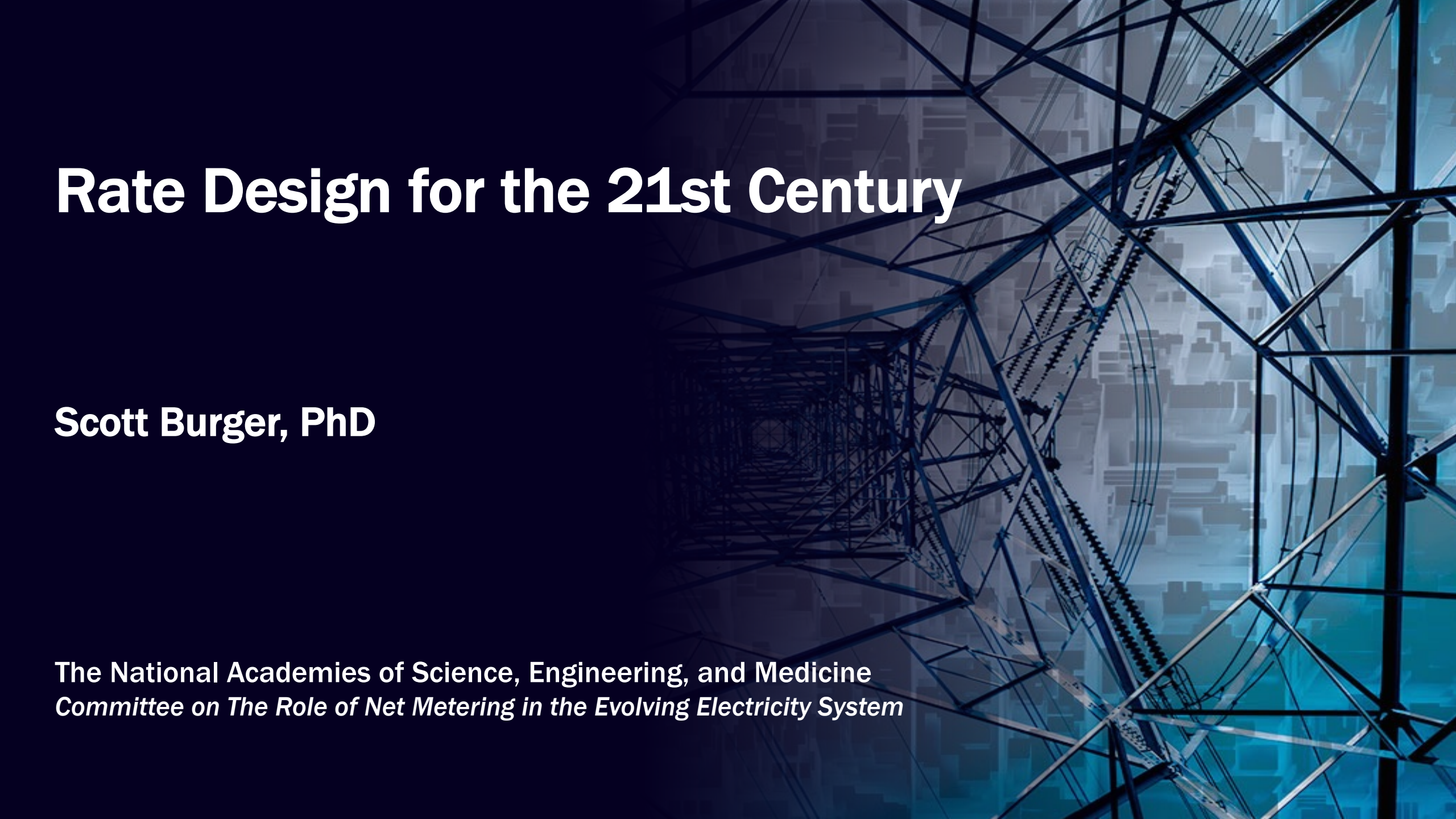
Rate Design for the 21st Century



Scott Burger, PhD

The National Academies of Science, Engineering, and Medicine
Committee on The Role of Net Metering in the Evolving Electricity System

2 key takeaways:

1. Net metering is one (problematic) path to remunerating the benefits of rooftop solar. Ultimate question is about the appropriate allocation of costs and benefits.

2. Today's rates aren't "fair", but new thinking can improve both efficiency and equity. This is likely to come at the expense of rooftop solar returns.

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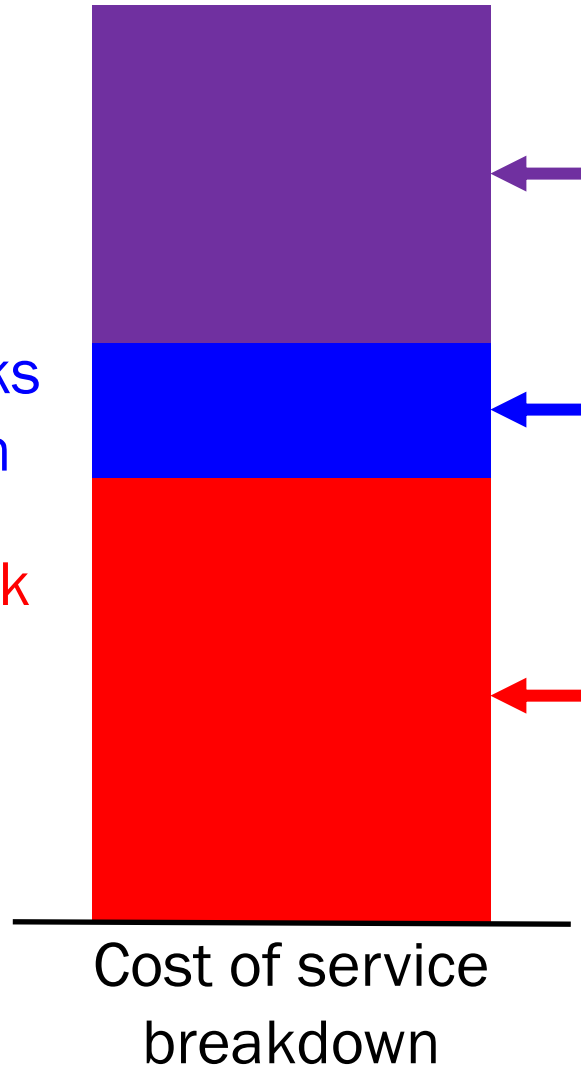
Efficient rates charge the short-run social marginal cost of consumption and recover residual costs through minimally distortive charges



