# Memo

MA ENERGY EFFICIENCY ADVISORY COUNCIL

→ CONSULTANT TEAM

To: **EEAC Council**

From: **Optimal Consultant Team**

Date: **March 10, 2016, Updated May 12, 2017**

Subject: **Increasing Energy Productivity through Strategic Energy Management**

The Consultant Team is pleased to provide this memo to the Council on ways that energy productivity could be increased in Massachusetts though the energy efficiency programs.

## EXECUTIVE SUMMARY

In Massachusetts, meeting the goals in the 2016-2018 three year plan and beyond will require savings from new tools and methods. The use of energy productivity metrics to measure changes in energy intensity for a variable, dynamic process is not a common method in Massachusetts. Strategic Energy Management programs (SEM) offer customers a comprehensive approach to energy management to improve energy productivity. This memo outlines the practices of Strategic Energy Management that could be adopted or expanded in Massachusetts (MA) to increase energy productivity, engage with Commercial and Industrial (C&I) customers more comprehensively, and contribute to the success of the energy efficiency programs.

*Energy productivity is defined as energy consumption per unit of output for goods or work. This is used to measure energy efficiency when the work being done is variable.*

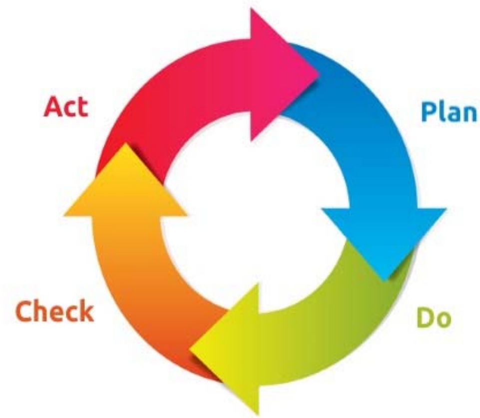
SEM is a customer engagement approach where Program Administrators (PA) work closely with customers to identify both operational changes that can save energy as well as traditional equipment retrofit energy efficiency projects. This is good model for working with large energy intensive customers either individually or as a group, or cohort, of up to 10 customers. SEM programs in other states have provided a basis of knowledge that the Massachusetts PAs are researching to determine how SEM program offerings can complement current customer engagement strategies. SEM activities include the identification and execution of capital projects, retro-commissioning, procurement, and behavior modification through employee engagement. Savings are calculated by using regression analysis models as a counterfactual baseline that is compared to actual customer production and energy use. Based on the identified market in Massachusetts and on the performance of SEM programs in other regions and states, SEM programs have the potential to save over 46 annual GWh and 170 lifetime GWh after five years of implementation, which is 5.7% and 1.8% of the C&I 2018 annual and lifetime goals respectively.

The Massachusetts PAs currently work closely with their largest customers, and in some cases already have memorandum of understandings with these customers to document shared priorities and goals. SEM programs can increase savings from these important customers by unlocking new sources of operational and behavioral savings. After research by the PAs conducted in 2016 and early 2017 confirmed the value of SEM programs, the Massachusetts PAs are planning to release an RFI/RFQ by the second quarter of 2018 for a third party contractor to run a cohort style SEM program. The PAs are also investigating the use of ISO 50001 for specific large customers. ISO 50001 is an international standard for strategic energy management, just as other ISO standards such as ISO 9001 and 14001focus on quality and sustainability.

By implementing an energy management system a customer can change the corporate culture, and make energy use improvement a corporate priority comparable to increasing quality or safety.

**STRATEGIC ENERGY MANAGEMENT PROCESS**

The steps used to put energy management into place with a customer are described below.




- → Perform a **self-assessment** to determine to what extent energy is already being managed
- → Set the **baseline** of energy performance from which to measure future improvement
- → **Plan** by setting goals and outlining steps to achieve the goals
- → **Do** implement the plan by taking the necessary steps to meet the goal
- → **Check** to make sure the plan is working
- → **Act** to make changes to continue improvement
- → **Report** progress to senior management at least annually, and start the cycle again with planning. Self-assessments and baselines can be revisited as is necessary

**PRIMARY RECOMMENDATION**

In order to provide consistency across states and energy efficiency programs, there is the opportunity for programs in the northeast to agree on the use of the ISO 50001 standard as the common fundamental structure of strategic energy management. Use of a common framework will help customers and program administrators with locations across multiple states.

**SEM BEST PRACTICES TO APPLY MASSACHUSETTS.**

Because SEM programs have been in operation in other regions for about a decade, practices have evolved and these programs have been evaluated multiple times. SEM is therefore well-established; the following SEM best practices are drawn from findings regarding existing programs and the Consortium for Energy Efficiency (CEE) minimum elements.[1] CEE worked to define what elements were necessary for a SEM program to be functional.

<u>Start with the largest customers:</u> Successful SEM programs in the Pacific Northwest have targeted large industrial customers. Following this approach, Massachusetts should start with the largest customers and work down in size. Massachusetts has about 300 customers that use 10 million kWh or more annually, and the industrial customers within this pool would be the best place to start.[2] There is another group of almost 400 customers that use between 5 million and 10 million kWh that could also be potential candidates.

<u>Tailor services to small cohorts:</u> Serving customers in a group or cohort of 10 or fewer customers is a cost effective way to deliver technical trainings and services. A cohort can foster a sense of both collaboration and positive reinforcement. However, working with customers individually can also be cost effective if their energy use, and probable savings, is large enough to justify the cost

<u>Correctly attribute energy savings:</u> SEM energy savings are typically calculated by comparing projected and actual energy usage, using a regression model to establish baseline energy use. Regression models must include all significant variables that impact energy use. Savings attributable to capital projects supported by traditional incentive-based efficiency programs should be netted out of the savings calculation.

<u>Consider industry standards:</u> The US Department of Energy has developed an ISO 50001 Ready Navigator tool to help prepare customers achieve ISO 50001 compliance. While customers may not want to take the next step to actually achieve certification, the use of ISO 50001 and this tool as the basis for SEM programs would establish a consistent approach across multiple states.

[1] https://library.cee1.org/system/files/library/11283/SEM_Minimum_Elements.pdf
[2] http://ma-eeac.org/wordpress/wp-content/uploads/2015-CI-Expedited-Customer-Profile-Report.pdf Table 3-2 page 11

## INTRODUCTION

This memo investigates equipment and processes that generate energy savings by driving improved energy productivity in the commercial, institutional, and industrial (C&I) markets. The EEAC Consultant Team believes that there is significant untapped energy savings potential from improving energy productivity in Massachusetts. The Team estimates that Massachusetts could realize annual savings of 46,300 MWh and lifetime savings of 170,080 MWh in the fifth year of a Strategic Energy Management program from operational and behavioral changes. These figures represent 5.7% and 1.8% of the C&I 2018 annual and lifetime goals respectively. The purpose of this memo is to outline the practices of Strategic Energy Management (SEM) that could be adopted or expanded in Massachusetts to increase energy productivity and contribute to the success of the energy efficiency programs. It is also intended to provide some information and context about the interdependent relationships between equipment, such as sub-meters and software, and the processes of strategic energy management.

Massachusetts does not have a formal SEM program offering at this time. The Massachusetts 2016-2018 Energy Efficiency Plan does commit to expanding SEM and describes the expansion efforts as additional retro-commissioning and training opportunities.[3] The plan also mentions process and behavioral approaches within the existing Memorandum of Understanding (MOU) relationships. While the type of senior level commitment necessary for the implementation of an MOU is also critical to implementing a SEM program, a SEM program goes deeper and involves more customer personnel than retro-commissioning. After research by the PAs conducted in 2016 and early 2017 confirmed the value of SEM programs, the Massachusetts PAs are planning to release an RFI/RFQ by the second quarter of 2018 for a third party contractor to run a cohort style SEM program. The PAs are also investigating the use of ISO 50001 for specific large customers.

## UNDERSTANDING ENERGY PRODUCTIVITY

Energy efficiency is often defined as using less energy to do a fixed amount of work. This definition works well for work that is relatively constant and regular such as lighting. Energy productivity is normally defined as the energy consumption per unit of output for goods or work, such as 1 MWh per ton of production. This is a dynamic measurement for energy efficiency; it is most appropriately used when the work being done is variable. A manufacturing process can experience seasonal or business cycle increases and decreases that affect energy use, thus making it harder to see energy efficiency savings that result from program-induced changes. In addition, weather is a variable that can impact energy use and the amount of energy per unit of output. By using an energy-per-unit of output metric that is normalized for weather and other relevant factors, savings can be measured and claimed despite production variability. Heating or air conditioning systems serving a commercial or institutional building also adjust for variations in building occupancy, internal heat gains, and external weather. These adjustments affect energy consumption. Using normalized energy productivity metrics, ratios, or mathematical models, with data from appropriate meters, allows the accurate measurement of energy savings from improvements to a dynamic process.

*Energy Purchasing Authority: Anyone who can flip on a light switch, turn on equipment, or plug something into an electrical socket has energy purchasing authority, so employee engagement is very important to manage energy use.*

Many businesses equate energy use with productivity and assume more energy use means more production. If more production leads to more sales, companies may see more energy use as a positive indicator. When efficiency programs try to persuade these customers to reduce energy use, customers can perceive it as an attempt to limit or hamper their business. Using a metric that relates energy use to production allows for energy savings to become a focus area independent of the volume of production. In fact, reducing energy use on a per-unit basis means that as production increases, so do savings. This methodology allows savings to be measured and claimed even if overall energy use does not decline as the result of increased production.

