Net Metering and Market Feedback Loops:
Exploring the Impact of Retail Rate Design on Distributed PV Deployment

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Context and Motivation

Rapid growth of distributed PV, supported in part by net metering with favorable (volumetric) retail rates

Concerns about financial impacts of distributed PV on utilities and ratepayers due, in part, to possible under-collection of utility fixed infrastructure costs

Revisions to rate design and net metering among the measures considered to address concerns: impacts PV-customer contribution to fixed costs, but also value of PV to host customers and overall PV deployment

Issues Impacted by Two Feedbacks Between PV Deployment and Retail Electricity Rates

Fixed Cost Recovery

Compounding the concern with fixed cost recovery is that, with PV deployment, fixed utility costs are potentially spread over a shrinking base of sales, increasing retail prices and further accelerating PV deployment

"Utility Death Spiral"

Time Varying Rates

Less-commonly noted opposing feedback: with PV deployment, peak price periods shift to evening hours, reducing PV bill savings for customers on time-varying rates and dampening PV deployment

Related to the "Duck Curve"

Objectives

Examine impact of changes in retail rate structures and PV compensation on U.S. distributed PV deployment

Quantify degree and conditions under which the two feedback mechanisms accelerate or dampen future PV deployment

Contribution

Unique effort to quantify impacts of rate design and PV compensation on PV deployment: *one of many factors policymakers might consider during rate design decisions*

Assess and quantify both feedbacks, in contrast to current conceptual discussions that focus largely on just one of the two feedbacks

Methods: PV Deployment Modeling

Apply NREL's Solar Deployment System (SolarDS) model

- Simulates distributed PV adoption in each state through 2050
- Based on assessment of customer economics of PV, considering costs, insolation, retail rates, incentives, adoption curves, solar-appropriate roof space, and PV system size

Model updated, then augmented to incorporate the two feedback mechanisms between PV adoption & retail rates

Important model caveats

- Not equipped to asses impacts of PV-storage on customer defection or altered demand ➔ future work
- Best-used for long-term national deployment assessments: not optimized for near-term or utility- and state-level analysis

Modeling Feedback Effects

Fixed-Cost Recovery Feedback

- When PV compensation > utility avoided costs from PV, raise retail rates to ensure utility cost recovery
- Utility avoided costs comprise energy and capacity value that decline with increasing regional PV penetration (based on published literature) and an "other" category

Time-Varying Rate Feedback

- For customers on time-of-use or real-time rates, compensation for PV depends on coincidence between PV generation and peak price periods
- Decrease compensation for PV at same rate as reductions in energy and capacity value with increasing PV penetration

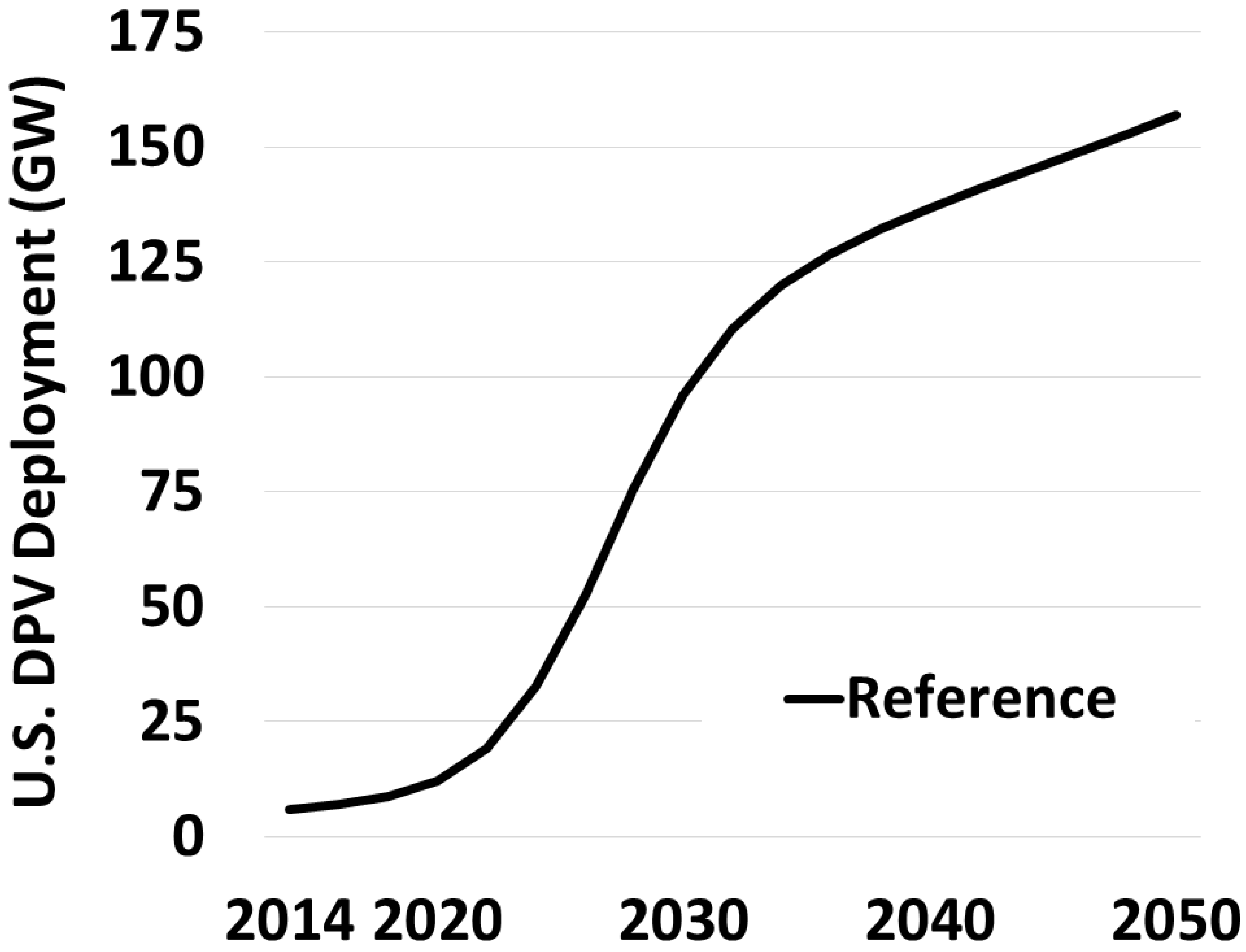
Retail Rate Design and PV Compensation

We model an important <u>subset</u> of possible rate design and PV compensation scenarios in this analysis

