**Southwest Energy Efficiency Project (SWEEP)**





**Energy Efficiency Standard Rulemaking**
**Technical Working Group Comments**

**May 29, 2009**

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# The Potential for Cost-Effective Energy Efficiency: Memo Prepared for the Massachusetts Energy Efficiency Advisory Council

Attached is the memo that Jeff Schlegel (SWEEP) mentioned during the Technical Working Group meeting on May 29, 2009. This memo was prepared for the Massachusetts Energy Efficiency Energy Efficiency Advisory Council (EEAC) by the EEAC's consultants (Mr. Schlegel serves as one of the EEAC's consultants). This is a public document.

The memo summarizes results from studies of the potential for electric and gas energy efficiency programs and combined heat and power (CHP).

In addition to the data on energy efficiency potential studies, the memo includes a table summarizing recent state regulatory or legislative goals set for electric and (where noted) gas energy efficiency, including Energy Efficiency Resource Standards (EERS). The data in the table are based on *Laying the Foundation for Implementing a Federal Energy Efficiency Standard,* ACEEE, March 2009, report no. E091. Please note that many states have set goals or targets equivalent to 2% of retail energy sales.

The attached memo is available on the MA EEAC's web site at:

http://www.ma-eeac.org/docs/090526-PotentialAssessment-NortheastSummary.pdf

A presentation summarizing the attached memo is also available on the MA EEAC website at:

http://www.ma-eeac.org/docs/090526-PrelimPotentialStudyReview.pdf

# Massachusetts Energy Efficiency and Combined Heat and Power Potential Assessment
# Regional Findings

## Submitted to the MA EEAC by its Consultants
## May 26, 2009

### Introduction and Caveats

The Green Communities Act requires the electric and gas program administrators to assess the available energy efficiency and combined heat and power (CHP) cost-effective potential as a part of establishing their statewide and individual goals. The assessments need to demonstrate that Program Administrators are seeking to acquire all available cost effective efficiency over the life of each three year plan. Correctly determining the assessment is an iterative process, a significant part of which is reviewing past work in Massachusetts and other states. All assessments are estimates, subject to many variables which are discussed in this paper.

This document provides the EEAC with historic results from relatively recent electric and gas energy efficiency and combined heat and power (CHP) potential studies. We also provide a summary of current efficiency program goals or legislative mandates in various states. Below are tables summarizing the results. It should be noted that many energy analysts believe that virtually all studies tend to produce conservative (*i.e.,* low) estimates of potential for a variety of reasons. Indeed, some studies have estimated achievable potential for some markets that were already being exceeded by reported results in the same area. There are many reasons why studies tend to estimate low potential.[1] Below are some of the major biases:

- **Many studies are arbitrarily constrained in scope.** For example, some studies have only considered efficiency opportunities from "lost opportunity" markets (driven by natural investments in buildings and equipment over time), thus eliminating large opportunities for early retirement (retrofit) of equipment and systems. Other studies constrain overall funding available, program designs, incentive levels, policies and other parameters. Where possible, we have tried to note major constraints.
- **Many studies ignore technology advancement.** Advances in technology can range from reductions in costs and improvements in performance over time, as well as dramatic new technologies that have potentially large impacts on future efficiency opportunities (*e.g.,* LED lighting). Even those studies that attempt to include emerging technologies typically only include a very limited set.
- **Economic analyses tend to exclude all benefits.** For example, rarely are demand induced price effects considered. It is also common to omit non-electric benefits from electric studies (and non-

[1] See, for example, Goldstein, David, *Extreme Efficiency: How Far Can We Go if We Really Need To?*, Natural Resources Defense Council, ACEEE Summer Study, 2008 for a more comprehensive list of reasons studies tend to be biased on the low side.

gas benefits from gas studies). Many analyses of retrofit opportunities (early retirement) do not take full accounting of the long term cost savings from deferral of the natural equipment replacement cycle and often substantial O&M benefits.

