

Towards the End of the Lighting Tunnel: The End-uses that Matter

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ABSTRACT

Electric utility energy efficiency programs that provide prescriptive rebates for commercial and industrial (C&I) customers rely heavily on lighting improvements to meet their regulatory energy savings targets. Such delivery methods have pros and cons pertaining to customer participation, cost effectiveness, and meeting customer needs. This paper focuses on a standard incentive program in Illinois, which has historically been dominated by lighting savings. Despite a rapid increase in light-emitting diode (LED) lamp and fixture adoption, the program has seen increased diversity with growth of non-lighting measures, including energy management systems (EMS), variable-speed drives (VSD), refrigeration, HVAC, and compressed air technologies.

Over a nine year period, the program saw a 12 percent decrease in the share of savings from lighting measures while the non-lighting share rose from eight percent to 20 percent of total program savings. Recent legislation in Illinois that mandates annual energy savings goals be based on cumulative persisting annual savings (CPAS) and emphasizes a shift to valuing the lifetime savings of the measure has generated interest in prioritizing measures that have long lives, with increasing focus on non-lighting measures to help attain future years' energy savings goals.

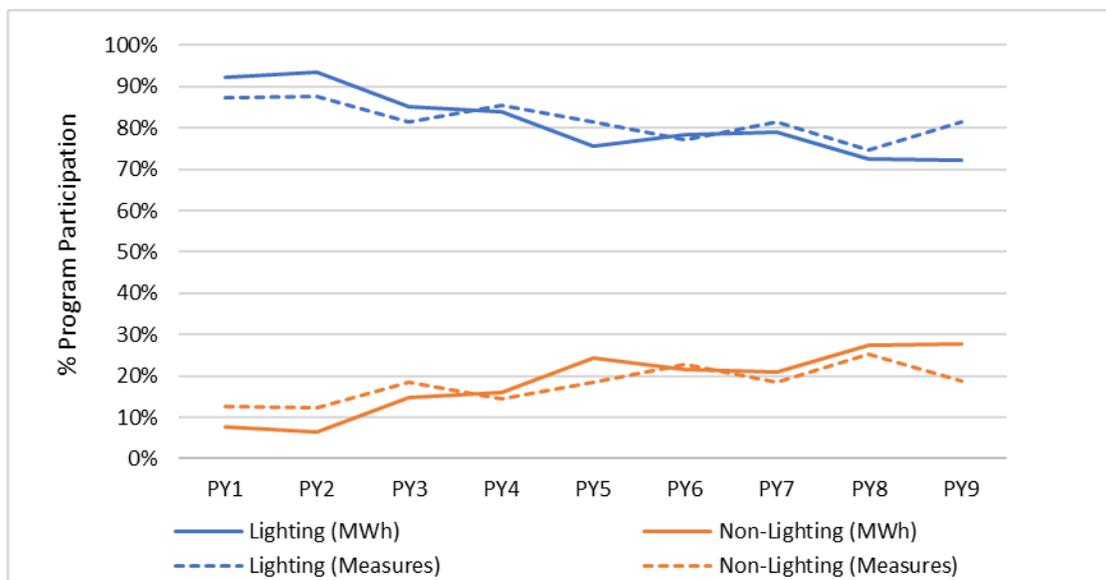
This paper discusses the factors that drive the increasing share of non-lighting measures, and how this increased participation affects the program realization rate, cost effectiveness, free ridership, and trade ally recruiting and training. The paper analyzes past actions that have affected program success in diversifying its measure mix, and discusses potential areas of opportunity for the program to improve the non-lighting share of program savings as the role of lighting technology fades, and draws lessons for other similar programs.

Introduction

The Commonwealth Edison (ComEd) Standard Program offers prescriptive financial incentives and a streamlined application to facilitate the implementation of cost-effective energy efficiency improvements for non-residential (commercial and industrial and recently public sector) customers and market segments, with a program network of trade allies and service providers driving the promotion of the program to customers. Eligible measures include energy-efficient indoor and outdoor lighting and controls, as well as non-lighting measures including HVAC equipment, energy management systems (EMS), variable speed drives (VSDs), compressed air equipment, and equipment with targeted market applications, such as laboratory, combined heat and power (CHP), farm and commercial food service equipment, and grocery refrigeration measures.