For a specific customer, appropriate energy productivity metrics must be chosen with care. An office might use worker hours as the unit of production (energy use/worker hour), and a hospital could use patients treated or

[3] http://ma-eeac.org/wordpress/wp-content/uploads/Exhibit-1-Gas-and-Electric-PAs-Plan-2016-2018-with-App-except-App-U.pdf page 153

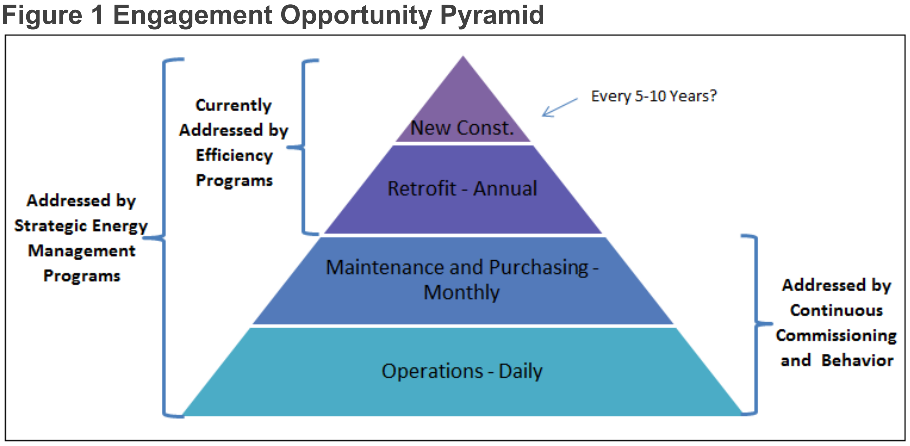
occupied beds as the unit of production (energy use/patient). At a mechanical system level, energy productivity can be defined as energy per ton of cooling output or energy per unit of air moved by a fan. Metrics that correlate energy use with some unit of production are often called either Key Performance Indicators (KPI) or Energy Performance Indicators (EnPI). It is important to note that the customer should define KPIs or EnPIs in a way that makes sense and is relevant for their business and operations. For many C&I customers, barriers exist that prevent them from being able to measure and improve energy productivity. First, there is currently a dearth of sub-metering in C&I buildings, which limits both the accurate measurement of energy use and the development of performance metrics and regression models.[4] It can also be challenging to identify and measure the appropriate unit of production. For example, production units may be recorded when shipped, rather than at the time of production when the associated energy is being used, making the alignment of energy use and production difficult. Many businesses are also sensitive about sharing production and related business data. Sometimes it is hard to understand the drivers that cause variations in energy use associated with output. Most businesses are focused more on their core business than on energy use. Unless there is a dedicated energy manager or energy champion within the company, energy use is often a secondary consideration. In addition, while most companies work diligently to instill a culture of workplace safety and product quality, it is less likely that the same effort is put towards creating a culture of energy use awareness.

Strategic Energy Management (SEM) programs are designed to overcome these barriers. SEM programs are a comprehensive approach to the management of energy within a facility, and can include the identification and execution of capital projects, retro-commissioning, procurement, and behavior modification through employee engagement.

## LIMITATIONS OF CURRENT ENERGY EFFICIENCY PROGRAMS

The limitation of C&I capital project-based retrofit and market opportunity efficiency programs is that they focus on capital improvement projects and miss opportunities resulting from operational practices and maintenance procedures. As represented in Figure 1, traditional efficiency programs only address the top of the pyramid: traditional retrofit and new construction projects. Daily operational parameters and decisions are not typically addressed, nor are the monthly maintenance and smaller purchasing decisions that represent business as usual. The bottom of the pyramid represents large opportunities to change or refine the way things are done in C&I facilities. Most traditional efficiency program savings comes from lighting even though lighting is not the largest energy use for many C&I customers. Process loads, plug loads, ventilation, air conditioning, space heat, and hot water use often use more energy than lighting and represent the savings opportunity at the bottom of the pyramid.

**Figure 1 Engagement Opportunity Pyramid**




Strategic Energy Management programs provide a way for a program administrator to engage large customers on a more complete, deeper level and to document and claim the savings resulting from this engagement. SEM programs should also include components such as retro-commissioning and behavior initiatives, both of which are discussed later in this memo, as part of a holistic approach to customer energy use. Commissioning, especially

[4] Barriers to sub-meters include cost, the requirement to shut off power to install the meter, and a lack of understanding of the potential value of the meter data.

where there are the equipment and processes in place to make commissioning and monitoring continuous and ongoing, addresses daily operations to ensure optimal energy use at all times. Behavior initiatives engage facility occupants and provide goals and direction to encourage savings, making energy use the responsibility of everyone and not just the facility personnel.

This memo outlines ways to go beyond the current offerings of traditional efficiency programs and engage with C&I customers more comprehensively. Strategic Energy Management Programs can promote a long term relationship between the customer and the program administrator. Whenever possible, effective programs and strategies implemented in other states or regions have been chosen as examples.

## PROCESSES THAT FOCUS ON INCREASED ENERGY PRODUCTIVITY

### Strategic Energy Management

The term "energy management" is commonly used in several ways. A Strategic Energy Management (SEM) *program* should not be confused with the term Strategic Energy Management *Plan* (SEMP) as used by National Grid. National Grid's SEMP consists of a multiyear Memorandum of Understanding (MOU) between the utility and the customer that sets goals and promises enhanced technical help to facilitate projects. The principal difference is that the primary purpose of a SEMP is to facilitate a greater quantity of conventional energy efficiency projects that require a capital investment and/or facilitate campus or customer wide Retro-Commissioning (RCx) or ongoing Monitoring Based Commissioning (MBCx) with a single customer. SEM programs are designed to both increase the quantity of capital projects *and* cause operational and behavioral changes that result in measureable, claimable savings with either a cohort or single customer. In short, SEM programs represent a more comprehensive approach. The following table highlights some differences in employee engagement and energy management structure between the PA commissioning programs and SEM programs.

**Figure 2 Comparison of Monitoring/Retro-Commissioning and SEM Program Elements**

| Program Element | MBCx or RCx | SEM |
|---|---|---|
| Requires senior management support | No | Yes |
| Requires a self-assessment of energy management practices | No | Yes |
| Requires setting a baseline by means of a statistically relevant model of energy performance | Yes | Yes |
| Requires setting a goal | No | Yes |
| Requires developing an energy management plan | No | Yes |
| Requires the involvement of all facility occupants | No | Yes |
| Incorporates both operations and behavior changes | Rarely | Yes |
| Track improvements | Yes | Yes |

The terms "energy management," "continuous energy improvement," and "strategic energy management" are used somewhat interchangeably for the same type of program. Energy Trust of Oregon (ETO), Bonneville Power Administration (BPA), and BC Hydro have well established programs that use the Strategic Energy Management name. Some programs in the east are using the term Continuous Energy Improvement, such as the pilot program by Efficiency Vermont. There is also the ISO 50001 standard for establishing an energy management system, which is an organizational process, and some programs are designed to help customers achieve ISO 50001 certification. Other examples include the DOE Superior Energy Performance program that recognizes companies that use ISO 50001 to achieve certain levels of savings[5] and the EPA Energy Star Energy Management program.[6] The term "energy management system" is commonly applied to the hardware and software that is used to control the HVAC systems in a building, as covered above, but that usage does not apply here. This memo uses the term SEM to refer to a specific type of efficiency program, described below, similar to the usage in the Pacific

[5] http://www.energy.gov/eere/amo/superior-energy-performance
[6] https://www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/guidelines

Northwest.

This section will explain how successful SEM programs deliver cost-effective savings in other states. While it may be possible to wrap a SEM program into a SEMP/MOU agreement, and indeed it is important to get documented customer commitment before allowing participation in a SEM program, twenty three program administrators in North America have seen enough value in SEM to make it a stand-alone program or pilot with a firm budget and goals.[7]

ACEEE states that an SEM program can comprise four elements:[8]

- → Training staff at C&I facilities on how to implement management systems and procedures for achieving continuous, long-term energy savings goals
- → Training staff to identify and implement low-cost operation and maintenance (O&M) improvements and measurement of the associated energy savings
- → Installing energy management information systems (EMIS) hardware and software programs
- → Co-funding energy managers at customer facilities

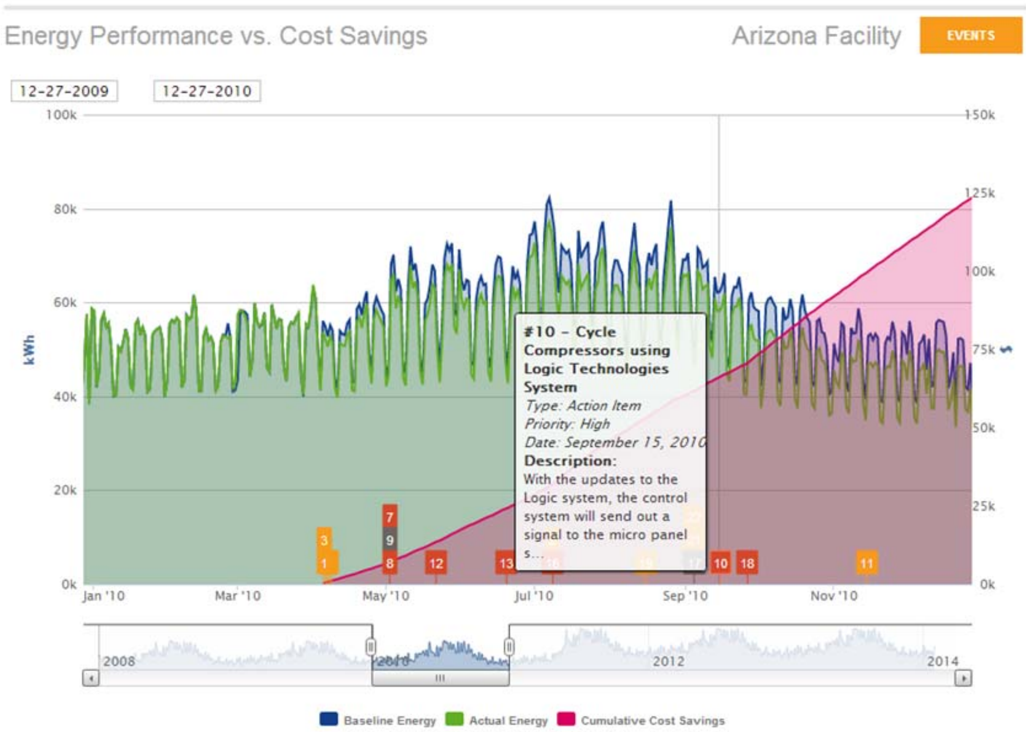
It is not necessary to include all four elements in an SEM program. The Consortium for Energy Efficiency (CEE) analyzed a dozen SEM programs in 2014 and found that almost all of them included the development of an energy plan and the training of staff, while less than half included an onsite energy manager or support for EMIS hardware and software.[9] CEE also defines the minimum elements necessary to deliver a SEM program effectively.[10] The fundamental process for SEM programs is the assessment of current management practices, followed by the implementation of a “Plan, Do, Check, Act” continual improvement framework for energy use.

