

# The Impact of Rate Design and Net Metering on the Bill Savings from Distributed PV for Residential Customers in California

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# Project Overview

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## Context and Motivation:

- Net metering has proliferated in the U.S., and has been instrumental in jump-starting the distributed PV market
- Challenges to net metering have been raised in a number of states and contexts
- The implications of transitioning to alternative compensation mechanisms are complex and not well-understood

**Project Scope:** Focusing on residential customers of the two largest electric utilities in California (PG&E and SCE)

- (1) Examine the impact of retail rate design and related factors on the value of bill savings from PV under net metering
- (2) Compare the value of the bill savings between net metering and several alternative compensation mechanisms



# The Scope and Implications of the Analysis Are Necessarily Limited

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**This analysis presents the value of bill savings from distributed PV, across a diverse set of residential customers. However, it:**

- Cannot be generalized to other states and utilities, given the unique characteristics of PG&E and SCE residential electricity rates
- Cannot be directly applied to the general population of PG&E and SCE residential customers, or to the actual population of PG&E and SCE residential customers with PV, given differing customer characteristics from our sample
- Does not consider the overall cost-effectiveness of distributed PV, and does not address the value of distributed PV to the utility, non-participating ratepayers, or society-at-large
- Does not consider any factors other than the value of the bill savings when comparing net metering to potential alternative compensation mechanisms



# Data Sources and Methods

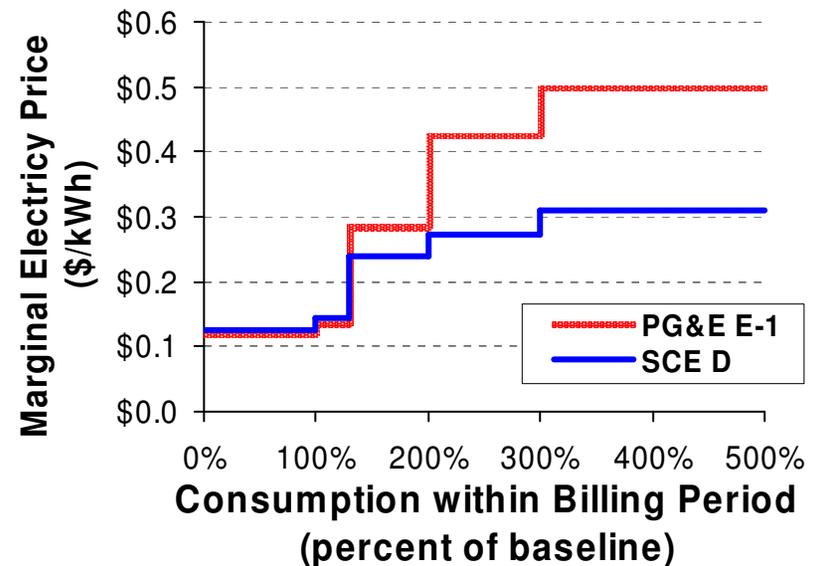
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- 15-minute load data from 215 single-family homes in PG&E and SCE territories, extending over one year
- Matched customer load data with simulated hourly PV production using nearby weather station data for the same time period
- Estimated customer electricity bills with and without PV systems
  - On each currently-available retail tariff option (flat rate and TOU rates)
  - PV sized to meet varying percentages (25%, 50%, 75%) of annual consumption; termed **PV-to-load ratio**
  - With varying PV panel orientations (south-facing, southwest-facing, flat)
  - Under net metering and three alternate compensation schemes
- Under each scenario, **bill savings** expressed in terms of annual reduction in utility bill per kWh generated (\$/kWh)



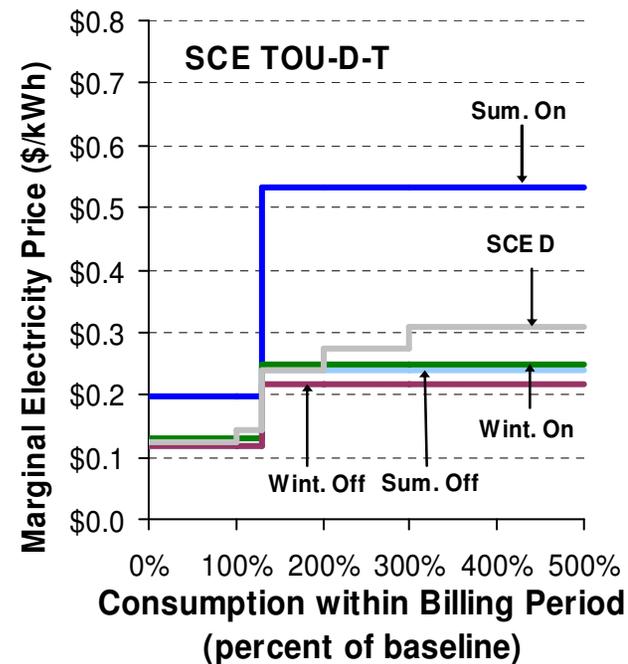
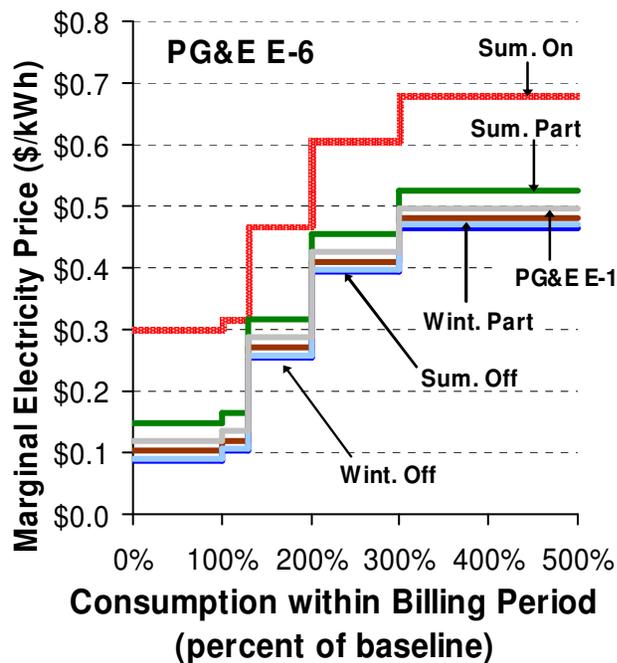
# PG&E and SCE Default Residential Rates Have Steeply Inclining Usage Tiers