Lighting measures have dominated the program since the program began in 2008 (program year 1 or PY1), in both measure counts¹ and share of savings, as seen in Figure 1. However, lighting's share has declined by approximately 12 percentage points over the PY1-PY9 period. Although the program has not set an explicit target to achieve increased non-lighting participation, it has undertaken strategic initiatives to diversify the program away from heavily reliance on lighting. These have included maintaining non-lighting incentive availability during times when lighting measures are wait-listed during periods of program oversubscription. The program has also provided bonuses to customers for projects with multiple end-use improvements, which are aimed at improving underperforming non-lighting measures, and has worked to recruit, train and offer performance incentives to non-lighting trade ally network and service providers to boost participation and savings generated by many non-lighting measures.

Figure 1. Lighting and non-lighting shares of savings and measure count



Source: ComEd Evaluation Reports PY1-PY9 and review of tracking database: Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/comed_eval_reports.html

Changes to federal legislation and market saturation have provided barriers to continued reliance on lighting savings and are great challenges to the program. These barriers have encouraged program interest in non-lighting measures. The factors associated with this interest are explored further in the next section, followed by the programmatic impact of these factors and how these impacts drive the program success into the future and what lessons have been learned.

¹ Measure count is project-level count of type (lighting or non-lighting) of measures installed, not the unit of quantities reported in program tracking system (unit of quantity may differ by type of measure and input used to estimate savings, e.g. watts reduced, per sign, etc.)

Factors Driving Growth in Non-Lighting Measures

Several incentive regimes and bonus structures for existing or new measures have been implemented by the program over the years. As shown in Table 1, until PY5 the program focused the bonus incentives on lighting end-uses, although incentive structures were also designed for the growing number of non-lighting end-uses and measures. Recently, bonus incentives focus on high impact and long life non-lighting technologies including VSDs, water- and air-cooled chillers, HVAC, and other comprehensive energy savings bonus offerings. Trade allies are given the opportunity to earn performance bonuses based upon how much energy savings they bring into the program, encouraging non-lighting trade allies to increase the size and quantity of projects submitted.

Table 1. Incentive and bonus types implemented over the program years

Program (Year)	Incentive End-uses	Bonuses	New Measure Incentives
PY1 (2008)	Food Service, HVAC, Lighting, Motors, Refrigeration, VSD		
PY2 (2009)	PY1 + Compressed Air		
PY3 (2010)	PY2 + Other	Lighting (e.g. T12 retrofits, New T5/T8), Trade Allies	Several VSD measures (incl. HVAC pumps, fans, and chillers, compressed air)
PY4 (2011)	PY2 (exclude Motors)	Lighting (e.g. T12 retrofits, New T5/T8), Trade Allies (performance reward system)	
PY5 (2012)	PY4 + Industrial Systems + EMS	Lighting (e.g. New T5/T8, occupancy sensor), Trade Allies (performance reward system)	EMS
PY6 (2013)	PY5 + Motors + Other	Energy Efficiency Expo (E3), Zero T12, HVAC Winter Bonus	
PY7 (2014)	PY6 + Advanced Lighting	Zero T12	Advanced lighting system and controls, advance controls for Rooftop systems
PY8 (2015)	PY7	Zero T12 (Q1)	Advanced lighting system and controls, EMS, advance controls for Rooftop systems
PY9 (2016/2017)	PY8	Energy Management Assistance, Comprehensive Energy Savings, Office Space Offering, Made in Illinois Bonus	Add LED screw-based HID replacements, compressed air systems, industrial systems, new refrigeration measures
			Decrease or remove incentives for several lighting measures (e.g. LED and T8/T5 reduced watts, metal halides, fluorescent and induction fixtures, occupancy sensors)
CY2018	NA	VSD, Chiller, Waste Water Treatment Plant,	Dark Sky, changes to comprehensive, office space, compressed air storage, traffic lights