Scenario	Description
Reference: net metering	Reference mix of flat rates, time-varying rates, and demand charges for residential & commercial customers
$10 fixed charge: net metering	Reference mix of retail rates, but with residential rates adjusted with $10 monthly charge
$50 fixed charge: net metering	Reference mix of retail rates, but with residential rates adjusted with $50 monthly charge
Flat, all-volumetric rate: net metering	All residential/commercial customers on flat rates
Time-varying rate: net metering	All residential/commercial customers on time-varying rates
Partial net metering	Reference mix of retail rates, but PV generation exported to grid compensated at avoided-cost rate
Lower feed-in tariff	All PV generation compensated at $0.07/kWh
Higher feed-in tariff	All PV generation compensated at $0.15/kWh

Impacts of Electricity Rate Design and PV Compensation Mechanisms on PV Deployment

In Reference Scenario with Net Metering, DG PV Deployment Increases to ~157 GW by 2050

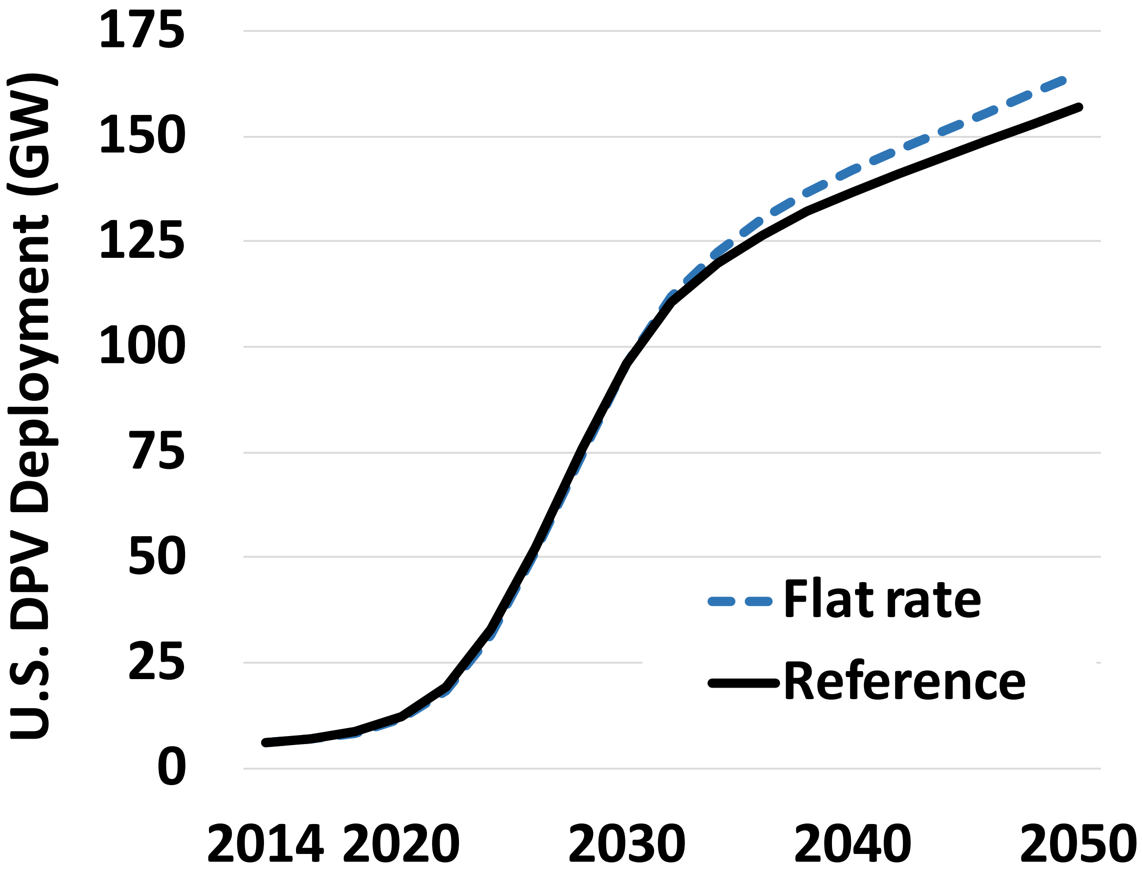


Note: Analysis focuses on distributed PV deployment; utility-scale PV adds to these figures

PV Deployment Is Highly Sensitive to Rate Designs and PV Compensation Mechanisms

Converting all customers to flat, all-volumetric rates modestly increases PV deployment

