related programs can yield savings higher than the results shown in our selected set of leading states. Our reasons for this conclusion follow.

CONSERVATIVE BIASES WITH EXISTING STUDIES OF ENERGY EFFICIENCY POTENTIAL

In examining the reasons why energy efficiency potential studies produce conservative results we draw on a recent paper by Goldstein (2008) and our own experiences. Below we highlight and discuss a number of reasons why existing studies underestimate the savings "achievable" through energy efficiency programs and related policies.

Avoided costs used in existing studies are much lower than present and projected avoided costs. Existing studies used costs that did not incorporate the much higher fuel costs and dramatically higher power plant construction costs that we now face. Such costs have risen much higher than overall indices for the economy as a whole (inflation adjustments used for economic forecasts).

Table 4—Electric Energy Efficiency Program Savings and Spending Data for Leading States

State	EE Spending: Total (includes utility and non-utility public benefit programs)		Total EE spending as % total revenues for all utilities (investor-owned and public power)		EE spending per capita		EE incremental savings—statewide total—EIA plus non-utility data (or other data source)		EE incremental savings—statewide as % of total state kWh sales	
	$000s		%		$/capita		MWh		%	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Rhode Island	$17,178	$17,400	1.6%	1.6%	$16.18	16.23	96,048	64,995	1.2%	0.8%
Connecticut	$70,999	$98,230	1.5%	2.1%	$20.31	28.05	328,000	355,000	1.2%	1.3%
Vermont	$15,806	$23,690	2.4%	3.5%	$25.46	37.78	62,872	105,243	1.1%	1.8%
Massachusetts	$125,000	$120,157	1.5%	1.4%	$19.43	18.49	455,000	489,622	0.8%	0.9%
Oregon	$63,318	$69,107	2.0%	2.2%	$17.15	18.54	369,827	437,494	0.8%	0.9%
Washington	$113,288	$126,678	2.2%	2.4%	$17.77	19.67	630,691	635,062	0.7%	0.7%
California	$357,000	$645,800	1.1%	1.9%	$9.85	17.64	1,912,000	2,275,000	0.7%	0.9%
Iowa	$55,296	$56,293	1.8%	1.8%	$18.60	$18.82	315,215	322,177	0.7%	0.7%
Nevada	$24,000	$28,700	0.7%	0.8%	$9.63	11.40	216,000	206,000	0.6%	0.6%
New York	$224,897	$241,543	1.0%	1.1%	$11.61	12.40	823,827	NA	0.6%	NA
Minnesota	$82,245	$91,239	1.8%	1.9%	$15.96	$17.53	411,999	NA	0.6%	0.7%
Wisconsin	$77,683	$80,580	1.4%	1.4%	$13.94	$14.32	451,192	467,725	0.5%	0.7%
New Jersey	$83,177	$95,914	0.9%	1.0%	$9.60	10.96	227,764	242,270	0.3%	0.3%
Texas	$57,800	$79,500	0.2%	0.2%	$2.47	3.36	397,305	457,808	0.1%	0.1%
Max									**1.2%**	**1.8%**
Min									**0.1%**	**0.1%**
Median									**0.7%**	**0.7%**
Mean									**0.7%**	**0.8%**

Schedule RAV-E4

Avoided costs used in existing studies do not include a cost of carbon. The cost of carbon could be expressed in several ways. One way is to simply use the traditional avoided cost of conventional generation, but add an estimate of the cost of CO_2 emissions. While there is great uncertainty surrounding carbon-cost estimates, one approximation is the mid-range forecast developed by Synapse Energy Economics, Inc. which predicts a levelized cost of $30 per ton of CO_2 emitted ($ 2007). An alternative way to account for the cost of carbon is to base avoided cost on resources with no or low greenhouse gas emissions, e.g. wind generation. A slight deviation on this alternative is to use an avoided cost estimate based on a blend of generation costs determined by a Renewable Portfolio Standard.

Determining an accurate estimate of avoided costs is important because this figure is used as a screen for determining what is cost-effective. Thus, a worthwhile energy efficiency program could be deemed not so simply because out-dated construction costs made it appear not cost-effective. That same worthwhile energy efficiency program may also be erroneously determined not cost-effective when avoided costs are based on the existing Midwestern generation fleet instead of adding incremental generation per a state's Renewable Portfolio Standard.

Existing studies include mostly incremental changes and improvements. Most studies build up the total estimate measure by measure, i.e., estimating the savings possible through individual, independent, incremental measures and then summing up all these savings to yield a total. This type of analysis can miss greater savings possible through integrated, synergistic effects of comprehensive packages of measures. Similarly, existing studies generally look at incremental improvements to existing technologies, not big, bold improvements that may be possible with comprehensive packages of measures and integrated program designs. For example, estimating savings possible for new commercial construction generally will go system by system, end-use by end-use to yield savings possible through incremental improvements on these individual components and systems in isolation. These studies don't look at the potential for major advances such as zero net energy buildings—a goal now in place in California for all new residential buildings by 2020 and all new commercial buildings by 2030. Studies that only look at marginal improvements to conventional designs and technologies miss the much larger savings that could result from reaching these advanced system goals.

Some markets and end-uses are excluded. Data availability and quality are major determinants of what markets and energy end-uses are included in energy efficiency potential studies. It is not uncommon to exclude a particular market or end-use because of unavailable or poor quality data. In some cases the initial scope of a study may expressly limit the study to certain markets and end-uses of most interest or relevance to the study's sponsor.

Conservatism is built into each key assumption. The amount of data needed to complete energy efficiency potential studies is very large. In many cases the data are best defined by possible ranges of values, especially where there is uncertainty about the values. Most analyses treat the inherent uncertainty of these estimates by using values at the low end of identified ranges of values. Across multiple data sets the net result can be a compounding of conservatism, yielding the most conservative estimates possible. Assumptions about customer participation (realization rates) are particularly biased toward conservative values due to questions about customer acceptance of energy efficiency technologies.

This conservatism is also supported by typical policy and program questions addressed by completing these studies, which generally is to show that present or proposed increases in program spending are adequate to capture a reasonable fraction of the energy efficiency potential.

Existing studies use positive discount rates, which in the context of climate change do not make sense. Discounting the benefits from energy efficiency, as is the convention in typical cost-benefit analyses, runs counter to the rationale for taking action in the face of climate change. If society makes choices (through public policy for example) to mitigate the impacts of climate change, this action reflects a desire to bear costs now, in order that future generations bear less of a cost. In this scenario present value is sacrificed for future value making positive discount rates meaningless, indeed inappropriate. Furthermore, should the impacts of climate change turn out to be on the severe end of the spectrum currently predicted, greenhouse gas emission reduction may actually be more valuable several generations into the future than it is today. Under such circumstances the standard net present value approach simply cannot address these multi-generational issues.

