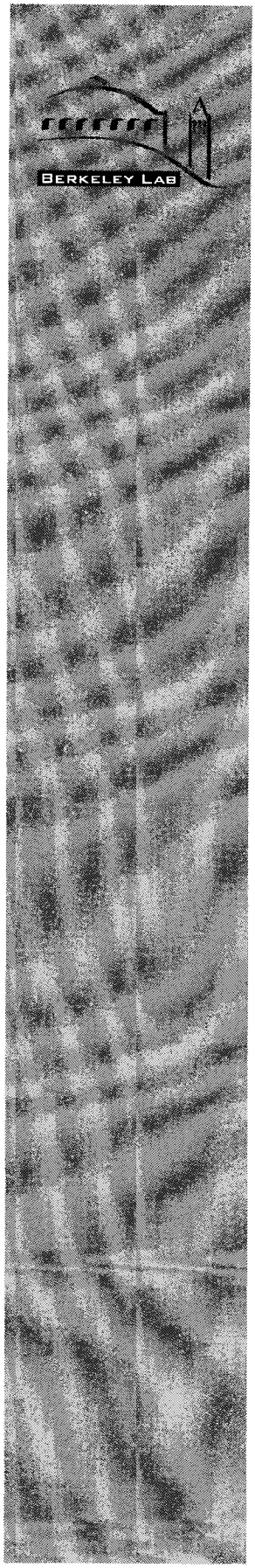

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Financial Impacts of Net-Metered PV on Utilities and Ratepayers: A Scoping Study of Two Prototypical U.S. Utilities

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Environmental Energy Technologies Division

September 2014

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Disclaimer

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Acronyms

APS – Arizona Public Service
BAU – business-as-usual
CAGR – compound annual growth rate
CapEx – capital expenditures
CFE – Comision Federal de Electricidad
DOE – U.S. Department of Energy
EE – energy efficiency
EPE – El Paso Electric
EPRI – Electric Power Research Institute
FAC – fuel adjustment clause
FCM – Forward Capacity Market
FERC – Federal Energy Regulatory Commission
GRC – general rate case
IRP – integrated resource plan
ISO-NE – Independent System Operator New England
LBNL – Lawrence Berkeley National Laboratory
LRAM – lost revenue adjustment mechanism
NAPEE – National Action Plan for Energy Efficiency
NE – northeast
NEM – net energy metering
NEVP – Nevada Power
NPV – net present value
O&M – operations and maintenance
PACE – PacifiCorp East
PNM – Public Service Company of New Mexico
PPA – purchased power agreement
PSCO – Public Service Company of Colorado
PUC – public utilities commission
PV – solar photovoltaic
REC – renewable energy certificate
ROE – return-on-equity
RPC – revenue-per-customer
RPS – renewable portfolio standard
SEEAction – State Energy Efficiency Action Network
SEIA – Solar Energy Industries Association
SEPA – Solar Electric Power Association
SPP – Sierra Pacific Power
SRP – Salt River Project
SW – southwest
T&D – transmission and distribution
TOD – time-of-delivery
TOU – time-of-use
UOG – utility owned generation
WACC – weighted average cost-of-capital
WACM – Western Area Power Administration, Colorado-Missouri Region
WALC – Western Area Power Administration, Lower Colorado Region

Executive Summary

Deployment of customer-sited photovoltaics (PV) in the United States has expanded rapidly in recent years, driven in part by public policies premised on a range of societal benefits that PV may provide. With the success of these efforts, heated debates have surfaced in a number of U.S. states about the impacts of customer-sited PV on utility shareholders and ratepayers, and such debates will likely become only more pronounced and widespread as solar costs continue to decline and deployment accelerates. To inform these discussions, we performed a scoping analysis to quantify the financial impacts of customer-sited PV on utility shareholders and ratepayers and to assess the potential efficacy of various options for mitigating those impacts.

