



# policy matters

california senate

OFFICE OF RESEARCH

## PRICING STRATEGIES CAN BE EFFECTIVE IN REDUCING RESIDENTIAL ELECTRICITY DEMAND

It is important for policy makers to understand how residential electricity consumers change behavior in response to electricity prices. The concept commonly is referred to in economics as price elasticity and can be quantified into a single ratio. For example, a price elasticity of -0.5 means a 10 percent price increase would reduce demand by 5 percent in response, whereas a -0.1 price elasticity would only see a 1 percent reduction. Policy makers use this information to determine the expected effectiveness of pricing strategies aimed at reducing or shifting electricity demand. In California, there is interest in pursuing pricing strategies that shift electricity consumption from the peak usage hours of the day to the more underutilized hours, as well as raising prices for high-usage consumers to reduce their overall use.

Although electricity price elasticities have been studied extensively for more than four decades, a number of confounding issues prevent policy makers from having a clear understanding of how consumers will respond to pricing strategies. This paper describes the research literature on price elasticities and presents our findings about the potential price responsiveness of consumers.

### Barriers to Understanding Price Elasticities

One of the most significant barriers to understanding price elasticities is that consumers are not well-informed about their electricity rates and consumption. A recent survey commissioned by California utility companies revealed most consumers typically are unfamiliar with their basic rate structure.<sup>1</sup> Another issue in estimating price elasticity is the wide variation between short-run and long-run elasticity estimates. Short-run elasticity represents temporary behavior changes, such as adjusting the thermostat, whereas long-run elasticity represents permanent behavior changes, such as investing in more efficient appliances. Additionally, estimates of price elasticity can be influenced by the income levels of the consumers studied, baseline prices of electricity, and impacts from specific rate structures. Because of these issues, some studies have shown low consumer responsiveness to electricity prices. However, our review of the body of research suggests efforts can be made to increase consumer responsiveness to pricing strategies if these issues are addressed.

### Price Elasticity Literature

We examined more than 40 research publications on residential consumer price elasticities and interviewed leading academic researchers<sup>2</sup> to determine whether pricing strategies potentially can be effective in reducing electricity consumption. One of the main differences in the research literature is between studies that measured short-run estimates versus long-run estimates. The range of short-run elasticity estimates is typically around -0.1 to -0.4. A review of 36 studies in 2004 calculated an average short-



run elasticity value of  $-0.35$ .<sup>3</sup> Long-run elasticity estimates in the literature range from around  $-0.35$  up to almost  $-1$ .

When considering what measure of price to use to study consumers' response, researchers use either the average or marginal cost consumers pay for electricity. Average cost incorporates all of the different prices consumers might be charged on a daily basis as an overall indicator for price. Marginal cost takes into account the different rate structure in each region studied and uses the exact prices consumers are charged at any given time to calculate their estimates. Using average cost eliminates part of the difficulty of accounting for complex rate structures by assuming consumers react based on their lack of complete information. There is debate in the literature over whether using the average or marginal cost will give a more accurate estimate of the elasticity of demand for electricity.

There are a variety of ways electricity pricing policies can be introduced to consumers. Mandatory participation policies require consumers to permanently adhere to a new pricing scheme, while opt-in and opt-out policies provide consumers options. With opt-in, consumers may sign up to participate in the new pricing strategy, while opt-out gives consumers the choice to leave after they are automatically enrolled. The vast majority of studies in the literature excluded opt-in rate structures to avoid biases. Despite this, we believe opt-in studies could potentially provide valuable insight about the price responsiveness of consumers who choose to participate on the basis of being well-informed about their rate structure.

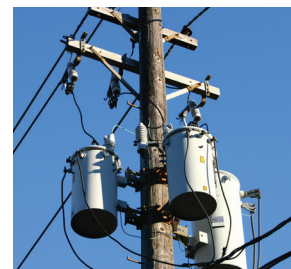
Price elasticity studies vary in scale. Some studies have a broad international focus, while others look at specific cities' electricity demand. The issue with smaller-scale studies is regional factors may more easily influence the elasticity estimate, compared with a larger study where regional differences average out to a more versatile estimate that can be indicative of more than a single, specific location.

