NET ENERGY METERING:
SUBSIDY ISSUES AND REGULATORY SOLUTIONS

Issue Brief
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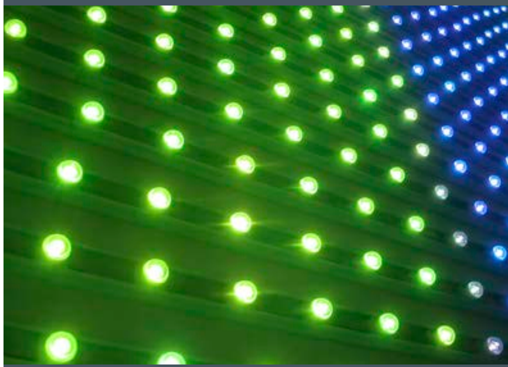

The Edison Foundation
INSTITUTE for ELECTRIC INNOVATION

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Prepared by

Robert Borlick
Borlick Associates

Lisa Wood
Institute for Electric Innovation
The Edison Foundation

EXECUTIVE SUMMARY

As distributed generation (DG) resources grow and comprise a larger share of the energy resources on the nation's power grid, and as the costs of DG decline, it is critical that these resources are priced appropriately and that subsidies that support them, and the recipients of the subsidies, are transparent to all parties – customers, regulators, legislators, solar providers, and DG advocates. This issue brief illustrates the subsidy created by current state net energy metering (NEM) practices and reveals the need to modify these practices.

Today, when a DG customer produces onsite energy, this correspondingly reduces the amount of energy the customer purchases from the local utility, thereby avoiding payment of that portion of the energy rate in the customer's retail tariff that is designed to recover the customer's contribution to the utility's fixed costs. This is the source of the NEM subsidy – it is the direct result of the energy rate in a customer's retail tariff exceeding the utility's avoided energy cost. In our analysis, we define the NEM subsidy as the difference between the customer's bill savings due to the onsite energy production and the utility's costs avoided by not having to deliver the electricity displaced by the energy produced onsite.

Customers who install onsite generation such as rooftop solar photovoltaic or PV (distributed generation or DG customers) receive the NEM subsidy, which is mostly paid for by non-DG customers, *i.e.,* DG customers shift the costs they avoid paying onto non-DG customers. DG customers who lease rooftop solar PV or sign power purchase agreements (PPAs) with solar leasing companies receive only a small fraction of the NEM subsidy; the bulk of the subsidy goes to the solar leasing companies.

To illustrate the nature of the NEM subsidy and its approximate size, we examined a typical residential customer located in southern California with rooftop solar PV. Although the monetary values produced in this analysis are based on a specific California utility tariff and, thus are not directly transferable to other states, the basic concept illustrated here does apply elsewhere. Even within California, the monetary values for a specific customer in a particular location will vary depending on a number of factors, including the size of the rooftop solar facility and its energy production, the utility's avoided costs associated with the solar production, the customers' retail tariff, and other factors.

The results presented in this issue brief demonstrate the excessive size of the NEM subsidy for residential rooftop solar PV customers and its unfortunate unintended consequences. In particular:

- The NEM subsidy for residential rooftop solar is overly generous and not transparent. In California, the NEM subsidy is substantially larger than the 30-percent federal tax credit and far exceeds what is necessary to incent rooftop solar. It is ironic that much national debate has centered on whether the federal tax credits should be continued for solar energy while the NEM subsidy is the elephant in the room and dwarfs the federal tax credits.

- In California, most of the NEM subsidies go to affluent households, and these subsidies are largely paid for by less affluent households through their electric bills.

- Under NEM practices in California today, when a residential customer leases rooftop solar PV (which accounted for about 75 percent of all new residential rooftop solar PV in 2013), most of the NEM subsidy is transferred to the leasing company. This is one of the unintended consequences.

- Regulatory approaches are available today (and in use in some jurisdictions) that reduce the excessive NEM subsidy and the cost shifting onto non-DG customers. Furthermore, one of these regulatory approaches also makes the subsidy transparent to all parties.

The findings presented in this issue brief should be of interest to state legislators, state utility regulators, and other parties investigating NEM and its effects on customers. The time to change NEM is now, and regulatory tools are available to do so.

INTRODUCTION

This issue brief illustrates the substantial subsidy created by current net energy metering (NEM) practices and reveals the need to modify these practices.

Today, when a DG customer produces onsite energy, this correspondingly reduces the amount of energy the customer purchases from the local utility, thereby avoiding payment of that portion of the energy rate in the customer's retail tariff that is designed to recover the customer's contribution to the utility's fixed costs. This is the source of the NEM subsidy – it is the direct result of the energy rate in a customer's retail tariff exceeding the utility's avoided energy cost. In our analysis, we define the NEM subsidy as the difference between the customer's bill savings due to the onsite energy production and the utility's costs avoided by not having to deliver the electricity displaced by the energy produced onsite.

Customers who purchase and install rooftop solar PV generation (distributed generation or DG customers) receive the NEM subsidy, which is mostly paid for by non-DG customers, *i.e.,* DG customers shift the cost of the subsidy onto non-DG customers. DG customers who lease solar PV facilities or sign power purchase agreements (PPAs) with solar leasing companies receive only a fraction of the NEM subsidy; the bulk of the subsidy goes to the solar leasing companies.