- Default residential tariffs for both utilities have increasing block pricing with 5 usage tiers
- Tiers defined as percentage of baseline allotment, which varies by climate zone
  - Most customers in our sample are in Tier 3 or Tier 4
- Both utilities have relatively steep tiers compared to elsewhere in the U.S., but PG&E's tiering is particularly steep
  - PG&E: \$0.12 (baseline/Tier 1) to \$0.47/kWh (Tier 5)
  - SCE: \$0.12 (baseline/Tier 1) to \$0.28/kWh (Tier 5)



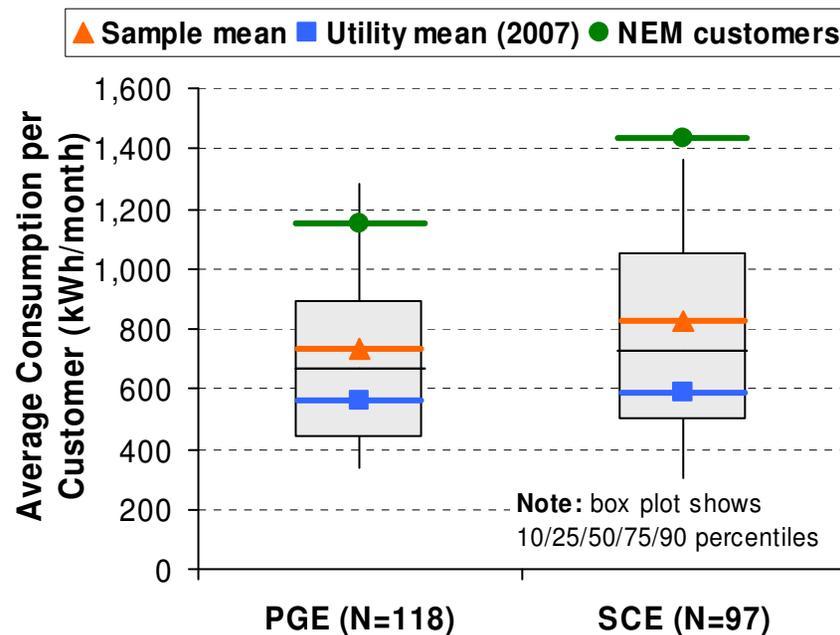
# PG&E and SCE Also Offer Residential TOU Rates

- PG&E's residential TOU rate has five usage tiers within each TOU period (same as default tariff)
- SCE's residential TOU rate has only two tiers within each TOU period, with a large increase in the summer on-peak price when usage >130% of baseline



# Average Size of Customers in Sample Differs from the Relevant Customer Populations

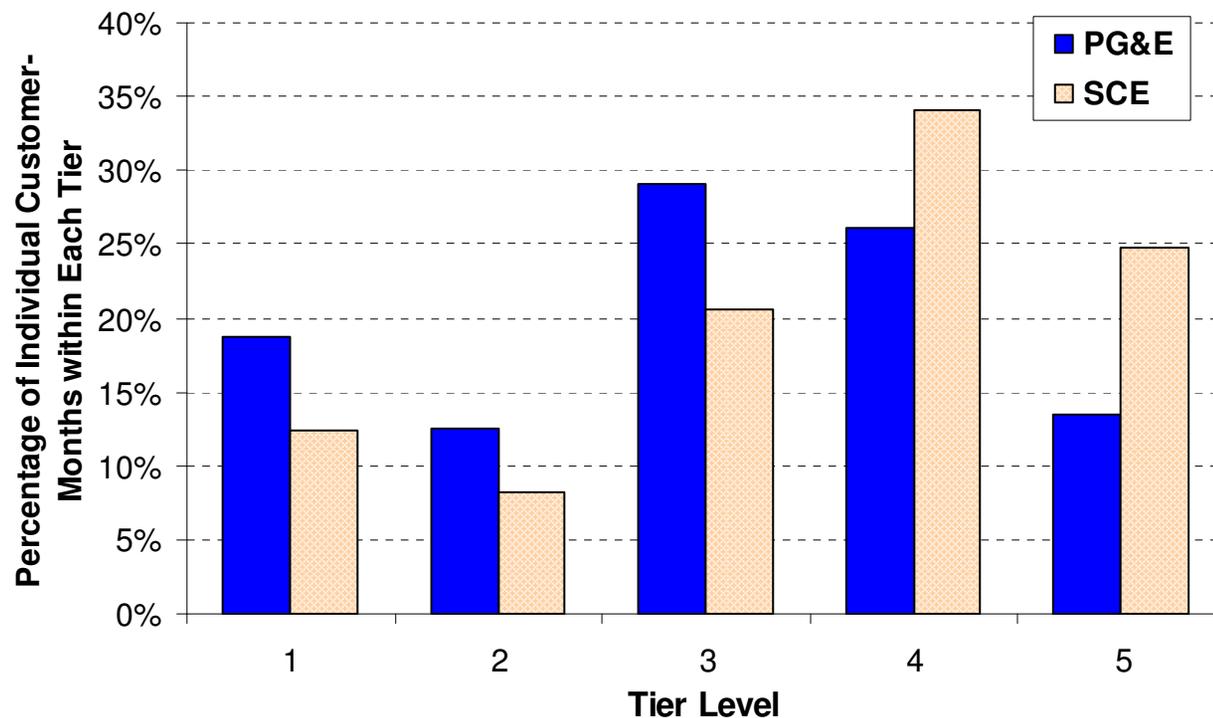
Figure compares the size of customers in the sample to the overall population of residential customers and to net-metered residential customers



- Average monthly consumption of customers in the sample: 734 kWh/month (PG&E) and 824 kWh/month (SCE)
- This is **larger** than average size of the overall population of residential customers: 564 kWh/month (PG&E) and 591 kWh/month (SCE)
- But customers in the sample are **smaller**, on average, than the actual population of net-metered residential customers: 1,148 kWh/month (PG&E) 1,434 kWh/month (SCE)

# Within the Customer Sample, Monthly Usage Typically Reaches Tier 3 or Tier 4

Figure shows the percentage of customer-months in which consumption reaches (but does not exceed) each of the five usage tiers

