Appendix F:

Custom, Refrigeration and
Compressed Air Potential Study

10/22/2018

MEMORANDUM

To: Anne Stephenson and Ian Burnes, Efficiency Maine

From: Joe Reilly and Andrew Cottrell, Applied Energy Group

Date: October 8, 2018

Re: C&I Custom Program, C&I Compressed Air Measures, and C&I Refrigeration Measures – Methodology for Program Planning Potential Analysis

1. Introduction and Study Objectives

The purpose of this memo is to provide Efficiency Maine with a detailed description of the methodological approach used to develop program budget and savings estimates for all measures potentially eligible for the Commercial and Industrial (C&I) Custom Program, as well as for C&I compressed air measures and refrigeration measures in Maine in the period from Fiscal Year (FY) 2020 through FY2022. The analysis determined achievable estimates for electric and natural gas savings as well as associated budgets for the entire C&I Custom Program and also for compressed air measures and refrigeration measures. The objectives for the study were to:

1. Analyze historical program achievements and characterize the potential market for each program;
2. Develop savings potential and budget estimates for FY2020-2022 for the C&I Custom Program, as well as compressed air measures, and refrigeration measures;
3. Project future program performance, including all savings (MWh, MW, MMBtu) and associated budgets; and,
4. Perform select scenario analyses to model impacts of key policy or market changes.

In order to achieve the study objectives, AEG conducted the following analytical steps:

Step 1. Market characterization

- Analyzed C&I customer billing data for investor-owned electric and natural gas utilities in the state of Maine and divided them into market segments (e.g., health care, manufacturing). The analysis helped to determine the baseline amount of consumption and customers in each market segment.
- Analyzed historical measure-level program data from FY2010 through FY2018. Historical trend analysis was performed to identify variance in program participation by segment and by measure, focusing on participation levels in FY2015-18. The measure data was linked to the billing data to quantify the remaining likely opportunity within customer segments.

Step 2. Develop measure savings estimates

- Calculated estimates for savings, incentives and costs for measures in the C&I Custom Program, as well as for any C&I compressed air measures, and refrigeration measures using the Efficiency Maine Technical Reference Manual (TRM)[1], where appropriate.
- Savings for prescriptive measures were estimated based on TRM guidance, using historical program tracking details to inform attribute-level assumptions.
- Savings for custom measures savings, incentives, and costs were estimated based upon historical average levels for each segment and adjusted based on industry standard expectations regarding expected market conditions.

Step 3. Assess future program potential

- Projected future program performance, participation and budget estimates were based upon historical trends by segment, taking into account future market, technological, and policy changes.

AEG compiled a variety of data sources to develop the inputs and assumptions needed to support the overall analysis. The table below summarizes the data development and key sources used for the analysis.

Table 1 Data Development for Program Potential Analysis

Model Inputs	Description	Key Sources
Market Size	Total electric and gas consumption and number of premises for customers in Maine.	Billing data from Central Maine Power, Emera Maine, Summit Natural Gas of Maine, Bangor Natural Gas, Unitil Natural Gas, and Maine Natural Gas
Measure Breakdown	-Measure types included in incentivized projects -Prevalence of each gas or electric measure type for each market segment -Average installed measure quantity for each measure type by market segment	Historical program data
Savings	-Total electric and gas savings by program and measure type -Average savings for each measure type	-Historical program data -Efficiency Maine C&I and Multifamily TRM, Version 2018.3
Measure Costs and Incentives	Average measure unit costs and incentives paid to customers.	-Historical program data -Efficiency Maine C&I and Multifamily TRM, Version 2018.3
Measure Attributes	-Inputs to savings algorithms (including annual hours of use, average horsepower) for compressed air and refrigeration measures -Custom measures were calculated from historical program data to determine average measure unit savings by segment.	-Historical program data -Efficiency Maine C&I and Multifamily TRM, Version 2018.3 -Xcel Energy Colorado TRM[2]
Avoided Costs	Forecasts for avoided costs of energy, electric generation capacity, natural gas, heating oil, kerosene, propane, wood and water.	AESC 2018

[1] Efficiency Maine Commercial/Industrial and Multifamily Technical Reference Manual Version 2018.3 Effective Date: January 1, 2018.

[2] The Maine TRM entry for custom measures recommends that savings estimates based on engineering analysis using project specific details. In lieu of specific project details, historical savings were used to develop estimates. Peak coincidence for custom measures based on Public Service Company of Colorado. 2017/2018 Demand-Side Management Plan. Colorado Public Utilities Commission. July 1, 2016.