Except for a few jurisdictions in the U.S. (*e.g.,* Austin, Texas and the few states that do not have NEM in place), NEM policies allow DG customers to avoid paying a portion of their share of the cost of grid services. *This cost avoidance is the primary source of the NEM subsidy, which is paid for by non-DG customers.* A recent study conducted by Energy+Environmental Economics, Inc. (E3) for the California Public Utilities Commission (CPUC) estimates that, by 2020, approximately $1.1 billion would be shifted annually from DG to non-DG customers if California's current NEM practices (and rate structures) remain unchanged.[1] That same study also revealed that non-DG customers are less affluent than the DG customers they are subsidizing, which raises a serious equity issue.[2]

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1 Energy+Environmental Economics, Inc., *California Net Energy Metering Ratepayer Impacts Evaluation*, October 28, 2013, p.6. Recently passed state legislation, AB 327, requires the California PUC to develop a new NEM program that will go into effect in 2017.

2 *Id.*, p. 11. The E3 study found that the average median household income of residential customers who installed DG since 1999 was $91,210, compared with an average median income of $54,283 for all residential customers

Today non-energy charges comprise a large percentage of the utility's costs that are recovered through a residential customer's retail tariff. These charges typically cover the fixed costs associated with grid services such as the transmission system, the distribution system, balancing and ancillary services, and the utility's investment in generation capacity. NEM, as practiced today, allows DG customers to avoid paying their fair share of the costs of these grid services, which then gets shifted onto non-DG customers.[3]

Alternative regulatory approaches exist for reducing, or totally eliminating, NEM cost shifting. Increasing the fixed monthly customer charge and/or adding one or more demand charges to better reflect the utility's actual cost structure is one approach.[4] Adopting a straightforward *buy-sell* arrangement, where the customer buys all of the energy consumed on site through the utility's retail tariff and sells to the utility all of the solar energy produced on site at the utility's avoided cost, is another approach. Properly implemented, either of these approaches could eliminate NEM cost shifting.

The primary beneficiary of the NEM subsidy changes when a residential customer chooses to lease a solar facility or to enter into a PPA with a solar leasing company. In this case, most of the NEM subsidy goes to the leasing company – not to the DG customer. In California, leasing companies install approximately 75 percent of all new rooftop solar PV facilities.[5] Thus, non-DG customers are predominately subsidizing solar leasing companies – an unintended consequence of the current NEM policy.

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in California. Some states have made concerted efforts to include all income levels of residential customers in solar projects through both rooftop and community solar.

A recent study prepared by Navigant Consulting, Inc. corroborated the E3 study results. The Navigant study found that participants in the California Solar Initiative are more affluent than the population of California homeowners and 60 percent have annual household incomes of $100,000 or more. See: Navigant Consulting Inc., *California Solar Initiative Market Transformation Study (Task 2)*. Final Report, March 27, 2014, p.52.

3 As more fixed costs are recovered via a fixed customer charge, the cost shifting to non-DG customers is reduced. See: IEE Issue Brief, *The Value of the Grid to DG Customers*, October 2013. www.edisonfoundation.net.

4 Prior to the introduction of "smart meters," it was too costly to implement demand charges for residential and small business customers. That barrier no longer exists. An ideal retail tariff would include a demand charge that accounts for the customer's contribution to the wholesale market peak load and possibly additional demand charges that account for customer contributions to the peak load flows on various components of the distribution system. Distribution system peak loads typically do not coincide with the wholesale market peak loads.

5 Climate Policy Initiative, *Improving Solar Policy: Lessons from the solar leasing boom in California*, July 25, 2013.

NET METERING IN CALIFORNIA – A CASE STUDY

To illustrate the nature of the NEM subsidy and its approximate size, we examined a typical residential customer with rooftop solar PV located near Los Angeles.[6] Although the monetary values produced in this analysis are based on a specific California utility tariff and, thus are not directly transferable to other states, the basic concept illustrated here applies elsewhere.[7]

For this case study, we modified a publicly available Southern California Edison (SCE) residential customer load shape to represent the typical SCE residential customer with rooftop solar PV served under that utility's Residential Domestic tariff.[8] This tariff consists of a small customer charge (about 91 cents per month) and four rate tiers that progressively increase from 13 cents per kilowatt-hour (kWh) to 31 cents per kWh as shown in Table 1. We chose a typical SCE residential customer with rooftop solar PV as an example because of the relative maturity of the market in California and the opportunity to build on publicly available data collected for the CPUC.

Table 1. Residential Domestic Retail Tariff in California

Southern California Edison Residential (Domestic) Retail Rate Structure[1]				
	Tier 1	**Tier 2**	**Tier 3**	**Tier 4**
Tiered Rate ($/kWh)	$0.1323	$0.1645	$0.2737	$0.3037
Usage Subject to Rate	0% to 100% of Baseline	101% to 130% of Baseline	131% to 200% of Baseline	Over 200% of Baseline
Summer Baseline (Daily kWh): 13.3		**Winter Baseline (Daily kWh):** 10.8		
Basic Delivery Charge ($/Meter-Day): $.0.031				
1. Rate design in effect on January 1, 2014. Baselines shown above apply to CEC Climate Zone 9 located east of the city of Los Angeles. Source: www.SCE.com.				