- **Studies are limited by time and resources, and thus simplified by exclusion.** An analyst can never include a fully comprehensive assessment of all possible technologies and practices. As a result, any exclusions are implicitly valued at zero, simply because they are not researched and analyzed. Rather than including approximate estimates for their inclusion, they are completely eliminated. For example, many studies omit measures that do not address the major end uses such as lighting, HVAC and refrigeration. As a result, things like plug load and other miscellaneous measures may be ignored. Some studies also do not fully address industrial process opportunities.
- **Interactions that magnify opportunities and systems that treat whole buildings comprehensively are often ignored.** Most studies do a good job of reducing savings from one measure as a result of prior assumed measures (*e.g., if a building shell is improved, it can reduce the* savings from an efficient air conditioner). However, they nonetheless consider discrete measures rather than using a more systems-based approach. These approaches can often take advantage of significant synergies that may allow for dramatic down-sizing or even eliminating of major capital equipment, thus rendering a much greater package of measures with deeper savings cost-effective.
- **Studies stretch out early replacement opportunities throughout the full analysis period.** Many studies do not consider the ability to fast-track early retirement savings, but simply spread the estimated achievable participation rates across the whole timeframe. In some cases, with unconstrained funding programs could target and capture these opportunities faster.

Indeed, the mean of annual achievable program electric efficiency potential shown in the table below is 2.2%. However, Efficiency Vermont has already exceeded this level in 2008 with statewide savings of 2.5%.[2] Further, EVT captured 4.5% of the current electric load from efficiency savings in specifically targeted geographic areas in 2008.[3]

One should not view efficiency potential as a finite amount that goes away once captured. Indeed, experience has shown that technologies have generally at least kept pace with past improvements in codes & standards, public efficiency program investments, and naturally adopted efficiency. For example, in 1989 the American Council for an Energy Efficient Economy (ACEEE) estimated the economic potential in New York to be approximately 30% of forecast load. After more than two decades of significant electric DSM program delivery in NY, a team led by Optimal Energy in 2003 (which included ACEEE) re-estimated the efficiency economic potential at 32.7% of forecast load, or approximately the same level. Thus, in a state that has been a leader in efficiency programs throughout the 1990s and 2000s, roughly the same proportional electric efficiency opportunities exist now as did when programs began. As a result, studies with longer time horizons tend to result in conservative implied annual achievable potential estimates.

## Potential Results

The tables below provide summaries of results from available studies throughout the Northeastern U.S. -- most within the past decade. While we report, where available, the estimates of technical and economic

[2] Efficiency Vermont 2008 Annual Report, March 2009. These figures are not yet fully verified by the VT DPS and are subject to adjustment. Past adjustments based on VT DPS EM&V process have ranged from 2% to 12% reduction in tracking estimates.
[3] Ibid. Analysis of geo-targeted loads based on 2006 actual electric loads and assumed 1.5% annual underlying (*i.e.,* without efficiency programs) growth.

potential, our focus is on achievable potential, as that should most closely align with Massachusetts' goal of capturing all *available* cost-effective efficiency. All figures should reflect *net* savings, excluding naturally occurring efficiency and codes & standards.

While definitions can vary from one study to the next, in general *technical* potential is defined as the net savings from all technically feasible efficiency opportunities without regard to economics or a customer's willingness to adopt them. *Economic* potential refers to the subset of technical potential that is cost-effective based on an economic screening. The cost-effectiveness test used varies among jurisdiction. However, the prevailing cost-effectiveness criteria in the region is the total resource cost test (TRC), which is also used in MA. However, rarely if ever is DRIPE included. *Achievable* potential is generally defined as the maximum amount of efficiency that can be expected to be captured with fully funded, well designed programs. However, in some cases, estimates reflect achievable potential subject to various economic, programmatic, budgetary, or other constraints. As such, the average results for achievable potential can be viewed as a low estimate of true maximum achievable potential.