Note that customer discount rates are rarely negative, and in fact we observe very high discount rates used when consumers make energy efficiency decisions. That fact, though, is a manifestation of the problem we are trying to address. Those high personal discount rates, which reflect all the frictions and constraints that market forces cannot overcome, produce much less energy efficiency than is socially optimal. If we were to use private discount rates in energy efficiency potential studies, we would fail to reflect the standard public policy approach to economic analysis, and we would reinforce the *status quo*. Private discount rates do have a key role to play in energy efficiency program design (i.e., they help us identify proper incentive payments), but they typically do not guide the determination of efficiency potential.

Existing studies do not account for emerging technologies, continued improvements of technologies and cost reductions of such technologies over time. Performance and cost data of energy-efficient technologies are generally taken as constants for present data for these variables. Technologies that are not yet commercially available are generally excluded from energy efficiency potential studies. In this same vein, technologies included in studies are assumed to be constant in terms of their performance and costs. Thus most existing energy efficiency potential studies—many of them extending 15–20 years into the future—fail to account for continued improvements of existing technologies and introduction of new, much more efficient technologies. As a concrete example, LED lighting is currently a technology on the cusp of major breakthroughs in terms of customer applications and commercial availability. Existing studies of energy efficiency potential generally do not include this technology as it was not commercially available at the inception of the studies.

A related problem is reflected in assumptions used about the cost of energy efficiency. Studies rely on projected costs of energy efficiency—not realized (actual) costs, which typically may be lower than projected and also may decrease over time. For example, compact fluorescent light bulbs show rapid actual price decreases since their introduction over a decade ago. Such decreases generally are not captured in energy efficiency potential studies; costs are held constant in real terms over the period of the study. While determining changes in technology costs is quite difficult, that does not justify relying on the conventional cost projections. This issue needs further investigation, but it is important in this context to note that technology cost changes will affect energy efficiency potential.

Existing studies ignore non-energy benefits, e.g., increased thermal comfort, increased productivity and environmental benefits. Such benefits are difficult to quantify and are often mentioned as non-quantifiable factors.

Existing studies do not recognize benefits of reducing other criteria pollutants associated with fossil fuel combustion. The societal cost of emitting a ton of mercury, sulfur oxide or nitrogen oxide varies for each pollutant and depends on many contributing factors. Despite the complexity of determining a total cost, a kWh saved from efficiency efforts is a kWh that does not emit pollutants into the environment (nor require remediation, combustion modifications nor post-combustion scrubbing).

Past studies largely ignore customer behavioral change, a rapidly emerging new program focus. The rapid change in consumer attitudes about the environment and climate change has created significant new opportunities to increase efficiency over the business-as-usual mindset. In fact there is evidence that consumers, in some cases, are taking action with respect to efficiency or renewable energy that would not be supported by traditional cost effectiveness studies that are the basis for potential studies. Consumers are clearly acting on many of the "non-quantifiable" benefits of efficiency. The increasing use of community energy programs, "blitz" program concepts and feedback mechanisms will take advantage of this opportunity. In addition, the adoption of smart grid technologies and advanced meters will enable significantly increased ability for consumers and businesses to more effectively control usage. Current studies of feedback approaches show reductions of up to 18 percent of load when both feedback and controls are available to consumers. (Neenan et al. 2009)

Behavior change is especially difficult to model because over time what now might be considered a change in typical behavior might eventually become the norm. The issue is when a behavior change is an innovation, and when it becomes part of the baseline. This issue, too, needs further research.

PAST ENERGY EFFICIENCY PROGRAM RESULTS AS PREDICTORS OF FUTURE PROGRAM PERFORMANCE

Past program results are not necessarily good indicators of future performance for the simple fact that past results reflect past funding levels and goals, not future funding levels and goals that may be dramatically different.

The conditions and objectives of energy efficiency programs today and into the future are dramatically different than those of past and most present efforts. Witness how energy efficiency program budgets have been established in most jurisdictions. Funding levels have generally been set according to the policy question, "How much can we afford?" rather than "How much do we need?" or "How much can we buy to meet this need?" These questions frame funding decisions much differently—yielding potentially very different results.

A key objective of past programs was to achieve high cost effectiveness—that is, a low cost of saved energy (*Figure 1* shows this cost to be in the range of 2 to 4 cents/kWh for comprehensive program portfolios in service areas with a long record of program delivery) or high benefit-to-cost ratios (at least 2:1 and in many cases 3:1 or higher). This objective has been driven by numerous reasons, but means that significant amounts of cost-effective energy efficiency resources have not been sought or captured by past programs. To achieve the more aggressive goals established by the MGA and policymakers elsewhere in the U.S., programs must move farther up the cost curves to capture energy efficiency resources—-resources that are more costly but are still cost effective compared to supply or other options.[3]

Recent McKinsey reports on carbon mitigation show energy efficiency strategies as significantly lower cost than other low carbon generation strategies.[4] Recent data collected from existing energy efficiency programs across the US underscore this issue.

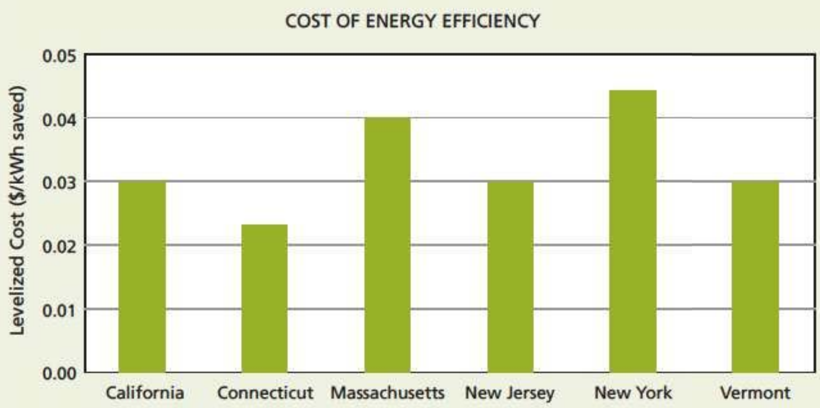
COMPARING MGA GOALS TO EXISTING AND PENDING STATE POLICY GOALS FOR ENERGY EFFICIENCY

The gaps and limited number of truly comparable studies of energy efficiency potential in the Midwest limits our ability to assess the magnitude of savings

[3]Utilities are not required to show that investments in supply resources meet benefit-to-cost ratios of 2:1.

[4]See Version 2 of the Global Greenhouse Gas Abatement Cost Curve. 2009. McKinsey & Company.

Figure 1



Source: ACEEE, "Five Years In," 2005

The obvious questions are, "Are the two percent savings goals realistic?" and "Are they too high?"