The typical California residential customer with rooftop solar PV consumes about 15,000 kWh per year, which is substantially more than the 6,800 kWh per year consumed by the average residential customer served by the three California IOUs.[9] We then simulated the annual energy

6 We modeled a solar facility location in Southern California Edison's (SCE's) service area just east of the Los Angeles city limits (*e.g.*, Pasadena), which is in CEC Climate Zone 9.

7 A forthcoming issue brief will examine other states.

8 The analysis, results, and recommendations presented in this paper are those of the authors, not SCE.

9 Energy+Environmental Economics, Inc., *California Net Energy Metering Ratepayer Impacts Evaluation*, October 28, 2013, p. 8.

production of a 4 kW-dc facility located east of the city of Los Angeles (in CEC Climate Zone 9) using a model developed at the National Renewable Energy Laboratory (NREL).[10, 11] This 4 kW rooftop solar PV facility would generate about 6,200 kWh in the first year, resulting in a net purchase from the utility of about 8,800 kWh in that year (about 60 percent of total consumption).[12] Hence, the typical DG customer produces less than it consumes.

We then estimated the monetary benefit gained by the DG customer, *i.e.*, the net present value (NPV) to the customer over the expected 25-year economic life of the solar panels, measured in 2014 dollars, for two different rooftop solar equipment financing options (customer purchase vs. signing a PPA with a solar leasing company) under NEM as currently practiced and under three alternative regulatory approaches.[13, 14]

Customer Has Option to Purchase or Lease Rooftop Solar

Under the Customer Purchase Option, the customer purchases, installs and maintains the 4 kW rooftop solar PV facility.[15] The installed cost is $14,586, in 2014 dollars.[16] Because the customer owns the facility, the customer receives a federal tax credit of 30 percent, which reduces its personal income tax liability by $4,376.[17] The customer also retains ownership of the

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10 National Renewable Energy Laboratory, *System Advisory Model (SAM)*, Version 2014.1.14.

11 Based on the California Solar Initiative (CSI) database (dated June 11, 2014), the median size of all residential solar facilities installed in SCE's service area is 4.6 kW; consequently, our 4 kW facility slightly understates the potential monetary benefits to be gained by the typical residential customer installing solar PV.

12 Solar PV generation typically declines by about 0.5 percent per year due to solar conversion degradation.

13 We calculated the DG customer's monetary benefits by computing the total savings in future electric bills (or sales revenues from solar generation in the *buy-sell* regulatory approach) less the annual maintenance costs and the upfront capital investment in the facility (reduced by the 30 percent federal tax credit), all discounted over the solar facility's expected 25-year life.

14 We chose a 25-year economic life because most manufacturers of solar panels warrantee the performance of their products for the first 25 years of service. For example, see: http://global.sunpower.com/products/solar-panels/warranty/.

15 In addition to a cash purchase, we examined the advantage of the customer using a 10-year home equity loan to finance the facility. Tax-deductible debt financing improves the project economics by adding as much as $1,350 to the project NPV, depending on the customer's marginal state and federal income tax rates. While significant, particularly for owners in high-income tax brackets, this financing option does not warrant further discussion.

16 The NREL *System Advisory Model (SAM)* produced this estimate for the installed cost of a nominal 4 kW-dc facility located near Los Angeles. An installer in California currently offers residential rooftop solar PV systems at costs close to the SAM estimate. See: http://www.petersendean.com/powersaver-solar-cost-estimator/.

17 There are two federal tax credits available to owners of solar PV facilities. The Investment Tax Credit (ITC) is available to businesses. The Residential Energy Efficient Property Credit (REEPC) is available to individuals that produce solar energy exclusively for their own consumption (*e.g.*, DG customers). In this paper, we use the term, "federal tax credit" to mean either the ITC or the REEPC (note that ITC is the more familiar term and is sometimes used to mean either the ITC or the REEPC).

project's Renewable Energy Credits (RECs), which can be separately sold (for reasons explained later, this analysis does not include the value of RECs). Under current NEM practices in California, the utility bills the customer for its net energy purchases (*i.e.*, on-site consumption less solar energy production) through the SCE residential domestic tariff displayed in Table 1.

Under the Customer Lease Option, the solar leasing company owns, installs, and maintains the rooftop solar PV facility and sells the energy it produces to the customer over the facility's projected 25-year life at prices stipulated in a power purchase agreement (PPA).[18] The customer makes no upfront investment. Because the leasing company owns the solar facility, the leasing company (or its investors) receives the federal investment tax credit (ITC) and the RECs.[19] Under this option, in the first contract year, the customer buys the solar energy from the leasing company at a price that saves the customer money relative to what its estimated electricity bill would be without the solar energy. Thereafter, the customer buys the solar energy at prices that increase at an annual rate set forth in the PPA.

As we will show, the Lease Option transfers most of the customer's bill savings to the leasing company. The sizeable subsidy transferred to the leasing company under current NEM practices in California is one of the unintended consequences, as demonstrated later in this paper.

