WORKSHOP TOPIC OVERVIEW

Commercial and Industrial (C&I) programs in Massachusetts help large non-residential customers make energy efficiency upgrades that reduce electricity and fossil fuel use. Commercial facilities can generally be characterized as buildings; however, C&I also includes industrial facilities like wastewater treatment plants and manufacturers, public assets like streetlighting, and other non-building energy consuming assets. C&I customers are responsible for 38% of total energy consumed in Massachusetts, topping the next largest sectors of transportation (33%) and residential energy use (29%).[1] C&I customers are also one of the largest contributors to the greenhouse gas emissions in the Commonwealth. In the 2019-2021 plan, C&I retrofits are 79% of total planned electric savings and 34% of total planned gas savings across the entire portfolio (Residential, Income Eligible and C&I). Retrofits also comprised the vast majority of total C&I planned savings (93% of electric, 77% of gas).[2]

In 2019, C&I retrofit programs achieved just 85% of planned lifetime electric savings and 84% of planned lifetime gas savings.

Table 1. 2019 C&I Program Results

2019 C&I Programs	Electric	Gas
Program participants	24,397	21,387
Program costs	$250,375,095	$46,977,451
Average cost per participant	$10,263	$2,197
Annual energy savings	617,824 MWh	9,183,395 therms
Average annual savings per participant	25.3 MWh	429.4 therms
Lifetime energy savings	7,913,449 MWh	132,991,792 therms
Average measure life	9.3 years	12.8 years
Total benefits	$1,249,042,034	$201,525,621

In 2020, the COVID-19 pandemic caused a complete shutdown of some C&I energy efficiency retrofit programs. Programs the PAs directly employ vendors to implement like the small business turnkey program and part of the industrial initiative were suspended until health and safety protocols could be established. Notably, the upstream (or point-of-sale) programs and open-market custom retrofits were not suspended by the PAs, however, much of the economy was shuttered and non-essential construction projects ground to a near standstill. Program activity started to rebound over the summer, but some businesses have either deferred or cancelled retrofit projects all together, and other businesses have closed permanently.[3]

As places of gathering, C&I buildings are particularly susceptible to the impacts of changing behaviors due to COVID-19. Essential businesses, public schools, community centers and healthcare facilities are all examples of customers who have had to dramatically change their normal operations to reduce the risk of viral transmission. Commercial HVAC systems have been under a greater level of scrutiny than almost any time in the history of these systems' existence. Hospitals and healthcare facilities started from a position of relative familiarity with high-efficiency ventilation systems and advanced filtration and purification technologies. Owners, operators and occupants of older buildings, especially in the public sector, are now more acutely

[1] https://www.eia.gov/state/?sid=MA#tabs-2

[2] Significant savings from CHP in the current plan distorts electric savings measured in megawatt hours because this does fails to recognize the gas use increase associated with these projects

[3] https://www.masssave.com/en/covid19-update

aware of the deficiencies in their building ventilation systems. The EEAC Consulting Team believes there is a role for the Mass Save C&I Existing Building Retrofit programs to play in helping C&I customers modernize their HVAC systems in an energy efficient manner through retrofit projects.

Organizing the Workshop Discussion

Four topics will be addressed in the workshop to focus on ways in which Commercial and Industrial retrofit programs can continue to lead and innovate in 2022-2024. The topics are directly tied to the long-term goals that Massachusetts has articulated as well as responding to current pandemic conditions that are even now changing the landscape for commercial buildings in the Commonwealth. The topics are:

I. Emphasize HVAC savings for all commercial customers

II. Transition support for lighting to controllable technologies

III. Invest in new opportunities for industrial/process savings

IV. Re-assess CHP Incentives to align with Long Term Climate Goals

Attention to each of these topics as the 2022-2024 Plan is created will help Massachusetts respond appropriately to current conditions while looking forward to new challenges and opportunities.

Please note: Small Businesses is not covered in this document or elsewhere in Workshop #3. Small Businesses will be discussed at Workshop #5 on January 12th, which is equity focused.

OVERVIEW OF RECOMMENDATIONS FOR COUNCIL CONSIDERATION

In each of the areas identified above and discussed below, there are recommendations for action and attention. These are summarized here for ease of reference.

I. Emphasize the delivery of HVAC savings for all commercial customers

1. **Increase electric and gas HVAC savings from existing buildings** by improving realization rates, increasing participation, addressing system optimization, providing benchmarking services, commissioning projects from concept through operations and including envelope upgrades.
    - Improve realization rates for implemented HVAC projects by consistently including third party commissioning to ensure the Massachusetts ratepayers and the customers investing in HVAC retrofits have accurate savings estimates that are realized.
    - Increase participation in custom HVAC projects and pursue system optimization to increase savings per project. System optimization includes right-sizing, eliminating pinch-points and by-passes, implementing optimal sequences of operations and commissioning.
    - Consistently support building envelope assessments and upgrades to increase comfort and reduce HVAC loads. Support cost-effective envelope measures including the incremental cost for triple glazed windows where window replacements are already planned.
    - Incorporate standardized benchmarking across PAs (using Energy Star Portfolio Manager) as a pre-post component of project implementation and capture benchmark data in PA tracking databases.

2. **Promote electrification projects**, including conversions to variable refrigerant flow (VRF) and/or ground-source heat pump systems paired with Dedicated Outdoor Air Systems (DOAS).

3. **Undertake a Deep Energy Retrofit Pilot**[4] including working with customers to leverage planned replacements to achieve cost-effective deep energy retrofits that result in balanced investment in envelope, HVAC and other improvements. Engage customers with significant real estate portfolios to identify potential buildings and undertake integrated design with scenario modeling, lifecycle and financial analysis to identify the optimum investments. Use the pilot to identify market actors with the skills best suited to delivering successful projects and document project characteristics in promotional materials.

    - Work with customers with significant real estate portfolios to identify buildings suitable for inclusion in the pilot. Help customers realize the full benefits of holistic lifecycle cost analysis by working with them to plan how they will replace equipment, systems and envelope components nearing end of life in order to move buildings towards lowest required energy inputs for HVAC operation.
    - Use an integrated design approach incorporating early retirement of existing equipment, systems, and components to ensure comprehensiveness and to identify the optimal package of integrated energy efficiency measures for the client; consider electrification in every package. Incorporate envelope improvements including assessments of the addition of insulated exterior cladding and upgrading windows to triple glazed units at the time of replacement.
    - As part of the process assess which service providers are best suited to support customers and the PAs in pursuing Deep Energy Retrofits.
    - Document project costs, savings, benefits and measured results in case studies and other promotional materials.

4. **Expand delivery of services and savings relating to building automation and energy management information systems** including legacy system upgrades and replacements and portfolio optimization. Increase the use of independent third-party commissioning in the existing building sector to improve savings.

    - Work with customers to upgrade legacy systems and optimize HVAC system performance. For customers with significant real estate holdings, work to ensure interoperability and optimization across their portfolio by helping them bring existing systems up to modern standards when new buildings or systems are added.
    - Increase participation in existing building commissioning using independent third-party commissioning providers from project kick-off through Measurement and Verification (M&V).

5. **Undertake an Energy Management Information Systems** (**EMIS) Pilot** to demonstrate the costs and benefits of EMIS and monitoring-based commissioning.

II. Transition support for lighting to controllable technologies

6. **End support for non-dimmable TLEDs starting in 2022 across all program pathways**; To receive support, dimmable TLEDs should be installed and commissioned to deliver some combination of initial wattage tuning, daylight harvesting, occupancy controls and dimming capabilities. Refocus upstream product offerings on “smart” dimmable and controllable TLEDs and DLC qualified luminaire-level lighting controls.

[4] Categorized as HVAC because most savings will be from reductions in HVAC system loads and increased efficiency in delivery of HVAC services

7. **Push customers towards luminaire-level lighting controls** wherever possible using performance lighting and other more comprehensive pathways. Improve the ease of participation for the Performance Lighting Plus program, particularly for existing buildings.
8. **Continue to invest in lighting controls training for contractors/installers and customers**; expand training efforts to include commissioning for contractors/installers, sales strategies for distributors/contractors, operation and maintenance best practices for facility managers, and customer education on energy and non-energy benefits of controls.