2. Market Characterization

The market characterization uses both the customer billing data and the historical program participation data to formulate a "snap-shot" of current market characteristics and historical savings trends. The purpose of the market characterization is to provide context for the following research questions:

- How many customers have participated to date in each market segment and how much energy do they consume? What energy savings opportunity remains at these customer sites?
- How many remaining customers in each market segment have not yet participated? How much energy do they consume? What energy savings opportunity is at these customer sites?
- What are the typical project characteristics for custom, compressed air, or refrigeration projects for each market segment?

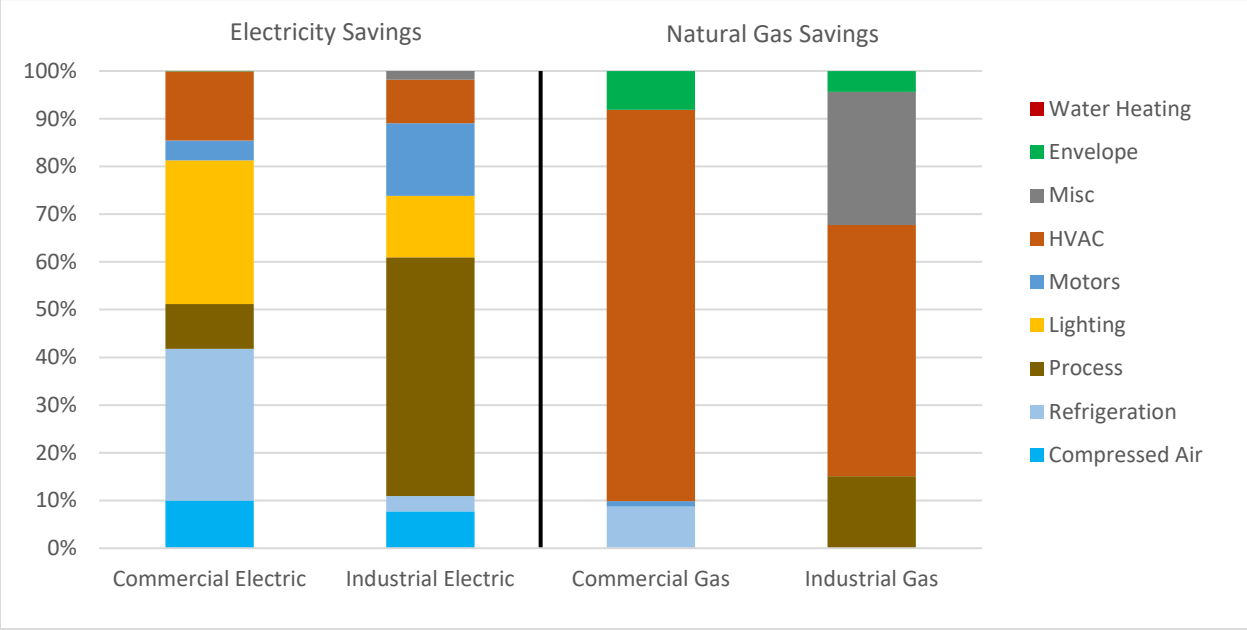
These questions help to characterize the market for the efficiency programs and anchor the analysis in historical market trends. To characterize the market, AEG conducted a detailed review of billing data and historical program data. Billing data from investor-owned electric and gas utilities in the state of Maine were used to determine the number of customers and the total amount of consumption in each market segment. The segmentation scheme used to structure the analysis is presented in the table below.

Table 2 Program Analysis Segmentation Scheme

Dimension	Variable	Description
1	Program	C&I Custom; C&I Prescriptive (compressed air and refrigeration measures only)
2	Sector	Commercial or Industrial
3	Segment	Commercial: Grocery, School, Marine, College, Health, Commercial Miscellaneous Industrial: Paper, Wood Products, Fabricated, Food & Beverage, Public Works, Transportation Equipment, Chemicals Plastics & Rubber, Computer & Electronics, Industrial Miscellaneous
4	Projects	Specific projects incentivized through one of the three Efficiency Maine programs listed above. A single customer may install multiple projects.
5	End Uses	End uses associated with the measures included in the programs above, including: Compressed Air, Refrigeration, Envelope, Process, HVAC, Lighting, Motors, Water Heating, and Miscellaneous
6	Measures	Measure types included in completed projects, according to Efficiency Maine's program database.
7	Installed Measure Quantity	Quantity of a single measure type installed in a project. For example, a lighting upgrade is considered one measure type within a project, but 1,000 LED bulbs may have been installed as part of the project.