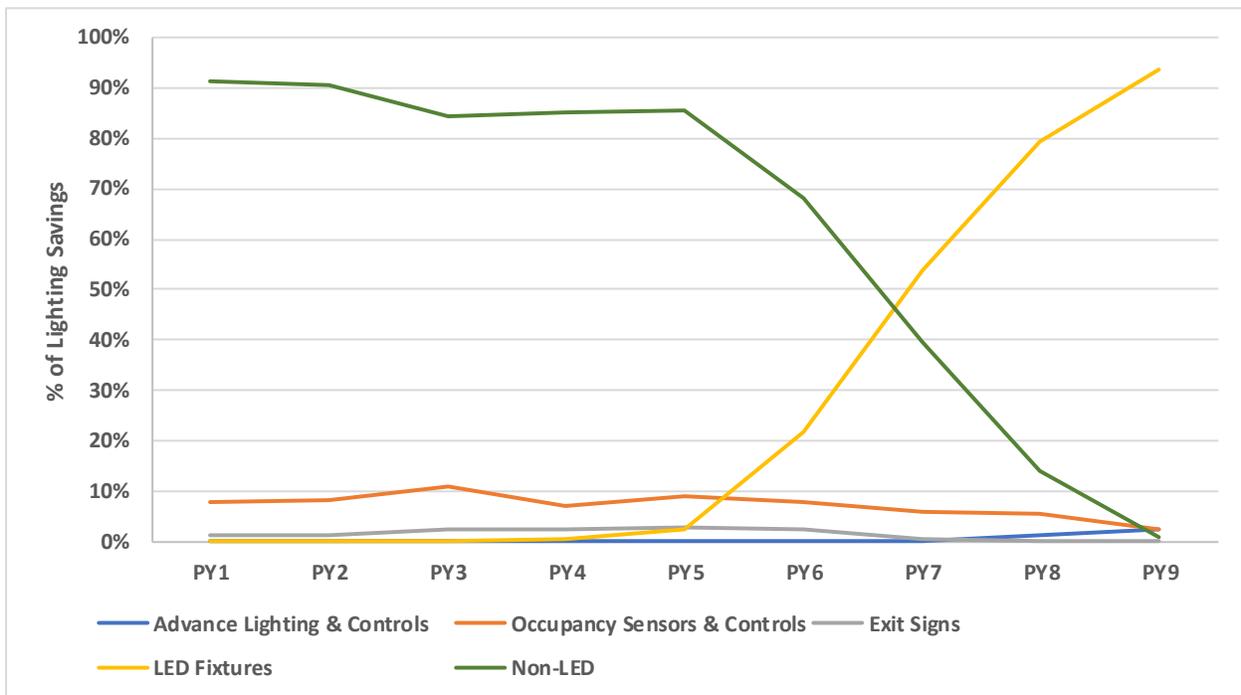
Source: ComEd Evaluation Reports PY1-PY9. For PY1 through PY4, refer to C&I Prescriptive Program or Business Prescriptive Program. For PY5 through PY9, refer to Business Standard Program. http://www.ilsag.info/comed_eval_reports.html. CY2018 is not final evaluation verified and are presented for context.

Other factors introduced to expand non-lighting measures include offering larger customers options for technical assistance in identifying projects at their facilities, streamlining

the application process, and deeming gross savings for most non-lighting measures through the Illinois Technical Reference Manual (IL-TRM).² These steps have minimized uncertainty on savings estimates, improved customer and trade ally understanding of savings estimation methodology, and increased participation in the non-lighting measures.

The program must adapt measure offerings and strategies each year to legislative changes. The federal Energy Independence and Security Act of 2007 (“EISA”) that mandates an increase in minimum efficiency standard for certain lighting baselines, and recent new legislation in Illinois (Future Energy Jobs Act)³ that encourages electric utilities to implement measures that have long lives and persistence, are two significant drivers. While the program now promotes more efficient and long-lived lighting technologies (e.g. LEDs and advanced lighting and controls), these new laws spurred market potential studies supporting the program by providing directional information on key customer classes, customer segments, and end-use technologies to drive opportunities for non-lighting participation and savings. Presented in Figure 2 and Figure 3, are the MWh trends of the lighting measures and non-lighting end-uses (focus on high impact measures) since the program became relatively mature with more non-lighting end-uses (PY5-PY9 analysis).

