Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions:

Draft Issue Paper

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

FEBRUARY 2009

About This Document

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The Leadership Group of the National Action Plan for Energy Efficiency is committed to taking action to increase investment in cost-effective energy efficiency. *Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions* was developed under the guidance of and with input from the Leadership Group. The document does not necessarily represent a consensus view and does not represent an endorsement by the organizations of Leadership Group members.

Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions is a product of the National Action Plan for Energy Efficiency and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

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For More Information

Regarding *Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions,* please contact:

Joe Bryson
U.S. Environmental Protection Agency
Office of Air and Radiation
Climate Protection Partnerships Division
Tel: (202) 343-9631
E-mail: bryson.joe@epa.gov

Regarding the National Action Plan for Energy Efficiency, please contact:

Stacy Angel
U.S. Environmental Protection Agency
Office of Air and Radiation
Climate Protection Partnerships Division
Tel: (202) 343-9606
E-mail: angel.stacy@epa.gov

Larry Mansueti
U.S. Department of Energy
Office of Electricity Delivery and Energy Reliability
Tel: (202) 586-2588
E-mail: lawrence.mansueti@hq.doe.gov

or visit www.epa.gov/eeactionplan

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Abbrev 1	Full spelling
Abbrev 2	Full spelling

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1: Introduction

Global climate change presents a daunting challenge in transforming the ways in which we generate and use energy. Based on the findings of the world's climate scientists and mitigation experts, significant emissions reductions are necessary to avoid severe changes in the earth's atmosphere with severe consequences for human health and the global environment. The most recent consensus findings of the Intergovernmental Panel on Climate Change state that greenhouse gas emissions need to be reduced 50-85% by 2050 to avoid global temperature rise of less than 2.5 degrees centigrade, and that global GHG emissions must stop rising no later than 2015.[1] With the majority of government leaders beginning to act on these findings, there is greatly increased focus in many nations on developing low-cost emission reduction options in the near term. This puts energy efficiency in the climate policy spotlight, as a near-term, low-cost resource for reducing the growth in carbon emissions and reducing the ultimate cost of attaining GHG emission reductions.

Energy efficiency provides multiple public policy benefits regardless of its carbon emissions impacts. It reduces home and business energy costs, improves productivity, stimulates economic growth, reduces energy market prices, improves energy systems reliability, reduces criteria air pollutant emissions, and enhances national energy security.[2] Efficiency typically costs less than conventional energy supply technologies, and thus reduces the overall cost of energy services.[3] Energy consumption per dollar of U.S. economic output has fallen by half since the 1970s, fueling sustained economic growth and softening the economic damage from recent energy price surges.[4] Efficiency has become a quiet engine of prosperity for the U.S. and other economies, and is at the forefront of a new wave of clean energy investment that can support economic prosperity as well as energy security and environmental protection.

Increased energy efficiency investment combats global climate change in two primary ways. First: simply put, "the less energy used, the fewer emissions produced". While this general statement overlooks the more complex relationships between energy efficiency and carbon dioxide (CO_2) emissions, it places energy efficiency in a core role for future energy and climate policies and programs. Second: cost-effective energy efficiency, achieves these environmental benefits at low cost, and thus can reduce the economic costs of achieving climate policy goals. That is, under a policy limit on greenhouse gas emissions, pursuing energy efficiency wherever it costs less than other low-emission options will lower the overall costs of the policy.

While energy efficiency's potential to achieve low-cost reductions in CO_2 emissions has been mentioned in earlier Action Plan materials, CO_2 impacts have been addressed only in a general way as one of many societal benefits. The Leadership Group of the Action Plan committed to develop an issue paper on "Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions" as a priority area to create more explicit information on this topic to help states, utilities and other stakeholders in their efforts to address climate change through a variety of policy and program mechanisms.

This paper supplements existing Action Plan materials that address CO_2 emissions in the context of methods for resource planning,[5] and establishing the business case for energy efficiency.[6] It focuses more fully on the benefits and issues around applying the energy efficiency resource in a climate policy context. Its scope is to explore the role of state-level policies in increasing investment in energy efficiency across the nation's buildings and industrial facilities. Policy options include building codes, state-level appliance standards, voluntary standards, labeling and rating, administered energy efficiency programs, and utility regulatory policies that support investment in energy efficiency where cost-effective.

Key objectives of the paper are to:

- Summarize the research and analysis on the magnitude and cost of the energy efficiency resource in the U.S., especially with respect to its potential to cost-effectively reduce carbon dioxide emissions.

- Inventory and summarize the current range of policy and program approaches that seek to leverage energy efficiency as part of greenhouse gas reduction strategies across the U.S., focusing primarily on state and regional efforts.

- Better define the need to address key market barriers to enable energy efficiency investment to increase fast enough to tap a large fraction of its economic potential, including a description of the nature and magnitude of market and policy barriers to increased energy efficiency investment.

- Briefly summarize the suite of energy efficiency policies and programs that can reduce key market and regulatory barriers to energy efficiency and help capture a significantly larger portion of the available cost-effective potential, referencing the tools and resources available under the National Action Plan as appropriate.

Further, through the synthesis of the collected and reviewed information, the paper provides support for the following statements:

- Energy efficiency is a relatively large and low-cost carbon abatement resource in the U.S.

- Current U.S. investment levels in energy efficiency tap only a small amount of the available low-cost energy efficiency.

- If developed substantially beyond current investment levels, energy efficiency can lower the costs of achieving greenhouse gas reduction.

- Increased energy prices alone (stemming from policies requiring greenhouse gas emissions reductions) will not accelerate efficiency investment at the rate needed to tap the majority of efficiency's economic potential. This is due not only to market and regulatory barriers, but also to the limits of price inelasticity of energy consumption in many end-use markets.

- Market and regulatory barriers can be reduced through targeted energy efficiency policies and programs, with the effect of increasing energy efficiency investment, reducing greenhouse gas emissions, and reducing the overall economic cost of climate policies.

- Many state and local governments, recognizing the important role of energy efficiency in their greenhouse gas reduction strategies, have pursued targeted policies and other initiatives to advance energy efficiency. A review of these initiatives provides useful information for policy-makers at all levels of government.

1.1 Structure of the Paper

The paper presents discussions of these key topics as outlined below:

- **Section 1.** The size and economic value of the energy efficiency resource and its potential to cost-effectively reduce CO_2 emissions.
- **Section 2.** The limitations to advancing energy efficiency through price mechanisms alone.
- **Section 3.** Summary of energy efficiency policies and programs that advance low cost energy efficiency.
- **Section 4.** Review of current climate policies across the U.S. that explicitly address energy efficiency.
- **Section 5.** Summary of findings and recommendations.

1.2 Development of the Paper

Energy Efficiency as a Low-Cost Resource for Achieving Carbon Emissions Reductions is a product of the National Action Plan for Energy Efficiency. With the direction and comment by the Action Plan Leadership Group (see Appendix A for a list of group members), conceptual outline and drafts of this Paper was prepared with the valuable input of Work Group. Bill Prindle of ICF International served as project manager and primary author of the Paper with the assistance of __*<to add additional key ICF staff>*__ under contract to the U.S. Environmental Protection Agency.

Work Group members include:

- *<to list "Name, Company" of all work group members>*

1.3 Notes

[1] IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[2] U.S. EPA (2006). Clean Energy-Environment Guide to Action: Policies, Best Practices, and Action Steps for States. <http://www.epa.gov/cleanenergy/documents/gta/guide_action_full.pdf>

National Action Plan for Energy Effi ciency (2008). National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change. www.epa.gov/eeactionplan

Ehrhardt-Martinez and Laitner. 2008. The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture. American Council for an Energy-Efficient Economy, Report Number E083

[3] Ibid.

[4] Ibid.

[5] **Action Plan Report** (Chapter 1, Introduction and Background: Chapter 3, Energy Resource Planning Processes) and **Guide to Resource Planning with Energy Efficiency**

[6] **Action Plan Report** (Chapter 4, Business Case for Energy Efficiency)

2: The Size, Economic Value, and Emissions Impacts of Energy Efficiency Resources

Questions on the scale of the energy efficiency resource as a low cost abatement option for CO_2 emissions can be answered by examining studies and or planning documents that fall into the following categories:

- Energy efficiency potential studies that estimate the overall cost-effective resource capability for energy efficiency to provide energy, economic and environmental benefits for various energy types, timeframes, and geographic areas.
- Energy resource plans that assess the specific role energy efficiency can play in meeting energy needs for a specific geographic area or energy system, These plans often draw on potential studies, but apply them in a more focused and constrained framework.
- Energy efficiency program portfolio evaluations and program filings that offer detailed plans on the energy that can be saved through energy efficiency and the cost of the saved energy.

This section reviews some of the leading recent examples of these studies and materials. It provides a summary of these studies, presents the key findings, and highlights key considerations as people interpret the results of these efforts. It is organized as follows:

- A synopsis of leading energy efficiency resource potential studies
- A summary of resource plans that include substantial efficiency components
- A sample of measured results from leading efficiency program portfolios
- Carbon dioxide emissions impact estimates from energy efficiency potential and other studies
- A summary of current spending in and benefits from U.S. efficiency programs
- Summary of findings from these analyses

2.1 Potential Studies for Energy Efficiency

Numerous potential studies have been undertaken over the last decade to assess the availability and cost of energy efficiency. These studies have been performed at the national, regional, and state levels and employ various screens (e,g, technically feasible, economically feasible, programmatically achievable)[1] to assess the energy efficiency resource. A selected set of leading analyses are highlighted in Table 2-1.

[WILL FLESH THIS TABLE OUT FURTHER ON METHODOLY DETAIL]

Table 2-1. Selected U.S. Energy Efficiency Potential Studies

Study Author/Date/*Title*	**Savings Potential**[2]	**Savings Timeframe**[3]	**Methodology Notes**
Interlaboratory Working Group. 2000. *Scenarios for a Clean Energy Future.*	19%	2020	• Covers all sectors and fuels • Electricity savings potential estimated at 24%
McKinsey & Co. 2007. *Reducing U.S. Greenhouse Gas Emissions: How Much as What Cost?*	20%	2020 (over 1%/yr)	• Covers all sectors and fuels • Economic potential; based on simplified 7% IRR economic test • Not constrained by policy mechanisms, market barriers or capital availability
Itron. 2006. *California Energy Efficiency Study.* CALMAC Study ID: PGE0211.01	9.4-26.3%	2016 (~1% - over 2%/yr)	• Electricity and investor-owned utilities only • Savings range from economic (26.3%) to market potential (9.4%)
EPRI. 2009. *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010–2030).*	8.5%	2030 (under 1%/yr)	• Electricity only • Potential based on “maximum achievable potential” a subset of economic potential • Savings based on utility programs only—other policies like appliance standards could realize another fraction of economic potential
Western Governors Association. 2006. *Energy Efficiency Task Force Report.* A report of the WGA Clean and Diversified Energy Initiative.	20%	2020 (over 1%/yr)	• Electricity only • Based on cost-effective technologies and a scenario of “best-practice” or achievable policies and programs
ACEEE. 2008. *Energizing Virginia: Efficiency First.*	19%	2025 (over 1%/yr)	• Electricity only • Estimates based on fraction of economic potential **achievable** by a wide range of policies, utility programs plus others •

Georgia Environmental Facilities Authority. 2005. *Assessment of Energy Efficiency Potential in Georgia*	2.3%-8.7%	2010 (over 1%/yr)	• Electricity portion of analysis • Short time frame—5 years—limits potential • Estimates based on policy impacts minus naturally-occurring efficiency
ACEEE. 2004. *The Technical, Economic, and Achievable Potential for Energy Efficiency in the United States: A Meta-Analysis of Recent Studies*	24%	1.2%/yr	• Meta-study of 11 reports • Estimates based on **achievable** potential • Annualizes savings because of varying study timeframes

To better understand the differences among the potential studies summarized in Table 2-1, it is helpful to understand several key methodology and related issues:

- **Sectors, geographic scope, and fuels covered.** These studies vary from national to state-level in scope. The McKinsey analysis is U.S. economy-wide, and covers all fuels. Its level of analysis is fairly aggregated, such that it does not get into as much detail on specific markets, technologies, or policies. The other studies, EPRI excluded, are state-based and focus primarily on electricity.

- **Potential framework.** Potential studies generally use a three-tier framework: technical potential, economic potential, and achievable (or market) potential.[4]

  - Technical potential is based on the assumption that all major end use devices and building components are replaced instantly with the best available technology, regardless of cost.

  - Economic potential applies one or more economic tests or criteria, screening out measures that are not economically attractive. These criteria can vary from simple payback calculations to complex life cycle benefit/cost tests.

  - Achievable potential constrains economic potential by various constraints, such as availability of funding, program delivery capacity, program design limits, market acceptance rates, and other factors. Many of the studies above use various sub-definitions of what is achievable and make comparisons difficult.

