The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture

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Foreword

Since its inception in 1981, ACEEE has produced a wide variety of reports and assessments focused on energy efficiency as a low-cost, reliable alternative to our nation's growing energy demands. This report departs from ACEEE's traditional focus on energy efficiency as a resource and instead frames efficiency as an invisible powerhouse and an underappreciated investment opportunity. As such, this new ACEEE publication seeks to quantify the size and scope of current investments in energy efficiency technologies both in terms of dollars invested and labor employed. The core question driving the current assessment is, "How Big Is Energy Efficiency in the U.S.?" Despite numerous obstacles and challenges, the authors successfully develop credible estimates of current spending on efficiency and discuss how those investments compare to annual investments in conventional energy supply. The results suggest that our nation is not aware of the role that energy efficiency has played in satisfying our growing energy service demands.

While this research effort is undoubtedly ambitious, the lack of appropriate data makes it even more challenging. Despite the plethora of the data collected and maintained by both government and private sources, measures of the cost of energy efficiency technologies are not collected. Similarly, while data on the annual contribution of energy supply resources are available, data on the annual contribution of efficiency resources are not. For that reason, the authors of this analysis, sociologist Karen Ehrhardt-Martinez and economist John A. "Skip" Laitner, have had to pull together a multidisciplinary analysis that draws on an interesting blend of economics, technology characterization, and working assumptions in providing a first estimate of the scale of the efficiency resource. As a starting point they've chosen the historical test-year 2004 to frame their inquiry and their methodology.

The results of this analysis may surprise some but will hopefully capture the attention of policymakers, business leaders, and the investment community more generally. Notably, since 1970 it appears that energy efficiency has met about three-fourths of the demand for new energy-related services while conventional energy supply has provided only one-fourth of this demand. Nevertheless, the contributions of efficiency frequently go unrecognized. As the authors note, efficiency is the energy we don't use in providing our nation with the goods and services needed to maintain our economy. The report also notes that although efficiency is a proven resource, it remains underdeveloped. In short, the evidence suggests that efficiency can make an even larger contribution towards stabilizing energy prices and reducing greenhouse gas emissions — should we choose to fully develop it. But this is hardly the last word in this investigation. This study provides a starting point for discussion. We anticipate and welcome further contributions to our effort.

Steven Nadel
Executive Director, ACEEE
May 2008

Acknowledgments

The year of research and planning that ultimately came to fruition in the publishing of this report occurred in parallel to another journey upon which the authors recently embarked: a backpacking adventure to the bottom of the Grand Canyon. Both adventures were sufficiently challenging so as to test the endurance, dedication and fortitude of the participants. Both adventures involved taking a calculated and well-planned leap into a large abyss with multiple unknown variables and few, scattered, and sometimes less-than-reliable resources. Despite the difficulties endured, we are pleased to report that we successfully survived both adventures, emerging with greater knowledge of and appreciation for the task that was accomplished and grateful for the help that we received from others along the way.

Of the highest priority, the authors gratefully acknowledge the support of the Civil Society Institute, the North American Insulation Manufacturers Association (NAIMA), and the Kendall Foundation, which helped underwrite this report. Each of these foundations gave us the impetus to move ahead with this initial research effort. We would also like to acknowledge the support of the Energy Foundation, which provided the means to establish the necessary framework within which this research was undertaken.

We are also grateful to the members of the project advisory committee who provided timely comments, insights, and expert opinions — often under significant time constraints — and who helped guide our decisions regarding research methodology, data sources, and underlying assumptions. Their support and encouragement were invaluable in structuring, formulating, and reformulating our research strategy and tactics and the development of our thinking around many of the issues discussed herein.

Finally, the authors would like to recognize the wide-ranging support provided by numerous ACEEE staff members. Glee Murray, Renee Nida, Sarah Black, and Katie Ackerly provided invaluable assistance in the editing, design, and layout of this publication. Vanessa McKinney provided assisted in data collection and assessment. Steve Nadel, Bill Prindle, Neal Elliott, and Harvey Sachs rightfully gave us pause to consider and reconsider the focus, flavor, and emphasis of our work.

Executive Summary

Energy efficiency is a means of using less energy to provide the same (or greater) level of energy services. With efficiency we can drive the same distance with less gasoline or watch the same program with fewer kilowatt-hours of electricity.[1] Achieving greater efficiency requires us to change our technologies, our behaviors, or both. Making these changes necessitates the spending of time, or money, or both. Importantly, however, these costs are not simply expenditures but investments that yield returns in the form of energy savings and often reduce resource consumption in other ways. When considered together, investments in energy efficiency technologies constitute a unique means of providing energy services, while lowering energy consumption and reducing our environmental impact. Taken together, these investments comprise what might be called an energy efficiency market.