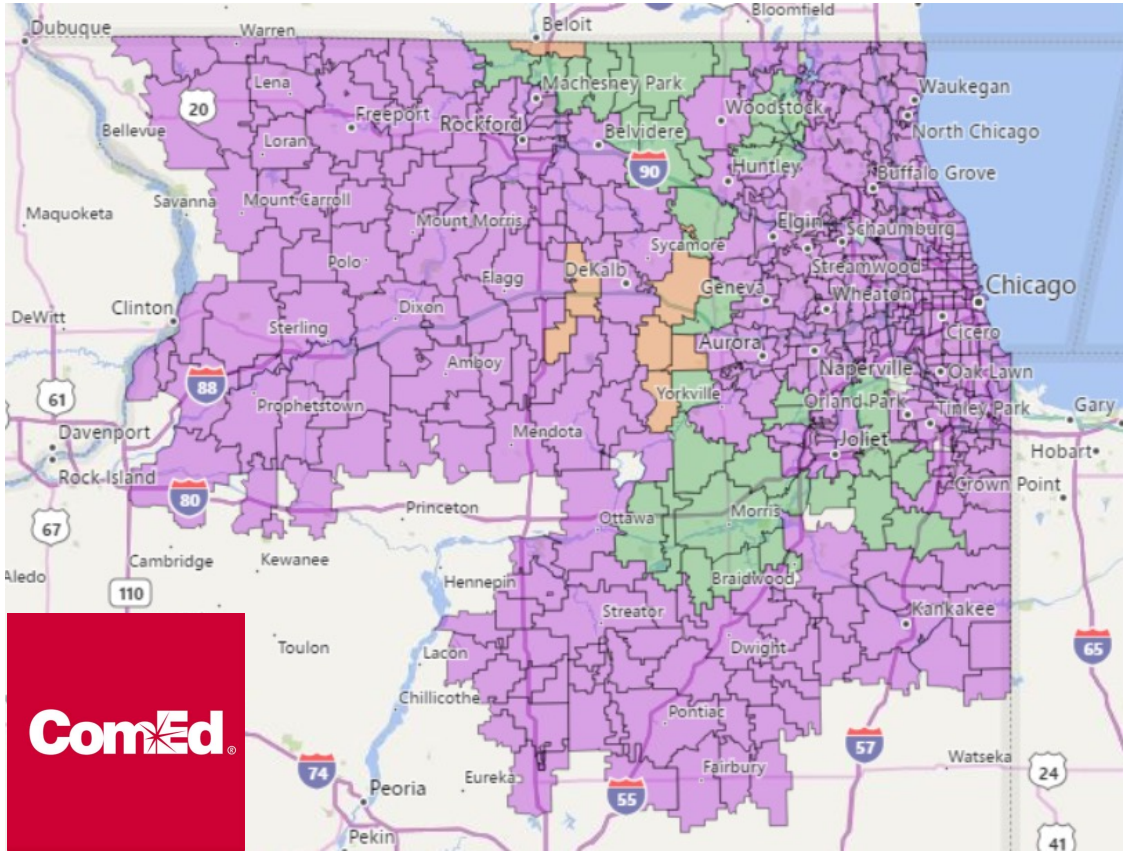
$/kWh charges that reflect the short-run social marginal cost of production or consumption

$/kW peak-coincident charges that reflect the incremental impact of demand on future network & generation capacity

$/customer charges that minimally distort short-run production or consumption decisions

To understand the real-world implications of efficient rates, we leverage meter data from Chicago, IL

- 100,170 anonymized households
- January-December 2016
- 30-minute consumption data from smart meters
- Housing type
- Heating type
- Geographic data: *9-digit zip code*



We map consumption data to Census data on income and other key socioeconomic variables as well as PV adoption likelihood