Different Regulatory Approaches

To examine how the existing NEM subsidies would be affected by different regulatory approaches, we examined three different alternatives to the current NEM practice while retaining the existing four-tiered tariff as a baseline. These general regulatory approaches are under discussion today by state regulators across the country. One approach increases the monthly customer charge while the other approach substitutes a separate *buy-sell* arrangement for NEM.[20] The two different regulatory approaches produce the following three alternatives:

1. Increase the customer charge to $10 per month and replace the existing tiered rate structure with a single energy price equal to 17.42 cents per kWh. This retail tariff

18 Other leasing options are also available. For simplicity, we examined only the PPA option.

19 The leasing company will often sell all or part of the project ownership (including the PPA and the RECs) to investors who can take better advantage of the tax benefits provided by the ITC and accelerated depreciation.

20 We did not explicitly model demand charges; however, the effect of a demand charge on a typical residential customer with rooftop solar PV would be virtually the same as an additional increase in the monthly customer charge.

produces approximately the same utility sales revenue as the existing tariff (*i.e.,* it is revenue-neutral relative to the current four-tiered tariff).

2. Increase the customer charge to $30 per month and replace the existing tiered rate structure with a single energy price equal to 13.96 cents per kWh. This retail tariff also produces approximately the same utility sales revenue as the existing tariff.
3. Implement a separate *buy-sell* arrangement whereby the customer purchases from the utility all of the energy it consumes on site through its existing retail tariff and sells to the utility all of the energy its rooftop solar facility produces at the utility's avoided cost.

As demonstrated below, either regulatory approach could significantly reduce or eliminate the NEM subsidy; thus, each deserves serious consideration by state regulators who are addressing the NEM cost-shifting problem.[21]

A $10 monthly customer charge is only a small fraction of the total cost of providing grid services to a DG customer and even a $30 monthly customer charge falls short of the actual cost to provide grid services.[22]

UTILITY AVOIDED COSTS

Utility avoided costs are a highly debated issue in California. It is not our intent to enter that debate with yet another set of estimates because the primary focus of our analysis is to highlight how large the NEM subsidy is in California, who gets this benefit, and its lack of transparency. For this reason we adopted the most recent avoided cost estimates produced for the CPUC by its consultant, Energy+Environmental Economics, Inc., (E3).

We estimated SCE's avoided costs applicable to where our typical solar facility is located (*i.e.,* CEC Climate Zone 9) by running the Avoided Cost Model that E3 employed in the NEM subsidy study conducted for the CPUC in 2013 (cited earlier in footnote 1).[23] Table 2 summarizes these avoided cost estimates. Although we used the E3 avoided cost estimates, we do not necessarily agree with them.

21 The NEM subsidy and related cost shifting will be eliminated under the buy-sell arrangement if the prices paid for the solar energy produced truly reflect the utility's avoided cost. However, this may not occur because the values adopted for a utility's avoided costs are typically the result of a negotiated settlement. The debates taking place in a number of states today regarding the "value of solar" are about whether to include adders in the utility's avoided cost that account for environmental and other external costs.

22 See: IEE Issue Brief, *The Value of the Grid to DG Customers*. October 2013. www.edisonfoundation.net.

23 The model is available at: http://www.ethree.com/documents/CSI/E3_NEM_Avoided_Cost_Model.xlsm.

Table 2. Utility Avoided Cost Estimates for CEC Climate Zone 9 near Los Angeles in 2014

Utility Avoided Cost Estimates Applicable to Year 2014	
Avoided Cost Components	**2014 Avoided Cost Estimate ($2014/MWh)[1]**
Avoided Energy Purchases (Excl. T&D Losses)[2]	$44.14
Avoided T&D Energy Losses[3]	$3.07
Avoided Ancillary Services Purchases	$0.56
Avoided Generating Capacity (Incl. Reserves)	$11.76
Avoided Transmission & Distribution (T&D) Capacity[4]	$17.31
Avoided CO2 Allowance Purchases[5]	$10.81
Avoided RPS Purchases[6]	$19.51
Total:[7]	$107.15

1. IEI did not independently develop estimates of SCE's avoided costs; it used the estimates produced by the E3 Avoided Cost Model, which were developed for the California Public Utilities Commission. This table presents a breakdown of the cost components for the first year of the solar facility's operation. These costs are MWh-weighted averages based on the solar facility's hourly energy output. The facility is located in CEC Climate Zone 9 to the east of the city of Los Angeles.

2. The cost of avoided energy purchases excludes the avoided energy losses, described in footnote 3, and also the associated cost of CO2 allowances, described in footnote 6.

3. T&D energy losses are those that occur between the offtake point on the CAISO transmission network and the rooftop Solar PV customers' meters.

4. This cost component is the avoided future investment in the transmission and distribution systems described above in footnote 3.

5. CO2 allowances must be purchased by fossil-fueled generators so their costs are internalized in the CAISO energy prices. The E3 Avoided Cost Model breaks out the allowance costs from the CAISO energy prices because these two components of avoided cost are driven by different factors; therefore, they must be separately forecasted.

6. This is the cost avoided of not having to procure the RPS share of the solar energy production, grossed up for avoided T&D energy losses. It is the price premium commanded by the marginal renewable energy resource relative to the market value of the energy it produces, multiplied by the RPS percentage (e.g., 33 percent in 2020 and beyond).

7. In nominal dollars, the avoided cost total escalates at an average annual rate of 7.7 percent through 2017 and thereafter at 2.4 percent through 2038.