Reviewing this historic program data, AEG determined that the electrical savings for the years FY2010-18 totaled 161,881 MWh and that 82% of these savings were realized in the industrial sector. Industrial electric savings were concentrated in the process end use; the commercial sector showed significant savings in refrigeration and lighting end uses.

Figure 1 Sector Electricity and Gas Savings by End Use for Custom, Compressed Air and Refrigeration Projects[3]



Historical gas savings for the years FY2015-18 were 307,818 MMBtu for the custom projects and refrigeration and compressed air measures, 87% of which was realized in the industrial sector. Both commercial and industrial gas savings were concentrated in the HVAC end use. The industrial sector also exhibited large gas savings in the miscellaneous end use due to one large automated processes project at a paper facility, funded through the Custom Program.

2.1 Program Performance Review

Identifying program participants according to market segment provided insight into the measure-level trends by facility type. For example, the health segment and grocery segment have distinct end-use profiles specific to consumption at those facilities. A health care facility may have a greater HVAC intensity compared to a typical commercial building; a grocery facility may have greater refrigeration consumption. By extension, these distinctive energy profiles may make certain measures more likely to result in energy savings. As such, including the participant data in the market characterization provides insight into future measure uptake as well as the remaining measure opportunities within each segment. Interviews with program staff indicated that there is remaining efficiency opportunities in each segment: AEG's analysis of participation by sector and energy consumption vs. savings per sector confirmed this.

First, AEG determined how past program savings compared to overall facility energy use. To do this, AEG developed a single customer database that included both billing data and program data for the analysis. By comparing program savings to facility energy consumption, AEG was better able to approximate the remaining level of savings potential as well as future measure savings and program uptake.

To create this database, AEG matched the billing data with the program participation data. Program participants were identified in the billing data using customer name and address. A subset of larger projects was also matched manually to help ensure accuracy. Overall, 79 percent of the program participants were positively identified using the billing data – ensuring a high likelihood that the previous program participants were not double counted. Unmatched participants typically had a nondescript name or an address that was listed as a

[3] Electric savings reflects program data from FY2010-2018; natural gas savings reflects program data from FY2015-18.

corporate mailing address (i.e., an out-of-state post office box). Next, the account-level billing data was aggregated to the facility-level. For example, a customer may have multiple accounts at a single premises property as well as multiple fuels. These accounts were aggregated to the level of individual facility for the analysis.

AEG then reviewed how program savings compared to the overall usage of the facility and identified remaining opportunity for energy efficiency in each segment. Each customer facility was assigned to a specific market sector and segment using the customer name and address. The segmentation workflow was prioritized beginning with the largest energy consumers, continuing through to medium and small customers, respectively. The largest customers were manually segmented due to their outsized impact on the segment to which they were assigned. Medium and small customers were assigned using keywords found in the customer name. Once the segmentation was established, a random sample of 10% of the database entries were manually checked to verify accuracy of the segmentation.

Once the database was assembled, we compared participants to the total number of premises in each segment. The figure below shows the cumulative total number of participants from FY2010 through FY2018 as a percentage of total premises in that segment. Results show that while many facilities have participated, a potentially significant opportunity exists for new participants in each segment in addition to repeat participation for customers who may have already participated.

The tables below compare historical total participants and savings by sector and segment.

Table 3 Cumulative Participants versus Customers

Sector	Segment	Total Premises in 2017	Cumulative Participants FY2010 – FY2018	% of Total
Commercial	College	930	11	1.20%
Commercial	Commercial Miscellaneous	25,611	102	0.40%
Commercial	Grocery	1,079	40	3.70%
Commercial	Health	6,548	7	0.10%
Commercial	Marine	408	9	2.20%
Commercial	School	2,867	32	1.10%
Commercial	**Subtotal**	**37,443**	**225**	**0.60%**
Industrial	Chemicals, Plastics & Rubber	27	6	22.40%
Industrial	Computer & Electronics	23	5	21.60%
Industrial	Fabricated	95	32	33.70%
Industrial	Food & Beverage	153	27	17.60%
Industrial	Industrial Miscellaneous	1,885	38	2.00%
Industrial	Paper	47	8	17.00%
Industrial	Public Works	404	7	1.70%
Industrial	Transportation Equipment	18	10	55.60%
Industrial	Wood Products	284	23	8.10%
Industrial	**Subtotal**	**2,937**	**156**	**5.30%**
Total	**Total**	**40,380**	**380**	**0.94%**

Overall, less 1% of the total commercial and industrial premises have participated in the C&I Custom Program, or installed compressed air measures, and refrigeration measures. This suggests that there are additional

opportunities for savings among customers who have not yet participated. To further verify the opportunity remaining in these segments, AEG compared the cumulative electric savings through efficiency projects in program years 2010-2018 compared to total consumption in the sector. The small percentage of cumulative savings compared to sector electricity consumption confirms remaining savings in all sectors.

