Rooftop Solar at Risk

Cuts to net metering could threaten California's clean energy progress

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Executive summary

Rooftop solar power is an essential tool for California to meet its ambitious climate and clean energy goals. California has become the nation's solar energy leader by adopting policies that have nurtured and grown the state's market for distributed solar panels on homes and businesses consistently, year after year.

Today, however, utilities and their allies are pushing for major rollbacks to the state's key policy for compensating solar panel owners for the surplus energy they share back to the electric grid – called "net metering." Such a rollback would likely slow down rooftop solar adoption dramatically, threatening California's continued clean energy progress.

Evidence from California and around the United States shows that the pace of solar adoption is dependent on the level of compensation provided to solar panel owners. The case studies in this report, taken from states from Hawaii to Missouri and from across California, show that **policy changes like sharply reducing net metering payments and imposing high, solar-only fixed charges that reduce the economic viability of solar power can slow its growth – and, in the most extreme cases, can cause solar installations to plummet**.

California cannot afford a "solar cliff" and still meet its climate and energy goals. The California Public Utilities Commission (CPUC) must adopt an approach to net metering (NEM 3.0) that facilitates the continued growth of rooftop solar power.

California needs rooftop solar to meet its ambitious climate and energy goals.

- California has committed to achieving 60% renewable electricity by 2030 and 100% clean, zero-carbon electricity by 2045.
- Modeling conducted for the state of California assumes that, to meet those goals, California will need to continue to add nearly as much rooftop solar as we currently do, every year through 2045.[1]

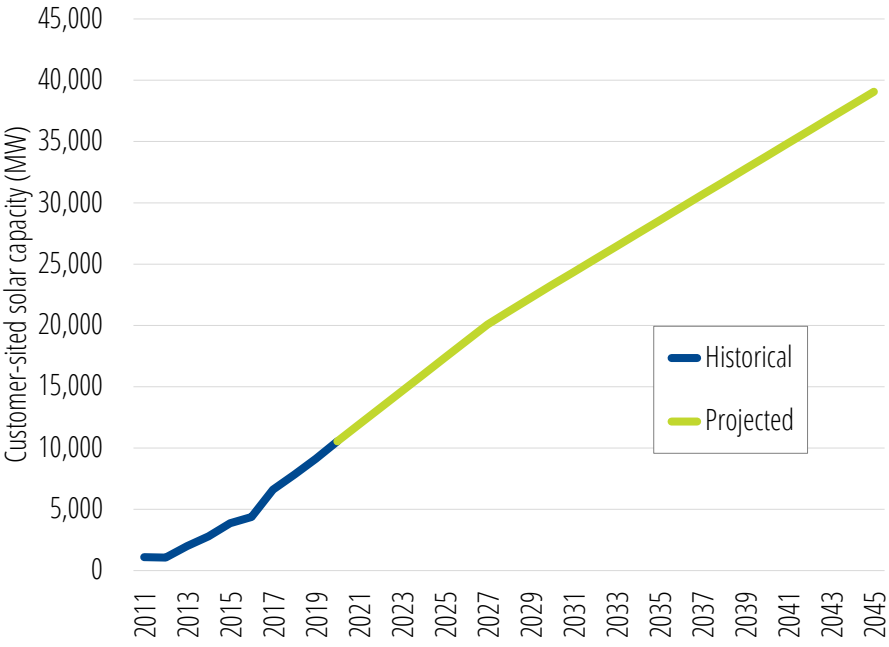


Figure ES-1. Historical and projected customer-sited solar in California[2]

- Rooftop solar is a uniquely powerful and beneficial way to reach California's clean energy goals – reducing conflicts between land preservation and renewable energy production, reducing the need for expensive long-distance transmission infrastructure, and helping to build an electricity system more resilient to wildfires and other climate-related disasters.[3]

California's strong and consistent net metering policies have helped facilitate the growth of solar energy.

- California is the nation's rooftop solar energy leader. As of the end of 2020, California had 38% of the nation's small-scale solar photovoltaic (PV) capacity despite accounting for less than 7% of the nation's electricity consumption.[4]
- California has adopted a series of policies to encourage the growth of rooftop solar, from the Million Solar Roofs program adopted in 2006 to the state's net energy metering (NEM) 1.0 and 2.0 policies. Net metering has enabled distributed solar customers to be compensated at the retail rate for the surplus electricity they supply to the grid.
- Electricity bill savings are the most important source of value for California homeowners and businesses who "go solar."[5] Net metering is a critical determinant of the amount of money solar panel owners will save on their electricity bills.
- California's three investor-owned utilities – those governed by the state's net metering policies – have experienced steady, consistent growth in customer solar adoption (see Figure ES-2), making them the top three utility territories in the nation for rooftop solar.

Reducing compensation to solar consumers reduces solar adoption – often dramatically.

- Utilities in California and elsewhere have pushed for several types of policy changes to reduce solar compensation, including reducing net metering rates and creating new fixed charges (either for solar customers only or all customers).
- A recent study of changes to net metering around the country commissioned by California's three large IOUs concluded that "net metering reforms

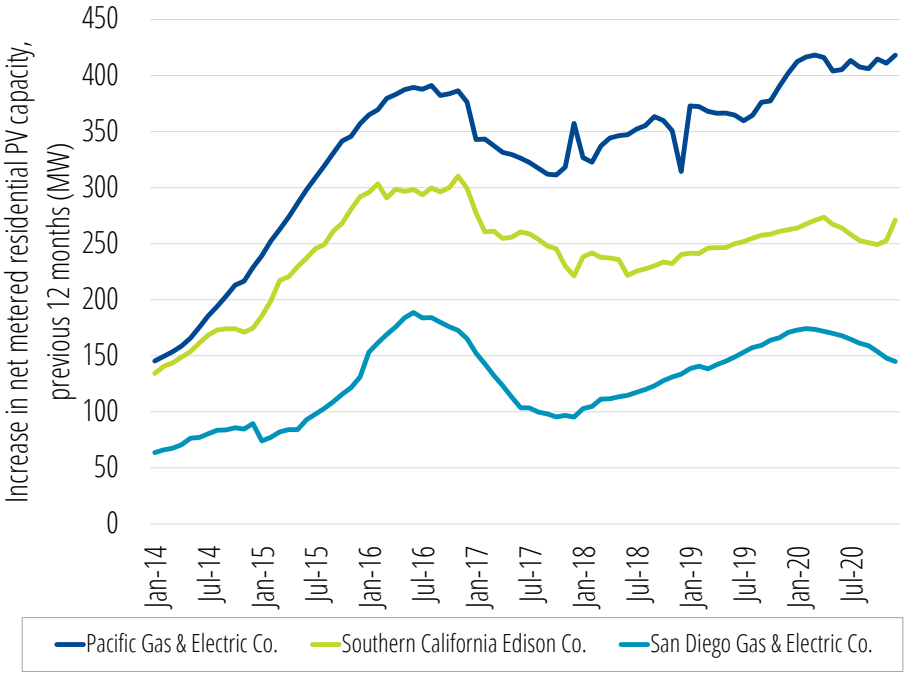


Figure ES-2. Increase in net metered residential solar capacity, preceding 12 months, California IOUs[6]

may have had a significant impact on residential solar adoption rates in several states."[7]

- Would-be solar customers are sensitive to the expected financial performance of their investment. A 2014 study by researchers with the National Renewable Energy Laboratory (NREL) estimated that half of potential new residential solar consumers would be willing to consider solar if the payback period was six years or less. That percentage drops to 20% for payback periods of 10 years or more.[8]

The experience of California's publicly owned utilities and other states around the country illustrates the impact of compensation changes on solar adoption.

- In **Arizona**, the Salt River Project adopted new fees and policies for rooftop solar that nearly doubled the payback time of solar projects. Researchers estimated that the policy change led to a decline in solar adoption of between 50% and 95%.[9]
- In **Hawaii**, ending net metering in 2015 led to a sharp slowdown in the state's booming rooftop solar industry. Hawaii installed roughly half as much residential rooftop solar between 2015 and 2018 as it had in the previous three years, despite sharp declines in solar prices during that time.
- An attempt to roll back net metering in **Nevada** led to two years of instability and decline in the state's solar market. A study filed by California's IOUs as part of the current NEM 3.0 proceeding found that Nevada's January 2016 cut to net metering compensation was followed by a 47% reduction in residential solar installations over the next year (compared with the 12 months preceding the change). The September 2017 restoration of net metering was followed by an increase in solar adoption that eventually led residential rooftop solar adoption to return to its earlier level.[10]

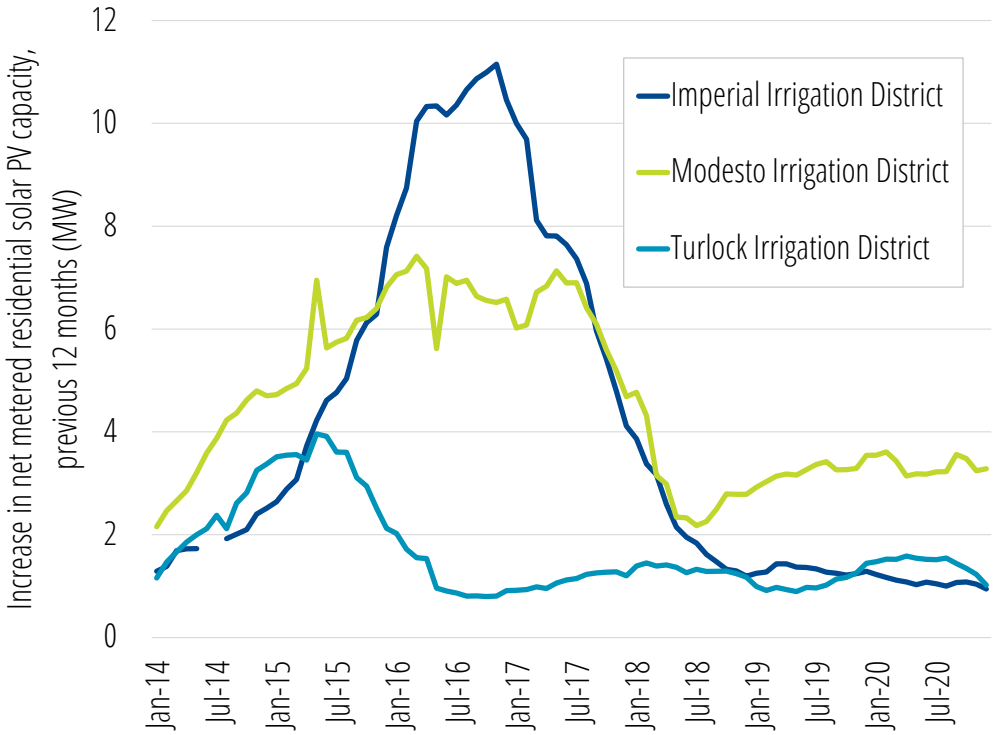


Figure ES-3. Change in net metered residential solar capacity, previous 12 months[12]

- **Missouri** had a nascent but growing solar market in the early 2010s, fueled by a system of rebates. The removal of those rebates caused the market to crash. New residential additions of rooftop solar in the territories of Missouri's three major IOUs fell from 23 megawatts (MW) in the 12 months ending June 2014 to 7 MW in the ensuing 12 months – a decline of 70%.[11]
- Similar declines in solar adoption have followed rate changes at California's publicly-owned utilities, which are not required to follow the CPUC net metering policies.
    - **The Imperial Irrigation District** abandoned net metering in July 2016, causing residential solar installations to fall from a peak of more than 11 MW per year to less than 2 MW annually two years later – a decline of 88%.
    - The **Modesto Irrigation District** reduced net metering compensation in January 2017. Over the course of the next year-and-a-half, residential solar installations fell from more than 6 MW per year to just over 2 MW – a decline of 64%.
    - The **Turlock Irrigation District** ended net metering at the beginning of 2015. Within two years, annual residential solar installations had fallen from 3.5 MW to less than 1 MW – a decline of 74%.

