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TECHNICAL
REPORT

# Regional Differences in the Price-Elasticity of Demand For Energy

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Prepared for the National Renewable Energy Laboratory


INFRASTRUCTURE, SAFETY, AND ENVIRONMENT

The research described in this report was conducted under the auspices of the Environment, Energy, and Economic Development Program (EEED) within RAND Infrastructure, Safety, and Environment (ISE), a division of the RAND Corporation, for the National Renewable Energy Laboratory.



Published 2005 by the RAND Corporation
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**Summary**

The Department of Energy (DoE) Office of Energy Efficiency and Renewable Energy (EERE) has a portfolio of energy efficiency research and development programs that is intended to spur development of energy-efficient technologies. The goal of these programs is to decrease costs and improve efficiency of emerging technologies and increase the potential for consumers and businesses to adopt them. EERE, under requirements of the Government Performance Results Act (GPRA), must estimate the benefits of their portfolio of energy efficiency programs. With these estimates of benefits, EERE can then assess the cost-effectiveness of its programs and use this information in allocating its budget.

Currently, EERE estimates the benefits of its programs by analyzing their effects using the DoE's National Energy Modeling System (NEMS), a complex model of the U.S. energy system. Because the projected benefits of their programs depend heavily on the NEMS model, EERE is interested to know if certain assumptions in the NEMS model might impact the projected benefits. Specifically, the NEMS model uses data and parameters aggregated to the regional and national levels. If, for instance, the data or parameters used in the analysis actually vary considerably within a region, then NEMS will project biased results and using more disaggregated data—possibly at the state or utility level—could improve accuracy of the results. In this study, we examine how trends in several measures of the energy market may vary at the state and regional levels and in particular how one important parameter used in the NEMS model, price elasticity of demand (a measure of how demand responds to price), varies at the national, regional, state, and utility levels. With this initial examination, we offer some recommendations on whether EERE can improve their benefit estimates by using more disaggregated data in analysis of their programs.

Economic theory says that as energy prices rise, the quantity of energy demanded will fall, holding all other factors constant. Price elasticities are typically in the negative range, which indicates that demand falls as prices increase or, conversely, that demand increases as prices fall.

To determine if regional, state, or sub-state characteristics could affect the size of the impact from energy-efficiency technologies on energy prices, supply, and consumption, we looked at how individual factors—such as climate, supply constraints, energy costs, and demand for natural gas—might themselves affect the extent of the impact of energy efficiency.

### *Are There Regional Differences in the Price-Demand Relationship?*

The object of this study is to determine whether the relationship between prices and demand differs at the regional, state, or sub-state level. In this study, we were interested solely in determining whether there are geographic differences in the price-demand relationship. We did not seek to understand how demand might impact prices and vice-versa, although some of our findings provide some insights into these issues. Our focus was on finding out whether the state- and regional-level differences were significant enough to recommend to the DOE that it should explore disaggregating its data by state or region when estimating the potential benefits of energy efficiency.

We examined three energy-demand components—electricity use in the residential sector, natural gas use in the residential sector, and electricity use in the commercial sector—at three or four levels of disaggregation of the data, depending on the availability of data. For each sector, we looked at national, regional, and state-level results. We also examined residential electricity use at the electric-utility level.

Our analysis indicates that there are regional and state differences in the price-demand relationship for electricity and natural gas. We did find, though, that there tends to be some consistency in residential electricity use among states within a region and visible differences between regions in demand and price trends, particularly for residential electricity use and less so for commercial electricity use or residential natural gas use. What this implies, for estimating the impact of energy-efficiency technologies, is that the DOE may have reason to explore differentiating the impacts of energy efficiency by region, at least for residential electricity. There does not seem to be a need, at least in the

short run, for further disaggregation by geographic area, although more research is needed to offer a more conclusive recommendation.

We also found that the relationship between demand and price is small. That is, demand is relatively *inelastic* to price. We also found that in the past 20 years, this relationship has not changed significantly; analyses performed in the 1980s[1] showed approximately the same results. These findings might imply that there are few options available to the consumer in response to changes in the price of energy, and that price does not respond much to changes in demand. On the other hand, because prices were declining in real terms over most of the period we studied, the inelasticity of demand may be more of an artifact of the lack of price increases.

However, we now may be witnessing some changes in this area. The past few years have seen some increases in energy prices, with some states facing increasing electricity prices and all states facing increasing natural gas prices. While it is difficult statistically to uncover specific changes in trends, there are signs that demand growth has slowed, possibly due to a combination of increasing or flat prices and the economic slowdown of the past few years. Although we cannot say specifically that the relationship between price and demand might shift in an increasing-price environment, more analysis of recent trends may be warranted.

[1] Bohi, Douglas R., and Mary Beth Zimmerman, "An Update on Econometric Studies of Energy Demand Behavior," *Annual Review of Energy,* Vol. 9, 1984, pp. 105–154; Dahl, Carol A., "Do Gasoline Demand Elasticities Vary?" *Land Economics*, Vol. 58, No. 3, August 1982, pp. 373–382; and Dahl, Carol A. and Thomas Sterner, "Analyzing Gasoline Demand Elasticities: A Survey," *Energy Economics*, July 1991, pp. 203–210.