Energy Efficiency in the U.S. Existing Building Stock: What's Worked; What Might Work Better

Paul Waide, International Energy Agency
Adam Hinge, Sustainable Energy Partnerships
Jennifer Thorne Amann, American Council for an Energy-Efficient Economy

ABSTRACT

The building stock in the USA accounts for approximately 40 quadrillion Btu of primary energy consumption, some 41% of combined national energy use. While much attention has been focused on policies and measures to improve the energy efficiency of new buildings, less has been directed at the existing building stock due to inherent and perceived difficulties of improving their energy performance. However, while freedom for action is constrained there is growing evidence that much can be achieved through targeted policies to encourage better energy management, cost effective upgrades of energy-using equipment and building fabric refurbishment.

This paper reports the findings of a new assessment of the techno-economic and policy-related efficiency improvement potentials of the US building stock, being conducted as part of a wider appraisal of existing buildings in member states of the International Energy Agency. The project assesses, as comprehensively as possible, impacts of previous policies and programs on building energy use in North America, and estimates future impacts of potential new efficiency policies for existing buildings. This paper summarizes the results and provides insights into lessons learned though the broader global review of best practices to improve the energy efficiency of existing buildings.

Introduction

The International Energy Agency (IEA) works within the framework of the Organization for Economic Cooperation and Development (OECD) to facilitate energy cooperation among member countries. The IEA's role includes reviewing the opportunities for energy savings in a variety of different energy use sectors. The buildings sector is a significant energy user around the globe, and in particular, the existing stock of buildings already built and consuming energy for the foreseeable future, represents a large opportunity for potential savings.

In 2004, in anticipation of a broader global review of policies and programs intended to improve the energy efficiency of the existing building stock, the IEA commissioned a review of historical initiatives in North America to feed into the broader global review of best practices in policies and programs for existing buildings. In 2005, at the G8 Summit in Gleneagles Scotland, world leaders further directed the IEA to develop indicators to assess efficiency in buildings and identify policy best practices. This broader international review is in early phases, but given the leading role of North America in the world economy, this review is an important contribution to the international best practices effort.

The results of this project as presented in this paper are initially looking at the US because of the size of the market. The complete review will include some details about policies and programs in Canada; additional review of Canada and Mexico may be performed at a later date.

Energy Use in U.S. Buildings

The building sector is the largest consumer of energy in the United States, using approximately 40.3 quadrillion Btu (quads) of energy in 2003—around 41 percent of total U.S. energy use. The 106 million households comprising the residential sector account for the largest portion of building sector energy use (21.3 quads), followed by 4.6 million commercial buildings (17.5 quads), and industrial buildings (2.0 quads) (DOE 2005). Most of the energy used in buildings is consumed by equipment that transforms fuel or electricity into end uses such as space heating or cooling, light, hot water, refrigeration, and other uses, as shown below in Table 1. Table 2 shows trends in energy use intensity in residential and commercial buildings, with average intensities dropping from 1980 to 1990 due to changes with higher energy prices, then rising in the 1990s as more electric equipment (such as office equipment and new consumer electronic appliances) is introduced into buildings.

Table 1. Primary Energy Use in U.S. Buildings, by End Use – 1997 & 2003

	1997		2003			1997		2003	
	Quads	%	Quads	%		Quads	%	Quads	%
Residential					**Commercial**				
Space Heating	7.1	37.4%	6.9	32.4%	Lighting	3.9	25.7%	4.3	24.6%
Space Cooling	1.7	8.9%	2.4	11.3%	Space Heating	2.6	17.1%	2.4	13.7%
Water Heating	2.7	14.2%	2.7	12.7%	Space Cooling	1.1	7.2%	1.9	10.9%
Refrigeration	2.5	13.2%	2.7	12.7%	Water Heating	1.1	7.2%	1.1	6.3%
Other Appliances	2.3	12.1%	2.2	10.3%	Ventilation	0.5	3.3%	1.1	6.3%
Lighting	1.3	6.8%	2.6	12.2%	Refrigeration	0.6	3.9%	1.0	5.7%
Other & Adjustments	1.4	7.4%	1.8	8.5%	Office Equipment	1.3	8.6%	1.5	8.6%
Total	19.0		21.3		Other & Adjustments	4.1	27.0%	4.2	24.0%
					Total	15.2		17.5	

Note: "Other & Adjustments" includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting; commercial service station equipment, ATMs, telecommunications equipment, medical equipment, pumps, emergency electric generators, combined heat and power in commercial buildings, and manufacturing performed in commercial buildings, and adjustments to relieve discrepancies between data sources.