**Electric Efficiency**

Achievable electric efficiency potential estimates range from a low in Maine (14%)[4] to a high in the Mid-Atlantic (37%). The mean from these studies is 24.3% of the forecasted future load (at the end of the analysis period) assuming no other interventions in the market. The study periods range from 5-20 years, with an average of 12. The implied *annual* achievable potential is shown by dividing the ultimate achievable potential by the analysis period. This ranges from 1.4% to 3.1%, with a mean of 2.2%. It should be noted that only two (out of 13) studies have implied annual achievable potential that meets or exceeds Vermont's 2008 statewide achievement, and none that approach EVT's 2008 geo-targeting achievement. These numbers do not include any savings potential from CHP.

[4] The Maine study excluded some major efficiency markets, including low income retrofit and all new construction opportunities.

# Electric Efficiency Potential

| State | Year of Study | Analysis Period (yrs.) | Technical Potential (% of total forecast load) | Economic Potential (% of total forecast load) | Achievable * (% of total forecast load) | Average Annual Achievable** (% of total forecast load) | Source | Notes |
|---|---|---|---|---|---|---|---|---|
| Connecticut | 2009 | 10 | 36.4% | 33.1% | 22.5% | 2.3% | KEMA | Draft. Total achievable estimated at 31% including codes & standards. |
| Maine | 2002 | 10 | N/A | 18.0% | 14.0% | 1.4% | Exeter/ OEI | Simplified analysis based on prior utility data. Did not include low income retrofit (early retirement) nor all new construction markets. |
| Maryland | 2008 | 17 | N/A | N/A | 29.0% | 1.7% | ACEEE | |
| Mass (Nstar only) | 2007 | 10 | N/A | N/A | 17.9% | 1.8% | OEI | High level analysis, electric efficiency only figure. With CHP estimate is 21.1%. |
| Massachusetts | 2001 | 5 | N/A | 24.0% | N/A | | RLW | |
| Mid-Atlantic (NY/NJ/PA) | 1997 | 14 | N/A | N/A | 37.0% | 2.6% | ACEEE | Represents approximate weighted average of sector-specific estimates of 35% Residential, 35% Commercial and 41% Industrial. |
| New England | 2004 | 10 | | | 23.0% | 2.3% | OEI | Meta-analysis for NEEP. Older relatively low CT and ME estimates drove result down. CT study was also assumed to apply to RI. More recent CT and RI studies would have resulted in significantly higher estimate. |
| New Hampshire | 2009 | 10 | 27.6% | N/A | 22.7% | 2.3% | GDS | Ignored most retrofit (early retirement) savings, so viewed as substantially low. |
| New Jersey | 2003 | 17 | N/A | 17.0% | N/A | | KEMA | |
| New York | 2003 | 20 | 35.1% | 32.7% | N/A | N/A | OEI | Forthcoming update with achievable potential has initially estimated about18% over 7 years, or approximately 2.5%/yr. Still in draft. |
| Rhode Island | 2008 | 10 | 28.0% | 24.0% | N/A | | KEMA | Phase 1 high level study. Detailed study forthcoming in 2009. |
| Vermont | 2003 | 10 | N/A | 38.4% | 30.7% | 3.1% | OEI | |
| Vermont | 2007 | 10 | 34.6% | N/A | 22.0% | 2.2% | GDS | Constrained analysis to 50% of incremental cost incentive levels. For some markets, estimate of achievable was already being exceeded by Efficiency VT at the time of the study. In 2008 EVT achieved 2.5% savings statewide and 4.5% in geotargetted areas (unevaluated results). |
| **Averages** | | **11.8** | **32.3%** | **26.8%** | **24.3%** | **2.2%** | | Mean of data available. |

* "Achievable potential" definitions can vary significantly. In some cases this is estimated as the maximum amount of EE that can be achieved from programs, with no constraints. However, many studies only analyze what could be achieved for a particular set of programs, incentive levels, or budget or rate impact constraints. In addition, some studies exclude some major EE markets completely. For example, some studies have excluded new construction, industrial process, early retirement, fuel switching, or other major opportunities. As a result, these figures should generally be viewed as conservative estimates. Finally, none of the these studies any savings from CHP.