Note that 2014 is the first year in the 25-year service life of our typical rooftop solar PV facility. For 2014, the model produced an estimated avoided cost for SCE of $107.15 per megawatt-hour (MWh) or 10.72 cents per kWh. In nominal dollars, the avoided cost escalates at an average annual rate of 7.7 percent through 2017, at which point the current California ISO generating capacity surplus is projected to be fully absorbed. After 2017, the rate of escalation declines to an average annual rate of about 2.4 percent through 2038.

CUSTOMER BENEFITS UNDER ALTERNATIVE REGULATORY APPROACHES

In this section, we discuss the results of our discounted cash flow (DCF) analysis of the typical rooftop solar PV project and the benefits under the current NEM arrangement and the three regulatory alternatives described earlier. We did not include the value of renewable energy credits (RECs) in this analysis (which provide an additional source of customer benefit) because future REC prices are very difficult to forecast and they have no impact on the NEM subsidy, which is the focus of this paper.[24]

Table 3 shows the net present values (NPVs) of the rooftop solar PV project to the customer for the two financing options under the four regulatory alternatives.

Table 3. Monetary Value to the Customer (NPV) under the Purchase vs. Lease Option Over 25-Year Rooftop Solar PV Project Life: Four Regulatory Alternatives

Impact of Regulatory Changes on Customer Value of 4 kW Solar Project Near Los Angeles		
Project Net Present Value (NPV) to Customer ($2014)		
Regulatory Alternative	Project Financing Option	
	Customer Purchase[1]	Customer Lease (PPA)[2]
Existing retail tariff with four energy price tiers	$20,359	$7,254
Energy price of $0.1742/kWh with $10 customer charge	$5,831	$6,381
Energy price of $0.1396/kWh with $30 customer charge	$1,637	$5,981
Buy at retail tariff and sell solar at utility's avoided cost[3]	$315	NA
1. The net present values (NPVs) exclude the monetary value of Renewable Energy Credits (RECs), which the owner of the solar facility can sell for added value.		
2. In this option the leasing company sets the initial PPA price such that the customer receives a 15 percent reduction in the combined cost of electricity purchases (from both the utility and the leasing company) in the first year; thereafter, the price escalates at 2.9 percent per annum, which is about 0.2 percent faster than the utility's retail tariff expected nominal escalation rate.		
3. In the *buy-sell* regulatory approach, the customer buys all of the energy consumed onsite through the retail tariff and sells all of the energy produced onsite at prices that reflect the utility's avoided cost. Leasing company PPAs are incompatible with this regulatory approach.		
Note: Present Values are expressed in Start-of-Year (i.e., January 2014) dollars.		

24 California has adopted a Renewable Portfolio Standard (RPS) that requires "retail sellers" of electric energy (*e.g.*, electric utilities with retail customers) to obtain a percentage of that energy from renewable resources. The renewable energy share increases over time and plateaus at 33 percent in 2020. Renewable energy resources create RECs through the energy they produce. RECs are tradable and can add significant economic value to a rooftop solar PV project, depending on future REC market prices. We found no reliable forecasts of REC prices, and current REC prices are very low, *e.g.*, a few dollars per MWh.

From a financial perspective, any project with an NPV greater than zero is worth pursuing. Because these NPVs exclude any benefits from REC sales, these estimates understate the actual value that rooftop solar PV facilities provide to their owners.

UNDER TODAY'S RETAIL TARIFF THE NEM SUBSIDY IS SUBSTANTIAL

The installed cost of the 4 kW-dc rooftop solar facility is about $14,586 or about $4 per Watt-dc; however, this is partially offset by the federal tax credit of $4,376 (30 percent of $14,586). The energy produced by the solar PV facility reduces the customer's electricity purchases from the utility, thereby realizing a bill reduction of about $1,900 in the first year under the utility's current tariff. Future bill reduction amounts will depend on the utility's future retail rates.

When the customer purchases the rooftop solar facility, as shown in Table 3 (Customer Purchase Option), the total monetary value (NPV) to the customer of the rooftop solar project is $20,359 over the 25-year project life. This corresponds to an after-tax rate of return of 17 percent and a payback period of just 7 years, which is extraordinarily high for a project of such low risk. The project's monetary value includes the full stream of costs and benefits to the customer, including the purchase and installation costs, the federal tax credit, and the customer's electric bill savings over the 25-year period, all discounted back to the start of 2014.[25] *The customer receives this substantial monetary benefit in addition to recovering the $14,586 that was initially invested.*

When the customer enters into a PPA with a leasing company, we assume that the PPA price is initially set such that the customer receives a 15-percent reduction compared to what its estimated electricity bill would be in the first contract year without the solar energy. Thereafter, the PPA price escalates at 2.9 percent per annum.[26] Table 3 (Customer Lease Option) reveals that the total value to the customer decreases to only $7,254. This means that, under the Leasing Option, $13,105 ($20,359 minus $7,254) of the project's benefit is transferred to the leasing company. As the owner of the facility, the leasing company receives the federal tax credit (*i.e.*, the ITC) and the majority of the NEM subsidy. In this example, when a customer leases rooftop

25 We computed the NPVs shown in Table 3 using separate risk-adjusted discount rates for each cost and benefit component, which range from 1.2 percent real to 2.5 percent real. Combining them with EIA's average 25-year inflation rate of 1.7 percent produced nominal composite discount rates of 4.50 percent for the customer purchase options and 5.85 percent for the customer lease options. The two composite discount rates differ because the stream of PPA payments is significantly less risky than the stream of the customer's bill savings.