III. Invest in new opportunities for industrial/process savings

9. **Continue to identify and eliminate barriers that are preventing project implementation** and savings already identified through the Industrial Initiative.
    - Continuously check back regularly with customers to see if circumstances have changed, or what it would take to move forward. Once a project has been identified, and quantified, the incremental support to cause a project to move forward should be less than the effort and cost to identify a new potential project.
    - Provide sales training to Industrial Initiative contractors.
    - Use the Massachusetts Pro Forma tool to provide cash flow analysis, rate of return, and other project financial information to the customer CFO to sell the project.
10. **Expand Strategic Energy Management (SEM) to a full program offering for all industrial customers.**
    - Pair SEM with implementation of traditional Industrial Initiative to drive more capital projects. Track any increases in capital projects to assess the impact of SEM participation in Massachusetts. SEM may be the most valuable marketing tool available to target manufacturers.
    - Change the measure life for Strategic Energy Management operational savings from three years to seven years as per the Oregon example. Massachusetts is using the same contractor used in Oregon and this firm is implementing the same best practices here.
    - Support Energy Management Information Systems through financial cost sharing.
11. **Identify niche customer segments where there are still appreciable non-lighting savings opportunities and construct targeted initiatives to address these markets:**
    - Smaller/distributed telecom sites, including cabinets and other unoccupied structures.
    - Cannabis cultivators with substantial process savings from CO2 extraction and environmental controls.
    - Laboratory freezers.

IV. Re-assess CHP Incentives to align with Long Term Climate Goals

12. **Re-asses incentives for natural gas fueled CHP** and consider reducing or eliminating all but the most energy-intensive market segments as necessary to meet long term climate goals.
    - Exemptions may include hospitals, pharmaceuticals, and manufacturing
    - Prioritize and offer enhanced incentives for renewable fuel CHP systems such as those that run on anaerobic digester gas.
13. **Complete a dedicated CHP impact evaluation no later than 2022** that also includes an update to free-ridership, spill-over and net to gross ratios. Study new and replacement systems separately. Implement programmatic changes based on results of impact evaluation.
14. **For all CHP projects, conduct detailed lifecycle emissions analysis** using an impartial and agreed upon forecast of ISO New England's emissions intensity between now and 2050. Also

conduct a project-by-project economic analysis that determines whether a given CHP project needs Mass Save support to generate a 5-year positive cash-flow.

EMPHASIZE HVAC SAVINGS FOR ALL COMMERCIAL CUSTOMERS

Background/Current Status

Heating, ventilation, and air conditioning (HVAC) systems provide indoor environmental conditions necessary to support business operations including comfort and fresh air and consume over half of the total energy and 25% of electricity used in commercial buildings in New England.[5] HVAC energy efficiency opportunities are an important component of the C&I programs as lighting savings continue to diminish. HVAC systems are typically custom designs, unique for each building and space with controls that range from individual thermostats to computer operated building automation systems (BAS). All buildings in the C&I market have HVAC equipment; while systems are highly varied, they typically include electrically powered cooling, fan and pumping equipment and fossil fuel combustion equipment to provide heat.

While HVAC opportunities are significant, the custom and interactive nature of HVAC systems makes capturing HVAC savings challenging and necessitates a more holistic approach. Figure 1 below shows that HVAC savings have declined during the past plan period and that trend has continued into the current plan.

Figure 1. C&I Electric HVAC Savings 2016-2019 (evaluated) and 2019-2021 (planned)

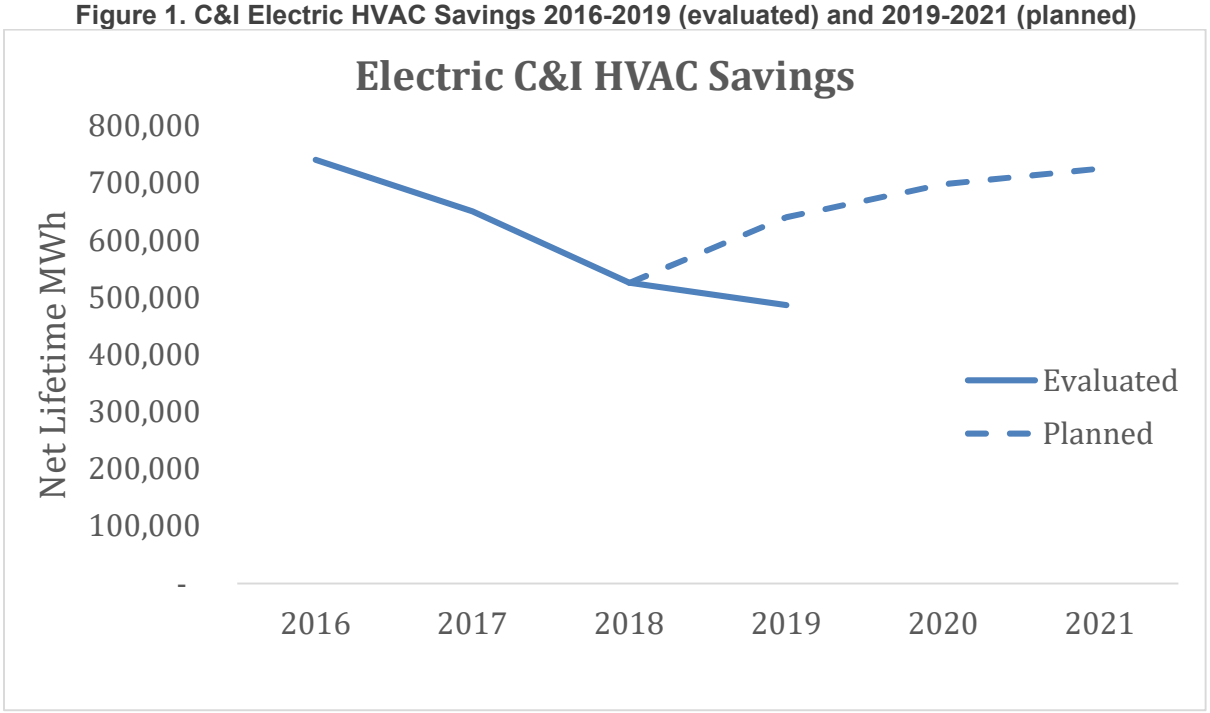
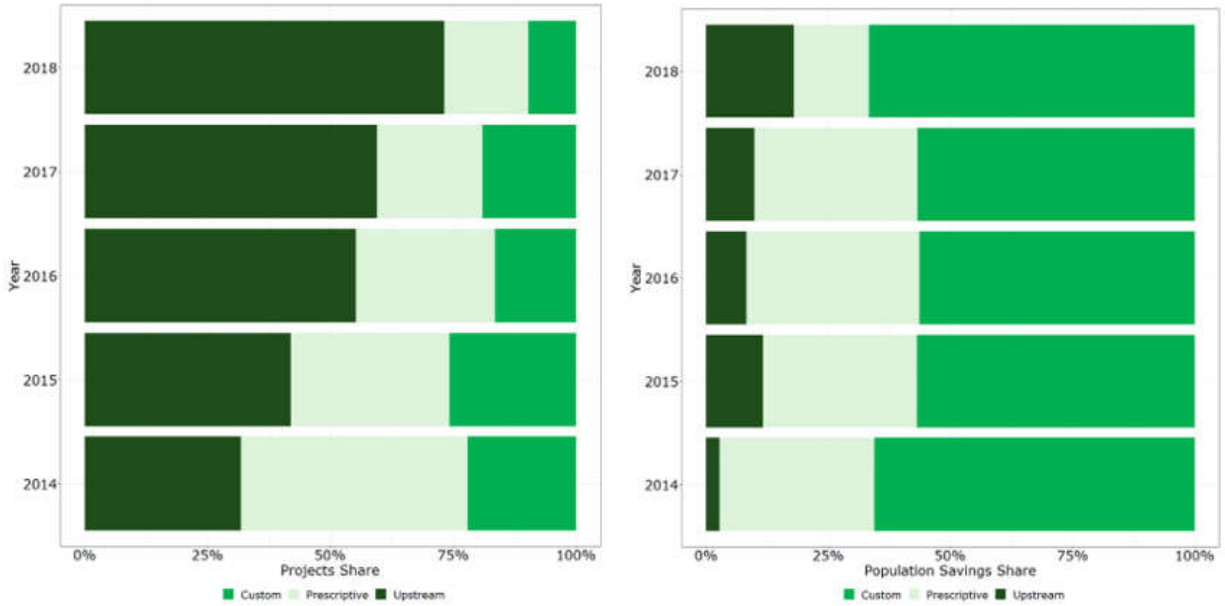


Figure 2 shows that the majority of HVAC savings is generated in custom projects and that upstream and prescriptive offerings, while affecting a large number of projects, deliver a very small portion of HVAC savings.