Source: DOE 1999, DOE 2005

Table 2. Building Energy Use Intensity Trends

	Residential			Commercial	
Year	Households (Millions)	Average House Size (sq. ft.)	Primary Energy (MMBtu/ Household)	Floorspace (Million square feet)	Primary Energy (MBtu/sq foot)
1980	79.6	1746	199.0	50.9	208.2
1990	94.2	1800	180.8	64.3	207.1
2000	105.7	1963	193.8	68.5	250.2

Source: DOE 2005; average house size from PNNL 2004.

Barriers to More Efficient Buildings

Energy consumption is often among the largest overall costs of a building over its useful life and there are substantial techno-economic potentials to minimize this through good design, construction, operation and retrofitting (where appropriate). Yet the historic and current construction market rarely delivers buildings with minimized energy costs over their useful life span and the energy performance of the building stock is far from being economically optimized in this respect. Numerous and significant barriers to efficient buildings exist. The recognition of these barriers is both the justification and spur to instigate meaningful energy efficiency policy measures. These measures in turn need to be designed and implemented to most effectively address these barriers.

Key among these barriers is the lack of visibility of energy performance. It is not apparent from visual inspection how much energy a building uses; past energy bills often are not available nor much of a guide to market actors. This invisibility relegates the importance of energy performance in the real estate market such that it has become very much a secondary factor. The primary factors are location, price and floor area; followed by amenities and aesthetic concerns. Energy is far down the list of characteristics that could influence a building's market value and as such is "bundled" in with many more apparent and telling factors. Even if this information were readily available and comparable, numerous split or inverse incentives exist that act as further barriers to improved building energy performance.

Nor do the barriers stop here. Developers are not motivated to minimize building energy consumption in the absence of strong market signals and as we have heard these are usually absent. However, even were there to be a desire to develop low energy construction, technical capacity is often constrained. It requires a common vision and execution from design, through construction including the integration and commissioning of building services equipment. Each actor in this process needs the necessary skill-sets, tools, materials and motivation to successfully execute their part of the design concept.

The discussion above presupposes that building developers and owners are aware that they can implement a range of measures that would substantially reduce buildings energy use and that they know how to do this cost-effectively. However, this is rarely the case and generally only a tiny proportion of market actors understand the cost-effective opportunities which exist to minimize energy consumption without loss of service. As a result of all these factors the energy performance of the building stock continues to fall far short of an economically-optimized level from a societal perspective. Nor will it reach levels close to this without policy intervention.

Policies and Programs to Improve Efficiency in Buildings

Through this project, we looked at policy instruments enacted at the federal, state, and local levels, and energy efficiency programs operated by utilities, market transformation organizations, manufacturers, and other private program implementers as well as a number of government-sponsored efficiency programs. Using program data, reported results, and evaluation studies, we examined program and policy impacts to determine the effectiveness of each approach in terms of energy savings and longer-term market impacts. Here we provide a brief summary of the major categories of policies and programs reviewed.

Federal Policies

The federal government first enacted broad energy efficiency policies in response to the energy crises of the 1970s. Among these were a number of far-reaching policy instruments directed toward energy efficiency in residential and commercial buildings. The federal government has had a tremendous impact on improving energy efficiency in the building stock through policies affecting products sold and buildings constructed in the U.S. and rules influencing the actions of the federal sector itself. Policies reviewed for this project include:

- Appliance and equipment efficiency standards
- Appliance labeling
- Government purchasing and procurement
- Building codes and standards
- Public sector facility management
- Tax incentives

One of the most effective federal policies by far has been enactment of mandatory minimum standards for appliances and equipment. Standards capture the technical improvements that allow for increased efficiency in some product models and spread those improvements throughout the product category. The least efficient products are eliminated from the market over time. This broad-based policy has yielded very large savings since the first federal standards were adopted in 1987; revised standards and newly adopted standards on an expanded list of products promise even greater savings over the coming years.