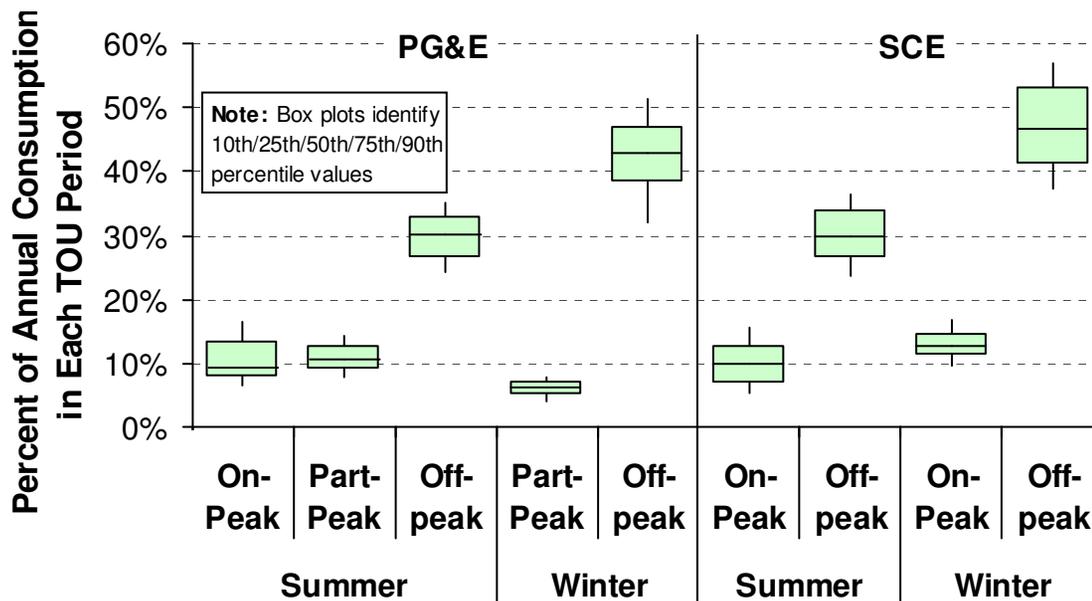


- In more than half of all customer-months, usage reaches Tier 3 or Tier 4

The distribution for the SCE customers in our sample is skewed more towards high-usage tiers, with almost 25% of SCE customer-months reaching Tier 5.

# Usage During the Summer Peak TOU Period is Typically a Small Percentage of Total Usage

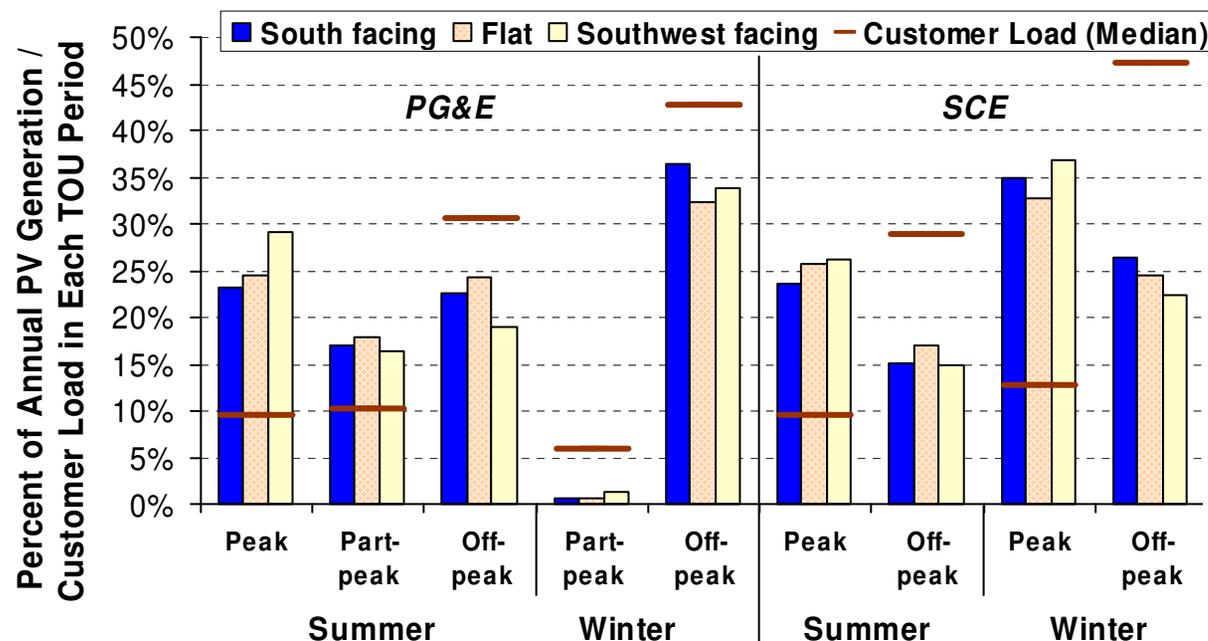
Figure shows the distribution, across customers in the sample, of the percentage of annual consumption occurring within each TOU period



- Customer rate choice between flat and TOU options is driven in large part by peak-period usage
- In the median case, 9.4% of PG&E customers' annual usage and 9.8% of SCE customers' annual usage occurs during the summer on-peak period.
- However, many customers' load profiles are either more or less concentrated during the summer on-peak period.

# PV Generation is More Concentrated During Summer Peak Period Than Customer Usage

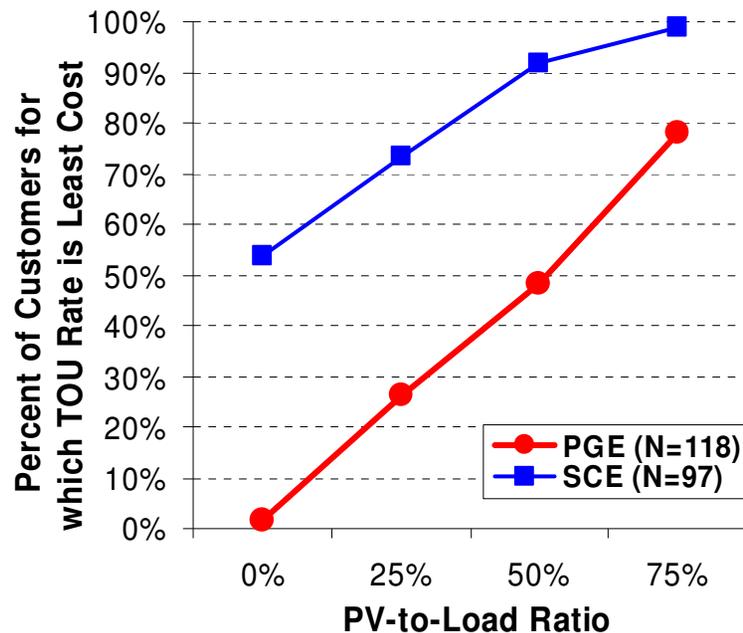
Figure shows the median percentage of annual PV generation occurring within each TOU period, for several PV orientations, compared to customer consumption