SEM savings are typically calculated by comparing projected and actual energy usage. The projected usage is based on a regression model designed to accurately reflect energy use at the industrial process or whole building level for that particular customer. A year or more of baseline operational usage data is used to create the model, which is then tested and calibrated to ensure it accurately represents relevant energy use. The regression model must take into account all relevant factors that drive energy use, such as production, occupancy, and weather variables. It may make sense to have one model for electric energy use and one for thermal energy use. The regression model must also be statistically tested for relevance and accuracy. Once created, the regression model can be used to model the baseline usage. The baseline represents how much energy would have been used absent energy management changes or capital projects.

Comparative analysis between the baseline regression model and actual consumption is used to identify both total savings and the rate of savings. When actual use is less than modeled consumption, this indicates that energy has been saved. In Figure 3 below, the actual energy consumption is shown in green and drops below the blue baseline energy consumption, demonstrating that energy savings are occurring. The cumulative monetary savings are shown by the magenta line. An inflection point in the magenta savings line that results in a shallower slope indicates a decreased rate of savings and is cause for investigation so that corrective action can be taken. An inflection point resulting in a steeper savings slope shows that savings are accumulating at a faster rate; this can be an indicator or confirmation of a positive change. To avoid double counting, any savings associated with capital energy efficiency projects are subtracted from SEM savings as calculated by the model and attributed to regular C&I programs; the remainder are counted as the SEM program savings. Program costs for operational and behavior SEM savings are also tracked separately from capital projects.

[7] Data from CEE’s survey of SEM programs and pilots as of October 2015
[8] http://aceee.org/sites/default/files/publications/researchreports/u1507.pdf
[9] Ibíd.
[10] http://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf

### Figure 3 Cumulative Savings Summation Chart[11]




The model should be updated if conditions change due to scheduling, production volume changes, new construction, or any other reason such that the model is no longer accurate.  If there are changes that necessitate the creation of a new model, there are several options as shown in the Figure 4. The table looks at two parameters: plant conditions and SEM practices. Plant conditions refers to changes either physically at the plant or with respect to production, and essentially asks if the changes are minor or major. SEM practices refer to how equipment is operated with respect to the standard operating procedures and set points. If prior standard operating procedures and set points have been rendered obsolete by the change, then it is generally best practice to start over from scratch. If the operating procedures and set points are still relevant, then it may be possible to carry savings realized before or during the change through to the new model.

While some changes may be unanticipated, most large customers plan major changes well in advance, so it is important to ask customers enrolling in an SEM program about any planned changes that may significantly impact energy use.

[11] Source: Cascade Energy Engineering

**Figure 4 Matrix of Options when Establishing a New Baseline Model**[12]

| | | Durability of SEM Practices<br>(e.g. standard operating procedures and conditions SOPs/SOCs, set points, maintenance) | |
|---|---|---|---|
| | | **Largely Persistent** | **Generally Rendered Obsolete** |
| **Plant Conditions** | New conditions similar or overlapping<br><br>(e.g. new product added, running at higher capacity) | An option exists to build a model using both baseline period and treatment period data, and apply indicator variables to code for the impact of the static change as well as the SEM intervention. This method is described in a NEEA-sponsored paper.[13]<br><br>The 'back-casting' approach described in the SEP M&V protocol is another option. | Create new baseline on current process. Savings are zeroed out, but plant has an opportunity to achieve new savings. |
| | New conditions significantly change plant's energy consuming characteristics<br><br>(e.g. entirely new production line, large-scale construction) | Create new baseline on current process. If model was detecting savings prior to the static change, all or a portion of the savings may be carried over as a constant in the new model, subject to physical inspection of the SEM measures/practices.<br><br>(e.g. are energy saving SOCs/SOPs still in place and being followed) | Create new baseline on current process. Savings are zeroed out, but plant has an opportunity to achieve new savings. |

Strategic Energy Management programs can overcome many barriers to saving energy, but because of the work and costs involved, they require a customer of a certain sophistication and size to ensure the program is successful and cost effective. The SEM programs in the Pacific Northwest have the longest track record with large industrial customers. To be considered, customers usually must use at least 4 million kWh annually, although new SEM programs have been launched specifically to work with smaller customers, down to 750,000 kWh annual usage. While smaller customers have successfully and cost effectively participated in SEM programs, it makes sense to start with the largest customers and work down in size. Massachusetts has about 300 accounts that use 10 million kWh or more annually, and the industrial customers within this pool would be the best place to start.[14] There is another group of almost 400 accounts that use between 5 million and 10 million kWh that could also be good candidates. Together, these two groups of customers have a good track record with the existing programs, with 50% of them participating in 2015.

Some customers may want to pursue ISO 50001 certification to document the elements of energy management in a formal way or to pursue Superior Energy Management certification in order to gain recognition. ISO 50001 has progressed most rapidly in Germany, where companies that obtain ISO 50001 certification are exempt from some taxes.[15] ISO 50001 certification requires significant time and investment, and really only makes sense for the largest customers who have a strong interest. A study of nine facilities by Lawrence Berkley Labs found that the average cost for customers to get ISO 50001 certified and participate in the Superior Energy Performance (SEP) program was $319,000. Energy savings resulting from this investment for companies that used at least 13 million kWh and 13,500 therms annually resulted in an average payback of 1.7 years.[16]

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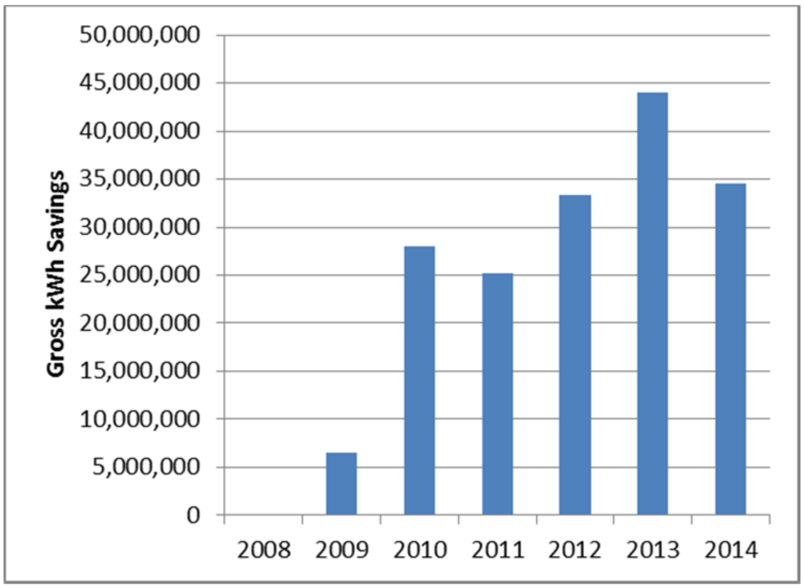
[12] Source: Cascade Energy Engineering
[13] http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/94789/ESL-IE-11-05-13.pdf?sequence=1%20%20
[14] Draft 2014 Base Customer profile Table 4-28 page 75
[15] As of 2014, roughly half of all of the ISO 50001-certified companies in the world, about 3,000 companies, were located in Germany. http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/files/documents/events/de_-_jrc_workshopenergyaudits_madrid_20140320_fleiter.pdf
[16] The LBNL study uses .27 TBTUs of source energy use as a threshold. The kWh and therm figures presented assume a 50/50 split between electrical use and gas use, and a 3:1 conversion from source to site usage for electricity.

The US DOE has developed a self-guided ISO 50001 Ready Navigator online tool to help customers implement the ISO 50001 energy management system.[17] The existence of this online tool and a companion regression analysis tool[18] will make it easier for customers to realize the benefits of the established structure of ISO 50001. While the DOE would like to see customers progress past the "Ready" stage to become ISO 50001 certified, and eventually be recognized through the SEP program, certification is not a requirement, and customers can realize most of the benefits of ISO 50001 without formal certification. Efficiency Vermont plans to make use of the ISO 50001 Ready Navigator tool in order to standardize service to their customers, regardless of whether or not the customer wants to actually go through the time and expense of becoming certified. If adopted widely, the usage of ISO 50001 as the basis for SEM programs could provide a standard approach for Program Administrators and customers with locations in multiple states.

The potential for savings from SEM programs is significant. Energy Trust of Oregon claimed a peak annual savings from a suite of SEM programs of over 44 million kWh in 2013. Gross savings are defined as pre-verification savings. Claimed electric net savings are actually higher because there are no free-riders and evaluations have increased the realization rate to 107%.[19] [20] These are operations and maintenance (O&M) savings only, as capital project savings are tracked separately. Energy Trust claims a three year measure life and offers $0.02 per kWh and $0.20 per therm in incentives for O&M SEM savings.