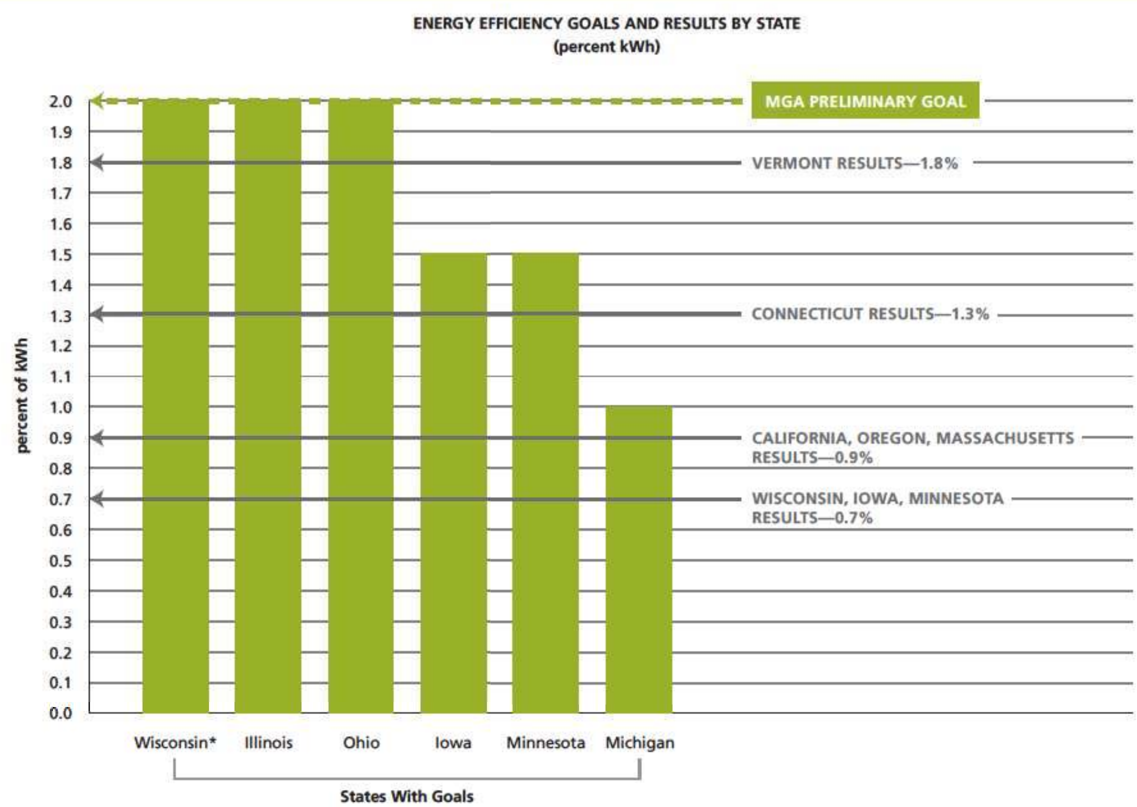
We believe that the MGA goals are realistic for two key reasons: (1) as noted before, existing energy efficiency potential studies are very conservative, and (2) existing program activity levels have not targeted this level of savings. The level of savings that states have achieved to date is the result of explicit decisions to limit energy efficiency funding to small percents of utility revenues. The savings levels are not a result of any physical, engineering or economic limit on the amount of cost-effective energy efficiency that could be acquired. In addition, the MGA targets include programs and approaches which may be outside the scope of those included in the potential studies we reviewed.

possible from energy efficiency improvements relative to the MGA goals. What we found is that existing studies of the achievable energy efficiency—the most relevant metric for comparison to the MGA's policy goals—suggest slightly less than 1 percent savings per year. For three leading states in the Midwest in terms of past and on-going energy efficiency programs, we found that actual savings for 2007 (the most recent year for which data are available) were 0.7 percent each for three states (Iowa, Minnesota and Wisconsin).

Broadening the set of energy efficiency potential studies to include non-Midwestern states, we find that the top performers estimated an average annual achievable savings of 1.5 percent. The MGA goals—two percent savings per year—are clearly and significantly higher than most results achieved to date, although a handful of states have reached annual savings greater than one percent and one state (Vermont) has nearly reached two percent (for 2008, not included in *Table 4*). *Figure 2* (page 20) shows Midwestern states' annual goals from current or pending legislation and initiatives, compared to the MGA target, as well as the achieved annual savings of states from across the nation.

Finally we offer an example that we believe illustrates what is possible with a comprehensive, massive effort at reducing energy use through energy efficiency and conservation. In 2000–2001 California faced an electricity reliability crisis. The state was threatened with dire predictions of massive rolling outages due to a number of convergent conditions. In response California's utilities and state government enacted an unprecedented level of energy efficiency and conservation programs—spending about $1 billion on such efforts—to keep the electricity flowing and avoid outages. The results of this effort were dramatic and clearly helped avoid the dire outcomes that had been forecasted (Kushler and Vine 2003). The programs and policies enacted yielded unprecedented savings—a 6.7 percent reduction in total electricity use in 2001 with an average summertime peak demand savings of 10 percent with a maximum peak demand reduction achieved in one period of

Figure 2



*The Wisconsin figure is the recommended level of annual electricity savings in the Governor's Task Force on Global Warming.

14 percent (Kushler et al. 2002). These were the aggregate impacts of energy efficiency improvements, customer energy conservation, and demand response/load management (efforts that target peak demand reduction). While this was perhaps a one-time achievement due to emergency conditions, it does illustrate clearly what is possible for at least a short period. It certainly suggests that higher levels of customer energy savings can be achieved through programs and policies than the levels shown by more recent results in our set of leading states (*Table 4*). The levels of savings achievable are clearly a function of programmatic efforts and associated budgets. Exactly how much savings can be achieved on a sustainable basis over an extended period remains mostly an unresolved question, however.

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Changing the Paradigm

Given concerns about the impact of utility emissions contributing to global climate change, one objective could be to employ enough cost-effective energy efficiency to not only slow the growth rate of electricity consumption, but to reverse the trend so that growth is negative. We can achieve this via aggressive promotion of higher levels of energy efficiency. An analysis of expected utility load growth is illustrative.

For example, our sample utility has baseline growth of 1.5 percent per year, typical of many Midwestern utilities. Note in *Figure 3* the dramatic difference in long-term sales growth under a one percent annual energy efficiency target versus that which results from a two percent annual target. The one percent goal slows, but does not reverse load growth. The two percent goal delivers the desired long-term reduction in load. In other words, the two percent goal allows us to achieve this objective; the one percent goal does not.