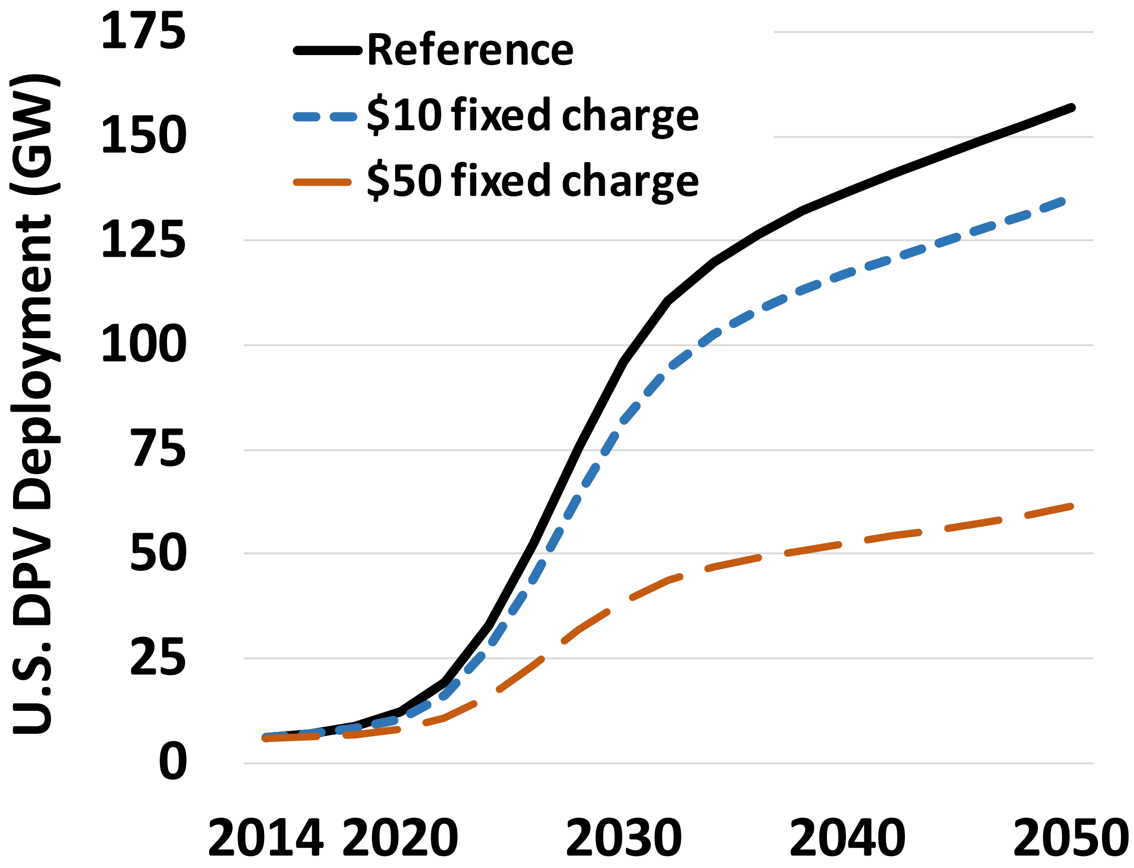
Those rates are more-favorable than demand charges and, at high PV penetrations, than time-varying rates



PV Deployment Is Highly Sensitive to Rate Designs and PV Compensation Mechanisms

Residential fixed monthly charges can substantially reduce PV deployment

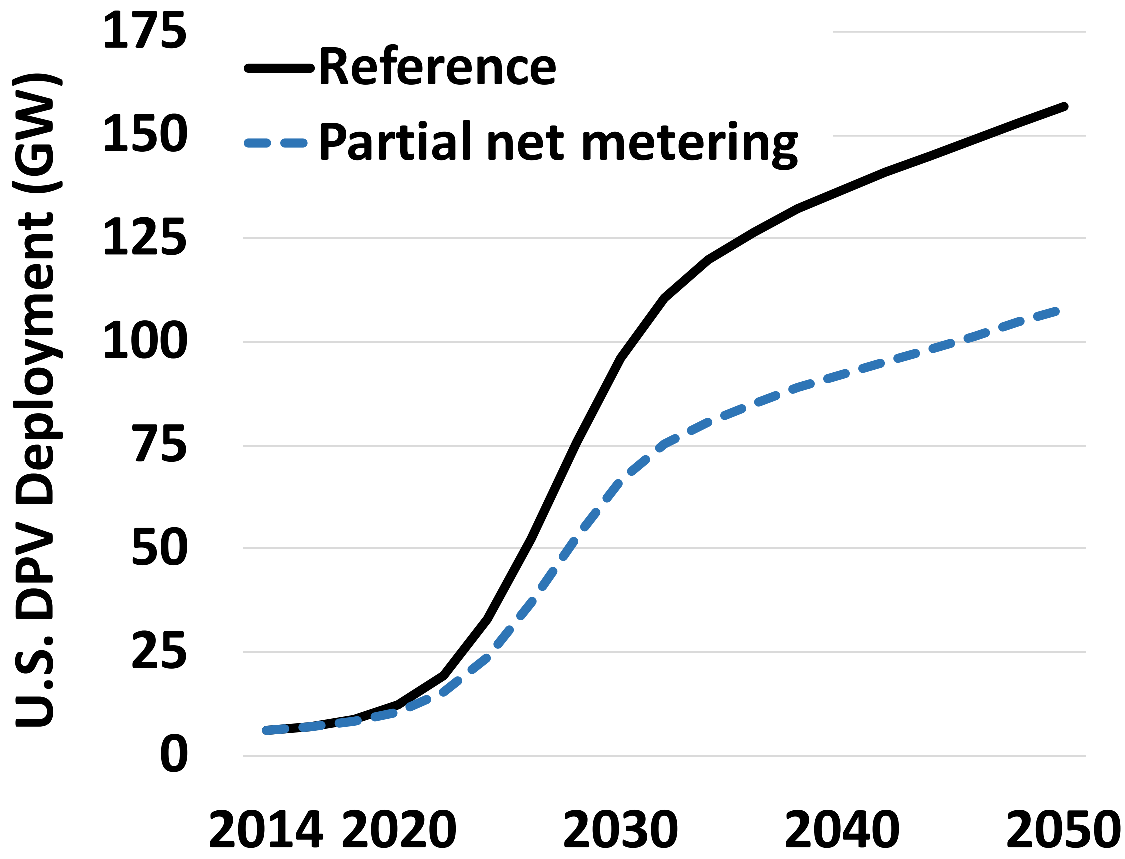
$50 monthly charge is especially damaging to PV deployment



PV Deployment Is Highly Sensitive to Rate Designs and PV Compensation Mechanisms

Removing full net metering and compensating hourly net-excess generation at a rate consistent with avoided utility costs (not social costs) decreases deployment