The PAs currently address HVAC through custom, upstream and prescriptive offerings. While acknowledging that intervening to ensure the procurement of new replacement equipment is above baseline is reasonable for energy efficiency programs, it is also important to recognize that to make significant inroads in reducing HVAC loads and consumption in MA, custom approaches will need to be expanded and improved.

[5] Regional building average data from Commercial Building Energy Consumption Survey 2012 (CBECS).

Figure 2. 2018 HVAC Projects and Savings by Track[6]



The most recent programmatic innovation made in the current plan period is the addition of services that the PAs have characterized as Energy Savings Performance Opportunities (ESPO) which addresses HVAC and other end uses. ESPO includes HVAC tune-ups and recommends monitoring-based commissioning. In many cases "tune-ups" will differ significantly from true retro-commissioning which typically includes revisions to sequences of operations to reflect current occupant needs and efficiency opportunities like those identified in ASHRAE Guideline 36.[7] There is no requirement in this offering for participation of an independent third-party commissioning provider.

Recent evaluations of projects where HVAC controls systems were added or modified generally found poor realization rates for these projects. The incorporation of independent third-party commissioning into the design and delivery of HVAC projects will help to ensure customers receive the savings they have been promised, and ratepayer investments yield the expected savings. HVAC savings comprise a significant, though decreasing, portion of total non-lighting custom projects. As of the latest impact evaluations published in 2020, custom electric non-lighting projects achieve a realization rate of just 71.5%[8] and custom gas projects had a realization rate of 85%. Applying these realization rates to HVAC projects in 2018[9] shows that the low realization rates resulted in a 40% increase in cost per MWH for custom electric HVAC savings and an 18% increase in the cost of gas savings. Increasing the realization rate for custom projects is critical to ensure effective spending of rate-payer dollars, and custom HVAC projects play a significant role in the portfolio and HVAC controls projects in particular have had highly varying realization rates in the past. Independent third-party commissioning of HVAC projects from concept through implementation, including operator support, will significantly improve realization rates over time.

The PAs offer small business incentives for fuel switching from delivered, non-regulated fossil fuels to electric heat pumps, but there is no formal offering available for medium and large size businesses. There are currently no efforts to address fuel switching customers from natural gas to electricity nor is there an offering suitable for driving such HVAC retrofits in larger existing buildings. There are opportunities to work with

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[6] Draft 2018 Customer Profile Report

[7] https://www.ashrae.org/news/esociety/new-guideline-on-standardized-advanced-sequences-of-operation-for-common-hvac-systems

[8] https://ma-eeac.org/wp-content/uploads/MA_CIEC_Stage5_Report_C07_Custom_Electric_Impact_Evaluation_PY2017_18_FINAL-2020-06-01.pdf

[9] https://insight.dnvgl.com/CICustomerProfile/report/320

customers to plan retrofits of heating system types as existing equipment approaches the end of its useful life, enabling customers to bring their buildings up to 21st century standards,[10] including providing improved indoor environmental (air and comfort) quality.

The programs have limited offerings associated with addressing building envelope performance in C&I buildings. An effort is underway within the small commercial sector to deliver more weatherization and building envelope savings, however, similar efforts have not been conducted for medium and large commercial customers. That said, examples do exist of cost-effective building envelope improvements. More than half of the buildings included in the first phase of the City of Boston's *Renew Boston Trust* program include simple improvements such as sealing windows, doors, and cracks in the building envelope to keep heat or air conditioning in the building.[11] Some of these upgrades occur in very large buildings such the Copley Library and Boston Police Headquarters, and include relatively simple measures like air sealing around doorways and capping abandoned ventilation shafts. By bundling measures with quick paybacks, such as lighting and controls upgrades, with longer payback measures like envelope and HVAC improvements, the average blended payback of these measures come into an acceptable range for a given customer.

C&I customers have a variety of opportunities to participate in the C&I Existing Building retrofit program. The options available to customers are dictated by many factors: customer interest, PA offerings, savings potential, technological advances, (etc.), but one critical factor that cannot be overlooked is timing. If a customer engages with the PAs early as part of a capital planning process, the opportunity to integrate energy efficiency into system replacements is much greater. This typically takes the form of custom retrofit projects where portions of existing systems are replaced before the end of their useful life. Finding more of these opportunities behoove both customers and PAs because planned retrofits provide significantly greater savings potential, including the ability to help transition customers away from fossil fuel as a heating source. Alternatively, unplanned emergency replacement scenarios that occur during a heating or cooling system failure is one of the worst times to engage a customer in discussions on energy efficiency upgrades. Customers are so focused on getting their building back in working order that in most instances, a like-for-like system replacement is the most likely outcome. Unfortunately, unplanned emergency replacements or replacement upon failure of assets are quite common.

A 2020 study of the market for HVAC system replacements by the Northwest Energy Efficiency Alliance (NEEA) found that 40% of surveyed building owners last replaced their HVAC systems in an unplanned emergency.[12] Another 23% intentionally built their HVAC replacement plans around whenever their next system failure occurred. Just 37% of building owners replaced their systems through a formal capital planning process. This same study found that a significant number of building owners ran their HVAC systems significantly past the effective useful life of the assets. NEEA analyzed various market segments and customer types to try to understand the motivations for various customers' approach to retrofitting their facilities. They found that institutional customers like schools were more likely to engage in capital planning processes and were less motivated by first-costs. One respondent was quoted: "For schools, operating and maintenance cost concerns often supersedes first costs concerns". They found that customer segments like retail and offices, which are more likely to be multi-tenant buildings, were more sensitive to first costs and the building owner rarely payed the full utility costs. The challenges of addressing energy efficiency in commercial rental properties are similar to those for residential rental properties; the split incentive between the owner who invests in energy efficiency building upgrades and the tenant who reaps those benefits persists.

The Rocky Mountain Institute has developed a deep energy retrofit portal[13] focused on advancing planned investments to maximize the opportunity to bring commercial building stock up to 21st century standards. The offerings include energy modeling software and guidance for deep energy retrofits, Passive House links, financial analysis guidance, integrative design tools, benchmarking resources, and lifecycle analysis tools. The site includes several case studies including the Empire State Building projects which leveraged the

[10] In this document "21st century standards" refers to buildings that have minimal greenhouse gas emissions while providing high quality indoor environments; it does not refer to a specific standard or document.

