Science and Technology Policy Institute

State-Level Changes in Energy Intensity and Their National Implications

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Preface

About This Analysis

In May 2001, the Bush administration released its National Energy Policy. Several of the policy's recommendations call for the U.S. Department of Energy (DOE) to explore opportunities and implement programs for further improving U.S. energy intensity (defined as energy consumption per dollar of gross economic output).

At the request of the DOE's Office of Energy Efficiency and Renewable Energy, RAND examined changes in energy intensity across states from 1977 through 1999 as part of a larger effort to identify factors at the state level that have contributed to efficient energy use. This study is intended as a first step in helping the DOE to identify state actions that may have led to reductions in energy intensity over the past two decades.

This report should be useful to policymakers at the national and state level who are interested in better understanding changes in energy intensity and the cause of those changes. Technical appendices are provided in this report for analysts and others who want to delve more deeply into the analytical approach and data used in this study.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was created in 1976 to provide the president of the United States with timely policy advice and to coordinate the federal investment in science and technology.

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- helps to improve understanding in both the public and private sectors of the ways in which science and technology can better serve national objectives.

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Summary

The National Energy Policy (NEP) released by the Bush administration in 2001 calls for continued reductions in *energy intensity*, which is typically defined as *energy consumption per dollar of gross economic output.* This study helps to identify states in which energy intensity has declined most sharply after taking into account non-policy-related factors that influence changes in energy intensity.

The analysis in this report is a first step toward understanding

- how changes (i.e., increases or decreases) in energy intensity differed across states over the past two decades
- how much of those changes is attributable to factors we can measure
- how much of those changes is potentially due to unobserved factors, which could possibly include state-level energy policies and actions.

States vary significantly in how they use energy, which is well illustrated by the changes in energy use by state over the past 20 or so years. In absolute terms, energy intensity varies substantially among states, but the magnitude and direction of change in energy intensity also vary significantly.

Analysis of energy intensity in the United States is often done at the national or energy-consuming-sector level. Because there is significant variation in energy intensity among states, we recognized that having more-disaggregate data could provide a more-robust set of analyses that may uncover additional information on what affects changes in energy intensity.

In this report, we examine changes in energy intensity in each of the 48 contiguous states, and we examine changes in energy intensity in the states' residential, commercial, industrial, and transportation energy-consuming sectors over the 1977–1999 study period. In attempting to better understand the variation in changes in energy intensity among states, we identified a number of factors that may explain why some states had different patterns of energy intensity than others. Those factors include:

- Energy prices
- Composition of an economic sector's output (e.g., the mix or type of industrial or commercial activities)

- Capacity utilization
- Capital investment and new construction
- Population and demographics
- Climate
- Technological innovation
- Energy policies and actions of national, state, and local governments.

The primary goal of this study is to measure how energy intensity varies across and within states, net of the effects of energy prices and other measured determinants of energy intensity. To this end, we use econometric techniques to model energy intensity as a function of four components:

- Measured variables (which we call the "factor effect")
- Fixed differences across states—i.e., unmeasured factors that are fixed in time but vary across states
- An aggregate time trend—i.e., unmeasured factors common to all states (which we call the "common effect")
- A "residual energy intensity" that varies across and within states.

In this report, we focus on residual energy intensity, which is a given state's energy intensity that cannot be explained by observed factors or by overall time trends. We do not know exactly what is "contained" in the residual, but we assume that it may partly represent unobserved differences in energy-related policy both across and within states over time.

We use estimated average annual percentage changes in energy intensity to rank the states in two ways: First, we rank states simply by their average annual percent change in observed energy intensity; second, we rank states by their average annual percent change in residual energy intensity. Thus, the second ranking tells us which states experienced the largest declines in energy intensity net of changes in observed factors.

We show which factors are important to understanding the variations in energy intensity among the four major energy-consuming sectors—residential, commercial, industrial, and transportation—and the variations in energy intensity over time. By examining the effect that certain factors have on changes in energy intensity in the energy-consuming sectors, we can explain large amounts of the variation among states and can begin to understand how those factors can affect energy use in each state. Clearly, energy prices and the structure of the economy are important factors in energy use, and to the extent

that states can influence these factors, they can have some influence on energy use. Certain common effects are likely to continue absent any state actions, although, as we show in this report, those common effects differ over time.