** Average Annual Achievable represents the total estimated achievable potential percent divided by the planning period.

## Combined Heat and Power

In MA the goal is to capture all available cost-effective energy efficiency *and* combined heat and power opportunities. As a result, it is useful to also consider estimates of CHP opportunities. There is less available experience and research on CHP achievable potential. CHP has generally not been promoted by efficiency programs. Rather, the installed CHP capacity now existing in the region has been mostly developed through natural market forces, and in some cases very limited incentives or tax breaks. As a result, the ability to dramatically influence CHP adoption with MA programs is unclear. However, a review of studies in NY and MA indicate *technical* CHP potential of between 40% and 62% of total electric load, with a mean of 51%.[5] Thus, it seems clear that the theoretical opportunities for CHP in MA are very large.

The NY study estimated "market potential" assuming a halving of current NY stand-by charges and a federal tax credit of 10% of installed cost, however, no other interventions in the market. Based on these assumptions it projected 10.5% CHP market potential, or 1.05% of total electric load per year. Certainly, well funded aggressive CHP programs in MA would presumably have been estimated by this study's authors to exceed this limited intervention scenario. In addition, a study for NSTAR that considered whether it was feasible to meet all load growth with EE and CHP made a high level estimate that, starting from scratch and assuming no changes to policies such as stand-by rates or interconnection agreements, could provide 3.2% of total load savings in 10 years, or 0.32%/yr. The mean implied annual achievable CHP potential from the two studies that provide estimates is 0.7%. Because the CHP studies are limited, and the range of estimated potential is large, more research is needed on CHP opportunities and likely customer adoption from well designed programs. This is being undertaken in RI, and will also be further analyzed in MA this year.

**Electric CHP Potential**

| State | Year of Study | Analysis Period (yrs.) | Technical Potential (% of total forecast load) | Economic Potential (% of total forecast load) | Achievable Potential (% of total forecast load) | Average Annual Achievable* (% of total forecast load) | Source | Notes |
|---|---|---|---|---|---|---|---|---|
| Massachusetts | 2006 | Instan-taneous | 62.0% | N/A | N/A | N/A | U of MA, Amherst | Figure based on installed load estimate, 65% of electricity used on-site (NY Study estimate for existing NY CHP load) and assumed 80% load factor. Based on fraction of current MA load. |
| Massachusetts (NSTAR Only) | 2007 | 10 | N/A | N/A | 3.2% | 0.3% | OEI | Constrained potential recognizing no programs existed at the time, no clear ability to coordinate with gas utilities, or assumptions about improved stand-by or interconnection policies. |
| New York | 2002 | 10 | 40.4% | N/A | 10.5% | 1.1% | Energy Nexus | Estimates are net of expected natural market adoption. The study did not estimate achievable potential. "Achievable" estimate represents assume market penetration without any state or utility programs but with reduction by 50% of stand-by charges and a 10% federal tax credit only. Figures are based on installed load estimates, 65% of electricity used on-site (Study estimate for existing NY CHP load) and assumed 80% load factor. |
| Averages | | 10 | 51.2% | N/A | 6.9% | 0.7% | | Mean of data available. |

[5] The studies estimated installed capacity rather than energy production. Estimates assume 65% of electric generation is used on-site (thus reducing line losses, based on the historic CHP installed in NY) and an average load factor for CHP systems of 80%.

## Total Electric Efficiency and CHP Potential

The mean implied annual achievable potential estimates for both electric efficiency and CHP sum to 2.9%. The range of annual levels is from a low of 1.7% to a high of 4.2%.[6]

## Gas Efficiency

As with CHP, gas energy efficiency has not benefited from as long or as aggressive efficiency efforts as the electric sector. As a result, there are fewer studies for the region, and less experience with fully funded programs and portfolios. The table below includes 4 studies done in the past 6 years. The achievable potential ranges from a low in Connecticut 17% to a high in New Hampshire of 21%. The mean is 19%. Implied annual achievable potential from these studies is a mean of 1.9%, with a range of 1.7% to 2.1%. The 4 studies have substantially less variation than the electric studies, despite the fact that one study excluded all but a few retrofit (early retirement measures) because the policy focus was on capturing savings only at the time of natural customer investment in equipment and systems, and another study excluded new construction and other opportunities related to new load growth. The one study (NJ) that did not provide *achievable* potential had a slightly higher *economic* potential estimate than any of the other studies, indicating it likely would have found achievable potential to be equal or higher than the mean.

