The Takeaway
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California's Solar Rooftop Experience: An Update

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An earlier Takeaway focusing on 2010 showed the necessity of state and federal subsidies to support the adoption of residential solar rooftops. Back then, the environmental bang for the buck was poor. But now, steeply falling solar costs have changed the picture. As before, our update looks not only at the costs and benefits to the solar adopters, but also to the investor-owned electric utilities, to the government, and to the environment. Cost reductions in solar panels now make subsidies unnecessary, but electric utilities continue to face a difficult situation. Two big policy changes are needed.

Since 2000 in California, solar rooftops have grown from virtually nil to 958,000 installations, and in 2018 accounted for 14% of California's renewable energy production.[1] Without tax credits, most residential users in 2010 would have found it too expensive to adopt solar. However, the cost of solar panels has since fallen steeply,[2] so it is instructive to see whether those tax credits are necessary today.

WHAT'S THE TAKEAWAY?

Rapidly falling solar costs make rooftop solar viable now without subsidies.

Regulators need to restructure electricity pricing by splitting it into two components—an access fee and a usage fee.

The environmental benefit for rooftop solar is now much closer to passing a cost-benefit test.

Using information from a paper by economist Severin Borenstein[3] and industry sources, we calculated how much a typical high consumption residence would spend on a 6 kilo-watt (kw) rooftop solar system based on the fixed cost of the equipment, tax credits, and monthly solar savings (see Table 1).[4] In 2010 without tax credits that residence would have had to pay more for the installation, than they would recoup in future electricity savings over the 25-year life of the solar panels. But with tax credits, even after discounting the future cost savings from solar (at Borenstein's recommended 4% rate), our hypothetical residence did offset their subsidized installation costs (+$4,500).

Now let's perform the same calculation for 2019 (see Table 1). The costs of solar installations have fallen dramatically, California has phased out its solar incentives, the federal tax credit remains, and due to rising electricity prices the present value of future electricity cost savings is higher. So in 2019, our solar adopter is much better off (+$25,600), and better off even in the absence of the solar tax credit (+$20,200). In 2019, it pays to go solar.

TIME TO LET TAX CREDITS LAPSE

Tax credits for solar are set to expire in 2019, but will they? They have been extended before. While they were essential in 2010, the marked drop in solar installation costs now make them unnecessary. In the current environment of run-away federal deficit spending, subsidies to the solar industry and affluent solar adopters are difficult to justify. It is time to let them go.

LOSSES TO ELECTRICITY PROVIDERS

Less obvious are the hidden costs solar adopters impose on electricity providers and in turn on other customers. In California, residential customers only pay for the electricity delivered to them, so electricity cost savings to solar adopters are a lost revenue to the electric utilities. Obviously, electric utilities will not have to purchase the electricity from the wholesale grid that solar displaced, but that only offsets about a quarter of the lost revenue. The local electricity providers must make up the difference. But who pays for this? Because the electric utilities are publicly regulated and investors are guaranteed a fair return on their capital, these costs are passed along to consumers. Solar adopters are ultimately imposing costs on non-solar adopters, many of whom may be too poor to incur the initial cost of a solar system.

The full local distribution network must still be maintained so when solar households turn on appliances at night or on cloudy days, the network will be there to provide service. Yet because utility providers are essentially compensated for the electricity delivered rather than for providing access to the grid, solar rooftop adoption has proven to be a big negative. Table 2 shows that in 2010, the reduced consumption from our hypothetical high-consumption solar adopter cost the utility $21,500 in discounted future revenues because the customer's savings (lost revenue to the provider) is only partially offset by reduced power purchases. By 2019, the problem is even worse—it's $32,700.

These price differentials point to a serious two-fold problem in the way California regulators price electricity—increasing block tariffs and negligible access fees for connection to the electricity grid.

Table 1: Hypothetical High-Consumption Solar Adopter 6 kw Installation

Year	Solar Install.	Lifespan Electricity Savings	Net Cost	30% Fed. Tax Credit	California Tax Credit	Net Savings
2010	-$45,000	+$27,000	-$18,000	+$13,500	+$9,000	+$4,500
2019	-$18,000	+$38,200	+$20,200	+$5,400	$0	+$25,600

California imposes increasing block tariffs, meaning that in 2010 the biggest users could pay marginal prices almost four times the price paid by the lowest users. Thus, high consumption users (paying the highest marginal prices) are the ones most incentivized to adopt solar, so they can move out of the high price blocks into the low price blocks that typically low-income, low-consumption users pay. Electricity providers take a big hit when they lose those high-consumption customers. In response, the steepness of the block tariffs have been reduced with the highest price block now being about 2.2 times the baseline rate.