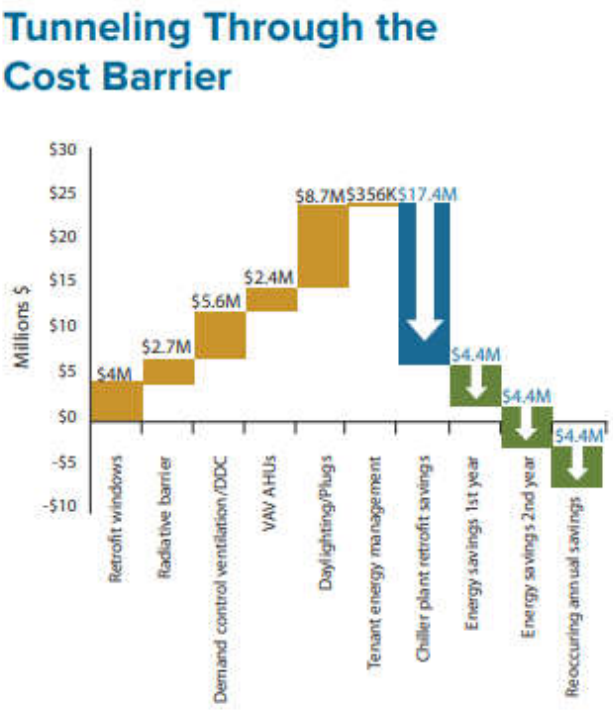
[11] https://www.boston.gov/environment-and-energy/renew-boston-trust

[12] https://neea.org/img/documents/Commercial-High-Performance-HVAC-Market-Characterization.pdf

[13] https://rmi.org/our-work/buildings/deep-retrofit-tools-resources/deep-retrofit-case-studies/

owner's need to replace the windows and add cooling capacity to meet loads. Guided by the two original project goals, the team conducted integrated analysis and the building was able to invest in deep energy retrofits that significantly reduced the cooling load, enabling the existing chiller plant to meet loads, improving comfort and indoor air quality for occupants and to achieve a project with less than a two year simple payback as shown in Figure 3.

Figure 3. Empire State Building Deep Energy Retrofit Financial Proforma



In Massachusetts, customers in the public sector and institutional sectors like colleges and universities tend to be motivated to pursue deep energy retrofits and goals like Zero-Net Energy. In these sectors buildings are generally owner-occupied and the full benefits of investing in efficiency accrue to the organization making the investment. Working with these motivated customers to develop and deliver deep energy retrofits will provide a foundation for advancing deep energy retrofits across the commercial market.

Recommendations

1. **Increase electric and gas HVAC savings from existing buildings** by improving realization rates, increasing participation, addressing system optimization, providing benchmarking services, commissioning projects from concept through operations and including envelope upgrades.
    - Improve realization rates for implemented HVAC projects by consistently including third party commissioning to ensure the Massachusetts ratepayers and the customers investing in HVAC retrofits have accurate savings estimates that are realized.
    - Increase participation in custom HVAC projects and pursue system optimization to increase savings per project. System optimization includes right-sizing, eliminating pinch-points and by-passes, implementing optimal sequences of operations and commissioning.
    - Consistently support building envelope assessments and upgrades to increase comfort and reduce HVAC loads. Support cost-effective envelope measures including the

incremental cost for triple glazed windows where window replacements are already planned.

- Incorporate standardized benchmarking across PAs (using Energy Star Portfolio Manager) as a pre-post component of project implementation and capture benchmark data in PA tracking databases.

2. **Promote electrification projects**, including conversions to variable refrigerant flow (VRF) and/or ground-source heat pump systems paired with Dedicated Outdoor Air Systems (DOAS).
3. **Undertake a Deep Energy Retrofit Pilot**[14] including working with customers to leverage planned replacements to achieve cost-effective deep energy retrofits that result in balanced investment in envelope, HVAC and other improvements. Engage customers with significant real estate portfolios to identify potential buildings and undertake integrated design with scenario modeling, lifecycle and financial analysis to identify the optimum investments. Use the pilot to identify market actors with the skills best suited to delivering successful projects and document project characteristics in promotional materials.
    - Work with customers with significant real estate portfolios to identify buildings suitable for inclusion in the pilot. Help customers realize the full benefits of holistic lifecycle cost analysis by working with them to plan how they will replace equipment, systems and envelope components nearing end of life in order to move buildings towards lowest required energy inputs for HVAC operation.
    - Use an integrated design approach incorporating early retirement of existing equipment, systems, and components to ensure comprehensiveness and to identify the optimal package of integrated energy efficiency measures for the client; consider electrification in every package. Incorporate envelope improvements including assessments of the addition of insulated exterior cladding and upgrading windows to triple glazed units at the time of replacement.
    - As part of the process assess which service providers are best suited to support customers and the PAs in pursuing Deep Energy Retrofits.
    - Document project costs, savings, benefits and measured results in case studies and other promotional materials.
4. **Expand delivery of services and savings relating to building automation and energy management information systems** including legacy system upgrades and replacements and portfolio optimization. Increase the use of independent third-party commissioning in the existing building sector to improve savings.
    - Work with customers to upgrade legacy systems and optimize HVAC system performance. For customers with significant real estate holdings, work to ensure interoperability and optimization across their portfolio by helping them bring existing systems up to modern standards when new buildings or systems are added.
    - Increase participation in existing building commissioning using independent third-party commissioning providers from project kick-off through Measurement and Verification (M&V).
5. **Undertake an Energy Management Information Systems** (**EMIS) pilot** to demonstrate the costs and benefits of EMIS and monitoring-based commissioning.

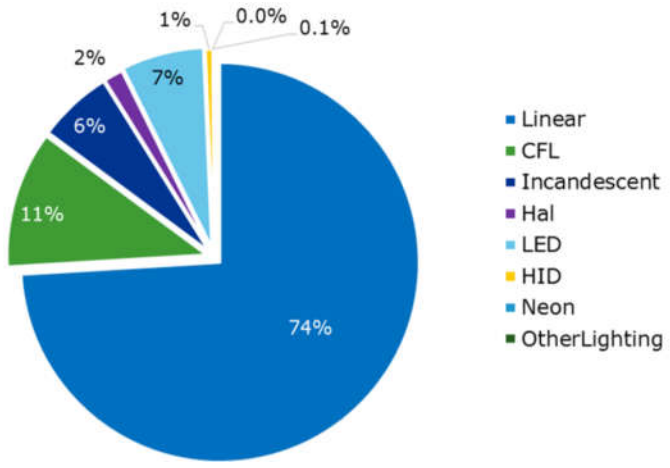
[14] Categorized as HVAC because most savings will be from reductions in HVAC system loads and increased efficiency in delivery of HVAC services

SUPPORT THE TRANSITION TO CONTROLLABLE LIGHTING TECHNOLOGIES

Background/Current Status

Lighting has historically been the largest source of C&I savings (60% of net lifetime electric savings from 2016-2018) and still makes up the single largest source of savings in the 2019-2021 plan cycle (49%). The lower percentage of total savings coming from lighting is primarily due to known large CHP projects. The largest opportunity for C&I lighting retrofits come from the linear market, which makes up nearly three quarters of all lights in commercial buildings in Massachusetts (Figure 4).

Figure 4. Distribution of Lamps by Type – Interior Lighting (MA Commercial Lighting)[15]



Based on current and projected market adoption of LEDs, the C&I lighting market is expected to undergo almost a complete transformation to LEDs in the next several years. If new lighting products installed in C&I buildings today do not include controls, the opportunity for deeper energy savings will become stranded. Retrofitting controls onto already installed LED lighting is typically cost prohibitive, and the long life of LED lighting ensures the ability to claim lighting control savings will have passed by the time the LED lighting needs to be replaced again. The potential missed opportunity for claimable lighting savings if the market were to be saturated with uncontrollable lamps could be over 1 billion kilowatt hours.

The EEAC Consulting Team wrote extensively on the topic of C&I lighting in the fall of 2019 in a paper titled *The Future of C&I Lighting*.[16] When this paper was written, the EEAC consulting team relied on an evaluation model that estimated the market saturation for LEDs in the commercial linear market. This market model projected that by the end of 2021, 70% of the linear market would be converted to LEDs and by the end of 2024, that would rise to 88%. As the market moves further along the adoption curve and LED becomes industry standard practice, claimable savings that the PAs can reasonably attribute to their actions declines dramatically. The net-to-gross factor (or percentage of gross savings that can be claimed net of free-riders and spill-over effects) for upstream Tubular LEDs or "TLEDs" will be 66% in 2021, the last year of this plan cycle. That means for every 100kWh of gross savings achieved from a TLED, the program can only claim 66 kWh. These ratios decline over time as products and technologies become standard practice. We do not yet know the net-to-gross factors for the 2022-2024 plan, but they will certainly be lower than they were in the current plan cycle. Recent Rhode Island evaluations of their upstream lighting program, which is the same as Massachusetts' program, found a net-to-gross ratio of just 45% for TLEDs. We can expect a similar result in Massachusetts and should plan accordingly by de-emphasizing our reliance on TLEDs for the remaining C&I lighting savings we put into the next three-year plan.