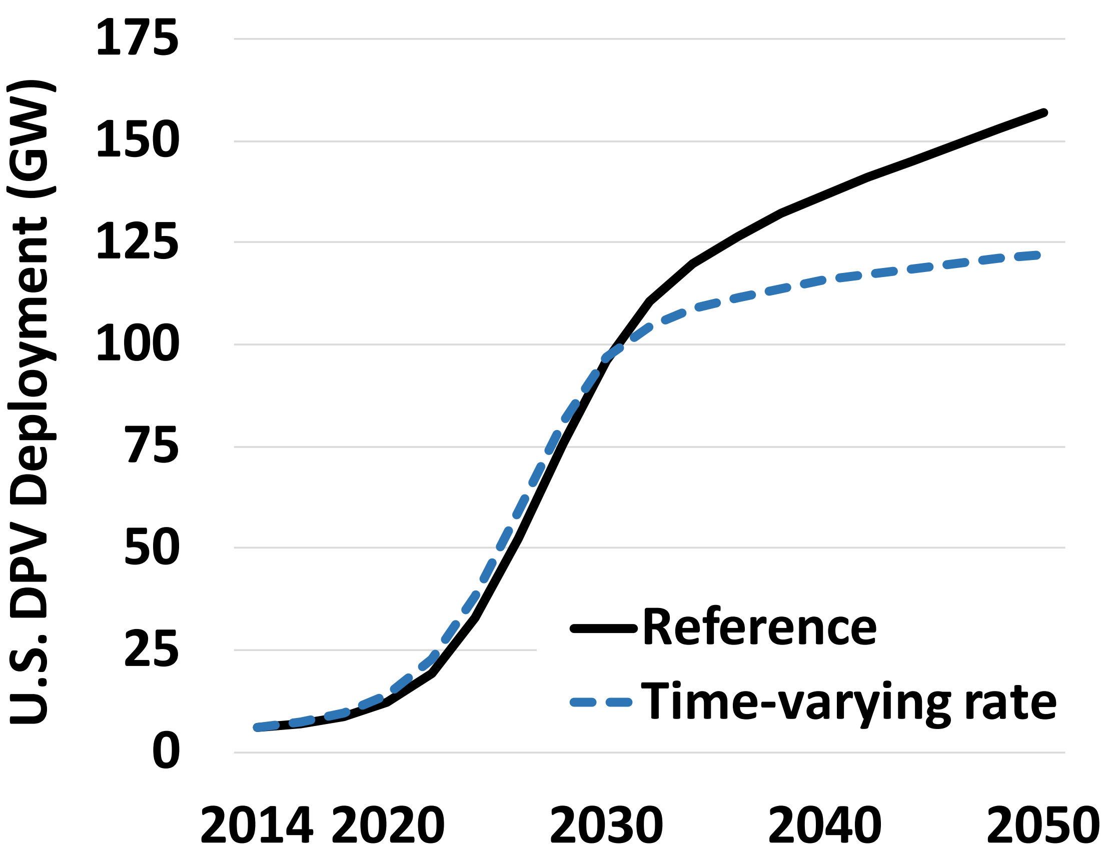
Calculated avoided utility costs are lower than retail rates



PV Deployment Is Highly Sensitive to Rate Designs and PV Compensation Mechanisms

Converting all customers to time-varying retail rates results in varying deployment results over time

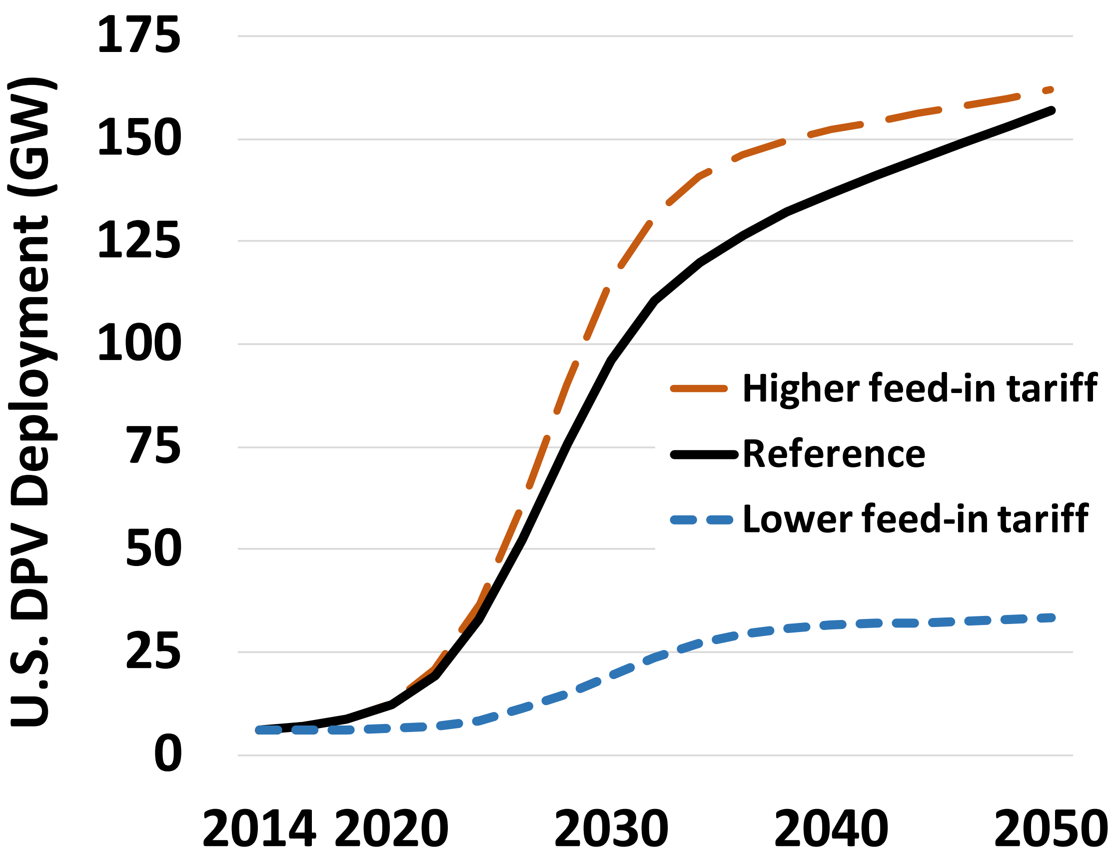
Results in increased PV deployment in the near term, but decreased deployment in the longer term



