# Turn off the Lights, the Party's Over: Equity and Efficient Residential Electricity Rate Design

Scott P. Burger, Institute for Data, Systems, and Society, MIT. +1-512-751-5450. sburger@mit.edu
Christopher R. Knittel, Sloan School of Management, MIT. +1-617-324-0015. knittel@mit.edu
Ignacio J. Pérez-Arriaga, Sloan School of Management, MIT. +1-617-784-3302. ipa@mit.edu
Ian Schneider, Institute for Data, Systems, and Society, MIT. +1-914-584-9139. ischneid@mit.edu
Frederik vom Scheidt, Institute of Information Systems and Marketing, Karlsruhe Institute of Technology. frederik.scheidt@kit.edu

## Overview

Residential retail electricity prices typically charge a nominal fixed fee and a single volumetric charge that covers both energy and the bulk of transmission and distribution costs. This yields prices that do not reflect marginal costs and that vary little across time and space. The emergence of distributed energy resources – such as solar photovoltaics and energy storage – has sparked significant interest among regulators and utilities in reforming electricity tariffs to enable more efficient utilization of these resources. The economic pressure to redesign electricity rates is countered by political and regulatory concerns of how more efficient rate structures might impact different socioeconomic groups. We analyze the bill impacts of alternative rate plans using interval metering data for more than 100,000 customers in the Chicago, Illinois area. We combine these data with granular Census data to assess the incidence of bill changes across different socioeconomic groups. We find that low-income customers would face bill increases on average in a transition to more economically efficient electricity tariffs. However, we demonstrate that simple design changes can mitigate these disparities while preserving all, or the vast majority, of the efficiency gains. This progressive price discrimination relies exclusively on observable information and could be replicated by utilities in many geographies across the U.S.

## Methods

We construct a cost model of the cost to serve the 100,170 customers in our sample using regulatory filings pulled from the Illinois Commerce Commission. Using the 30-minute interval metering data, we construct four revenue neutral electricity tariffs, covering the range of tariffs commonly discussed by utilities, policy makers, and regulators. We then compute the incidence of bill changes across customers in different socioeconomic groups. We use a simple price elasticity model to assess the relative change in consumer surplus across these different rates. Finally, we demonstrate a simple price discrimination model that preserves all – or the vast majority of – the efficiency gains of he efficient tariff, while preserving protections by default for vulnerable socioeconomic groups.

## Results

1. Any transition creates winners and losers, even within customer segments that benefit or hurt on average from a transition.
2. Updating the energy component of the tariff to better reflect the real-time marginal costs of energy generally benefit low-income customers on average, although the gains are relatively modest (1\% to 5\% of expenditures) if no changes are made to the design of residual cost recovery mechanisms.
3. Transitioning to fixed charges for residual cost recovery is likely to harm low-income customers on average.
4. With relatively limited price elasticity, nearly all socioeconomic groups are likely to see consumer surplus benefits in the transition to an efficient tariff with fixed charges for residual cost recovery, even if bills increase for certain groups.
5. The recovery of residual network and policy costs through volumetric rates appears to be a larger economic distortion than the recovery of energy costs through time invariant rates.
6. Finally, we find that simple price discrimination methods can create default protections for vulnerable socioeconomic groups while dramatically improving consumer surplus above today's rates.

## Conclusions

The emergence of DERs has placed renewed pressure on regualtors and policy makers to reform electricity rates. However, little progress has been made, in part due to the potential distributional impacts of transitioning to more efficient designs. In this paper, we demonstrate that a truly efficient tariff – one that passes on the short run marginal cost and efficiently recovers network and policy costs – has substantially more benefits relative to alternative designs. However, a naïve implementation of this efficient tariff could result in substantial distributional challenges. We demonstrate a simple price discrimination method that could keep all – or the vast majority of – the efficiency benefits of an efficient tariff, while maintaining critical protections for low-income customers.