The point of this illustration is to show that it is the policy objective that determines the savings target. We can make this sort of policy determination without any reference to energy efficiency potential studies. If the objective is to reduce electric load growth so as to reduce utility emissions, the efficiency goal must be developed in consideration of the load forecast. This is no better or no worse than relying on potential studies. It is merely another way of framing the problem.

While the graph depicts what has been typical load growth for Midwestern utilities, recent economic conditions may have altered this baseline growth. Currently, many Midwestern utilities are experiencing sales declines due to load reductions resulting from large industrial customers shutting plants or slowing production. This does not mean that energy efficiency is no longer needed. The size of the energy efficiency opportunity will be less but the need to offer energy efficiency services to all customers will be important to keep utility bills affordable in the long run and to address carbon mitigation.

Figure 3

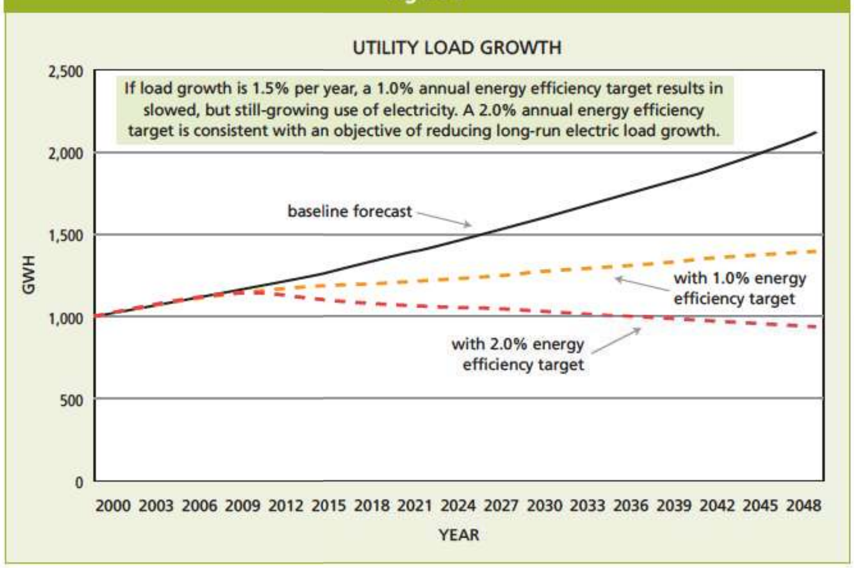
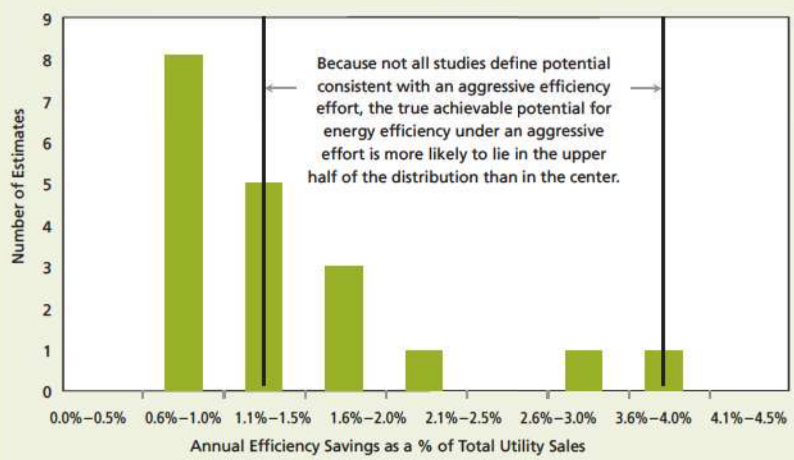


Figure 4

DISTRIBUTION OF ACHIEVABLE ANNUAL ENERGY EFFICIENCY EFFORTS MIDWESTERN AND NON-MIDWESTERN STUDIES FOR ELECTRICITY



The amount of achievable energy efficiency is primarily a function of financial investment, programmatic efforts and political will. That is, energy efficiency impacts are heavily driven by policy decisions. Put most directly, utilities and policymakers create their own energy futures. Utilities and policymakers can increase funding for energy efficiency programs, they can offer new programs, and they can change program evaluation protocols to make them more supportive of energy efficiency efforts. New and emerging technologies can be developed and implemented by customers through increased levels of research and development.

We should not be overly influenced by low or even mid-point estimates of energy efficiency potential. Since some potential studies apply a more passive, *exogenous* view of energy efficiency, while others take a more aggressive, *endogenous* perspective, it would be a mistake to look at the central tendency of potential studies and conclude that it represents the achievable potential under an aggressive policy.

The histogram in *Figure 4* shows the distribution of achievable energy efficiency for the studies mentioned in this report. If we look at the data in terms of the *reasonable upper limit* on what we could expect to achieve, then we should pay more attention to the right side of the distribution. This is likely to be where the estimates based on aggressive efforts are likely to lie.

The recent study from the Energy Center of Wisconsin, Energy Efficiency and Customer-Sited Renewable Resource Potential in Wisconsin for the Years 2012 and 2018, is an example of a potential study that estimates what we can achieve by implementing more aggressive energy efficiency programs. The results show that Wisconsin can achieve annual energy savings of 1.6 percent of total electricity sales and 1.0 percent of total natural gas sales. In contrast, an earlier study conducted in 2005 by the Energy Center of Wisconsin found a range of annual electricity savings of 0.5 percent to 0.7 percent. Both studies estimated cost-effective achievable energy efficiency. However, the major changes in methodology in the most recent study reflected changing policy objectives for pursuing energy efficiency savings and included:

- quantifying the environmental benefits of avoided carbon emissions and
- querying experts on the savings that could be achieved under an aggressive policy and program scenario, one that lifts the constraints currently placed on these programs.

The results show that Wisconsin can approach the MGA's two percent goal with cost-effective energy efficiency programs. If potential energy savings resulting from changing building codes and appliance standards, and changes in our energy-using behavior are thrown into the mix, then we can surpass the two percent goal.

Schedule RAV-E4

ROADMAP TO SUPPORT MGA POLICY GOALS

We believe the following actions will provide insight on the achievable potential for energy efficiency to meet the two percent annual savings goal established in the Energy Security and Climate Stewardship Platform.

1. Commission energy efficiency potential studies for the region that:

- Include forward looking avoided costs when assessing how much energy efficiency would be cost-effective—using ranges may be helpful. Studies should also examine a low-carbon generation cost as one cost comparison
- Fully incorporate carbon costs in the analysis—exploring ranges of possible, likely outcomes.
- Include reasonable assumptions on energy efficiency technology improvements and resulting costs over time—and better capture advanced, integrated packages of measures.
- Attempt to reflect the new and different social/political and economic contexts surrounding energy and energy efficiency.
- Avoid discounting future environmental benefits to recognize that the present value of environmental damage actually increases over time.
- Make an effort to collect current baseline data. Studies often use data that is over 10 years old due to lack of ongoing research.
- Incorporate expert opinions in the study rather than relying solely on the preprogrammed calculations in a potential model.
- Incorporate the potential for behavior based strategies to enhance efficiency efforts. Such strategies can include providing indirect or direct feedback on usage and pricing and the ability to directly control usage.
- Include full, comprehensive sets of markets and customer end-uses.
- Explore a range of benefit-cost constraints to understand how these constraints affect the estimated results. Not all energy use decisions are based on a TRC or other benefit-cost test. In addition cost is not always the barrier to increasing energy efficiency.