- **Timeframe.** Some potential studies show lower percentage numbers because the timeframe of their analysis is shorter than others. The Georgia study is a case in point, covering only 5 years. The ACEEE Virginia study, by contrast, covers 17 years. Where possible, Table 2-1 estimates the annualized savings. Many studies indicate annual savings potential of 1% or sales or more per year. Continued over several years, these modest annual savings can cumulate to a large increment of a long-term forecast.

- **Technical assumptions.** Part of the variability of these studies' results stems from differences in the energy efficiency measures selected for analysis, and different assumptions about their energy performance. Some use very detailed "bottom-up" methods of aggregating thousands of different efficiency measures; others use more aggregated or stylized characterizations of technology choices in various end uses and markets.

- **Economic assumptions.** Key parameters that can explain variations in potential studies' findings include the cost of avoided energy, the costs assumed for efficiency measures, the lifetime of efficiency measures, and discount rates used in present value analyses. Avoided costs tend to be the most subject to local variations; they can be agreed on in specific states or power systems where public processes have published such data, but establishing national or regional averages can be challenging.

- **Technologies versus practices.** Many potential studies are "widget-based"; they look at individual equipment measures that can improve the efficient of specific products or systems. However, greater efficiencies can be found in systems and whole buildings through design and operating practices. Such improvements are harder to standardize, and are thus left out of some studies. Including such approaches could improve efficiency potential study estimates on a technical or economic basis, though implementing such practices consistently in energy markets can be challenging, which could limit the achievable estimates for such approaches.

- **Policy and other "baseline" considerations.** Studies vary considerably in their assumptions on the fraction of economic potential that can be achieved incrementally. Market-based, autonomous trends driven by market forces such as energy prices and technology advancement can be projected to capture some fraction of economic potential. Policies and programs already in place can be projected to capture another fraction, leaving a remainder to be captured by incremental policies and programs. Some studies focus narrowly on what utility-funded efficiency programs can achieve, such as the EPRI and Itron studies. Others consider a broader suite of policies, such as the ACEEE and Georgia studies. In the EPRI study, for example, the overall economic potential estimate does not differ greatly from other studies' estimates, but it projects the expected effects of policies such as the Energy Independence and Security Act of 2007 (EISA), and limits its estimate of efficiency potential achievable through new utility-sector programs to incremental estimates above such baseline assumptions. ACEEE estimates that EISA will reduce reference-cast electricity sales in 2030 by about 6%. These kinds of factors can affect studies' net estimates of achievable potential.

- **Fixed vs. dynamic assumptions.** All of the above studies take existing technologies' performance and costs, and project them forward on a fixed basis. However, experience has shown that technology performance often improves, and costs often drop. It is also difficult to project these dynamics very far into the future. Nonetheless, it is worth considering such dynamics in sensitivity analyses.

More information can be found in the National Action Plan Guides on Potential Studies and Resource Planning at <www.epa.gov/eeactionplan>.

Several potential studies also address efficiency potential for natural gas end-uses. While less extensive, the analytical literature on natural gas end use energy savings is also part of the research record. Natural gas potential studies tend to show somewhat lower potential as a total fraction of gas consumption, in part because the number of end-uses for gas tends to be fewer in typical buildings, which limits the number of efficiency measures available for study. In addition, basic differences between natural gas and electricity end-use applications can limit efficiency potential based on current technologies.[5]

2.2 Efficiency Potential in Utility Resource Planning Studies

Energy efficiency potential studies create information that can be used in utility resource planning processes.[6] Often referred to as Integrated Resource Planning, these processes are used in many states on a periodic cycle to identify supply and demand resource options needed to meet utility customers' future energy needs. Resource planning studies typically use many of the same data sources and analytical techniques applied in potential studies. The principal difference is that a resource planning analysis uses timeframes, economic assumptions, and other factors specific to the utility service area. Efficiency potential data, when used in a resource plan, tends to be constrained to the lower end of the spectrum, using conservative estimates of achievable potential to be deemed realistic and reliable. Resource plans can also be built up from individual program designs; these programs may draw on some of the data in potential studies, but tend to use market-based estimates and funding projects to limit expected impacts.

Below are brief summaries of selected recent studies showing the expected energy savings from energy efficiency as part of Integrated Resource Planning.

- [WILL ADD EXAMPLE/S OF UTILITY-CONDUCTED STUDIES]

- **Western Governors Association (WGA).** WGA set a goal, in 2005, of reducing electricity usage by 20% in 2020 compared to baseline forecasts. In 2006, a report was issued comparing the resource plans of more than a dozen utilities in the western states with the WGA 20% goal. The report is one of very few attempts to compare efficiency components of utility resource plans across a large number of states and utilities. The report found that some utility plans contained energy efficiency savings projections that would achieve a substantial fraction of the 20% goal, and others held much lower efficiency gains.[7] More specifically, the report shows that the California utilities, which have the most aggressive energy savings targets in the region, have efficiency resource plans expected to offset over 70% of forecast load growth, about 60 percent of capacity growth, and 10 percent of total energy consumption by 2013, the last year of the study timeframe (see Table 2-2).[8] Further they have reduced annual energy load growth by about 1 percent (see Figure 2-1)[9]

- **Northwest Power and Conservation Council (NWPCC).** The NWPCC is a unique organization, created by Congress by the 1980 Pacific Northwest Electric Power Planning and Conservation Act as a resource planning structure for the region served by the federal Bonneville Power Administration. While its authority does not extend to all retail utilities in the region, the Council's planning process exerts substantial influence, and its resource plans are viewed as credible and authoritative. The Council's Fifth Power Plan, issued in 2005, projects that cost-effective and achievable energy efficiency could reduce forecast load growth by just over 50% by 2025, avoiding about 2800 average MW of load growth out of a mid-range forecast growth of 5343 average MW.[10] [WILL DETERMINE IMPACT ON ANNUAL GROWTH RATES]

In reviewing resource plans, it is important to remember that these plans are developed using information locally and or regionally specific information and guidelines.. In the NWPCC planning process, efficiency is treated prominently, consistently, and transparently, and efficiency is included in the plan as achievable potential, not as the impacts of specific program portfolios. In most utility IRPs, efficiency impacts are based on estimates of expected impacts from programs likely to be implemented, and program impact estimates can be more variable than the aggregate estimates found in potential studies.

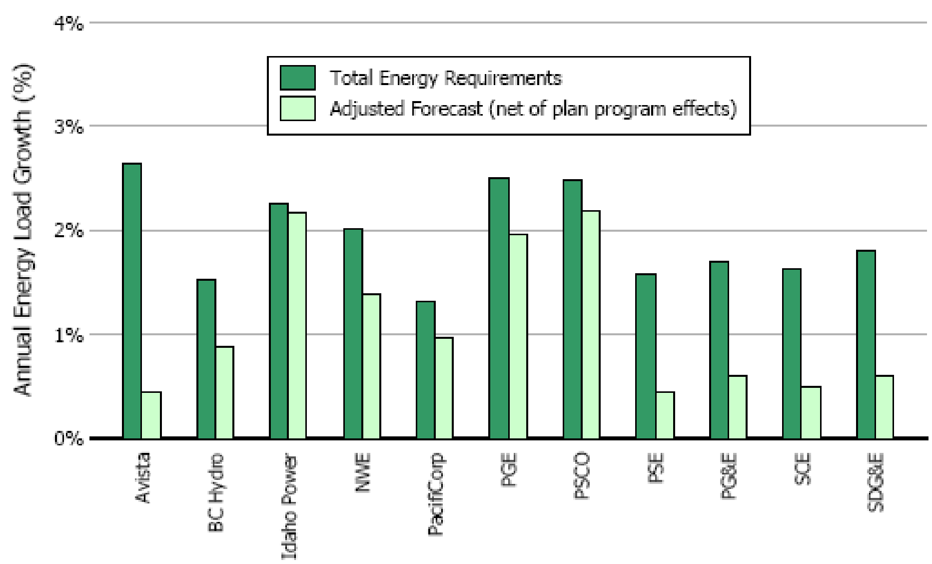
Table 2-2. Summary of Utilities' Progress Toward the CDEAC Goal of 20 Percent Reduction in Energy Consumption by 2020

Utility	Plan Program Effects as % of Total Energy Requirements[7]	
	2008	2013
Avista	2.5%	4.8%
BC Hydro[1]	3.8%	6.0%
Idaho Power	0.4%	0.9%
Nevada Power[2]	*0.7%*	—
NWE	2.9%	5.9%
PacifiCorp	1.9%	3.4%
PGE[3]	2.8%	5.1%
PSCO	1.4%	2.8%
PSE[4]	5.7%	10.4%
PG&E[5]	5.0%	10.1%
SCE[5]	5.3%	10.4%
SDG&E[5]	6.7%	11.3%
Sierra Pacific[6]	*1.4%*	—

LBNL made assumptions in calculating Italicized values—values in regular font are compiled directly from resource plan data.

[1] BC Hydro's plan only commits to implementing its PowerSmart-2 program through 2012; possible continued savings from PowerSmart-3 are included for 2013.
[2] Nevada Power only reported annual savings for 2004; this level of savings was assumed for each year from 2004 through 2008.
[3] PGE identifies *plan program effects* for 2005–2011; the 2013 value was extrapolated.
[4] PSE values include residential fuel conversion programs—standalone energy-efficiency program savings were not available.
[5] The energy savings goals for the California utilities include all programs administered by the utilities, including those offered to direct access customers. Some portion of savings from energy-efficiency standards is included in these goals, as the utilities administer programs to support their implementation.
[6] Sierra Pacific only reported annual savings for 2005; this level of savings was assumed for each year from 2004 through 2008.
[7] *Total energy requirements* do not include load reductions from *plan program effects* or reserve margins.

Figure 2-1. Summary of Utility Energy Load Growth Forecasts through 2013 with and without Energy Efficiency Programs

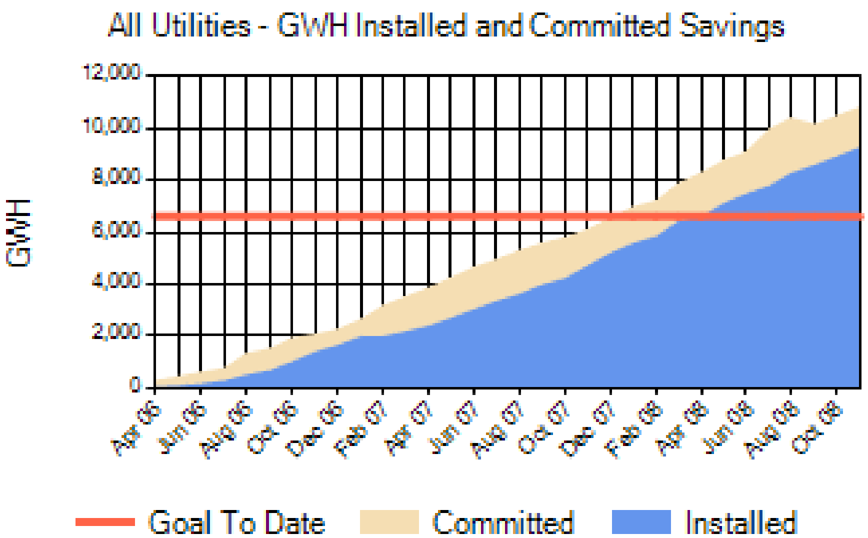


2.3 Energy Efficiency Resources in Current Program Portfolios

Several states and utilities have moved to deploy efficiency resources in comprehensive program portfolios and the achievements from these efforts also provide important evidence of the savings that can be achieved through energy efficiency. The reported impacts from a sampling of these programs include:

- **California.** The three largest investor-owned electric utilities have just completed a three-year program cycle, driven by plans developed under the California Public Utility Commission (CPUC). A snapshot of the companies' cumulative savings impacts to date is shown in Figure 2-2 below.

Figure 2-2. California Utilities Energy Efficiency Program Impacts 2006-2008



Source: CPUC EEGA reporting system: http://eega2006.cpuc.ca.gov/Default.aspx.

