Putting the Potential Rate Impacts of Distributed Solar into Context

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Overview

The rapid growth of distributed solar in a number of states has raised questions about its potential effects on retail electricity prices, prompting concerns by some utilities and stakeholders about cost-shifting between solar and non-solar customers. These concerns have, in turn, led to a proliferation of proposals to reform retail rate structures and net metering rules for distributed solar customers, often extending to states that have yet to witness significant solar growth. These proposals have typically been met with a great deal of contention and often absorb substantial time and administrative resources, potentially at the expense of other issues that may ultimately have greater impact on utility ratepayers. Given these inevitable tradeoffs, state regulators might ask: How large could the effect of distributed solar on retail electricity prices conceivably be? And how does that compare to the many other factors that also influence electricity prices—and over which state regulators and utilities might also have some control?

This paper seeks to address these questions, with the aim of helping regulators, utilities, and other stakeholders gauge how much attention to devote to evaluating and addressing possible impacts of distributed solar on retail electricity prices. Drawing on a combination of back-of-the-envelope style analyses and literature review, we estimate ranges for the potential effects of distributed solar on retail electricity prices, at both current and projected future penetration levels, and compare those estimates to a number of other important drivers for future retail electricity prices.

To be sure, in focusing on potential effects on retail electricity prices, we address just one motivation behind rate reforms for solar customers—namely, concerns about cost-shifting between solar and non-solar customers. Other motivations, including impacts on utility shareholders and economic efficiency, are also relevant and may ultimately provide a more compelling rationale for retail rate reforms, but are outside the scope of this paper. Several other important limitations to the study scope are noted in the text box to the right.

Limitations to the Scope of this Paper

This paper presents illustrative comparisons between the effects of distributed solar and other drivers of retail electricity prices. **It does not:**

- **Address distributed energy resources as a whole.** While this paper focuses specifically on distributed solar, retail rate reforms in some states may be motivated by distributed energy resources more broadly and by other technologies that enable customer price-responsiveness.
- **Provide state- or utility-specific analysis.** The analyses presented here are based on U.S. average or otherwise illustrative conditions, and draw from a variety of pre-existing studies. The paper may inform, but is not a substitute for, detailed state- or utility-specific studies.
- **Support any particular approach to defining the value of solar.** This paper shows, generically, how the effects of distributed solar on retail electricity prices are a function of the value of solar to the utility. However, the paper makes no assumptions or conclusions about how to estimate that value.
- **Provide a cost-benefit analysis of distributed solar or any other type of policy or resource.** This paper focuses narrowly on retail electricity price effects. It does not address the full set of costs and benefits relevant to evaluating the resources and policies discussed.

This executive summary is based on a longer report: Barbose, G. 2017. *Putting the Potential Rate Impacts of Distributed Solar into Context*. Berkeley, CA: Lawrence Berkeley National Laboratory. This work was funded by the Solar Energy Technologies Office, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Estimating the Effects of Distributed Solar on Retail Electricity Prices

Debates about the existence and size of any cost-shifting from distributed solar have focused to a large degree on how to properly value the costs and benefits of distributed solar. We abstract from those methodological questions and show, generically, how the effect of distributed solar on average retail electricity prices is a function of three basic drivers: its penetration level, the net avoided costs to the utility, and the compensation rate provided to distributed solar customers.

To generalize the effects on cost-of-service based retail electricity prices, we express these three key drivers in normalized (percentage) form:

- ***Penetration level*** is expressed in terms of total distributed solar generation as a percentage of total retail electricity sales.
- ***Net avoided costs*** are expressed as the net value of solar (VoS) to the utility (i.e., benefits minus costs) relative to the utility's average cost of service (CoS).
- ***Solar compensation rate*** is the payment or bill savings per unit of solar generation, relative to the CoS.