Table 3 summarizes energy savings and carbon reductions from standards adopted to date. Standards have also proven to be an extraordinarily cost-effective policy instrument. With cumulative consumer savings of $234 billion through 2030, standards enacted to date have a benefit-cost ratio of approximately 3.0 to 1.0; consumer savings outweigh government expenditures on the program by more than 2,000 times (Nadel et al 2006; Kubo, Sachs and Nadel 2001).

Table 3. Overall Savings from U.S. Appliance Standards

Standards (Year Enacted)	**Electricity Savings (TWh/yr)**			**Primary Energy Savings (Quads/yr)**			**Carbon Reduction (MMT)**		
	2000	2010	2020	2000	2010	2020	2000	2010	2020
NAECA (1987)	8.0	40.9	45.2	0.21	0.55	0.61	3.7	10.0	10.1
Ballasts (1988)	18.0	22.8	25.2	0.21	0.27	0.29	4.4	5.0	5.0
NAECA updates (1989-91)	20.0	37.1	41.0	0.23	0.43	0.47	4.8	8.1	8.1
EPAct (1992)	42.0	110.3	121.9	0.59	1.51	1.67	11.8	27.5	27.9
NAECA updates (1997-2001)	0.0	42.0	107.7	0.0	0.5	1.19	0.0	10.4	23.4
EPAct 2005	0.0	14.7	53.0	0.0	0.21	0.65	0.0	3.7	11.5
TOTAL	**88**	**268**	**394**	**1.2**	**3.5**	**4.9**	**25**	**65**	**86**
% of projected U.S. use	**2.5%**	**6.9%**	**9.1%**	**1.3%**	**3.1%**	**4.0%**	**1.7%**	**3.6%**	**4.4%**

Source: Nadel et al 2006

Other broad mandatory policies impacting the efficiency of the existing building stock are building codes and appliance labeling. Although specific energy codes for private buildings are enacted at the state level in the U.S., the federal government plays an important role in stimulating the adoption and effective implementation of state-of-the-art energy efficiency codes as instructed by the Energy Policy Act of 1992. While the greatest impact of building codes applies to new construction, codes also require that additions and significant renovations to existing buildings meet minimum code requirements. The U.S. experience with appliance labeling has been mixed. Display of the EnergyGuide label has been required since 1980 to provide consumers with comparative information on the efficiency of appliances sold. Although the distinctive yellow label is widely recognized as a source for energy use information, research has demonstrated a number of problems limiting use and effectiveness of the label (Thorne and Egan 2002). The U.S. label has not had the same impact on the efficiency of products available and sold as labeling programs used elsewhere including the European Union, Australia, and Thailand. The government is currently considering changes to the U.S. label to improve its effectiveness.

In addition to these regulatory approaches, the federal government has offered short-term tax incentives to consumers and businesses to encourage investment in energy-efficient products and services. During the 1970s, incentives were made available for a handful of relatively conventional energy efficiency measures. Although the tax credits were widely subscribed, costing the U.S. Treasury nearly $10 billion in lost revenues, energy savings were modest. Research demonstrated a high level of free-ridership and limited impact in stimulating technological innovation (Geller 1999). With the Energy Policy Act of 2005, Congress enacted a new set of tax incentives worth more than $2 billion. Unlike the earlier tax incentives, these manufacturer and consumer tax incentives cover a number of advanced energy-saving technologies and practices with the goal of stimulating the market for high-efficiency appliances, equipment, and building improvements. Estimated annual savings from the tax incentives are expected to reach 0.5 quads in 2020 (approximately 0.8% of U.S. energy use) with cumulative savings through 2020 totaling 2.9 quads (Nadel 2005). One major drawback is that the tax incentives are only available over the two-year period from 2006-2007; Congress is already under pressure to extend many of the provisions.

The government has also instituted policies to improve the efficiency of federal facilities. The federal government is the largest single energy user in the United States. Government purchasing and procurement efforts establish recommended, and in some cases mandatory, specifications for federal purchases which total over $10 billion for energy-using products and services (FEMP 2006). The Federal Energy Management Program develops recommended product specifications, produces lists of qualifying products, and provides guidance to government procurement officials in all federal agencies. The Agency also administers provisions of the Energy Policy Act of 2005 requiring government agencies to purchase ENERGY STAR-qualified products and oversees implementation of Executive Order 13221 requiring federal agencies to seek out products with low standby power consumption. Through these efforts, the federal government is able to use its size to drive the market for more energy-efficient products.