Table 4 Cumulative Electric Savings versus Consumption

Sector	Segment	Total Consumption in 2017 (MWh)	Cumulative Electric Savings FY2010 – FY2018 (MWh)	% of Total
Commercial	College	143,077	5,008	3.50%
Commercial	Commercial Miscellaneous	1,612,268	9,674	0.60%
Commercial	Grocery	336,645	7,406	2.20%
Commercial	Health	538,297	2,691	0.50%
Commercial	Marine	177,007	2,301	1.30%
Commercial	School	339,196	1,018	0.30%
Commercial	**Subtotal**	**3,146,489**	**28,318**	**0.90%**
Industrial	Chemicals, Plastics & Rubber	85,212	2,897	3.40%
Industrial	Computer & Electronics	108,756	11,963	11.00%
Industrial	Fabricated	59,149	2,543	4.30%
Industrial	Food & Beverage	164,697	5,106	3.10%
Industrial	Industrial Miscellaneous	464,727	3,718	0.80%
Industrial	Paper	114,237	45,809	40.10%
Industrial	Public Works	259,129	3,887	1.50%
Industrial	Transportation Equipment	104,372	3,236	3.10%
Industrial	Wood Products	153,665	17,979	11.70%
Industrial	**Subtotal**	**1,513,944**	**121,116**	**8.00%**
Total	**Total**	**4,660,433**	**149,434**	**3.21%**

Overall, the cumulative total electric savings from FY2010 through FY2018 amounts to 3.21% of total electricity consumption in 2017. As in the table above, this is another indicator that additional savings opportunities exist among C&I customers for custom, compressed air, and refrigeration measures. Nevertheless, the data shows that some segments are more represented than others. For example, the paper segment has the highest percentage of cumulative savings, however, additional opportunities may exist among customers who have already participated or by bringing new customers into the programs.

Table 5 Cumulative Natural Gas Savings versus Consumption

Sector	Segment	Total Consumption in 2017 (MMBtu)	Cumulative Natural Gas Savings FY2015 – FY2018 (MMBtu)	% of Total
Commercial	College	664,203	28,561	4.30%
Commercial	Commercial Miscellaneous	6,911,172	0	<0.01%
Commercial	Grocery	433,462	3,468	0.80%
Commercial	Health	2,535,670	-	-
Commercial	Marine	1,537,014	-	-
Commercial	School	1,410,479	2,821	0.20%
Commercial	**Subtotal**	**13,492,000**	**40,476**	**0.30%**
Industrial	Chemicals, Plastics & Rubber	726,300	-	-
Industrial	Computer & Electronics	336,418	1,346	0.40%
Industrial	Fabricated	289,183	17,351	6.00%
Industrial	Food & Beverage	452,071	-	-
Industrial	Industrial Miscellaneous	1,598,155	11,187	0.70%
Industrial	Paper	116,047	77,868	67.10%
Industrial	Public Works	108,898	-	-
Industrial	Transportation Equipment	177,655	-	-
Industrial	Wood Products	87,459	-	-
Industrial	**Subtotal**	**3,892,186**	**252,992**	**6.50%**
Total	**Total**	**17,384,186**	**293,468**	**1.69%**

Overall, the cumulative total natural gas savings from FY2015 through FY2018 amounts to 1.69% of total natural gas consumption in 2017. Many segments have not yet achieved natural gas savings, which is an indication that more potential exists with for these measures. Results of the market characterization will be used to help anchor future participation and savings estimates to historical program participation.

2.2 Interviews with Program Managers

In addition to quantitative analysis, AEG conducted structured, in-depth interviews with program managers from both the prescriptive and custom programs to learn more about how programs are implemented, to help identify market barriers, and to identify new opportunities for potential. Interview questions varied slightly for the two programs, but generally included the following topic areas:

- Program implementation topics: Target market; market barriers and changes; program operations
- Trade Ally Networks: Qualified Partner Network coverage, engagement, feedback
- Program Performance: Measures; observed market trends; challenges and achievements

Program managers have visibility and insight into current and future market conditions that may not be evident in the data shown. For example, program managers provided insight on specific measures and market dynamics. Analysis of past program data suggested a large savings opportunity from back-pressure steam turbines; however, program manager input revealed that the custom program has already incentivized most of the cost-effective projects that could potentially be achieved in the state and therefore the measure is unlikely to be part of the program moving forward.