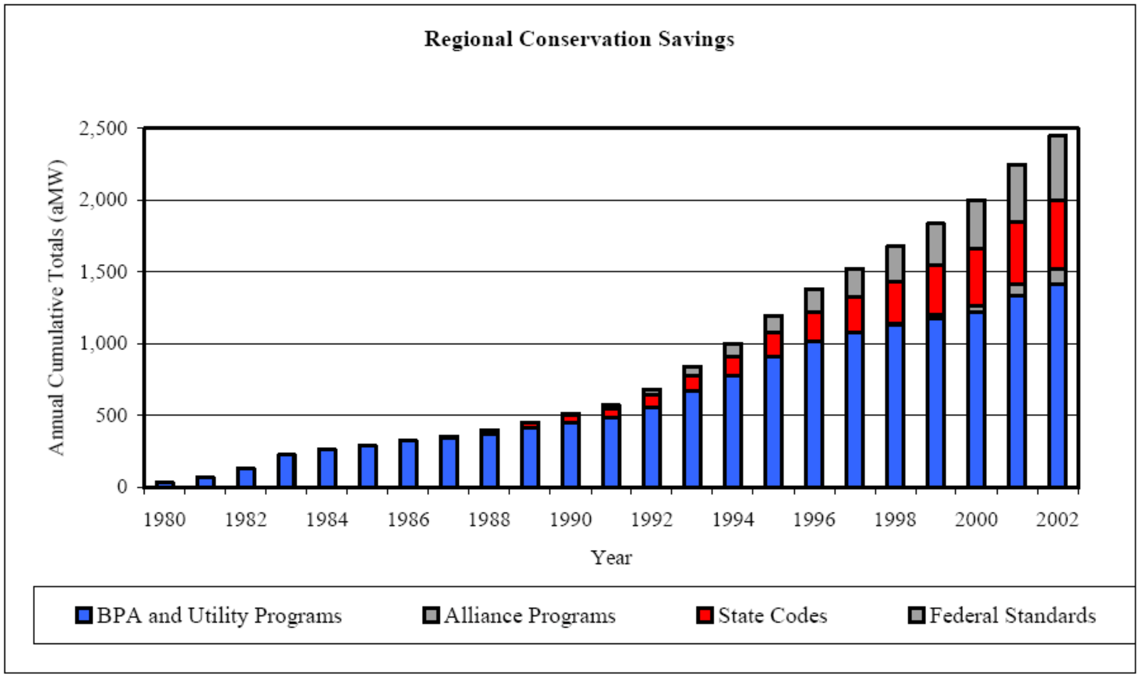
Note that the savings reported in the CPUC EEGA system represent about 3% of estimated 2008 investor-owned utility electricity sales. Over the 2006-2008 program period, this means savings are averaging about 1% of total sales for each year's program efforts. This is consistent with the efficiency savings potential estimates in the studies summarized in Table 2-1.

- **Minnesota.** The state's Conservation Improvement Program (CIP) has continued fairly steadily for more than a decade. A 2005 report of the state's Office of Legislative Auditor found that the investor-owned utilities' CIP program savings totaled 328 million kWh in 2003.[11] This is about 0.8% of 2003 IOU electricity sales, which is also within the range of estimates found in the potential studies in Table 2-1.

- **Pacific Northwest.** In the NWPCC Fifth Power Plan cited earlier, the Council estimates the impacts of regional energy efficiency programs operated since 1980. Figure 2-3 below summarizes those estimates. While this figure includes the impacts of state building energy codes and federal appliance standards, the great majority of energy savings come from utility and Northwest Energy Efficiency Alliance programs. These

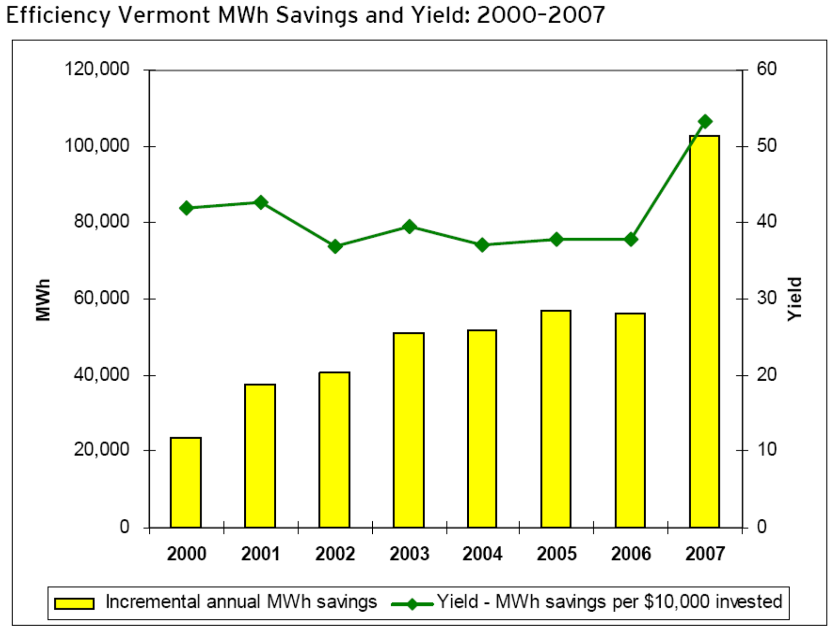
2500 average Megatts of energy savings are equal to 10-12% of 2002 electricity sales. Since these savings were realized over a period of some 20 years, the average annualized savings were under 1% of sales. In recent years, however, annual savings have been higher, ranging closer to 1% of sales.

Figure 2-3. Northwest Power and Conservation Council Efficiency Estimates



- **Vermont.** The Efficiency Vermont program, in which a single entity is contracted to deliver energy efficiency programs for the whole state, reports significant impacts from its programs. Efficiency Vermont's 2007 annual report estimated that its program portfolio saved about 103,000 MWH, or about 1.7% of total electricity sales, which is at the high end of efficiency potential estimates[12]. This level of savings was estimated to fully offset growth in electricity sales. Figure 2-4 below illustrates Efficiency Vermont program impacts since 2000.

Figure 2-4. Efficiency Vermont 2007 Impacts



2.4 Energy Efficiency's Potential Impact on Carbon Dioxide Emissions

Efficiency has long been discussed in general terms as a "no regrets" element of climate policy, on the precept that because efficiency is cost-effective in its own right, it makes sense to pursue efficiency to prevent carbon dioxide emissions associated with energy usage. Efficiency has been viewed as providing at least two broad benefits in the climate arena: (1) slowing the growth of energy use, to buy time for non-emitting supply technologies to reduce average emission rates, and (2) reducing the cost of meeting carbon dioxide emission reduction goals.

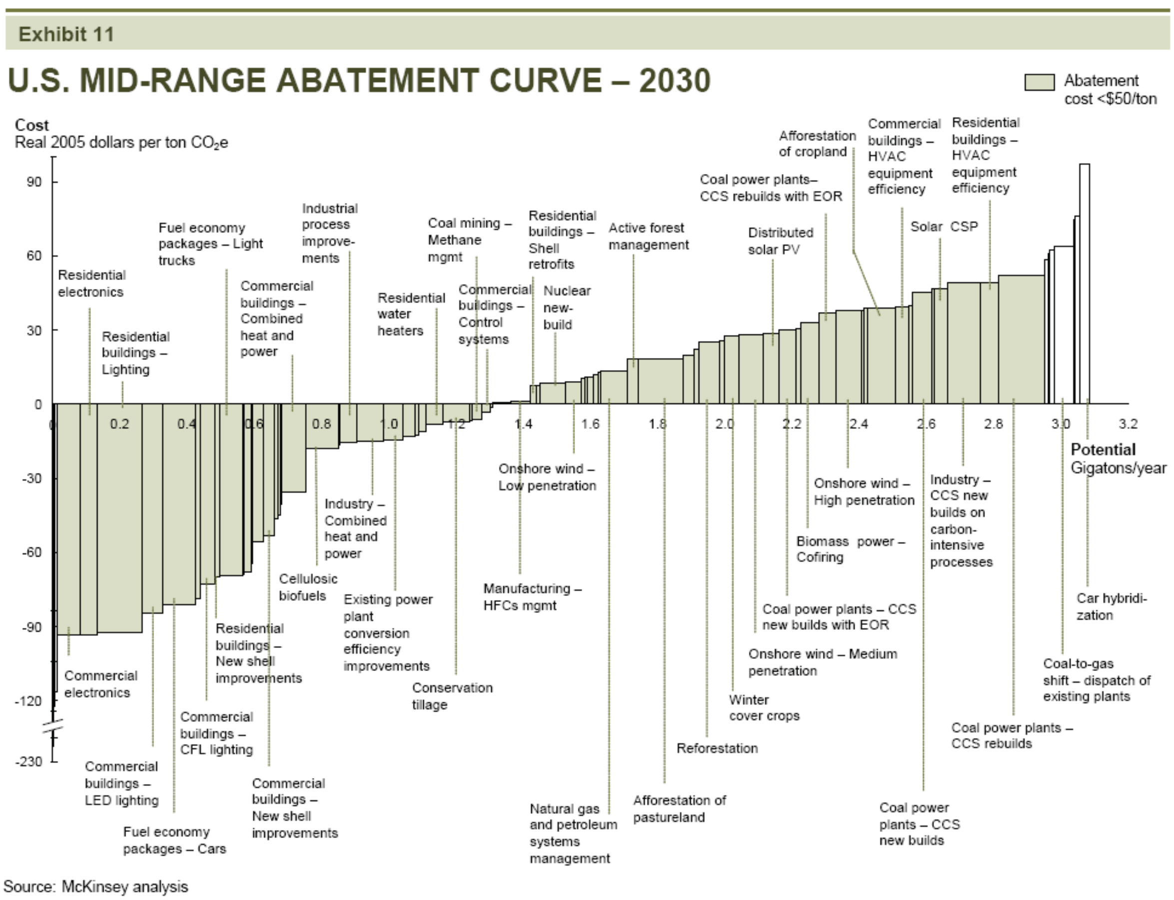
Efforts to quantify the link between energy efficiency and carbon dioxide emissions have been fewer than the analyses of energy efficiency potential, and have generally been conducted in long-term, aggregate frameworks. In electricity systems, because electricity usage is distant from the generation facilities that emit carbon dioxide, efficiency's impact on carbon dioxide emissions is indirect, and depends on specific factors like the hourly load shape impact of efficiency measures, and the marginal generating unit at a given hour for the affected power system. In a capped carbon market, one would also need to look at short-term vs. long-term impacts on emissions with respect to relevant compliance periods. While these issues are beyond the scope of this paper, they could be relevant for future policy and program design.

A sampling of carbon dioxide impact estimates from recent studies includes:

- **[WILL ADD EPRI "The Power to Reduce CO2 Emissions: The Full Portfolio."]**

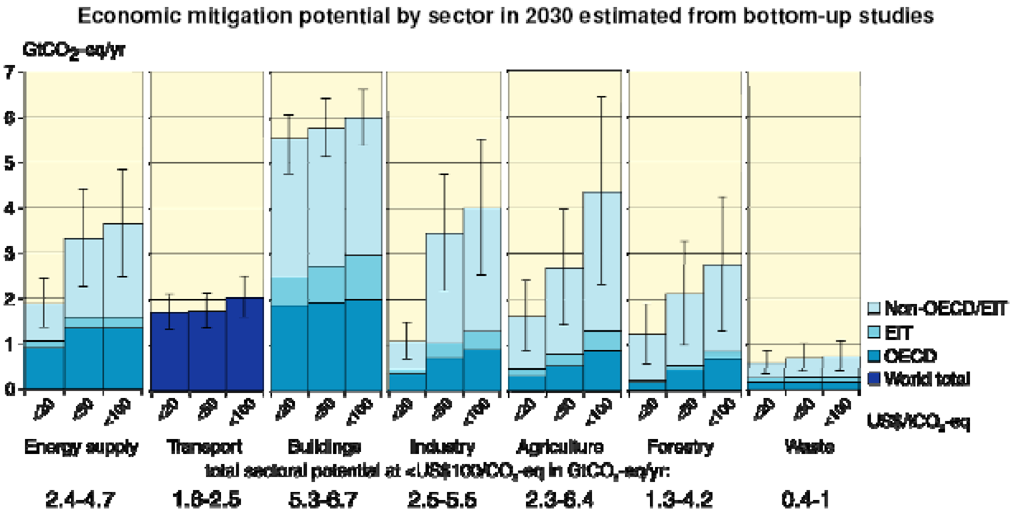
McKinsey &Co. In parallel with the energy productivity study cited earlier, McKinsey developed a carbon abatement cost curve as part of a report it produced in 2007[13] (see Figure 2-5 below.) Energy efficiency technologies account for most of the lowest-cost resource options, shown on the left side of the graphic. While the level of detail available in the report does not precisely segment efficiency vs. other technology impacts, a rough estimate shows energy efficiency technologies providing on the order of 1 billion tons of CO_2 emission reductions in the 2030 timeframe. McKinsey's analysis also estimates costs per ton of CO2 emissions reduced. Most energy efficiency technologies are shown as negative-cost measures. This negative-cost calculation is based on net lifecycle costs, measured against reference case estimates of energy supply costs. McKinsey does not include non-capital costs, such as the administrative and other program costs needed to overcome market barriers, and so may somewhat underestimate the total cost of delivering efficiency resources. McKinsey's use of the lifecycle-cost framework, in which efficiency investments show lower lifecyle costs than reference supply investments, does not suggest that efficiency bears no initial capital cost; this difference in the frameworks through which costs are viewed, in this case between initial capital cost and relative lifecycle costs, has generated some confusion over the negative-cost issue[14].