Just how big is the market for energy efficiency technologies? How much do we invest annually in that market? What level of energy savings have we achieved? How much more could we invest? Why aren't we investing more to reduce the energy we waste? What could we gain from greater energy productivity? Would it be worth the cost? What should we do to further develop the full array of energy efficiency resources? These are the questions that are the subject of this report.

Whether the goal is reducing the impact of climate change, increasing energy security, or improving economic productivity, energy efficiency is among the most cost-effective solutions available to consumers, businesses, policymakers, and investors. Nevertheless, researchers have yet to establish a clear picture of the size and scale of current efficiency investments. Because the energy efficiency technology market is fragmented and difficult to measure, policymakers, would-be investors, and the public are left without sufficient or accurate information as to its size, or its potential for growth. Unfortunately, the absence of a vivid efficiency picture serves to constrain alternative visions of viable and sustainable energy futures.

This report provides a unique assessment of the size and scale of current investments in the U.S. energy efficiency market and reveals the scope of potential benefits that future investments might yield. Ultimately our goal is threefold: (1) to increase the visibility of the contributions that efficiency currently makes to our economy; (2) to illustrate the potential contributions that efficiency can make in terms of energy security, economic productivity, and climate change mitigation; and (3) to recommend specific means of accelerating our transition to a more energy-productive, low-carbon economy.

Why is there a renewed focus on energy and efficiency? The evidence suggests that the transformation to a much more energy-productive economy is entirely possible. Indeed, there is a palpable shift in the opinions and preferences of policymakers and businesses leaders that may already be changing the market dynamics compared to standard economic forecasts. Consumers are also responding more positively in response to an array of market drivers and influences shaping the nation's energy productivity. Among the major influences are:

[1] See Section II and Appendix A for a more detailed discussion of how we define efficiency.

- Rising and more volatile energy prices
- Tight delivery capacity for conventional energy supplies
- Increased urgency in responding to the climate challenge
- Growing consumer and investor concerns about energy industry responsibility
- Accelerated pressure from global competition
- The rapid pace of technological advancements

Taken together, these six drivers have created a new and fertile environment for energy efficiency investments.

How much are we currently investing? In 2004, an estimated $300 billion was invested in energy efficiency technologies and infrastructure in the United States. This amount is three times the size of investments made in the conventional energy supply infrastructure but represents less than a third of the nation's total annual energy expenditures. Three hundred billion dollars represents the full cost associated with the efficiency technology investments, including the base cost of the technology needed to simply maintain previous levels of energy intensity, as well as the incremental cost needed to provide the increased level of productivity. If we narrow our focus to include solely the premium associated with improvements in energy efficiency technologies, the market (across all sectors of the economy) is estimated at roughly $43 billion.

How much energy did we save? These investments in energy efficiency technologies are estimated to have generated approximately 1.7 quads of energy savings in 2004 alone. In other words, had the nation maintained the same level of energy productivity as it had achieved in the year 2003, total primary energy use in 2004 would have reached 101.8 to 102.0 quads compared to the actual level of 100.3 quads documented in the databases maintained by the Energy Information Administration. These savings are roughly the equivalent of the total energy required by the operation of 40 mid-sized coal-fired power plants. By the end of 2008, these investments will have saved roughly 6.6 quads of energy on a cumulative basis or the equivalent of at least $77.4 billion (2004 $).

Which sectors received the most investment? Not surprisingly, the size of efficiency investments varied considerably across energy end use sectors. Approximately $178 billion or nearly 60% of total energy efficiency investments were made in the buildings sector. Of these investments, nearly half (49%) were made in energy-efficient appliances and electronics, while 29% were made in energy-efficient commercial building structures and 22% were made in energy-efficient residential building structures. Investments in energy efficiency in the industrial sector were roughly $75 billion, representing one-quarter of total efficiency investments. The transportation sector received approximately 11% of investments in efficiency or $33 billion.

Interestingly, this pattern of investments does not mirror the patterns of energy use across sectors. While energy consumption is highest in the building sector, buildings account for only 39% of total energy consumption compared to 62% of total efficiency investments. Within the buildings sector, investments in appliances and electronics (48%) far exceeded the proportion of energy consumed by these devices (7.7%). In the industrial sector, the proportion of investments was lower than the proportion of energy use (25% and 34%, respectively). Notably, however, the

transportation sector also proved to be significantly unbalanced, representing only 11% of efficiency investments but 28% of overall energy use.