We report on the states that had the greatest reductions in energy intensity over the full study period, 1977–1999, and over two subperiods, 1977–1987 and 1988–1999. We show results by total energy intensity and by each of the four major energy-consuming sectors. For each of those sectors, we list the top-ranked states in terms of actual reductions in energy intensity and reductions in residuals. For example, Figure S.1 illustrates the amount of the common effect, factor effect, and residual energy intensity for the five states with the greatest residual reduction in 1988–1999. These states had significant reductions in energy intensity over this period and had annual reductions in residuals or unexplained reductions in energy intensity that were more than 0.7 percent above what we would have predicted after taking into account the factor effects.

We also present some estimates of future possibilities for trends in energy intensity. If the unexplained reductions in energy intensity are dominated by the effects of policies and programs, and if the performance of the top five states were to be replicated in the other states, the United States could reduce its energy

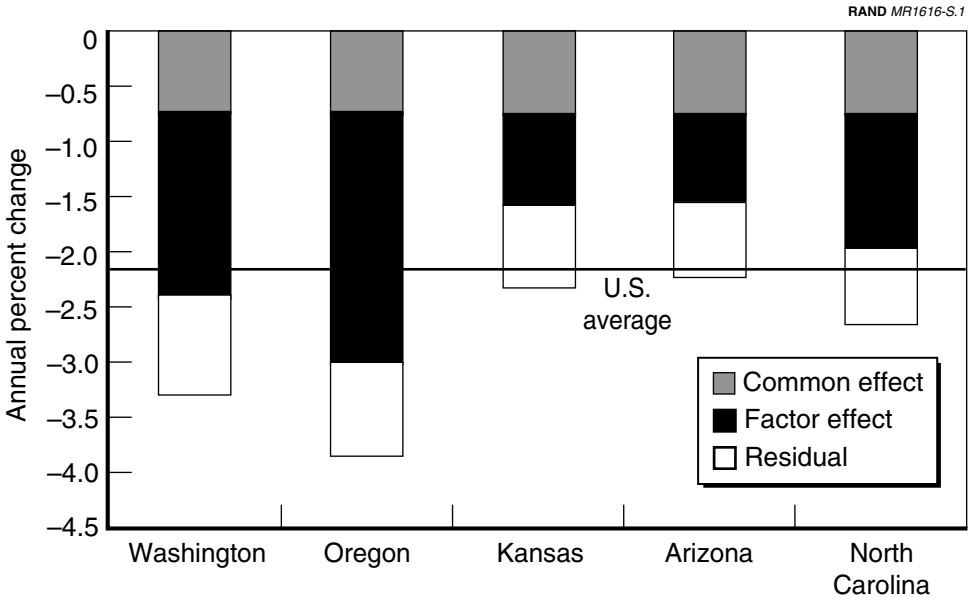

Figure S.1—Common Effect, Factor Effect, and Residual Energy Intensity for the Five Top-Ranked States in Residual Energy Intensity Reductions, 1988–1999

intensity overall by more than 3 percent per year, as opposed to the business-as-usual forecast from the Energy Information Administration of an approximately 1.5 percent reduction per year. The results from this study suggest that there may be opportunities for the DOE to enhance its involvement in helping states share information and provide guidance on effective state-level actions to reduce energy intensity.

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Acronyms

ACEEE	American Council for an Energy Efficient Economy
BEA	Bureau of Economic Analysis
Btu	British thermal unit
CEI	Commercial (sector) energy intensity
DOE	U.S. Department of Energy
DSM	Demand-side management
EI	Energy intensity
EIA	Energy Information Administration
F	Fahrenheit
F.I.R.E.	Finance, Insurance, and Real Estate
GDP	Gross domestic product
GSP	Gross state product
IEI	Industrial (sector) energy intensity
mmbtu	Million(s) British thermal units
NEP	National Energy Policy
NS	Not significant
OSTP	Office of Science and Technology Policy
REI	Residential (sector) energy intensity
SIC	Standard Industrial Classification
TEI	Transportation (sector) energy intensity