Figure 2-5. McKinsey Carbon Abatement Cost Curve



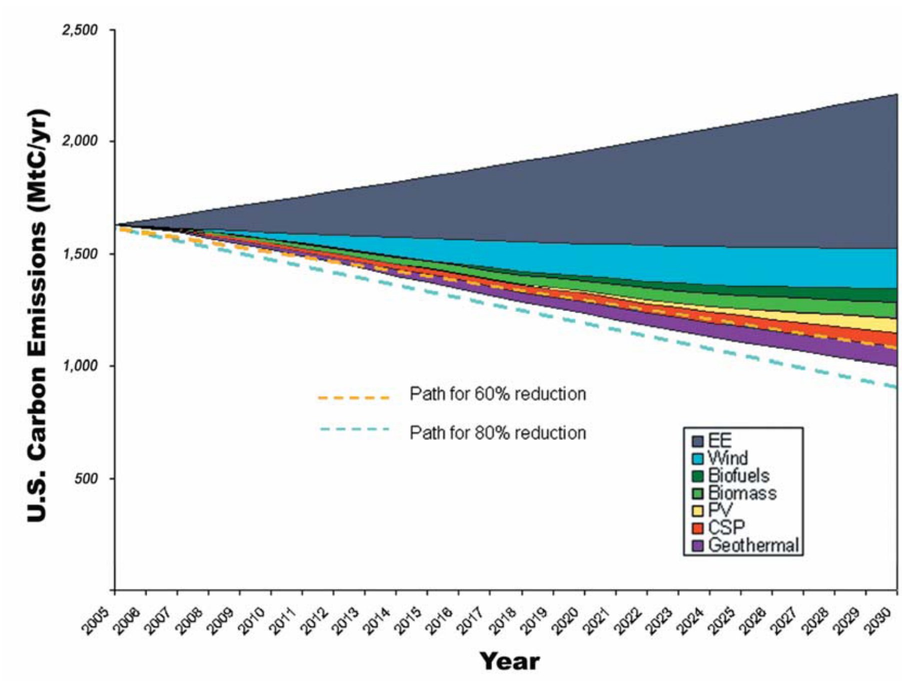
- **Intergovernmental Panel on Climate Change (IPCC).** The IPCC's mitigation working group developed substantial analysis on energy efficiency and carbon abatement potential.[15] While this work is primarily global in scale, the findings generally apply to U.S. markets on a proportional basis. Figure 2-6 below summarizes the project contributions from various sectors. Note that the buildings sector holds the largest fraction of emissions reduction potential, and that most of that comes from electricity savings.

Figure 2-6. IPCC CO_2 Emissions Abatement Estimates



- **American Solar Energy Society (ASES).** The 2007 ASES report shows a large fraction of carbon dioxide emission reductions coming from energy efficiency in the 2030 timeframe.[16] In the ASES analysis, efficiency accounts for 57% of the 1.2 billion tons of carbon equivalent the study finds could be achieved by 2030. The total reduction potential is close to that of the McKinsey report.

Figure 2-7. Carbon Dioxide Reductions from Energy Efficiency and Renewable Energy



- **Scenarios for a Clean Energy Future (CEF).** Cited earlier in the discussion of energy efficiency potential, this study also project carbon emission out to 2020. In its advanced scenario, with maximum reductions of 565 million tons of carbon, energy efficiency accounted for 65% of total emission reductions.

- **National Action Plan Vision for 2025.** The national cost-effective energy savings cited above from extrapolating the costs and benefits from existing energy efficiency efforts translates into a reduction in greenhouse gas emissions on the order of 500 million metric tons of CO_2 annually.[17]

These analyses all point to a major potential role for energy efficiency in reaching substantial greenhouse gas emission reduction goals. The remaining focus of this paper is on overcoming the market barriers and other forces that inhibit energy efficiency gains, through proven and cost-effective energy efficiency policies and programs

2.5 Summary of Costs and Benefits of Current Energy Efficiency Investments

To better understand the role that energy efficiency can play in reducing CO_2 emissions and at what cost, it is important to look at the cost of saved energy and information on the current level of investment in energy efficiency across the country and the resulting aggregate savings.

Cost per unit of saved energy. Various potential studies, resource plans, and program reports and evaluations have estimated the cost-effectiveness of energy efficiency, both as an aggregate resource and as individual measures and programs. The preponderance of these analyses find that energy efficiency is relatively inexpensive, especially when compared to conventional energy supply resource options. A sample of these estimates includes:

- An ACEEE review of efficiency programs around the U.S. found that the levelized lifecycle cost of saved energy for the programs reviewed ranged from 2.3 to 4.4 cents per kWh[18]. This compares favorably with avoided costs for conventional thermal power plants. It is important to note that the definition and the calculation methods of “avoided costs” vary from state to state, so there is no single national benchmark for the cost of electricity supply resources that would be avoided by efficiency programs. In California, current estimates of avoided costs are in the range of 9 cents per kWh. This is within a typical range of avoided costs filed in various resource plans around the U.S. Picking a single number for avoided costs is complicated by the fact that some avoided costs are estimated on an hourly basis, such that kWh saved during peak demand periods avoid higher costs than those saved during lower-cost off-peak periods.

- Consistently, a nominal calculation from ACEEE’s State Energy Scorecard[19] data shows an average cost of about 20 cents per first-year saved kWh. On a levelized lifecycle basis, this would likely translate to a cost of saved energy in the range of 2 cents per kWh. Note that this estimate would be termed the “program administrator cost” for the saved energy; because customers typically pay a substantial portion of total efficiency investment costs, the “total resource cost” of these savings would be higher than 2 cents.[20]

- The NWPCC’s Fifth Power Plan estimates levelized costs and benefit-cost ratios for individual efficiency measures and end-uses. The levelized cost of saved energy averages 2.4 cents per kWh, ranging from 1.2 to 5.2 cents. The Council’s avoided cost estimates are unique and variable, given its mix of low-cost hydropower and most costly thermal resources, and a sophisticated hourly modeling approach. But the Council's costs for energy savings are by definition lower than avoided costs.

- Efficiency Vermont's 2007 Annual Report, cited earlier, estimates the cost of saved energy at 2.7 cents per kWh. Vermont avoided costs for electricity supply are estimated to average 10.7 cents per kWh.

- The Minnesota CIP evaluation cited earlier shows 2003 costs of $52 million for annual savings of 328 million kWh. That averages to a cost per first-year saved kWh of 16 cents per kWh; while the report does not calculate levelized lifecycle costs of saved energy, based on typical measure lives, this would likely translate to a levelized cost of 2 cents per kWh or less.

- The July 2006 Action Plan Report[21] references twelve best practice program portfolios with lifetime levelized costs of $0.02-$0.05 per kWh for electricity measures and $0.06 to $2.32 per MMBtu for natural gas efficiency measures.

Total investment in efficiency technologies and programs and resulting savings. Energy efficiency has yielded important benefits across the U.S. economy over the last 35 years. However, while various analyses have sought to estimate total energy efficiency investment and benefits from energy efficiency across the U.S. economy[22], such efforts are limited by data and methodology constraints. Reports like the Rand study of California's efficiency policies provide useful examples of the significant streams of economic and other benefits these policies and programs deliver.[23] Based on data available, energy efficiency delivered through state and utility-administered programs is funded at the following levels and has provided the following benefits:

- Approximately $2 billion (approximately 0.5 percent of utility revenues) is being invested annually in state- and utility-administered energy efficiency programs.[24]

- Cumulative annual electricity savings total 63 billion kWh (about 2 percent of retail sales) and cumulative annual natural gas savings total 135 million therms (0.1 percent of retail sales) as of 2006.[25] The cumulative electricity savings have avoided the need for 16 GW of new capacity.[26]

These estimates have been developed from a variety of available information sources, [27] which introduces inconsistencies in timeframes, reporting categories, universe of respondents, and quality control of data. Due to data limitations, these initial values are likely to underestimate the full contribution that energy efficiency investments are making to reduce energy demand as well as the full cost of investing in energy efficiency. Some of the key limitations include:

- The energy savings values only capture savings from administered energy efficiency programs and do not reflect energy savings from other state and local efforts such as building energy codes, state-level appliance standards, and local and state lead-by-example initiatives.

- The energy savings values do not include the benefits from national efforts to promote energy efficiency, federal appliance standards, or the autonomous rate of improvement in efficiency across the economy.

- The program funding values represent program costs alone and not the costs that program participants may bear.

Additional attention is necessary to expand the breadth and accuracy of energy efficiency resource information in order to improve the ability to measure progress toward all cost-effective energy efficiency using these national performance metrics

Comparison of Current Energy Efficiency Program Funding to Investment Necessary to Achieve Economic Potential. While additional work is necessary to more precisely estimate the level of investment in energy efficiency consistent with capturing the attainable cost-effective energy efficiency, ball park estimates demonstrate that the current level of program funding and investment is substantially below the investment levels necessary. For example, leading energy efficiency programs being deployed in some states across the country, as described above, are being funded at 2 to 3 percent of energy sales and delivering energy savings on the order of 1 percent per year. If these programs where deployed throughout the country, annual energy efficiency program funding and investment would be on the order of 4 to 5 times larger. These ballpark estimates do not reflect the costs of implementing energy efficiency policies such as building codes and minimum appliance standards.

2.6 Summary of Resource Analysis Observations

A review of these recent potential studies leads to the following observations:

- The scope of cost-effective energy efficiency is large, and a substantial percentage of future energy needs can be met through efficiency resources. Several studies in the electricity sector indicate that savings in the range of 1% of total sales annually are achievable. These estimates suggest that efficiency policies and programs can offset a significant portion, on the order of 50 percent or more of electric load growth. [28] The percent of load growth that can be offset depends in part on underlying forecast growth rates; in high-load-growth areas, efficiency may have a lower percentage impact on load growth, while in slower-growth areas, efficiency can offset a higher fraction.

- Studies that cover a full range of markets, end-uses, and technologies tend to show substantial energy efficiency savings opportunities across residential, commercial and industrial end-use sectors. While the efficiency potential found in a given state, metro area, or utility service area depends in part of its unique mix of housing, commercial building stock, and industry sectors, potential studies are relatively consistent in finding savings opportunities in comparable ranges across the state and local economy.

- Because some studies calculate the CO2 emissions impacts of energy savings, they show that energy efficiency offers substantial low-cost opportunities to reduce CO2 emissions. There is some confusion in the literature about some studies' association of the term "negative cost" with energy efficiency investments. These studies use negative cost in a lifecycle-cost framework, against a benchmark of reference case energy supply costs. In this framework, efficiency can be said to bear negative costs on a lifecycle, comparative basis. Such findings should not be confused with a present-day, investment-oriented framework, in which all resource choices bear initial capital and other costs. From a policymaker's point of view, the comparative lifecycle cost perspective can be appropriate; and it is also true that the up-front costs of all resource choices must be considered.

- Substantial savings are possible through energy efficiency programs administered under policy requirements. The promise found in potential studies has been partially borne out by measured impacts from programs operated in some states over an extended period.

- Extrapolating the costs and benefits of existing programs reveals a national potential to meet 50 percent or more of load growth, or 20% of electricity demand and 10% of natural gas demand in 2030. Achieving such an increase in energy efficiency savings would require a substantially increased investment by states and utilities from current investment levels of $2 billion per year.

- There are macroeconomic benefits from the pursuit of energy efficiency, including reduced energy expenditures for end-use consumers, increased spending of saved energy dollars in other sectors, increased employment and personal income, and increased total economic output.

2.7 Notes

[1] Efficiency potential is typically defined in three categories: technical, economic, and achievable. Technical potential is based on the highest level of energy savings that could be achieved with best available technologies, without regard to cost or practical constraints. Economic potential screens out part of technical potential by applying cost-effectiveness criteria. Achievable potential further limits resource estimates by imposing constraints based on market barriers, program limitations, or funding constraints. For more information, see National Action Plan for Energy Efficiency (2007). *Guide for Conducting Energy Efficiency Potential Studies.* Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. <www.epa.gov/eeactionplan>

[2] Savings potential as presented in this table is expressed as a percentage of a future forecast level of energy consumption. Percentages tend to vary based on the length of the time horizon; eg. shorter timeframes tend to show smaller savings percentages. It is thus important to take the timeframe into account when comparing percentage estimates.

[3] To provide a more consistent basis for comparison of savings potential, a rough estimate is made in this column to show energy savings on an annualized basis. This tends to even out the differences in timeframe among the various studies. However, these estimates are only approximate and are meant as indicative only.

[4] National Action Plan for Energy Efficiency (2007). *Guide for Conducting Energy Efficiency Potential Studies.* Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. <www.epa.gov/eeactionplan>

[5] For more information, see Nadel et al, op. cit.

[6] Add references to both EE Potential Study and Resource Planning Guide.

[7] Hopper et al. 2006. Energy Efficiency in Western Utility Resource Plans: Impacts on Regional Resource Assessment and WGA Plans. Lawrence Berkeley National Laboratory, report no. LBNL 58271.

