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Energy Efficiency and the Rebound Effect: Does Increasing Efficiency Decrease Demand?

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Summary

Intuitively it seems obvious to most observers that increasing energy efficiency will ultimately reduce demand for an energy resource such as electricity. Paradoxically, economic theory suggests that this decrease in demand and subsequent decrease in cost of using the resource could cause a rebound in demand. A commonly cited example is an increase in the efficiency of home air conditioning which may reduce the resident's monetary incentive to conserve. The resident may opt to change the thermostat setting to keep the amount he pays constant, but living at a more comfortable temperature. When actually measured this "Rebound Effect" is generally acknowledged to lower predicted reductions in electricity demand by 10%-40% depending on the device that is made more efficient. This report will be updated as events warrant.

Introduction

Several bills introduced in the 107th Congress focus on increasing energy efficiency. Three bills in particular have been reported in the House that aim to promote energy efficiency through tax credits, grants, efficiency standard mandates or increased money for energy efficiency research (H.R. 2587, H.R. 2511, and H.R. 2460, all of which have been incorporated into H.R. 4). However some have suggested that government-supported efforts to conserve energy by increasing efficiency will not produce the expected results because of the "Rebound Effect"[1]. This brief paper describes the rebound effect and outlines the current thinking of those studying this effect.

The rebound effect (also referred to as the "take-back" or "snap-back") was first described in 1865 when Stanley Jevons observed that the introduction of the new efficient

[1] see K. Strassel, *Conservation wastes money*, Wall Street Journal, May 17, 2001, Eastern Edition, p. A26; F. Pearce, *Consuming myths*, New Scientist, September 5, 1998, p. 18-19; and J. Glassman, *The conservation myth as the latest (sub)urban legend*, [http://www.TechCentralStation.com/NewsDesk.asp?FormMode=MainTerminalArticles&ID=68]

steam engine initially decreased coal consumption which led to a drop in the price of coal. This meant not only that more people could afford coal, but also that coal was now economically viable for new uses, which ultimately greatly increased coal consumption[2]. More recently, analysts have focused on the rebound effect in the electricity and gasoline markets. If a large rebound effect exists in these markets, it could weaken arguments for increased efficiency requirements and strengthen arguments to scale back such efforts.

Definition of the Rebound Effect

The rebound effect is most simply measured by the difference between the projected and actual savings due to increased efficiency. The rebound effect consists of direct, indirect and macroeconomic effects that can happen following the installation of more efficient equipment.

Direct Effects - The consumer chooses to use more of the resource instead of realizing the energy cost savings. For example, a person with a more efficient home heater may chose to raise the setting on the thermostat or a person driving a more efficient car may drive more. This effect is limited since a person will only set the thermostat so high or have so many hours to spend driving.

Indirect Effects - The consumer chooses to spend the money saved by buying other goods which use the same resource. For example, a person whose electric bill decreases due to a more efficient air conditioner may use the savings to buy more electronic goods.

Market or Dynamic Effects - Decreased demand for a resource leads to a lower resource price, making new uses economically viable. For example, residential electricity was initially used mainly for lighting, but as the price dropped many new electric devices became common. This is the most difficult aspect of the rebound effect to predict and to measure.

Theory Versus Practice

Under certain circumstances, the rebound effect could actually turn an increase in efficiency into an increase in demand. However this has only happened in very special cases such as in some developing countries or in new markets such as the coal market in the mid 1800s or the electricity market in the early 1900s. For mature markets, it is generally accepted that although real the rebound effect is limited[3]. The actual rebound depends on many variables, including specific resource, the specific device and how developed the resource market and overall economy are.

Actual measures of the rebound effect for electric end-use equipment have been found to be between 0% and 40%[4]. That is, the actual decrease in demand realized can range from 100% to about 60% of the projected amount. The result is very dependent on

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[2] W.S. Jevons *The coal question: can Britain survive?* First published 1865, Republished Macmillan, London 1906.

[3] Lee Schipper, *On the rebound: the interaction of energy efficiency, energy use and economic activity. An introduction.* Energy Policy 28 (2000): 351-353.

[4] L. Schipper, p. 353

the type of device. For example, increasing the efficiency of home appliances (so called "white goods") showed no measurable rebound effect, while the rebound for space heating or cooling units ranged from 0% to 50% (see Table 1). The rebound effect for increasing automobile fuel economy has also been much studied. This rebound is generally reported to range between 10% and 30%[5].

Table 1. Measured Rebound Effects on Various Devices.

DEVICE	SIZE OF REBOUND	NUMBER OF STUDIES
Space Heating	10-30%	26
Space Cooling	0-50%	9
Water Heating	10-40%	5
Residential Lighting	5-12%	4
Home Appliances	0%	2
Automobiles	10-30%	23

Adapted from L.A. Greening *Energy Policy* (2000) 28:398

Effects on Policy

Energy Efficiency.

There has been much debate on the role government-supported increases in energy efficiency should play in the development of national energy policy. At one end of the spectrum, some have even suggested increases in efficiency are counterproductive because the rebound effect will lead to increased demand. Although most experts agree that this is theoretically possible, in the U.S. domestic electricity and gasoline markets the rebound effect will likely not exceed 10% to 40%, depending on which device is improved[6].

Policy makers may be able to more accurately gauge the true benefits of proposed efficiency programs by accounting for the rebound effect. For instance, some may consider it desirable to increase appliance efficiency or fuel economy standards even further than previously suggested to compensate for the predicted rebound effect. On the other hand, some policy makers may feel that the proposed energy savings have been reduced to the point to make the program no longer cost effective. Another choice could be to keep the same program but slightly lower expectations of the benefits. In any event, it should help policy makers objectively evaluate programs to know if the proponents of a plan have accounted for the possible rebound effect in their projections of energy savings.

It is important to remember that losses in energy savings due to the rebound effect would generally be associated with gains in quality of life of the consumer. That is the

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[5] L.A. Greening, *Energy efficiency and consumption - the rebound effect - a survey*, Energy Policy (2000) 28: 389-401

[6] L. Schipper, p. 351

recipient of a more efficient heater can choose to live in a warmer house or spend the energy cost savings on some other consumer good.

Greenhouse Gas Emissions.

The rebound effect can increase the difficulty of projecting the reduction in greenhouse emissions from an improvement in energy efficiency. For example, a consumer who saves money on his heating bill may spend it on a more carbon intensive activity. Alternatively, the money could be spent on a less carbon intensive activity. Currently, the only general agreement among specialists in this field, is that it is likely that increases in energy efficiency will reduce carbon emissions per unit of Gross Domestic Product[7]. Some argue that this suggests that increasing efficiency through government efforts is the best route to reduce emissions while others argue that the market would produce the same or better results without government intervention[8].

For Additional Reading

On the rebound: the interaction of energy efficiency, energy use and economic activity Energy Policy, v.28 (6-7), June 2000 p.351-500, L. Schipper ed.

U. S. Dept. of Energy, *An econometric analysis of the elasticity of vehicle travel with respect to fuel cost per mile using RTEC survey data.* ORNL-6950.

CRS Report RL30414. *Global Climate Change: The Role for Energy Efficiency,* by Fred Sissine.

CRS Report IB10020. *Energy Efficiency: Budget, Oil Conservation, and Electricity Conservation Issues*, by Fred Sissine.

[7] L. Schipper, p. 351

[8] J. Glassman, p. 2