Rate Structures for Utility Distribution Services

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A combination of technological changes and shifting environmental priorities is placing new and powerful stresses upon the traditional model of electric utility service. Declining loads and increasing "behind the meter" supply is making it increasingly difficult for utilities to recover distribution costs, much of which are fixed or sunk. At the same time, growing concern about climate change is leading policy-makers to place even further emphasis on energy efficiency and the expansion of distributed renewable energy. Dramatic growth in the adoption of distributed energy resources by utility customers, emergence of Community Choice Aggregation programs, and increased consumer interest in exercising more "personal choice" over their electricity procurement decisions, among other developments, challenges the traditional model of electric utility service.

Advances in the technology of grid services, distributed generation, and storage could cause the industry to evolve in one of several possible directions. Many hope that these technologies will be deployed in a fashion that will increase the integration and responsiveness of a wider range of end-users and power producers. An alternative vision has individual users or community micro-grids becoming increasingly self-sufficient and, by implication, less responsive to the needs and resource availability of neighboring users and the grid.

Several technical, political, and economic factors will influence the degree to which the industry becomes increasingly integrated or isolated, but rate design and utility pricing will no doubt play an important role in this process. Tariff characteristics such as the size of fixed or minimum charges, the use of demand charges or time-varying pricing, and the extent and magnitude of increasing-block pricing strongly influence the economic benefits of distributed technologies. Differences in current rate structures have been demonstrated to be an important factor in the adoption of distributed generation. This proposal represents a first step in a project to evaluate current rate structures and estimate the implications they have for the long-term financial stability of electric utility companies.

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There are several elements of next-generation distribution-level rate design to consider, with the goal of better reflecting the marginal cost of service – including network costs – in the end-use prices paid by consumers. Broadly the cost of service includes both the recovery of the costs of sunk assets (e.g., existing network infrastructure), the marginal cost of consumption (e.g., energy cost), and *long run* incremental costs reflected in the need (or lack of need) for future investment in infrastructure. Improved rate design not only improves efficiency of consumption (with prices reflecting costs), but also discourages inefficient investment that is economic only in response to distorted rate designs that do not reflect costs.

Research Questions

1. What kind of electric rate structures are socially optimal under conditions of declining end-use volumes and increasing distributed generation? How well do these structures allow for a sustainably financed electric distribution system? This question must consider the degree to which rates can and should capture the short-run marginal costs of energy consumption and the long run marginal cost of energy distribution.

2. What is the current landscape of rate structures in the United States? To what extent to revenues collected correlate with the marginal cost of energy? How does the penetration of renewable energy (both distributed and grid scale) influence that relationship? How do rate structures vary with the existence and intensity of retail competition?

Research Plan

1. *Develop a theoretical model to characterize the aspects of optimal rate design.*

   This aspect of the project will frame of the criteria and attributes of desirable (or optimal) rate designs in the presence of distributed resources, energy efficiency investments, and fixed or sunk costs. We will discuss the considerations that dominated rate design and rate structures over the previous decades and incorporate the new challenges raised by greater use of distributed energy resources, including efficient versus inefficient bypass of grid energy, two-way flow on distribution systems, and heterogeneous distribution-level shadow costs of energy. This analysis would build off of questions raised in Borenstein and Bushnell (2015), which raised similar issues at the grid level in contrasting the economic challenges facing utilities today with those that buffeted the industry through restructuring.

2. *Document the landscape of rate structures currently in place throughout the United States.*

   A detailed survey of rate structures throughout the U.S. is a natural starting place for establishing the directions in which rates could evolve, as well as analyze the

potential inefficiencies of current rates in the presence of distributed resources. To the extent that there are discernable trends detected, such changes could be utilized to inform such questions as the relationship between rate structures and energy use, the deployment of distributed resources, and infrastructure investment.

We foresee multiple strategies for approaching the empirical component of the project. One line of approach would be to utilize available databases of rates and rate structures. The "US Utility Rate Database" available on OpenEI documents hundreds of utility rates from throughout the country, but the sample is neither random nor comprehensive.

For quantitative analysis of the variation of price levels over time, we propose utilizing electric price datasets such as the form 861 from the Energy Information Administration. Analogous data have been utilized in studies of retail tariffs for natural gas (Davis and Muehleggar (2010), Borenstein and Davis (2012)).

These data contain annual (and in some cases monthly) data on the KWh sales and revenue for each load-serving entity and customer class (residential, commercial, industrial). By aggregating these data, we can assemble a time series of average utility prices and estimate the degree to which revenues vary with measures of total quantities sold per household and measures of wholesale costs. With the former relationship, it may be possible to produce metrics that capture the linearity (or non-linearity) of tariffs.

The latter relationship, between wholesale costs and rates, could also capture some degree of the linearity of tariffs, but also be used to examine questions relating to the impact of renewable generation on retail rates. There has been much concern over the effect of large scale renewable penetration on wholesale prices and on the efficiency of service overall (Borenstein 2012). But concerns about "price suppression" (Felder, 2011) have largely focused on wholesale markets. Renewables subsidies could create a growing wedge between wholesale prices (or system marginal costs) and retail rates. Our project would test for the presence of such a relationship.

The data also provide some ability to separate out tariffs for distribution-only services, energy-only services, and traditional "bundled" services in states where retail competition is sufficiently active. While research has explored the relationship between retail competition, rate structures, generation investment, and reliability (Joskow and Tirole (2006), Borenstein and Holland (2005)), we intend to examine the degree to which retail competition has influenced the rate structures for distribution services.

Summary

The impact of technology and climate policy on the economics of the electricity industry is a very large and important topic. Our project would lay the groundwork for understanding some aspects of this broad issue. We approach the project with two goals. The first is to articulate, in economic terms, the relationship between rate design and the future of the utility. Such a discussion would be targeted at both economists and policymakers. We also hope to document and broadly characterize rate structures throughout the United States. Such an exercise would yield metrics about rate structures that could in turn be used as a dependent variable for further explorations of the relationship between policy initiatives - such as support for renewable energy and retail competition – and retail rates.

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