The analysis relied on a pro-forma utility financial model that Lawrence Berkeley National Laboratory previously developed for the purpose of analyzing utility shareholder and ratepayer impacts of utility-sponsored energy efficiency programs. Using this model for the present study, we quantified the impacts of net-metered PV for two prototypical investor-owned utilities: a vertically integrated utility located in the southwest (SW) and a wires-only utility and default service supplier located in the northeast (NE). For each utility, we modeled the potential impacts of PV over a 20-year period, estimating changes to utility costs, revenues, average rates, and utility shareholder earnings and return-on-equity (ROE). The analysis is thus focused on utility shareholder and ratepayer impacts, and thus does not consider all relevant aspects of these debates. Other important boundaries of the study scope and methods (and potential sources of misinterpretation) are highlighted in Text Box 1 within the main body of the report.

The utility shareholder and ratepayer impacts of customer-sited PV were first assessed under a set of base-case assumptions related to each utility's regulatory and operating environment, in order to establish a reference point against which sensitivities and potential mitigation strategies could be measured.[1] The base-case analyses were performed with total penetration of customer-sited PV rising over time to stipulated levels ranging from 2.5% to 10% of total retail sales (compared to current penetration levels of 0.2% for the U.S. as a whole and of roughly 2% for utilities with the highest penetrations, excluding Hawaii).[2] Each of these PV penetration cases were compared to a scenario with no customer-sited PV over the entire analysis period. Although the estimated impacts of customer-sited PV reflect an assumption of net metering, those impacts should not be attributed to net metering, per se, as some amount of customer-sited PV deployment could occur even in the absence of net metering.

Key findings from the **base-case analysis** are as follows:

- **Utility Costs and Revenues.** Customer-sited PV reduces both utility revenues and costs (i.e., revenue requirements). In the case of the SW Utility, the impacts on revenues and costs are roughly equivalent under the 2.5% PV penetration scenario. At higher PV penetration

[1] See Sections 3 and 4 for a full description of base-case assumptions. Variations around these and other base-case assumptions are explored within the sensitivity analysis.

[2] Specifically, penetration of customer-sited PV rises from zero in year-1 to levels ranging from 2.5% to 10% of retail sales in year-10, and then remains constant as a percentage of retail sales for the latter 10 years of the 20-year analysis period. This approach was taken in order to capture end-effects that occur after PV additions take place.

levels, however, revenue reductions exceed cost reductions, in part because of a declining marginal value of PV. In the case of the NE Utility, revenue reductions exceed cost reductions across all of the future PV penetration levels considered, and the divergence is considerably wider than for the SW Utility. This occurs because the NE Utility has higher assumed growth in certain fixed costs that customer-sited PV does not reduce.

- **Achieved ROE.** Impacts on achieved shareholder ROE varied by utility and PV penetration level (see Figure ES-1). Under the scenario with PV penetration rising to 2.5% of retail sales (roughly the same order of magnitude as the current largest state markets), average achieved shareholder ROE was reduced by 2 basis points (a 0.3% decline in shareholder returns) for the SW utility and by 32 basis points (5%) for the NE Utility. Under the more aggressive 10% PV penetration scenario, average ROE fell by 23 basis points (3%) for the SW Utility and by 125 basis points (18%) for the NE Utility. These ROE reductions occur because of the proportionally larger effect of customer-sited PV on utility revenues than on utility costs, under our base-case assumptions. ROE impacts were larger for the wires-only NE utility, because of both its higher assumed growth in fixed costs and its proportionally smaller ratebase (as it does not own generation and transmission).

- **Achieved Earnings.** The impact of customer-sited PV on shareholder earnings for the SW Utility was somewhat more pronounced than the ROE impacts, because of lost earnings opportunities associated with deferred capital expenditures that would otherwise generate earnings for shareholders. Under the 2.5% PV penetration scenario, average earnings for the SW Utility were reduced by 4% (compared to a 0.3% reduction in ROE). Because of the lumpy nature of capital investments and the way in which they change the timing of general rate cases (GRCs) and setting of new rates, those earnings impacts do not necessarily scale with the penetration of customer-sited PV; under the 10% PV penetration scenario, earnings for the SW Utility were reduced by 8%. Because the NE Utility does not own generation or transmission, the lost earnings opportunities from customer-sited PV are less severe, and thus impacts on earnings are similar to impacts on ROE, ranging from a 4% reduction under the low-end PV penetration scenario to a 15% reduction in earnings at the high-end PV penetration scenario.[3]

