Nearly every U.S. state and territory has a building code that mentions energy efficiency. At least 11 states and Washington, D.C., have energy appliance standards. According to data compiled by the North Carolina Solar Center and the Interstate Renewable Energy Council, state and local governments have more than 1,000 financial incentive programs to encourage energy efficiency.

But whether states and local governments are getting what they pay for is a matter of debate. A 2004 audit by a private consulting firm of the California Public Utility Commission’s more than 200 efficiency programs concluded that they generated only 75 percent of the expected energy savings.

The Rebound Effect

The world of energy efficiency rarely finds itself at the hub of controversial policy debates. It often bridges philosophical and political divides because much of the conventional thinking in the energy and environmental policy arena promotes efficiency improvements as the easiest way to save money for businesses and consumers, reduce energy consumption, as well as lower air emissions. A common refrain used in policy circles is “the cheapest dollar is always the one you don’t have to spend.”

However, studies by environmental and free-market research groups, such as The Breakthrough Institute and the Institute for Energy Research, have questioned the projections of overall reductions in energy consumption promised by energy efficiency standards because of a theory called the rebound effect. Economic literature studies have found several instances where consumers take the savings gained from energy efficiency to purchase new goods or services requiring more energy—like home electronics or appliances—thus producing a rebound of energy consumption. Indirect energy increases that could have economy-wide impacts also have been observed. Those increases come because efficiencies gained in the production or manufacturing process by industry drive down the cost of goods and encourages more consumption overall in other unforeseen ways.

Critics of the rebound effect say there is no direct causality between efficiency improvements and additional energy consumption, and contend that the existence of rebound is minimal at best for developed nations like the United States. Increases in wealth and disposable income are more likely responsible for increases in energy consumption, in their opinion, than gains in energy efficiency.

Origins of the Rebound Effect

William Jevons, a 19th century British economist, provides the foundation of the rebound effect theory. Jevons was interested in enhancing the role of coal-fired steam engine technologies that ultimately became the driving force behind much of the Industrial Revolution. His initial inquiries were aimed at finding additional ways to enhance the capabilities of Britain’s substantial coal reserves to avoid or mitigate negative economic consequences when supplies ran out. His findings, however, pointed to a different conclusion. Coal only had value as a transportation fuel if
it could be cheaply converted into commercial use. He posited that a more fuel-efficient engine would lead to more coal-burning rather than less because inventors and related industries would devise ways to derive more work per unit of fuel and make cheaper engines. The engineering principles gleaned from engine production would later be applied to locomotives, ships and other manufacturing industries — especially steel production — which all drove increases in coal mining. By driving down the cost of travel and goods, consumers had more money to spend and invest. The Jevons case is one of the clearer examples of energy rebound because the amount of energy consumption unleashed by steam engine efficiency improvements was tremendous. It was so big that it would fall into a category that economists and policymakers describe as backfire, which is increase in rebound levels exceeding 100 percent.

Beginnings of the Current Policy Debate

Although the rebound effect theory dates back to the 19th century, interest in it and its applications for energy and climate policy grew in 2010 after a controversial article was published in the New Yorker. The article, “The Efficiency Dilemma,” chronicled a cascading array of negative effects that increased energy efficiency in refrigeration, cooling and transportation have had on the environment. Author David Owens suggested that declining costs in refrigeration have made nearly all aspects of food preparation more cost-efficient, which has made the cost of throwing away edible food fall substantially. In turn, that food required more water, fertilizer and energy to produce it in the first place, which are examples of indirect rebounds.

Further, consumers have used energy efficiency gains in refrigeration to purchase larger appliances, which require more energy. As a majority of electricity is still derived from fossil fuels, those energy increases are negating the benefits of enhanced efficiency. For example, Owens noted that air conditioners in the U.S. increased their energy efficiency by 28 percent from 1993 to 2005, but homes with air conditioning increased their consumption of energy for those appliances by 37 percent — representing an example of backfire, which is an increase in rebound levels exceeding 100 percent.

The article stirred a passionate debate, with think tanks and environmental advocacy organizations issuing forceful rebuttals stating two key factors were omitted in the discussion: economic growth (leading to more disposable incomes and larger home sizes), and gains made in energy efficiency are not actually “lost” during a rebound scenario. James Barrett, an economist with the Clean Economy Development Center, found that real per capita income had grown more than 30 percent and the average home size for U.S. households had increased by 16 percent during the time period referenced by Owens when air conditioning use increased.

An August 2012 white paper on the rebound effect from the American Council for an Energy-Efficient Economy argued that critics of efficiency standards and programs, like Owens, had overstated the prevalence of backfire. According to the report, more than 100 studies conducted to examine the direct rebound effects of specific energy efficiency programs found that direct rebound effects generally are 10 percent or less. Indirect rebound effects, a field the Council and other advocacy groups believe is less understood along macroeconomic lines, are generally thought to be around 11 percent depending on the type of industry examined. Thus, the council postulates rebound effects of roughly 20 percent do not cancel out the benefits of an 80 percent gain in energy efficiency improvements or the overall economic benefits to the economy.