- The base-case analysis assumes south-facing PV panels at 25° tilt, but two alternate PV orientations considered as sensitivities (southwest at 25° tilt and flat)
- Depending on PV orientation, the percentage of PV generation occurring during summer peak period ranges from 23-29% for PG&E and 24-31% for SCE

# TOU Becomes Increasingly Attractive at Higher PV Penetration Levels

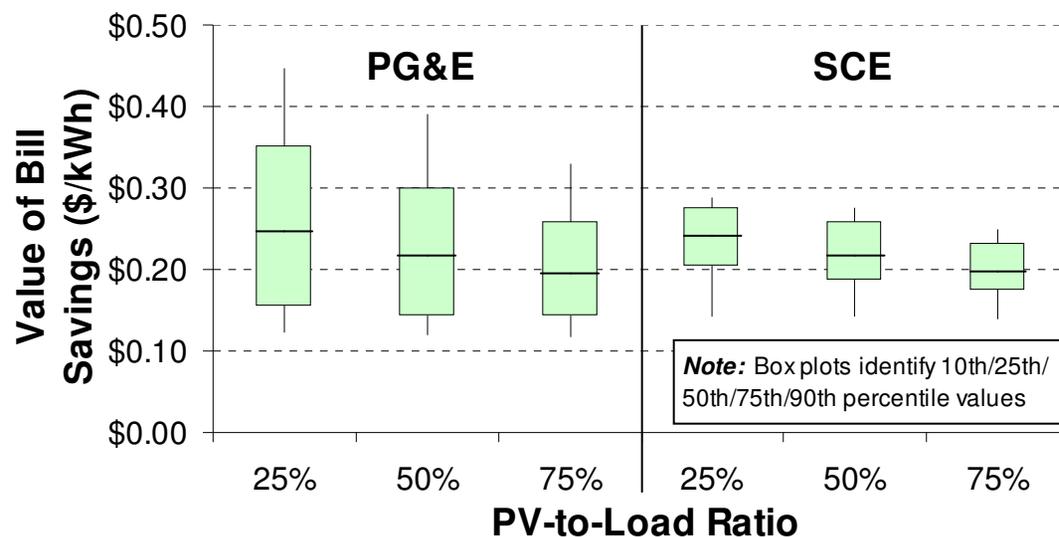
Figure shows the percent of customers that would be better off on the TOU rate than on the “flat” rate, at varying PV-to-load ratios



- Throughout our analysis, we assume customers choose the least-cost rate, both with and without a PV system
- Without a PV system, the TOU rate is least-cost for almost none of the PG&E customers, and ~50% of the SCE customers
- Increasing PV generation disproportionately offsets peak period consumption, making the TOU rate progressively more attractive at high PV-to-load ratios
- At a 75% PV-to-load ratio, the TOU rate is least cost for ~80% of the PG&E customers and ~100% of SCE customers

# The Value of Bill Savings for Residential PV with Net Metering Varies Significantly

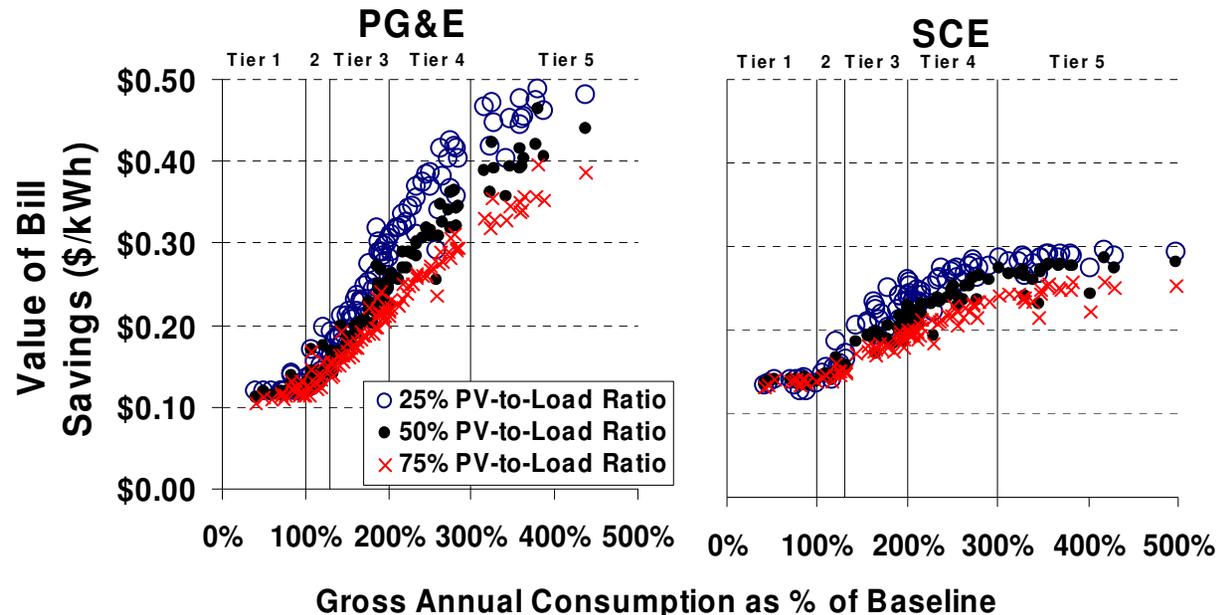
The figure shows the distribution in bill savings across customers assuming that customers choose the **least-cost rate** before and after PV installation



- Per-kWh bill savings decline with PV system size as larger systems offset usage in progressively lower priced tiers
- Median bill savings across the three PV-to-load ratios range from \$0.19-\$0.25/kWh (PG&E) and from \$0.20-\$0.24/kWh (SCE)
- Distributions around median values reflect differences in customer usage levels, and are wider for PG&E than for SCE, because PG&E's usage tiers are more steeply inclined

# Value of Bill Savings Increases with Customer Consumption Level

The figures show the value of bill savings as a function of customer consumption (expressed as a percentage of the baseline allotment)