- **Average Rates.** The ratepayer impacts of customer-sited PV were relatively modest compared to the impacts on shareholders. In the 2.5% PV penetration scenario, customer-sited PV led to a 0.1% increase in average rates for the SW Utility and a 0.2% increase for the NE Utility. Under the more aggressive 10% PV penetration scenario, average rates rose by 2.5% and 2.7% for the SW and NE Utilities, respectively. These rate impacts reflect the net impact of customer-sited PV on utility costs and sales, where reduced costs are spread over a smaller sales base. Note, though, that these impacts represent the increases in average rates across all customers, including those with and without PV, and thus do not measure cost-shifting, per se.

[3] The prototypical NE Utility in our analysis may present a case where the ROE of future investments does not cover the cost of equity, in which case the deferral of future capital investments would benefit shareholders; however, a cost of equity test, which is beyond the scope of this study, would be required to make such a determination.

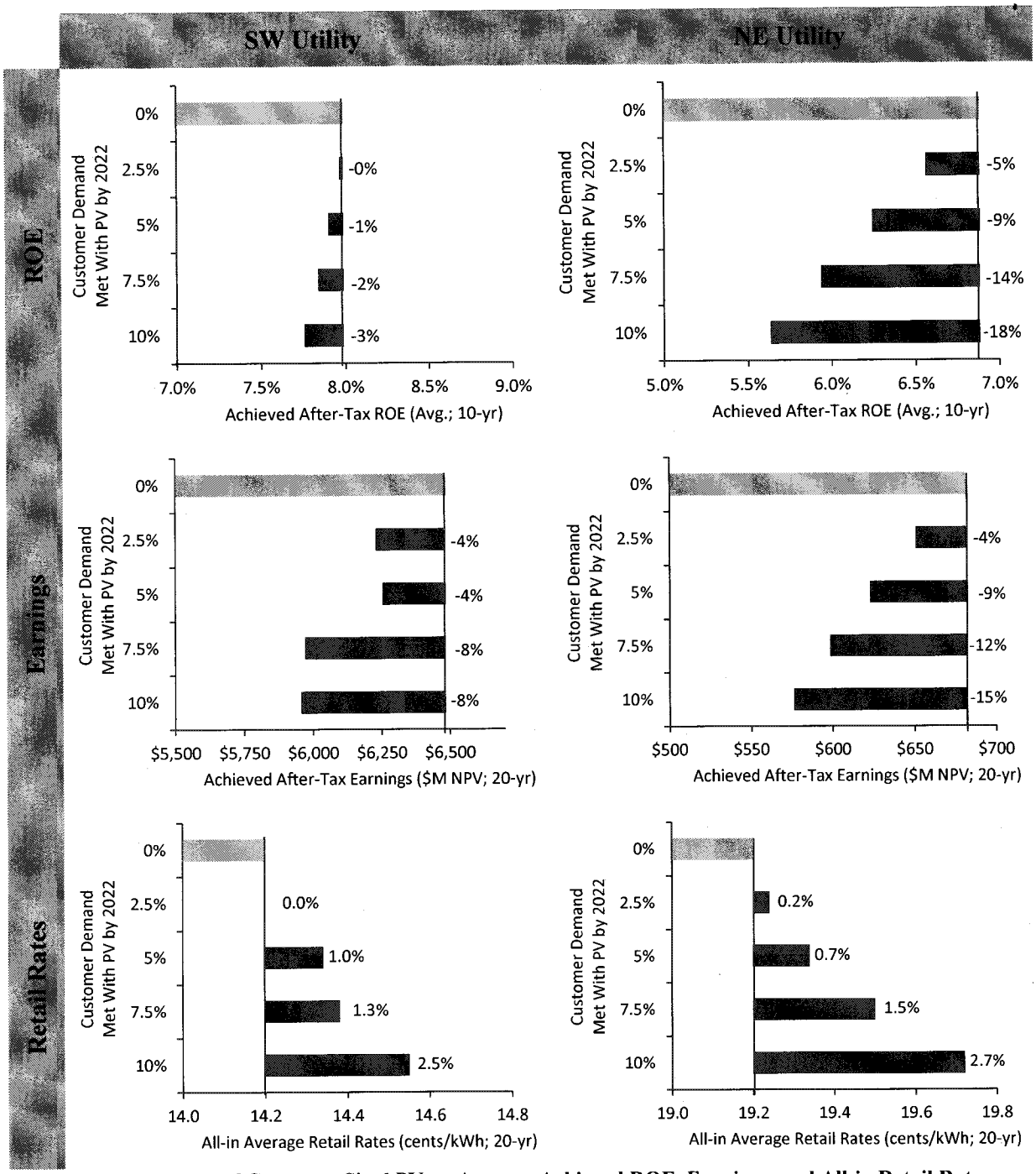

Figure ES-1. Impacts of Customer-Sited PV on Average Achieved ROE, Earnings, and All-in Retail Rates

One key objective of this scoping study was to illustrate the extent to which the potential impacts of customer-sited PV on utility shareholders and ratepayers depend on underlying conditions of the utility. To explore these inter-relationships, we compared the impacts from PV under a wide array of sensitivity cases, each