Despite the reduction in claimable savings for simple products like TLEDs, there are remaining opportunities in

[15] http://ma-eeac.org/wordpress/wp-content/uploads/MA-CI-Market-Characterization-Study.pdf

[16] https://ma-eeac.org/wp-content/uploads/The-Future-of-CI-Lighting-October-2019.pdf

the C&I lighting market. The combination of multiple control strategies into a single system, with coordinated operation and individually addressable light fixtures, is often referred to as Networked Lighting Control ("NLC"). In 2017, the DesignLights Consortium (DLC) collected energy data from multiple networked lighting control system installations to develop improved estimates of energy savings. This study was revised and expanded in 2020, now covering 194 buildings across a variety of building types.[17] The research found that NLC systems reduced energy consumption by 49% on average for the buildings in the study, not including the original savings captured through an LED retrofit.[18] For luminaire-level lighting controls ("LLLC"), a subset of NLC where the sensors and control logic are integrated into every fixture, the DLC study found the savings to be even higher at 63% on average. The impacts of widespread NLC deployment/adoption would go beyond energy savings. The EEAC Consulting Team provided recommendations to further integrate Active Demand into standard efficiency program implementation at the 1st Planning Workshop held on November 5th. If, for example, half of all linear fixtures in the Commonwealth were dimmed by just 10%, the Mass Save program could deliver 28% more peak demand savings from C&I customers than the Program Administrators filed for 2019.[19] Figure 5 shows the current pathways of the PAs' C&I lighting portfolio.

Figure 5. Current Program Pathways and Approaches[20]

Pathway	Upstream	Downstream			
Approach	Point of Sale	Direct Install	Prescriptive		Custom (Incl. Performance Lighting)	
Project Type(s)	All	Retrofit	New Construction	Retrofit	New Construction	Retrofit
Scalability	High	Medium	Medium		Medium (PL – Low)	
Transaction Costs	Very Low	High	Medium		High	
Target Market	Small CI Customers Large DIY Customers with Small Projects	Small C&I Customers	Medium / Large C&I Customers		Large Customers and Projects, including New Construction and Major Renovation	
Target Lighting Types	Most lighting types from screw-based and TLEDs (smaller incentives) to fixtures with controls (higher incentives)	Focus on fixture replacements and controls (where appropriate). TLEDs are not generally included.	Most lighting types from screw-based and TLEDs (smaller incentives) to fixtures with controls (highest incentives.		All lighting types. Depends on situation / need / preferences. (PL – 3 tiers incl. fixtures only, fixtures + controls, fixtures + advanced controls on performance basis)	

Upstream programs are notable for their high scalability, low transaction costs, and wide market. Upstream participants receive a per unit rebate on qualified efficient equipment, including LED linear fixtures and tubular TLEDs. While this pathway can deliver significant volume in projects, it typically delivers very few projects with controls for several reasons:

- The incremental cost of controls can be a barrier for upstream sales
- Contractors and distributors may have negative perceptions of controls and/or inadequate training
- The benefits of controls may be poorly understood, and program administrators have no direct interaction with customers in the upstream rebate process.

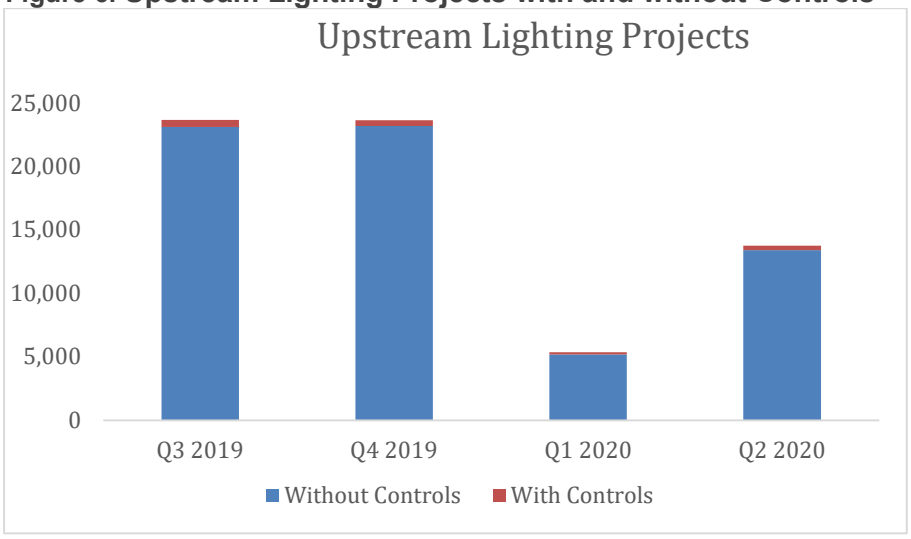
[17] https://www.designlights.org/lighting-controls/reports-tools-resources/energy-savings-from-networked-lighting-controls-with-without-LLLC/report/

[18] https://www.designlights.org/lighting-controls/reports-tools-resources/nlc-energy-savings-report/

[19] 2019 C&I ADR filed = 102.4MW; 49 million linear lamps in MA x 50% x 14W x 10% dimming x 0.83 CF (summer) = 28.5 MW

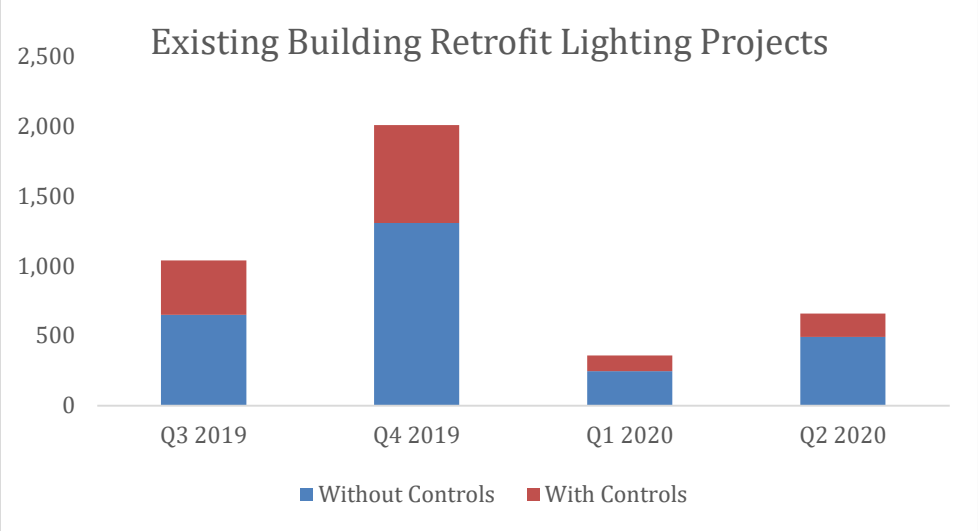
[20] http://ma-eeac.org/wordpress/wp-content/uploads/EEAC-Meeting-CI-10-16-2019.pdf

Figure 6. Upstream Lighting Projects with and without Controls [21]



The various downstream approaches all cater to more specific markets and are better equipped to deliver more sophisticated lighting solutions. For example, the Performance Lighting program offers a tiered incentive structure that provides incrementally higher incentives for higher performance lighting solutions. Tier 1 projects must demonstrate efficiency that is at least 10% beyond code required lighting power density (measured in watts per square foot). Tiers 2 and 3 offer incrementally higher incentive rates for greater levels of controls functionality and system integration. Non-upstream retrofit pathways have been marginally more successful in delivering projects that include controls during this plan cycle, however, these results have been uneven across Program Administrators. In the first year of the current plan cycle, National Grid had significantly more success delivering lighting projects that included controls, followed by Eversource, then Cape Light, then Unitil.