In the majority of studies looking at the long-run elasticity of demand for electricity, income is viewed as having a significant effect on demand. More wealthy consumers generally are less responsive to changes in electricity prices, when compared with lower-income consumers.<sup>4</sup> Studies use various techniques to account for these income effects on demand to eliminate its influence on estimating elasticity.

## Factors Affecting Elasticities

Considering the divergent methods we found in the research literature, we decided to focus on studies with the following attributes:

- > **Long-run Elasticity Estimates.** For policy-making purposes, long-run elasticities are more relevant estimates because we are most interested in the feasibility of the longer-run, permanent impacts of policy implementation.
- > **Average Cost.** We focused on studies using average cost since the research literature shows consumers typically base their responses around the average cost, rather than the marginal cost. According to a comprehensive study conducted in 2014, using the average price leads to a more realistic estimate because that is the price on which consumers generally base their decisions.<sup>5</sup> If consumers do not have an in-depth understanding of their electricity rate structure, they are responding only to the price they see on their bill at the end of the month, which essentially is their cumulative average cost.
- > **Regional Scale.** We tried to avoid small-scale studies focused only on a specific city or county. Small-scale study estimates are more easily skewed by unique and idiosyncratic regional factors affecting price sensitivity.
- > **Mandatory Participation Studies.** These studies generally are regarded in the literature as more reliable in estimating price elasticity because they are able to evade the self-selection bias of opt-in studies. For this reason, almost all of the studies in the literature we reviewed analyzed mandatory participation.
- > **Income.** We avoided studies that did not account for the influence income has on demand independent from price.



## Potential Price Responsiveness

After reviewing the research literature, we determined that the long-run price elasticity of electricity potentially can be around  $-0.6$ . This means a 10 percent increase in electricity prices can be expected to reduce electricity consumption by approximately 6 percent. This is our best attempt to capture the potential price responsiveness of

**TABLE 1:**  
**Comparison of Long-Run Elasticities**

Commodity	Elasticity Estimate
Flu Vaccination <sup>7</sup>	0
Gasoline <sup>8</sup>	-0.4
Electricity	-0.6
Water Utilities <sup>9</sup>	-0.6
Soft Drinks <sup>10</sup>	-1.2

consumers after filtering the research literature for the issues discussed previously. It also lies within the range of studies such as Alberini (2011),<sup>6</sup> which estimates long-run elasticity in the range of -0.45 to -0.75 and is considered comprehensive as it reviews data from almost every state.

Table 1 shows the estimate of electricity price elasticity compared with the estimated long-run elasticities of other common commodities—flu vaccination, gasoline, water utilities, and soft drinks.

As the table shows, residential electricity consumption is potentially slightly more responsive than gasoline, but about the same as water utilities. It is notable the demand for flu vaccination is far less

responsive than any other commodity because it is potentially a lifesaving service for the elderly and other at-risk groups. In contrast, demand for soft drinks is substantially more responsive than the other commodities because there are so many substitutes consumers can buy instead if the price rises too high.

## Policy Implications

Our review of the relevant research reveals pricing strategies can be an effective tool to reduce or shift electricity consumption. For example, if pricing schemes are implemented to shift demand away from peak hours by raising prices, we expect consumer response could be significant enough to pursue those policies. In comparison with other commodities, such as gasoline or flu vaccination, we find residential electricity consumers have the potential to be fairly more responsive to prices. However, the numerous issues discussed above, such as consumer information, will need to be addressed to capture this result.

As mentioned earlier, several other factors also could impact consumer responsiveness when policies are put into action. Table 2 below describes these factors, their potential impacts, and related policy considerations.