Table ES-1. Energy Efficiency Investments Summary

	Buildings	Industrial	Transportation	Utilities	Total
Total Energy Use (quads)	38.9 (39%)	33.6 (33%)	27.9 (28%)		100.4 (100%)
Total Efficiency-Related Investments ($billion)	178	75	33	15.7	300
Premium Investments ($billion)	24	11	5	2	43
Investment- Related Employment (000)	990	351	151	139	1,630
Energy Savings (quads)	.72	.66	.08	.19	1.7
Energy Savings ($billion)	12.2	5.6	1.1	0.5	19.5

* Note: Totals may not match due to rounding.

How many jobs rely on efficiency investments? Annual investments in energy efficiency technologies also support a high level of employment across sectors. In total, 1.63 million jobs are supported by efficiency-related investments. If we consider all efficiency-related employment, the largest number of related jobs is found in the buildings sector, which generated approximately two-thirds of all efficiency-related jobs or nearly one million jobs. Within the buildings category, investments in the appliance and electronics sector generated the most jobs (more than 370,000), followed by efficiency-related jobs in residential construction and renovation (316,000) and commercial construction and renovation (301,000).[2] Other significant levels of employment are associated with investments in the industrial sector, which generated an estimated 351,000 jobs. Investments in energy efficiency in transport were lower, generating an estimated 151,000 jobs, while efficiency investments in the utility-sector employed roughly 139,000 workers in 2004.

How much more could we invest? While these figures indicate that, as a nation, we are clearly making positive strides toward increasing our energy productivity and reducing our carbon footprint, analysis performed for this report also suggests that we have only begun to scratch the surface of the potential savings that additional investments in energy efficiency technologies could provide. Although existing data make a precise assessment difficult, our research findings indicate that in an environment of accelerated market transformation and rapid growth in efficiency investments, total investments in more energy efficiency technologies could increase the annual energy efficiency market by nearly $400 billion by 2030, resulting in an annual efficiency market of more than $700 billion in 2030.

This estimate is based on two assumptions. The first is that the right set of policies, market forces, and new financing mechanisms could facilitate a cost-effective, 20% reduction in total energy use by 2030, compared to the forecast from *Annual Energy Outlook 2008* (EIA 2008b). The second is that movement "up the cost curve" implies a longer payback period for energy efficiency investments, beginning with a typical three-year payback today but rising to an average five-year payback by 2030. In that scenario, total cumulative investments in the

[2] These estimates include jobs in manufacturing, sales, installation, and other services.

efficiency technology infrastructure over the period 2008-2030 would increase by nearly $7 trillion.

What can we gain from efficiency? Given the right choices and investments in the many cost-effective but underutilized energy efficiency technologies, a variety of studies (by ACEEE and others) suggest that the United States can cost-effectively reduce energy consumption by 25-30% or more over the course of the next 20-25 years.

Conclusions. The energy-related challenges of the 21st century require a dramatic shift in direction, from an emphasis on energy supply to an emphasis on energy efficiency. While current investments in energy efficiency are having an important impact on our economy, efficiency remains under-funded, and the potential benefits of efficiency remain unrealized. Based on our assessment of existing impediments, we make the following three recommendations:

1. Improve the visibility of the energy efficiency resource through data collection and dissemination. We think this can best be done by creating a national energy efficiency data center.

2. Facilitate investments in energy efficiency technologies and services by expanding the range of investment options.

3. Promote and reward the adoption of energy efficiency technologies and services by identifying and providing social, political, and economic incentives and mechanisms that steer behavior toward sustainable energy practices.

I. Introduction

Currently, our nation consumes more energy than any other country in the world. In the United States our livelihoods and our lifestyles are rooted in, and shaped by, our access to energy and the many services that energy resources provide. Historically, our growing demand for energy services has been satiated primarily through the burning of fossil fuels. However, the energy-related challenges of the 21st century require a dramatic shift in direction. These challenges — ranging from the possibility of disruptive climate change and other environmental concerns to the adequacy of reliable energy supplies at stable and reasonable prices — require a new vision for the future. While the vision must undoubtedly be multi-faceted, affordable solutions to our energy challenges will require strategic investments in maximizing energy efficiency: efficiency investments that will save consumers and businesses money even as they productively reduce energy waste and greenhouse gas emissions. Hence, investments in energy efficiency not only offer the opportunity to build on the historical success and momentum of technological innovations and innovative behavioral change, they also make economic and environmental sense. As such, energy efficiency must become the first fuel of choice to meet our growing demand for energy services.

