energy Metering Cap*, D. 12-05-036, 24 May 2012.

60. Based on an inflation-adjusted analysis of residential installations in the California Solar Initiative through the end of March 2013. Data from California Solar Initiative Incentive Application Database, available at www.californiasolarstatistics.ca.gov/current_data_files/.

61. This approximates the rate of solar price improvements used in the *SunShot Vision Study*. (See note 56.) The SunShot reference case scenario starts at \$6.5/Watt AC in 2013, falling to \$4.9/Watt AC in 2020.

62. This is a lower-end estimate. Net energy metering policy exempts solar energy customers from paying interconnection costs to their utility. (See note 2, California Public Utilities Commission, page 10.) If the suspension of net energy metering required solar energy customers to begin to pay interconnection costs, it would directly impact the up-front cost of solar. Estimating the size of this impact was beyond the scope of this report.

63. See note 56, page 248; and Navigant Consulting for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*. NREL/SR-581-42306, 2008.

64. Ibid.

65. Calculated by the authors using a DC to AC derate factor of 0.77, per U.S. Department of Energy, National

Renewable Energy Laboratory, *PVWatts 2.0*, available at maps3.nrel.gov/PVWatts_Viewer/index.html.

66. See note 56.

67. Easan Drury, Paul Denholm and Robert Margolis, National Renewable Energy Laboratory, *Sensitivity of Rooftop PV Projections in the SunShot Vision Study to Market Assumptions*, Technical Report NREL/TP-6A20-54620, January 2013.

68. A "no net energy metering" policy case would apply such a price reduction to 20 to 50 percent of the generation of a solar energy system, not 100 percent.

69. See note 67.

70. See note 1.

71. See note 56.

72. "Total Global Solar PV Capacity Now Approaching or Over 100 GW," *CleanTechnica.com*, 11 April 2013.

73. Geoffrey Jones and Loubna Bouamane, Harvard Business School, *"Power from Sunshine": A Business History of Solar Energy*, 25 May 2012.

74. Ibid.

75. Ibid.

76. Ibid.

77. See note 4.

78. See note 16.

79. Alexander Quinn, Christine Safriet and Christopher Clement, AECOM, *Economic and Fiscal Impact Analysis of Residential Solar Permitting Reform*, July 2011.

80. The White House, Executive Order 13514, 5 October 2009.

81. Guy Kovner, "Sebastopol Poised to Add Solar Requirement to New Construction," *Press-Democrat*, 4 May 2013.