Census data at Census Block Group (CBG) level

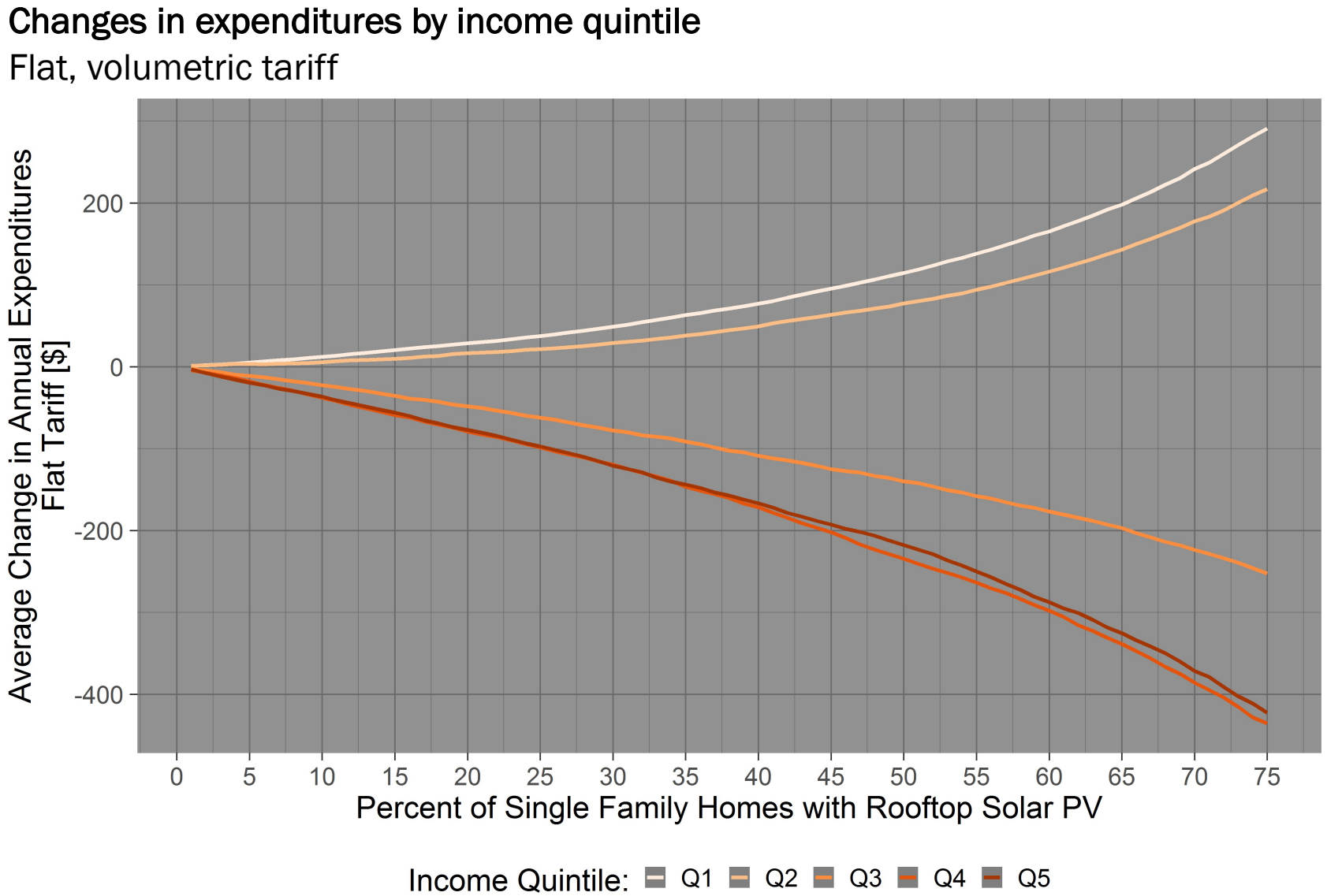
Distributions of household incomes and other socioeconomic variables

- Nine discrete income classes
- Also track impact by race, employment, education, etc.