The CPUC must adopt a new version of net metering that assures the continued growth of rooftop solar in California.

- As California updates its net energy metering policy, it should **ensure that the revised policy provides sufficient support to allow the undiminished growth of rooftop solar**. Slower growth of distributed solar creates a risk that the state will not meet its climate and clean energy targets.
- California should seek to **accelerate solar energy adoption on affordable and rental housing**, including by allowing financing through utility bills and ensuring that solar owners who pay reduced rates are fully compensated for the power they provide to the grid.
- In addition, cities and counties should establish online automated **permitting systems for standard onsite solar projects** to speed up permit approvals and reduce "soft costs" resulting from installation delays, using systems like SolarAPP+ developed by the National Renewable Energy Laboratory.

Introduction

California has been at the forefront of rooftop solar power for so long that its leadership feels inevitable.

It isn't. California's successful expansion of rooftop solar power over the last two decades is not just the result of our abundant sunshine and strong environmental values. It is the product of decades of strong, clear public policies designed to foster the growth of clean, local energy across California.

Some of the policies that initially gave life to California's growing solar market – such as the Million Solar Roofs program that was launched in 2006 – are now largely in the rearview mirror. Over time, California's approach to supporting rooftop solar has evolved as solar costs have come down, the state's electricity challenges have changed, and the urgency of transitioning to a decarbonized electricity system has grown.

Today, California's solar policy landscape is evolving again, as the California Public Utilities Commission (CPUC) develops a successor program to the state's current rules for net energy metering (NEM) – the policy that governs the compensation received by homeowners and businesses for the solar electricity they supply to the grid.

Net metering is currently a key policy providing value to solar homeowners and business owners in California. It can be the make-or-break factor determining whether rooftop solar will make economic sense to an individual consumer.

The CPUC's upcoming decision in its "NEM 3.0" proceeding will determine whether rooftop solar remains economically viable and attractive – or becomes economically out of reach for ordinary Californians, putting California's ability to meet its ambitious climate and clean energy goals in jeopardy.

The evidence – from academic studies, experience in California and around the country, and even from documents submitted by California's investor-owned utilities (IOUs) themselves in the CPUC's NEM 3.0 proceeding – shows that changes to net metering can have significant effects on residential solar adoption. Time and again, states across the country have faced similar decision points as the one now facing California, with those that cut solar compensation most severely experiencing dramatic declines in solar adoption. Some of those states later reversed their decisions – with solar adoption taking years to recover to its previous levels. Others are currently scrambling to reinvigorate their rooftop solar markets in order to meet their own ambitious clean energy goals.

With time running out to address the climate crisis and big clean energy deadlines looming ever closer, California cannot afford missteps that bring the state's rooftop solar growth to a halt. The examples and evidence presented in this report show clearly that the CPUC must adopt an approach to NEM 3.0 that assures continued growth of the rooftop solar market.

California is a rooftop solar leader. Strong public policy helped make it so. And smart public policy can assure that California avoids the mistakes made by other states and retains its leadership in rooftop solar, now and for years to come.

Rooftop solar is a critical component of California's clean energy future

California leads the nation in the adoption of clean, renewable energy and in actions to protect the climate. California's strong and consistent policy support for renewable energy has created fertile ground for the growth of new clean energy technologies – including rooftop solar.

California is committed to obtaining 60% of its electricity from clean, renewable sources by 2030 and 100% of its electricity from carbon-free forms of energy by 2045.[13] To get there, California will need to dramatically expand its renewable energy capacity and its ability to integrate renewable energy into the grid. That includes rooftop solar.

Rooftop solar is generating increasing amounts of clean energy

California leads the nation in the development of a robust industry for customer-sited solar power. Policy steps such as the state's Million Solar Roofs program, adopted in 2006, accelerated the deployment of solar energy on California rooftops, helping to trigger a "virtuous cycle" of price declines and technological improvements that have helped make solar a mainstream source of energy in California and around the world.

As of December 2020, California had 10.5 gigawatts (GW) of small-scale solar photovoltaic (PV) capacity enrolled in net metering programs statewide and accounted for 38% of the nation's small-scale PV capacity, despite accounting for less than 7% of the nation's electricity consumption.[14] The amount of customer-sited solar capacity in California has increased at an average rate of just over 1 GW per year since 2011. Since 2016, California has added an average of 1.5 GW of customer-sited solar per year – more than doubling the amount of customer-sited solar in the state in just four years.[15]

California is counting on rooftop solar to meet its clean energy goals

California will need to continue installing customer-sited solar energy at roughly the rate of the last decade if it hopes to meet its clean energy goals. In their joint report on how to achieve the 100% clean electricity system promised by the adoption of SB 100 in 2018, the California Energy Commission (CEC), California Public Utilities Commission (CPUC) and California Air Resources Board (CARB) assumed a large and growing role for customer-sited solar energy. By 2045, the agencies' core scenario assumes that California will have 39 GW of customer-sited solar – a near quadrupling of the size of today's distributed solar capacity. [16]

Achieving that target would require the addition of an average of approximately 1.1 GW of new customer-sited solar per year every year until 2045. That is slightly less than the 1.4 GW that California adopted during 2020.[18] (See Figure 1, next page.)

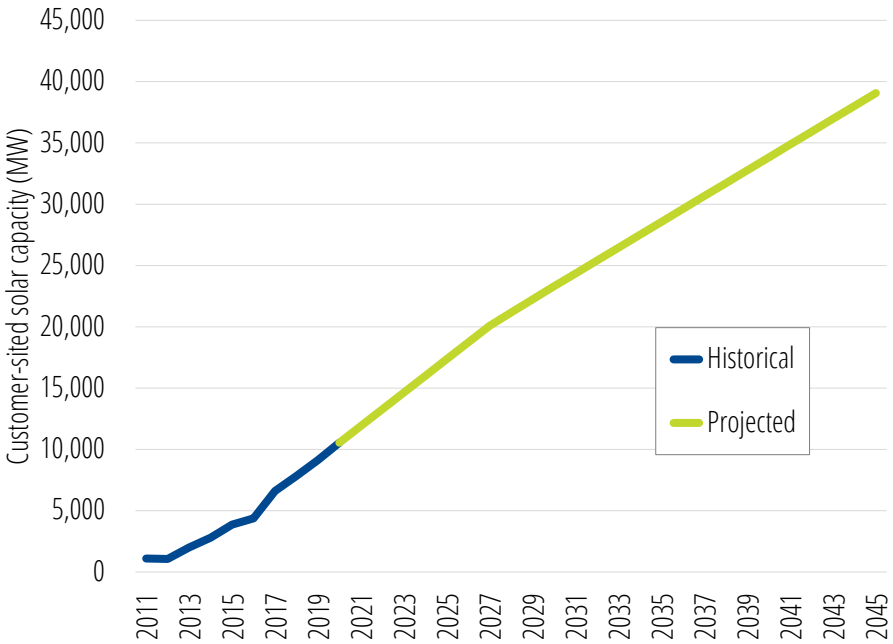


Figure 1. Historical and projected customer-sited solar in California[17]

If California fails to achieve that trajectory of customer solar growth, the difference will need to be made up by other forms of renewable energy – all of which are being counted on to grow significantly in their own right in order to facilitate the transition to a 100% clean energy grid. Moreover, the accelerating pace of climate change demands that California ramp up its deployment of renewable energy – small- and large-scale – as quickly as possible. Rooftop solar can play a critical role in achieving that rapid growth.

California must maintain continued, steady growth of rooftop solar at approximately the rates of the last decade if customer-sited solar is to meet the expectations set for it in California's clean energy transition. Recent rates of solar energy growth have been supported by strong pro-solar policies, including the state's approach to net metering.

Rooftop solar delivers powerful benefits

Continued growth of rooftop solar power in California is also critical because of the unique benefits it brings for the environment and our communities.

- **Reduced land use conflicts:** Rooftop solar energy is built on already-developed land, reducing the amount of wild and undeveloped land that will be needed for utility-scale renewable energy. If the additional rooftop solar California is projected to install by 2045 were to be in utility-scale installations instead, it would consume an additional 148,000 acres of land.[19]

- **Reduced transmission costs:** Rooftop solar generates power in close proximity to where it is used, reducing the need for new transmission capacity. A 2018 report found that California has been able to avoid $2.6 billion in spending on transmission and other grid projects largely due to increases in rooftop solar and energy efficiency.[20] Maximizing distributed solar power – especially if paired with energy storage – can limit the cost of future transmission upgrades.[21]

- **Resilience:** Rooftop solar is a key part of a more resilient energy future for California – an important benefit given the state's vulnerability to wildfires and other disruptive impacts of climate change. When paired with battery storage, including as part of community microgrids, rooftop solar can enable continued access to power even amid wider grid disruptions caused by wildfires or preemptive power shutoffs. PG&E's preemptive power cuts in October 2019 were estimated to cost the California economy as much as $2.5 billion.[22]

Net metering has helped support steady growth of rooftop solar in California

Net metering has proven to be an important part of California's policy approach to supporting the growth of rooftop solar. California's steady growth in customer-sited solar installations over the last decade has reduced greenhouse gas emissions and represented an important down payment toward the achievement of California's clean energy goals.