State and Local Policies

State and local governments have also been active in promoting improved energy efficiency through policy instruments—in many cases the same types of policies used at the national level. While individual state efforts cannot compare with the impact from federal policies, successful approaches first tried at the state and local level have been adopted at the federal level. The state and local policies covered include:

- Appliance and equipment efficiency standards
- Building codes and standards
- Government purchasing and procurement
- Funding of public benefit programs/activities
- Public sector facility management
- Tax incentives
- Existing building benchmarking

As noted above, states are responsible for enacting specific energy codes for residential and commercial buildings. While building codes generally apply to additions and major renovations of existing buildings, the bulk of the energy savings from codes are found in new construction. To improve the efficiency of the existing stock of single- and multi-family homes, a handful of cities and states have enacted residential energy conservation ordinances (RECOs) and weatherization standards requiring homeowners and landlords to implement specific, low-cost efficiency measures at the time a property is sold or substantially renovated. Although the requirements are typically much less stringent than building codes for new construction, estimated energy savings for homes subject to RECO improvements are approximately 15% (Thorne 2001). Similar commercial energy conservation ordinances have been enacted in two U.S. cities.

State action on appliance efficiency standards pre-dates federal standards. States first began setting minimum efficiency standards for products sold or installed in state in the mid-1970s. Action at the state level led to manufacturer support for the first federal standards in the 1980s. States remain free to set minimum efficiency standards for products that are not regulated at the federal level. The past few years have seen a resurgence in standards activity at the state level. A total of 10 states have passed standards on a wide range of products; a number of these standards were adopted at the federal level with passage of the Energy Policy Act of 2005. Additional standards now under consideration in several states would yield annual energy savings of more than 641 trillion Btu in 2020 growing to more than 1.0 Quad in 2030 (Nadel et al 2006).

State governments have also instituted a variety of tax incentive measures to encourage consumers and businesses to invest in energy efficiency. The measures vary from state to state and include deductions or credits on state income taxes and elimination of state sales taxes on qualifying products.

States and municipalities have also taken steps to reduce their own energy use through government purchasing and procurement policies and the use of performance targets for existing buildings. These efforts not only save the governments money, they can also promote local markets for energy-efficient products and build local capacity for energy-efficient services.

As the U.S. utility industry faced a wave of restructuring through the 1990s, investments in ratepayer-funded efficiency programs dropped dramatically from a high of $1.8 billion in 1993 to about $900 million in 1998. Recognizing the ongoing need for these programs, many states have established new mechanisms for funding efficiency programs. The adoption of "public benefits funds" (also referred to as "systems benefits funds," "public goods charges," or "systems benefits charges") together with renewed support for utility rate-payer funded programs has led to a rebound in efficiency program spending to a total of $1.35 billion in 2003 (York and Kushler 2005). Savings from these programs amounted to 1.9% of national electricity sales in 2003; however, the benefits are not evenly distributed. Twenty states account for 87% of the nationwide energy savings total. The potential for expanded programs in additional states or adoption of a national public benefits fund is tremendous.

Private Sector Initiatives

Private institutions have sponsored a wide variety of energy efficiency initiatives targeting residential and commercial buildings. Program sponsors include utilities, independent non-profit organizations, quasi-governmental agencies, manufacturers, and others. These programs can serve to complement government policies or to drive adoption of updated codes, standards, and procurement practices. The types of private initiatives reviewed for this study include:

- Resource acquisition programs
- Market transformation initiatives
- Manufacturer-based programs
- Peak load/demand response programs

Under the rubric of demand-side management, utilities began to operate resource acquisition programs as a way to eliminate or delay the need for additional electric generation capacity. A typical resource acquisition program offered financial incentives—often in the form of customer rebates—for purchase of high efficiency products and equipment. Common program targets included commercial lighting and HVAC equipment and residential appliances. Billions of dollars were invested in these programs in the 1980s and 1990s. While these program were effective in securing energy savings for the sponsoring utilities, there were no mechanisms to ensure that customers would continue to purchase high efficiency products in the absence of program incentives or that retailers and distributors would continue to stock these products once the incentives had phased out.

In response to these shortcomings, a number of utilities and other efficiency organizations began to develop and implement market transformation initiatives designed to create lasting changes in the market for energy-efficient goods and services; changes that would persist after incentive programs were discontinued. To meet these goals, market transformation programs targeted all aspects of the product cycle, working with manufacturers, distributors, installers and other contractors, retailers, and consumers. Typical program activities could include information and education campaigns, training programs for retailers and contractors, manufacturer and retailer incentives, financing assistance, customer rebates, and performance contracting, among others.