### Gas Efficiency Potential

| State | Year of Study | Analysis Period (yrs.) | Technical Potential (% of total forecast load) | Economic Potential (% of total forecast load) | Achievable * (% of total forecast load) | Average Annual Achievable** (% of total forecast load) | Source | Notes |
|---|---|---|---|---|---|---|---|---|
| Connecticut | 2009 | 10 | 29.0% | 25.0% | 17.0% | 1.7% | KEMA | Final draft. Gas efficiency only. Total achievable including codes & standards estimated at 22%. |
| New Hampshire | 2009 | 10 | 29.2% | N/A | 21.1% | 2.1% | GDS | Ignored most retrofit (early retirement) savings. Typically retrofit measures account for a large portion of EE opportunities over 10 years. |
| New Jersey | 2003 | 17 | N/A | 30.0% | N/A | | KEMA | Constrained to existing load, so excluded new construction opportunities and other efficiency from load growth. |
| New York | 2006 | 10 | N/A | 28.3% | 19.0% | 1.9% | OEI | Conservative estimate of max achievable based on 67% of economic, without detailed analysis. |
| **Averages** | | **11.8** | **29.1%** | **27.8%** | **19.0%** | **1.9%** | | Mean of data available. |

* "Achievable potential" definitions can vary significantly. In some cases this is estimated as the maximum amount of EE that can be achieved from programs, with no constraints. However, many studies only analyze what could be achieved for a particular set of programs, incentive levels, or budget or rate impact constraints. In addition, some studies exclude some major EE markets completely. For example, some studies have excluded new construction, industrial process, early retirement, fuel switching, or other major opportunities. As a result, these figures should generally be viewed as conservative estimates. Finally, none of the these studies any savings from CHP.

** Average Annual Achievable represents the total estimated achievable potential percent divided by the planning period.

[6] Summing the lowest efficiency and CHP values for the low range and the highest for the high range.

## Energy Efficiency Resource Standards

In addition to the above data on regional potential studies, shown below are recent state regulatory or legislative goals set for electric and (where noted) gas efficiency. This is based on *Laying the Foundation for Implementing a Federal Energy Efficiency Standard,* ACEEE, March 2009, report no. E091. The far right column provides the "implied annual efficiency savings target" as a percentage of the ultimate years load. For some EERS, goals were set based on reducing load to a portion of current load. In this case, average annual underlying growth in the load forecast net of energy efficiency programs was assumed to be 1.5%. In some cases, states have adopted *Renewable* Portfolio Standards (RPS) that allow some goals to be met with efficiency. In this case, EE targets are shown based on the maximum allowable use of EE to meet the RPS.[7] In some cases, goals are not clearly defined, and the table shows current plans.

Annual electric efficiency savings goals (as a percent of total electric load) range from a low of 0.4% in NC to a high of 3.25% in MD. Ten of 22 states have implied annual electric efficiency goals of 2.0% or more. Of the 9 states in the Mid-Atlantic and New England region, all but 3 have electric efficiency goals in excess of 2.0% per year.[8] It is likely that most if not all of these estimates exclude CHP, although a thorough analysis of whether any do include CHP has not been completed.

Annual gas efficiency goals are much more limited. Of the 5 sates with established goals, all but one (IA at 0.3%) are 1.5% or greater. Within the Region's 4 states, NY has a goal of 1.5%/yr., while the others require all cost-effective achievable potential (assumed here to be 2.0% or more).