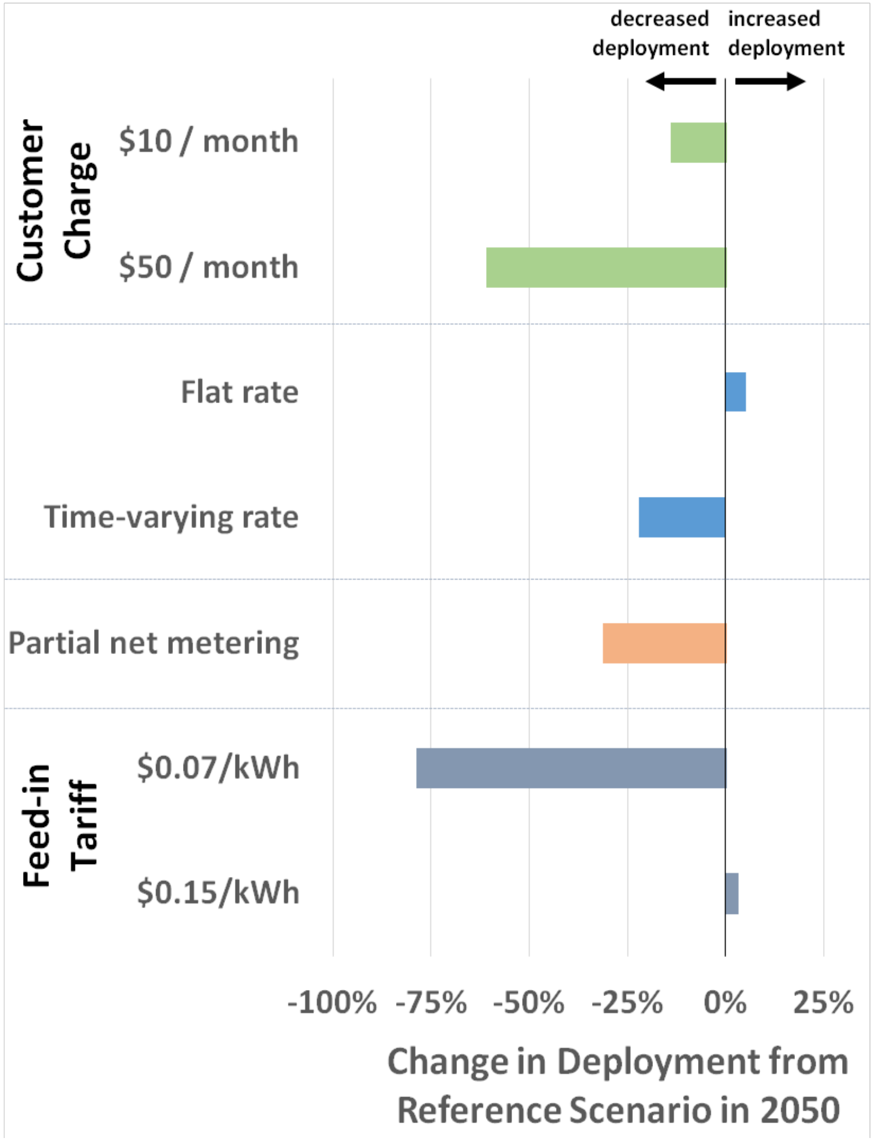
PV Deployment Is Highly Sensitive to Rate Designs and PV Compensation Mechanisms

Impact of feed-in tariffs or value-of-solar tariffs depends on the specific tariff value

When tariff is higher than compensation coming from retail rates, then deployment increases; opposite is true in reverse



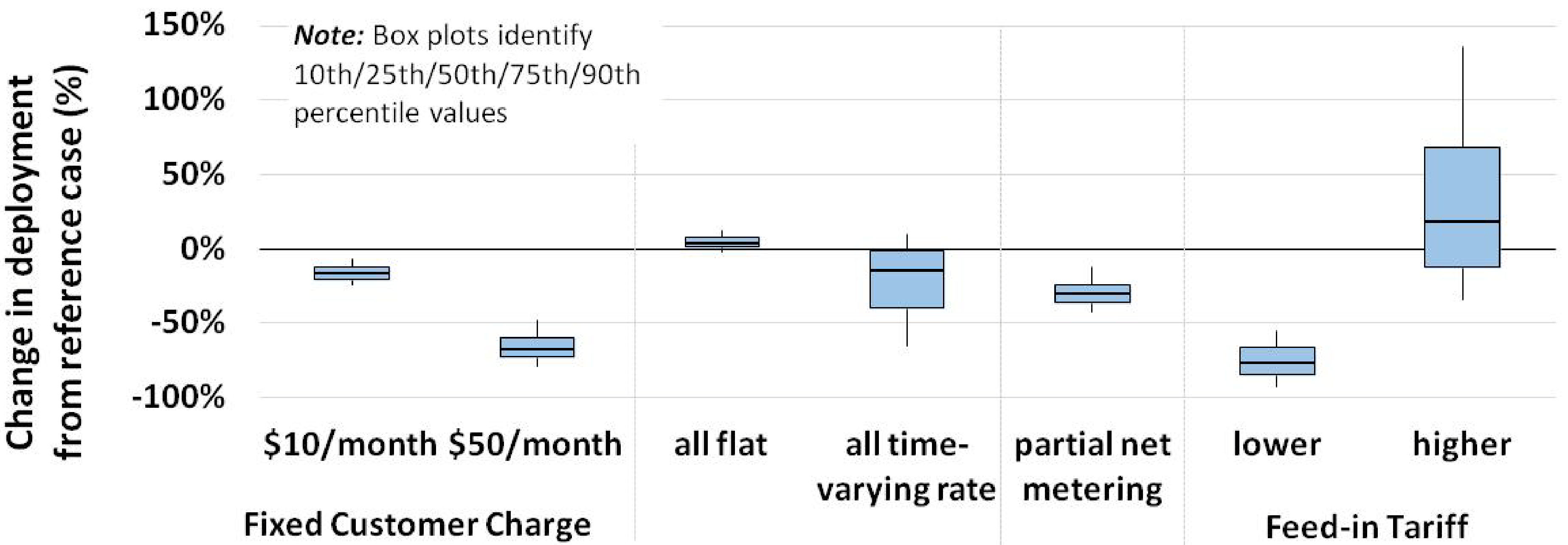
Summary of National Results by 2050, Compared to Reference Scenario