**Figure 5 Energy Trust of Oregon SEM Gross Annual Savings in kWh[21]**

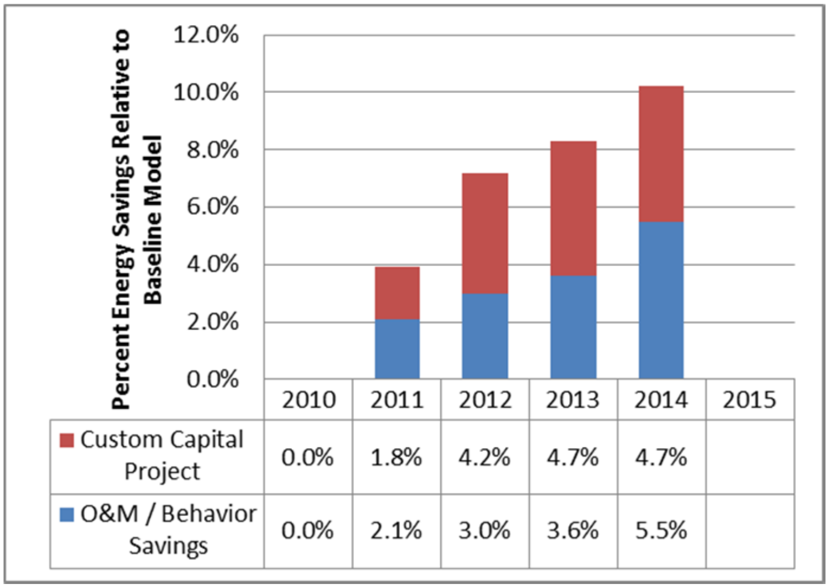



Bonneville Power Administration has also seen significant savings from their Energy Smart Industrial program. The program has three SEM tracks: funding for Energy Project Managers, High Performance Energy Management (HPEM) which uses a cohort approach, and the Track and Tune program discussed in the EMIS section of this memo which works with customers individually. As shown in Figure 6, HPEM O&M savings from the first cohort of 13 customers increase over time from 2.1% of total usage the first year to 5.5% in the fourth year of a five year program. In addition, Figure 6 also shows the effect of SEM on capital projects, which increase in savings from 1.8% to 4.7% of usage in the fourth year. Because SEM represents a deeper level of engagement and provides proof of savings, it drives businesses to identify and complete more capital projects. Total savings from the first BPA SEM cohort, from both O&M and capital projects identified through SEM, totaled 25,100 million

[17] https://navigator.industrialenergytools.com/
[18] https://qest.industrialenergytools.com/
[19] http://assets.energytrust.org/api/assets/reports/PE_Impact_Eval_2009-11.pdf page 5-15
[20] Ibid, Oregon Energy Trust's SEM gas realization rate is 99%
[21] Table from JP Batmale, Program Manager at Energy Trust of Oregon

kWh in 2014. We can use this number to estimate O&M savings, which increase from 6,600 MWh in the first year to 13,500 MWh of savings in year four. BPA offers incentives of $0.025 per kWh for operations and maintenance savings. Capital projects are incentivized through the regular programs.

**Figure 6 Bonneville Power Administration High Performance Energy Management Cohort 1 Annual Savings**




### Estimated Potential Savings in Massachusetts

The EEAC Consultant Team has estimated the potential savings from a SEM program in Massachusetts. Assuming a cohort size of ten customers and the recruitment of one cohort per year for ten years results in a need for 100 participants from the identified pool of 685 customers of sufficient usage size. The rate of savings per year is assumed to match the BPA Operations and Maintenance/Behavior-Based savings percentages shown in Figure 6. The analysis assumed an additional 0.5% savings in year 5 over the reported 4 year BPA results for a total reduction in energy use from Operations and Maintenance/Behavior of 6.0%. The analysis also assumed a mix of customer sizes in each cohort, but with a minimum annual usage of 5 million kWh for the smallest customers. The example assumes an average customer usage of 22.9 million kWh annually, which is slightly larger than the BPA average customer size in their Cohort 1. The example cohort composition is shown below.

**Figure 7 Massachusetts Cohort Composition Example**

| Usage Size Category (millions of kWh) | Number of Billed Customers In Massachusetts in 2014[22] | Assumed Number of Customers per Cohort |
|---|---|---|
| **5.0 – 9.0** | 386 | 4 |
| **10 to 25** | 231 | 3 |
| **25 – 50** | 58 | 2 |
| **> 50** | 10 | 1 |
| **Totals** | 685 | 10 |

[22] Draft 2014 Base Customer profile Table 4-28 page 75

Figure 8 shows an estimate of the amount of savings potential in Massachusetts based on the following assumptions:

- One cohort is recruited each year consisting of the mix of customer sizes outlined in Figure 7
- Annual Savings are claimed for each year
- Lifetime savings are claimed using a one year measure life for the first four years, and a ten year measure life at the end of the customer commitment in year five[23]

**Figure 8 Massachusetts Estimated Achievable SEM Savings in GWh**

| Cohort | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | | | | | | |
| 2 | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | | | | | |
| 3 | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | | | | |
| 4 | | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | | | |
| 5 | | | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | | |
| 6 | | | | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | | |
| 7 | | | | | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 | |
| 8 | | | | | | | | 4.81 | 6.88 | 8.25 | 12.61 | 13.75 |
| 9 | | | | | | | | | 4.81 | 6.88 | 8.25 | 12.61 |
| 10 | | | | | | | | | | 4.81 | 6.88 | 8.25 |
| Sum of Annual GWh Savings | 4.81 | 11.69 | 19.94 | 32.55 | 46.30 | 46.30 | 46.30 | 46.30 | 46.30 | 46.30 | 41.49 | 34.61 |
| Lifetime GWh | 4.81 | 11.69 | 19.94 | 32.55 | 170.08 | 170.08 | 170.08 | 170.08 | 170.08 | 170.08 | 165.26 | 158.39 |

[23] Our potential estimate adopts the approach of the BPA High Performance Energy Management SEM program, which assumes a measure life of one year for each of the first four years of participation, but ten years for the annual savings claimed in year five. The reasoning behind the ten year measure life for the savings acquired in year five is that the savings are assumed to be institutionalized at that point. By comparison, Oregon's industrial SEM program engages with the customer for one year, calculates savings at the end of that year, and claims a three year measure life.

| Cohort | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total MWh |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | | | | | | 46.3 |
| 2 | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | | | | | 46.3 |
| 3 | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | | | | 46.3 |
| 4 | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | | | 46.3 |
| 5 | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | | 46.3 |
| 6 | | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | | 46.3 |
| 7 | | | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | | 46.3 |
| 8 | | | | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | | 46.3 |
| 9 | | | | | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | | 46.3 |
| 10 | | | | | | | | | | 4.8 | 6.9 | 8.3 | 12.6 | 13.8 | 46.3 |
| Sum of Annual GWh Savings | 4.8 | 11.7 | 19.9 | 32.5 | 46.3 | 46.3 | 46.3 | 46.3 | 46.3 | 46.3 | 41.5 | 34.6 | 26.4 | 13.8 | 463 |
| Lifetime GWh | 4.8 | 11.7 | 19.9 | 32.5 | 170.1 | 170.1 | 170.1 | 170.1 | 170.1 | 170.1 | 165.3 | 158.4 | 150.1 | 137.5 | 1,701 |

Figure 8 shows that for each cohort, incremental annual savings increase for each year of participation, reaching a maximum in year five. Savings from each cohort accumulate, reaching a total annual savings of 46.3 GWh in year five. This rate of savings could be maintained as long as new cohorts of sufficient size could be recruited. In the example above, ten cohorts are shown at the rate of one cohort per year, although it may be possible to recruit two or more cohorts in a given year. There may also be more than 100 willing participants. However, after ten cohorts, the average size of the customers must decline due to limited availability of the largest customers and so the average savings per cohort would probably decline.

For context, the estimated 46.3 GWh of annual savings would represent 5.7% of the annual 2018 C&I goal; the 170.1 GWh lifetime savings is equal to 1.8% of the 2018 lifetime C&I goal. However, it takes five years to reach that level of savings if there is only one cohort per year. Therefore, the earlier SEM programs are implemented in Massachusetts, the sooner appreciable savings can be realized. In addition, offering a SEM program to their largest customers will increase the perceived value of the PAs and the efficiency programs, which is important as program costs and goals continue to rise.

Energy Trust of Oregon and Consultant experience with Efficiency Vermont has provided some input with respect to the costs associated with SEM programs. Below are the estimated costs associated with the first and subsequent years of running and incentivizing a SEM program, including cost shares for meters/EMIS and software for the first year. No additional costs are expected for meters after the first year, but it is assumed that the customer would take over the cost of the software after the first year. Incentives are estimated at $0.02/kWh, which is typical in the Pacific Northwest. The resulting costs per annual kWh range from a high of $0.23/kWh the first year to $0.03/kWh the fifth year, with an average cost of $0.06/kWh. These assumptions are for O&M savings only; capital projects are assumed to be addressed through the regular retrofit programs.

**Figure 9 Estimated Costs per Cohort of 10 Customers**

| 10 Customers/Cohort | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Average |
|---|---|---|---|---|---|---|
| Customer Engagement | $500,000 | $200,000 | $200,000 | $200,000 | $200,000 | $260,000 |
| Metering Cost Share | $500,000 | | | | | |
| Software License Cost Share | $25,000 | | | | | |
| Incentive at $0.02/kWh | $96,270 | $137,529 | $165,035 | $252,137 | $275,058 | $185,206 |
| Estimated Total Costs | $1,121,270 | $337,529 | $365,035 | $452,137 | $475,058 | $550,206 |
| Annual Savings (GWh) | 4.81 | 6.88 | 8.25 | 12.6 | 13.8 | 9.26 |
| Cost per Annual kWh | $0.23 | $0.05 | $0.04 | $0.04 | $0.03 | $0.06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Measure Life** | 1 | 1 | 1 | 1 | 10 | 3 |
| **Lifetime Savings (GWh)** | 4.813 | 6.88 | 8.25 | 12.6 | 138 | 34.0 |
| **Cost per Lifetime kWh** | $0.23 | $0.05 | $0.04 | $0.04 | $0.03 | $0.07 |

SEM programs should also include a gas component. The Consultants have not tried to quantify potential gas savings, but if the SEM program were to also include additional gas incentives for documented gas savings, these savings would likely be highly cost-effective by leveraging the funding for the electric savings. Oregon offers $0.20 per therm for SEM gas savings.

### Strategic Energy Management Process

To better understand SEM programs, it is helpful to discuss the processes of implementing both a SEM program and how to establish SEM at a customer's facility. Efficiency program administrators typically contract SEM programs to an experienced outside implementer who coordinates with the PA and works with the customers directly. CEE has established a set of minimum elements to define what a Strategic Energy Management program should include.[24] At the customer level, most efficiency programs and the ISO 50001 standard use a similar process, built around the Plan, Do, Check, Act cycle, to establish and maintain an energy management system. The steps used to put energy management into place with a customer are described below.