Figure 1. Lighting measures MWh savings trend

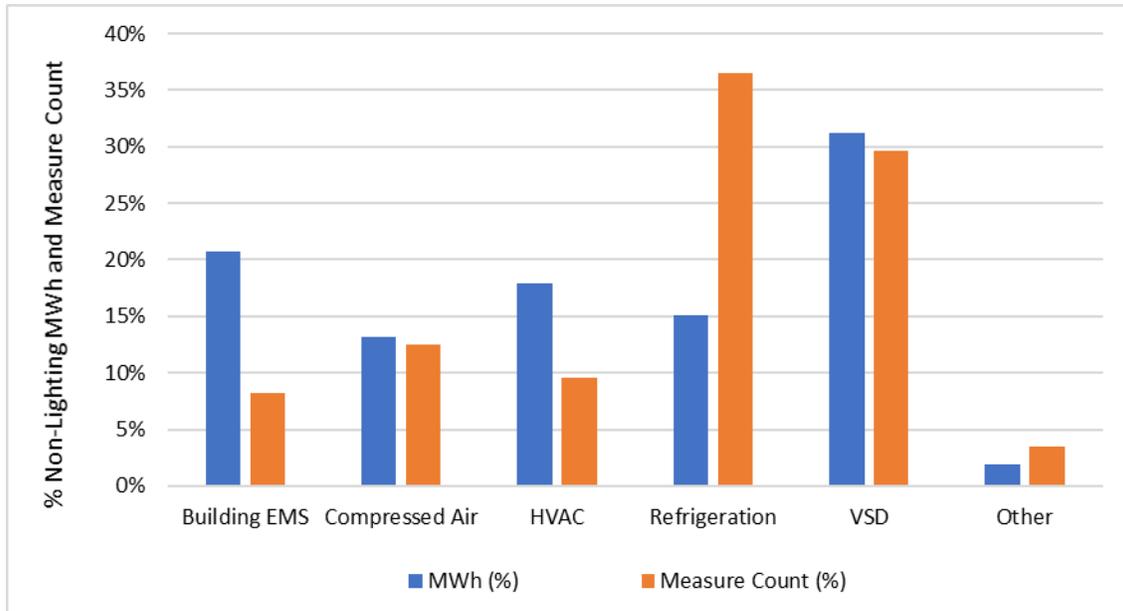


Source: ComEd Evaluation Reports PY1-PY9. For PY1 through PY4, refer to C&I Prescriptive Program or Business Prescriptive Program. For PY5 through PY9, refer to Business Standard Program. http://www.ilsag.info/comed_eval_reports.html

² Illinois Statewide Technical Reference Manual for Energy Efficiency, <http://www.ilsag.info/technical-reference-manual.html>

³ Future Energy and Jobs Act (IL Public Act 099-0906), Section 8-103B.(b) <http://www.ilga.gov/legislation/publicacts/99/PDF/099-0906.pdf>

Figure 2. Non-lighting measures MWh savings trend and measure count



Source: ComEd Evaluation Reports PY1-PY9 and review of tracking database: Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/comed_eval_reports.html. Data covers PY4-PY9 since the program became more matured with more non-lighting end-uses.

Trends in lighting participation have changed from non-LED technologies including T12 fluorescent, T5/T8 lamps, high performance and reduced wattage fixtures (HPT8/RWT8), induction lighting, CFLs, bi-level fixtures, and metal halides, to LED fixtures and lamps (including advanced lighting systems and controls). LED market saturation is not a subject of this paper, but as seen in Table 1, the reliance of the program on LEDs to achieve most program savings goals not only poses a challenge but a risk to the program. With inclusion of an EMS end-use application, the program has seen a 20 percent share of non-lighting savings over the past five years (over the last three program years, EMS has averaged eight percent of the total program savings and has become the highest contribution to non-lighting savings). Trends in VSDs, HVAC chillers, new compressed air and refrigeration technologies, and other high-impact measures are expected to increase non-lighting participation and savings, although certain programmatic factors need a critical review to achieve expected results. These include cost effectiveness, code baseline requirements, measure free ridership, gross savings realization, persistence and trade ally technical assistance and incentives.