Table 2: Total Costs and Benefits for All Groups Assuming a Hypothetical High-Consumption California Solar Adopter: 2010 & 2019

	Solar Adopter	Electricity Provider	Government	Environment	Net Impact (over 25 years)
2010 Economics					
No Tax Credit	–$18,000	–$21,500	$0	+$2,600	–$36,900
With Tax Credit	+$4,500	–$21,500	–$22,500	+$2,600	–$36,900
2019 Economics					
No Tax Credit	+$20,200	–$32,700	$0	+$2,600	–$9,900
With Tax Credit	+$25,600	–$32,700	–$5,400	+$2,600	–$9,900
2019 Proposed					
No Tax Credit	+$1,000	$0	$0	+$2,600	+$3,600
With Tax Credit	+$6,400	$0	-$5,400	+$2,600	+$3,600

But even going to a flat-rate tariff would only solve part of the problem. The usage-based pricing structure still only compensates the utility provider when they deliver electricity to the households—and not for providing access to the electricity grid. The advent of solar rooftops means that the providers only receive revenue on their sales to solar customers during the shoulder and off-peak, night-time hours. Yet it bears the fixed cost of providing a distribution network that is uncompensated during the daytime hours when solar rooftops are providing electricity. With this type of pricing structure in place, as more homeowners adopt rooftop solar, the utility providers will incur greater losses, forcing them to request increases to the tariff schedules. Frank Wolak, a Stanford economist, found that two-thirds of the increase in residential distribution network prices between 2003 and 2016 can be attributed to the growth in distributed solar capacity.[5]

A PROPOSED FIX FOR REGULATORS

The economist's prescription is to split the pricing of electricity into two components—an access fee and a usage fee.[6] Charging a fixed monthly access fee would compensate the utility provider for maintaining the electrical grid, and would allow the usage charges to be substantially reduced. For our hypothetical high-consumption user, there are a variety of pricing structures that could alleviate electricity providers' losses and still provide an incentive to adopt solar. For example, assuming a flat usage fee of $.14/kwh and a monthly access fee of $215/month[7] would completely eliminate the loss to the electricity provider (see Table 2). Since the monthly access fee is payable whether or not one adopts solar, it removes the artificial incentive to adopt solar created by sole reliance on usage-based pricing, while our household would still have a positive incentive to adopt solar (+$1,000)—even without tax credits!

ENVIRONMENTAL BENEFITS

The environmental benefits for our hypothetical solar adopter in terms of reduced carbon dioxide (CO_2) emissions to the atmosphere is 2.77 tons less carbon annually than if a combined cycle natural gas plant had produced the those 8,340 kwh of electricity.[8] Over the 25-year life of the rooftop solar system, that amounts to 69.4 less tons of CO_2. Putting a price on a ton of CO_2 has led to a vast economic literature with no consensus. For our calculations we used the EIA estimate of $37/ton of CO_2 resulting in a $2,600 benefit to the environment.

PUTTING IT ALL TOGETHER

As shown in Table 2, summing the costs and benefits to all four groups—consumers, electricity providers, government, and the environment—results in a significant net loss for our 2010 solar adoption. Clearly, in 2010 without large subsidies solar rooftops were not economic even for our hypothetical high consumption household. Furthermore, the modest environmental benefits could not justify the program. The falling cost of solar now results in a much smaller net loss, households have more incentive to adopt solar even without subsidies, and the environmental benefit is much closer to passing a cost-benefit test. Our analysis suggests that replacing increasing block tariffs with flat rates and instituting a substantial access fee to the distribution system is workable and could actually yield positive net benefits. Under such a pricing scheme, consumers would still have incentives to adopt solar, electricity providers could be fully compensated, government could eliminate the tax credit, and the environment is made better. The prognosis for solar in 2019 is now much better, but work remains to be done in Washington on the tax credits and at the California Public Utility Commission on restructuring electricity rates for a world with solar rooftops.

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Notes:

[1] California Energy Commission (2019). https://ww2.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf

[2] See https://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/

[3] Borenstein, S. (2017). Private net benefits of residential solar PV: The role of electricity tariffs, tax incentives, and rebates. *Journal of the Association of Environmental & Resource Economists*, *4(*S1), S85–S122.

[4] Our earlier *Takeaway* assumed a 10 kw installation which was unnecessarily large. We have refined some other assumptions as well.

[5] Wolak, F. (2018, Sept). The Evidence from California on the economic impact of inefficient distribution network pricing. NBER Working Paper No. 25087. doi: 10.3386/w25087.

[6] Zajac, E. (1978). *Fairness or efficiency: An introduction to public utility pricing*. Cambridge, MA: Ballinger.

[7] In order to implement such a pricing strategy, the monthly access fees would differ across customer groups. In fact, Wolak has proposed a formula to compute customer-specific access charges.

[8] Only an insignificant amount of coal is used in California for electricity production. See https://www.energy.ca.gov/almanac/electricity_data/electricity_generation.html.

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