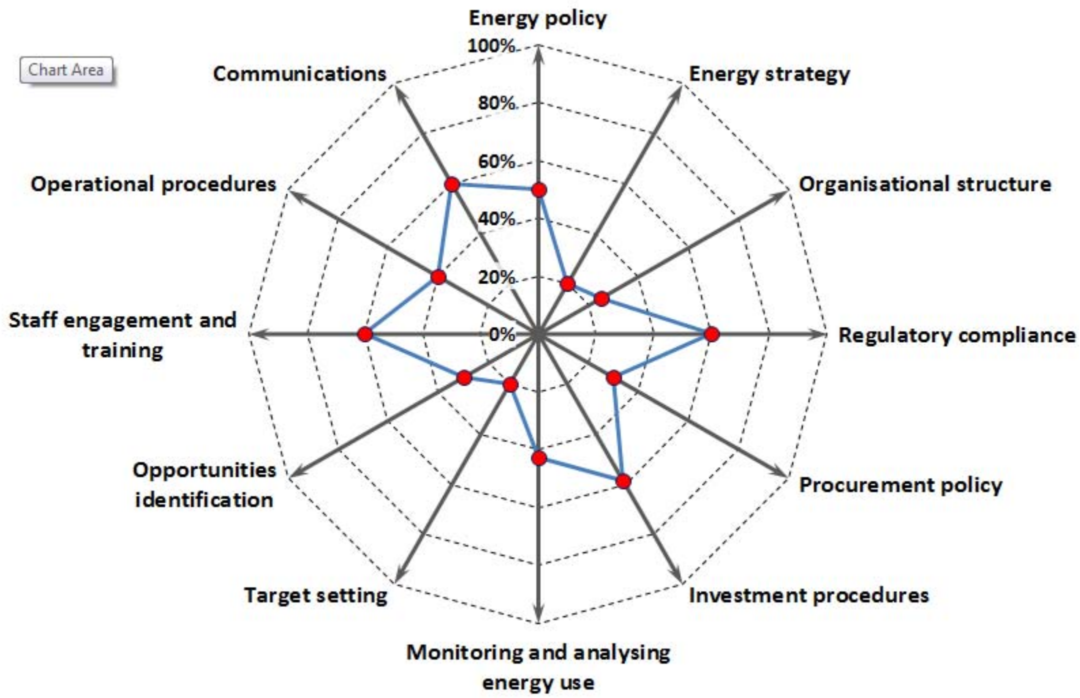
- → Perform a self-assessment to determine to what extent energy is already being managed
- → Set the baseline of energy performance from which to measure future improvement
- → Plan by setting goals and outline a set of steps to achieve the goals
- → Do implement the plan by taking the necessary steps to meet the goal
- → Check to make sure the plan is working
- → Act to make changes to continue improvement

#### 1. Self-Assessment

Like a SEMP/MOU agreement, a SEM program must have the full support of senior management to be successful. Once this vital step has been achieved, the next step is to complete a self-assessment to evaluate the organization for gaps or room for improvement in energy management. The self-assessment is often quite eye opening for the customer. There are several publically available tools to help with the assessment. These include the Carbon Trust Energy Management Self-Assessment tool, and a pair of tools from the EPA.[25]

### Carbon Trust Self-Assessment Tool Output Radar Chart

[24] http://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf
[25] http://www.carbontrust.com/resources/tools/energy-management-self-assessment-tool




Using the Carbon Trust Tool, customers self-rank their status with respect to having an established Energy Policy, writing and communicating an Energy Strategy, and so on. For example, a customer may have a written energy policy, but it may not have been updated for some time, and perhaps not everyone knows about it. Thus, there is some room for improvement in this area of energy management. The radar chart above provides a map for the customer to follow, until they believe they are at 100% in each category. The EPA also offers a pair of matrices that allow a customer to self-evaluate a facility or an energy program.[26,27] The EPA matrices are very similar to the Carbon Trust tool in concept, but do not have the nice visual output of the radar chart.

### 2. Set the Baseline

SEM programs provide a rigorous methodology to set a baseline, against which future usage can be compared to measure savings. Setting a baseline typically involves creating a regression model that accounts for variables that affect energy use such as outdoor temperature and humidity, production levels, and other relevant factors. The model should be tested for relevance, in that it must be statistically accurate. It may be challenging to understand and account for the factors that really drive energy use. It is not uncommon for the customer to have erroneous information about where energy is being consumed, or to have a poor understanding of the drivers of energy consumption in their facility. It may also be necessary to install one or more sub-meters in order to accurately track the energy use relevant to the processes that are being managed, or to meter the process itself. While the output of most processes is measured at some point during production, it is necessary for the measurement to coincide with energy use for energy management to be most effective. In other words, if a product is produced but not counted until it ships a month later, then it is hard to match production to energy use in order to manage it.

### 3. Plan - Set Goals and Develop an Energy Management Plan

A key element of the process is to establish energy goals and measure progress towards those goals. Both the goal and progress toward the goal should be communicated to all employees, and everyone should be instructed of the role they play in energy use and how they can contribute to meeting the goal. The importance of meeting or beating the goals should matter to everyone. Just as a culture of quality and safety is emphasized at most

[26] https://www.energystar.gov/buildings/tools-and-resources/facility-energy-assessment-matrix-excel
[27] https://www.energystar.gov/sites/default/files/buildings/tools/Energy_Program_Assessment_Matrix_9032013.xls

businesses, a culture of wise energy use is created and supported through the implementation of Energy Management Plan.

**4. Do - Implement the Energy Management Plan**

It is often the case that energy use is seen as the responsibility of maintenance or the energy manager. Implementation of the Energy Management Plan must be everyone's responsibility. Everyone has a role to play, but to participate, people need to know what to do. Training is necessary for all employees as to their role in implementing the plan. This includes procurement, as the equipment bought for use at the facility and the raw materials coming into the facility can have a big energy impact. If outside personnel have access to the facility, then they should be informed of the goals and coached as to their role in energy use and management as well.

**5. Check - Track Energy Use versus the Baseline**

It is important to implement a system to regularly monitor, track, and report on energy use. Ideally, monitoring should happen in real time so that corrections can be made immediately should something go wrong. For example, an equipment operator can make adjustments if an industrial process is using more energy than expected, or office occupants can close shades if sunlight is heating up a space and increasing air conditioning use. Real time monitoring can also highlight very low energy use, which can then be investigated and hopefully reproduced. However, monitoring energy use can be meaningless unless there is the proper context. When energy use is compared against the established baseline, a customer can see how they compare to the model, and strive to beat the model, which is based on the average previous performance of the company. An example of this is shown in Figure 3 above, the cumulative summation (CUSUM) of savings graph.

Ideally, the CUSUM shows an increase in savings as opposed to a decrease, but CUSUMs may start out as negative if energy use is increasing. Of particular interest are inflection points in the CUSUM chart that indicate there was a change in the rate of energy use versus the baseline. These inflection points, where changes in the slope of the chart indicates the rate of savings increase or decrease, can highlight either good or bad changes, thus leading to an increased understanding of the process. The numbered boxes represent activities aimed at reducing energy use, and may provide both an explanation and documentation for inflection points and increased savings.

**6. Act**

Make changes and improvements to the process based on the findings. Depending on the frequency of checking, taking action could be continuous, hourly, daily, weekly, or monthly. At least once per year the baseline model should be evaluated for continued relevance and accuracy, and a report should be made to track progress towards goals.

The Plan, Do, Check, Act steps are a recurring cycle. Customers should report results to senior management at least annually, and create or update the plan to start the cycle again.

### Equipment and Strategies to Better Enable Energy Management

Strategic Energy Management is more easily accomplished with timely data and the resources and context to understand what the data means. Appendix A discusses the use of sub-meters and energy management information systems to collect and process data in order to make it actionable.

Appendix A also discusses a number of strategies to make use of data in order to effect change. For example, energy managers are dedicated people whose job it is to pay attention to energy use, to look for ways to improve energy use, and to implement changes. Commissioning is a practice that ensures equipment runs optimally as designed. Behavior programs can engage facility occupants in productive ways to save energy and change the company culture to include energy consciousness. These are all methods that can be included as elements of a larger strategic energy management program, or can be used independently.

## CONCLUSION

Meeting the goals in the 2016-2018 Three Year Plan and beyond will require savings from new tools and methods. This memo has provided recommendations to both enhance existing approaches and to investigate and implement new tactics in the pursuit of increased savings from the C&I sector. The tools and methods highlighted in this memo go beyond traditional incentives-for-equipment programs and are intended to:

→ Make energy use more visible (submeters, EMIS)

→ Provide context for understanding and managing energy use (EMIS, SEM, behavior)

→ Provide a structured approach for managing energy use (SEM, retrocommissioning, behavior)

→ Make optimization of energy use an institutionalized part of the business culture (SEM, behavior)

→ Document and claim savings as the result of O&M changes (EMIS, SEM, RCx)

Strategic Energy Management programs offer an integrated way to engage customers and claim operational and behavioral savings by improving energy productivity. Improving energy productivity both saves energy and helps businesses be more competitive. SEM programs represent a significant potential new source of operations and maintenance savings for the Massachusetts Program Administrators. Because SEM requires a deeper level of engagement with customer management and personnel, it can also drive increased savings from traditional capital projects.

In order to provide consistency across states and energy efficiency programs, there is the opportunity for programs in the northeast to agree on the use of the ISO 50001 standard as the common fundamental structure of strategic energy management. This is not to advocate for universal ISO 50001 certification, which may not be the right choice for all customers, but the ISO 50001 Ready Navigator tool makes this international standard much more accessible to everyone.

The following table links barriers to desired outcomes, and lists potential tools and solutions to overcome the barriers.

**. C&I Savings Barriers and Related SEM Opportunities**

| Barrier | Desired Outcome | Tools/Methods to Achieve Outcome |
|---|---|---|
| Lack of sub-meters limits understanding of when and where energy is used | Make energy use more visible | Meters, energy management information systems (EMIS) |
| Limited understanding of drivers that cause variations in energy use associated with output | Provide context for understanding and managing energy use | EMIS, SEM, ISO 50001 |
| Many business do not manage energy use, create an energy plan, or set energy goals | Provide a structured approach for managing energy use | SEM, retrocommissioning (RCx), behavior programs, ISO 50001 |
| Most businesses are focused primarily on their core business, with energy use a secondary consideration | Make optimization of energy use an institutionalized part of the business culture, like quality or safety | SEM, behavior programs, ongoing commissioning, ISO 50001 |
| Lack of targeting and tracking operations and behavior savings by current programs | Document and claim savings as the result of operations or behavior changes | EMIS, SEM, RCx, ISO 50001 |

## EQUIPMENT THAT SUPPORTS ENERGY PRODUCTIVITY

### Sub-Meters

One challenge to measuring performance-based energy use and savings is a lack of sub-meters installed in C&I buildings. Utility-provided meters measure energy use for a part of a building, an entire building, or a whole campus for the purpose of charging for the energy consumed. Utility meter systems may also include interval meters to enable billing for peak demand. Utility meters are held to very high standards for accuracy because they are the primary tool for determining the proper customer charges. While utility meters are useful for determining total energy use, they cannot determine where energy is being used within the customer's home or facility. In some cases, hospitals, manufacturing facilities, or even campuses with multiple buildings are all measured by a single utility meter, which makes it impossible to tell where most of the energy is being consumed. Sub-meters installed by customers behind the utility meter provide discrete information to better understand energy use and allow for energy management.