Government Programs

The federal government, often in partnership with states and other entities, administers a number of other programs to promote energy efficiency. Examples include the ENERGY STAR® program, the low-income weatherization program, and the new Partnerships for Home Energy Efficiency. The ENERGY STAR product labeling and building performance programs offer an easily-recognizable symbol for consumers to identify energy-efficient products, while providing valuable tools, training and skills to contractors serving the residential and commercial buildings market, encouraging manufacturer investments in new technologies, and providing a common platform for the many agencies and organizations promoting energy efficiency at the federal, state, and local level. US EPA and DOE share responsibility for administration of the program. Through the low-income weatherization program, DOE works with state and local agencies to improve the efficiency of the existing housing stock, helping low-income residents save money while making their homes more comfortable and safer. In 2005, the Partnerships for Home Energy Efficiency was launched to coordinate the efforts of DOE, EPA, and the Department of Housing and Urban Development (HUD) with the goal of saving 10% or more of energy use in US homes over the next 10 years. The agencies will work together to improve coordination of existing programs and explore new opportunities for collaboration.

Effectiveness of Historical Energy Efficiency Initiatives

As noted in the earlier section, a wide variety of programs and policies have been implemented around the US over the past two decades. Measuring effectiveness of these initiatives is a challenge, as there are a many different drivers for the initiatives, and different perspectives support different goals and objectives. On some level, ongoing funding and support for a given policy or program is an indicator of its effectiveness, but this project has attempted to assess the effectiveness in a more systematic manner.

In reviewing the effectiveness of initiatives toward improving the energy efficiency of existing buildings, there are two principal indicators that seem to summarize the overall impacts of the policy or program: level of energy saved, and market transformation effects. Table 4 summarizes the authors' review of effectiveness.

The "energy saved" indicator can further be broken down into four metrics:

- The magnitude of the energy savings. Later work on this project will attempt to assign quantitative results to the indicators, while the table currently shows a range from "very high" (VH) down to "very low" (VL).
- The persistence/permanence of the savings. How lasting are the effects of the initiative, and is there likelihood for a reversal of the impacts?
- The savings to date from the initiative, and remaining savings potential. Again, these metrics will eventually have more quantitative values applied.

Similarly, the market transformation effects can be measured by three subjective metrics: the ability to drive innovation in the targeted sector or technology; the spillover, or "free drivership" effects, where the initiative has effects beyond the specific intervention that is targeted; and, the potential for backsliding, or reversal of the progress once the intervention is stopped or removed.

Table 4. Energy Efficiency Initiatives and Indicators of Effectiveness

Initiatives	Energy Saved				Market Transformation Effects		
	Magnitude	Persistence/ Permanence	Savings to Date	Remaining Savings	Drive Innovation	Replication/ Free Drivership	Potential for Backsliding
Federal Policies							
Equipment standards	VH	VH	VH	H	M	L	L
Building codes/regulations	H	H	H	H	M	M	M
Government purchasing, procurement, facility mgmt	M	M	M	M	M	M	
Tax incentives	M		L	H	H	M	M
State and Local Policies							
Building codes/regulations	VH	H	H	M	H	M	L/M
Equipment standards	H	M	M	M	M	H	L
Funding of public benefits programs/activities	VH	H	H	VH	M	M	M
Government purchasing, procurement, facility mgmt	M	M	M	M	M	M	M
Tax incentives	M	L	M	H	M	H	M
Programs							
Product Replacement Incentives:							
-- Independent programs	H	M	H	H	M	L	H
-- Coordinated efforts	H	H	H	H	H	H	M
Market Transformation:							
-- Information/Education	M	M	M	H	L	M	M
-- Training	M	M	M	H	L	M	M
-- Manufacturer/Retailer incentives	L	L	M	M	H	M	M
-- Financing assistance	L	M	L	M	L	L	M
-- Performance contracts	H	M	H	H	L	L	M
Manufacturer Programs	L	M	L	M	H	M	M
Peak Load Management/ Demand Response	L	L	L	M	M	L	M
Government Programs							
Energy Star	H	M	H	M	M	H	M
Weatherization	H	M	H	H	M	L	M
Partnerships for Home Energy Efficiency	M	M	L	H	M		M