Distributions of rooftop solar adoption likelihood by income

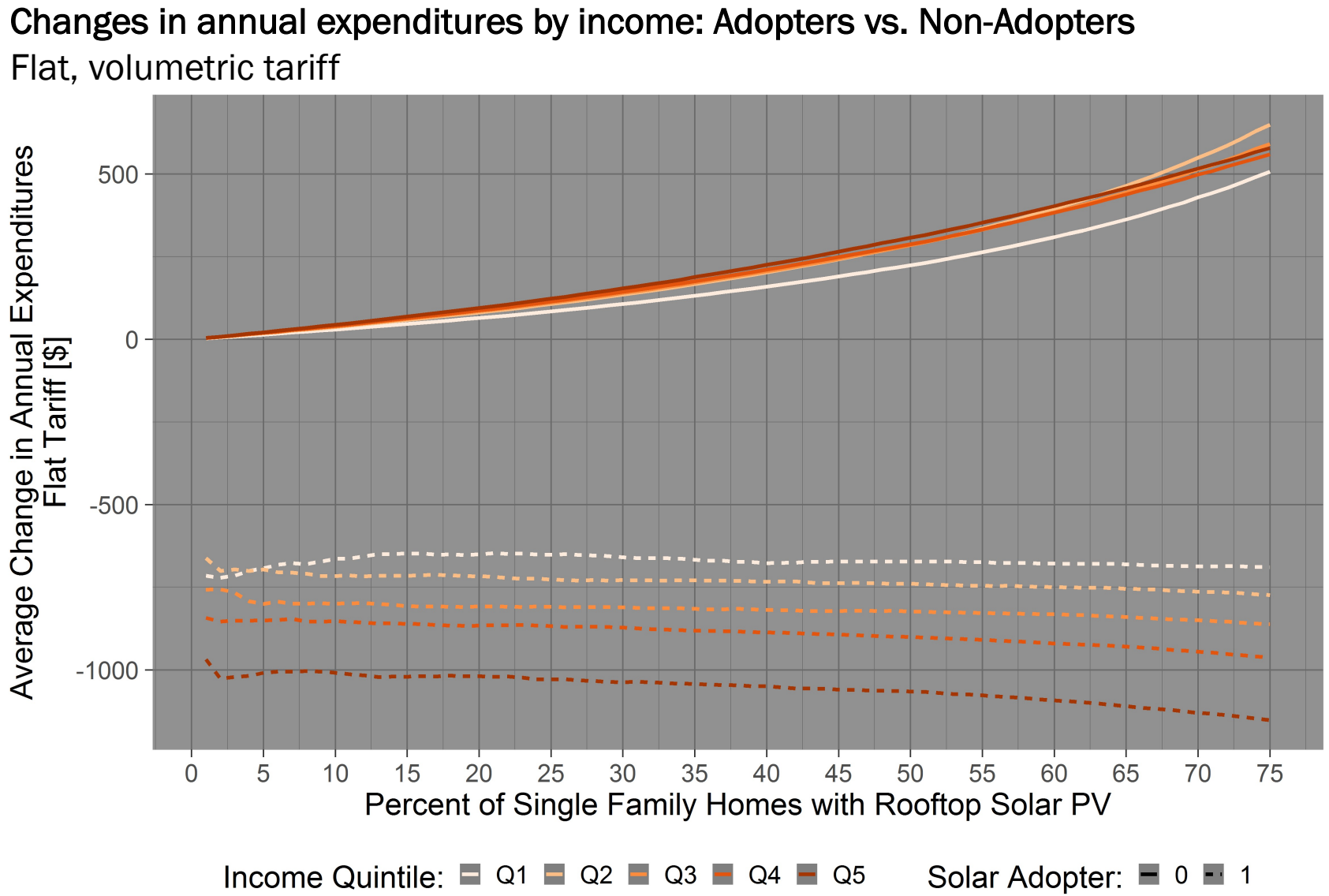
United States™ Census Bureau

Under tariffs with volumetric residual cost recovery, solar is likely to lower bills for high-income customers at the expense of low-income customers



Source: Scott Burger, 2019. Tariff Design for the 21st Century: Designing Efficient Electricity Tariffs Within Socio-Political Constraints. Forthcoming.

Within and across income classes, solar adopters benefit at the expense of non-adopters



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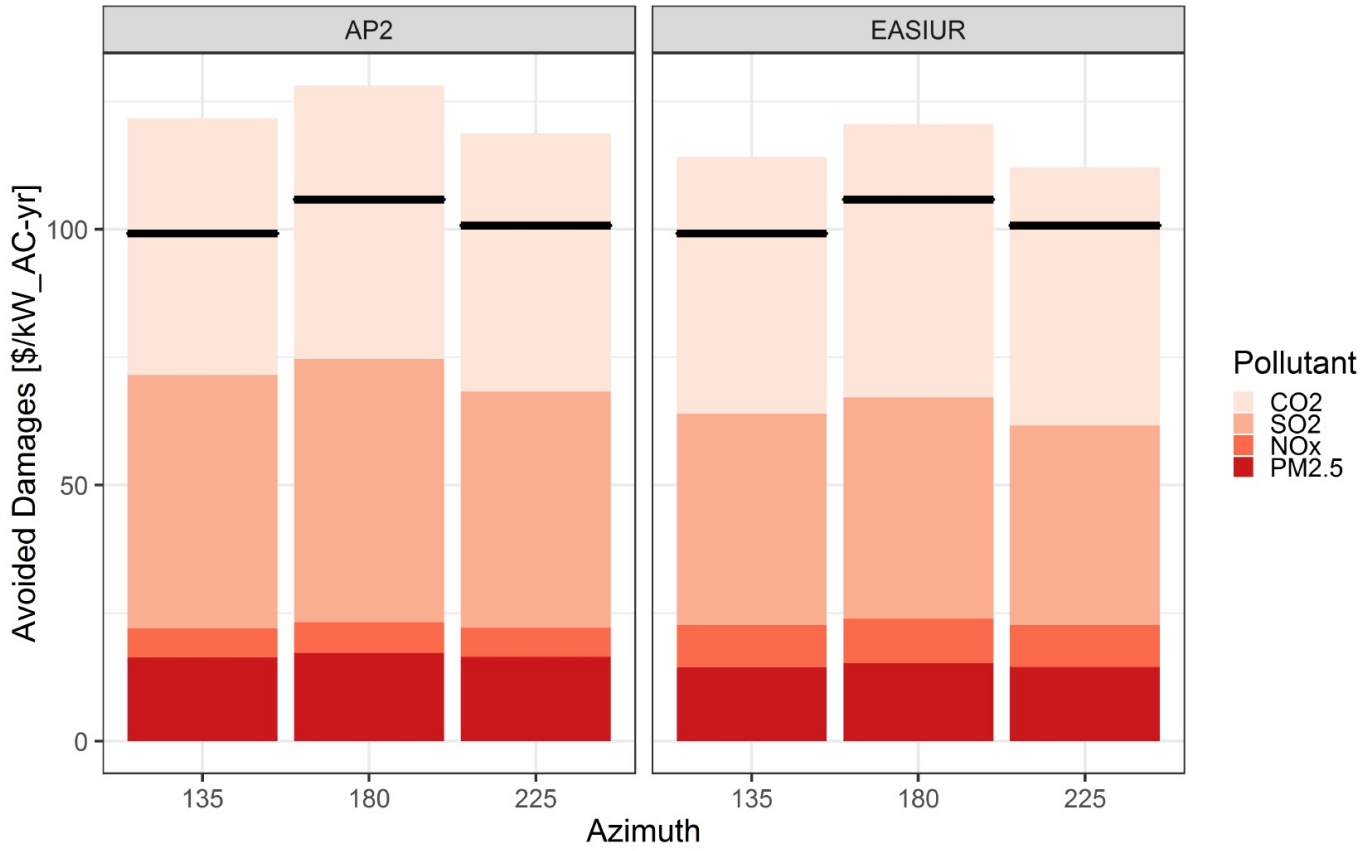
The emissions reduction value of solar may exceed the magnitude of avoided residual cost in some regions. This implies that, in certain regions, PV adoption under net metering may create a cost shift but may not be economically inefficient

Figure 5-14: Estimation of avoided emissions value of distributed solar PV



κ: Peak Demand PV Case. $\phi = 0$.