Figure 7. Existing Building Retrofit Lighting Projects with and without Controls [22]



While the downstream pathways have a greater share of controlled lighting, the volume of participation and savings remains much lower than upstream. As a result, the overall portfolio success of promoting lighting with controls remains limited. (Figure 7).

Unlike simple lamp replacements, successfully installing, commissioning, and operating sophisticated lighting

[21] Program Administrator KPI #4; note – not all upstream products have controllable options

[22] Program Administrator KPI #4

systems can be challenging for installers and customers alike. The PAs frequently reference unsuccessful lighting controls projects in the past as a barrier to future deployments. While these early setbacks are disappointing, the PAs rightly looked to improve on these results by investing in various lighting controls training events. At the October 2019 EEAC meeting, the PAs provided a list of trainings they had conducted to educate the market.[23] Almost all of these trainings were focused on contractors and installers, and notably did not provide necessary training for customers (building operators and facilities personnel). Training the contractor and installer market addresses the supply side of the lighting market, however, similar (or perhaps greater) emphasis must be placed on the demand side of the lighting market: customers who are ultimately responsible for maintaining these systems.

Recommendations

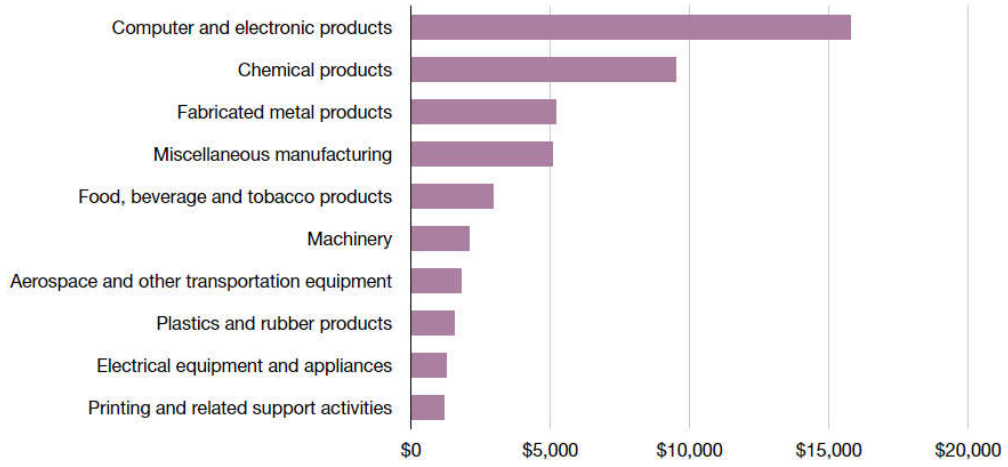
6. **End support for non-dimmable TLEDs starting in 2022 across all program pathways**; To receive support, dimmable TLEDs should be installed and commissioned to deliver some combination of initial wattage tuning, daylight harvesting, occupancy controls and dimming capabilities. Refocus upstream product offerings on "smart" dimmable and controllable TLEDs and DLC qualified luminaire-level lighting controls.
7. **Push customers towards luminaire-level lighting controls** wherever possible using performance lighting and other more comprehensive pathways. Improve the ease of participation for the Performance Lighting Plus program, particularly for existing buildings.
8. **Continue to invest in lighting controls training for contractors/installers and customers**; expand training efforts to include commissioning for contractors/installers, sales strategies for distributors/contractors, operation and maintenance best practices for facility managers, and customer education on energy and non-energy benefits of controls.

INVESTING IN NEW OPPORTUNITIES FOR INDUSTRIAL/PROCESS SAVINGS

Background/Current Status

Industrial process savings result from improvements to the operations and equipment used to manufacture products and goods, and for processes such as treating water and wastewater. Massachusetts has a range of manufacturers with electronics and biotech/pharma as the top two manufacturing sectors by sales.

Figure 8. Massachusetts Top 10 Manufacturing Sectors, Millions of Dollars (2017) [24]



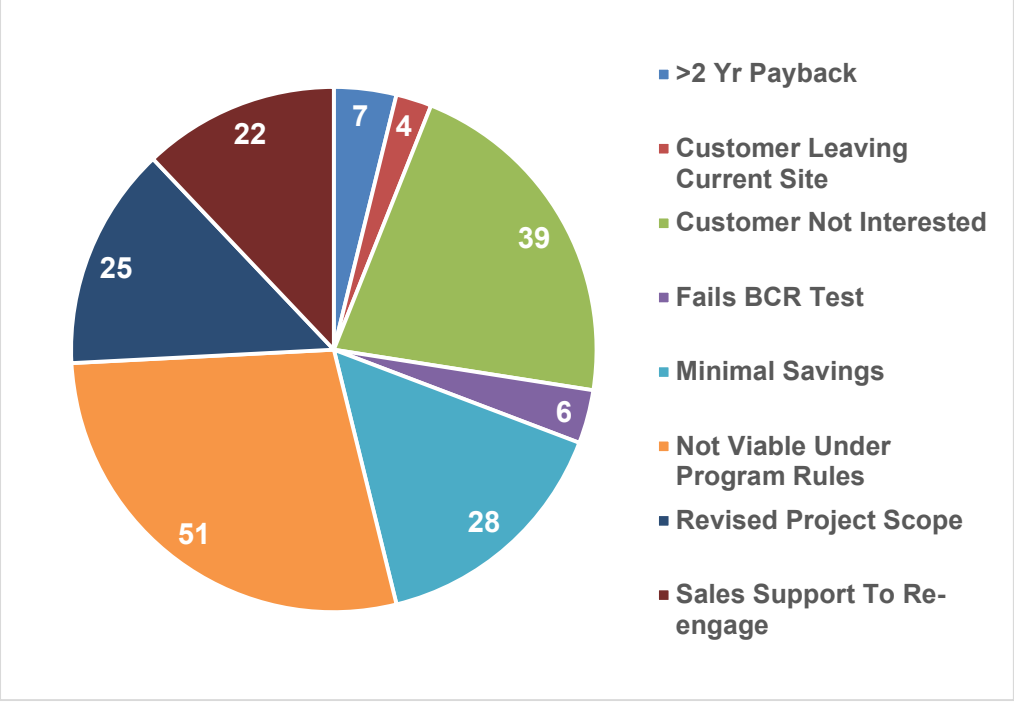
[23] http://ma-eeac.org/wordpress/wp-content/uploads/EEAC-Meeting-CI-10-16-2019.pdf (slide 50)
[24] https://www.nam.org/state-manufacturing-data/2020-massachusetts-manufacturing-facts/

Capital industrial process projects can cover a wide range of equipment such as air compressors or vacuum pumps, fluid pumps, ovens, or machines that make parts or components. Industrial process projects tend to be large, capital intensive and complex, but very cost effective (from an energy efficiency perspective). Because these projects impact the core of a manufacturer's business, there are typically a number of barriers to making efficiency improvements:

- Making changes to industrial processes normally requires significant engineering analysis and support
- Customers are reluctant to make changes that may impact productivity or quality
- There may be regulatory barriers to making changes to the process, especially for pharmaceutical or military products
- Customer finances, investment criteria, or budget cycles can be difficult to navigate
- Customers may not prioritize efficiency projects over other investments
- Many processes are proprietary, making best-practice sharing across an industry difficult
- Changes in operations or equipment can be seen as risky

The Mass Save Programs have worked to address barriers by implementing the Industrial Initiative in 2015. The Industrial Initiative provides support to customers through on-site assessments, metering, and engineering analysis to identify opportunities. This Initiative also provides project management support to facilitate implementation. It has been successful in both identifying and implementing projects. However, the Initiative has identified far more savings opportunities than have been implemented, indicating that there are still barriers left to overcome to capture the remaining savings potential. The chart below illustrates the primary reason that 182 projects identified by the PAs industrial initiative vendor have not moved forward.