Massachusetts Program Administrators (PA) do not typically offer incentives or rebates for permanent sub-meters except in cases when a customer has signed a MOU with the PA and there is a good chance that installing a sub-meter will lead directly to savings. On the other hand, a PA's Technical Assistance vendor would typically install temporary sub-meters to identify baseline energy use for a piece of equipment or process from which to assess energy savings for a proposed project.

The value of sub-metering electric consumption can be explained by analogy to automotive fuel consumption. Imagine if you were limited to knowing your average speed, total distance driven, and gasoline consumed at the end of each month. It would be even worse if these data were only reported in aggregate for all the cars in your family. Such information would not be very useful for making decisions about how to reduce fuel consumption while driving. Facility managers face this problem when energy use is only reported for a campus or whole facility on a monthly basis. As car manufacturers have recognized, real time feedback on fuel-economy is most effective for causing behavior and operational change.

Most utility programs do not provide incentives for sub-meters directly because, unlike most measures, meters do not directly save energy. However, sub-meters can save energy indirectly and highlight opportunities to save energy using more conventional measures or through operational or behavioral changes. A common example of indirect savings is when a commercial or multi-family residential building that was previously metered with one master meter becomes sub-metered. By installing sub-meters to measure each tenant's actual usage, each tenant can be billed for what their actual usage. This often reduces energy consumption because high energy users see their bills increase and therefore make changes to try to reduce their costs. The following table estimates the potential for energy savings based on progressively more intensive energy management and occupant engagement.

**Figure 10 Estimated Sub-Meter Savings Ranges**[28]

| Action | Observed Savings |
| --- | --- |
| Installation of meters | *0 – 2%*<br>Initial impact, but savings will not persist |
| Bill allocation only | *2.5 – 5%*<br>Improved occupant awareness |
| Building tune-up and load management | *5 – 15%*<br>Improved awareness, identification of simple operations and maintenance improvements, and managing demand loads per electric rate schedules |
| Ongoing commissioning | *15 – 45%*<br>Improved awareness, ongoing identification of simple operations and maintenance improvements, and continuing management attention |

Electric meters can be categorized in to two general groups, older style electromechanical meters and advanced meters. Electromechanical utility meters always measure total energy consumed (usually in kilowatt-hours), but may also measure average peak demand in kilowatts (kW), usually over a fifteen minute interval. A person must read these meters in order to capture their data. Smart or advanced meters are typically characterized as electronic meters that can be networked; can store data; and can often measure other parameters such as voltage, current, frequency, and power factor. Advanced meters can report directly to a building or energy management system and can therefore provide real-time feedback on energy use. Advanced meters typically cost between $1,000 to $2,500 installed, depending on the quantity, features and capabilities.[29] The US government and a coalition of over 200 commercial building sector partners have issued a challenge to meter manufacturers to develop a meter with a cost of $100 to help drive acceptance and insight into energy use.[30]The DOE estimates that if meters reduced energy use in commercial buildings by at least 2%, it would represent a savings of $1.7 billion nationwide.

Gas and fluid meters for natural gas, compressed air, and water can be mechanical or electronic. Both types of meters may provide output data that can be tied into an energy management or reporting system.

Ideally, a facility would have sub-meters on all building level energy services and on significant energy uses to provide real time feedback to facility personnel, equipment operators, and facility occupants so they could know what was happening while it was happening. In order to fully utilize the data, additional software programming is required to display performance metrics (e.g., targeted energy use vs. actual energy use) and provide alarms as energy consumption hits certain thresholds. Sub-meters that feed data to software, which in turn provide some analysis and context make up an Energy Management Information System; these are discussed later in this memo. Because of the costs of sub-meters and software, scale is important to consider. The costs should be offset by the benefits and savings within a reasonable time frame. The Government Services Agency has provided guidance about evaluating the business case for sub-meters by looking at simple payback, net present value, and internal rate of return.[31]

[28] DOE 2006
http://www.gsa.gov/portal/mediaId/156791/fileName/Energy_Submetering_Finance_Paper_Knetwork_2012_11_269(508).action
[29] Estimated costs do not include any shutdown costs that may be incurred by the customer as the result of temporarily turning off the electricity in order to install the mater.
[30] http://energy.gov/articles/federal-and-industry-partners-issue-challenge-manufacturers
[31] http://www.gsa.gov/portal/mediaId/156791/fileName/Energy_Submetering_Finance_Paper_Knetwork_2012_11_269(508).action

Sub-meters can play a role in energy management, continuous commissioning, verification of operations, predictive maintenance, and fault detection and diagnostics (FDD).[32] Analysis of information from sub-meters can directly lead to energy savings by highlighting opportunities for reducing energy use, by sounding an alarm when operations are out of specifications, or by illustrating when maintenance is required. In some cases, these data are already used in the PAs' Pay-For-Performance RCx and MBCx offerings. Of course, information must have context to be useful. Context can be provided by developing performance metrics such as a target chiller plant efficiency (kW/ton of cooling) or energy use per unit of production. Current performance should be displayed directly against the target value to allow operators and energy managers to recognize and respond to deficiencies as well as identify opportunities to increase energy productivity over time. Baseline performance levels also provide useful context as discussed under the Strategic Energy Management section later in this memo.

There are two recommendations for improving energy productivity in Massachusetts by increasing the use of sub-metering:

**RECOMMENDATIONS**

→ **Develop the capability and protocols for supporting sub-metering for a wide variety of customers beyond MOU customers.** Installing a sub-meter can provide valuable insight into energy usage that can unlock significant savings. Consider sharing the costs advanced sub-meters to be used for retro-commissioning, industrial process, or campus applications on a case by case basis for non-MOU customers. Consider including sub-metering in the project package covered by the incentive, whether a Technical Assistance study or equipment incentive. Make the incentive money conditional on PA access to the sub-meter data for measurement and verification purposes.[33] Installing a permanent sub-meter instead of a temporary meter for commissioning or measurement & verification purposes can be cost effective in the long run, and installing a permanent meter instead of a temporary one is less disruptive in that the power must be shut off only once for installation.

→ **Require a minimum level of metering as a prerequisite for incentives in whole building new construction programs.** Require sub-meters and an EMIS for major end uses in new construction projects above a certain size/incentive threshold.

## Energy Management Information Systems

Energy Management Information Systems (EMIS) are commonly defined as software tools that "store, analyze, and display energy use or building systems data."[34] Meters collect these data and are therefore often considered a part of EMIS. Note that EMIS is distinct from a building or process Energy Management System (EMS) in that an EMIS analyzes and reports information, but does not control equipment. An EMS does control equipment and is eligible for incentives in Massachusetts because it can generate measureable savings. EMIS hardware and software are not currently eligible for incentives because although they enable energy intelligence, they do not directly save energy. An EMIS can be used to identify and track operational and behavioral energy improvements (which can eventually result in savings), whereas an EMS automatically controls equipment according to its programming to save energy.

The Northwest Energy Efficiency Alliance (NEEA) published an inventory of available EMIS systems in 2013. The report took the perspective that these systems are useful for opportunity identification, occupant engagement, and as a supplement to measurement and verification (M&V) of energy efficiency savings.[35] The report also defines EMIS, explains its applications and use, provides examples of utility use to support efficiency programs, and identifies and lists commercially available offerings at the time. NEEA published a companion report in July of 2015 that updated the 2013 study and provides information that will help energy efficiency program administrators move forward in supporting EMIS with their customers.[36] This new report identifies and quantifies the potential

[32] Fault detection and diagnostics is software that generates alarms when key parameters reach a predetermined threshold level and provide information on the drivers behind the change.
[33] Access to data from PA incentivized sub-meters should be written into the Terms and Conditions for all projects.
[34] http://www.eeperformance.org/uploads/8/6/5/0/8650231/inventory_of_mv_applications.pdf
[35] Ibid
[36] http://neea.org/docs/default-source/reports/opportunities-for-action-on-industrial-energy-management-information-systems.pdf?sfvrsn=6

market for EMIS, estimates the penetration of the market, and outlines the value to customers. This report also identifies energy efficiency programs that are already supporting EMIS and the available incentives.