Relying on those three terms, we can express the percentage change in average retail electricity prices resulting from distributed solar, as follows (see Appendix A in the report for the derivation):

$$Percent\ Change\ in\ Retail\ Electricity\ Price = \ Penetration\ \times \left[\frac{Solar\ Comp.Rate}{CoS} - \frac{VoS}{CoS}\right]$$

Based on this relationship, the family of curves shown in Figure 1 illustrates the percentage change (either increase or decrease) in average retail electricity prices resulting from varying distributed solar penetration levels, where each curve corresponding to a particular VoS rate. If, for example, the value of solar is equal to half the utility's cost of service (VoS/CoS=50%), then a 10% solar penetration would lead to a 5% increase in retail electricity prices under this compensation regime. A higher VoS would result in smaller increases (or conceivably even decreases) in average retail prices.

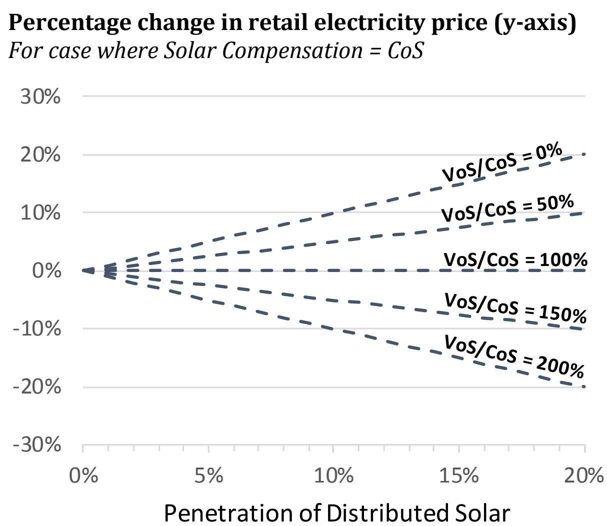
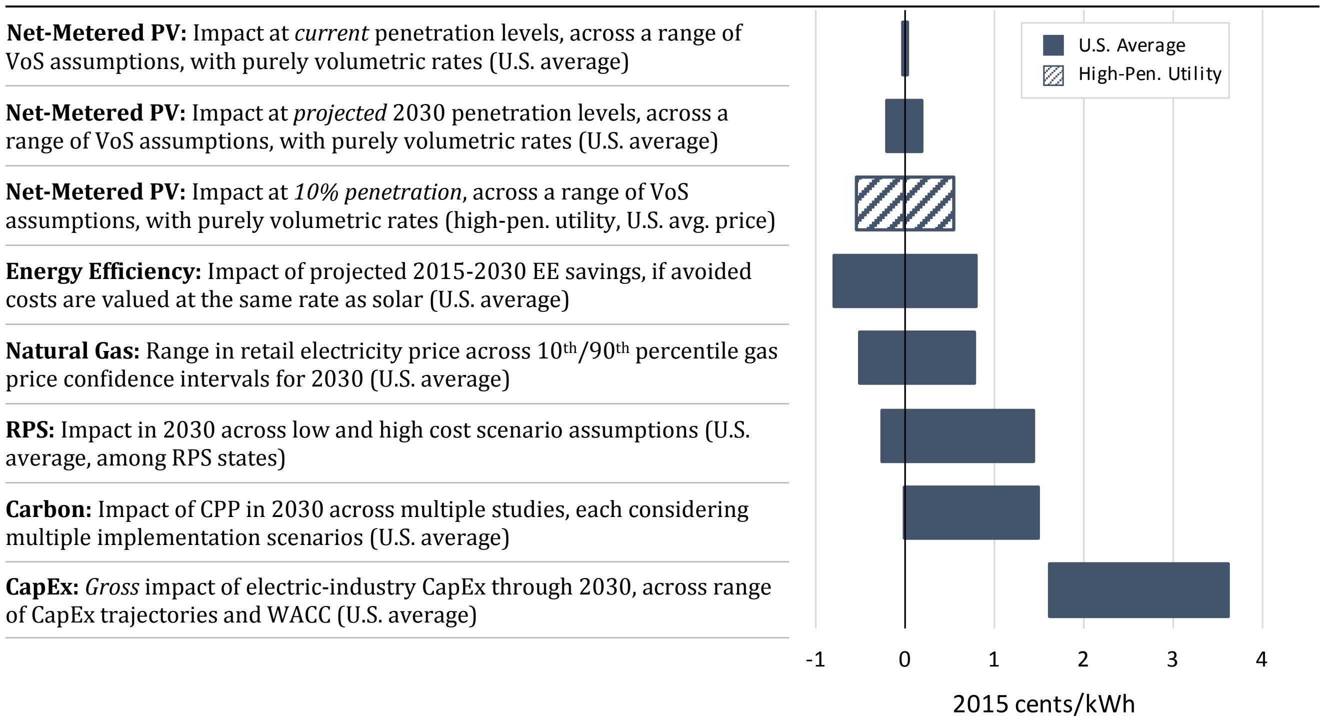