After an examination of economic literature, The Breakthrough Institute stated in a February 2011 report that, “Rebound effects are real and significant, and combine to drive a total, economy-wide rebound in energy demand with the potential to erode much (and in some cases all) of the reductions in energy consumption expected to arise from below-cost efficiency improvements.” (Below-cost improvements typically mean a particular efficiency program provides more in overall net energy savings than it actually costs and improvements to economic welfare.) Consumer choices in the auto industry offer a compelling real-world example. A December 2011 peer-reviewed study by MIT economist Christopher Knittel found that technological advancements improved efficiencies in auto engines by 60 percent between 1980 and 2006. The public, in theory, could have been driving cars that were 60 percent more fuel efficient over that same time period if vehicle weight and engine performance characteristics remained constant. Consumers, however, chose to use the vast majority of those efficiency improvements to increase engine performance and vehicle weight as the average horsepower and vehicle weight of the U.S. vehicle fleet increased by 99 percent and 26 respectively from the mid-1980s to 2004.

To address these types of conundrums associated with rebound effects, The Breakthrough Institute has suggested direct policy controls — carbon pricing poli-
cies (i.e., a carbon emissions tax) or a cap and trade system for carbon emissions—to mitigate against energy rebounds.10

**New Rebound Study**

Robert Michaels’ July 2012 study for the Institute for Energy Research offers a more skeptical view of the ability or capability of governments to confront the issue with regulation. Although energy efficiency regulations have been virtually exempt from political criticism, Michaels said, that time is coming to an end. Energy savings are becoming harder and more expensive, he said, and more policymakers are becoming aware of the rebound effect.11

Instead, the Cal State-Fullerton economist suggests that price signals from market forces and the promotion of disruptive technological innovations are a sounder course for policymakers to chart rather than efficiency mandates or technology forcing solutions. He shares several examples of backfire in various countries, including China, Spain and Norway, citing international studies showing substantial increases in economy-wide rebound due to government efficiency mandates.12 For example, Roberts cites a 2004 study that appeared in *Energy Economics* that found more than a 100 percent rebound, or backfire, occurred as efficiencies doubled in the oil and electricity sector.13 In 2010, another study found that a 5 percent improvement in energy efficiency across several industrial sectors in Spain generated backfire of 177 percent.14 His research found that when studies used an economy-wide estimate of rebound effects through a “computable general equilibrium” model, which measures inputs and outputs between various industrial sectors for very long periods of time, that the energy backfire phenomenon occurs more than half the time.15

In essence, Roberts found that rebound effects and backfire are frequently observed when efficiency programs and rebates are studied on an economy-wide basis that takes into account the ramifications mandates have on manufacturing and energy production which spur unexpected consumer demand in other sectors. Roberts argues that promoters of efficiency mandates have not thoroughly examined its unintended consequences in all facets of the economy, especially with indirect rebound, because cheaper efficiencies gained in other industries will drive up consumption that negates touted energy savings.

**State Implications of Rebound**

Economists urge caution when states are considering new energy efficiency policies and programs.

California’s 2010 Cash for Appliances program provides another instance of the potential unintended consequences of efficiency incentives. Under the initiative, consumers received a $200 rebate for purchasing energy-efficient appliances that exceeded the standards of the Energy Star program, the federal government’s energy efficiency labeling initiative. Exceeding the Energy Star efficiency standards can be difficult for some smaller refrigerators because of current product engineering limitations. A policy expert with the Council on Foreign Relations showed that the rebate could be used to purchase a much larger refrigerator, which uses 76 percent more energy than the smaller one, at a cheaper price because it met the technical definition of exceeding Energy Star requirements.16

In March 2012, the Nevada Public Utilities Commission voted to cut the energy conservation incentives of the state’s largest utility, NV Energy, by more than $20 million. The incentives helped pay for second refrigerator recycling programs and rebates for compact fluorescent light bulbs. The commission felt many consumers were getting rebates for decisions they already would make when purchasing new refrigerators and compact fluorescent light bulbs—especially since state law requires the phasing out of 60-watt incandescent bulbs.17

These examples are not intended to discourage or disparage interest or adoption of energy efficiency programs by states. A host of academic studies and policy information supports the sound economic and environmental benefits of improving energy efficiency. The important takeaway for states in setting energy efficiency policies, especially rebate programs, is to think critically about its structure and built-in assumptions, which can potentially overestimate the amount of energy savings and carbon emission or air pollutant reductions.
REFERENCES


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