Additionally, program managers provided valuable information that informed savings estimates but are not self-evident the program data analysis. For example, economic factors have resulted in reduced activity among paper mills. While there may still be significant opportunity in existing paper mills, given their unique end-use characteristics and large amount of energy consumption, the overall statewide opportunity is less than in prior planning periods.

3. Future Program Performance Projections

After establishing the market characterization using the participant and billing database, the next step was to project future program performance and budget estimates.

3.1 Measure Characterization

Each program was broken into its constituent measures to identify historical trends at the measure-level and to determine the average project profile for each market segment. Each market segment's average project profile reflects the types of measures and quantity of installations that customers in each segment chose to install. The measure-level granularity also allows for the model to account for reductions in measure savings that may shift to other program offerings within the Efficiency Maine portfolio. For example, custom lighting opportunity may decline as these projects shift to prescriptive lighting programs.

In addition to existing measures, AEG considered other options for measures utilizing our Database of Energy Efficiency Measures (DEEM). AEG has maintained DEEM since 2004 as a comprehensive database that includes highly-detailed information on thousands of measures and emerging technologies applicable for residential and C&I customers. DEEM is updated continually to reflect new source material and new technologies. Each database entry references the original source containing the measure information, including the Efficiency Maine Commercial/Industrial and Multifamily Technical Reference Manual (TRM). Results show that many of the current projects and measure-types remain cost-effective over the next three-year plan period. Technology trends show developments for consideration in compressed air leakage management, process upgrades and heat recovery equipment.

3.2 Program Savings and Budget Estimates

Future program savings and budget estimates were based on a combination of historical program achievement and expected program uptake given the market potential in each segment. Project savings were calculated separately for the C&I Custom Program, compressed air measures, and refrigeration measures. Average historic custom savings by project and end use formed the basis for measure savings estimates in the C&I Custom Program. For prescriptive measures, the algorithms from the TRM were used to calculate measure savings with different assumptions at the attribute level to reflect conditions specific to the market segment. Historical program data was used to develop inputs for the savings algorithms. For example, the historical program data included information on annual hours of use (HOU) and equipment ratings (system horsepower or cubic feet per minute) for most refrigeration and compressed air projects. These data were aggregated by segment to calculate average segment attributes to be used as inputs to the TRM savings algorithms. For example, the hours of use for a grocery store may differ than the hours of use for a typical commercial building.

The future program savings and budget estimates were modeled using BenCost, AEG's Program Planning and Cost Benefit Analysis Tool. BenCost is a Microsoft Excel®-based model primarily used to perform benefit cost modeling. AEG's BenCost conforms to industry best-practices in cost-effectiveness analysis and was customized to include the approved planning assumptions provided by Efficiency Maine. In particular, the BenCost model was calibrated to reflect Efficiency Maine-specific discount rates, retail rates, and avoided cost forecasts.

The results showing the program savings and budget estimates are included below as well as in Triennial Plan IV, Appendix B. A detailed review of future participation levels show a decline in overall budgets from the average of the last five year period. This shift can largely be explained by the following:

- A shift of lighting measures out of Custom and into the Prescriptive Program.
- A decline in the paper industry, leading to decreased participation
- A portion of refrigeration measures failed to pass the cost-effective test
- Combined heat and power projects smaller than 250 kWh could not pass the cost-effective test when operations and maintenance costs were considered.

Results indicate that positive savings potential for compressed air and custom measures over the next three-year period, comprised of a mix of new participants and customers who have already participated. Overall, results show that there is cost-effective savings potential across all major sectors and customer types for the next three-year planning cycle.

Table 6 Cost-Effectiveness Results

Measure Name	TRC	Benefits (3-year average NPV)	Costs (3-year average NPV)	Program Budget 2020	Program Budget 2021	Program Budget 2022
Custom: Electric	2.73	$16,456,536	$6,018,139	$3,378,377	$3,378,377	$3,378,377
Custom: Natural Gas	1.68	$353,958	$210,216	$115,791	$115,791	$115,791
Custom: Unregulated Fuels	3.36	$1,149,425	$342,023	$205,069	$205,069	$205,069
Custom: Distributed Generation	2.60	$3,225,982	$1,241,911	$541,353	$541,353	$541,353
Prescriptive: Compressed Air	4.51	$818,120	$181,337	$215,807	$215,807	$215,807
Prescriptive: Refrigeration	4.04	$379,656	$93,933	$72,984	$72,984	$72,984