Some efficiency programs do provide incentives for EMIS. The Bonneville Power Administration (BPA) has an EMIS program called Track and Tune that is primarily focused on opportunities in refrigeration and pulp and paper industrial processes. This program co-funds meters and a software tracking system with a $50,000 ceiling. The program cost is typically around $16,000 per customer for hardware and software. Incentives are $0.0025 per kWh of operational and maintenance savings.[37]. BPA has realized 20,600 MWh in annual operations and maintenance savings from Track and Tune as of March 2014, with an expected additional 11,500 MWh in the pipeline for 2015.[38] Customers are required to make either a three or five year commitment. Lifetime savings are claimed as follows for the two options:

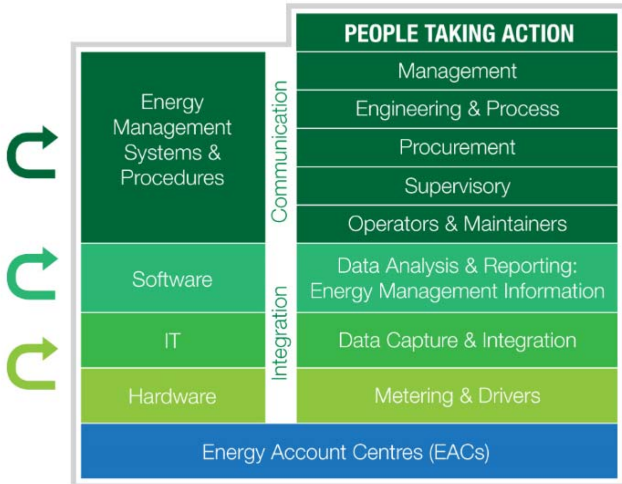
**Figure 11 BPA Track and Tune Program Lifetime savings**

| Savings Period | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 3 Year Period | 1 year | 1 year | 3 years | N/A | N/A |
| 5 Year Period | 1 year | 1 year | 1 year | 1 year | 6 years |

There have also been or are currently programs in Canada, specifically in New Brunswick and Nova Scotia, that have used assistance for meters and software as the basis for an energy management program referred to as an EMIS program. In these cases, Efficiency New Brunswick and Efficiency Nova Scotia recruit customers based on the perceived value of EMIS, which then becomes a Strategic Energy Management program. Efficiency Nova Scotia offers EMIS support, providing incentives for the installation of meters and software, in exchange for a commitment from the customer to manage and save energy through the use of the EMIS.[39] Like the BPA Track and Tune program, these EMIS programs work with customers on an individual basis as opposed to a cohort or group. The incentives for equipment, software, audits, and training typically represent a 50% share of total costs, which can exceed $100,000. The focus of the Nova Scotia EMIS program is to divide plant energy use into Energy Account Centers. An Energy Account Center could be a department or a process. Once identified and metered, each Energy Account Center is assigned to an appropriate manager within the facility whose job it is to monitor, manage, and reduce energy use and costs. The following graphic shows how meters feed data to software that provides information to people so that they can take action.[40]

[37] Call with BPA June 2, 2015
[38] https://cascadeenergy.com/wp-content/uploads/2015/05/4_BPA-ESI-Program-Overview1.pdf slide 12
[39] http://www.efficiencyns.ca/energy-solutions/energy-management-for-business/
[40] http://www.efficiencyns.ca/wp-content/uploads/2013/03/Emis2.jpg

**Figure 12 EMIS Account Center Illustration**




Similarly, Efficiency Vermont has offered to pay up to 75% of the cost for hardware and software to sub-meter a facility in order to facilitate the implementation of SEM. This offer includes the first year of the EMIS annual software subscription. Other program administrators that offer support for EMIS include Oregon Energy Trust, Bonneville Power Administration, Hydro Quebec, BC Hydro, Pacific Gas and Electric, and Ontario Power Authority.[41]

Massachusetts does not have an EMIS program offering at this time, but does offer incentives for sub-meters as part of SEMP/MOU agreements or substantial custom projects or customer engagements on a case by case basis. The PAs also offer a pay for performance MBCx incentive which motivates the customer to invest in EMIS in order to receive incentives on the demonstrated operational savings.

Below is a recommendation for improving energy productivity in Massachusetts though EMIS:

**RECOMMENDATION**

→ **Consider a formal EMIS approach for large customers (average annual usage of 5 million kWh or greater) who want to better manage their energy usage, but do not want to participate in a cohort with other customers**. EMIS incentives should be part of a structured approach to energy management with specific goals toward measured and claimable energy savings. Said another way, this is a SEM approach for a single customer as opposed to a cohort.

## STRATEGIES THAT SUPPORT ENERGY PRODUCTIVITY

There are a number of elements that can help improve energy productivity and should be considered for inclusion in the design of a SEM program.

### Energy Managers

Some program administrators help customers fund an energy manager at the customer's site. The size of the customer (with respect to energy usage) can determine if the energy manager is fully or partly funded and if the position of energy manager is full or part time. The energy manager may be an internal person who moves into the role or a new hire. It is also possible that one energy manager splits their time between multiple customers who share the cost of the salary and benefits with the program administrator.

National Grid has earmarked funds to cost-share project management as part of their Industrial Initiative. This

[41] http://neea.org/docs/default-source/reports/opportunities-for-action-on-industrial-energy-management-information-systems.pdf?sfvrsn=6 pages 18-20

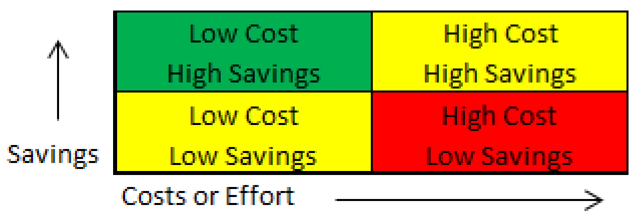
money can be used by the customer to hire either Leidos or another outside contractor to manage a specific energy efficiency project. While this approach is effective in completing identified and approved projects, it does not help to identify new projects or facilitate their approval by management.

Bonneville Power Administration's energy manager component offers to co-fund an energy manager up to their full salary, subject to a $250,000 cap.[42] The goal is for the energy manager to deliver at least 1 million kWh of annual savings each year, and the incentive is $0.025 per kWh. The energy manager has 3 months to develop an energy management plan, with funding guaranteed for 12 to 18 months. Customers must have an average demand of at least 3 MW to qualify. Bonneville currently subsidizes 31 energy managers who oversee 36 different facilities. Capital and O&M savings resulting from these managers totaled 47,300 MWh in 2013 and was projected to be another 50,000 MWh in 2014.[43]

## Kaizen Events

Kaizen is Japanese for "improvement" or "good change." It is used in business as a term that describes continuous improvement. A kaizen event is when one or more groups of people, with each group typically composed of a mix of both internal facility personnel and outsiders, tour a facility with an eye to finding opportunities for energy productivity improvement. Some SEM programs include kaizen events as part of the program, facilitated by the SEM contractor. The list of opportunities generated by the event should include behavioral, operational, maintenance, and capital improvements. Opportunities identified can be as simple as turning off equipment or as involved as a recommendation for a deeper study of a complex process. The list can then be evaluated and the findings sorted into different bins and prioritized for action. The following chart shows high-level bins that can be used to make a quick assessment. Low cost/high savings opportunities should probably be done first, followed by high cost/high savings and low cost/low/savings opportunities.

**Figure 13 Prioritization Matrix**




## Commissioning and Retro-Commissioning

Commissioning (Cx) and Retro-Commissioning (RCx) increase energy productivity by ensuring that the systems and programs necessary to optimize system performance are installed and operating correctly and that end users are trained in their operation. Commissioning is applied to new buildings and new systems (such as the upgrade of a legacy building control system) and should start during the design stage, continue through construction, and extend into the occupancy phase to ensure the building or system operates as the designers and owners intended. RCx is applied to existing buildings and assesses how the building is currently used, which is often different from the original design concept, and ensures that systems are optimized to meet current needs. The PAs currently include a commissioning component on larger new construction projects and claim only a portion of the savings until the commissioning is completed. In general the commissioning savings are not broken out separately from other new construction savings, so it is difficult to tell how much of an impact on program savings it may be having today.

The Massachusetts Program Administrators also offer retro-commissioning programs for existing buildings. Retro-commissioning for existing buildings can take the form of a one-time project or continuous monitoring based commissioning. Monitoring based commissioning involves checking on the performance of equipment on a regular basis; incentives are paid only for realized savings, rather than for predicted savings estimates. This type of program is called Pay for Performance. To qualify for the Pay for Performance incentives, the customer must

[42] http://aceee.org/sites/default/files/publications/researchreports/ie132.pdf
[43] https://cascadeenergy.com/wp-content/uploads/2015/05/4_BPA-ESI-Program-Overview1.pdf slide 10 Savings are provided in average MW reduction (aMW) which can be multiplied by 8760 hours to calculate annual MWh savings.

collect data for a year to demonstrate savings and agree to two years of additional monitoring and data collection.

Commissioning is critical to ensure that most of the approaches outlined above are installed and functioning properly to actually delivery energy savings. Below is a quick list of the intersection between commissioning and other strategies in this memo:

→ **Sub-meters**: Commissioning providers ensure that the right meter is correctly installed and that the outputs displayed are accurate. Typically, meters provide a low voltage or pulse output that software needs to translate to a numeric value. Often these programs are imperfect and offset factors are necessary and identified during the commissioning process. In addition, it is not uncommon for meters to be installed and for no one to have access to the data, or for the meter to be installed incorrectly. The commissioning provider should ensure that not only is the data accurate, but also that it is useful.

→ **EMIS**: The commissioning provider again helps ensure that the programming necessary to translate the data coming from measurement systems are translated into useful information for the building managers. This includes ensuring that the specifications developed by the designers are adequate to get a working system, that the proposed systems comply with the specs and the owner's needs, and that the installed system delivers the visual information and functionality required.

→ **Controls**: Commissioning providers should help the owners and operators define the necessary functionality and energy efficiency objectives through the development of the Owner's Project Requirements document at the project inception. Their role is then to ensure that the specified control systems and sequences are adequate to meet the owner's requirements and that the installed systems are consistent with the design. This work is slightly different for RCx where the provider may be specifying the changes to the existing programs and hardware and then verifying that the changes were implemented correctly to deliver the performance improvements.

The Consultant Team worked with the PAs in 2014 to produce a Retro-Commissioning Best Practices memorandum. The PAs have since put the findings of that memo into practice through a hospital retro-commissioning initiative. Hospitals that use at least 2 million kWh or 150,000 therms annually are eligible to participate with the following conditions: (1) hospitals must have access to funds to implement commissioning fixes within 12 months, and (2) there must be a designated "champion" at the hospital to manage the project. The PAs also address the recommendations of the memo in the 2016-2018 Three Year Plan.

The limitation of commissioning is that it typically involves a small group of facility people working in conjunction with an outside team of experts, so there is often little or no building occupant engagement or education. Most building occupants may not even know that retro-commissioning is in progress or may even work unintentionally against the RCx process. On the other hand, it is possible to perform commissioning in conjunction with behavior initiatives as part of an energy management approach. With everyone focused on the same goal, it should be easier to achieve deeper, lasting savings.

#### RECOMMENDATIONS

**Work to increase the effectiveness of commissioning with respect to contributing to timely and successful project completions.** Key considerations for commissioning new and existing buildings and systems for energy efficiency include:

→ Explicitly tie the commissioning scope to the energy efficiency measures. Some Cx/RCx providers do not have a strong background in energy efficiency. It is critical that their scope of work includes design review, testing and operator training for the specific energy efficiency measures for which savings are being claimed in addition to the more general scope of commissioning.