[7] EE is generally far cheaper to capture than RE. Experience has shown that utilities generally plan to maximize use of EE in meeting RPS goals.
[8] Note, a number of states – including MA -- require all available cost-effective efficiency. This is assumed to equal at least 2.0%/yr.

| State Energy Efficiency Resource Standards Activity | | | | |
|---|---|---|---|---|
| State | Date Established | Goal | Target End Date | Implied Annual % savings* (% of total forecast load) |
| Texas | 2007 | 20% of load growth | 2010 | 0.5% |
| Vermont | 2008 | 2.0% per year (contract goals) | 2011 | 2.0% |
| California | 2004 | EE is first resource to meet future electric needs[1] | 2013 | 2.0% + |
| Hawaii | 2004 | .4% - .6% per year[2] | 2020 | 0.5% |
| Pennsylvania | 2008 | 3.0% of 2009-2010 load | 2013 | 0.6% |
| Connecticut | 2007 | All Achievable Cost Effective[3] | 2018 | 2.0% + |
| Nevada | 2005 | 0.6% of 2006 annually[4] | n/a | 0.6% |
| Washington | 2006 | All Achievable Cost Effective | 2025 | 2.0% + |
| Colorado | 2007 | 1.0% per year | 2020 | 1.0% |
| Minnesota (elec & gas) | 2007 | 1.5% per year | 2010 | 1.5% |
| Virginia | 2007 | 10% of 2006 load | 2022 | 2.2% |
| Illinois | 2007 | 2.0% per year | 2015 | 2.0% |
| North Carolina | 2007 | 5% of load[5] | 2018 | 0.4% |
| New York (electric) | 2008 | 10.5% of 2015 load[6] | 2015 | 1.5% |
| New York (gas) | 2009 | 15% of 2020 load[6] | 2020 | 1.5% |
| New Mexico | 2009 | All achievable cost-effective, minimum 10% of 2005 load | 2020 | 1.0% + |
| Maryland | 2008 | 15% of 2007 per capita load[7] | 2015 | 3.3% |
| Ohio | 2008 | 2.0% per year | 2019 | 2.0% |
| Michigan (electric) | 2008 | 1.0% per year | 2012 | 1.0% |
| Michigan (gas) | 2008 | 0.75% per year | 2012 | 0.8% |
| Iowa (electric) | 2009 | 1.5% per year | 2010 | 1.5% |
| Iowa (gas) | 2009 | 0.85% per year | 2013 | 0.3% |
| Massuchesetts | 2008 | All Achievable Cost Effective | | 2.0% + |
| New Jersey (electric & g | 2008 | 20% of 2020 load[8] | 2020 | ≤2.0% |
| Rhode Island | 2008 | All Achievable Cost Effective | | 2.0% + |

**Source:** ACEEE, Laying the Foundation for Implementing a Federal Energy Efficiency Standard, March 2009, report no. E091.

**Notes:**

* Implied annual reduction for targets based on current year loads assumes average underlying load growth (not accounting for EE) of 1.5% per year. Texas based on recent load growth of 3%/yr.

1 CA programs exceeded 1.5%/yr. in 2007. While current mandated goals are lower, CA policy requires investment in efficiency whenever it is less costly than alternative new supply.

2 HI established a renewable portfolio standard that includes efficiency as a resource and requires 20% savings by 2020, or approximately 2.8%/yr. However, this can come from efficiency or renewable resources. Current efficiency savings has ranged from 0.4% - 0.6%/yr.

3 CT requires capture of all available cost-effective efficiency resources. Current utility plans reflect goals of about 1.5%/yr.

4 NV has an RPS requiring 15-20% of load and allows EE to meet 25% of the goal. Utilities are ramping up to meet the maximum level of 5% of load from efficiency. Figure reflects 2006 program achievements.

5 NC RPS ramps up to 12.5% of load in 2021, with EE capped at 40% of this target, or 5%.

6 NY established a 15% savings goal (July 2008) for electric efficiency by 2015, however this includes an estimated 4.5% savings from codes & standards. Electric figure is for efficiency programs only. NY just established a 14.7% goal for gas efficiency by 2020. However, it is unclear whether this includes any savings that might come from codes & standards.

7 MD goal is set as a reduction off of 2007 per capita load. Implied annual goal assumes underlying load growth per capita (net of efficiency programs) of 0.75%.

8 NJ legislature recently authorized the BPU to set electric and gas goals of 20% savings each by 2020. Goals still under development.