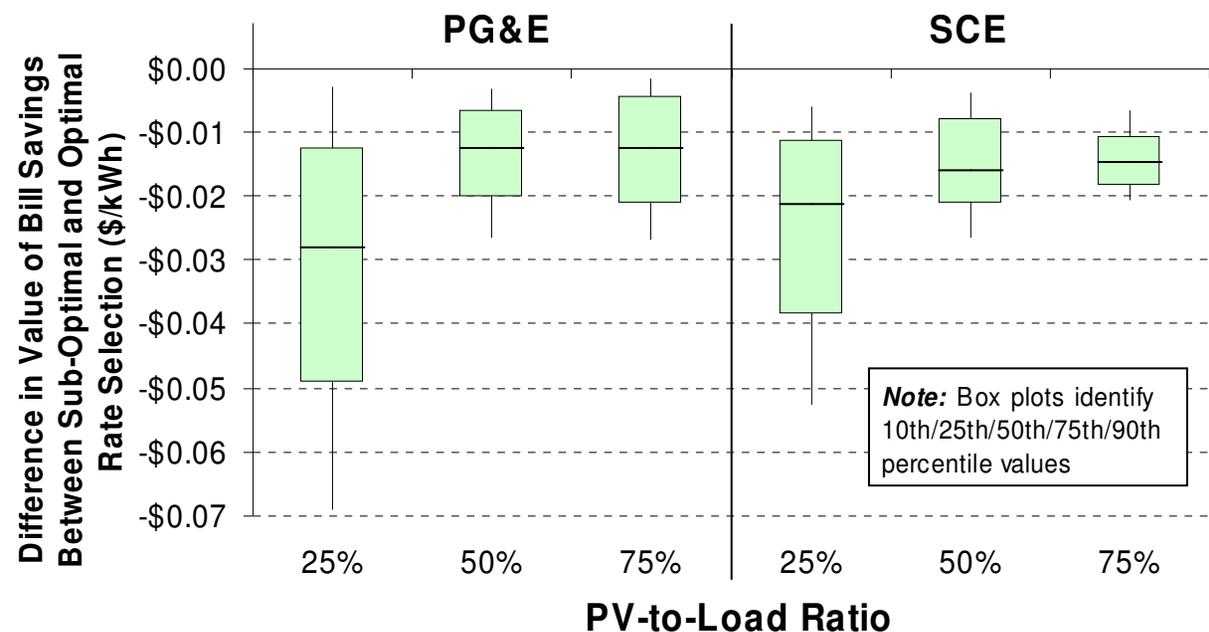


- Higher-usage customers offset consumption in higher-price usage tiers
- The increase in bill savings value with consumption is much more pronounced for PG&E than for SCE, due to the more steeply inclined usage tiers
- For customers in Tier 5, bill savings reaches \$0.32-\$0.49/kWh for the PG&E customers, and \$0.21-\$0.30/kWh, depending on PV-to-load ratio

# Sub-Optimal Rate Selection Reduces Bill Savings Value under Net Metering

- Base-case analysis assumes that customers choose least-cost rate option both before and after PV
- If, instead, customers choose incorrectly, the bill savings from PV are lower
- Biggest impact is at low PV-to-load ratios, and for customers with especially flat or peaky load profiles

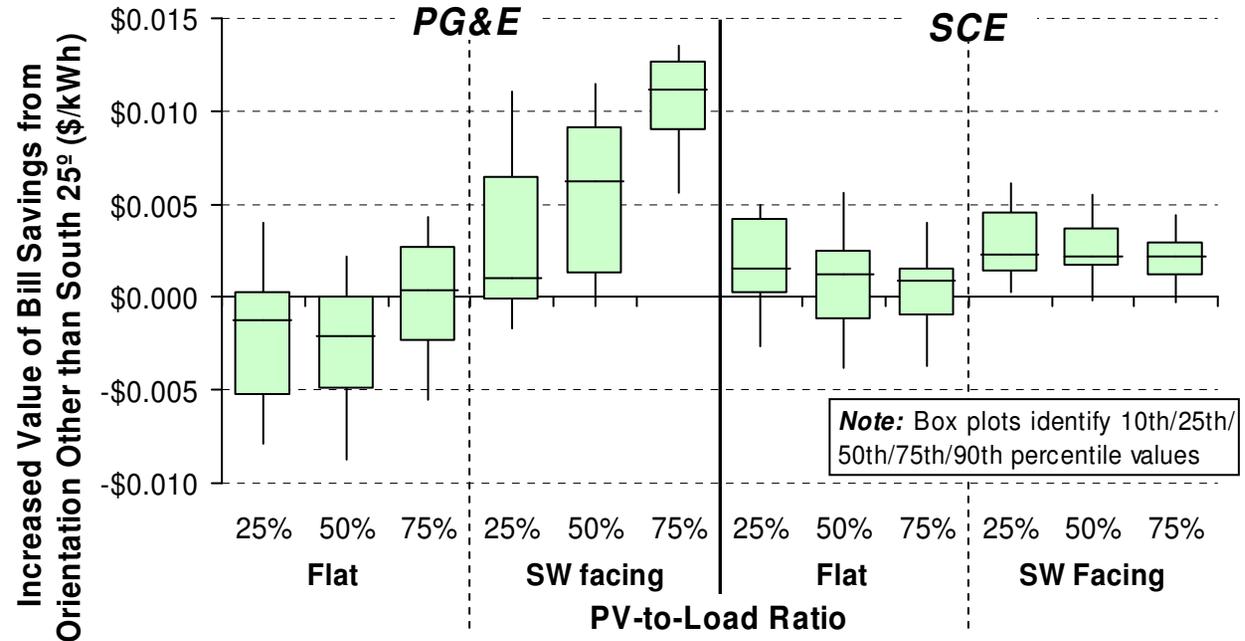
The figure shows the *difference* in bill savings value between sub-optimal and optimal rate selection



# Alternate PV Panel Orientations Have Small Impact on per-kWh Bill Savings

- Base case assumes panels are south-facing at a 25° tilt
- Two other PV panel orientations were also examined:
  - SW-facing at 25°
  - Flat
- The effect on the *per-kWh* value of the bill savings is small (<\$0.01/kWh or 5%)

The figure shows the difference in per-kWh bill savings value for each alternate PV panel orientations compared to the base-case PV orientation