Notes: VH = very high; H = high; M = medium; L = low

It is difficult to view or measure the effectiveness of initiatives standing alone; it is really the mix of initiatives that pushes both energy savings and market transformation effects. For example, the magnitude of energy savings from product efficiency standards is very high, though product standards might remain stagnant and have little remaining efficiency potential without other market transformation programs driving innovation so that new, dramatically more efficient products come into the market that can eventually be considered for minimum standards. Similarly, a number of different types of initiatives feed into utility and other public benefit programs, so that the large amounts of funding available for these programs can be most effectively targeted to deliver significant energy savings and market transformation effects.

Discussion

There has been a wide range of policy and programmatic activity in North America over in recent years to address energy efficiency in existing buildings. Over the past year the level of interest has grown due to higher energy prices and concerns about energy supply. Great progress has been made in improving the efficiency level of specific technologies and end uses (e.g., typical refrigerators now use around 25% of the energy of an average early 1970s model, and commercial lighting systems provide much higher efficacy when measured in lumens of light output per watt input). It is only in recent years, though, that there has been more focus on systems and "whole building" approaches, both for the residential and commercial buildings sectors.

Despite the improvement in energy efficiency in specific products and end uses, the total energy use in buildings in the US has grown significantly over the past two decades. The energy use in residential buildings has grown from 8.9 to 10.4 quads during the period from 1985 to 2002, with the energy intensity of residential buildings improving by 8% over the period, primarily due to the fact that the number of households in the country grew by over 24%. Commercial buildings have become significantly more energy intensive over the same period, with the energy intensity increasing by 12%, with total commercial sector energy consumption more than 50% higher in 2002 than it was in 1985 (PNNL 2004).

There are many reasons that energy use is growing despite the improvements in efficiency in specific technologies. There are a wide variety of new electric appliances in use in buildings now than twenty, or even five, years ago. Many US households have dramatically more consumer electronics; the growth of new electronic entertainment devices continues to grow and is not expected to slow down in the near future. The saturation of air conditioning equipment also continues to grow, as consumers can afford lower cost comfort systems that improve their quality of life.

In commercial buildings, the intensity growth is driven both by increased use of electronic equipment (computers, printers, and a variety of other systems) along with trends toward more sophisticated ventilation and space conditioning systems that are more energy intensive. In most regions of the US, only a small percentage of new commercial construction is completed with operable windows for ventilation; standard practice now includes ventilation systems that consume significant electricity to move air (or other heat transfer fluids) as well as more energy for heating and cooling spaces.

The recognition that a lot of potential exists for savings exists has led to some new initiatives. In California, which often sets a model for policies in other states and eventually national policy, an effort has been underway over the past few years to examine potential strategies to capture the savings potential. A variety of new initiatives have recently been proposed in California toward energy savings and market transformation in existing buildings, and state regulatory policies have provided significant funding for programs to drive these initiatives (CEC 2005).

While large scale federal efforts lock in the very large magnitude savings from energy standards and codes, development of state codes and standards (and in some cases, product standards first set in Canada) drive federal policy decisions, as industry prefers having single federal standards to a patchwork of slightly different state based standards. In recent years, more states have been adopting efficiency standards both to save energy in their own state, and also to help push additional federal action. This is not new; state actions led to the first national products efficiency standards in 1980s.

Energy codes have a large impact on energy use in existing buildings as they effect the efficiency of any renovations and equipment replacements. With any codes or standards, though, there is a balance between setting the most stringent code that could result in the greatest energy efficiency, vs. setting simpler and perhaps slightly less stringent codes that are easier to administer and enforce. This is an ongoing challenge; more research is needed on the effectiveness of code enforcement and administration to better understand the optimal solution.

While the historic view of efficiency programs on improving the efficiency of a given technology or end use has been successful in moving toward more efficient products, if overall energy use reduction and carbon constraints are the goal then effectiveness measures need to focus more on energy intensity, or total energy use per household or unit of commercial building floor area. With average house size growing, and the addition of lots of new electronic equipment in commercial buildings, there has been less progress toward this type of effectiveness metric: improving the overall energy intensity of the standard household or commercial building. Newer whole building approaches are a good start toward this type of metric, though these programs are relatively early in the maturation cycle.