Impacts on Regional Resource Assessment and Support for WGA Policies.

[8] Ibid.

[9] Ibid.

[10] NWPCC. 2005. The Fifth Northwest Electric Power and Conservation Plan. http://www.nwcouncil.org/energy/powerplan/5/Default.htm

[11] Minnesota Office of the Legislative Auditor. 2005. *Energy Conservation Improvement Program Evaluation Report.*

[12] Efficiency Vermont. 2008. *2007 Annual Report*.

[13] Cite McKinsey Report

[14] The conclusion of the study is accompanied by the following important caution: "Achieving these reductions at the lowest cost to the economy, however, will require strong, coordinated, economy-wide action that begins in the near future." Further, the study makes clear that achievement of the identified potential will require strong policy support "needed to address fundamental market barriers." The costs associated with such policies are not accounted for the analysis.

[15] IPCC. 2007. Intergovernmental Panel on Climate Change. Fourth Assessment Report, Working Group III Report.

[16] Kutscher. 2007. *Tackling Climate Change in the U.S. Potential Carbon Emission Reductions from Energy Efficiency and Renewable Energy by 2030*. American Solar Energy Society.

[17] Citation for Vision document.

[18] Kushler et al. 2004. *Five Years In: An Examination of the First Half-Decade of Public Benefits Energy Efficiency Policies*. American Council for an Energy-Efficient Economy, Report no. U041.

[19] Eldridge et al. 2008. *The 2008 State Energy Efficiency Scorecard.* American Council for an Energy-Efficient Economy, report no. E086.

[20] For a fuller discussion of cost-effectiveness issues, see the Action Plan report Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers at <http://www.epa.gov/solar/documents/cost-effectiveness.pdf>

[21] Add footnote.

[22] Ehrhardt-Martinez, Karen, and Laitner, Skip. 2008. The Size of the U.S. Energy Efficiency Market:Generating a More Complete Picture. American Council for an Energy-Efficient Economy, report no. E083

[23] Bernstein, Mark, Robert Lempert, David Loughran, and David Ortiz. 2000. *The Public Benefit of California's Investments in Energy Efficiency.* MR-1212.0-CEC. Prepared for the California Energy Commission by the RAND Corporation. Santa Monica, California: RAND Corporation.

[24] Annual spending value considers both ACEEE's 2006 actual electricity efficiency program spending (Eldridge et al., 2008) and CEE's 2007 budget estimates for residential, commercial, and industrial electricity and gas efficiency programs (Nevius et al., 2008). CEE budget estimates capture both CEE members and nonmember administrators of energy efficiency program respondents. Program funding for low-income, load management, and other programs is not included in these estimates. Actual 2006 spending for electricity efficiency programs comes from ACEEE, leveraging EIA and ACEEE's independent information collection efforts.

[25] Natural gas savings are from the Consortium for Energy Efficiency (CEE) for their members only (Nevius, M., J. Krouk, S. Griffith, and C. Lasky (2008). Energy Efficiency Programs: A $3.7 Billion U.S. and Canadian Industry. Boston: Consortium for Energy Efficiency. http://www.cee1.org/ee-pe/2007/ “Nevius et al., 2008”) and include estimated savings from measures installed in 2006, as well as those installed as early as 1992 that were still generating savings as of 2006.

[26] Annual incremental electricity savings are from the American Council for an Energy-Efficient Economy (ACEEE) (Eldridge et al., 2008) and cumulative electricity savings are from Energy Information Administration (EIA) Form-861 data (EIA, 2008b), both for year 2006. Values reflect reported data for administered energy efficiency programs only and do not include low-income programs nor other load management efforts such as demand response. Cumulative savings do not capture those programs administered by state entities. Peak electricity savings are from EIA Form-861 data for year 2006 and reflect reported data for utility-administered energy efficiency programs only and do not include load management programs.

[27] For additional information on data sources and calculation methodologies see Appendix E of the Vision for 2025: A Framework for Change.

[28] Cite Action Plan Vision Report

3: Limitations to Advancing Energy Efficiency Through Energy Pricing Policies Alone

In traditional energy and environmental policy analysis, getting energy prices “right”, such that they fully reflect direct economic costs as well as indirect environmental social costs, is a central concern[1]. In this approach to policymaking, setting the right energy price signals would result in the best allocation of resources among various options. It would suggest that proper price signals would also capture the cost-effective energy efficiency resource potential embedded in the various sectors of the U.S. economy. [1] This paper explores two factors that tend to undercut or limit the effects of price signals in seeking to harvest the full potential for energy efficiency. They are:

- **The substantial and persistent market barriers that affect large parts of end-use markets.** Decades of experience in real energy markets, backed up by recent analyses that seek to quantify the effects of market barriers, show that barriers are real, large, and lasting, and require targeted policy and program initiatives to overcome.

- **The limits of price elasticity in effecting net changes in energy use throughout the economy.** While price elasticity effects are real, they are also counteracted by other forces, such as income elasticity and cross elasticity, such that the net effect of price signals on energy consumption can be blunted.

There are certainly other factors that can limit the observed price elasticity of electricity demand. One is the lack of practical substitutes for electricity in many end-uses. While end uses such as heating or hot water can be served with technologies using other fuels, others such as cooling, ventilation, appliances, and electronics cannot.

Limitations in the transparency of electricity prices can also affect elasticity. The traditional ratemaking practice of average-cost, non-time-differentiated pricing tends to mask the marginal cost of producing electricity. Also, utility billing statements, in which customers receive bills after consuming the product, and in which prices are embedded in a list of billing line items, present challenges to consumer understanding of prices.

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[1] Selected recent references on price elasticity include:

Faruqui and Wood. 2008. *Quantifying the Benefits of Dynamic Pricing in the Mass Market.* Edison Electric Institute, Washington, DC.

Neenan, Bernard. 2008. “Juneau Response to Jolt Confirms Price Elasticity” *The Electricity Journal*, *Volume 21, Issue 5*, *June 2008*, *Pages 4-5.*

McDonough and Kraus. 2007. “Does Dynamic Pricing Make Sense for Mass Market Customers?” *The Electricity Journal*, *Volume 20, Issue 7*, *August-September 2007*, *Pages 26-37*

Siddiqui. 2003. *Price-Elastic Demand in Deregulated Electricity Markets.* Energy Analysis Department, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory. *http://eetd.lbl.gov/ea/EMS/EMS_pubs.html*

Barbose et al. 2004. *A Survey of Utility Experience with Real Time Pricing.* Energy Analysis Department, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory. *http://eetd.lbl.gov/ea/EMS/EMS_pubs.html*

3.1 Market Barriers to Energy Efficiency

One of the roles of efficiency potential studies is to identify the cost-effective technologies, practices, and programs that reduce life-cycle or societal costs, because such measures justify policy or program intervention to remediate market failures. Substantial work in this area has been undertaken as seen in the earlier section. Further, a principal purpose for many of the energy efficiency programs and policies already in place in the U.S. at the national, state, and local levels is to reduce market barriers or policy barriers that can be shown to significantly limit energy efficiency investment, relative to the level of investment that would occur if markets operated “perfectly”.

There is substantial economic research on the existence and magnitude of market barriers, and on the ability of policies and programs to overcome them.[2]

Barriers to energy efficiency are reviewed in the National Action Plan.[3] Other market barrier research includes [IEA, etc.] [4]One of the helpful aspects of the *Mind the Gap* report is that it takes care to segment barriers into phenomena that classical economists recognize, conditions that behavioral economists and psychology and sociology practitioners might study, and conditions that that energy efficiency practitioners experience.

Several commonly acknowledged market barriers are described below:

- **The Principal-Agent Barrier.** This involves a condition in which one entity (the agent) makes energy efficiency investment decisions, and another entity (the principal) pays the energy operating costs that flow from that decision. The most common principal-agent barriers observed in the U.S. are the builder-buyer barrier, in which building designers or construction contractors decide the efficiency levels for building thermal performance, heating and cooling systems, hot water systems, lighting systems, and major appliances. Builders will rarely optimize energy performance on a life cycle basis, unless they are under contract directly to informed buyers who specify such performance and are willing to pay for it. This “custom-building” or owner-designed construction accounts for a small minority of U.S. building starts. In rental property, be it residential or commercial, tenants do not normally have the ability to specify energy performance for major building systems or appliances, and landlords typically pass through energy costs to tenants, so they are rarely motivate to reduce energy usage in their buildings. Principal-agent problems can exist even within organizations: for example, if a procurement department buys energy using equipment for the organization on a low-bid first cost basis, and facility operators seek to reduce operating costs through efficient technologies that have a cost premium, the organization may chronically under-invest in efficiency.

- **The Transaction-Cost Barrier**. Economists sometimes use terms like “information-cost” or “search cost” for this type of barrier. It refers to the condition in which energy users, even if they have the ability to choose the energy efficiency performance of a product or system, are unwilling to invest the time, effort, and analysis to make an economically-optimum decision. Most residential and small commercial consumers frequently experience this situation: they need to replace a product, such as a water heater, but lack the knowledge, expertise, and time to figure out the best decision. These factors—information, time, analytical skill—add up to a set of transaction costs that average consumers are unwilling or unable to pay. By contrast, some larger customers, and some energy professionals, have the information, expertise, and time to make better decisions, so some customer markets are less afflicted by this barrier.

Numerous other conditions are often referred to as barriers. Consumers' aversion to risk, competing attributes of products that drive decisions based on non-energy factors, and other conditions that can be observed in markets and consumer behaviors. Understanding these phenomena can be helpful for some purposes, such as designing the marketing, outreach, and delivery systems for efficiency programs, or public education and media efforts. However, the scope of this paper limits the extent of such a review, so this assessment is limited to the more classic barrier types.

3.2 Regulatory Barriers

Policies can create additional barriers in some cases, by adding constraints or prescriptions to market structures or practices. In the power sector, regulatory barriers to efficiency revolve around utility resource planning and ratemaking policies.

Examples of regulatory barriers to efficiency in the power sector include:

- **Unbundling of distribution, transmission, and generation functions.** While restructuring of these three utility system functions can be argued to increase economic efficiency by opening markets to competitive forces, from a resource planning point of view, unbundling of these functions can also fracture the jurisdictional ability to plan for and estimate the resource value of energy efficiency. This is particularly true for distribution-only utilities regulated by state or local government. Because transmission and generation around outside these agencies' jurisdiction, it can be difficult for them to assign a fully-bundled set of values to energy efficiency resources. Transmission system operators, in a related way, are able to value only the transmission-related resource benefits of efficiency, and in some cases the generation capacity value (if a capacity market has been established.

- **Resource planning practices.** Energy efficiency potential takes a long time, typically decades, to be fully realized. The markets for new buildings, energy systems, and other end use products take many years to turn over; efficiency programs must be in place for the duration of such cycles to fully realize efficiency's market potential. However, not all jurisdictions undertake resource planning on the 15-25 year timeframes needed to adequately plan for efficiency. In addition to the time horizon issues, resource planning must include robust and consistent resource assessment methods that treat demand and supply resources with comparable levels of analytic rigor.[5]

- **Ratemaking practices.** The mechanisms by which utilities recover costs and earn returns can have a strong effect on investor-owned companies' willingness to invest in demand-side resources. The predominant approach to rate design in most U.S. states is to recover fixed and variable costs and allowed margins on a volumetric basis, based on estimates of kWh sales. If kWh sales fall short of estimates, utilities' fixed cost recovery and shareholder returns can be reduced substantially. This limits many companies; willingness to invest substantial amounts on energy efficiency. [6]

The Action Plan discusses these barriers and related issues more extensively in The National Action Plan Vision for 2025 and the National Action Plan Report.

3.3 Price Elasticity

"Price elasticity of demand" is an economist's term for the effects of changes in energy prices on energy consumption. Price elasticity assumptions underlay many energy policies, relying on energy prices to change energy use patterns. While price elasticity is an important policy tool, experience in end-use markets questions the limits of price elasticity effects. This experience suggests a discussion on whether pricing policies alone are sufficient to realize the full potential for energy efficiency. This section discusses the limits of price elasticity and the implications of such limits for policies to encourage efficiency investment in the power sector.

The limits of price elasticity can be summarized in the following points:

- **Market barriers.** As discussed above, barriers such as the principal-agent problem and the transaction-cost problem have the effect of isolating some energy end-use markets from price elasticity effects. Builders, for example, do not see the effect of future changes in energy prices when they make building efficiency decisions at construction. IEA-funded research [Mind the Gap] shows that this barrier affects a large fraction of residential and commercial end-use markets.