Figure 1. Impacts of distributed solar on average retail electricity prices: A simple model of underlying drivers

The curves in Figure 1 correspond to the specific case where solar compensation is equal to exactly the utility's CoS, as would occur under full net-energy metering (NEM) with flat volumetric prices and no fixed or demand charges. This is roughly representative of how residential customers with distributed solar are often compensated. However, most commercial customers, and increasingly residential customers as well, take service under rate structures that provide lower levels of compensation for distributed solar. In those cases, the curves in Figure 1 shift downward; the full report provides an example where solar compensation is equal to 50% of the utility's CoS, as would occur if fixed charges were used to meet half of the utility's revenue requirements.

Benchmarking against Other Drivers for Changes in Retail Electricity Prices

Armed with the relationship identified above, we compare the potential effects of distributed solar to other drivers for changes in retail electricity prices. We focus, in particular, on a set of issues with relatively broad geographical applicability, namely: energy efficiency programs and policies, natural gas prices, renewables portfolio standards (RPS), state and federal carbon policies, and capital expenditures (CapEx) by electric utilities.



Notes: Current net-metered PV penetration equal to 0.4% of total U.S. retail electricity sales, as of year-end 2015. Projected 2030 net-metered PV penetration is 3.4%, based on Cole et al. (2016). VoS assumptions range from 50% to 150% of average cost-of-service. Please refer to the main body of the report for further details on how the ranges shown here were derived.

Figure 2. Indicative ranges for potential effects on average retail electricity prices

Drawing on existing studies and several simple analyses presented within the full report, Figure 2 compares indicative ranges for the potential retail price effects of distributed solar and each of the aforementioned drivers. This comparison is by no means comprehensive or precise, but rather is intended to provide some illustrative and approximate benchmarks against which the potential impacts of distributed solar might be gauged. With this in mind, we offer the following summary points, also noting some of the ways in which effects in particular states or regions might differ from those shown above:

For the vast majority of states and utilities, the effects of distributed solar on retail electricity prices will likely remain negligible for the foreseeable future. At current penetration levels (0.4% of total U.S. retail electricity sales), distributed solar likely entails no more than a 0.03 cent/kWh long-run increase in U.S. average retail electricity prices, and far smaller than that for most utilities. Even at projected penetration levels in 2030, distributed solar would likely yield no more than roughly a 0.2 cent/kWh (in 2015$) increase in U.S. average retail electricity prices, and less than a 0.1 cent/kWh increase in most states, where distributed solar penetration is projected to remain below 1% of electricity sales. These estimates assume a relatively low VoS equal to just 50% of the average utility CoS, and relatively generous solar compensation levels based on full NEM with volumetric pricing.

For states or utilities with particularly high distributed solar penetration levels, retail electricity price effects may be more significant, but depend critically on the value of solar and underlying rate structure. Four utilities, all in Hawaii, currently have solar penetration rates on the order of 10% of electricity sales, and three other states are projected to reach this mark by 2030. Assuming a utility VoS ranging from 50% to 150% of its average CoS (based on a broad set of VoS studies reviewed), this level of distributed solar would yield between a 5% decrease and a 5% increase in retail electricity prices, under NEM with purely volumetric rates. Thus, for a utility with electricity prices otherwise equal to the national average, this would equate to a ±0.5 cent/kWh effect. Under rate structures with fixed charges or demand charges—as are already common, particularly for commercial customers—this range would be shifted downward.