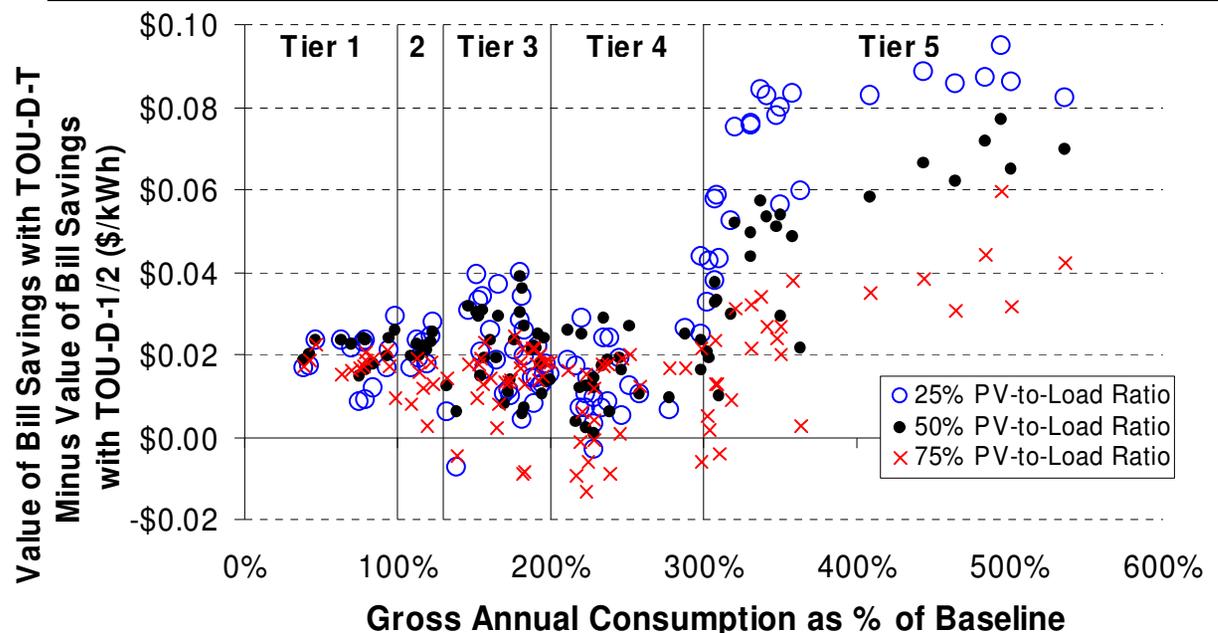


- More importantly from the perspective of the dollar size the bill savings, the quantity of PV generation is 10-11% lower under the alternative orientations

# Changes to Rate Structures Can Significantly Impact the Bill Savings Value of PV

- SCE significantly modified its residential TOU rate structure in October 2009
- Under our base-case set of assumptions (e.g., least cost rate choice), the new rates yield higher bill savings
- In the median case, the effect is small (\$0.01-\$0.02/kWh)
- The effect is much larger for high-usage customers; without a PV system, these customers pay more under the new TOU rate, resulting in larger bill savings from PV

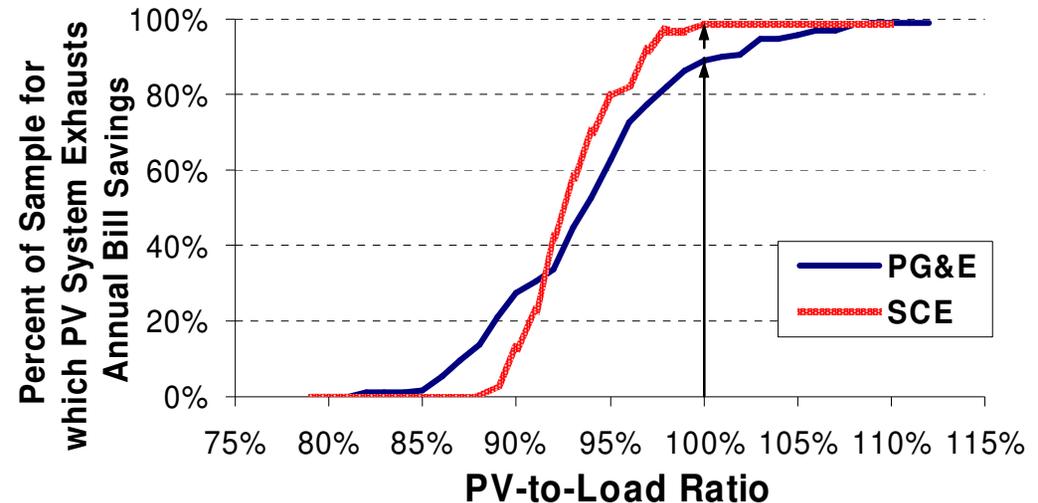
The figure shows the difference in bill savings value for SCE customers on the current set of rate options and the pre-October 2009 set of rate options



# Under Current Net Metering Rules, Customers Exhaust Bill Savings with PV <100% of Load

- Current CA net metering rules require customers to forfeit remaining bill credits at year-end (under AB920, this will change)
- Customers on TOU rates will generally exhaust bill savings with PV systems sized to meet less than 100% of annual load
- This occurs for 80% of the PG&E customers and 97% of the SCE customers in our sample
- In median case, PG&E customers exhaust bill savings at PV penetration of 95% and SCE customers at 93% PV-to-load ratio

The figure shows the percent of customers for which annual net metered bill savings are exhausted at varying PV penetration levels



# Bill Savings Also Calculated Under Three Hypothetical Alternatives to Net Metering

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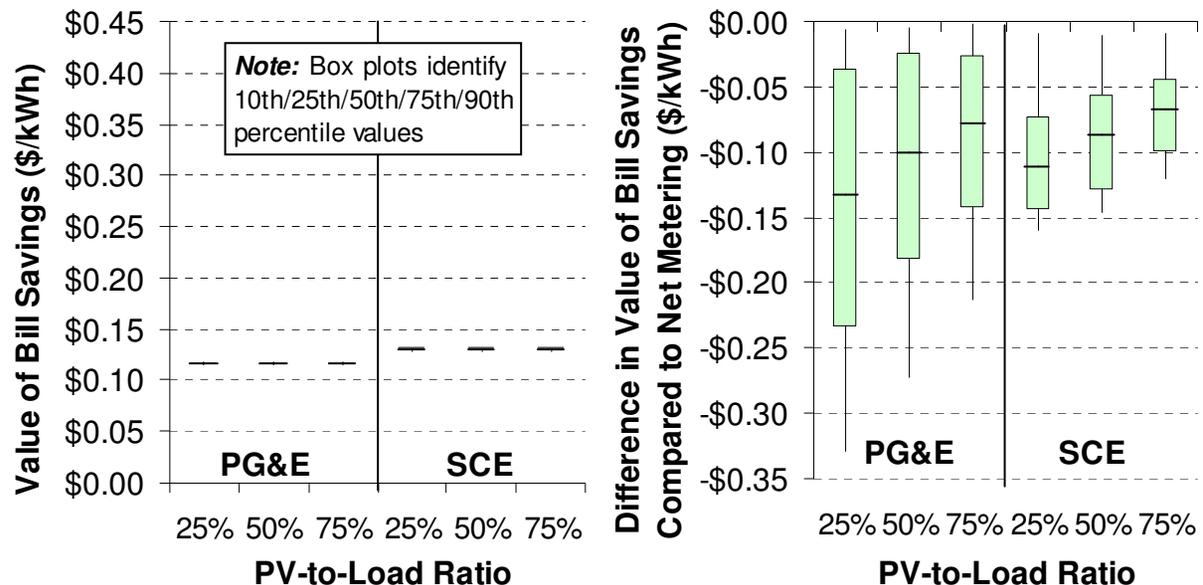
Each option compensates some portion of PV production at the 2009 Market Price Referent (MPR) using the CPUC-approved time-of-day adjustments