- **Price transparency.** End users can only respond to price signals when prices are transparent: that is, when prices are perceived at or before the time of energy consumption. For example, in motor fuel markets, drivers see posted fuel prices at retail stations before making their purchases, and thus have a very transparent signal that may affect both short-term driving behavior and longer-term vehicle purchase behavior. By contrast, in utility markets, customers get bills after they have consumed electricity. Bills are often complex, such that customers may have to do arithmetic to discover the net price per kWh, and then compare that price to what they paid in previous periods. This can mask price effects. Moreover, vehicle drivers have more transparent choices regarding future energy use: they can drive less, or buy more fuel-efficient vehicles. Electricity consumers, however, typically have dozens of power-using devices in their homes or businesses, and do not typically know which will yield the greatest savings if used differently or replaced. This compounds the lack of price transparency with a lack of transparency for choices in demand reduction.

- **Countervailing price effects.** Price elasticity is but one element of economic price theory. Income elasticity and cross-elasticity effects also operate in energy markets, and can serve to countervail price elasticity effects. Income elasticity means the effect of income on energy demand. In prospering economies, rising incomes tend to drive up the demand for energy services: for example, consumers want larger homes and more appliances in good economic times. Cross elasticity refers to effects where changes in energy prices cause energy users to reduce consumption of other goods, rather than directly reducing energy consumption. For example, consumers may continue to drive to a shopping center, using the same amount of fuel, but may make fewer discretionary purchases on a given shopping trip. Electricity users may see electricity as an essential service, and may choose to cut back on entertainment or other expenses if utility bills rise. While it is difficult to quantify the net effects of price, income, and cross elasticity, for the purposes of this paper it is sufficient to point out that price elasticity effects may be limited in some markets.

The limits of price elasticity as discussed in this section are not meant to suggest that energy pricing policies do not have any impact on promoting energy efficiency. Rather, the intent is to point out that to realize the potential for efficiency in all end-use markets, pricing policies will need to be complemented with other approaches.

3.4 Summary of Findings on Limitations to Advancing Energy Efficiency through Energy Pricing Policies Alone

A review of the information presented above leads to the observations that energy prices alone (assuming that a principal impact of climate policies will be to raise energy prices) may not accelerate efficiency investment at the rate needed to tap the majority of efficiency's economic potential. Price signals alone are likely insufficient because:

- Market and regulatory barriers are large and persistent, especially as principal-agent barriers, information-cost or transaction-cost barriers, and regulatory policies in the area of utility ratemaking.

- The price elasticity of energy consumption in many residential and commercial markets is relatively weak, due to countervailing elasticity effects, and relying solely on price elasticity to drive efficiency investment may not harvest a large fraction of efficiency potential.

- More analysis is needed to quantify the impacts of barriers and evaluate the solutions designed to address them.

3.5 Notes

[1] In practice, environmental costs are incorporated to some degree through a number of different mechanisms including requirements by some state utility commissions for utilities to apply factors representing the societal costs of environmental externalities (e.g., cost per ton of CO2 emitted) when conducting resource planning, to federal or state emissions regulations that require emissions controls that increase costs of power plants and are ultimately reflected in electric rates.

[2] One of the fundamental distinctions made in the market barrier literature is between market barriers and market failures. Some economists distinguish barriers and failures by defining a market failure as a condition that reduces energy efficiency and economic efficiency, whereas a market barrier is a condition that reduces energy efficiency without necessarily reducing economic efficiency. For example, one could point out a market barrier that keeps home builders from constructing homes that use 75% less energy than current building codes require. However, this condition would only be classified as a market failure if the life cycle cost of the home were lower at the 75%-energy-savings level than at the current-code level. If it can be shown that energy performance at that level does not reduce overall life cycle costs, builders' unwillingness to build to that level of performance would not be a market failure. If, by contrast, a performance level 30% better than current codes can be shown to reduce life cycle costs, and builders still fail to build to this level of performance, that would be deemed a market failure.

[3] Provide Action Plan document cites – year one report, vision and sector collaborative report.

[4] Citation needed.

[5] Reference Action Plan planning guide

[6] Reference Action Plan utility incentives paper

4: Summary of Energy Efficiency Policies and Programs that Advance Energy Efficiency

A common rationale for public policy and programs aimed at energy efficiency is removing the known barriers to energy efficiency in key end-use markets. Another key focus is in the policy arena itself, such as reforming regulatory policies to remove utility disincentives to efficiency investment. Market barriers can be addressed through directive policy interventions (e.g., building codes, appliance standards, setting energy efficiency resource requirements) and through voluntary, incentive-based programs administered by utilities, government entities, and third parties. Addressing regulatory barriers involves less a market-oriented focus than a review of regulatory policy specifics.

This section reviews the policies and programs that can address the key barriers identified above. It outlines the policies and programs currently used for:

- Addressing market barriers
  - Purchase of individual products
  - New building construction
  - Improving existing facilities
- Addressing regulatory barriers
  - Utility regulatory issues
  - Encouraging cost-effective distributed generation
  - Pricing policies

4.1 Addressing Market Barriers

This section summarizes the policy and program options most commonly used today to address market barriers and increase energy efficiency in end-use markets. It matches policy/program options to the main markets affected by barriers. Table 4-1 summarizes this approach.

Table 4-1. Policy/Program Options Matched to Markets

	Market Focus		
Policy/Program Option	Individual Products	New Construction	Existing Buildings
Mandatory appliance standards	X		
Product labeling	X		
Voluntary appliance standards	X		
Building codes		X	
Voluntary building standards		X	
Building labeling/benchmarking		X	X
Retrofit programs			X

4.1.1 Purchase of Individual Products

Product purchases exemplify a "lost-opportunity" market, in that consumers or businesses routinely purchase energy-using products or equipment, and each purchase represents an opportunity that will be lost if the efficiency program does not influence the purchaser to make a more efficient choice. Principal-agent and transaction-cost barriers can make millions of these routine transactions lost opportunities. Fortunately, there are several policy tools for improving the efficiency of individual products at the point that these products are purchased. These include minimum appliance standards and approaches that go beyond standards which are each discussed below.

- **Mandatory Minimum Appliance Standards.** Minimum appliance standards help address the principal-agent problem in new construction and in leased space, as well as the transaction cost barrier that arises in the typical purchase of an energy using product. The latter is best highlighted by explaining how purchases are frequently made. If, for example, a hot water heater, air conditioner, or refrigerator fails, the owner's first concern is to replace the unit as soon as possible. This "panic purchase" situation tends to severely truncate any broader study of efficiency options, and tends to drive consumers toward models that are available and affordable on short notice. For many of the larger energy using products the new construction market and the retrofit markets comprise relatively equal sales, emphasizing the role of appliance standards in addressing these various barriers.

  Appliance standards play a complementary role to building codes, by addressing the devices that consume energy within the building. This is particularly true for residential buildings, where federal law covers most major energy using devices. It is less so for commercial buildings, where some types of heating and cooling equipment are not covered by federal law, and most lighting systems are not covered. The difference between product or equipment types covered—or not covered—by federal appliance efficiency standards defines the opportunity for states to use appliance standards as an energy policy.

  States are able to set standards for products or equipment types that are not covered by federal law[1]. ACEEE analysis indicates that several technologies represent opportunities for states to enact as standards[2]. Historical precedent indicates that standards, once enacted, tend to become federal standards over time. Manufacturers generally oppose multiple state standards, but once enacted, they often negotiate federal standards to avoid the situation of multiple standards in customer markets. As of October 2008, 16 states have set their own appliance standards.[2]

- **Voluntary Product Promotion.** This program also addresses the principal-agent and transaction-cost problems, albeit through voluntary approaches. The leading U.S. example is the ENERGY STAR program, introduced by the U.S. EPA in 1992. The first program strategy was to specify and promote products that are significantly more efficient than minimum standards, and to provide efficient choices for product categories not covered by standards. Specifications are set to identify efficient products that are cost-effective to the consumer, offering short simple paybacks, while providing for the features and performance consumers expect. The ENERGY STAR label is now used on more than 50 product categories across the residential, commercial, and industrial

[2] http://www.epa.gov/cleanenergy/energy-programs/state-and-local/efficiency_actions.html

sectors. Many types of organizations are using ENERGY STAR requirements as part of their energy efficiency efforts. These include:

- Retailers in their retail stores
- State and local governments establishing procurement policies requiring the purchase of ENERGY STAR qualifying products
- Energy efficiency program administrators using ENERGY STAR branding, products, programs, and tools as part of their energy efficiency programs.

Product certification and promotion programs such as ENERGY STAR require supplementary marketing efforts with partners, to make them available and visible to buyers through the full range of purchasing channels.

- **Product Energy Labeling.** The Federal Energy Guide labeling program was established by Congress in the 1970s to provide basic energy use information for major energy-using products. The yellow Energy Guide labels seen on home appliances and other products make it easier for consumers to select efficient models by reducing the transaction costs of comparing the energy efficiency of different models. ENERGY STAR goes beyond this basic labeling approach, by identifying certain products as energy efficient, making the consumer's choice even simpler. Morever, ENERGY STAR's partnership efforts ensure that the ENERGY STAR branding is actively supported in the marketplace through multiple channels.

4.1.2 New Building Construction

The new building construction market is another "lost-opportunity" market. The design decisions made before construction are difficult and expensive to correct later, making new construction the most cost-effective time to achieve major energy savings in the building stock. The new construction market is also home to one of the largest and most persistent market barriers that limit energy efficiency investment. In U.S. housing and commercial construction markets, the builders who make efficiency decisions in design and construction are typically far removed from the occupants responsible for paying the building's energy bills. The "agent"—the builder—is motivated primarily to limit upfront construction costs, whereas the "principal"—the ultimate owner/tenant who pays the energy bills—is motivated to find the lowest total cost of owning and operating the building. In U.S. construction markets, many buildings are built speculatively, meaning that the builder does not know the ultimate owner/occupant before key design and construction decisions are made. Under such conditions, builders chronically underinvest in efficiency. This persistent principal-agent has been addressed through policy action through building codes and beyond code programs.

- **Mandatory Building Energy Codes.** Building energy codes are commonly used by state and local governments to address the principal-agent problem. Building energy codes address primarily the thermal performance of the building envelope—insulation and window efficiency, air leakage through walls, ceilings, window and door assemblies, and in some cases leakage from heating and cooling ducts. Codes are limited in most cases to the "envelope" for two reasons: (1) the envelope contains the most permanent design and construction decisions, because these components can last indefinitely and can be difficult or expensive to rebuild after construction; and (2) federal law pre-empts states from regulating most heating, cooling, hot water and other appliances. These devices can be replaced somewhat more quickly, on a 10-30 year cycle, and typically do not require expensive construction modifications to replace, and are addressed through the appliance standards discussed above.

The majority of states have a relatively recent building code in force for both residential and commercial buildings[3]. Beyond the basic question of whether an energy code exists, the relative stringency of the code can also reflect the principal-agent problem. Because builders participate in the code development and adoption process, and are influential economic interests in most states and localities, they can influence the stringency of building energy codes. The stringency issue is an important issue in developing, adopting, and implementing energy codes. Other important issues with building codes include builder training, and enforcement and verification.

- **Voluntary, Beyond-Code Programs.** Regardless of the presence of building codes, programs such as ENERGY STAR that establish performance levels more stringent than code also work to address the principal-agent barrier while providing greater energy savings. This program encourages buyers to evaluate the energy performance of a building before buying and influences builders to upgrade the energy performance of their buildings. These programs are being used in energy efficiency programs to offer more efficient buildings to interested home buyers and procure energy savings by the utility. These programs require the development of a building rating infrastructure to ensure that the buildings are constructed to the more efficient levels.

- **Standardized Benchmarking of Building Energy Use.** Assessing the energy performance of new and existing buildings through standardized protocols and benchmarks is a growing practice in the United States and countries around the world. This practice addresses the transaction cost barrier in the purchase, resale and leasing of building space. It also works as an information management system to help building owners/managers understand and ultimately reduce their energy use and costs. This benchmarking and monitoring practice requires collection of data both from the energy provider and the building owner to generate ratings that reflect key building characteristics as well as actual energy use. An important issue affecting the cost and wider use of benchmarking is the standardization of energy billing data, so that customers can access utility bills and other data, download it into software tools, and assess energy performance on a common basis in various states and utility service areas around the country. The Action Plan has developed guidance on standardizing access to energy data through the *Utility Best Practices Guidance for Providing Business Customers with Energy Use and Cost Data* report, available on the Action Plan website.

4.1.3 Existing Facility Improvements

Beyond the lost-opportunity markets driven by equipment replacement and new construction cycles, there is a vast set of energy efficiency measures that can be installed as elective retrofits. Many lighting measures, insulation, air leakage reduction, controls, and other technologies can be cost-effective to install without waiting for a time-of-replacement point. These retrofit measures hold significant energy savings, but also present challenges in reaching customers and engaging trade allies, because there are few if any existing market channels through which to promote these options. Getting retrofits to occur takes much more active marketing, and sometimes additional administrative effort to coordinate marketing and delivery, than do measures that can be driven through existing market channels.