2. Monitor leading states (not just in the Midwest) for the energy efficiency results they achieve as a result of higher, more aggressive energy efficiency goals.

3. Sponsor research to understand better how energy is used and how policies and programs influence that use including: trends in technology adoption, effectiveness of building codes on upgrading building standards and building stock and how behavior-based programs influence and accelerate more efficient energy use.

The two percent energy efficiency savings target established in the Energy Security and Climate Stewardship Platform is aggressive but also achievable and a necessary goal if the Midwest is to significantly reduce its carbon emissions. Beyond the realm of the potential study, there is a growing body of literature showing that energy efficiency is the least-cost resource for reducing our carbon emissions and for which there are existing technologies that can immediately and cost-effectively reduce our energy use.[5] The Chicago Council on Global Affairs lists specific energy efficiency technologies for the Midwest as leading strategies for carbon abatement. Explicit recognition of the value of energy efficiency compared to other abatement strategies will increase the results of future estimates of energy efficiency potential. Further, companion efforts to utility programs can accelerate program results due to increased awareness of the broader benefits of energy efficiency to the environment and to the economy of the Midwest. ■

[5]Embracing the Future: The Midwest and a New National Energy Policy. 2009. The Chicago Council on Global Affairs, Chicago, IL.

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Annotated Bibliography of Midwestern Energy Efficiency Potential Studies Reviewed

ENERGY EFFICIENCY AND CUSTOMER-SITED RENEWABLE ENERGY: ACHIEVABLE POTENTIAL IN WISCONSIN 2006–2015

STATE: Wisconsin

STUDY NAME: Energy Efficiency and Customer-Sited Renewable Energy: Achievable Potential in Wisconsin 2006–2015

AUTHOR: Energy Center of Wisconsin

YEAR COMPLETED: 2005

PERIOD OF STUDY: 2006–2015

FUELS: Electricity, Natural Gas

SECTORS: Residential, Commercial/Industrial

PURPOSE OF STUDY: "To provide information to policymakers, regulators, utilities and other energy stakeholders in Wisconsin to determine the appropriate level of investment in Wisconsin's energy efficiency and renewable energy 'public benefits' programs."

METHODOLOGY: The Energy Center of Wisconsin used a market opportunity approach to estimate achievable energy efficiency savings. It sought input from diverse stakeholders on the most cost-effective markets, selected 30 markets, and determined that these markets covered most major opportunities. Missing markets totaled 10–25 percent of the energy efficiency potential. For the renewable energy market, the Energy Center chose the six most promising technologies.

The Energy Center then studied these 36 markets, outlined likely program approaches, assessed their probable costs and energy savings, and aggregated the results. The technologies selected were feasible, cost-effective, and likely to be accepted by the market. The analysis excluded free riders and included spillover effects (participation without incentives).

TECHNICAL POTENTIAL: Not given

ECONOMIC POTENTIAL: Not given

ACHIEVABLE POTENTIAL: The percentage of reduction in demand in the final year of the analysis period was 4.2–8.0 percent for electricity demand, 6.1–9.2 percent for electric energy, and 3.0–5.2 percent for natural gas energy. The cumulative potential over the time period divided by the number of years was not given.

AVOIDED COST VALUES: The target avoided costs were \$60–80/kW/year for electricity demand, 4–8 cents/kWh for electric energy, and 60–140 cents/therm for natural gas energy.

CARBON COSTS: Discussed as factor but not quantified

ILLINOIS RESIDENTIAL MARKET ANALYSIS

STATE: Illinois

STUDY NAME: Illinois Residential Market Analysis: Final Report

AUTHOR: MEEA

YEAR COMPLETED: 2003

PERIOD OF STUDY: Not specified

FUELS: Electricity, Natural Gas

SECTORS: Residential

PURPOSE OF STUDY: Rising energy costs and global warming have made this an important time to take steps toward energy efficiency goals. This study identifies "opportunities to fuel the growth of energy efficiency in Illinois.... The findings can be used to inform impending decisions about how public and private money will be spent to promote energy conservation in Illinois."

METHODOLOGY: "MEEA used a modified stratification sampling strategy to identify and recruit single-family homeowners in five different geographic segments of the state. Within each of those segments, towns or cities with high ratios of owned homes to rental units were identified, and then a random sampling of phone numbers... was used to recruit homeowners." MEEA conducted a walk-through audit of each home and surveyed the homeowners. 309 site visits and surveys took place. Researchers used DOE2 modeling to analyze the technical, economic and market potential for savings associated with 34 home improvement measures. MEEA then selected 19 of the measures for further analysis. The results were weighted and averaged for the entire state.

FINDINGS: The cumulative potential savings over the time period divided by the number of years was not given. For the 19 measures which were analyzed in depth:

TECHNICAL POTENTIAL: 67 percent of demand (at the end of the period studied)

ECONOMIC POTENTIAL: 36 percent of demand (at the end of the period studied)

ACHIEVABLE POTENTIAL: 1.5 percent of demand (at the end of the period studied)

AVOIDED COST VALUES: The top 19 measures could save $17,637,000, 179.5 MW/year, 164,471 MWh/year, and 4,403 kTherms/year.

CARBON COSTS: Not given

ASSESSMENT OF ENERGY EFFICIENCY POTENTIAL: 2006–2025

STATE: Ontario, CA

STUDY NAME: Assessment of Energy Efficiency Potential: 2006–2025

AUTHOR: ICF Consulting

YEAR COMPLETED: 2005

PERIOD OF STUDY: 2006–2025

FUELS: Electricity

SECTORS: Residential, Commercial/Industrial

PURPOSE OF STUDY: "The [Ontario Power Authority] seeks recommendations [for] the development of conservation targets through 2025 within the context of already-existing efficiency goals…. The OPA seeks further understanding of the energy efficiency portfolio options at its disposal and the risks inherent in each option. Moreover, the OPA requires explicit identification of the action required by government to enact these options."

