Designing Efficient and Equitable Retail Rate for Distributed Energy Resources

Madalsa Singh, Department of Energy Science and Engineering, Stanford University, CA 94305

+1412-708-6652, madalsa@stanford.edu

Ines Azevedo, Department of Energy Science and Engineering, Stanford University, CA 94305

iazevedo@stanford.edu

Bruce Cain, Department of Political Science, Stanford University, CA 94305

bcain@stanford.edu

**Overview**: Rooftop solar and storage (distributed electricity generation, DER) can play an important role in enabling decarbonization and improving reliability. Households can consume, store, or send the electricity produced by DER back to the grid. Under net-energy metering policies, households with DER are compensated for the surplus electricity produced at the retail electricity rate. Retail rates typically charge residential users a volumetric rate that covers the bulk of energy, transmission, and distribution costs. The result price, charged per unit of electricity, neither reflects the marginal costs of producing the electricity nor does it vary by space and time. Non time-varying volumetric electricity rates also don’t accurately reflect the true benefits that DERs provide to the electricity grid and has led to interest among policymakers to modernize the electricity rates. Significant concerns on cross-subsidies have also been raised. By realizing significant bill savings under net-energy metering, adopters of DERs effectively shift part of their obligation for the grid operation costs to non-adopters. Hence, challenge to modernize the electricity rate entails aligning prices to the true cost of generation of electricity; pricing benefits to the true benefits DERs provide; and ensuring that non-adopters, often low income and/or renters, don’t bear the burdens of cost-shift. In this work, we propose an electricity pricing and household electricity consumption model that tests different electricity rates to enable efficiency and equity for adopters and non-adopters. California, which has one of the highest electricity rates and penetration of DERs in the United States, is used as a case-study for demonstration.

**Methods**: There are 3 main methodological steps in this work. First, we incorporate various features of rate design that have been implemented or are being discussed for future policy reform. This includes flat and dynamic time-of-use rates, with and without of component of fixed costs, and varying compensation rates (rate at which DER production is compensated). Second, we formulate a utility maximization model of adopter household with varying degrees of DER such as solar, storage, and electric vehicles. Third, we evaluate welfare, payback periods of investment, and cost-shift from adopters to non-adopters under various electricity tariff regimes subject to parametric assumptions about penetration level, income characteristics of adopters, and breakdown of electricity costs between generation and fixed components.

**Results**: This is work-in-progress. The toy model shows that time-varying retail rates (peak off-peak ratio of 1.6) with compensation at marginal electricity costs without fixed costs has least cost-shift to non-adopters but highest the pay-back period for adopters compared to the one-part volumetric retail rates. Presence of a fixed cost component further reduces cost shift. Time-of-use rates with high peak-off peak incentivize self-consumption and storage while higher compensation rate incentivizes selling it back to the grid.

**Conclusions**: Modernizing electricity rates is imperative to integrate DER at scale to decarbonize the electricity system reliably, efficiently, and equitably. This work presents a model across various agents to analyze various electricity retail rate choices and how they impact social welfare, payback period (for adopters), and cost-shift (non-adopters).