Home weatherization measures are a classic case of the challenges faced by programs aimed at retrofit measures. With most U.S. housing stock built before the current era of high energy prices, environmental concerns, and advances in building design, there are enormous opportunities for improving home insulation, windows, air leakage, duct leakage, lighting, and other features. However, reaching homeowners one by one, and customizing measures and installation techniques to each home, can be challenging. These challenges stem in part from the diverse and complex nature of home improvement markets, the overriding effect of which is to increase transaction cost barriers.

Key programs operating in U.S. markets today that seek to overcome these barriers include:

- **Low income weatherization.** The federal Weatherization Assistance Program (WAP) currently serves about 100,000 homes annually with a range of retrofit measures, from air and duct leakage reduction to insulation and equipment replacement.

- **Comprehensive home retrofits.** Some states and utilities offer packages of retrofit services to residential customers. One of the leading national umbrella efforts for these programs is Home Performance with ENERGY STAR (HPwES). This program, takes a comprehensive approach to home retrofits, using advanced diagnostics and treatment methods to deliver energy efficiency solutions that reduce energy bills while improving comfort.

- **Commercial building retrofits.** Several states and utilities offer direct installation, re-commissioning, and customized retrofit programs for non-residential customers. ENERGY STAR Buildings is a commonly-used umbrella approach for many of these efforts; it uses a benchmarking approach to determine relative energy performance based on a statistical software methodology. Many building owners then pursue a range of retrofits and operating practices to improve the building's performance to a level that can be recognized by the ENERGY STAR program.

4.1.4 Electricity and Natural Gas Efficiency Programs

These programs seek to address both types of market barriers, by focusing on new construction markets as well as equipment replacement programs and other markets.[4] They dovetail with many of the policies outlined above, though they tend not to be connected to mandatory regulatory policies like building codes and appliance standards. By providing a range of market transformation efforts, technical assistance services, and financial incentives, utility-sector programs can achieve significant impacts across all major end-use markets.

These voluntary programs are needed to realize the maximum achievable potential for energy efficiency resources. Building energy codes tend to be limited in stringency compared to an economic optimum level of performance, and also tend to contain simplified, prescriptive measures addressing each component separately. Voluntary programs can be based on measures designed to realize a greater fraction of the economic potential in new construction. They can play a similar role in equipment-replacement markets, where minimum standards typically capture only part of cost-effective efficiency potential. Voluntary programs can move replacement markets to more efficient products that capture more of the market's economic potential. Voluntary programs can also cover a wider range of products, services, and design and operating practices, beyond those typically affected by building codes and appliance standards, adding to their ability to realize a greater portion of efficiency potential. As reviewed earlier in this report, the cost effectiveness of these programs has been found to be substantially below that of generation alternatives.

4.2 Addressing Regulatory Barriers

Even if market barriers such as the principal-agent problem and the transaction-cost barrier could be eliminated, regulatory policies covering energy markets can still serve as barriers to energy efficiency. In the electricity and natural gas sectors, these policies revolve around utility regulations on ratemaking and related issues. While not the primary focus of this paper, policies affecting efficient distributed generation technologies such as combined heat and power can also inhibit efficiency investment. These include utility interconnection policies, and tariff policies regarding standby and supplemental power.

4.2.1 Utility regulatory policies

As with efficiency programs, the Action Plan has dedicated substantial effort to exploring the policy issues involved in re-directing utility regulatory policies to encourage utility and customer investment in energy efficiency. These issues include:

- Integrating energy efficiency into resource planning
- Providing sufficient, timely and stable cost recovery of program costs
- Addressing utility revenue stability given the reduction in throughput from efficiency
- Providing incentives to shareholder for measured and verified savings
- Designing rates to maximize customer incentives for energy efficiency

These issues are covered discussed in the initial Action Plan Report, with substantial detail provided in additional existing and pending Action Plan guides and papers. These documents can be found at www.epa.gov/eeactionplan.

4.3 National Action Plan Vision for 2025 Provides Framework for Achieving All Cost-Effective Energy Efficiency by 2025

The Vision document provides an overall framework and rationale for a suite of energy efficiency policies and programs, by defining 10 specific implementation goals, each with additional policy and program steps outlined. The policy framework in the Vision is based on over two decades of program and policy experience. By implementing these policies by 2015 to 2020, the policy foundation is in place to help ensure the long-term aspiration goal of the Action Plan to achieve all cost-effective energy efficiency by 2025 is met. The Action Plan is measuring progress towards achieving its Vision, as illustrated in Table 4.x.

Figure 4-x. State Progress in Meeting the National Action Plan for Energy Efficiency Vision

Implementation Goal and Key Steps		States Having Adopted Policy Step as of December 31, 2007			
		Electricity Services		Natural Gas Services	
		Completely	Partially	Completely	Partially
Goal One: Establishing Cost-Effective Energy Efficiency as a High-Priority Resource					
1	Process in place, such as a state and/or regional collaborative, to pursue energy efficiency as a high-priority resource.	14	0	14	0
2	Policy established to recognize energy efficiency as high-priority resource.	21	22	8	8
3	Potential identified for cost-effective, achievable energy efficiency over the long term.	25	1	13	0
4	Energy efficiency savings goals or expected energy savings targets established consistent with cost-effective potential.	15	3	5	2
5	Energy efficiency savings goals and targets integrated into state energy resource plan, with provisions for regular updates.	0	16	0	1
6	Energy efficiency savings goals and targets integrated into a regional energy resource plan.**	TBD	TBD	TBD	TBD
Goal Two: Developing Processes to Align Utility and Other Program Administrator Incentives Such That Efficiency and Supply Resources Are on a Level Playing Field					
7	Utility and other program administrator disincentives are removed.	17	8	18	5
8	Utility and other program administrator incentives for energy efficiency savings reviewed and established as necessary.	10	5	5	2
9	Timely cost recovery in place.**	TBD	TBD	TBD	TBD
Goal Three: Establishing Cost-Effectiveness Tests					
10	Cost-effectiveness tests adopted which reflect the long-term resource value of energy efficiency.	29	2	9	0
Goal Four: Establishing Evaluation, Measurement, and Verification Mechanisms					
11	Robust, transparent EM&V procedures established.	14	6	5	2
Goal Five: Establishing Effective Energy Efficiency Delivery Mechanisms					
12	Administrator(s) for energy efficiency programs clearly established.	24	2	13	1
13	Stable (multi-year) and sufficient funding in place consistent with energy efficiency goals.	4	9	2	4
14	Programs established to deliver energy efficiency to key customer classes and meet energy efficiency goals and targets.	24	2	7	0
15	Strong public education programs on energy efficiency in place.	18	5	13	6
16	Energy efficiency program administrator engaged in developing and sharing program best practices at the regional and/or national level.	30	0	18	0

Implementation Goal and Key Steps		States Having Adopted Policy Step as of December 31, 2007			
		Electricity Services		Natural Gas Services	
		Completely	Partially	Completely	Partially
Goal Six: Developing State Policies to Ensure Robust Energy Efficiency Practices					
17	State policies require routine review and updating of building codes.	28	13	28	13
18	Building codes effectively enforced.**	TBD	TBD	TBD	TBD
19	State appliance standards in place.	11	0	11	0
20	Strong state and local government lead-by example programs in place.	13	24	13	24
Goal Seven: Aligning Customer Pricing and Incentives to Encourage Investment in Energy Efficiency					
21	Rates examined and modified considering impact on customer incentives to pursue energy efficiency.	7	5	2	0
22	Mechanisms in place to reduce consumer disincentives for energy efficiency (e.g., including financing mechanisms).	4	1	0	0
Goal Eight: Establishing State of the Art Billing Systems					
23	Consistent information to customers on energy use, costs of energy use, and options for reducing costs.**	TBD	TBD	TBD	TBD
Goal Nine: Implementing State of the Art Efficiency Information Sharing and Delivery Systems					
24	Investments in advanced metering, smart grid infrastructure, data analysis, and two-way communication to enhance energy efficiency.	5	29	***	***
25	Coordinated energy efficiency and demand response programs established by customer class to target energy efficiency for enhanced value to customers.**	TBD	TBD	***	***
26	Residential programs established to use trained and certified professionals as part of energy efficiency program delivery.	9	0	9	0
Goal Ten: Implementing Advanced Technologies					
27	Policies in place to remove barriers to combined heat and power.	11	24	***	***
28	Timelines developed for the integration of advanced technologies.**	TBD	TBD	TBD	TBD

* See Appendix D of the full *Vision for 2025* report for additional information on how these numbers have been determined.

** See Appendix D of the full *Vision for 2025* report for discussion of why progress on this policy step is not currently measured.

*** Steps 24, 25, and 27 do not apply to natural gas.

TBD = To be determined

In addition, the Action Plan provides a comprehensive suite of resources and technical assistance to help states, utilities, and other stakeholders to help them realize the Vision. Available reports and guides are summarized in Figure 4-1 by Vision goal.

Figure 4-1. National Action Plan for Energy Efficiency Tools by Implementation Goals [table to to updated to reflect Year Four Work Plan]

Table ES-4. National Action Plan for Energy Efficiency Tools by Implementation Goals

Goal	Type of Tool or Resource		Detailed Action Plan Tools and Resources
	Introduced in Action Plan Report	Detailed Guide/ Material	
Goal One: Establishing Cost-Effective Energy Efficiency as a High-Priority Resource	X	X	• Guide to Resource Planning with Energy Efficiency • Guide for Conducting Energy Efficiency Potential Studies • Communications Kit
Goal Two: Developing Processes to Align Utility and Other Program Administrator Incentives Such That Efficiency and Supply Resources Are on a Level Playing Field	X	X	• Aligning Utility Incentives with Investment in Energy Efficiency Paper
Goal Three: Establishing Cost-Effectiveness Tests	X	X	• Understanding Cost-Effectiveness of Energy Efficiency Programs Paper • Guide to Resource Planning with Energy Efficiency • Guide for Conducting Energy Efficiency Potential Studies
Goal Four: Establishing Evaluation, Measurement, and Verification Mechanisms	X	X	• Model Energy Efficiency Program Impact Evaluation Guide
Goal Five: Establishing Effective Energy Efficiency Delivery Mechanisms	X		• Program Design and Implementation Best Practices Guidance (under development)
Goal Six: Developing State Policies to Ensure Robust Energy Efficiency Practices		X	• Building Codes for Energy Efficiency Fact Sheet • Efficiency Program Interactions with Codes Paper (under development) • State and Local Lead-by-Example Guide (under development)
Goal Seven: Aligning Customer Pricing and Incentives to Encourage Investment in Energy Efficiency	X		• Executive Briefings on Customer Incentives Through Rate Design (under development)
Goal Eight: Establishing State of the Art Billing Systems		X	• Utility Best Practices Guidance for Providing Business Customers with Energy Use and Cost Data
Goal Nine: Implementing State of the Art Efficiency Information Sharing and Delivery Systems			• Paper on Coordination of Demand Response and Energy Efficiency (under development)
Goal Ten: Implementing Advanced Technologies			• Most Energy-Efficient Economy Scoping Paper (under development)

4.4 Summary of Findings on Energy Efficiency Policies and Programs that Advance Energy Efficiency

- Market and regulatory barriers can be reduced through targeted energy efficiency policies and programs, with the effect of increasing energy efficiency investment, reducing greenhouse gas emissions, and reducing the overall economic cost of climate policies.
  - Policies and programs are available to address a range of identified market barriers
  - Policies and approaches are available to address a range of regulatory barriers
- Great progress has made at the state level to advance energy efficiency policy and programs to address these barriers, but more work needs to be done.
- Additional work is also necessary to better understand the extent to which individual policies and programs can address the existing barriers and help access the available, cost-effective potential.
- The National Action Plan Vision 2025 and supporting tools and resources offer important policy frameworks and assistance for capturing the low cost energy efficiency resources

4.5 Notes

1 Appliance Standards Awareness Project: www.standardsasap.org

2 Nadel et al. 2006. Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards. American Council for an Energy-Efficient Economy, report no. A062

3 Energy building codes have been adopted by 37 states for commercial buildings and 34 states for residential buildings. See http://www.epa.gov/cleanenergy/energy-programs/state-and-local/efficiency_actions.html for more information.

4 The Action Plan has produced ample research and supporting information on utility and state energy efficiency programs aimed at customers of electric and natural gas utilities [cites].

5: How U.S. Climate Policies and Programs Employ Energy Efficiency Today

A review of U.S. climate-related policies and programs finds that efficiency is used in two main forms:

- **Within climate policy mechanisms.** These policies are directly included as a component of the core climate policy mechanism (e.g., a cap and trade program for greenhouse gases) and are used to encourage energy efficiency investment. An example of this approach is an allowance allocation approach whereby auction proceeds are used to fund energy efficiency programs.