Key solar policies in California

California has a long history of pioneering programs to encourage the adoption of solar energy. Today, net metering represents the most important policy lever driving the growth of local solar power.

Million Solar Roofs/ California Solar Initiative

Adopted in 2006, the Million Solar Roofs program (also known as the California Solar Initiative), set aside $3.3 billion in upfront rebates and other supports for solar power adoption, with the size of the rebates declining over time as solar prices fell, before phasing out for the general market, as planned, at the end of 2016.[23]

Rebates extended through the initiative supported the installation of 1.9 GW of solar PV capacity across California.[24] Specialized programs targeting single-family and multi-family affordable housing supported more than 8,700 additional solar projects as of the end of 2019.[25] Other programs created through the initiative continue to support the installation of solar power on affordable housing and in disadvantaged communities.

Solar requirement for new homes

In 2018, California adopted new statewide building energy efficiency standards requiring new homes built in the state (with some exceptions) to incorporate solar power. The requirement went into effect in 2020, but was weakened to allow compliance through the purchase of solar power from off-site installations.[26] While the new policy will expand the use of solar power in California, the state adds only approximately 80,000 new homes each year, compared to an overall housing stock of more than 14 million units.[27] Continuing to expand the number of solar panels on existing homes will need to remain a key part of the state's overall clean energy strategy, as will ensuring that consumers required to go solar under the new policy aren't penalized financially by high fixed charges or reduced net metering compensation.

Federal Investment Tax Credit

The second-most important source of policy support for new rooftop solar installations (after net metering) is the federal solar Investment Tax Credit (ITC).[28] The ITC provides a 26% tax credit for residential and commercial solar installations. Previously a 30% credit, the ITC is scheduled to phase down over time (following a two-year delay intended to support the industry during COVID-19). The credit is scheduled to drop to 22% in 2023 and be eliminated entirely for residential projects and reduced to 10% for commercial projects in 2024.[29]

The importance of net metering

Policies related to the compensation solar PV owners receive on their electric bills are the most important policies supporting the installation of rooftop solar power in California.

California's strong net metering rules, which govern the compensation solar panel owners receive for the surplus electricity they supply to the grid, historically have been a key factor in the state's success in expanding solar adoption. The state put net metering in place in 1995 with Senate Bill 656, which was designed to encourage private investment in renewable energy but included a size limit on systems and a tight cap on total net metering payments.[31]

Subsequent legislation in 2001, 2002, 2006 and 2010 raised the net metering cap successively to 5% of peak load, but 2013 legislation directed the California Public Utility Commission (CPUC) to develop a successor program to full net metering, which would end in mid-2017.[32]

In 2016, the CPUC issued updated net metering rules (NEM 2.0) that kept the overall system in place but cut credits to solar owners for power they sent to the grid by about 2-3 cents per kilowatt-hour (kWh), in theory to make sure solar owners paid fairly for utility costs related to energy efficiency and low-income assistance programs.[33] The update also required new solar owners to sign up for time-of-use billing (TOU), which allowed utilities to charge higher rates for power at certain times of the day.[34]

The combination of California's net metering program, the state's high retail electricity rates, and the lack of other direct subsidies for solar has resulted in net metering providing much of the economic incentive for Californians to "go solar." Research by the National Renewable Energy Laboratory (NREL) shows that while California's direct subsidies and incentives for solar power (shown in dark blue in Figure 2) are lower than in many other leading solar states, the electricity bill savings delivered in part by net metering result in Californians enjoying greater per-watt value from adopting solar than in all but one of those states.[35]

In the absence of extended federal tax credits or expanded direct incentives for solar, electric bill savings will soon become the dominant – and virtually only – way in which most California consumers will reap economic benefits from going solar. Net metering is a key tool for delivering those savings.

Evidence from around the country, as well as California, shows that when utilities succeed in curtailing electric bill savings from solar energy, solar adoption drops – sometimes dramatically. At a moment when California must significantly ramp up its production of renewable power to meet its climate and energy goals, it is critical that policymakers review the evidence on the link between solar compensation and adoption.

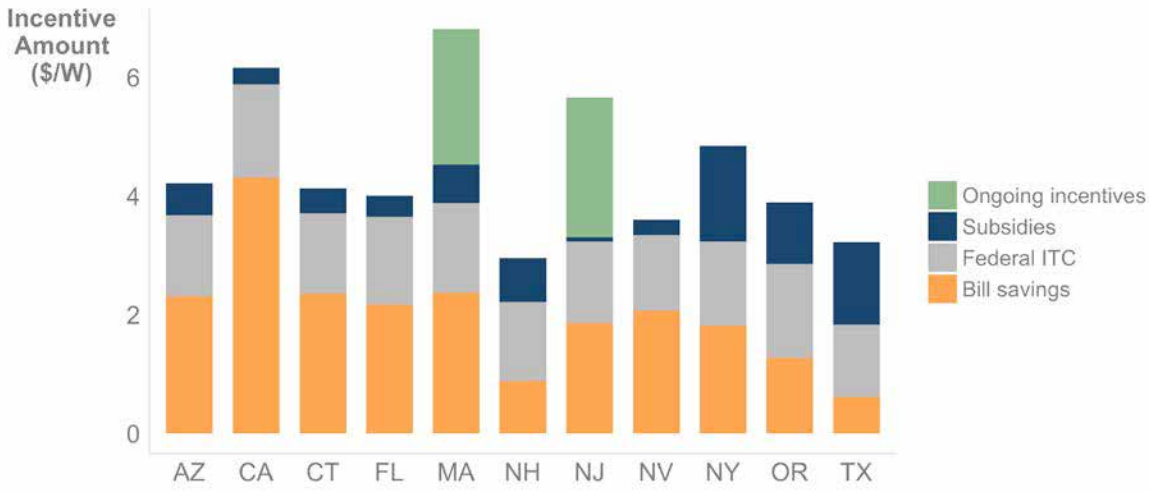


Figure 2. Value of solar PV adoption by state. (Reprinted with permission by the National Renewable Energy Laboratory)[36]

Reducing compensation can put the brakes on solar power deployment

Across the country and in the territories of several California municipal utilities, changes to solar compensation have sparked major declines in rooftop solar adoption. Evidence from academic studies shows that consumers are sensitive to the expected financial return on their investment in solar power and that reducing the economic attractiveness of solar shrinks the size of the potential market – in some cases dramatically. Recent research commissioned by the state's IOUs verifies that reductions in solar compensation may have led to declines in residential solar adoption in some states. And a review of national data on solar adoption shows that steep declines in small-scale solar adoption tend to follow policy changes that reduce compensation for owners of solar panels.

This evidence suggests that California policymakers must weigh the potential effects of changes in net metering policy on solar adoption when considering adjustments to solar compensation.

How utilities are pushing to make rooftop solar an economic loser for consumers

Utilities in California and across the country have advocated for a series of changes to reduce the compensation received by customers who install solar panels.

- **Reduction in net metering compensation rates** – "Net metering" refers to policies that provide compensation to solar owners at the retail rate for the surplus electricity they supply to the grid – the equivalent of "running the meter backwards." Utilities have pushed in other states (and are currently pushing in California) to adopt less-generous compensation policies, including policies that compensate solar panel owners at lower rates that often fail to account for the full benefits provided by solar power to the grid and to society.[37] Requiring adoption of time-of-use electricity rates can also affect the compensation paid to solar power owners for their excess electricity, as can limiting customers' ability to "carry over" solar credits from one month to the next.
- **Creation of new fixed charges** – Utilities often argue that customers with solar panels shift costs related to maintaining the grid to customers without solar power. These arguments about cost shifting are often exaggerated, ignoring the benefits delivered by rooftop solar power for public health, the environment and the electric grid.[38] To address the supposed shift, utilities often propose instituting high fixed charges that either must be paid by all customers, or, in some cases, only by solar customers. These fixed charges can severely undermine the economic case for going solar.

Incentives matter

Evidence suggests that would-be solar consumers weigh the expected return on their investment heavily when considering whether to adopt solar panels. Lengthening the payback period for a solar investment by reducing compensation shrinks the potential market for solar and can reduce adoption.

A 2014 study by researchers with the National Renewable Energy Laboratory (NREL) estimated that half of

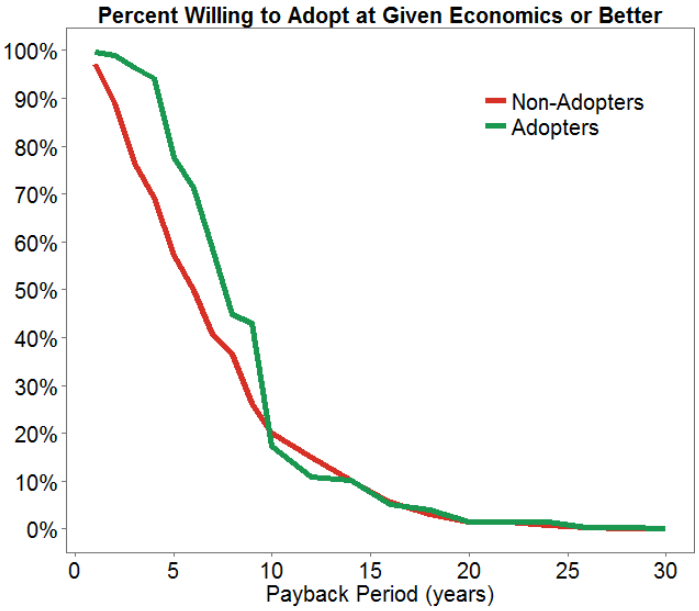
potential consumers would be willing to consider solar if the payback period was six years or less. That percentage drops to 20% for payback periods of 10 years or more.[39] (See Figure 3, below.)