- Flat rate and higher feed-in tariff scenarios increase PV deployment
- Cumulative distributed PV ~15% lower in 2050 w/ $10/month residential fixed charge, ~60% lower w/ $50/month charge, and ~30% lower w/ "partial" net metering
- Time-varying rate scenario reduces deployment by ~20% in 2050
- Direction and magnitude of impact from feed-in tariffs depend entirely on level of the tariff in comparison to compensation based on retail rates

State-Level Results Can Vary in Direction and Magnitude, Depending on Scenario

- Fixed charges decrease deployment in all states; small range among states
- Flat rate modestly increases deployment in most states; switching all customers to time-varying rates reduces PV by 2050 in 75% of states
- Partial net metering reduces deployment in all states: magnitude depends on relationship between avoided costs and retail-rate compensation
- Change from net metering to feed-in tariffs produces range of deployment impacts: depends on how tariff level compares to retail-rate compensation

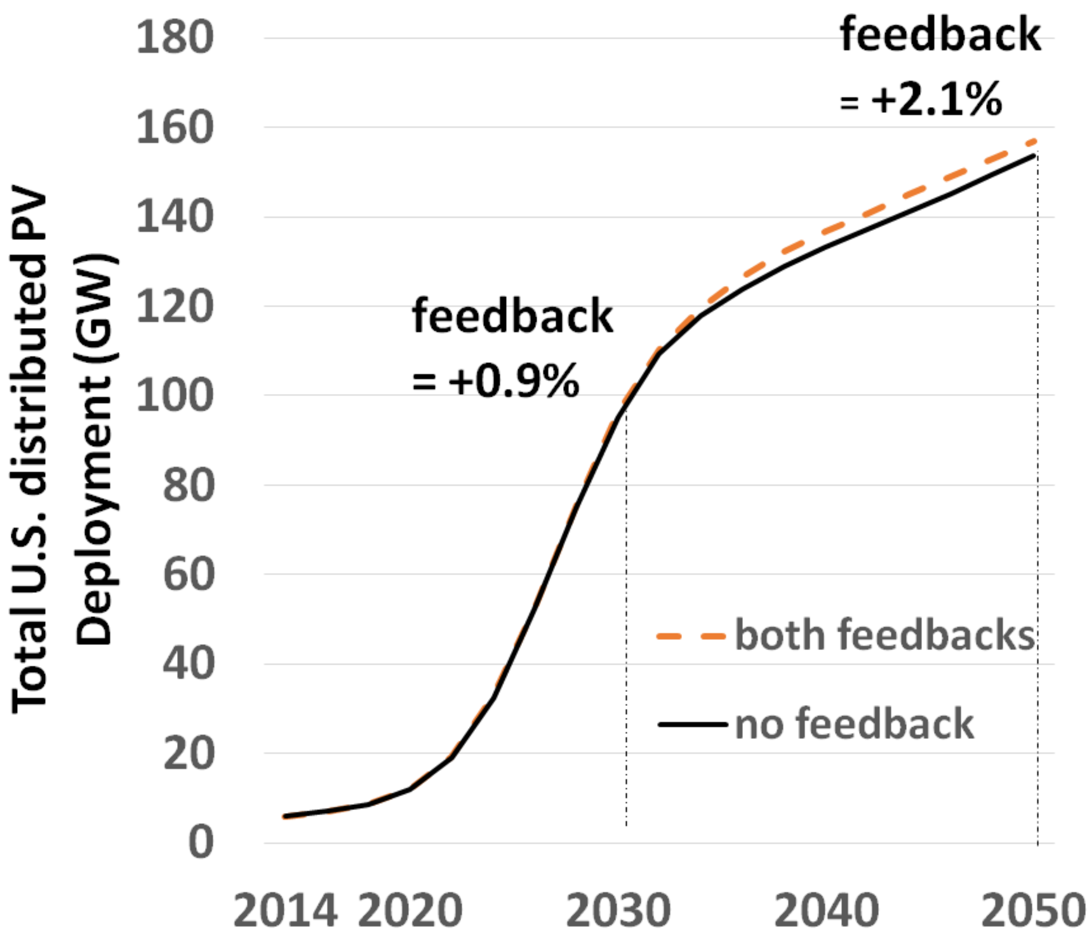


Quantifying Feedback Effects from Increased PV Penetration Levels

Aggregate Impact of Two Feedbacks at the National Level Is Modest in Reference Scenario

Combined impact of two feedbacks never increases cumulative PV deployment by more than 3% over the no feedback case (in reference scenario)