with varying assumptions about the utilities' operating or regulatory environment (see Table 3 in the main body for the full list of sensitivity cases). The sensitivity cases all focus specifically on impacts from customer-sited PV at a penetration level

of 10% of total retail sales. This is the highest penetration level examined within this study, and was used for the sensitivity cases in order to most clearly reveal the underlying relationships between the impacts of PV and the sensitivity variables (that is, to distinguish the signal from the noise). Were lower PV penetration levels assumed, the impacts of PV would be smaller and the ranges across sensitivity cases would be narrower, but the fundamental results would be qualitatively the same.

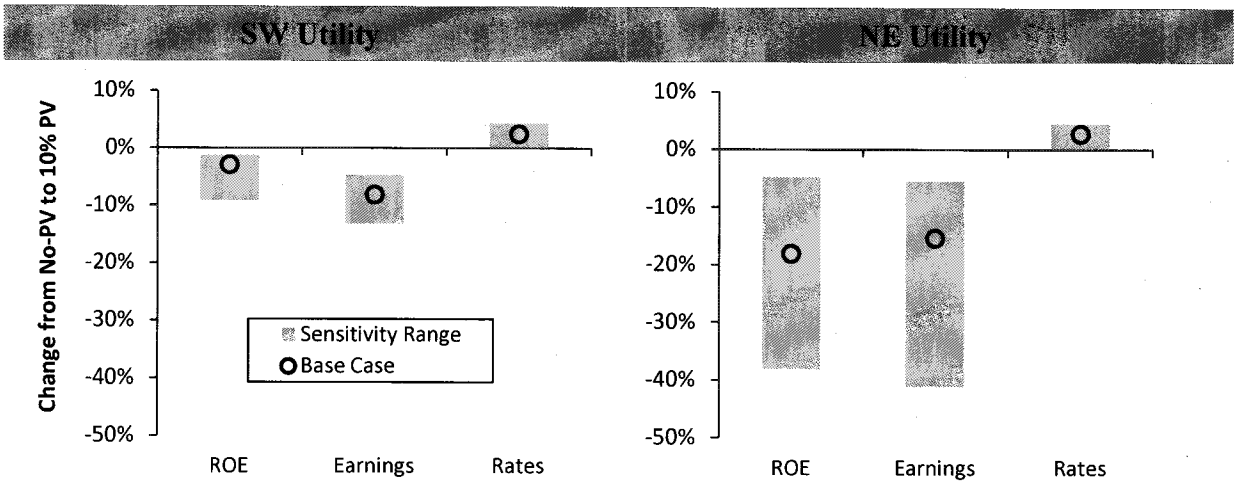

Figure ES-2. Impacts of Customer-Sited PV across Sensitivity Cases

Key themes and relationships illustrated through the **sensitivity analysis** are as follows[4]:

- The magnitude of shareholder impacts varies considerably across the sensitivity cases, as illustrated in Figure ES-2. Specifically, achieved earnings were reduced by 5% to 13% for the SW utility and by 6% to 41% for the NE utility, with similar ranges in the impacts on achieved ROE, illustrating the degree to which these impacts potentially depend on utility-specific conditions. By comparison, the ratepayer impacts were relatively stable across sensitivity cases, with increases in average rates ranging from 0% to 4% for the SW utility and from 1% to 4% for the NE utility.