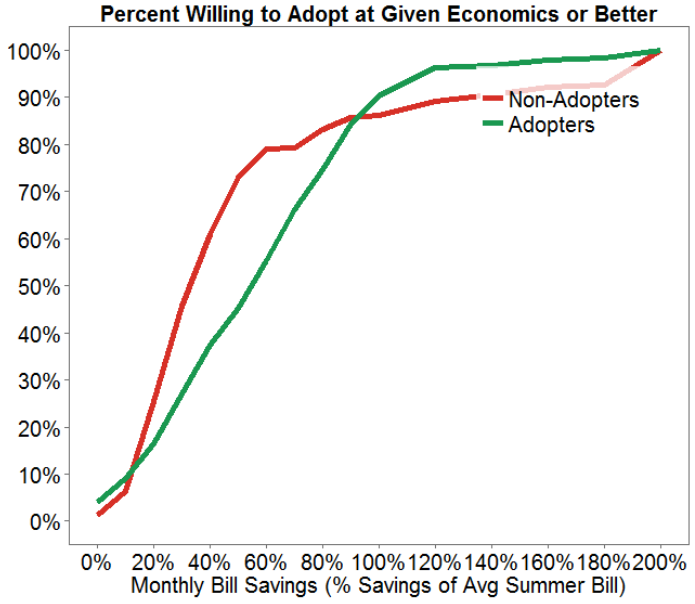
A 2015 analysis by researchers affiliated with the Lawrence Berkeley National Laboratory estimated the likely impacts of fixed charges or reductions to net metering compensation on residential solar adoption. Compared to the study's reference case scenario, assigning a $10 monthly fixed charge nationally would reduce residential solar adoption by 14%, a $50 monthly charge would slash adoption by 61%, and a low "feed-in tariff" that reduces solar compensation dramatically would reduce adoption by 79%.[41] (See Figure 4, next page.)

The potential effect of reduced compensation on solar adoption has even been acknowledged in the filing made by the state's three IOUs during the California PUC's current proceeding on NEM 3.0. The utilities' joint NEM 3.0 proposal included a report commissioned by the utilities and produced by the North Carolina Clean Energy Technology Center at North Carolina State University.[43] The report reviewed eight case studies of changes in solar compensation including three in California (Los Angeles Department of Water and Power, PacifiCorp and the Sacramento Municipal Utility District) and their impact on solar adoption. The examples included some changes that were unfavorable to solar customers and some that were favorable. In one case – NV Energy in Nevada – the analysis included a reduction in net metering compensation followed by its later restoration.

In the case of Nevada (reviewed in further detail on page 21), a January 2016 cut to net metering compensation was followed by a 47% reduction in residential solar installations over the next year, compared with the 12 months preceding the change. The September 2017 restoration of net metering was followed by a three-and-a-half-fold increase in residential PV adoptions over the ensuing year.[44]

Reviewing the evidence, the report's authors concluded that "net metering reforms may have had a significant impact on residential solar adoption rates in several states."[45]





"Adopters" refers to those who have already adopted solar power; "non-adopters" to those who have not yet done so.

Figure 3. Potential solar market at various payback times and levels of bill savings[40]

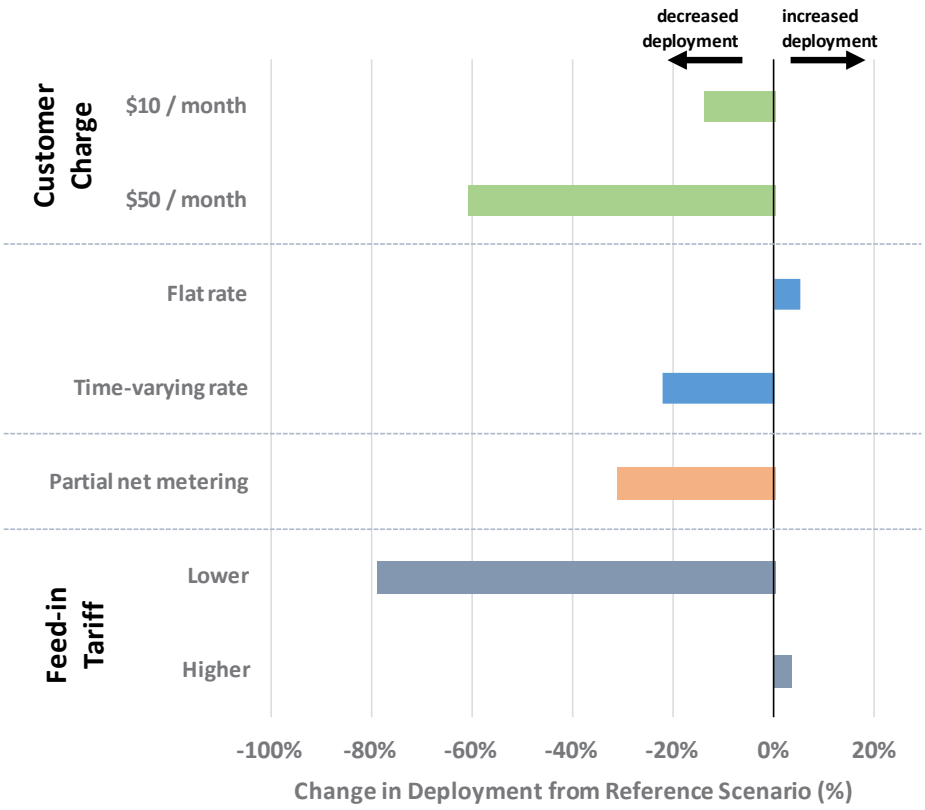


Figure 4. Impact of compensation policies on solar adoption. Copyright Regents of the University of California, produced with funding from the U.S. Department of Energy. Used with permission. [42]

Rollbacks of solar policies have led to drop-offs in solar installations

To identify utilities where changes in solar compensation may have resulted in a decline in solar adoption, we reviewed data for net metered solar PV from U.S. Energy Information Administration (EIA) Forms 861 and 861-M (formerly Form 826) from 2010 to 2020. We then selected several utilities – in California and elsewhere – that had experienced steep year-over-year declines in solar adoption to investigate whether changes in solar compensation may be related to those declines.

> The study also examined residential solar adoption rates before and after major net metering reforms, using data from the U.S Energy Information Administration's Form 861-M. Table 3 compares the average monthly residential net-metered capacity additions in the 12 months prior to a net metering reform taking effect to the additions in the 12 months following the reform. These figures suggest that net metering reforms may have had a significant impact on residential solar adoption rates in several states. Another factor likely affecting solar adoption rates is the market uncertainty when major reforms are under consideration and when utilities have reached state-established aggregate caps on net metering.

Excerpt from a study conducted on behalf of California's major investor-owned utilities that concluded that reductions in net metering compensation may have affected residential solar adoption. Source: North Carolina Clean Energy Technology Center at North Carolina State University, A Review of Net Metering Reforms Across Select U.S. Jurisdictions.

To identify these utilities, we calculated, for each utility reporting via Form 861, the increase or decrease in total solar net metering capacity compared to the previous year, and initially screened utilities where a significant (greater than 40%) year-over-year decline in net metered solar additions had occurred, or where zero growth in solar had occurred, during at least one year between 2011 and 2019. We then focused on two groups of utilities: the top 100 utilities for total net metered solar capacity nationwide in 2015 and the 34 California utilities reporting net metering information to Form 861.

Of the top 100 U.S. utilities for net metered solar PV adoption in 2015, 72 had experienced a drop of 40% or more in residential net metered solar additions (or zero growth in solar) during at least one year between 2011 and 2019. Of the 34 California utilities reporting to the EIA, 29 had experienced such a decline in solar growth. The experiences of several of these utilities are reviewed later in this section.

California's net metering rules have supported consistent solar growth

Federal data show that rooftop solar markets can be turbulent and continued growth is not assured. One state, however, stands out for consistent, steady growth in solar energy: California. And that growth has been driven largely by investor-owned utilities governed by CPUC net metering policies.

California's three largest IOUs – Pacific Gas & Electric (PG&E), Southern California Edison (SoCal Edison) and San Diego Gas & Electric (SDG&E) – are the top three in the nation for customer adoption of solar power. Together with public utilities Los Angeles Department of Water and Power (LA DWP) and the Sacramento Municipal Utility District (SMUD), the IOUs are among the five utilities in California, and 28 utilities nationwide with significant solar adoption in 2015, that have not experienced a significant drop in solar installations in any year since 2011. The transition from the first generation of net metering policy to the less-generous "NEM 2.0" compensation system in 2016 was followed by a slowdown in new residential solar installations at the state's large IOUs, followed by subsequent recovery of the market, but not the dramatic "solar cliff" experienced by other utilities nationwide following major rollbacks to net metering. (See Figure 5.)

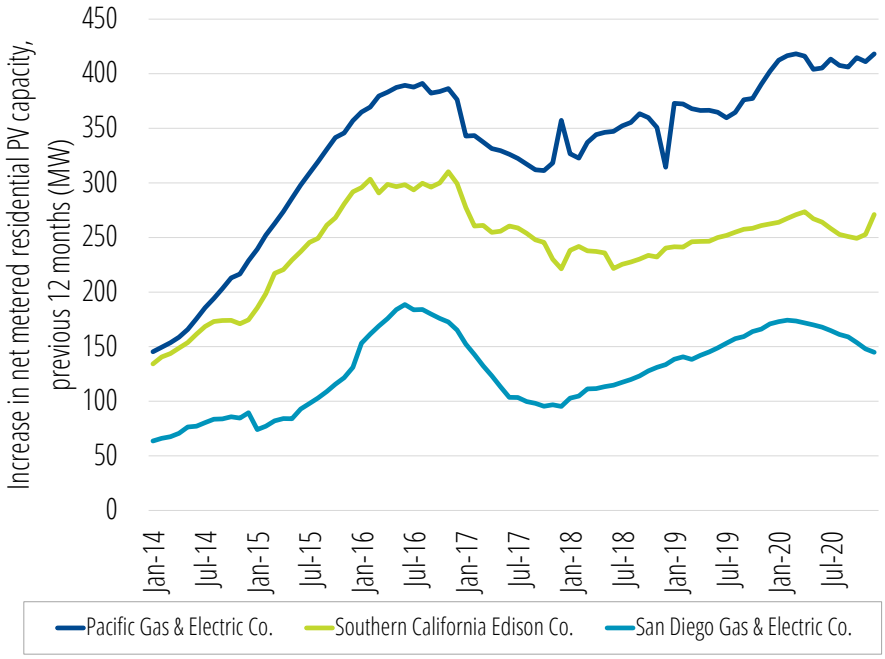


Figure 5. Increase in net metered residential solar capacity, California IOUs, preceding 12 months.[46]