Although current levels of investment in energy efficiency are arguably inadequate and sub-optimal, energy efficiency is already hard at work in our economy. The irony is that energy efficiency may be best characterized as an *invisible* powerhouse, working behind the scenes to meet our nation's growing demand for goods and services. In many ways, efficiency resources and investments are hard to observe, to count, and to define because they represent the energy that we *don't use* to meet our energy service demands. And the energy that we don't use, almost by default, becomes the energy we don't see. Compared to the construction of a new power plant or the drilling of a new oil well, energy efficiency gains are often distributed across the many productive technologies and market behaviors that are part of the normal course of doing business. However, our very inability to observe, measure, and quantify efficiency acts as an impediment to smart policy, planning, and investment.

Irish satirist, poet, and essayist Jonathan Swift once commented, "Vision is the art of seeing the invisible." In terms of energy production and consumption, a smart energy future must make the invisible contribution of cost-effective energy efficiency investments much more evident so that we can recognize both their past contributions and future potential in helping us meet the energy-related challenges that lie ahead. As such, this report attempts to assist policymakers and business leaders in three ways. First, it provides an assessment of the historical contributions of efficiency and our (in)ability to foresee those contributions. Second, it identifies the forces that are currently shaping the renewed focus on energy and efficiency. And third, it offers "a more visibly concrete" and quantitative picture of the size and impact of current energy efficiency investments in terms of their energy bill savings, their significant environmental benefits, and their positive impact on job creation. The report concludes with a discussion of the future potential of efficiency investments and the mechanisms needed to achieve that potential.

Ultimately, the goal of this report is to enable economic policy leaders and investors to see energy efficiency investments as an accessible and perhaps even a critical resource for the future development of our economy. As such, we see this report as providing the vital information needed to assemble not only a coherent picture of the current contributions of energy efficiency

but also for envisioning a more productive and less energy-intensive future — because our vision of the future also influences our actions today. As long as the significant contributions of the many energy efficiency resources remain invisible, they are less able to play a role in shaping our vision of the future, thereby creating a poverty of choice. Unfortunately, the inadequate assessments of the energy efficiency resource, whether in policy forums or economic models, have forestalled productive investments in new programs, technologies, and markets. That, in turn, has retarded potentially significant gains in our nation's energy productivity.

II. The Facets of Efficiency and the Problem of Invisibility

Energy efficiency is a means of using less energy to provide the same (or greater) level of energy services. With efficiency we can drive the same distance with less gasoline or watch the same television program with fewer kilowatt-hours of electricity.[3] Achieving higher levels of efficiency requires that we change our technologies, our behaviors, or both. Making these changes necessitates the spending of time, or money, or both. Importantly, however, these costs are not merely expenditures but investments that yield returns in the form of energy savings and often reduce resource consumption in other ways. When considered together, investments in energy efficiency technologies constitute a unique means of providing energy services, while lowering energy consumption and reducing our environmental impact. Taken together, these investments comprise what might be called an energy efficiency market.

As we indicated in the opening section of this study, the purpose of this report is to enable economic policy leaders to see energy efficiency investments as an accessible and critical resource for the future development of our economy. Importantly, however, while energy efficiency is a distinct element of the larger energy and economic puzzle, it is also closely linked to several other economic concepts. Therefore, in order to generate a clearer picture of the role of energy efficiency, we must begin by defining and distinguishing several core concepts. Subsequently, we discuss the invisibility of efficiency and its implications for policy, planning, and future energy consumption.

A. Efficiency and Other Energy-Related Concepts

The concept of energy efficiency is commonly understood as the use of less energy to provide the same (or greater) level of energy service. However, to really place the idea of energy efficiency within a meaningful policy context, we should think of the energy picture in perhaps six different dimensions. In addition to energy efficiency, we reference the concepts of energy services, energy conservation, energy intensity, energy-related structural change, and overall energy productivity, as we define and describe them below.

(1) Energy services: As each individual, household, or company seeks to maintain a desired level of comfort or a specific level of economic activity, the achievement of these efforts requires a certain level of energy services. For example, when we want to read a book, we are looking for some given amount of light that makes it easier to enjoy the reading of that book. Or if we are making an effort to pay our monthly bills or perhaps complete the assembly of an automobile, there is an implied demand for energy that allows us to undertake and complete the requisite

[3] See Appendix A for a more detailed discussion of how we define efficiency.