- The impacts to both prototypical utilities are particularly sensitive to the capacity value and avoided T&D costs from customer-sited PV. Important to note, however, is the divergent set of implications for ratepayers vs. shareholders. The greater the capacity value and avoided T&D costs from PV, the greater the deferral of utility capital expenditures. This reduces the impacts of customer-sited PV on retail rates. Indeed, under one set of assumptions for the SW Utility, customer-sited PV results in a slight decrease in average rates. For utility shareholders, however, increased deferral of capital expenditures leads to greater erosion of earnings.

[4] The focus of our sensitivity analysis is on how the metrics vary between cases with and without PV and how the size of that difference varies depending upon underlying utility conditions, not on how the absolute level of the shareholder and ratepayer metrics varies between sensitivity cases.

- The impact of customer-sited PV on average retail rates also depends on underlying load growth (prior to the effects of PV on load). With lower load growth, as may occur in the case of a utility with aggressive energy efficiency programs, customer-sited PV results in a larger increase in average retail rates, because of the smaller base of retail sales over which fixed costs must be recovered, and because of reduced opportunity for cost savings from deferred capital expenditures. Shareholder impacts from customer-sited PV can also be sensitive to underlying load growth, though those relationships are complex and can be idiosyncratic depending upon details of the particular utility and the choice of metric used.

- The shareholder impacts of customer-sited PV tend to be more severe when retail rates rely predominantly on volumetric energy charges and also tend to be more severe when longer lags exist within the ratemaking process (e.g., longer periods between rate cases or use of historic test years). The heightened shareholder impacts in these cases occur because of greater revenue erosion associated with PV.

- The shareholder and ratepayer impacts from customer-sited PV also depend, though often to a lesser extent, on the magnitude and growth rates of various utility cost elements; however, the degree and direction of those sensitivities depend on the type of cost and how it is recovered. For example, the erosion of shareholder profitability from customer-sited PV is unaffected by fuel costs (assuming they are a pass-through), but may be highly sensitive to capacity costs for utility-owned generation.

Finally, we analyzed a number of (though by no means all) options for mitigating the possible impacts of customer-sited PV on utility shareholders and ratepayers (see Table ES-1). As in the sensitivity analysis, we again focused on the impacts under the 10% PV penetration scenario, in order to most clearly reveal the effects of the mitigation measures considered. These mitigation scenarios borrow, to some degree, from the kinds of measures that have been implemented or suggested in connection with energy efficiency programs. Most target shareholder impacts associated with either revenue erosion or lost earnings opportunities from customer-sited PV, and in some cases may exacerbate the ratepayer impacts from customer-sited PV.

Table ES-1. Mitigation Measures Examined in This Study

Mitigation Measure	Revenue Erosion	Lost Earnings Opportunities	Increased Rates
Revenue-per-Customer (RPC) Decoupling	●		○
Lost Revenue Adjustment Mechanism (LRAM)	●		○
More Frequent Rate Cases	●		○
No Regulatory Lag	●		○
Current & Future Test Years	●		○
Increased Demand Charge & Fixed Charge	●		○
Shareholder Incentive		●	○
Utility Ownership of Customer-Sited PV		●	○
Customer-Sited PV Counted toward RPS			●

● Primary intended target of mitigation measure

○ May exacerbate impacts of customer-sited PV

Key themes and findings from the **analysis of mitigation options** include the following:

- Decoupling and lost-revenue adjustment mechanisms may moderate revenue erosion from customer-sited PV, and thereby mitigate its impacts on shareholder ROE and earnings; however, the size (and even direction) of impact varies greatly depending upon the design of these mechanisms and characteristics of the utility. Depending on the utility's underlying rate of cost growth, similar outcomes may also be achieved by transitioning to more-frequent rate cases, use of current or future test years, and reduced regulatory lag. However, to the extent that these various mitigation measures serve to restore shareholder ROE and earnings, they may entail some corresponding increase in average retail rates, exemplifying the kind of tradeoffs inherent in many potential mitigation measures.