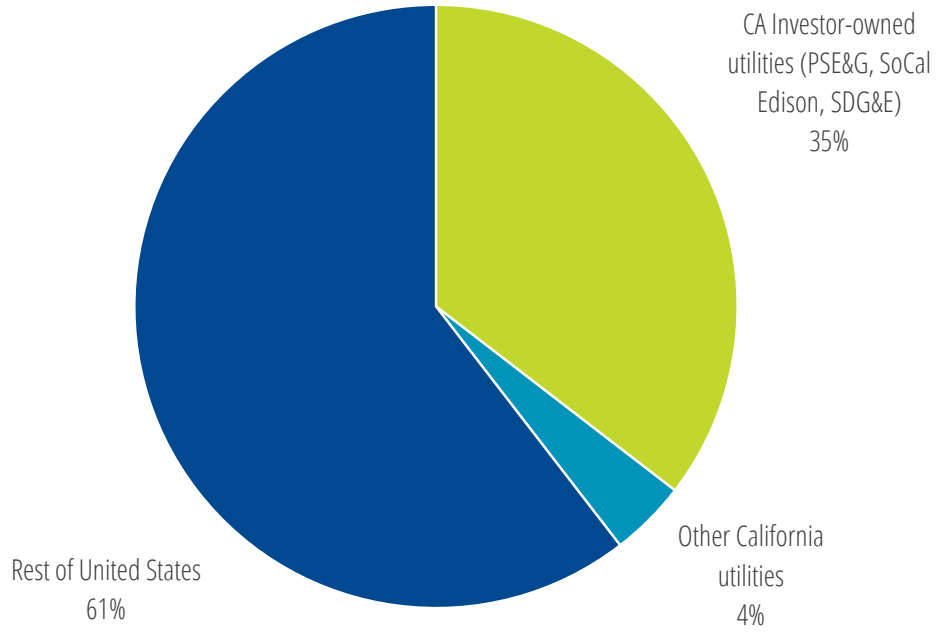


Figure 6. Net metered solar PV capacity, United States[49]

As of 2020, PG&E, SoCal Edison and SDG&E ranked first, second and third, respectively in net metered PV capacity nationally.[47] The service territories of the three major IOUs accounted for 9.4 GW of net metered PV capacity in 2020 – 90% of all net metered PV capacity in California and 35% of all net metered capacity nationally.[48]

California's solar surge – and America's – owes a great deal to the growth of distributed PV in the service territories of the state's largest IOUs, which have been governed to date by the CPUC's net metering policies.

Not all parts of America – nor even all parts of California – have experienced the same consistent growth in rooftop solar capacity. Indeed, previous utility-driven net metering "reform" efforts in states across the country have triggered significant declines in residential solar adoption. The following case studies – from around the country and California – illustrate the immediate and dramatic impact that changes in solar compensation can have on adoption of solar power.

Arizona

Arizona is one of the nation's leading solar states. But Arizona has endured several major efforts by utilities to reduce solar compensation – some successful – that have made the state's solar progress uneven and caused significant disruption to its solar market.

In 2015, the public utility Salt River Project (SRP) enacted a policy subjecting new distributed generation customers to mandatory demand charges and high fixed charges. This new policy subjected owners of rooftop solar to an average $50-per-month increase in electricity bills and reduced compensation for the excess power they generated.[50]

One analysis of the rate change found that the payback time for a representative solar energy system lengthened from 10.9 years in 2014 (before implementation of the policy) to 19.9 years in 2015.[51] The same study found a dramatic effect on solar adoption. With new solar projects approved prior

to December 8, 2014, grandfathered into the previous rates, solar adoption continued to rise in the SRP territory in the first half of 2015 before declining sharply. The study estimated that solar installation rates declined by 50% to 95% in the wake of the change.[52] Residential solar installations slowly recovered in the subsequent five years, but remain at or below 2014 levels of growth, despite plummeting solar power prices.

In 2016, the Arizona Corporation Commission (ACC) approved changes to the distributed solar policies of the state's three investor-owned utilities, allowing them to end net metering. The new policy replaced net metering with a less-generous compensation scheme based on the average wholesale price of utility-scale solar power and allowed the utilities to switch to an even less generous "avoided costs" price model over time. Additionally, it also slashed the time for which new rooftop solar customers were guaranteed their rates, from 20 years under net metering to just 10 years in the new system.

Arizona Public Service's (APS) new rates, which phase down solar compensation over time, went into effect in September 2017. By 2019, APS was adding 124 MW of new residential net metered solar capacity to its system, only slightly more than the 114 MW it added in 2016, the last full year before the new rates took effect, despite continued steep declines in solar energy prices.[54]

Hawaii

Hawaii was an early leader in solar energy. As an island state with high electricity costs and a strong solar resource, rooftop solar energy is a particularly powerful solution.

In the early 2010s, Hawaii's solar market was growing rapidly – between 2012 and 2015, Hawaii's solar capacity on homes and businesses nearly tripled, from 172 MW to 487 MW.[55] According to a study by Energy+Environmental Economics, "The NEM tariff helped boost large amounts of [behind the meter] solar installations."[56]

In 2013, Hawaiian Electric Company, the state's largest electric utility, abruptly changed its interconnection policy for new rooftop solar customers, imple-

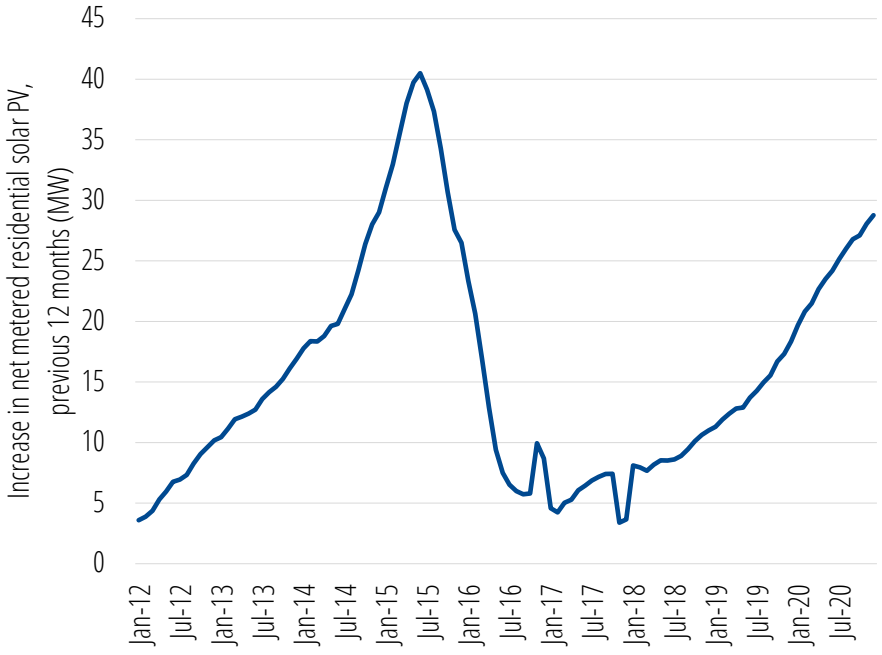


Figure 7. Salt River Project, increase in residential solar net metered capacity, preceding 12 months (MW)[53]

menting stricter requirements and all but halting newly approved projects for months.[57] The sudden shift, according to one news story, "left thousands of consumers stranded in 'solar limbo' and caused large-scale lay-offs."[58]

Then, in 2015, the Hawaii Public Utilities Commission ended the state's net metering program in favor of less generous and more complicated compensation structures.[59] The change caused an immediate decrease in the number of new solar permits issued, which continued to fall during 2016, 2017 and 2018.[60] The number of new interconnections over that time period was slightly buoyed by the huge backlog of projects that had already been permitted before the end of net metering, but the last of those installations concluded in 2018.[61]

The effect on solar adoption was significant. Between 2015 and 2018, Hawaii's residential solar capacity, increased by 108 MW – roughly half the amount of residential solar added in the three years before the change (209 MW) despite the dramatic decline in solar prices during that period.[62]

Solar installations in Hawaii have begun to bounce back in the last couple of years, as rooftop solar has come to be seen as increasingly critical to meeting the state's commitment to 100% renewable energy (and, perhaps, as consumers rushed to take advantage of federal tax credits scheduled for phaseout). Residential growth, however, has continued to be slow. Between 2018 and 2020, Hawaii's three investor-owned utilities saw residential PV capacity increase by 16%, while commercial capacity increased by 47%.[64]

In May 2021, Hawaiian Electric announced a new effort to accelerate rooftop solar and other consumer-sited energy resources to meet the state's 100% renewable energy goal. "We simply do not have enough open land to sustainably balance renewable energy with other vital needs such as housing and local food supply," said a company spokeswoman.[65] The effort comes on the heels of interconnection reforms designed to make it faster and easier for many consumers to connect solar panels to the grid.

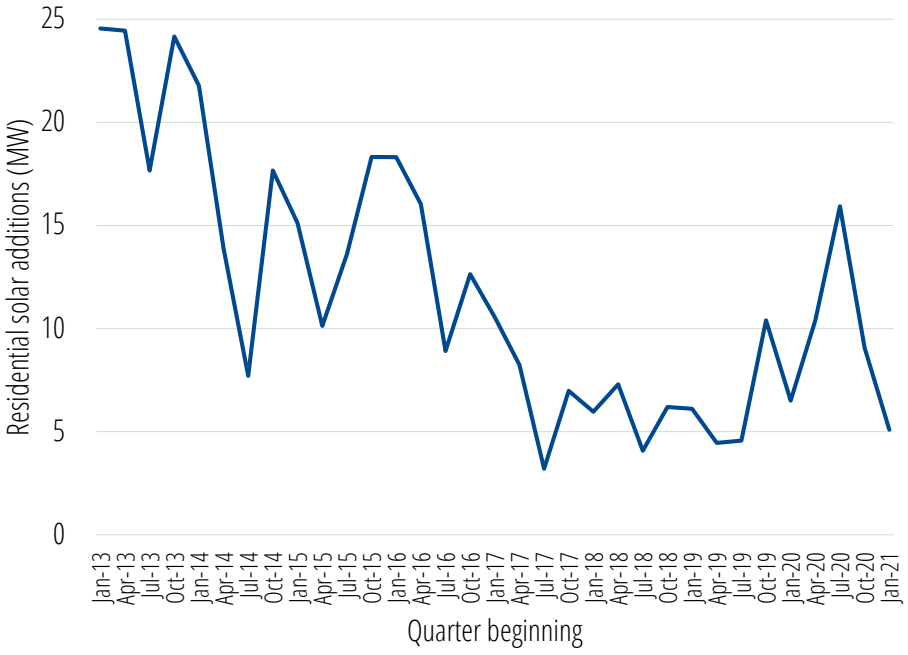


Figure 8. Residential solar PV additions by quarter, Hawaiian Electric (MW)[63]

Missouri

Missourians declared their support for rooftop solar in a 2008 ballot initiative that began a $2,000 per kilowatt rebate program for new installations of solar panels, paid through the state's public utilities.[66] In mid-2013, the state legislature passed a bill that would have phased out the rebate between 2014 and 2020.[67] When implementing the rebate originally, however, the legislature included a provision allowing utilities to stop offering the rebate if doing so would cause customer rates to increase by more than 1%.[68] In 2013, both Union Electric (which became AmerenMissouri in a merger) and Evergy (formerly Kansas City Power & Light) declared that they had reached that 1% cap, and filed to end the rebate program.[69]

In November 2013, AmerenMissouri (formerly Union Electric) reached an agreement with the local solar industry and the Missouri Public Service Commission – which regulates utilities – to pay out an additional $50 million on top of the $42 million it had already spent on the rebate program. By December 2013, due to huge interest in the program and the imminent end of the rebate, AmerenMissouri had allocated the entire $50 million sum and closed the program, stipulating that installations must be completed by the end of June 2014.[70]

Missouri's solar industry, which had been growing steadily prior to elimination of the rebate, was stopped in its tracks. New net metered residential solar installations fell from 23 MW in the 12 months ending June 2014 to 7 MW in the following 12-month period – a decline of 70%. Residential solar installations remained at roughly that same low level through 2018 in the territories of the former Union Electric and Evergy Missouri West, and only began to recover during 2019. (See Figure 9.)