Energy efficiency has had, and is likely to continue to have, a far greater impact on electricity sales than distributed solar. Distributed solar and energy efficiency can both impact retail electricity prices by virtue of reducing electricity sales. Utility energy efficiency programs and federal appliance efficiency standards together reduced U.S. retail electricity sales in 2015 by an amount 35-times larger than that of distributed solar. Projected growth in energy efficiency savings from those policies through 2030 is almost 5-times greater than projected growth in distributed solar generation. Assuming, for the sake of simple comparison, that the value of energy efficiency savings to the utility is based on the same VoS range as above (50-150% of the utility CoS), growth in energy efficiency savings over the 2015-2030 period would result in up to a ±0.8 cent/kWh change in U.S. average retail electricity prices.

Natural gas prices impose substantial uncertainty on future electricity prices. Electricity prices have become increasingly linked with gas prices, and are likely to become more so with continued growth in the share of electricity generated from gas. Although current gas prices are near historical lows, future prices remain highly uncertain, and that uncertainty is skewed upward. Gas-price confidence intervals developed Bolinger (2017) suggest a 10% probability that gas prices in 2030 will be at least $1.9/MMBtu higher than expected (based on the current NYMEX gas futures strip). Based on a broad set of electricity market modeling studies, an increase in gas prices of this magnitude would lead to roughly a 0.8 cent/kWh increase in U.S. average retail electricity prices. Restructured regions, which have more acute sensitivity to natural gas prices, could see retail electricity price effects of more than twice that amount.

Though their historical effects on retail electricity prices appear small, state RPS programs could lead to greater impacts if supply does not keep pace with demand. RPS compliance cost data suggest that the policies have thus far increased retail electricity prices by just 0.1 cents/kWh, on average, in RPS states. Rising targets over the coming years may put upward pressure on costs, which could be amplified if supplies of eligible renewable energy don't keep pace. At the extreme (and arguably rather implausible) upper end—which assumes that REC prices in all markets are trading at their caps and that other administrative cost caps are not enforced—we estimate that retail electricity prices in RPS states could increase by 1.4 cents/kWh in 2030, on average, and by 3-4 cents/kWh in some states. Smaller retail price effects are expected in practice, and even decreases in average prices are possible, depending in part on how barriers to renewables development are addressed.

The effects of state and federal carbon policies on future retail electricity prices are highly dependent on program design and implementation details. Existing cap-and-trade programs in

California and the Northeast have had limited impacts on retail electricity prices to-date. In large part, this is because complementary policies have accomplished much of the targeted emission reductions, and because auction proceeds are used for ratepayer bill credits. Studies of the CPP—currently under stay and facing an uncertain future—have estimated that it could result in anywhere from 0.0-1.5 cent/kWh increase in U.S. average retail electricity prices. Much of that range reflects differences in assumptions about how states implement the federal standard, such as whether states pursue rate-based or mass-based compliance, how allowances are allocated, the scope of allowance trading, and the degree of reliance on energy efficiency. Over the long-term, additional or more-stringent carbon policies at the state or federal levels are also possible and could yield a wider range of potential effects on retail electricity prices.

Future capital expenditures in the electricity industry will put upward pressure on retail electricity prices. Capital expenditures (CapEx) in the electric industry have been on the rise, increasing by roughly 6% per year in real terms (8% nominal) since 2000, despite relatively flat load growth. Going forward, the impacts of continued utility CapEx on retail electricity prices will depend on both the pace of future investments as well as utilities' cost of capital. Considering a plausible range of assumptions for those two factors, we estimate a 1.6-3.6 cent/kWh impact on U.S. average retail electricity prices in 2030, as a result of future CapEx by regulated utilities (some portion of which will be offset as existing CapEx investments become fully depreciated). For some utilities—for example, those making investments in new nuclear generation capacity or undertaking major grid modernization initiatives—the potential impacts on retail prices may be greater than the range estimated above or may occur over a more-accelerated timeframe.

Conclusions

The most basic conclusion of this paper is that, in most cases, the effects of distributed solar on retail electricity prices are, and will continue to be, quite small compared to many other issues. That is not to say that reforms of net metering rules or retail rate structures for distributed solar customers are unwarranted. However, other objectives, such as economic efficiency, likely provide a more compelling rationale. Reforms may thus best be tailored to meeting those objectives—for example, through rate structures that accurately signal the long-term marginal cost of producing and delivering electricity.