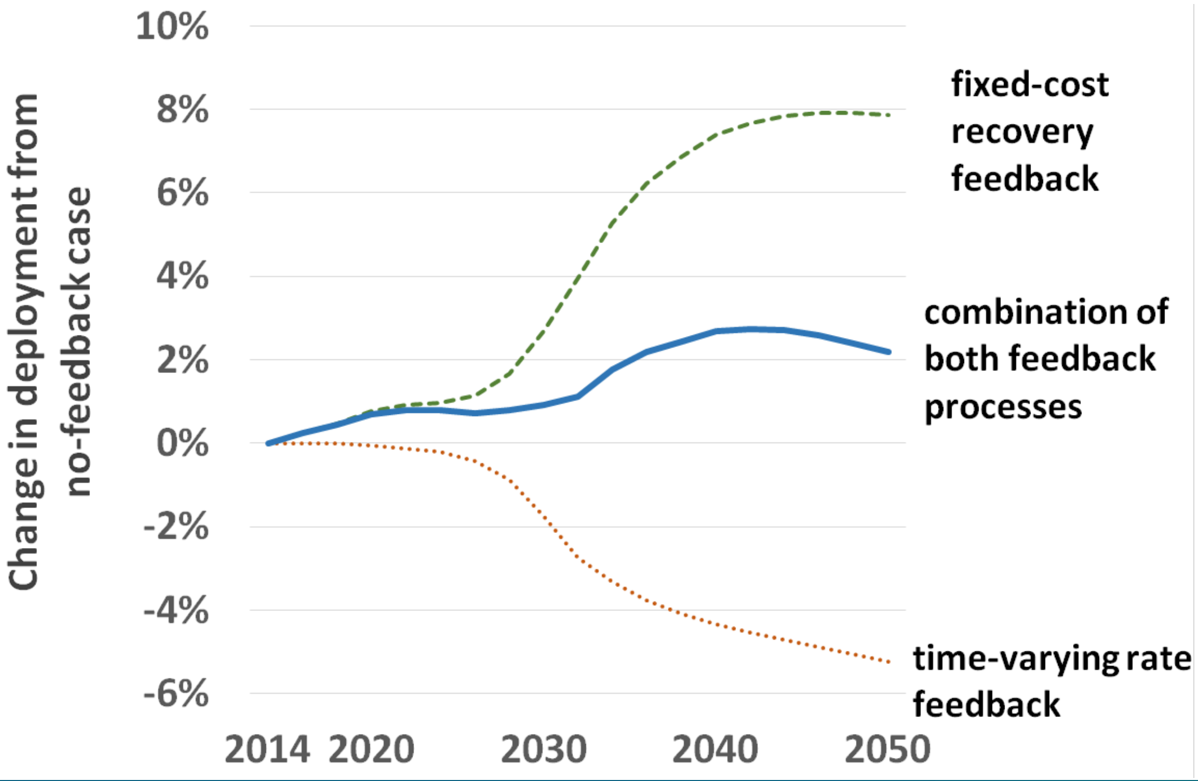
By 2030, the combined impact of the two feedbacks increases deployment by 0.9%; by 2050, increases by 2.1%



Two Feedback Mechanisms Largely Offset Each Other at National Level in Reference Scenario

Fixed-cost recovery feedback: increases PV deployment +8% in 2050, relative to no feedback case

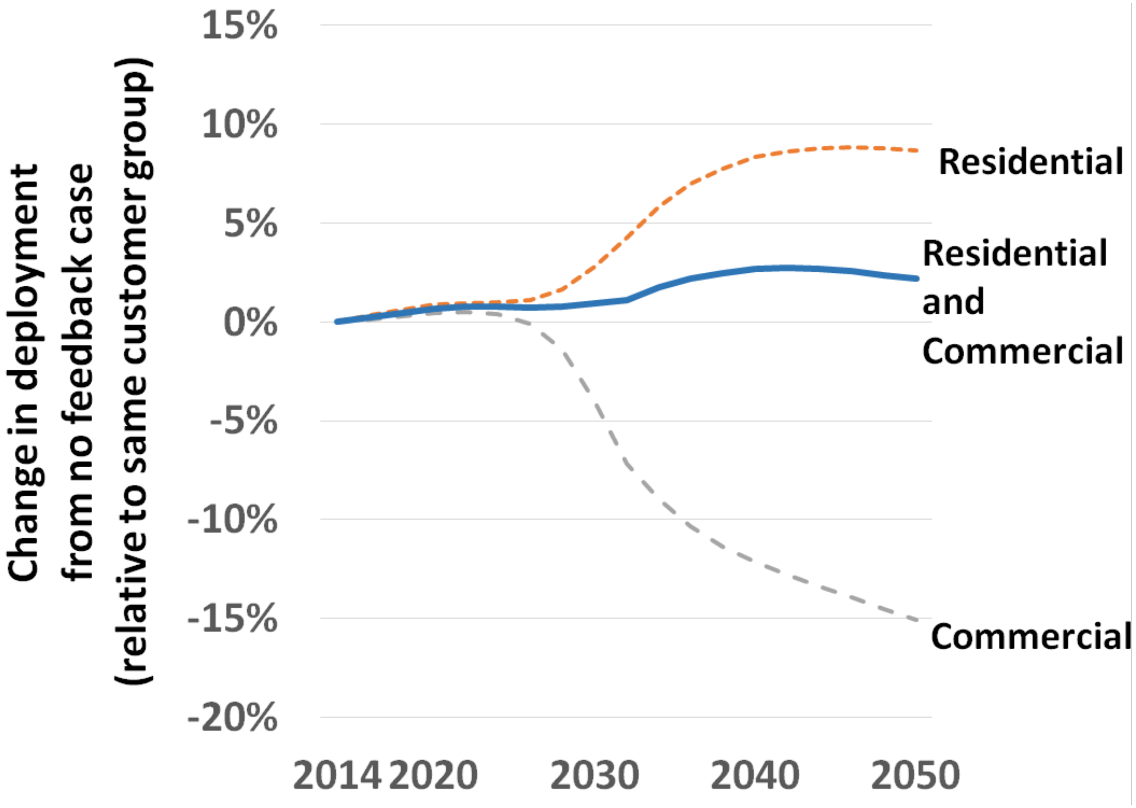
Time-varying rate feedback: decreases PV deployment -5% in 2050, relative to no feedback case



Feedback Effects Differ by Customer Segment in Reference Scenario

Most **residential customers** today face flat, volumetric rates: residential deployment increases by 9% through 2050, relative to no feedback case

Most **commercial customers** today face time-varying rates: commercial deployment decreases by 15% through 2050, relative to no feedback case