Figure 9. Lost Opportunities – Stalled Projects with Identified Savings [25]



Projects categorized as "Not Viable Under Program Rules" don't fit within program parameters for a variety of

[25] Source: PA Industrial Initiative Vendor - Leidos Engineering

reasons. The next largest category of measures identified but not pursued are those where the "Customer (is) not interested" in the measure. As previously noted, this could be due to perceived or real risks the measure poses to a customer's industrial process. Some of these risks could be mitigated to ease customer concerns and convert these lost opportunities into executed measures. Some of the other categories, such as measures with ">2yr paybacks" and measures where "Sales Support to Re-engage" also present potential savings with appropriate program interventions.

Massachusetts is also conducting a Strategic Energy Management (SEM) demonstration project referred to by the PAs as Continuous Energy Improvement (CEI). The CEI pilot is planned to run for three years and is currently more than a year into the demonstration. The CEI demonstration has recruited a small group of non-competing customers into a cohort, who learn and work together to implement strategic energy management practices into their daily business operations. Operational changes to process that result in energy savings can be identified and quantified using a regression model unique to each customer that predicts energy use based on variables such as production and weather. The goal of CEI is to make energy use more visible and important within an organization's management structure, such that controlling and managing energy use rises to the same level of importance as controlling and managing safety or quality. One participant referred to CEI as "the future of efficiency" at National Grid's Energy Efficiency Summit in the fall of 2019.

Currently Massachusetts assumes a 3-year measure life for CEI. Strategic Energy Management programs have been implemented successfully in the Pacific Northwest for more than a decade, and a recent evaluation has found that a seven-year measure life is justified.[26] Adopting a longer measure life would increase and more accurately reflect the lifetime value of the CEI savings.

Participation in a Strategic Energy Management has also been found to increase capital project savings. In Oregon, "Energy Trust customers were four times more likely to complete a new capital project annually after participating in a SEM program than those that did not participate."[27] Another study found that in Bonneville Power Administration territory, the number of capital projects doubled and savings increased threefold when customers participated in a SEM program.[28] Using these programs as a way to instill an energy-focused organizational strategy can reinforce PA marketing materials for other industrial initiatives.

Making energy use visible is a challenge in any facility, but the ability to measure how and when energy is being used is critical to energy management. Energy Management Information Systems (EMIS) are a combination of metering hardware and software systems that measure energy use and provide valuable data and insights on a facility's energy use. An EMIS can provide information about how much energy input it takes to produce a unit of output (example: kWh per widget produced). Another every-day example of this type of measurement is the instantaneous *miles per gallon* data provided on modern cars' dashboards. A real time feedback loop is an important management tool that can drive better operational performance and SEM/CEI savings. Real time feedback can also identify when a piece of equipment is failing or has failed. Financial support for EMIS through the programs should be considered a form of ongoing technical support that will lead to savings, much like engineering analysis.

The legalization of cannabis has created a new industry in Massachusetts. Growing plants indoors on a large scale is energy intensive and is essentially an industrial process. The State of MA has introduced some significant efficiency requirements, particularly for lighting in growing operations and it now requires new growers to engage with Mass Save. Like in many other manufacturing processes, it is important to control light, humidity, heat, and the composition of the atmosphere in the growing room to maximize the plant growth yield. The PAs have been working with customers who are setting up grow spaces in warehouses. The race to get into this new industry means that energy efficiency opportunities may not be prioritized as new facilities and growers enter the market. The PAs have reported that large growers who have experience from other states with legal cannabis production are reported to be more engaged and interested in energy efficiency than small growers. Smaller, locally established firms starting a cannabis cultivation operation for the first time may be more sensitive to first costs and less likely to invest in efficiency. These customers are also less likely to

[26] https://www.energytrust.org/wp-content/uploads/2020/04/DNVGL_2019_Persistence_Study_Report_FINAL-w-SR.pdf
[27] https://www.aceee.org/sites/default/files/publications/researchreports/ie1901.pdf
[28] https://www.swenergy.org/data/sites/1/media/documents/publications/documents/Utility_SEM_programs_03-2013.pdf

have the in-house expertise to understand compressive design and operation of an efficient cannabis cultivation facility.[29]

There are other industry segments worth focusing on as additional opportunities for savings, such as telecom. While data centers have been a focus for year, there are numerous smaller telecom shelters and cabinets that contain telecom equipment, battery systems, battery chargers, rectifiers and HVAC equipment that provide constant space conditioning. Since this equipment runs continuously to provide uninterrupted communication services, the opportunity for energy savings is also continuous. As part of their latest three-year plan, National Grid Rhode Island has partnered with a new vendor who specializes in telecom operations to pursue this market segment. National Grid pointed to the telecom industry's reluctance to working with unfamiliar vendors who do not have experience working with their specific needs in the past. Hiring a dedicated firm who has this expertise will be critical in serving this unique customer segment's needs. While each individual telecom site may offer relatively smaller savings compared to typical industrial sites, in aggregate this market segment is a significant user of energy.

Recommendations

9. **Continue to identify and eliminate barriers that are preventing project implementation** and savings already identified through the Industrial Initiative.
    - Continuously check back regularly with customers to see if circumstances have changed, or what it would take to move forward. Once a project has been identified, and quantified, the incremental support to cause a project to move forward should be less than the effort and cost to identify a new potential project.
    - Provide sales training to Industrial Initiative contractors.
    - Use the Massachusetts Pro Forma tool to provide cash flow analysis, rate of return, and other project financial information to the customer CFO to sell the project.
10. **Expand Strategic Energy Management (SEM) to a full program offering for all industrial customers.**
    - Pair SEM with implementation of traditional Industrial Initiative to drive more capital projects. Track any increases in capital projects to assess the impact of SEM participation in Massachusetts. SEM may be the most valuable marketing tool available to target manufacturers.
    - Work with EM&V to change the measure life for Strategic Energy Management operational savings from three years to seven years as per the Oregon example. Massachusetts is using the same contractor used in Oregon and this firm is implementing the same best practices here.
    - Support Energy Management Information Systems through financial cost sharing.
11. **Identify niche customer segments where there are still appreciable non-lighting savings opportunities and construct targeted initiatives to address these markets:**
    - Smaller/distributed telecom sites, including cabinets and other unoccupied structures.
    - Cannabis cultivators with substantial process savings from CO2 extraction and environmental controls.
    - Laboratory freezers.

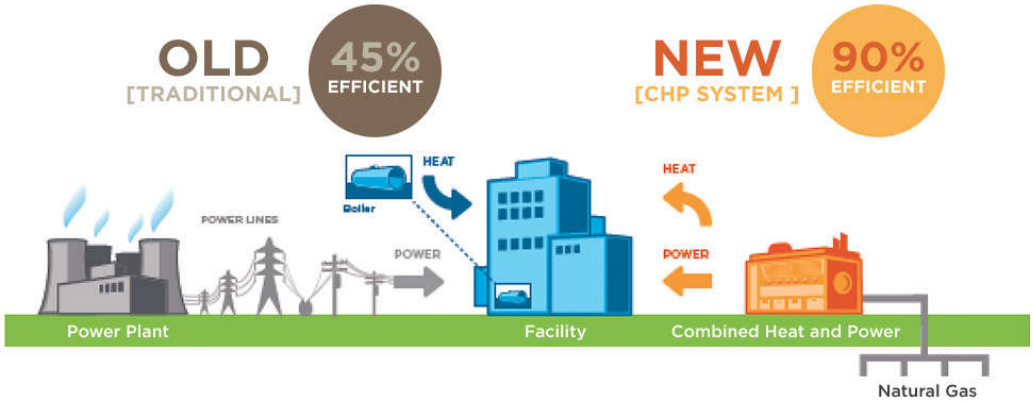
RE-ASSESS CHP INCENTIVES TO ALIGN WITH LONG-TERM CLIMATE GOALS

Background/Current Status

[29] Information shared by PA staff at September 15, 2020 C&I Management Committee Meeting