There is an important role for broad Federal market transformation initiatives, such as those that are run through the Energy Star program, though the real effectiveness in successful programs delivering savings are through local programs that more directly engage consumers and energy use decision makers. There is an ongoing need to tune and balance these different initiatives, which seems to be done reasonably well.

A recent analysis of savings opportunities prepared by the Alliance to Save Energy found that a relatively modest set of national policies, many of which are already in place in certain parts of the US, could reduce US building energy use in 2020 by about 14%, with cumulative savings of 46.4 quads (Loper et al 2005). This study recommended 40 specific policies that would expand upon existing initiatives and cut the growth in building energy use over the coming fifteen years by two thirds.

Conclusions

There has been a lot of progress with energy efficiency policies and programs to date. The initiatives have delivered significant amounts of energy savings so far, in many cases with lasting market transformation effects. That said, there are yet larger amounts of efficiency savings yet to be tapped. The biggest remaining savings seems to be on based on whole building approaches rather than individual hardware improvements; this potential is very large, but also harder to achieve.

Innovation in policies and programs has been driven by state activity. Several states, led particularly by California, have demonstrated great leadership with both significant funding for programs and more aggressive policies. As noted in the discussion about funding for public benefits funds, twenty states account for 87% of the energy savings delivered by rate-payer funded energy efficiency programs. With wider adoption of these sorts of funding priorities, either by additional state policies or national leadership, the remaining thirty states would see substantial, cost-effective savings streams throughout the entire country. The relatively wide spread of energy intensity of residential and commercial building energy use shows that there is a great deal of "low-hanging fruit" in energy savings opportunities in those states where policies have not followed the more innovative leaders.

Moving forward, there are no magic solutions seen for capturing savings, but innovative combinations of things that have already been started or now beginning should drive improvement in existing building energy efficiency in the coming decade.

References

Brown, Marilyn A., et al. 2005. *Toward a Climate-Friendly Built Environment*. Pew Center on Global Climate Change, June 2005.

CEC. 2005. *Options for Energy Efficiency in Existing Buildings: Staff Draft Report*. California Energy Commission, CEC-400-2005-039-SD2. September 2005.

DOE 1999. 1999 BTS Core Data Book. Prepared for the Office of Energy Efficiency and Renewable Energy, US Department of Energy. Washington, DC. June 1999.

DOE 2005. 2005 Buildings Energy Data Book. Prepared for the Office of Energy Efficiency and Renewable Energy, US Department of Energy. Washington, DC. August 2005.

FEMP. 2006. http://www.eere.doe.gov/femp/program/equip_procurement.cfm

Geller, H. 1999. *Tax Incentives for Innovative Energy-Efficient Technologies*. July. Washington, D.C.: American Council for an Energy-Efficient Economy.

Kubo, T., H. Sachs, and S. Nadel. 2001. *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs*. September. Washington, D.C.: American Council for an Energy-Efficient Economy.

Loper, J., L. Unger, D Weitz and H. Misuriello. *Building on Success: Policies to Reduce Energy Waste in Buildings*. The Alliance to Save Energy, July, 2005.

Nadel, S. 2005. *The Federal Energy Policy Act of 2005 and Its Implications for Energy Efficiency Program Efforts.* September. Washington, D.C.: American Council for an Energy-Efficient Economy.

Nadel, S., A. deLaski, M. Eldridge, and J. Kleisch. 2006. *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards (Revised).* February. Washington, D.C.: American Council for an Energy-Efficient Economy.

PNNL 2004. *Indicators of Energy Intensity in the U.S.*. Prepared by Pacific Northwest National Laboratory (PNNL) for the US Department of Energy. Last Updated November 16, 2004. http://intensityindicators.pnl.gov/index.html (accessed March 14, 2006).

Thorne, J. and C. Egan. 2002. *An Evaluation of the Federal Trade Commission's EnergyGuide Appliance Label: Final Report and Recommendations*. August. Washington, D.C.: American Council for an Energy-Efficient Economy.

Thorne, J. 2001. "Policy Options for Improving the Efficiency of Existing Buildings: Experience to Date in the United States." Prepared for the Joint OECD-IEA Workshop on the Design of Sustainable Buildings Policies. Paris. June 28-29.

York, D. and M. Kushler. 2005. *ACEEE's 3rd National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-Level Activity*. October. Washington, D.C.: American Council for an Energy-Efficient Economy.