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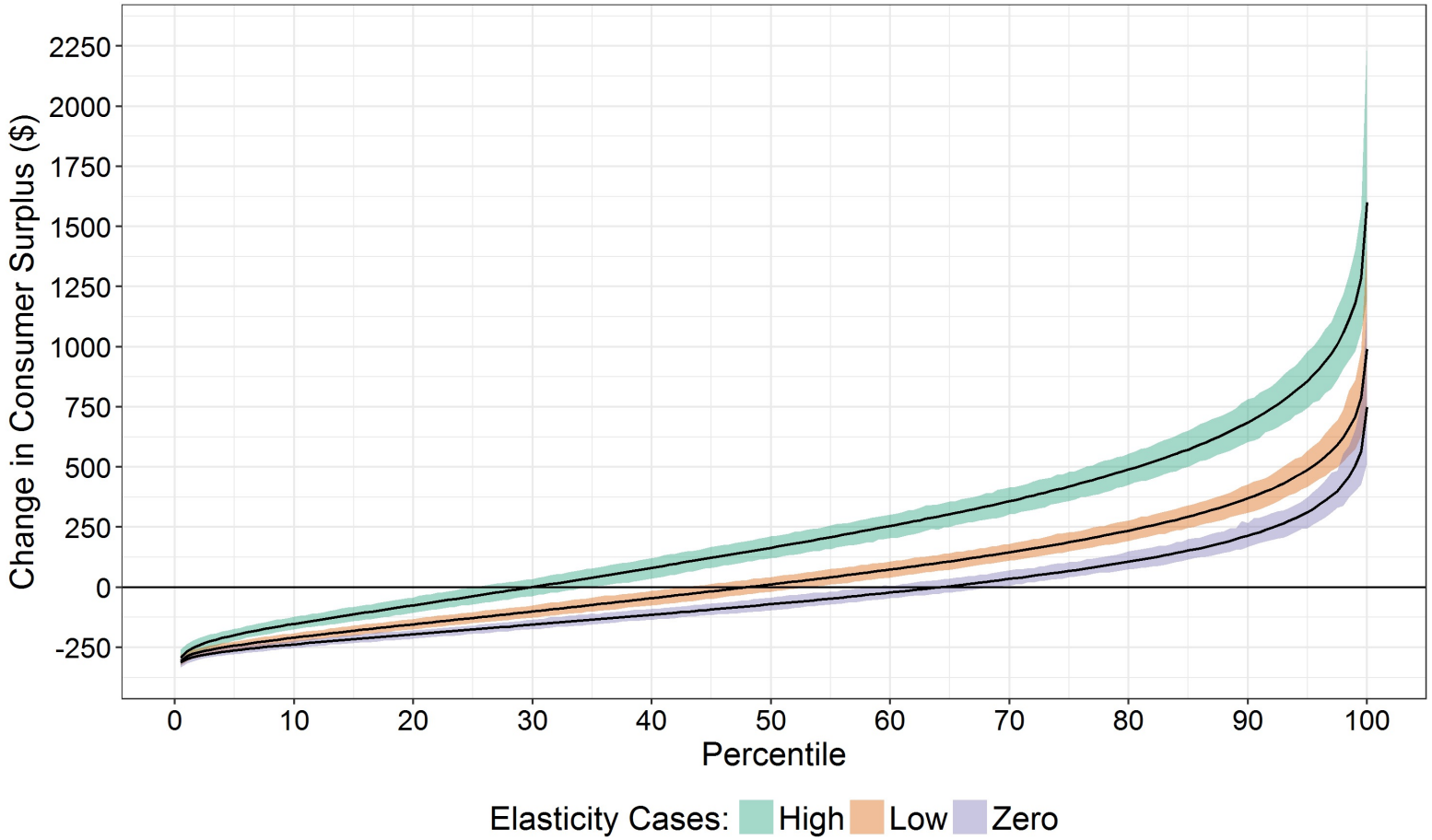
Efficient rate designs increase consumer surplus for nearly all customer segments at very low levels of price elasticity – Nonetheless, some low-income customers are negatively impacted