METHODOLOGY: Researchers established a baseline energy demand forecast segmented by sector, sub-sector, and end use. The study used published growth rates for employment and households. The baseline forecasts were segmented based on the type of technology used by the customer. The organization used a list of energy efficiency measures that had been screened for applicability and feasibility. These measures were then screened for cost-effectiveness using the Technical Cost Test (TCT). Measures that passed this test became part of the final set of efficiency measures. The researchers analyzed several levels of incentive-based support and also included the effects of new technologies.

TECHNICAL POTENTIAL: Energy efficiency measures could eliminate 21–36 percent of residential demand, 18–41 percent of commercial demand and 17–38 percent of industrial demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 1.05–1.8 percent for the residential market, 0.9–2.05 percent for the commercial market, and 0.85–1.9 percent for the industrial market.

ECONOMIC POTENTIAL: Energy efficiency measures could eliminate 10.6–30 percent of residential demand, 12.7–35 percent of commercial demand, and 6.2–32 percent of industrial demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 0.53–1.5 percent for the residential market, 0.635–1.75 percent for the commercial market, and 0.31–1.6 percent for the industrial market.

ACHIEVABLE POTENTIAL: Energy efficiency measures could eliminate 5.3–21.7 percent of residential demand, 5.1–17 percent of commercial demand; and 2–19 percent of industrial demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 0.265–1.085 percent for the residential market, 0.255–0.85 percent for the commercial market, and 0.1–0.95 percent for the industrial market.

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

KANSAS ENERGY COUNCIL DSM POTENTIAL STUDY AND PLAN

STATE: Kansas

STUDY NAME: Kansas Energy Council DSM Potential Study and Plan

AUTHOR: Summit Blue Consulting

YEAR COMPLETED: 2008

PERIOD OF STUDY: 2008–2028

FUELS: Electricity, Natural Gas

SECTORS: Residential, Commercial/Industrial

PURPOSE OF STUDY: The Kansas Energy Council hired Summit

Blue Consulting and Energy Insights to develop an energy efficiency potential study that would "[provide] technical, economic and market potential for metropolitan/suburban and rural Kansas by end use in the residential market and by industry segment and end use in the C&I markets." The authors mention that "several Kansas utilities are currently conducting energy efficiency and/or demand response programs. Several additional Kansas utilities have submitted energy efficiency and demand response programs to the Kansas Corporation Commission for approval."

METHODOLOGY: Summit Blue took the following steps:

1. conducting a Midwest-focused DSM benchmarking and best practices analysis,
2. developing baseline consumption profiles and simulation model specifications,
3. simulating energy consumption in buildings,
4. deciding which DSM measures were appropriate for Kansas (based on the simulations),
5. analyzing cost-effectiveness per measure and sector, and
6. estimating DSM potentials for residential and non-residential customers.

TECHNICAL POTENTIAL: Energy efficiency measures could eliminate 43 percent of residential demand and 34 percent of non-residential demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 2.15 percent for the residential electricity market, 2.95 percent for the natural gas residential market, 1.7 percent for the non-residential electricity market, and 2.25 percent for the non-residential natural gas market.

ECONOMIC POTENTIAL: Energy efficiency measures could eliminate 35 percent of residential demand for electricity, 46 percent of residential demand for natural gas, 34 percent of non-residential demand for electricity, and 45 percent of non-residential demand for natural gas during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 1.75 percent for the residential electricity market, 2.3 percent for the residential natural gas market, 1.7 percent for the non-residential electricity market, and 2.25 percent for the non-residential natural gas market.

ACHIEVABLE POTENTIAL: This varied depending on the incentives supplied (see pages E-9, E-13, E-14 and E-18.) Energy efficiency measures could save 11–25 percent of residential electricity demand, 29–46 percent of residential natural gas demand, 17–29 percent of non-residential electricity demand, and 19–35 percent of non-residential natural gas demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 0.55–1.25 percent for the residential electricity market, 1.45–2.3 percent of the residential natural gas market, 0.85–1.45 percent of the non-residential electricity market, and 0.95–1.75 percent of the non-residential natural gas market.

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

DUKE ENERGY INDIANA DSM MARKET ASSESSMENT AND DSM ACTION PLAN: FINAL REPORT

STATE: Indiana

STUDY NAME: Duke Energy Indiana DSM Market Assessment and DSM Action Plan: Final Report

AUTHOR: Summit Blue Consulting and WECC

YEAR COMPLETED: 2007

PERIOD OF STUDY: 2008–2027

FUELS: Electricity

SECTORS: Residential, Commercial/Industrial

PURPOSE OF STUDY: "This study was conducted in response to a May 25, 2005 Indiana Utility Regulatory Commission order regarding Duke's April 2, 2004 filing to expand its Indiana DSM programs and to change certain DSM financial arrangements in Indiana, such as recovery of lost revenues due to DSM programs."

METHODOLOGY: Summit Blue took the following steps:

1. conducting a Midwest-focused DSM benchmarking and best practices analysis,
2. developing baseline consumption profiles and simulation model specifications,
3. simulating energy consumption in buildings,
4. deciding which DSM measures were appropriate for Indiana (based on the simulations),
5. doing a cost-benefit analysis, and
6. estimating DSM potentials for residential and small commercial/industrial customers.

WECC assisted Summit Blue with its market assessment, reviewed Duke's existing DSM programs and recommended changes, developed new program designs, and built a program portfolio for the recommended action plan.

The researchers considered emerging technologies to some extent.

TECHNICAL POTENTIAL: Assessed, but not given.

ECONOMIC POTENTIAL: Assessed, but not given.

ACHIEVABLE POTENTIAL: Energy efficiency measures could eliminate 15 percent of residential electricity demand and 9 percent of small commercial/industrial electricity demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 0.75 percent for the residential electricity market and 0.45 percent of the small commercial/industrial electricity market.

AVOIDED COST VALUES: The avoided transmission/distribution costs in Year 25 are $30.59/kW. See page 79 for details.

CARBON COSTS: Not given

2006 MISSOURI STATEWIDE RESIDENTIAL LIGHTING AND APPLIANCE EFFICIENCY SATURATION STUDY

STATE: Missouri

STUDY NAME: 2006 Missouri Statewide Residential Lighting and Appliance Efficiency Saturation Study

AUTHOR: RLW Analytics

YEAR COMPLETED: 2006

PERIOD OF STUDY: N/A

FUELS: This study is organized by appliance type rather than by fuel.

SECTORS: Residential

PURPOSE OF STUDY: To serve a group of utilities in Missouri by providing "baseline information on residential appliance, building, equipment and lighting saturations and efficiencies… for use in understanding future energy savings potential in the residential sector." Two of the study's goals were: first, to develop a web-based tool to allow utility staff to visualize potential energy savings scenarios, and second, to calculate potential analyses for energy efficiency opportunities.