→ Raise the knowledge base and skill of commissioning providers by sponsoring more trainings. There is a high degree of variability in commissioning provider sophistication and the depth of service provided.

→ Encourage customers contracting for commissioning to include the following requirements in RFPS:

a. Indicate the hours per task and the person or job title and hourly rate associated with those hours. This will enable owners to better compare proposals. Commissioning is labor intensive. If an owner is commissioning a new laboratory, for example, it may be better to have more hours from a senior person on site to ensure the knowledge base is available to identify and resolve issues.

b. Include in construction contracts that 50% of the controls cost will be retained until successful commissioning. Because standard construction practice is to bill for components when they are installed it is not uncommon for the owner to pay for 90% of a controls system before it is programmed. Unfortunately, without programming, the control devices have minimal benefit to the owner. Because of the regional shortage of skilled controls programmers, control contractors often push out the programming of projects well beyond construction completion. This makes it difficult to complete verification of system operation through commissioning and increases the challenge in getting the programmer back to the site to rectify issues identified during the commissioning process.

→ **Include commissioning into a larger energy management effort that involves building occupants in a behavior program.**

## Behavior Programs

Behavior programs for residential customers have become a standard program offering in many jurisdictions including Massachusetts, but commercial behavior programs are less common and have had less reliable demonstrable savings. C&I behavior savings typically result from both changes in behavior by building occupants (tenants and workers) and changes made by facility personnel in building operations and maintenance.

A recent report completed for the EEAC and Massachusetts PAs entitled "Comprehensive Review of Behavior and Education Programs" discusses many residential programs, K-12 school oriented education programs, and some C&I behavior programs.[44] C&I behavior programs are distilled down into three types: Competitions, Building Energy Reports, and Workplace Engagement.

→ Competitions, such as between dormitories at a college or departments in an office, can save significant energy, but the competition is often short in duration and the savings may not be persistent once the competition ends.

→ Building Energy Reports, which are the equivalent to the standard residential programs, can be difficult to implement due to the variability of businesses, which results in a more limited pool of comparable partcipants for treatment and control groups. The treatment group recieves tips for saving energy and information about how they compare to other similar businesses. The control group recieves no information. The two groups are then compared and the difference in average energy usage is claimed as savings. C&I Business Energy Report programs have not proven to save very much energy as demonstrated by a recent PG&E program.[45] This randomized controlled trial program is reportedly only realizing savings of 0.3% for electricity and 0.1% for gas.[46]

→ Workplace engagement is often described as the implementation of a workplace culture that cares about energy use as much as safety or quality. Workplace Engagement Programs appear to be the most effective for realizing savings and have the potential for verifiable, claimable savings. Workplace engagement is often part of a larger effort to reduce energy use through capital projects and strategic energy management.

One successful workplace engagement program is Duke's Smart Energy in Offices program, which appears to be a viable, proven model to gather claimable savings.[47] The Smart Energy Now pilot of this program saw evaluated net savings of 6.2% (6.9% gross) of consumption in 64 of the largest office buildings in the Charlotte (North

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[44] http://ma-eeac.org/wordpress/wp-content/uploads/Comprehensive-Review-of-Behavior-and-Education-Programs.pdf
[45] http://www.pge.com/en/mybusiness/save/ber/index.page?WT.mc_id=Vanity_ber
[46] Navigant: Comprehensive Review of Behavior and Education Programs March 3, 2015
[47] http://smartenergyinoffices.com/

Carolina) Uptown area. These buildings represent over 20 million square feet of office space, 300 organizations, and 20,000 building occupants. The participating buildings represented 98% of the target market. The critical elements of the Smart Energy in Offices program appear to be as follows:[48]

- → Outreach to building owners to secure management commitment
- → Sub-meters that provide 15 minute usage information to publicly-accessible kiosks and a website
- → A universal goal of 5% energy reduction
- → Creation of an Energy Action Plan[49]
- → Recruitment of Energy Champions
- → A brainstorming session (kaizen event) in each building combined with training for the Energy Champions
- → A variety of outreach and engagement approaches, including games and competition between buildings
- → Sharing best practices among Energy Champions and facility personnel
- → Recognition of progresss in energy savings

There are additional examples of C&I workplace engagement behavior programs that have saved appreciable energy. Many of these programs have saved 4% of total energy or more, which is about double the normal rate of residential behavior savings programs. The table below is from an ACEEE report and identifies some of these successful C&I behavior programs.

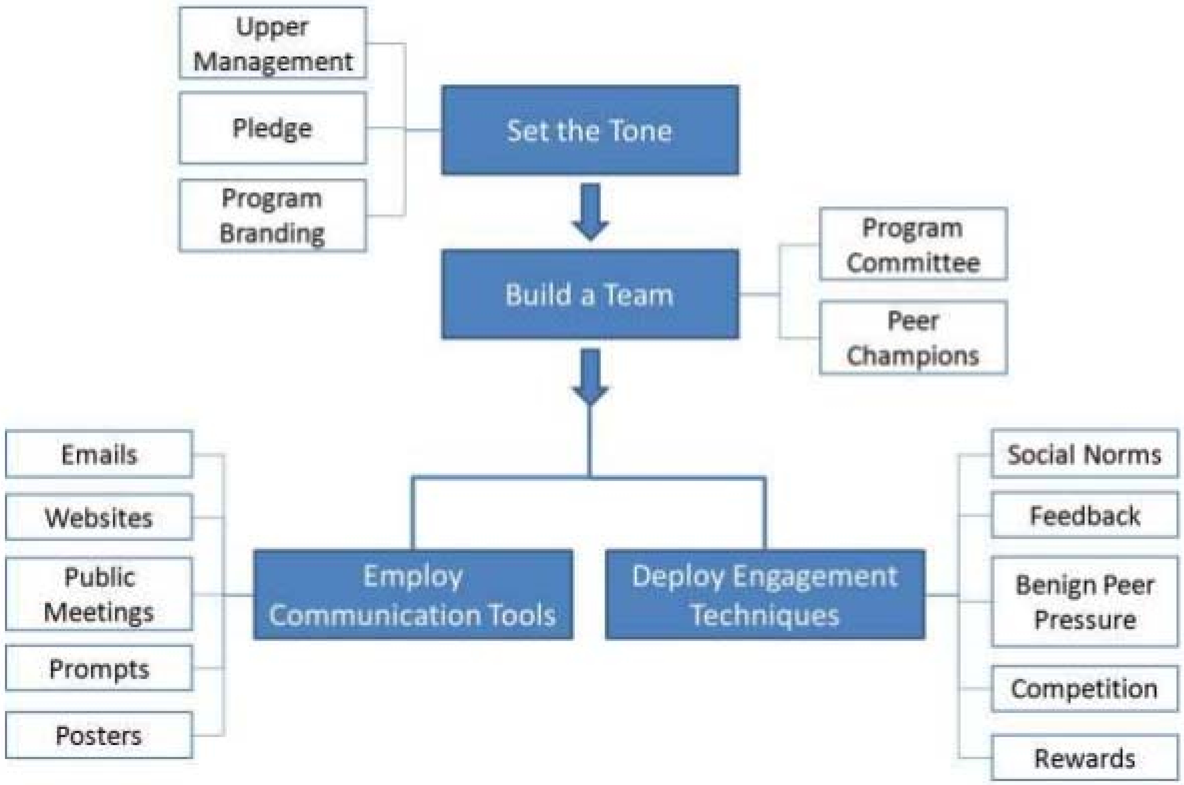
### Figure 14 Greening Work Styles: An Analysis of Energy Behavior Programs in the Workplace[50]

| # | Program Names | Project Year | Program Names in the Report | Behavior Program Only? | Project Savings |
|---|---|---|---|---|---|
| 1 | Green the Capitol | 2007–2012 | The "Green the Capitol" case | No. It falls under a comprehensive project targeting sustainability in the workplace, along with reduction in energy use, carbon emissions, and waste. | [Total project savings] Within 18 months of its launch, there was a 74% reduction in carbon emissions through the use of energy-efficient equipment and products, changes in fuel types, and behavior changes. |
| 2 | Tenant Energy Management Program | 2009–2013 | The "Empire State Building" case | No. It is a component of a large retrofit project. | [Total project savings] It is estimated that the retrofit project (including tenant energy management program) will reduce energy use by 31%. |
| 3 | Conservation Action! | 2007 | The BC Hydro case | Yes. It aims to create a culture of energy conservation. | [Savings from the energy behavior program only] The project produced a 5% reduction in electricity use by the end of the first year. |
| 4 | Employee Engagement Program | 2008 | The MEMPR case | Yes. It aims to create a culture of energy conservation. | [Savings from the energy behavior program only] During a week-long lighting campaign, a floor that used manual lighting switches reduced electricity consumption by 12%. |
| 5 | TLC—Care to Conserve | 2007–2010 | The TLC case | No. It is one of six projects under the same program. The other projects focus on technological means of energy saving. | [Savings from the energy behavior component only] The TLC case led to a 4.2% energy saving during the first two years. |

48 http://aceee.org/files/proceedings/2012/data/papers/0193-000111.pdf
49 http://smartenergyinoffices.com/
50 http://aceee.org/sites/default/files/publications/researchreports/b121.pdf

The ACEEE Greening Work Styles report concludes that the key to success in behavior based programs includes the following strategies in Figure 15.

**Figure 15 ACEEE Tactics for Developing a Behavior Program in the Workplace[51]**




The critical element, as represented by the upper portion of the flow chart, is management commitment. Without visible backing from management and a public pledge to meet a specific goal, the effort is likely to fail. The next element in the critical path is a team that includes a committee who will manage the effort and champions to answer questions, lead by example, and lead the cheers. There are many ways to communicate information and engage employees as shown at the bottom of the flow chart. It is best to use multiple methods.

**RECOMMENDATION**

→ **Further investigate the Duke Smart Energy in Offices program to determine energy savings, costs, and cost effectiveness.** Design and implement a similar program in Massacusetts if the findings are encouraging. Use the tactics identified by ACEEE to help insure success. A commercial behavior program could be complementary to a SEM or RCx program, or could be used by itself instead of SEM program for smaller customers.

[51] Ibid.