26 These assumptions approximately reflect the PPA pricing terms currently being offered in California by one of the largest solar leasing companies in the U.S. Other leasing companies may price PPAs differently.

solar PV, about two-thirds of the total project value is transferred to the leasing company. This transfer of subsidies is described in more detail later in this paper.

HIGHER MONTHLY CUSTOMER CHARGES AND DEMAND CHARGES REDUCE THE NEM SUBSIDY

Table 3 shows that the NPV of the rooftop solar project progressively declines but is still substantially greater than zero as the monthly fixed customer charge increases to $10 and $30 per month, respectively. These changes, in turn, reduce the retail energy rate in order to maintain a revenue-neutral rate structure. *This means that the NEM subsidies also decline progressively because the lower energy rates produce lower bill savings for the customer. In addition, a higher customer charge (and/or the introduction of one or more demand charges) causes the DG customer to pay more of its share of the grid services it utilizes. Hence, the cost shifting from DG to non-DG customers decreases as the retail tariff becomes more cost-reflective. This is an important result.*

Increasing the monthly customer charge also reduces the profitability of the solar project for the leasing company. This occurs because the lower retail energy rate forces down the PPA prices needed to provide the leasing company's quoted percentage discount off of the customer's estimated first-year electric bill without the solar energy. Although we do not know how leasing companies would respond if the energy rate(s) were significantly reduced in California, we suspect that they would offer discounts smaller than 15 percent.

Under current NEM practices in California, the leasing company receives a large subsidy that is paid for by non-DG customers. This should concern state's legislators and the CPUC. A simple increase in the monthly customer charge would reduce the subsidy and the underlying cost shift, as we describe below.

THE BUY-SELL APPROACH (THEORETICALLY) ELIMINATES THE NEM SUBSIDY

Under this regulatory approach, the customer purchases all of the electric energy that is consumed on site through the utility's retail tariff and sells all of the electric energy produced by the rooftop solar facility at the utility's avoided cost.[27] Thus, the amount paid to the customer is

27 To determine the amount of electric energy consumed on site, a second meter is needed to record the solar facility's production. The solar production in each hour is then added to the electric energy the utility delivered to the customer in that hour. The customer is billed for this amount of "reconstituted" total consumption.

tied directly and transparently to the value to the utility of the solar energy produced by the rooftop solar facility. This is conceptually similar to the regulatory model adopted by Austin, Texas.

Table 3 reveals that the *buy-sell* approach produces an NPV of $315, meaning that the project is essentially a break-even investment for the customer (but bear in mind that this value excludes any benefits derived from debt financing or REC sales). The *buy-sell* approach eliminates the shifting of costs from DG customers to non-DG customers if the prices paid for the solar energy produced by the rooftop solar PV facility approximately represent the utility's avoided costs. In addition, this approach strongly discourages the development of uneconomic projects.

PPAs currently offered by leasing companies are incompatible with the *buy-sell* approach because the customer receives no bill savings from solar energy production. However, leasing companies could still offer equipment leases that also obviate the need for upfront customer investment.

Although residential rooftop solar PV may be a breakeven investment under the *buy-sell* approach, customers will still purchase and install rooftop solar if they value generating some or all of their own electricity, value the environmental benefits of low-carbon energy, and/or believe that REC prices are likely to substantially increase in the future. Furthermore, as the installed cost of rooftop solar PV declines further, the *buy-sell* approach will provide larger NPVs for cost-beneficial DG projects.

OWNERS OF THE SOLAR PV FACILITIES RECEIVE MULTIPLE SUBSIDIES

Table 4 summarizes the NEM subsidy and the federal tax credit (ITC or REEPC) subsidy that the owner of a typical solar PV facility receives under the four regulatory alternatives.[28] In our analysis, we define the NEM subsidy as the difference between the *customer's bill savings* (which equals the utility's revenue loss) and the *utility's costs avoided* by not having to deliver to the DG customer the energy produced by the rooftop solar facility.

28 The difference between the federal tax credit of $4,376 (which is 30 percent of the $14,586 project cost) and the $4,314 subsidy amount is due to discounting; the tax saving is effectively received six months after the solar facility is installed, *i.e.*, when the customer or leasing company pays its income taxes for 2013.

Table 4. Subsidies Associated with a 4 kW Solar Project Near Los Angeles

Impact of Regulatory Changes on the Subsidization of a 4 kW Solar Project Near Los Angeles		
Present Value of NEM and FTC Subsidies for Rooftop Solar ($2014)		
Regulatory Alternative	NEM Subsidy[1]	FTC Subsidy
Existing retail tariff with four energy price tiers	$20,044	$4,314
Energy price of $0.1742/kWh with $10 customer charge	$5,516	$4,314
Energy price of $0.1396/kWh with $30 customer charge	$1,322	$4,314
Buy at retail tariff and sell solar at utility's avoided cost[2]	0	$4,314
1. The NEM subsidy excludes the value of the federal tax credit (FTC), i.e., the ITC or the REEPC.		
2. In the *buy-sell* regulatory approach the customer buys all of the energy consumed onsite through the retail tariff and sells all of the energy produced onsite at prices that reflect the utility's avoided cost.		
Note: Present Values are expressed in Start-of-Year (i.e., January 2014) dollars.		