- Increased fixed customer charges or demand charges may also moderate revenue erosion, and the associated impacts on shareholder ROE and earnings, from customer-sited PV. Importantly, though, the effectiveness of those measures depends critically on the underlying growth in the number of customers or customer demand. For the prototypical NE utility in our analysis, a shift in revenue collection from volumetric energy charges towards larger fixed customer charges (when implemented for all customers, not just those with PV) actually *exacerbates* the erosion of shareholder ROE, due to the low rate of growth in the number of utility customers relative to growth in sales. Moreover, such shifts in rate design are not without other consequences, including that they dampen incentives for customers to invest in energy efficiency and PV.

- Shareholder incentive mechanisms, similar to those often implemented in conjunction with utility-administered energy efficiency programs, as well as utility ownership or financing of customer-sited PV, both offer the potential for substantial shareholder earning opportunities, though the associated policy and regulatory issues may be significant. The significance of the potential earnings boost is most pronounced for wires-only utilities with otherwise limited investment opportunities: in the case of the NE Utility in our analysis, nearly all of the earnings erosion that would otherwise occur as a result of customer-sited PV is offset in a scenario where the utility owns just one-tenth of the customer-sited PV deployed in its service territory offsets.

- Allowing utilities to automatically apply all net-metered PV towards their RPS obligations, without providing any explicit payment to the customer, has the potential to substantially mitigate the rate impacts from PV. However, such an approach is not without tradeoffs, as it effectively entails transferring ownership of renewable energy certificates (RECs) as a condition of service under net metering, and it achieves cost savings by, in effect, reducing the amount of incremental renewable generation required to comply with the RPS.

Policy Implications and Areas for Further Research

In summary, the findings from this scoping study point towards several high-level policy implications. First, even at 10% PV penetration levels, which are substantially higher than exist

today, the impact of customer-sited PV on average retail rates may be relatively modest (at least from the perspective of all ratepayers, in aggregate[5]). At a minimum, the magnitude of the rate impacts estimated within our analysis suggest that, in many cases, utilities and regulators may have sufficient time to address concerns about the rate impacts of PV in a measured and deliberate manner. Second and by comparison, the impacts of customer-sited PV on utility shareholder profitability are potentially much more pronounced, though they are highly dependent upon the specifics of the utility operating and regulatory environment, and therefore warrant utility-specific analysis. Finally, we find that the shareholder (and, to a lesser extent, ratepayer) impacts of customer-sited PV may be mitigated through various "incremental" changes to utility business or regulatory models, though the potential efficacy of those measures varies considerably depending upon both their design and upon the specific utility circumstances. Importantly, however, these mitigation strategies entail tradeoffs – either between ratepayers and shareholders or among competing policy objectives – which may ultimately necessitate resolution within the context of broader policy- and rate-making processes, rather than on a stand-alone basis.

As a scoping study, one final objective of this work is to highlight additional questions and issues worthy of further analysis, many of which will be addressed through follow-on work to this study and further refinements to LBNL's utility financial model. Although by no means an exhaustive list, these areas for future research include examining: the relative impacts of customer-sited PV compared to other factors that may impact utility profitability and customer rates; the combined impacts of customer-sited PV, aggressive energy efficiency, and other demand-side measures; the rate impacts of customer-sited PV and various mitigation measures specifically on customers without PV and differences among customer classes; a broader range of mitigation options; potential strategies for maximizing the avoided costs of customer-sited PV; and continued efforts to improve the methods and data required to develop reliable and actionable estimates of the avoided costs of customer-sited PV.

[5] We do not evaluate rate impacts for individual customer classes or rate classes, and the average rate impacts described within this report may not capture more substantial impacts that could occur within individual customer or rate classes.