- **As complementary energy policies/programs.** These initiatives are not directly a part of the regulatory system governing the core climate policy, but rather operate in parallel in the energy sector, with the intent of reducing the overall trajectory of greenhouse gas emissions, or reducing the cost of meeting greenhouse gas reduction targets. These policies and programs were discussed in more detail in Chapter 4.

Figure 5-1 broadly summarizes state policies being implemented in support of greenhouse gas reduction objectives.

Figure 5-1. States Leveraging Energy Efficiency in State Climate Policies as of October 2008

<Map will be created from table below.>

State Climate Policy Leveraging EE	*Number of States with Policy in Place*
GHG allowance revenue from GHG Cap & Trade utilized to expand funding of energy efficiency programs	10
State Climate Change Action Plans that highlight the potential role for energy efficiency policy and programs	34
http://www.epa.gov/cleanenergy/energy-programs/state-and-local/efficiency_actions.html	

Examples of each or these policy forms are provided below.

Regional Greenhouse Gas Initiative (RGGI). RGGI is a 10-state policy in the Northeast, including states from Maryland to Maine (MD, DE, NJ, NY, CT, RI, MA, VT, NT, ME). Since its origins in a 2003 governors' agreement, RGGI has established a model regulation that establishes an electricity-sector CO_2 cap-and-trade system. The program begins compliance in 2009, caps emissions in 2014, and then requires a 10% reduction by 2018.

Within RGGI's regulations, the principal means through which efficiency is promoted is the RGGI allowance auction policy. The model rule requires that at least 25% of allowances be auctioned, and that the proceeds be used to support energy efficiency and other carbon emission reduction strategies. States have for the most part structured their RGGI implementation rules to require higher auction percentages, most at or near 100%. As states have worked out their allowance auction processes and the use of allowance proceeds, energy efficiency has been designated for specific levels of funding. For example, the 2008 Maryland legislation establishing the state's Strategic Energy Investment Fund designates 46% of allowance proceeds for energy efficiency [cite]. The first RGGI emission allowance auction was held September 25, 2008, producing a clearing price of $3.07/ton. At that price, Maryland would garner $117 million in total funds and $54 million for energy efficiency programs. Another 2008 Maryland bill (the EmPOWER Maryland Act), which sets energy savings targets for utilities, requires utilities to coordinate their efficiency programs with the state-run programs funded with RGGI dollars. Other RGGI states appear to be taking similar paths.

Most of the RGGI states are also pursuing complementary energy efficiency policies, including building codes, appliance standards, and Energy Efficiency Resource Standards (EERS). These policies are referenced in various RGGI documents, including the following statement on complementary policies in the RGGI Memorandum of Understanding, which all participating states have signed:

> COMPLEMENTARY ENERGY POLICIES
>
> Each state will maintain and, where feasible, expand energy policies to decrease the use of less efficient or relatively higher polluting generation while maintaining economic growth. These may include such measures as: end-use efficiency programs, demand response programs, distributed generation policies, electricity rate designs, appliance efficiency standards and building codes. Also, each state will maintain and, where feasible, expand programs that encourage development of non-carbon emitting electric generation and related technologies.

EERS, which set overall energy savings targets for utility-sector efficiency programs, are in place in Vermont, New York, Connecticut, Maryland, and Ohio.

California AB 32 legislation and subsequent actions from the Air Resources Board and Public Utility Commission. Assembly Bill 32 (AB 32) is the authorizing legislation for actions by the Air Resources Board (CARB), the Public Utility Commission (CAPUC), and other entities to act on several fronts. Key documents to date include the Climate Change Draft Scoping Plan: a Framework for Change and the California Public Utilities Commission Final Opinion on Greenhouse Gas Regulatory Strategies under Rulemaking 06-04-009.

The CARB Scoping Plan's proposed portfolio of policies and programs is shown in Figure 5-1 below. Energy efficiency policies, including transportation measures, accounts for more than one-third of total emission reductions targeted under the plan.

Figure 5-1. California Air Resources Board AB 32 Compliance Plan Summary

Recommended Reduction Measures	Reductions Counted Towards 2020 Target ($MMTCO_2E$)	
ESTIMATED REDUCTIONS RESULTING FROM THE COMBINATION OF CAP-AND-TRADE PROGRAM AND COMPLEMENTARY MEASURES		**146.7**
California Light-Duty Vehicle Greenhouse Gas Standards • Implement Pavley standards • Develop Pavley II light-duty vehicle standards	31.7	
Energy Efficiency • Building/appliance efficiency, new programs, etc. • Increase CHP generation by 30,000 GWh • Solar Water Heating (AB 1470 goal)	26.3	
Renewables Portfolio Standard (33% by 2020)	21.3	
Low Carbon Fuel Standard	15	
Regional Transportation-Related GHG Targets[16]	5	
Vehicle Efficiency Measures	4.5	
Goods Movement • Ship Electrification at Ports • System-Wide Efficiency Improvements	3.7	
Million Solar Roofs	2.1	
Medium/Heavy Duty Vehicles • Heavy-Duty Vehicle Greenhouse Gas Emission Reduction (Aerodynamic Efficiency) • Medium- and Heavy-Duty Vehicle Hybridization	1.4	
High Speed Rail	1.0	
Industrial Measures (for sources covered under cap-and-trade program) • Refinery Measures • Energy Efficiency & Co-Benefits Audits	0.3	
Additional Reductions Necessary to Achieve the Cap	34.4	
ESTIMATED REDUCTIONS FROM UNCAPPED SOURCES/SECTORS		**27.3**
High Global Warming Potential Gas Measures	20.2	
Sustainable Forests	5.0	
Industrial Measures (for sources not covered under cap and trade program) • Oil and Gas Extraction and Transmission	1.1	
Recycling and Waste (landfill methane capture)	1.0	
TOTAL REDUCTIONS COUNTED TOWARDS 2020 TARGET		**174**

Other Recommended Measures	Estimated 2020 Reductions ($MMTCO_2E$)
State Government Operations	1-2
Local Government Operations	TBD
Green Buildings	26
Recycling and Waste (other measures)	9
Water Sector Measures	4.8
Methane Capture at Large Dairies	1.0

The CAPUC decision defers a number of specific questions, including the use of allowance auction proceeds, so it is difficult to determine the exact role that efficiency will play within the Commission's purview. However, the Commission has already established aggressive energy efficiency targets for utilities, and anticipates even more ambitious targets in its 2020 Strategic Plan, so it is safe to say that the CAPUC has already acted to make efficiency a significant complementary energy policy within the larger scope of the state's energy and environmental policies. One statement in the recent greenhouse gas decision does indicate an intent to devote some portion of allowance allocation revenues to energy efficiency:

> We recommend that ARB require that all allowance auction revenues be used for purposes related to Assembly Bill (AB) 32, including the support of investments in renewables, energy

efficiency, new energy technology, infrastructure, customer bill relief, and other similar programs. (p.289)

Western Climate Initiative (WCI). This multi-state effort, begun in February 2007 by the Governors of Arizona, California, New Mexico, Oregon, Montana, Utah, and Washington, plus four Canadian provinces, issued the Design Recommendations for the WCI Regional Cap-and-Trade Program in September 2008. One of its statements names energy efficiency as a targeted use for allowance revenues:

> The WCI Partner jurisdictions agree that a portion of the value represented by each WCI Partner jurisdiction's allowance budget (for example, through set-asides of allowances, a distribution of revenues from the auctioning of allowances, or other means) will be dedicated to one or more of the following public purposes which are expected to provide benefits region wide:[12]
>
> - Energy efficiency and renewable energy incentives and achievement;
> - Research, development, demonstrations, and deployment (RDD&D) with particular reference to carbon capture & sequestration (CCS); renewable energy generation, transmission and storage; and energy efficiency;
> - Promoting emission reductions and sequestration in agriculture, forestry and other uncapped sources; and
> - Human and natural community adaptation to climate change impacts.
>
> (page 7)

The WCI design recommendations also support the use of complementary energy policies like energy efficiency.

> Complementary Policies: The analysis demonstrated that energy efficiency programs, vehicle emissions standards, and programs to reduce vehicle miles traveled (VMT) are important for achieving emission reductions. The manner in which these policies are represented in ENERGY 2020 results in overall savings being realized from these policies. Resources from the cap-and-trade program (e.g., from the auctioning of emission allowances) can fund these complementary programs.
>
> (page 59)

Midwest Greenhouse Gas Reduction Accord. The Midwest Governors' Association issued the *Energy Security and Climate Stewardship Platform* for the Midwest and the *Midwestern Greenhouse Gas Reduction Accord* in 2007. The Accord commits the member states to developing a carbon cap and trade system, in concert with the more specific, near-term policy initiatives laid out in the more detailed Platform. The Platform document makes the following five recommendations for energy efficiency policies:

1. **Establish quantifiable goals for energy efficiency.** Policy-makers need to determine what level of efficiency improvement is economically achievable for their jurisdiction to meet the regional goal. If each state identified targets for megawatt-hours and therms saved, it would be possible to determine what role each jurisdiction can play in achieving the region's overall 2 percent energy efficiency objective. Progress should be continually measured and evaluated, and adjustments should be made as necessary.

2. **Undertake state assessments that quantify the amount of energy efficiency that would cost less on a unit cost basis than new generation.** This analysis should include a cost-benefit analysis of pursuing this amount of efficiency.

3. **Require retail energy providers to make energy efficiency a priority.** Resource plans should begin with all cost-effective energy efficiency goals, targets and strategies before reliance upon any additional supply.

4. **Remove financial disincentives and enable investment recovery for energy efficiency program costs.** Regulatory practices and rate designs sometimes result in barriers to efficiency investments because efficiency reduces potential energy sales. Changes should be implemented to remove financial disincentives and provide appropriate incentives for prudent expenditures on energy efficiency.

5. **Strengthen building codes and appliance standards and requisite training, quality assurance and enforcement.** The experience of other countries and regions in developing progressive codes and standards should be a model for this region. For example, leading states have updated state building codes to keep up with technological advances in energy efficiency.

A review of these documents shows that all three of the U.S. climate policies that have committed to developing a cap-and-trade system have also recognized and made specific commitments to developing energy efficiency as a resource to support their overall goals.

5.1 Summary of Findings on How U.S. Climate Policies and Programs Employ Energy Efficiency Today

Many states and local governments have recognized the important role of energy efficiency in their greenhouse gas reduction strategies and have developed targeted policies to capture the available low-cost energy efficiency opportunities. These policies include energy efficiency strategies that complement carbon policies as well as the use of revenue from the carbon policy to fund energy efficiency programs.

6: Findings and Recommendations

This paper's finding regarding energy efficiency as a resource for reducing carbon dioxide emissions can be summarized as follows

- Energy efficiency is a relatively large and low-cost resource available to states and other entities to meet future energy needs. Approximately 20% of end use energy is likely available at costs less than half that of new generation. This can reduce energy bills as well as the total cost of energy resources.

- Efficiency is also a low-cost carbon abatement resource. If tapped in substantial quantities beyond current investment levels, efficiency can help achieve the goals and lower the costs of reducing carbon dioxide emissions – whether or not specific climate policies are in effect.

- Energy prices alone (assuming that a principal impact of climate policies will be to raise energy prices) may not accelerate efficiency investment at the rate needed to tap the majority of efficiency's economic potential.

  – Market and regulatory barriers are large and persistent, especially as principal-agent barriers, information-cost or transaction-cost barriers, and regulatory policies in the area of utility ratemaking.

  – The price elasticity of energy consumption in many residential and commercial markets is relatively weak, due to countervailing elasticity effects, and relying solely on price elasticity to drive efficiency investment may not harvest a large fraction of efficiency potential.

  – More analysis is needed to quantify the impacts of barriers and evaluate the solutions designed to address them.

- Market and regulatory barriers can be reduced through targeted energy efficiency policies and programs, with the effect of increasing energy efficiency investment, reducing greenhouse gas emissions, and reducing the overall economic cost of climate policies.

  – Policies and programs available to address

  – Approaches are available to address the regulator barriers

- Many states and local governments have recognized the important role of energy efficiency in their greenhouse gas reduction strategies and have developed targeted policies to capture the available low-cost energy efficiency opportunities. These policies include energy efficiency strategies that complement carbon policies as well as the use of revenue from the carbon policy to fund energy efficiency programs.

- The National Action Plan Vision 2025 and supporting tools and resources offer important policy frameworks and assistance for capturing the low cost energy efficiency resources

Based on these findings, this paper recommends that energy efficiency should be part of any future consideration of climate policies that seek to create cost-effective options for reducing carbon dioxide emissions and should continue to be addressed at all levels of government.

Appendix A: National Action Plan for Energy Efficiency Leadership Group

Co-Chairs

[paste here]

Leadership Group

[paste here]

Observers

[paste here]

Facilitators

U.S. Department of Energy

U.S. Environmental Protection Agency

Appendix B: Glossary

Term: Definition.

Term: Definition.

Appendix C: [Other Information]

Section Header

Placeholder (if needed)

Appendix D: References

To be constructed.

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