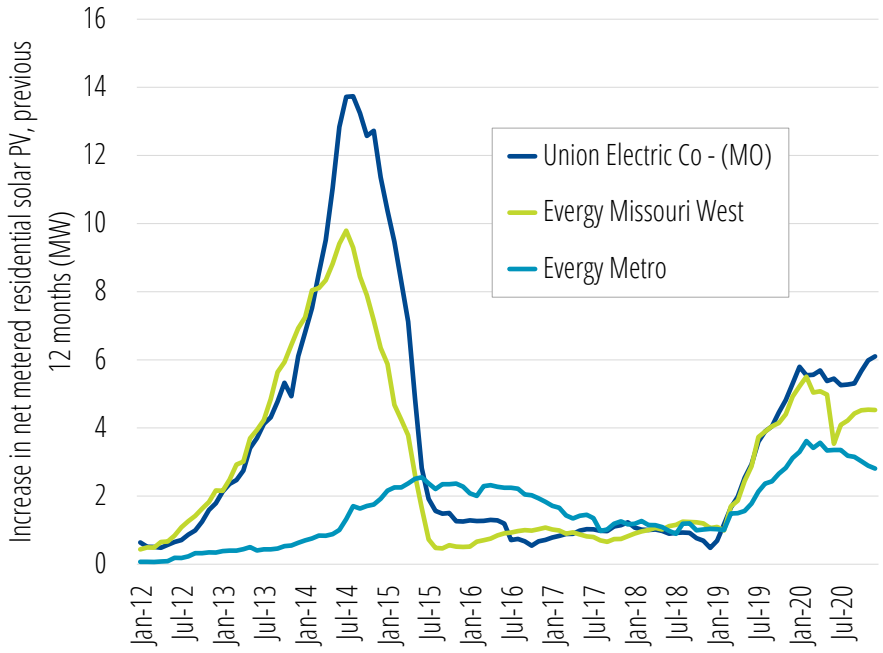


Figure 9. Increase in net metered residential solar PV capacity, preceding 12 months, Missouri utilities (MW)[71]

Nevada

Nevada's on-again, off-again policies toward solar compensation are among the nation's best indicators of the critical role net metering policies play in solar energy adoption.

In late 2015, the Public Utility Commission of Nevada (PUCN) issued a decision to introduce new, higher fixed costs on net metered customers, including those with rooftop solar, and to reduce the price paid for the excess energy those customers generate by about 75%.[72] This caused a "substantial controversy" and a decline in solar industry activity in the state, according to an analysis of net metering changes nationwide conducted for California's major IOUs.[73] In September 2016, the PUCN issued a new decision to allow customers who had applied for net metering agreements before the end of 2015 to opt in to net metering.[74] In 2017, the commission amended that decision to allow customers to opt in to net metering if they applied before July 2017.[75]

The elimination of net metering and policy uncertainty around the policy caused residential solar PV installation growth in Nevada to plummet in 2016 and the first part of 2017. (See Figure 10 for data on NV Energy). As stated above, a study filed by California's IOUs as part of the current NEM 3.0 proceeding acknowledged that Nevada's January 2016 cut to net metering compensation was followed by a 47% reduction in residential solar installations over the next year (compared with the 12 months preceding the change).[77]

Continued outcry at the reduction in solar compensation put enough pressure on the state government that, in June 2017, the legislature passed a law to reinstate net metering with no additional costs to distributed generation customers.[78] Residential solar PV installations gradually recovered over the next several years, making Nevada once again a leading solar state.

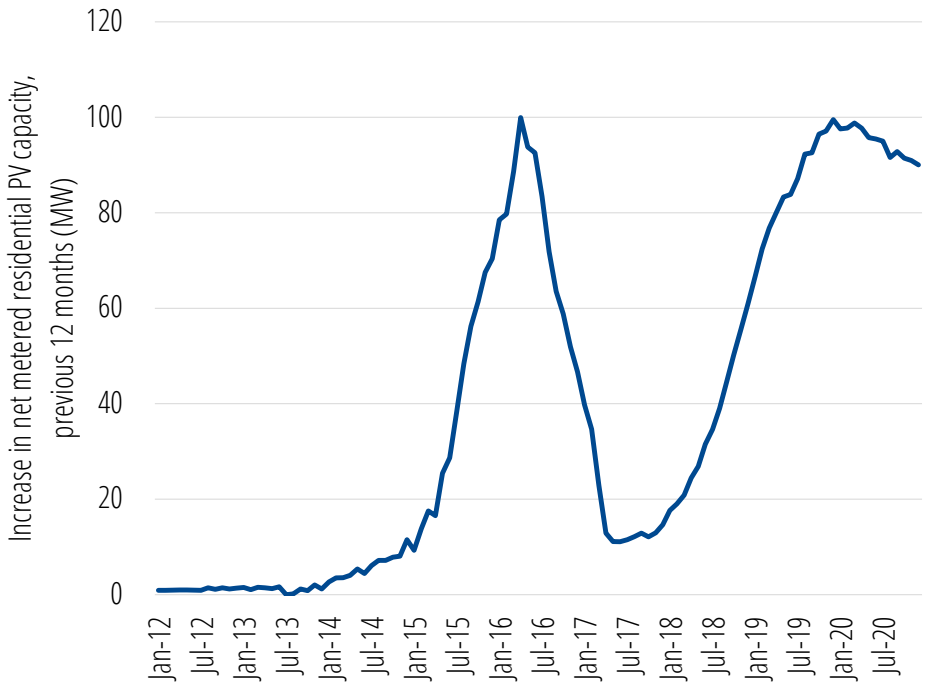


Figure 10. Increase in net metered residential PV capacity, preceding 12 months, NV Energy (Nevada Power Co.)[76]

California

While California's investor-owned utilities (as well as some of its largest municipal utilities) have experienced consistent solar growth over the last decade, that is not true everywhere in the state. California's municipal utilities are not regulated by the CPUC and can set their own policies for solar compensation. Many of those utilities have experienced the same policy-driven surges and falls of solar installations as other states around the country, as well as slower growth in solar installations.

Imperial Irrigation District

In March 2016, Imperial Irrigation District suspended new subscriptions to its net metering program. In July of that year, the utility fully transitioned away from net metering, and switched to a net billing program that compensated customer-generators much less generously.[79] This change caused a significant decline in the number of new solar generation systems installed that began in 2017, continued through 2019, and has not yet bounced back. (See Figure 11.)

Modesto Irrigation District

On January 1, 2017, Modesto Irrigation District switched from its original net metering program – which compensated customers at retail rates for excess electricity they generated – to the second-generation net metering scheme, "NEM 2.0," which reduced compensation to customers to just a portion of the retail price of electricity.[81] The pace of new residential installations held relatively steady through the summer of 2017, but then began a steep decline over the course of the next year, with installations continuing at a lower level thereafter.

Turlock Irrigation District

On January 1, 2015, Turlock Irrigation District (TID) ended net metering and put in place a suite of new policies that disincentivized rooftop solar installations.[83] An immediate decline in residential solar installations followed, with installations failing to regain previous levels in the years since. (See Figure 13, next page.)

Other California municipal utilities

Most smaller California municipal utilities report only annual net metering data to the Energy Information Administration. The limited data available, however, show several instances in which the end of net metering was followed by an effective end to the addition of new residential solar capacity:

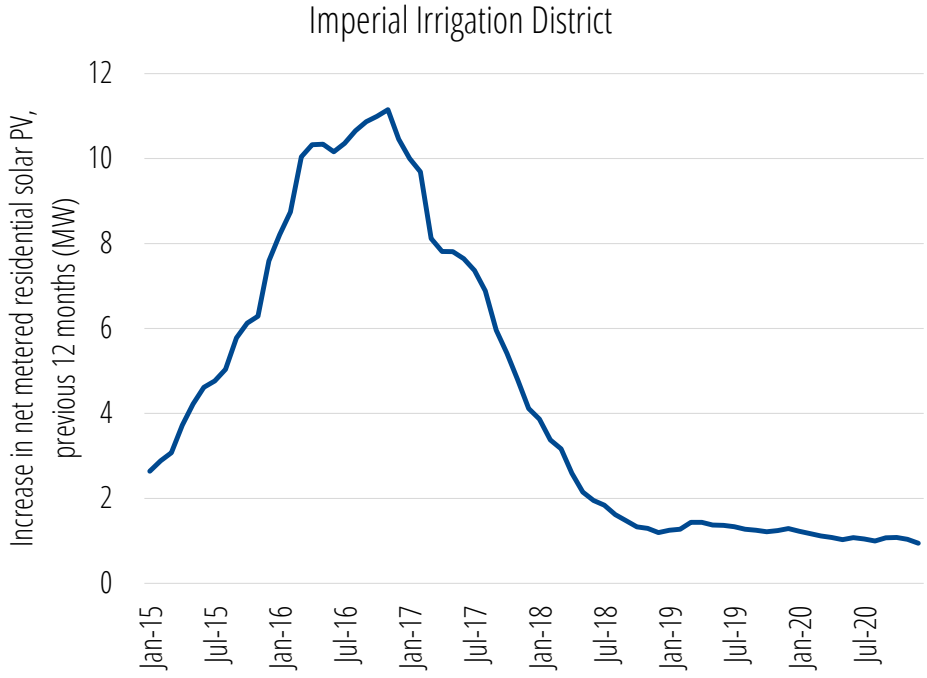


Figure 11. Increase in net metered residential PV capacity, Imperial Irrigation District, previous 12 months (MW)[80]

