Equity in Residential Electricity Pricing

Shira Horowitz and Lester Lave

Department of Engineering and Public Policy, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213 USA

Wholesale and retail electricity prices are decoupled for most residential electricity customers. Wholesale prices change in real time to reflect marginal cost and can range from negative values to thousands of dollars. Residential retail rates are typically flat rates, which are load weighted averages of expected price over a certain period of time (typically a year or more). Flat rate (FR) pricing is inefficient because price does not reflect marginal cost, so customers may be under- or over-consuming at any point in time. Customers with a high coincident peak relative to their average demand are, on average, paying below marginal cost while customers with flatter usage or those whose peak demand occurs at off-peak prices are paying above the marginal cost they impose, on average. Customers that add to peak load impose high costs on the system, but under FR pricing, all customers pay the same amount. This is a policy where customers with high coincident peaks are receiving a cross-subsidy from the remaining customers.

Real-time pricing (RTP) has the potential to address these problems by directly coupling retail and wholesale prices. The energy charge in a residential RTP tariff changes hourly to reflect either the day-ahead or real-time locational marginal energy price (LMP). This provides a signal for customers to use only the amount of power that they value at or above the current marginal price of power. If customers respond to high prices by lowering usage, RTP can potentially lead to lower peak demand and price. Even if only some customers respond, all customers can potentially benefit from lower marginal price and lower capacity costs due to lower peak demand. Charging customers the RTP is no guarantee that customers will reduce or shift load when price is high. The potential savings must be large enough for customers to invest in the time, education and technology necessary to effectively reduce peak demand.

Here, we address a question of practical importance to electric utilities and public utility commissions who are considering a move to dynamic pricing: which consumers "win" (will save money under RTP compared to FR) and which consumers "lose" (lose money under RTP compared to FR) when switching from FR to RTP? Because of the inherent cross-subsidies between customers under FR pricing, when a utility switches to dynamic pricing, the cross subsidy will be reduced (CPP) or disappear entirely (RTP), and the cost burden will shift from customers with flatter loads or non-coincident peaks to those with high coincident peaks. Some customers may experience significant changes in their bills – both increases and decreases if they don't shift their usage. It will be important for utilities and PUC's to know in advance which customers will have large bill increases, so they can supply those customers with information and tools to help mitigate the increased bill by increasing energy efficiency or shifting or curtailing load, or create policies to tax the "winners" and subsidize the "losers".

The question can be reframed for those utilities that are not considering a switch to RTP: which customers are currently providing cross-subsidies to other customers under FR pricing? Is the wealth transfer caused by the cross-subsidies an acceptable policy from an equity perspective?

We address these questions by taking a sample of customers and calculating their bill difference under RTP and FR under both inelastic and elastic demand. We treat the scenario with inelastic demand as a zero-sum game used to explore cross-subsidies: one customer's loss is another's gain. This is also a "worst case scenario" for RTP programs, where consumers don't respond, so there are no net savings to consumers. Under elastic demand, there are net savings to consumers due to avoided energy usage, lower marginal prices and lower capacity costs. We then analyze customer characteristics including income and demand. We obtained data from a sample of ComEd customers.

We find that under inelastic demand, only 36% of consumers would save money under RTP. With elastic demand of -0.2 (an upper bound), roughly 50% of customers would save money from reductions in energy usage and energy price. Many more customers save if we assume reductions in capacity costs due to demand response. The customers who save tend to be the largest consumers, while those who would lose money under RTP tend to be smaller consumers and represent a disproportionate amount of low-income customers.

RTP can bring efficiency to retail electricity markets and has the potential to bring a net welfare increase to consumers if they shift or curtail usage during peak times. However, many consumers will not save money in the short run, even if they have elastic demand from discretionary load, because they would lose the cross-subsidy they receive under FR when switching to RTP. These customers tend to have smaller loads (which may imply less discretionary load, and therefore less elastic demand) and includes a greater proportion of low-income consumers. If there is a mass rollout of RTP, many of these consumers would still lose money in the short run even if they have elastic demand. In the particular case we explored, 50% of customers would still lose money in the short run, even if they had elasticity of -0.2 (which is higher than most estimates of elasticity under RTP).

There is a potential for major savings for all customers in the long run, from avoiding to build more capacity. If customers are able to cut peak demand and avoid increased capacity costs in the long run, then many more, or perhaps all customers can save money, however these customers may still see a net bill rise at first.

Policy makers who are considering implementing RTP must not just consider the net efficiency gains and net savings to consumers, but must also look at how these gains will be distributed, and consider that many consumers will actually incur losses relative to FR. Policy makers can consider giving RTP only to the portion of consumers who would contribute the most to peak shaving and will also see direct benefits, however this would be removing a large portion of those who provide the cross-subsidy under FR, pricing, and those being cross-subsidized would still see bill increases. Dynamic rate designs other than RTP, such as CPP, which focus on only changing prices during the hours when capacity is at the margins, and compensate consumers based on capacity costs only and not energy costs, may be a solution to this issue.

Policy makers also need to focus on how to communicate long run savings to consumers, since RTP can lead to very substantial savings in the long run if significant increases in capacity prices are avoided. This is a huge policy barrier however – it is difficult to tell consumers to bear an increase in electricity bills today to avoid an even larger increase in bills in several years.