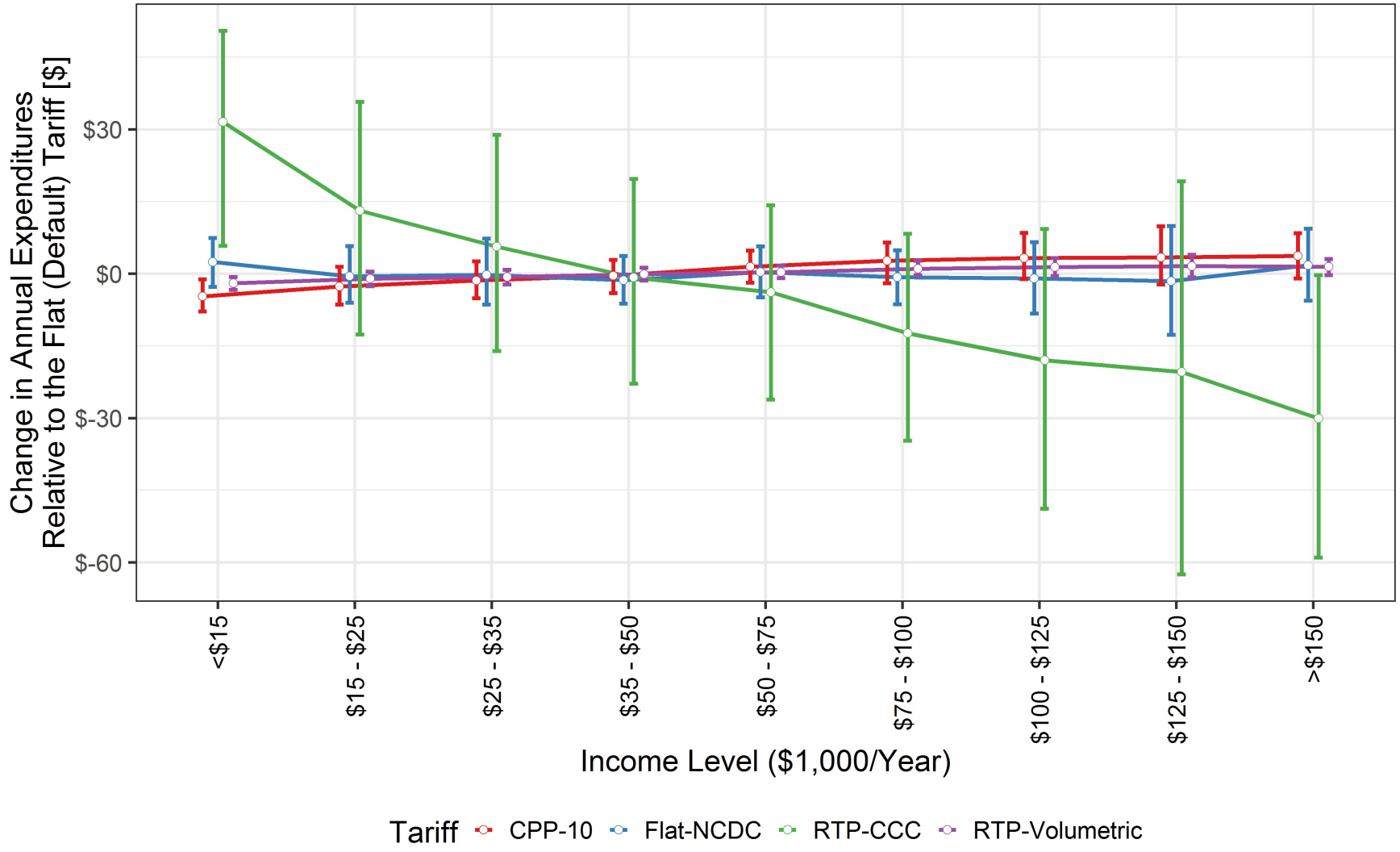
Changes in consumer surplus relative to the flat (default) tariff for customers with <$15,000 per year in income



Source: Burger et al., 2019. The Efficiency and Distributional Effects of Alternative Residential Electricity Rate Designs. *The Energy Journal.* Forthcoming.

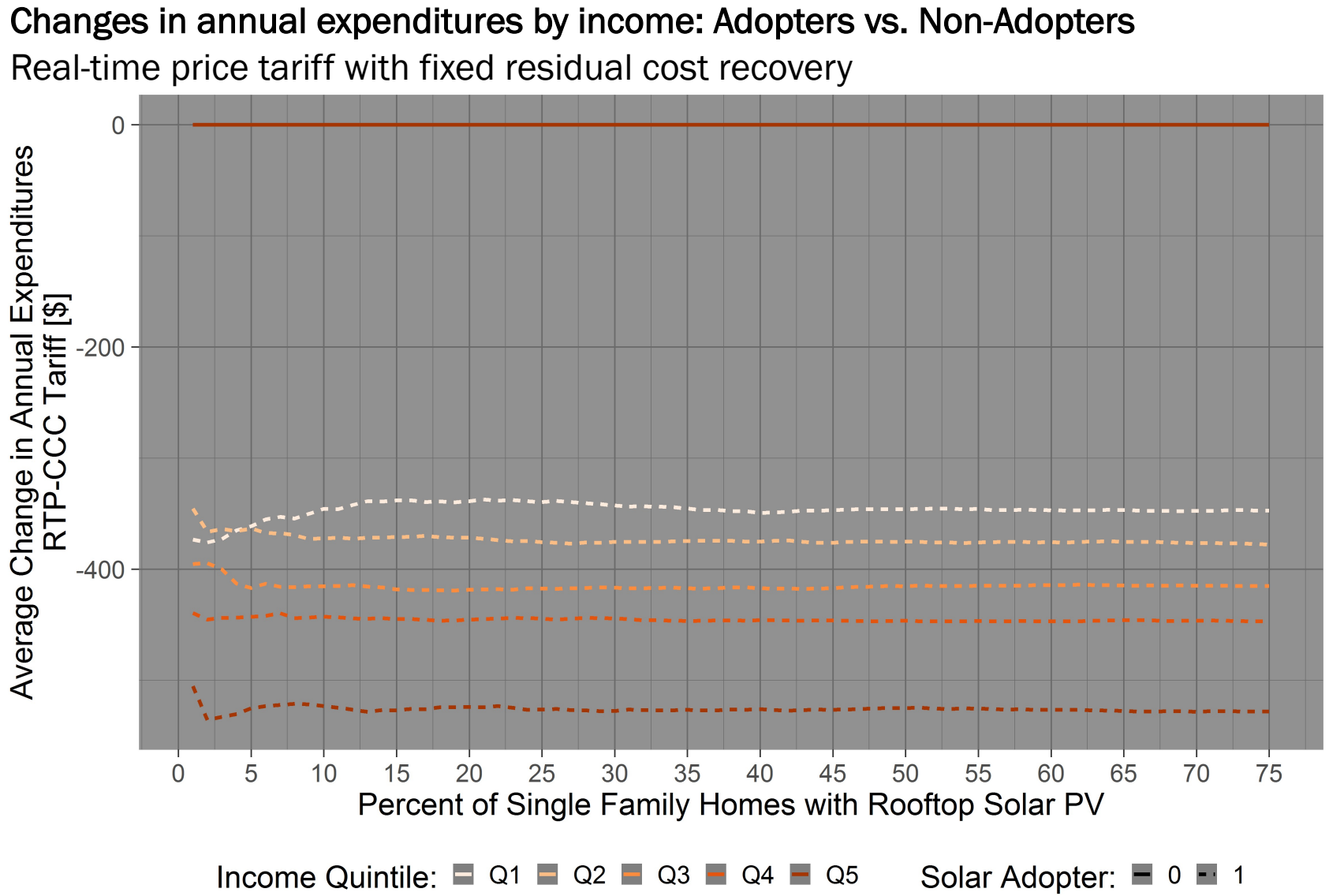
Increasing fixed charges in a uniform fashion increases expenditures for low-income customers, but moving to real-time prices does not