**TABLE 2:**  
**Confounding Issues That Impact Electricity Elasticity**

Issue	Description of Issue	Potential Impact on Elasticity	Policy Considerations
<b>Information</b>	Consumers are unaware of rates or energy usage.	A lack of information is likely to reduce expected responsiveness. If consumers are not cognizant of rate structure changes, they are unable to respond.	Implementation of information technology has demonstrated the ability to increase consumer responsiveness dramatically. <sup>11</sup> Policy makers should consider ways to use technology to better inform consumers.
<b>Income</b>	Income has an effect on how sensitive consumers are to price changes.	Generally, higher-income consumers are less responsive to increases in electricity pricing, while lower-income consumers are more responsive.	Policy makers should consider the economic demographics of the consumers affected by potential policies.
<b>Baseline Prices</b>	There is no uniform price for electricity across the United States.	Areas with higher baseline prices for electricity would be more responsive to any percent increase in price. California currently has relatively high average electricity prices, <sup>12</sup> and therefore is expected to be more responsive than other states.	Policy makers should consider the initial electricity prices in a region when determining potential responses.
<b>Rate Structure</b>	There are a number of unique rate structures utilized by different U.S. utility companies.	Individual rate structures, such as tiered structures, time of use, and critical peak pricing, may have different effects on the price sensitivity of consumers.	Policy makers should consider potential variation of price elasticity under different rate structures before implementation.

Policy makers must grapple with numerous issues before they can expect to observe the approximate -0.6 long-run elasticity estimate from the research literature. Looking toward the future of price elasticity in the residential electricity market, information is clearly one of the most influential factors that could evolve over the coming years. Studies have shown that enhancing the information available to consumers has a notable effect on the elasticity of demand.<sup>13</sup> In addition, the implementation of specific rate structures could impact long-run consumer

responses in a number of different ways, particularly if complex rate structures lead to further barriers of consumer information. The implementation of new pricing policies for electricity without properly considering the potential impacts on elasticity could result in ineffective or unintended results. Based on our review of the relevant research, we conclude there is a significant potential for consumers to be responsive to electricity prices, and that pricing strategies can be an effective tool for adjusting residential electricity demand.

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## Endnotes

- 1 HINER & Partners, "Residential Rate OIR Customer Survey Research," August 8, 2013, p. 3.
- 2 David Rapson, Associate Professor, Department of Economics, University of California, Davis, July 13, 2017. Charles Kolstad, Senior Fellow, Institute for Economic Policy Research, Stanford University, July 6, 2017.
- 3 James A. Espey and M. Espey, "Turning On the Lights: A Meta-Analysis of Residential Electricity Demand Elasticities," *Journal of Agricultural and Applied Economics*, vol. 36, no. 1, 2004, p. 65–81.
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- 5 Koichiro Ito, "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing," *American Economic Review*, vol. 104, no. 2, 2014, p. 537–563.
- 6 Anna Alberini and M. Filippini, "Response of Residential Electricity Demand to Price: Effect of Measurement Error," *Energy Economics*, vol. 33, 2011, p. 889–895.
- 7 Masahide Kondo, S. Hoshi, and I. Okubo, "Does Subsidy Work? Price Elasticity of Demand for Influenza Vaccination Among the Elderly in Japan," *Health Policy*, vol. 91, 2009, p. 269–276.
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- 9 Molly Espey, J. Espey, and W.D. Shaw, "Price Elasticity of Residential Demand for Water: A Meta-Analysis," *Water Resources Research*, vol. 33, no. 6, 1997, p. 1,369–1,374.
- 10 Lisa M. Powell et al., "Assessing the Potential Effectiveness of Food and Beverage Taxes and Subsidies for Improving Public Health: A Systematic Review of Prices, Demand and Body Weight Outcomes," *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, vol. 14, no. 2, 2013, p. 110–128.
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- 13 Ahmad Faruqui and S. Sergici, "Household Response to Dynamic Pricing of Electricity: A Survey of 15 Experiments," *Journal of Regulatory Economics*, vol. 38, no. 2, 2010, p. 193–225.



**Written by Tim Scott and Paul Jacobs.** The California Senate Office of Research is a nonpartisan office charged with serving the research needs of the California State Senate and assisting Senate members and committees with the development of effective public policy. The office was established by the Senate Rules Committee in 1969. For more information, please visit <http://sor.senate.ca.gov> or call (916) 651-1500.