METHODOLOGY: The study is based on energy audits and surveys of over 300 homes. RLW analyzed 32 home improvement options in the first iteration of the process. RLW calculated the technical, economic and market potential of the energy efficiency improvements (which combined results for several different fuels.) The market potential calculations assumed rebates of 50 percent of the differential costs.

FINDINGS: The technical, economic and market potential of each residential energy efficiency improvement (i.e., replacing appliances) were analyzed separately; combined impacts were not given. For more information about the individual measures, refer to pages 136–138.

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

ASSESSMENT OF ENERGY AND CAPACITY SAVINGS POTENTIAL IN IOWA

STATE: Iowa

STUDY NAME: Assessment of Energy and Capacity Savings Potential in Iowa

AUTHOR: Quantec, Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation and Britt/Makela Group

YEAR COMPLETED: 2008

PERIOD OF STUDY: 2008–2018

FUELS: Electricity, Natural Gas

SECTORS: Residential, Commercial, Industrial

PURPOSE OF STUDY: "To conduct an assessment of technical and economic opportunities for electric and gas energy efficiency and renewable resources in the service territories [of three utilities]." The utilities are required to pursue energy efficiency opportunities.

METHODOLOGY: The methodology combines "top-down" methods, consisting of analysis of current utility load forecasts, with "bottom-up" methods analyzing the potential impacts of demand-side and supplemental resource technologies on end use of energy resources. The "bottom-up" results were aggregated to produce macro-scale estimates. The researchers assessed technical and economic potential for residential, commercial and industrial sectors for each utility, subdividing them by fuel type. The study generally did not consider the impact of new technologies.

TECHNICAL POTENTIAL: Energy efficiency measures could eliminate 46 percent of residential electricity demand, 40 percent of residential natural gas demand, 30 percent of commercial electricity demand, 38 percent of commercial natural gas demand, 11 percent of industrial electricity demand, and 18 percent of industrial natural gas demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was not given.

ECONOMIC POTENTIAL: Energy efficiency measures could eliminate 30 percent of residential electricity demand, 28 percent of residential natural gas demand, 17 percent of commercial electricity demand, 26 percent of commercial natural gas demand, 10 percent of industrial electricity demand, and 18 percent of industrial natural gas demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was not given.

ACHIEVABLE POTENTIAL: Not given

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

MIDWEST RESIDENTIAL MARKET ASSESSMENT AND DSM POTENTIAL STUDY

STATE: Midwest (nine states)

STUDY NAME: Midwest Residential Market Assessment and DSM Potential Study

AUTHOR: MEEA

YEAR COMPLETED: 2006

PERIOD OF STUDY: 2006–2025

FUELS: Electricity, Natural Gas

SECTORS: Residential

PURPOSE OF STUDY: To "characterize the Midwest residential market, including estimating saturation rates for existing energy efficiency technologies, products, practices and behavior;" to evaluate efficiency opportunities; to estimate a baseline for the purpose of assessing future residential DSM programs; and to compare other Midwest states to Xcel Energy's service area in Minnesota.

METHODOLOGY: The authors used data and results from four recent Midwest residential market assessments to characterize those four states. The team also surveyed energy auditors and homeowners. They then developed a mathematical model of DSM potential in the Midwest.

TECHNICAL POTENTIAL: Energy efficiency measures could eliminate 24 percent of residential electricity demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 1.18 percent for electricity and 2.33 percent for natural gas.

ECONOMIC POTENTIAL: Not given

ACHIEVABLE POTENTIAL: Energy efficiency measures could save 10.3 percent of residential electricity demand and 25.2 percent of residential natural gas demand during the final year of the period studied. The cumulative potential over the time period divided by the number of years was 0.515 percent for electricity and 1.26 percent for natural gas.

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

MINNESOTA STUDIES

STATE: Minnesota

STUDY NAME: Data not published; presented at ACEEE Summer Study

AUTHOR: Summit Blue Consulting

YEAR COMPLETED: 2003

PERIOD OF STUDY: Not given

FUELS: Electricity

SECTORS: Not given

PURPOSE OF STUDY: Not given

METHODOLOGY: Not given

TECHNICAL POTENTIAL: The cumulative potential over the time period divided by the number of years was 3.90 percent for electricity.

ECONOMIC POTENTIAL: The cumulative potential over the time period divided by the number of years was 0.70 percent for electricity.

ACHIEVABLE POTENTIAL: Not given

AVOIDED COST VALUES: Not given

CARBON COSTS: Not given

ENERGY EFFICIENCY POTENTIAL IN WISCONSIN (2009)

STATE: Wisconsin

STUDY NAME: Energy Efficiency and Customer-Sited Renewable Resource Potential in Wisconsin for the Years 2012 and 2018

AUTHOR: Energy Center of Wisconsin, et al

YEAR COMPLETED: 2009

PERIOD OF STUDY: 2008–2018

FUELS: Electricity, Natural Gas

SECTORS: Residential, Commercial, and Industrial

PURPOSE OF STUDY: "The Public Service Commission of Wisconsin (PSCW) retained the Energy Center of Wisconsin (Energy Center) for the purpose of analyzing the potential for Wisconsin to increase its use of energy efficiency resources."

METHODOLOGY: The study analyzed the potential for increased use of high-efficiency measures in the various sectors. For the residential sector, a bottom-up approach was used, aggregating savings potential associated with individual types of energy-using equipment. For the commercial, industrial, and agricultural sectors a top-down approach was used, which disaggregated savings estimates based on an assumed distribution of energy use within each market segment.

ECONOMIC POTENTIAL: Energy efficiency measures could eliminate 18 percent of statewide electricity use and 16 percent of natural gas use.

ACHIEVABLE POTENTIAL: The study found that energy efficiency could reduce overall electricity use by 1.6 percent per year for both energy and peak demand, and natural gas use by 1.0 percent per year. These estimates do not include the potential impact of behavior-based programs or advanced rate designs. Results by sector for electricity are: residential 1.0 percent, commercial 2.0 percent, industrial 1.6 percent, and agricultural 2.4 percent. Natural gas results by sector are: residential 0.2 percent, commercial 1.0 percent, industrial 1.7 percent, and agricultural 0.9 percent.

AVOIDED COST VALUES:
- Avoided electric energy and generation cost—$0.0546 per kWh
- Avoided electric transmission and distribution cost—$30 per kW-yr
- Avoided natural gas cost—$0.84 per therm

CARBON COSTS:
- Electricity—$0.025 per kWh
- Natural gas—$0.176 per therm

ENERGY EFFICIENCY POTENTIAL FOR IOWA MUNICIPAL UTILITIES (2009)

STATE: Iowa

STUDY NAME: Energy Efficiency and Demand Response Potential for Iowa Municipal Utilities for the Years 2012 and 2018

AUTHOR: Energy Center of Wisconsin, et al

YEAR COMPLETED: 2009

PERIOD OF STUDY: 2008–2018

FUELS: Electricity, Natural Gas

SECTORS: Residential, Commercial, and Industrial

PURPOSE OF STUDY: "The Iowa Association of Municipal Utilities (IAMU) retained the Energy Center of Wisconsin (Energy Center) to conduct an empirical assessment of energy efficiency and demand response potential in IAMU member service territory."