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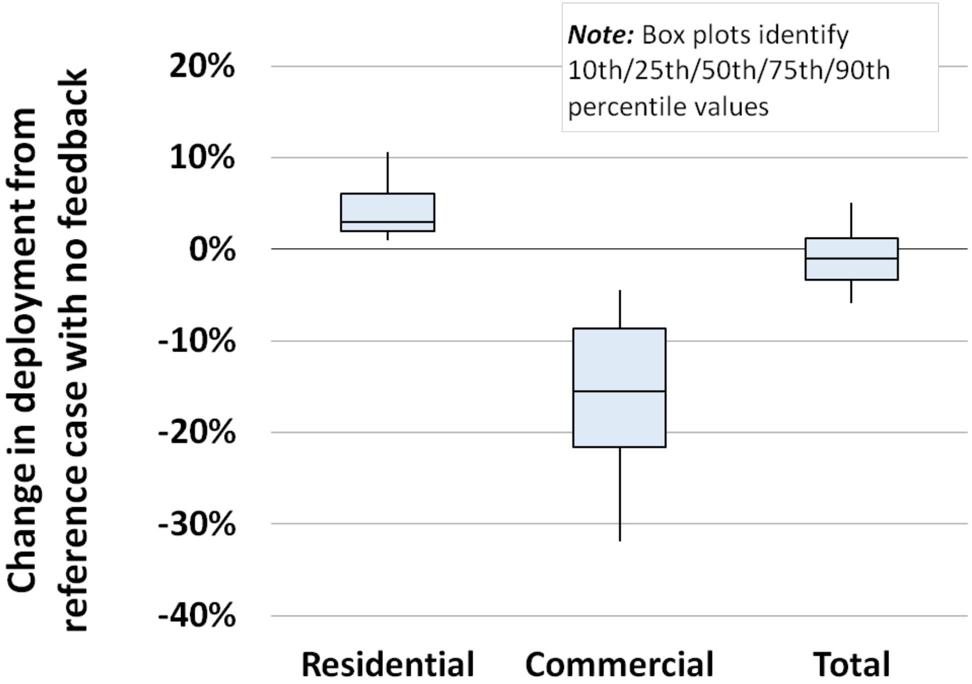
State-level Variation in Feedback Effects Exist in Reference Scenario

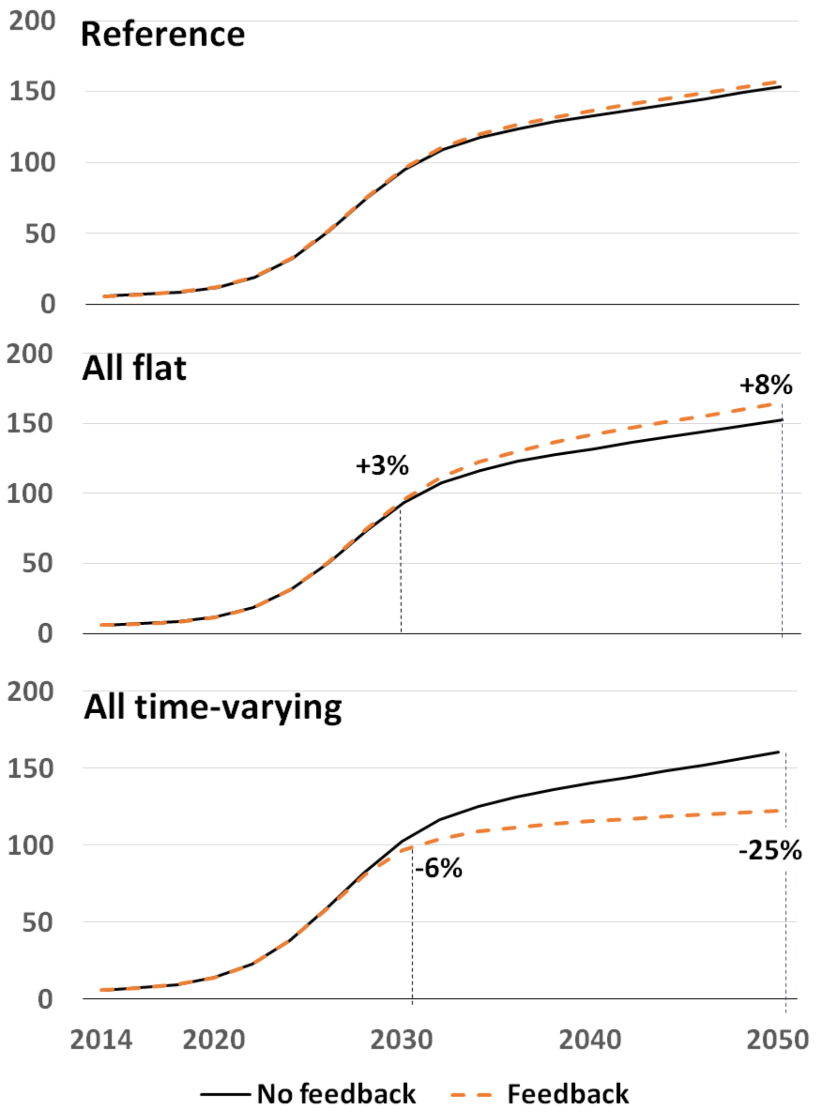
- **Residential:** Combined feedback effects increase PV deployment by 2050 (2%-6% for inner 25th-75th percentiles of states)
- **Commercial:** Combined feedbacks decrease PV (9%-22%, 25th-75th)
- **Aggregate:** Most states have negative total feedback: *national avg. of +2.1% influenced by states w/ large PV markets*



Feedback effects vary across states due to differences in PV penetration, regional conditions, retail rates, and percentage of customers on flat vs. time-varying rates

Combined feedback effects are small, span a narrow range among states

Flat and Time-Varying Rate Scenarios Bound Feedback Results



- Given uncertainties in future rate mix, scenarios with all customers on flat rate vs. all on a time-varying rate bound feedback results
- For flat rate scenario, feedback increases PV deployment whereas for time-varying rate scenario, feedback reduces PV deployment

Given the generally-expected move to time-varying rates, PV deployment feedback effects may be predominantly in the *negative* direction

Conclusions

Retail rate design and PV compensation approaches can have dramatic impacts on distributed PV deployment

- Increasing fixed customer charges or implementing alternatives to full net metering could significantly slow distributed PV deployment
- ***Note:*** *Policymakers must weigh these impacts against many other considerations when making rate design decisions*

Concerns about fixed-cost recovery feedback effect (aka, "utility death spiral") as it relates to PV may be overstated

- Current debates tend to miss the opposing time-varying rate feedback
- Combined feedback is small and, with expected move towards time-varying rates, may result in dampening (not accelerating) deployment
- ***Note****: does not imply that concerns about fixed-cost recovery are misplaced, only that a sizable "feedback loop" is not evident; note also that analysis does not consider PV-storage or non-PV load impacts*

For More Information

Download the full report, a 2-page fact sheet, and a summary briefing:

http://emp.lbl.gov/reports/re

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