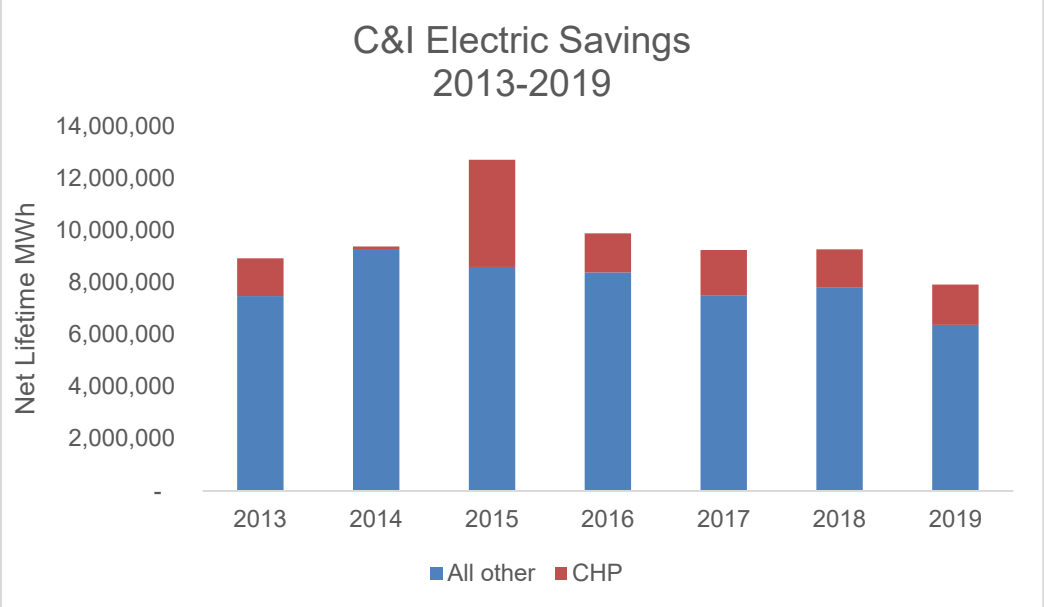
Combined Heat and Power (CHP) is the simultaneous production of electricity and useful thermal energy. CHP is a highly efficient form of energy conversion which can achieve primary energy[30] savings of up to 45% compared to the separate purchase of electricity from the grid and utilization of a gas boiler onsite for heating. CHP systems are typically found in hospitals, manufacturing facilities and other highly energy intensive facilities. CHP provides significant customer utility cost savings, and in New England, where we have high electricity prices and relatively low gas prices, these utility savings are even more pronounced than in some other parts of the country.

Figure 10. CHP Compared to Traditional Separate Electricity and Heating



CHP has been a major contributor to C&I electricity savings for the Mass Save program. Looking at the past two plan cycles (2013-2015 and 2016-2018) as well as the first year of the current plan cycle (2019), CHP has comprised over 17% of total net lifetime megawatt-hours. The remaining two years of this plan cycle are expected to bring even more CHP savings into the portfolio due to some very large systems being replaced in Eversource service territory.

Figure 11. C&I Electric Savings from CHP and All Other Measures

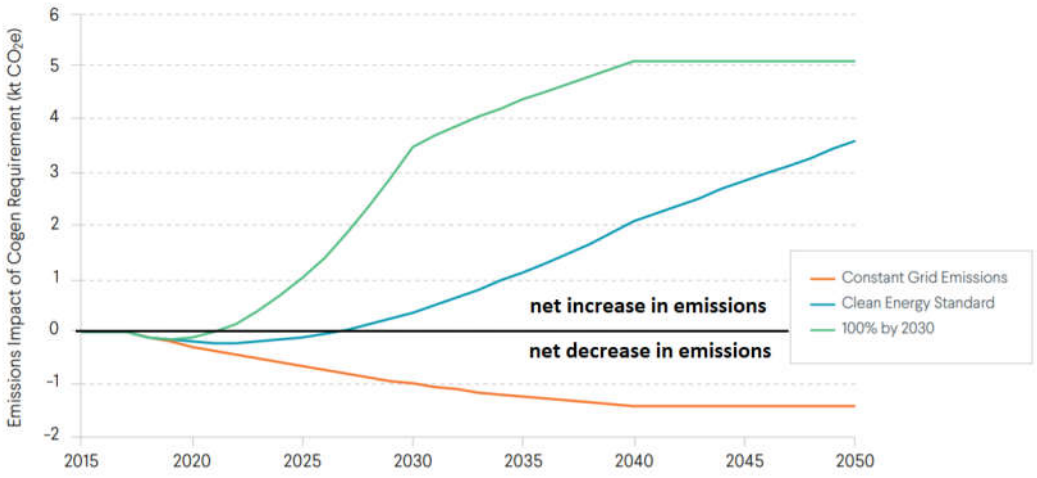


Historically, CHP has been a net source of greenhouse gas reductions. The efficiency gains of combined heat

[30] Primary Energy accounts for losses that occur in the distribution, storage and dispensing of the primary fuel (e.g., natural gas, fuel oil).

and power systems over traditional grid-sourced electricity and on-site heating through use of boilers has resulted in net reductions of emissions. However, as our electric grid becomes cleaner from renewable and other low-carbon power generation sources, CHPs net greenhouse gas emissions reach a tipping point and begin to produce net increases in emissions. According to the Boston Green Ribbon Commission's Carbon Free Boston Report and City of Boston Climate Action Plan, that tipping point is likely occur between 2025-2035 for the New England electric grid.[31]

Figure 12. Carbon Free Boston Report – CHP Emissions Tipping Point



Understanding that CHP systems are capital-intensive, and long-lived assets, it is imperative that we heavily scrutinize the impacts of these systems on GHG emissions. A new system installed in 2020 will likely be in operation well into the range of where CHP delivers a net increase in emissions. For this reason, all new CHP systems and those up for retrofit/refurbishment should be subject to an impartial lifecycle emissions analysis.

As previously noted, based on current electric and gas prices in New England, CHP systems are already very cost-effective for customers. DOER research indicates that these systems are already highly cost effective even without support the Alternative Portfolio Standard.[32] The CHP systems studied in this report had a simple payback of around one year, and it is extremely likely that these systems would still be very cost-effective without support from the PAs as well. For this reason, the probability of free-ridership is high and the programs very likely do not need to provide financial support in order to drive these projects forward. The last CHP impact evaluation was from program years 2011-2012, which is unheard of for such a huge part of the PAs' portfolio.[33] Net-to-gross factors were updated in a 2018 C&I Free-rider and Spillover study and found relatively low free-ridership amongst CHP systems, however, this study only surveyed a total of seven CHP participants and was unable to deliver the desired level of relative precision.[34] CHP is a significantly different technology than essentially all other energy efficiency measures and likely warrants a different approach to studying the impact factors used to claim savings.

Recommendations

12. **Re-asses incentives for natural gas fueled CHP** and consider reducing or eliminating all but the most energy-intensive market segments as necessary to meet long term climate goals.
    - Exemptions may include hospitals, pharmaceuticals, and manufacturing

31 https://www.boston.gov/sites/default/files/imce-uploads/2019-10/city_of_boston_2019_climate_action_plan_update_2.pdf
32 https://www.mass.gov/doc/alternative-energy-portfolio-standard-review/download
33 https://ma-eeac.org/wp-content/uploads/Combined-Heat-and-Power-2011-12-Program-Evaluation-November-2013.pdf
34 https://ma-eeac.org/wp-content/uploads/TXC_49_CI-FR-SO-Report_14Aug2018.pdf

- Prioritize and offer enhanced incentives for renewable fuel CHP systems such as those that run on anaerobic digester gas.

13. **Complete a dedicated CHP impact evaluation no later than 2022** that also includes an update to free-ridership, spill-over and net to gross ratios. Study new and replacement systems separately. Implement programmatic changes based on results of impact evaluation.
14. **For all CHP projects, conduct detailed lifecycle emissions analysis** using an impartial and agreed upon forecast of ISO New England's emissions intensity between now and 2050. Also conduct a project-by-project economic analysis that determines whether a given CHP project needs Mass Save support to generate a 5-year positive cash-flow.