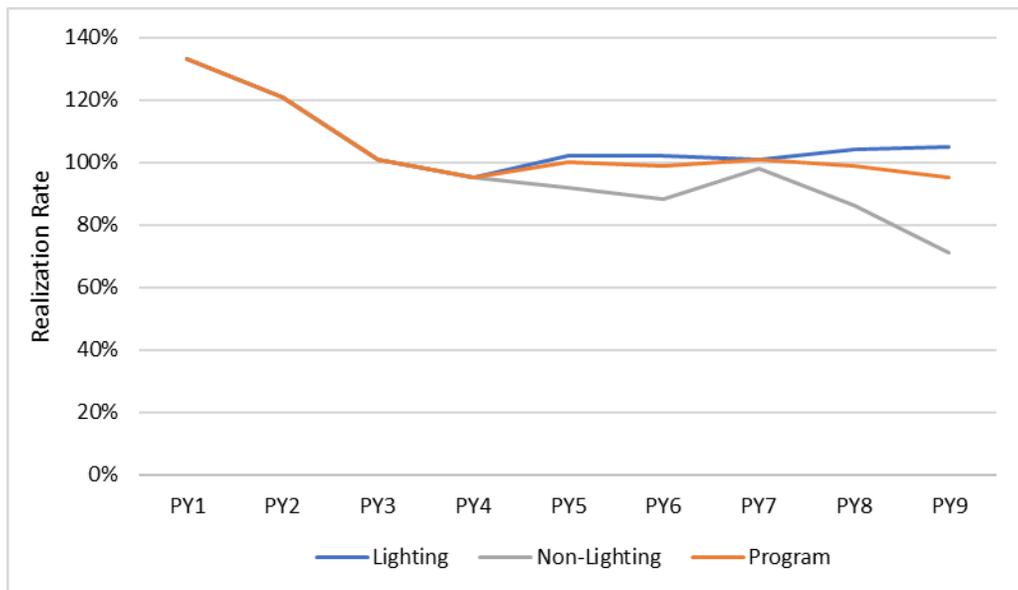
Programmatic Impact

Free Ridership and Realization Rate

The program overall **savings realization rate** (or ratio of evaluation verified gross savings to program reported gross savings) has stabilized over the years, driven by high realization rate in the initial years when lighting dominated the program, to an average 100

percent since PY5. Beginning with the PY5 evaluation, the non-lighting participation became statistically significant to warrant a split of the gross savings realization rate and net-to-gross ratio analysis for the lighting and non-lighting program components. While the lighting savings realization rate has averaged 103 percent during the same period from PY5-PY9, the results from non-lighting end-uses have been relatively low (averaging 87 percent), as shown in Figure 4.

Figure 3. Gross MWh realization rates by end-use

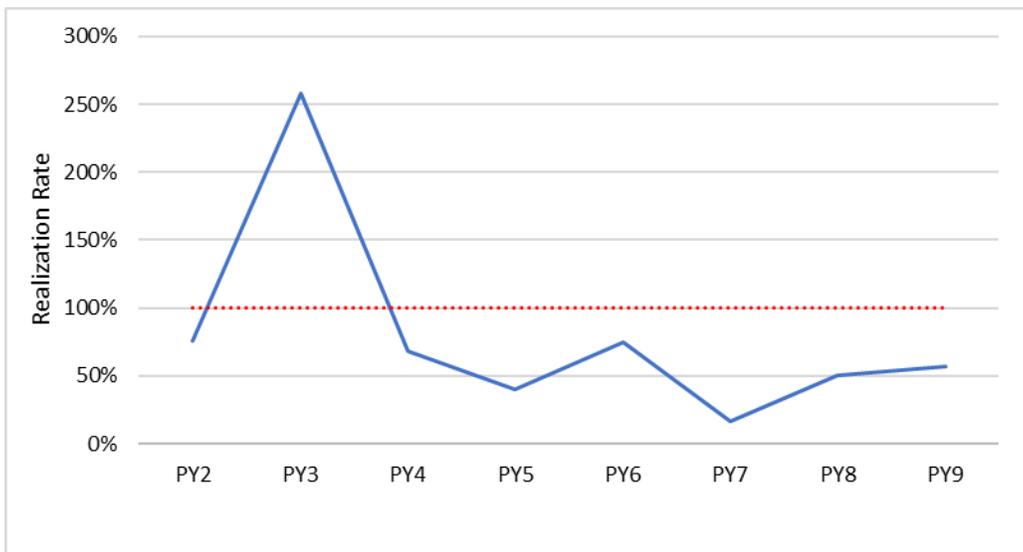


Source: ComEd Evaluation Reports PY1-PY9: Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/comed_eval_reports.html.

While lighting savings are based almost completely on deemed assumptions from the IL-TRM, the deemed inputs for non-lighting measures are supplemented, in accordance with the IL-TRM, by using ComEd workpapers and site-collected data to guide the estimation of non-deemed or custom savings inputs. Unlike fully deemed inputs, custom inputs are subject to retrospective evaluation adjustment of claimed impacts.