- **Option 1: MPR Feed-In Tariff**
  - All PV production priced at applicable MPR rate
- **Option 2: MPR Hourly Netting**
  - PV production can offset consumption within each hour, but excess hourly production is compensated at applicable MPR rate
- **Option 3: MPR Monthly Netting**
  - PV production can offset consumption within each month (or, for customers on a TOU rate, within each TOU period of each month), but excess production is compensated at the applicable MPR-based rate



# Bill Savings Would Be Substantially Lower under the MPR-Based Feed-In Tariff

The figures show the distribution in the bill savings value under the MPR-based feed-in tariff (left), and the difference relative to net metering (right)



- Median bill savings value is ~\$0.12/kWh for the PG&E customers and ~\$0.13/kWh for the SCE customers, with little variation across customers or PV-to-load ratios
- Bill savings are substantially lower than under net metering: a median reduction of \$0.08-\$0.12/kWh (40%-54%) for the PG&E customers and \$0.14-\$0.23/kWh (55%-67%) for the SCE customers
  - Greater loss of bill savings for high-usage customers, who benefit the most from net metering

# For Hourly and Monthly Netting, Bill Savings Depends on the Amount of Net Excess kWh

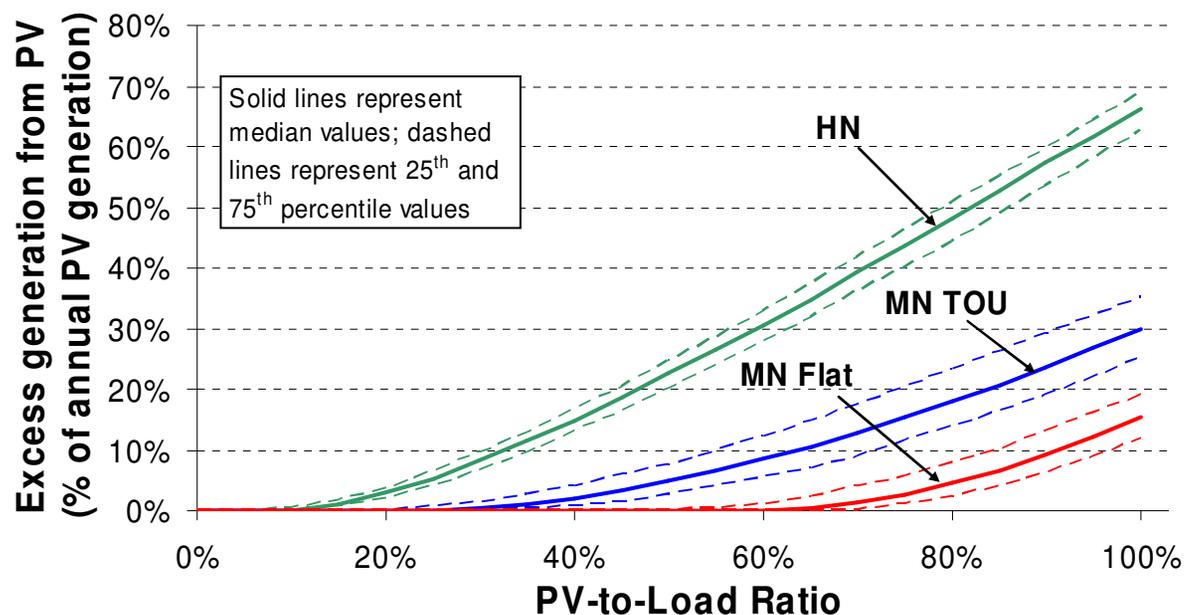
## ■ Net excess generation:

- Is greater, the shorter the “netting period”
- Increases with PV penetration

## ■ At a 75% PV penetration, net excess rises to:

- 45% for hourly netting
- 15% for monthly netting, where the customer is on the TOU rate
- 3% for monthly netting, where the customer is on the flat rate

The figure shows net excess generation as a percent of total annual generation under the hourly and monthly netting options