METHODOLOGY: The study analyzed the potential for increased use of high-efficiency measures in the various sectors. For the residential sector, a bottom-up approach was used, aggregating savings potential associated with individual types of energy-using equipment. For the commercial, industrial, and agricultural sectors a top-down approach was used, which disaggregated savings estimates based on an assumed distribution of energy use within each market segment.

ECONOMIC POTENTIAL: Energy efficiency measures could eliminate 22 percent of member electricity use, 38 percent of member electric peak demand, and 22 percent of member natural gas use.

ACHIEVABLE POTENTIAL: The study found that by the year 2018 energy efficiency could reduce overall electricity use by 1.2 percent per year, electric peak demand by 1.8 percent, and natural gas use by 1.8 percent per year. Results by sector for 2018 electricity are: residential 0.8 percent, commercial 1.5 percent, and industrial 1.2 percent. Natural gas results by sector are: residential 2.2 percent, commercial 1.5 percent, and industrial 1.6 percent.

AVOIDED COST VALUES:
- Avoided electric energy and generation cost
  On-peak summer—$0.069 per kWh
  Off-peak summer—$0.032 per kWh
  On-peak winter—$0.064 per kWh
  Off-peak winter—$0.035 per kWh
- Avoided electric transmission and distribution cost
  On-peak summer—$30 per kW-yr
  Off-peak summer—$0 per kW-yr
  On-peak winter—$30 per kW-yr
  Off-peak winter—$0 per kW-yr
- Externality factor
  Electricity—$0.0235 per kWh
  Natural gas—$0.067 per therm
- Avoided natural gas cost
  Summer—$0.89 per therm
  Winter—$1.00 per therm

CARBON COSTS:
(used in sensitivity analysis only)
- Electricity—$0.0235 per kWh
- Natural gas—$0.180 per therm

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ASSESSMENT OF ACHIEVABLE POTENTIAL FROM ENERGY EFFICIENCY AND DEMAND RESPONSE PROGRAMS IN THE U.S.

STATE: National

STUDY NAME: Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

AUTHOR: Electric Power Research Institute (EPRI)

YEAR COMPLETED: 2009

PERIOD OF STUDY: 2010–2030

FUELS: Electricity

SECTORS: Residential, Commercial, Industrial

PURPOSE OF STUDY: As energy efficiency is seen more and more as a solution for the contemporary challenges facing utilities, many states have passed, or are considering, legislation mandating energy efficiency savings levels. Such policies rely on sound estimates of the potential for energy efficiency. "To help address this need, the Electric Power Research Institute (EPRI) commissioned a study to assess the potential of electric end-use energy efficiency and demand response programs to mitigate the projected growth of U.S. electricity consumption and summer peak demand through 2030. A key objective of the study is to inform utilities, electric system operators and planners, policymakers, and other electricity sector industry stakeholders in their efforts to develop actionable savings estimates for end-use energy-efficiency and demand-response programs."

METHODOLOGY: "The study applied two distinct approaches to estimate electric energy efficiency: one for residential and commercial buildings and another for industrial facilities. For the residential and commercial sectors, the study implemented a bottom-up approach for determining electric energy efficiency savings potential. The residential and commercial approach begins with a detailed equipment inventory (e.g., the number of refrigerators), the average unit energy consumption (per household or per square foot in the commercial sector), and the diversified load during the non-coincident summer peak. In each sector, annual energy use and peak demand are the product of the number of units and the unit consumption annually, and at peak. This process is repeated for all devices across vintages and sectors. AEO 2008 [Annual Energy Outlook] provided both the number of units and the unit consumption. Diversified peak-load estimates were also developed as part of the study. For the industrial sector, the study applied a top-down approach in which the sector forecast is allocated to end uses and regions."

TECHNICAL POTENTIAL: 29.1 percent of total load (at the end of the period studied)

ECONOMIC POTENTIAL: 13.6 percent of total load (at the end of the period studied)

ACHIEVABLE POTENTIAL: 0.4 percent

AVOIDED COST VALUES: Not explicitly discussed.

CARBON COSTS: Not given

MINNESOTA GAS ENERGY EFFICIENCY POTENTIAL

STATE: Minnesota

STUDY NAME: Minnesota Gas Energy Efficiency Potential

AUTHOR: Navigant Consulting Inc. (NCI)

YEAR COMPLETED: 2009

PERIOD OF STUDY: 2009–2019

FUELS: Gas

SECTORS: Residential, Commercial, Industrial

PURPOSE OF STUDY: "Navigant Consulting, Inc. (NCI) worked with the three Minnesota gas utilities to develop estimates of the potential for gas energy efficiency including detailed analysis of existing gas use, available energy efficiency options, and policies and programs."

METHODOLOGY: Program potentials are calculated based upon detailed analysis of gas use in Minnesota and the measures for cost effectively improving efficiency at the customer segment and end-use level. Steps included (1) Sales Profiles and Forecasts—Develop detailed estimates of gas use by customer segment and end-use; Reconcile with utility sales forecasts; Develop gas price forecasts (2) EE Technology—Identify energy efficiency technologies that will provide significant cost effective gas energy savings in Minnesota; Develop detailed data on current penetration, costs, energy savings and lifetimes (3) Technical & Economic Potentials—Forecasts for energy efficiency if all customers adopted all applicable measures: all measures, only cost-effective measures (4) Program Design—Interview stakeholders about strategies for improving current programs; Best practices in other programs; Develop recommended program improvements and estimated additional costs (5) Program Potentials—Forecast energy efficiency savings and costs for: current programs and improved programs (with several scenarios) (6) Recommendations—Provide recommendations on policy issues to complement programs.

FINDINGS: Potentials were calculated for each utility.

TECHNICAL POTENTIAL: 2009–2019 Cumulative savings potential: Utility 1: 37%, Utility 2: 29%, Utility 3: 33%

ECONOMIC POTENTIAL: 2009–2019 Cumulative savings potential: Utility 1: 29%, Utility 2: 22%, Utility 3: 23%

ACHIEVABLE POTENTIAL: 2009–2019 Annual savings potential: Utility 1: 1.7%, Utility 2: 1.2%, Utility 3: 1.6%

AVOIDED COST VALUES: Avoided cost values are not presented in dollars per energy unit. Instead they are presented as net benefits and are given for each utility across five scenarios.

CARBON COSTS: The potential rage of carbon price is estimated to be $20–50 per ton of CO_2.

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