Because the *buy-sell* regulatory approach (theoretically) eliminates the NEM subsidy (assuming that the price paid for solar energy produced approximately matches the utility's avoided cost), the other regulatory alternatives are compared to that approach to quantify the NEM subsidy that the typical residential customer with a 4 kW rooftop solar facility receives. As Table 4 shows, the total subsidy under the current regulatory approach is $24,358, which is equal to the NEM subsidy of $20,044 plus the federal tax credit subsidy of $4,314. When the customer purchases the rooftop solar facility, the customer receives this entire subsidy.

Under the regulatory approaches with the $10 and $30 monthly customer charges, Table 4 shows that the resulting NEM subsidies are reduced from $20,044 to $5,516 and $1,322 respectively, while the federal tax credit subsidy remains at $4,314. Under the *buy-sell* approach, there is (theoretically) no NEM subsidy. Thus, under the *buy-sell* approach, the rooftop solar facility owner only receives the federal tax credit subsidy of $4,314.

Under California's current NEM arrangement, subsidies for rooftop solar PV facilities are substantial and exceed what is necessary to incent customers to invest in these facilities. In addition, NEM subsidies are not transparent and are difficult to calculate.

It is important to understand not just the magnitudes of the subsidies, but also to identify the subsidy recipients. Table 5 shows how the total subsidy (*i.e.*, the sum of the NEM subsidy and the federal tax credit subsidy) gets distributed between the customer and the solar leasing company under the four regulatory alternatives.

Table 5. Distribution of Subsidy Amounts for Customer-Owned vs. Leased 4 kW Solar Project (for a 15 Percent Discount on First Year Bill)

Distribution of Subsidy Amounts Under Customer Own vs. Lease a 4 kW Solar Project			
Present Value of NEM and FTC Subsidies for Rooftop Solar ($2014)			
Regulatory Alternative	Customer Purchases Solar	Customer Leases Solar[1]	
	Customer Subsidy Amount	Customer Subsidy Amount	Leasing Company Subsidy Amount
Existing retail tariff with four energy price tiers	$24,358	$6,939	$17,419
Energy price of $0.1742/kWh with $10 customer charge	$9,830	$6,067	$3,763
Energy price of $0.1396/kWh with $30 customer charge	$5,637	NA	NA
Buy at retail tariff and sell solar at utility's avoided cost[2]	$4,314	NA	NA

1. In this option, the leasing company sets the initial PPA price such that the customer receives a 15 percent reduction in the combined cost of electricity purchases (from both the utility and the leasing company) in the first year; thereafter, the price escalates at 2.9 percent per annum, which is about 0.2 percent faster than the utility's retail tariff expected nominal escalation rate.

2. In the *buy-sell* regulatory approach, the customer buys all of the energy consumed onsite through the retail tariff and sells all of the energy produced onsite at prices that reflect the utility's avoided cost. Leasing company PPAs are incompatible with this regulatory approach.

Note: Present Values are expressed in Start-of-Year (i.e., January 2014) dollars.

Customer Purchases the Solar PV Facility

When the customer purchases the rooftop solar PV facility, the total subsidy goes to the customer under each of the regulatory alternatives. The total subsidy ranges from $24,358 under the current NEM practices to $4,314 (*i.e.*, the value of the federal tax credit) under the *buy-sell* regulatory approach. Increasing the monthly customer charge to $10 or $30 reduces the NEM subsidy, but does not affect the federal tax credit (REEPC) subsidy.

Customer Leases the Solar PV Facility

When the customer leases the rooftop solar PV facility, the leasing company receives the federal tax credit (*i.e.*, the ITC) subsidy and a portion of the NEM subsidy based on the PPA pricing.[29] Under current NEM practices, the customer receives $6,939 of the total subsidy and the remaining $17,419 is transferred to the leasing company.

29 Under the lease option, the total subsidy that the customer receives is equal to the total customer subsidy under the purchase option less the subsidy received by the leasing company.

With a $10 monthly customer charge, the amount of the total subsidy transferred to the leasing company declines to just $3,763, which is less than the ITC subsidy. This implies that the leasing company receives none of the NEM subsidy; in fact, it has to rebate $551 of the ITC subsidy through lower PPA prices in order to deliver its promised 15-percent discount offer. Clearly, the total subsidy to the leasing company (and its profits) decreases significantly by simply increasing the monthly customer charge to $10. This occurs because the DG customer is paying more of the costs of the grid services that it utilizes, thereby decreasing the NEM subsidy.

If the monthly customer charge is increased to $30, we do not believe that leasing companies will offer customers 15-percent bill discounts because they would have to substantially lower their PPA prices. Hence, we do not provide a subsidy distribution in Table 5 for this lease option.

To further explore the response of the leasing company to a $30 monthly customer charge, we examined how the total subsidy would be redistributed if the leasing company reduced the customer bill discount from 15 percent to 10 percent. Table 6 presents the results.