Tariff changes	Effects on bills for low-income customers
Increased time granularity in energy prices	↘
Reducing volumetric & increasing fixed network charges	↑
Non-coincident demand charges	~



Source: Burger et al., 2019. The efficiency and distributional effects of alternative residential electricity tariffs. *In revision, The Energy Journal.*

Efficient tariffs eliminate cost shifts, enabling energy cost savings and average savings across income quintiles



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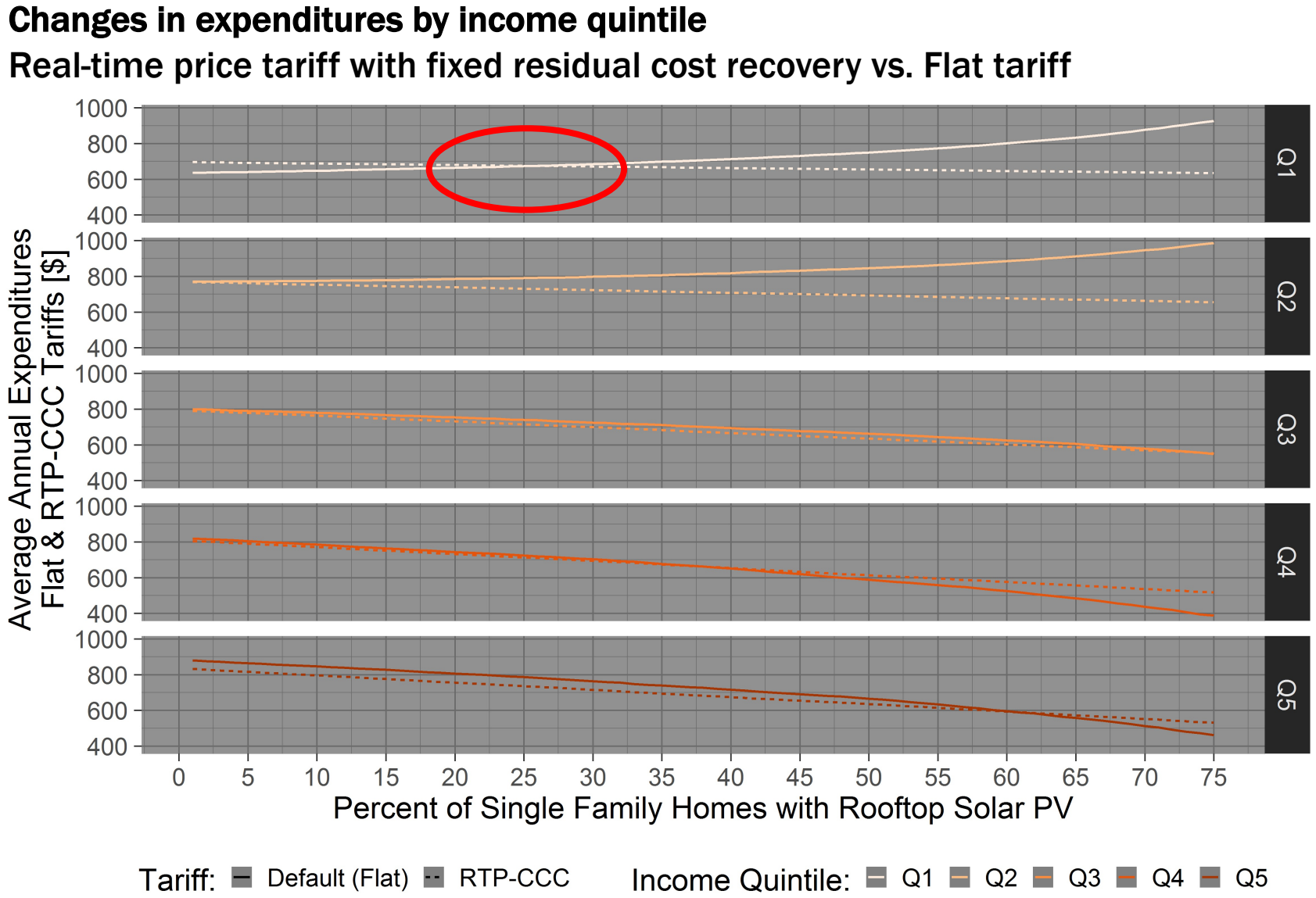
Low-income expenditures may be lower under a fixed-charge tariff at moderate rooftop solar penetrations – This observation contradicts common rate design logic