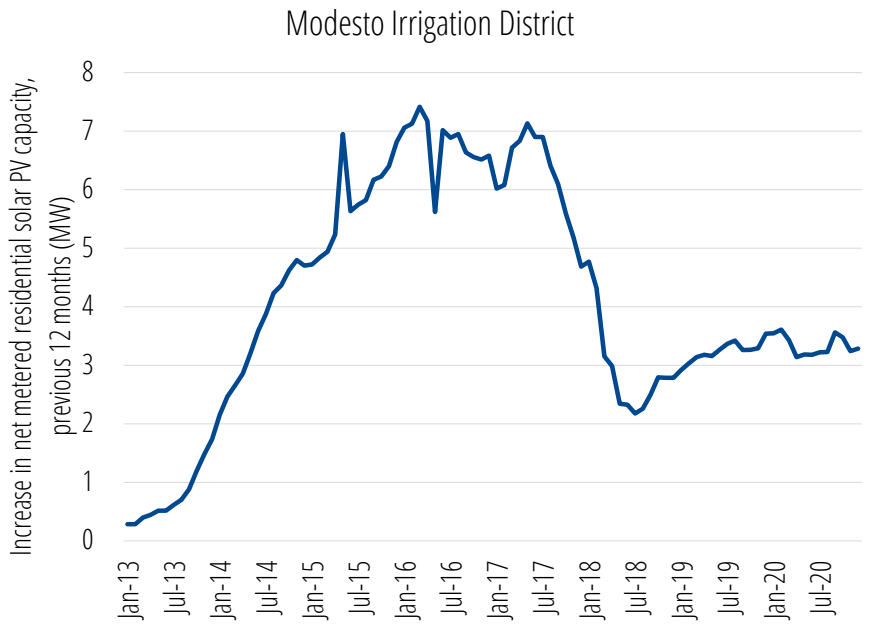


Figure 12. Increase in net metered residential PV capacity, previous 12 months, Modesto Irrigation District (MW)[82]

- The **City of Alameda**'s net metering program closed to new customers in August 2017.[85] The city reported zero growth of new residential solar capacity in 2018 or 2019.[86]
- The **City of Lodi** closed its net metering program in January 2017.[87] EIA data show no growth in residential solar capacity in 2018 or 2019.[88]
- **Bear Valley Electric Service** closed its net metering program in January 2018.[89] The utility reported minimal growth in residential solar capacity in 2018 and none in 2019.[90]
- **Lassen Municipal Utility District** closed its net metering program in January 2019.[91] The utility reported no growth in residential solar capacity in 2019.[92]

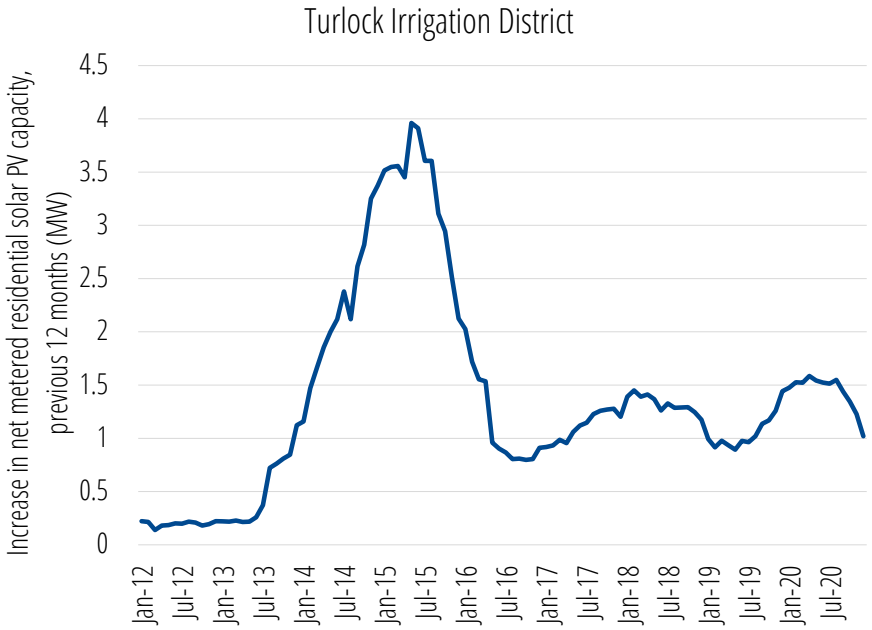


Figure 13. Increase in net metered residential PV capacity, preceding 12 months, Turlock Irrigation District (MW)[84]

California should adopt an NEM 3.0 policy that assures continued growth of solar energy

The future of rooftop solar – and of California's ability to meet its goals for clean, renewable energy – depends on the California PUC's decision on the future of net metering.

The electricity bill savings delivered in part by net metering are the primary source of economic benefit received by most Californians who "go solar" – and, with the upcoming phase-out of the federal investment tax credit for solar power, they will become even more central to the economic viability and attractiveness of solar power.

Consistent, reliable compensation for solar customers – especially customers of investor-owned utilities governed by the state's NEM 1.0 and 2.0 policies – has driven the growth of rooftop solar power in California, and, to a considerable degree, in the United States. California's IOUs are among the few in the United States that have experienced consistent, steady growth in solar adoption.

By contrast, both academic studies and real-life experience, including in California, show that policies that reduce compensation for would-be solar customers can have immediate – and often dramatic – negative effects on solar adoption. The logic is as simple as it is straightforward: the longer the payback time for an investment in solar power, the smaller the pool of people and businesses willing to consider it. This is especially true as the market for rooftop solar among environmentally conscious "early adopters" becomes saturated and solar power must compete for new adopters across the economic spectrum.

California cannot afford to experience a "solar cliff" if it hopes to meet its climate and clean energy goals – especially with California's energy agencies expecting the state to continue to add rooftop solar at near-current rates as part of its strategy to get to 100% zero-carbon electricity by 2045.

California is now undertaking the next revision to its NEM policy. The revised policy should **provide sufficient support to allow rooftop solar to continue to grow**, as is needed for the state to reach its carbon reduction and clean energy goals.

- California's new policy should **take into account the full benefits of rooftop solar** for utility customers, the environment and society, including but not limited to the value of rooftop solar for meeting the state's climate goals over the short- and long-term, benefits for conservation and community resilience, and reduced need for investment in transmission and distribution infrastructure.

- California should **ensure equitable access to onsite solar energy**, including for renters and in low-income communities, which will help the state maximize the amount of rooftop solar energy installed. Customers who qualify for the California Alternate Rates for Energy (CARE) program and who install solar panels should receive compensation

from the utility for excess power at non-CARE rates. Maintaining virtual NEM, which allows tenants to benefit financially from solar installed on multifamily buildings, will allow more landlords to install solar power. In addition, NEM credits should be transferred to incoming tenants instead of defaulting to the utility.

- Fees levied only on solar customers will discourage growth in solar energy and energy storage, are not compatible with meeting the state's clean energy goals, and should be avoided.
- Utilities must honor commitments they made to customers who installed solar panels in past years about how much compensation consumers would receive for solar energy they supply to the grid. Retroactively changing those agreements would undermine consumer faith in the future of solar energy and would slow installation of additional capacity.
- As California revises its NEM policy, it should provide clear, long-term rules. Abrupt changes to NEM policy have the potential to interrupt the state's momentum in adding customer-sited solar and storage capacity.

California should adopt other policies that support the continued and equitable growth of consumer-sited solar energy and battery storage.

- Cities and counties should **establish online automated permitting systems** for small onsite solar projects. The National Renewable Energy Lab has developed SolarAPP+, a free online permitting software that helps local governments process permits more easily. The state of California has provided $20 million to the California Energy Commission for a grant program for cities and counties to get technical backup needed to set up this new permitting system for solar and storage. Local jurisdictions should take advantage of that program to clear backlogs in permit approvals and help drive down "soft costs" resulting from permitting delays.
- California should provide **support for the installation of solar energy on community buildings**, such as schools, libraries and community centers. Especially if coupled with battery storage, these sites can produce clean energy and improve local resilience, and serve as community cooling centers during heat waves, even when the power is out.
- The state should adopt policies that **enable the creation of virtual power plants**. The California Independent System Operator and the CPUC can adopt a policy that would make it possible for utility customers to sell the energy stored in consumer-sited batteries to the broader grid. This would increase the ability of consumer-sited solar energy and battery systems to provide power to the grid at times of high demand.
- The state should require utilities to **allow customers to finance their solar energy and/or storage system through zero- or low-interest loans that are repaid through their utility bill**. Coupled with adequate consumer protections, this would benefit lower-income customers who have less access to conventional lending streams.

Methodology

The analysis of changes in rooftop solar deployment at utilities in California and elsewhere is based primarily on data reported by utilities to the U.S. Energy Information Administration via Form 861 and Form 861M, accessed during April and May of 2021. Form 861M, which includes monthly reporting, is submitted by a smaller number of utilities. Where available, Form 861M data were used.

To identify utilities that may have experienced a disruption in local solar markets resulting from a change in policy, Form 861 data for total net metered solar capacity across all customer classes in 2015 were sorted to identify the top 100 solar utilities in that year. (2015 was chosen to allow for the possibility that some utilities that were leaders had dropped from the list due to changes in solar compensation policies or other factors). For these utilities, we calculated annual growth in residential solar PV by subtracting the previous year's figure for residential PV capacity from that of the current year. We then compared those figures for annual growth in solar capacity to identify years in which the growth of residential solar fell by 40% or more compared with the previous year or in which there was no growth. (For example, if a utility had 1 MW of residential solar capacity in 2015, 3 MW in 2016, and 4 MW in 2017, solar growth would have declined from 2 MW in 2016 to 1 MW in 2017 – a decline of 50%.) These 72 utilities were isolated for further study, with preference for inclusion as case studies given to larger utilities and states with multiple utilities that had experienced similar trends.

Charts in the report generally represent net metered residential solar PV installations over the preceding 12-month period as reported on Form 861M. To calculate this figure, the cumulative amount of residential PV that existed on the grid 12 months prior to a given month was subtracted from the total for that month.

Both the EIA Form 861 and 861M databases include some gaps in reporting, and the Form 861M data for some utilities includes some discontinuities, particularly at the beginning and end of certain years. These discontinuities are referenced in footnotes where they may have some bearing on the results of the analysis.