Table 6. Distribution of Subsidy Amounts for Customer-Owned vs. Leased 4 kW Solar Project (for a 10 Percent Discount on First Year Bill)

Distribution of Subsidy Amounts Under Customer Own vs. Lease a 4 kW Solar Project			
Present Value of NEM and FTC Subsidies for Rooftop Solar ($2014)			
Regulatory Alternative	**Customer Purchases Solar**	**Customer Leases Solar[1]**	
	Customer Subsidy Amount	**Customer Subsidy Amount**	**Leasing Company Subsidy Amount**
Existing retail tariff with four energy price tiers	$24,358	$3,020	$21,338
Energy price of $0.1742/kWh with $10 customer charge	$9,830	$3,069	$6,761
Energy price of $0.1396/kWh with $30 customer charge	$5,637	$2,975	$2,662
Buy at retail tariff and sell solar at utility's avoided cost[2]	$4,314	NA	NA

1. In this option, the leasing company sets the initial PPA price such that the customer receives a 10 percent reduction in the combined cost of electricity purchases (from both the utility and the leasing company) in the first year; thereafter, the price escalates at 2.9 percent per annum, which is about 0.2 percent faster than the utility's retail tariff expected nominal escalation rate.

2. In the *buy-sell* regulatory approach, the customer buys all of the energy consumed onsite through the retail tariff and sells all of the energy produced onsite at prices that reflect the utility's avoided cost. Leasing company PPAs are incompatible with this regulatory approach.

Note: Present Values are expressed in Start-of-Year (i.e., January 2014) dollars.

For a $30 monthly customer charge, the customer subsidy is $2,975 and the leasing company subsidy is $2,662.

The subsidy amounts going to solar leasing companies under current NEM practices in California should be a cause for concern – especially so when non-DG customers are paying those subsidies and receiving little value in return. A customer charge as small as $10 per month would substantially reduce the transfer of subsidies to solar leasing companies. Lastly, the NEM subsidy can be eliminated with the *buy-sell* regulatory approach if the prices paid for the solar energy produced by the rooftop solar PV facility truly reflect the utility's avoided costs. The NEM subsidy also can be eliminated if the monthly customer charge is increased by the appropriate amount and/or is combined with appropriate demand charges.

CONCLUSION

The legitimate purpose of a subsidy is to provide an incentive to pursue a desirable public policy. Subsidies should not be overly generous; the amount of the subsidy should be transparent; and the recipient of the subsidy should be clearly identified. As our analysis demonstrates, the current NEM regulatory approach in California fails all three tests. Subsidies for rooftop solar PV facilities are substantial and far exceed what is necessary to incentivize customers to invest in these facilities. Moreover, NEM subsidies are not transparent, are difficult to calculate, and largely go to solar leasing companies, rather than to the utility's customers.

The NEM subsidy – which is a result of DG customers not fully paying for the grid services they use – represents the lion's share of the total subsidy in California today. While much of the national debate has focused on whether the 30-percent federal tax credits (*i.e.,* the ITC and the REEPC) should be continued in the future for solar energy, this analysis makes clear that the elephant in the room is the NEM subsidy, which dwarfs the federal tax credits.

Even more disconcerting than the size of the NEM subsidy in California is that the primary beneficiaries are the solar leasing companies while most of their customers appear to be uninformed about the financial consequences of choosing to lease rather than own a rooftop solar facility. At a minimum, DG customers as well as non-DG customers deserve objective information about the consequences of leasing and the flow of the subsidy dollars.

As the cost of rooftop solar PV continues to decline, spurring rapid adoption of the technology, it is critical to send appropriate price signals to both customers and solar leasing companies. Current NEM practices do not do this. *In fact, the current NEM subsidy of more than $20,000 for a modestly sized rooftop solar PV project that costs about $14,500, is too large and lacks transparency.*

Regulatory tools are available today (and are in use in several jurisdictions) to send appropriate pricing signals that reduce unintended and excessive subsidies to both customers and to solar leasing companies while reducing cost shifting to non-DG customers.

Given the discussions underway in California today regarding NEM and the current retail tariffs, the most straightforward approach is to require DG customers to pay for more for the grid services they utilize through a higher monthly customer charge and to simplify the tiered retail rate structure. However, a more elegant solution is to include one or more demand charges in the retail tariff that are designed to directly recover the costs of generation, transmission, and distribution capacity that DG customers impose on the utility.

Two of the regulatory alternatives examined in this paper replace the tiered rate structure in California with a single energy rate combined with higher monthly customer charges. *Tiered rates exacerbate the NEM subsidy; if retained, they should not be available to DG customers.*

The *buy-sell* approach is also worth serious consideration because it could eliminate the NEM subsidy and the cost shifting from DG customers and solar leasing companies to non-DG customers. However, this would only occur if the prices paid for the solar energy produced by the DG facility were truly equal to the utility's avoided cost. While we believe this is unlikely to occur, given that the values used for a utility's avoided cost are often the result of settlements reached through regulatory negotiations, the cost shifting could be small enough to be acceptable. Moreover, the *buy-sell* approach is transparent and can be adjusted over time in response to changes in the utility's avoided cost, whereas the subsidy amount under the NEM approach lacks transparency and does not functionally respond to changes in the utility's avoided costs. These are serious problems.

The time to change NEM is now, and regulatory approaches are available to do so.

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For more information contact:

Lisa Wood
Executive Director
Institute for Electric Innovation
701 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2696
202.508.5440
lwood@edisonfoundation.net

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