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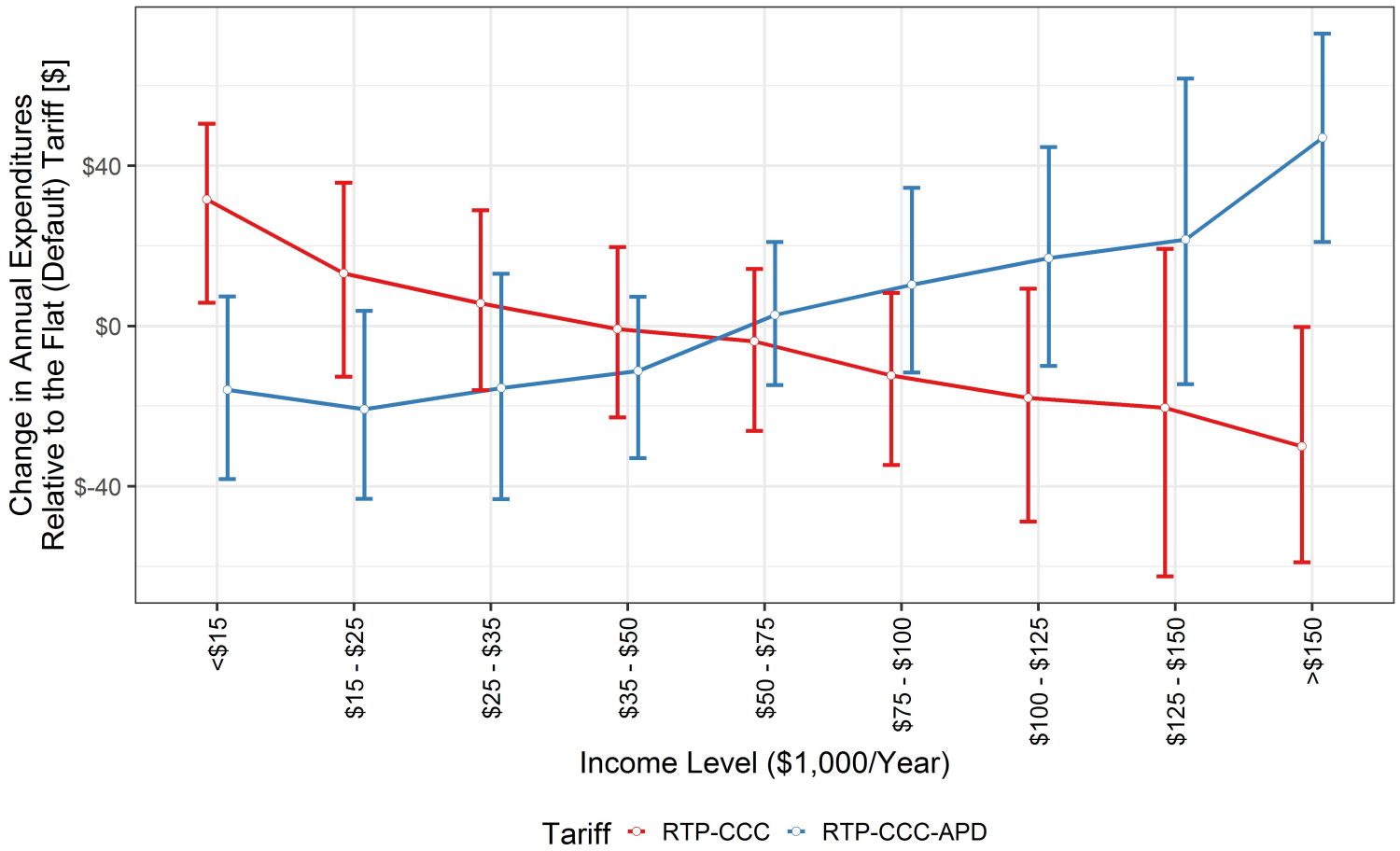
Fixed charges based on customer demand characteristics that correlate strongly with income can be far more progressive than uniform fixed charges

- Feasible with existing and available data
- Risk of Type 1 and Type 2 errors
- Inefficient incentives when changed frequently



Source: Burger et al., 2019. The Efficiency and Distributional Effects of Alternative Residential Electricity Rate Designs. *The Energy Journal.* Forthcoming.

In summary:

1. PV adoption under rates with volumetric residual cost recovery may create substantial regressive cost shifts.

2. Efficient rates eliminate cost shifts between PV adopters and non-adopters.

3. Rooftop solar may, by random chance, create more benefits than net metering with volumetric rates remunerates, but this does not eliminate cost shift problems.

4. Efficient rates create substantial surplus relative to alternatives.

5. Efficient marginal prices with uniform residual charges are regressive.

6. Simple changes to fixed charges can efficiently mitigate undesirable distributional impacts.

Thank you!

Questions?

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Reference Slides