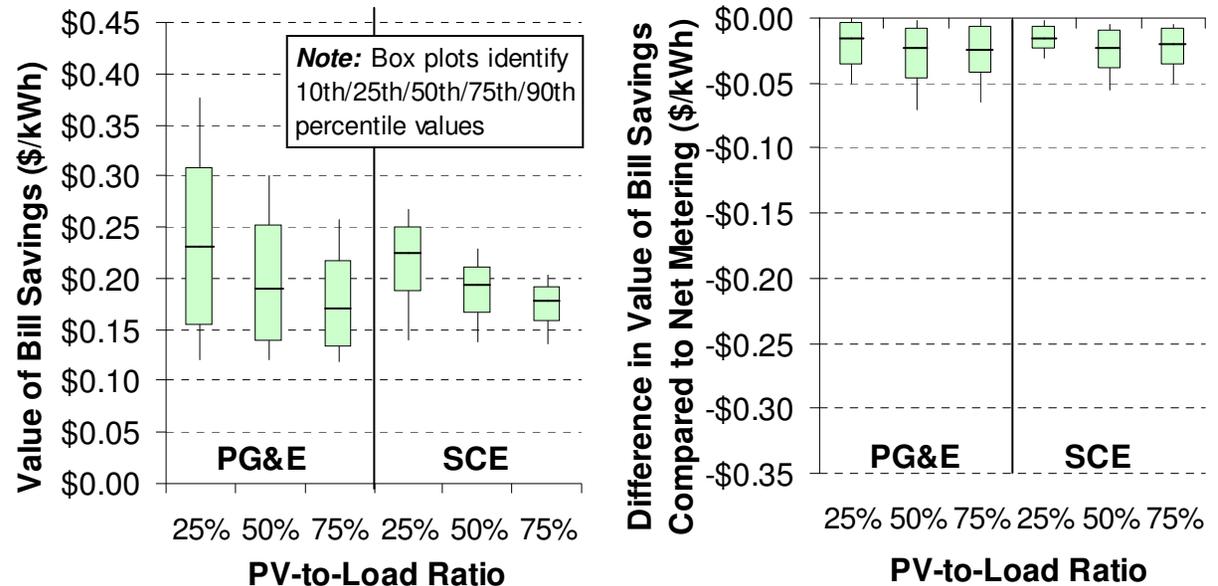


HN = Hourly Netting; MN = Monthly Netting



# Loss of Bill Savings Under Hourly Netting is Much Less than for the Full Feed-In Tariff

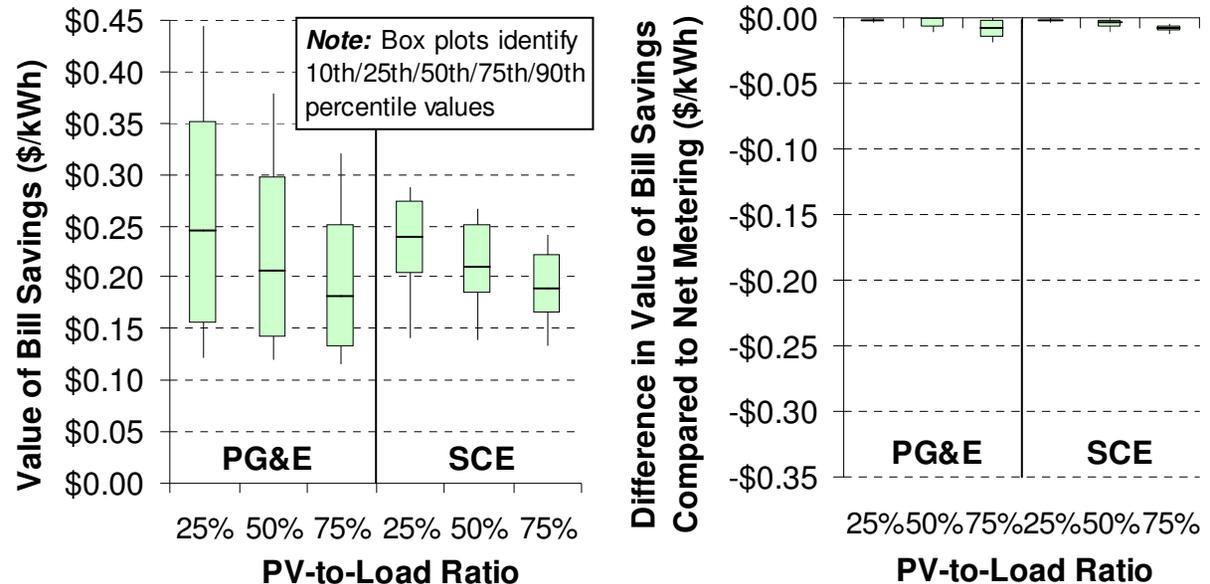
The figures show the distribution in the bill savings value under the MPR-based hourly netting option (left), and the difference relative to net metering (right)



- Median bill savings value range from \$0.17-\$0.23/kWh for the PG&E customers, and from \$0.18-\$0.23/kWh for the SCE customers, across PV-to-load ratios
- Bill savings are substantially lower than under net metering: a median reduction of \$0.015-\$0.024/kWh (6%-12%) for the PG&E customers and \$0.016-\$0.021/kWh (6%-11%) for the SCE customers
  - Relatively small variation across customers or PV-to-load ratios

# Bill Savings under Monthly Netting Differs Only Marginally from Net Metering

The figures show the distribution in the bill savings value under the MPR-based monthly netting option (left), and the difference relative to net metering (right)



- Median reduction in bill savings is zero (or approximately zero) at low PV-to-load ratios, and slightly greater at higher PV-to-load ratios (<\$0.01/kWh at a 75% PV-to-load ratio, for both the PG&E and SCE customers in the sample).
  - A small portion of PV generation is compensated at MPR-based prices
  - Under net metering, monthly excess PV production is effectively credited at Tier 1 prices, which differ only slightly from the MPR-based prices

# Adding Avoided T&D Costs and Line Losses to the MPR-Based Prices Would Narrow the Gap

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- The MPR-based prices are a proxy for long-run market cost of electricity, and don't reflect potential avoided T&D costs or reduced line losses from distributed PV, as well as other potential utility/ratepayer benefits
- Avoided T&D costs are highly idiosyncratic and estimates for distributed PV vary widely
- **A \$0.01/kWh T&D avoided cost adder** would narrow the gap between the bill savings under net metering and alternative compensation mechanisms
  - Full feed-in tariff: median difference in bill savings would be reduced by 8%-13% (PG&E) and by 9-15% (SCE), depending on PV-to-load ratio
  - Hourly netting option: gap would be narrowed by 13%-26% (PG&E) and 10%-23% (SCE) in the median case, across PV-to-load ratios
- **A 110% multiplier for reduced line losses** would also narrow the gap
  - Full feed-in tariff: median difference in bill savings would be reduced by 9%-15% (PG&E) and by 11%-19% for the SCE customers, depending on PV-to-load ratio
  - Hourly netting: gap would be narrowed by 15%-29% (PG&E) and 13%-30% (SCE) in the median case, across PV-to-load ratios



# Summary of Results for Customers in the Study Sample

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- **TOU rates provide greater value to customers with PV systems sized to meet a relatively large portion of their load**
- **Value of bill savings under net metering varies widely**
  - From \$0.11-\$0.49/kWh for the PG&E customers, and \$0.14-\$0.30/kWh for the SCE customers, across PV-to-load ratios
- **Variation in bill savings across customers is primarily the result of usage tiers**
  - Value of PV greater for high usage customers, and for customers with relatively small PV systems
- **Net metering provides significantly greater bill savings than an MPR-based feed-in tariff, particularly for high-usage PG&E customers**
  - Loss of bill savings with hourly/monthly netting is relatively small



# Conclusions

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- Net metering has served as a pillar of policy support for advancing the deployment of distributed PV
- The variability and uncertainty in the value of bill savings under net metering is potentially problematic
- Consideration of any alternatives to net metering must weigh all of the advantages and disadvantages
- If a full feed-in tariff were employed in place of net metering, the feed-in tariff prices would likely need to be well above the current MPR in order to enable continued market growth
  - Accounting for avoided T&D costs and line losses probably wouldn't be sufficient to make most customers financially indifferent with NEM
- An hourly netting alternative would likely be less disruptive to the PV market, but would not fundamentally mitigate the variability and uncertainty in bill savings under net metering



# For Further Information...

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## Download the report:

<http://eetd.lbl.gov/ea/emp/re-pubs.html>

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