Where concerns about minimizing retail electricity price remain a priority, other issues may prove more impactful. Among the issues explored in this paper, future electric-utility capital expenditures are expected to have, by far, the greatest impact on the trajectory of retail electricity prices. That is not to say anything about the potential benefits or prudence of such investments, but clearly this is an area where regulatory oversight can play a crucial role in managing retail electricity price escalation. Similarly, resource planning and procurement processes provide another important point of leverage over future retail electricity prices, where utilities and regulators can manage ratepayers' exposure to natural gas price risk and the possible costs associated with state or federal carbon regulations. Regulators and policymakers in states with RPS policies also have significant influence over retail electricity prices by developing RPS rules and other supportive policies that ensure renewable electricity supply keeps pace with growing RPS demand, keeping REC prices in check.

For states and utilities with exceptionally high distributed solar penetration levels, the effects on retail electricity prices could begin to approach the same scale as other important drivers (at least among residential customers, where solar compensation is based on full net metering with predominantly volumetric rate structures). In these cases, questions about the value of solar become more important to assessing possible cost-shifting. Efforts to encourage higher value forms of deployment also offer a strategy for mitigating any cost-shifts, for example by directing development toward geographic regions with the greatest T&D deferral opportunities, by developing mechanisms to leverage the capabilities of advanced inverters, or by incentivizing the pairing of solar with storage or demand response. Such strategies represent an alternative (and potentially less contentious) approach to addressing the effects of distributed solar on retail electricity prices (Barbose et al. 2016).

Experiences with energy efficiency also offer lessons for states witnessing especially high levels of distributed solar penetration. In particular, these experiences suggest that short-term retail price impacts from distributed energy resources may be more acceptable, provided that they yield net savings to ratepayers over the long run, and that adequate opportunities exist for all ratepayers (especially low- and moderate-income customers) to participate. As solar costs continue to decline, grid-friendly PV technologies advance, and initiatives to broaden solar access continue, issues of cost-shifting from distributed solar will become more similar to those of energy efficiency. As this occurs, concerns about cost-shifting may naturally soften, to a degree.

For More Information

Download the full report

G. Barbose. 2017. *Putting the Potential Rate Impacts of Distributed Solar into Context*. Berkeley, CA: Lawrence Berkeley National Laboratory. LBNL-1007030. https://emp.lbl.gov/publications/putting-potential-rate-impacts

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Acknowledgments

We thank Caroline McGregor, Elaine Ulrich, Ammar Qusaibaty, and Odette Mucha of the U.S. Department of Energy for their support of this project, as well as Andy Satchwell (Lawrence Berkeley National Laboratory) who provided many helpful suggestions. For providing comments on a draft of the paper, we thank Dan Boff (U.S. Dept. of Energy); Melissa Whited and Tim Woolf (Synapse Energy Economics); Rich Sedano (Regulatory Assistance Project); Richard McAllister (Western Interstate Energy Board); John Sterling (Smart Electric Power Association); Rick Gilliam (Vote Solar); Karl Rabago (PACE Energy and Climate Center); and Mark Bolinger, Naïm Darghouth, and Ryan Wiser (Lawrence Berkeley National Laboratory). Finally, we also thank many individuals who graciously offered data, analysis, or other information that directly informed various elements of this paper. These include Jan Beecher (Michigan State University), Michael Buckley (Edison Electric Institute), David Feldman (National Renewable Energy Laboratory), Chris Kavalec (California Energy Commission), Venkat Krishnan (National Renewable Energy Laboratory), Pat Knight (Synapse Energy Economics), Kevin Lucas (Alliance to Save Energy), Amy Mesrobian (California Public Utilities Commission), Trieu Mai (National Renewable Energy Laboratory), Steve Meyers (Lawrence Berkeley National Laboratory), Andrew Mills (Lawrence Berkeley National Laboratory), Autumn Proudlove (North Carolina Clean Energy Technology Center), Anne Smith (NERA Economic Consulting), Chris Van Attan (MJ&Bradley Associates), and Nora Vogel (RGGI, Inc.). Of course, any remaining omissions or inaccuracies are our own.

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