Notes

1. Modeling conducted for the SB 100 Joint Agency Report assumes California will have 39 GW of customer-sited rooftop solar by 2045: California Energy Commission, California Public Utilities Commission and California Air Resources Board, *2021 SB 100 Joint Agency Report*, 15 March 2021, p. 104, downloaded from https://www.energy.ca.gov/sb100; California had 10.5 GW of net metered rooftop solar as of the end of 2020: U.S. Energy Information Administration, *Form 861-M Detailed Data: Net Metering* (Excel file), downloaded from https://www.eia.gov/electricity/data/eia861m/, 23 April 2021; California would need to install 28.5 GW in 25 years, which is slightly greater than 1.1 GW/year; in 2020, California added 1.4 GW of net metered solar, per U.S. EIA Form 861-M as cited above.

2. Historical: U.S. Energy Information Administration, *Form 861-M Detailed Data: Net Metering*, downloaded from https://www.eia.gov/electricity/data/eia861m/, 23 April 2021; projected: based on SB 100 RESOLVE Model Outputs, Total Resource Summary for SB 100 Core Scenario (Excel file), supplemental data to California Energy Commission, California Public Utilities Commission and California Air Resources Board, *2021 SB 100 Joint Agency Report*, 15 March 2021, accessed at https://www.energy.ca.gov/sb100; projected figures based on linear interpolation between current, 2027, 2030 and 2045 results.

3. Bryn Huxley-Reicher and Laura Deehan, Frontier Group and Environment California Research & Policy Center, *The Environmental Case for Rooftop Solar Energy: Protecting California's Climate and Land*, July 2021. https://frontiergroup.org/reports/fg/environmental-case-rooftop-solar-energy.

4. Small-scale PV capacity from U.S. Energy Information Administration, *Form EIA-861M Detailed Data: Small Scale PV Estimate* (Excel file), downloaded from https://www.eia.gov/electricity/data/eia861m/#solarpv, 9 May 2021. Data for Georgia were unavailable and therefore excluded.; electricity consumption: U.S. Energy Information Administration, *Retail Sales of Electricity by State by Sector by Provider (EIA-861)* (Excel file), downloaded from https://www.eia.gov/electricity/data/state/, 16 June 2021.

5. Eric O'Shaughnessy, *State and Local Policy Impacts on the Residential Solar PV Installation Industry*, National Renewable Energy Laboratory, January 2019, p. 12, archived at https://web.archive.org/web/20210521162146/https://www.nrel.gov/docs/fy19osti/72149.pdf.

6. See Methodology.

7. North Carolina Clean Energy Technology Center at North Carolina State University, *A Review of Net Metering Reforms Across Select U.S. Jurisdictions*, February 2021, p. 4, as part of: Steven W. Frank, *Before the Public Utilities Commission of the State of California: Joint Proposal of Pacific Gas and Electric Company (U 39-E), San Diego Gas & Electric Company (U 902-E) and Southern California Edison Company (U 338-E): R.20-08-020*, 15 March 2021, archived at https://web.archive.org/web/20210521142944/https://static1.squarespace.com/static/54c1a3f9e4b04884b35cfef6/t/605120343d32dd18332462a2/1615929399865/R.20-08-020_Joint%20Proposal_3.15.2021.pdf.

8. Ben Sigrin and Easan Drury, "Diffusion into new markets: Economic returns required by households to adopt rooftop photovoltaics," *Energy Market Prediction: Papers from the Association for the 2014 Advancement of Artificial Intelligence Fall Symposium*, 2013, archived at https://web.archive.org/web/20150509235825/http://www.aaai.org/ocs/index.php/FSS/FSS14/paper/viewFile/9222/9123.

9. Ana Dyreson et al., *Effects of Salt River Project's Demand-Based Rate Change on the Rooftop Solar Market in Maricopa County, Arizona*, 2017, p. 35, archived at https://web.archive.org/web/20210321204254/https://emp.lbl.gov/sites/default/files/uwisconsin-srp_solar_event_study_final051117.pdf.

10. See Figure 10, page 21. Source: U.S. Energy Information Administration, *Form 861-M Detailed Data: Net Metering*, downloaded from https://www.eia.gov/electricity/data/eia861m/, 23 April 2021.

11. U.S. Energy Information Administration, *Form 861-M Detailed Data: Net Metering*, downloaded from https://www.eia.gov/electricity/data/eia861m/, 23 April 2021.

12. Ibid.

13. California Public Utilities Code § 399.11 and § 399.15 and § 399.30 and § 454.53 (8 November 2018).

14. See note 4.

15. See note 11.

16. Based on SB 100 RESOLVE Model Outputs, Total Resource Summary for SB 100 Core Scenario (Excel file), supplemental data to California Energy Commission, California Public Utilities Commission and California Air Resources Board, *2021 SB 100 Joint Agency Report*, 15 March 2021, accessed at https://www.energy.ca.gov/sb100.

17. See note 2.

18. California had 10.5 GW of net metered rooftop solar as of the end of 2020, and added 1.4 GW of net metered solar in 2020: See note 11.

19. See note 3.

20. Robert Walton, "Efficiency, DERs saving $2.6B in avoided transmission costs, CAISO says," *UtilityDive,* 26 March 2018, available at https://www.utilitydive.com/news/efficiency-ders-saving-26b-in-avoided-transmission-costs-caiso-says/519935/.

21. See, for example, conclusion of CPUC that "the value for unspecified transmission avoided cost [from distributed generation] is not zero," per California Public Utilities Commission, *Order Instituting Rulemaking to Create a Consistent Regulatory Framework for the Guidance, Planning and Evaluation of Integrated Distributed Energy Resources: 2020 Policy Updates to the Avoided Cost Calculator*, Rulemaking No. 14-10-003, Decision 20-04-010, 16 April 2020.

22. Pippa Stevens, "PG&E power outage could cost the California economy more than $2 billion," *CNBC*, 10 October 2019, archived at http://web.archive.org/web/20210329065851/https://www.cnbc.com/2019/10/10/pge-power-outage-could-cost-the-california-economy-more-than-2-billion.html.

23. California Public Utilities Commission, *2020 California Solar Initiative Annual Program Assessment*, June 2020.

24. Ibid.

25. Ibid., p. 43.

26. Carlyn Kranking, "Regulators loosen California's groundbreaking rule to require residential rooftop solar," *CalMatters*, 21 February 2021, archived at http://web.archive.org/web/20210421013226/https://calmatters.org/environment/2020/02/california-rooftop-solar-mandate-smud-community-neighborhood-solar-shares/.

27. Current rate: Kate Irby, et al., "Bad news for Gavin Newsom's housing goals: New home permits are down in California," *The Sacramento Bee*, 23 July 2019, archived at https://web.archive.org/web/20210216075431/https://www.sacbee.com/news/business/real-estate-news/article232979792.html; overall stock: U.S. Census Bureau, *Quick Facts: California*, accessed 21 May 2021 at https://www.census.gov/quickfacts/fact/table/CA/RHI725219.

28. See note 5.

29. Solar Energy Industries Association, *Solar Investment Tax Credit (ITC)*, undated, archived at https://web.archive.org/web/20210512213630/https://www.seia.org/initiatives/solar-investment-tax-credit-itc.

31. Ben Zientara, "Big changes on the horizon for California net metering in 2021," *Solar Reviews*, archived at https://web.archive.org/web/20210218172938/https://www.solarreviews.com/blog/big-changes-for-california-net-metering.

32. Ibid.

33. Ibid.

34. Ibid.

35. See note 5, p. 12.

36. Reprinted with permission by the National Renewable Energy Laboratory. Source: See note 5.

37. See, for example, Kaumi Soulemane Hayibo and Joshua M. Pearce, "A review of the value of solar methodology with a case study of the U.S. VOS," *Renewable and Sustainable Energy Reviews* 137(2):110599, March 2021, doi: 10.1016/j.rser.2020.110599.

38. See, for example, Gideon Weissman, Emma Searson and Rob Sargent, Environment America Research & Policy Center and Frontier Group, *The True Value of Solar: Measuring the Benefits of Rooftop Solar Power*, July 2019, available at https://frontiergroup.org/sites/default/files/reports/AME%20Rooftop%20Solar%20Jul19%20web.pdf.

39. See note 8.

40. Ibid.

41. Naïm R. Darghouth et al., *Net Metering and Market Feedback Loops: Exploring the Impact of Retail Rate Design on Distributed PV Deployment*, Lawrence Berkeley National Laboratory, July 2015, p. 17 and 18, archived at https://eta-publications.lbl.gov/sites/default/files/lbnl-183185_0.pdf.

42. Ibid. Chart Copyright Regents of the University of California, produced with funding from the U.S. Department of Energy. Used with permission.

43. See note 7.

44. Ibid.

45. Ibid.

46. See Methodology.

47. See note 11.

48. Ibid. Note: EIA data on solar net metering for each distribution utility include customers purchasing electricity through community choice aggregations (CCAs) or other non-utility suppliers. CCAs are not subject to the CPUC's net metering rules. Net metering policies or offers of direct rebates or incentives for solar power adoption by CCAs or other electricity providers may also affect solar adoption within the territories of California IOUs.

49. Ibid. Note: California's share of U.S. net metered solar capacity (39.5%) is slightly higher than its share of small-scale solar capacity (38%) including non-net metered applications, per the U.S. Energy Information Administration.

50. Brad Heavner, et al., California Solar & Storage Association, *Before the Public Utilities Commission of California: California Solar & Storage Association's Proposal For A Successor To The Current Net Energy Metering Tariff*, Rulemaking 20-08-020, 15 March 2021.

51. See note 9.

52. Ibid., p. 29-30. Similarly, a study produced by Energy+Environmental Economics and Verdant for the California Public Utilities Commission found that the "implementation of the new NEM rate slowed down the number of applications in SRP's service territory." Energy+Environmental Economics and Verdant, *Alternative Ratemaking Mechanisms for Distributed Energy Resources in California: Successor Tariff Options Compliant with AB 327*, 28 January 2021, p. 37, archived at http://web.archive.org/web/20210320055804/https://www.ethree.com/wp-content/uploads/2021/02/Alternative-Ratemaking-Mechanisms-for-Distributed-Energy-Resources-in-California-Successor-Tariff-Options-Compliant-with-AB-327-1.pdf.

53. See note 11.

54. Note: EIA data for 2018 show a discontinuous dramatic rise in net metered residential PV in APS followed by an equally dramatic drop. 2019 appears to provide a more applicable comparison to the period before the change in net metering policy. Source: See note 11.

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73. See note 7, p. 24.

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