Findings from evaluation and monitoring (M&V) have shown the highest variation in non-lighting savings realization rates are found in the building EMS measures, HVAC chillers, and VSDs. In analyzing the factors impacting the contribution by measure types to the lower overall non-lighting savings realization rate, realization rates for VSDs and HVAC receive reductions from disqualification of measures from individual projects for not meeting program eligibility requirements, such as not having feedback controls or operating at a fixed speed instead of modulating. Other adjustments were made due to incented equipment being deemed to be required by code. It was observed from billing analysis or interval data that EMS projects have had low savings realization rates and high variability in site-specific data to estimate savings, as shown in Figure 5. Retrospective evaluation adjustment to EMS and other non-lighting measures with low realization rates affects program savings goal achievement, but minimizing negative impacts requires attention to causes unique for each non-lighting measure type.

Figure 4. Historical EMS gross savings realization rate

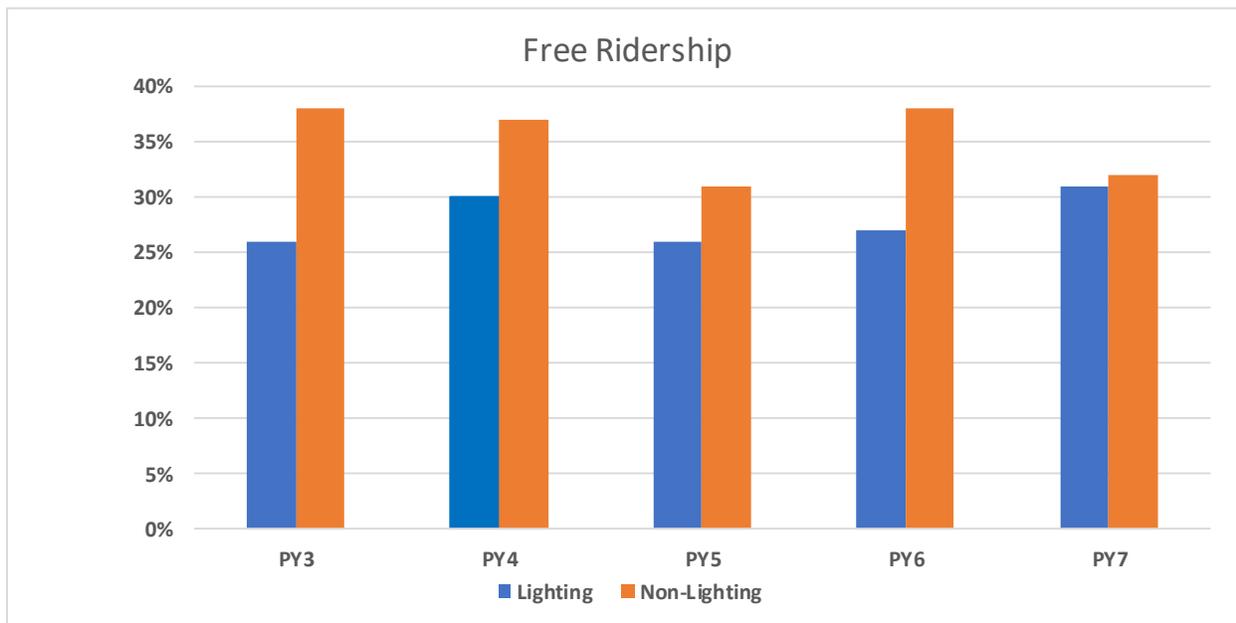


Source: ComEd Evaluation Reports PY1-PY9 and review of tracking database: Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/comed_eval_reports.html. EMS data includes projects installed in the Standard and Custom programs of the ComEd Business Incentive program.

Free ridership research findings, shown in Figure 6, provide an estimate of what would have happened in the absence of the program, based on customer self-report from data gathered during participant telephone interviews.⁴ As shown in Figure 6, free ridership research estimates from the non-lighting end-use is historically higher than lighting end-use, and this affects the program net savings impact.

⁴ Free ridership is defined as the proportion of program savings that would have been installed by participating customers in the absence of program influence.

Figure 5. Free ridership values for lighting and non-lighting end-use



Source: ComEd Evaluation Reports PY1-PY9 and review of tracking database: Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/comed_eval_reports.html. EMS data includes projects installed in the Standard and Custom programs of the ComEd Business Incentive program.

Research is currently required as part of program evaluation to provide recommendations for reducing free ridership among program participants, including assessment of free ridership impact of the current bonus incentives being rolled out for non-lighting measures. Previous research assessed the impact of bonus offerings on free ridership, mostly from respondents with lighting bonus, but findings did not show a significant difference from the program overall free ridership estimate.

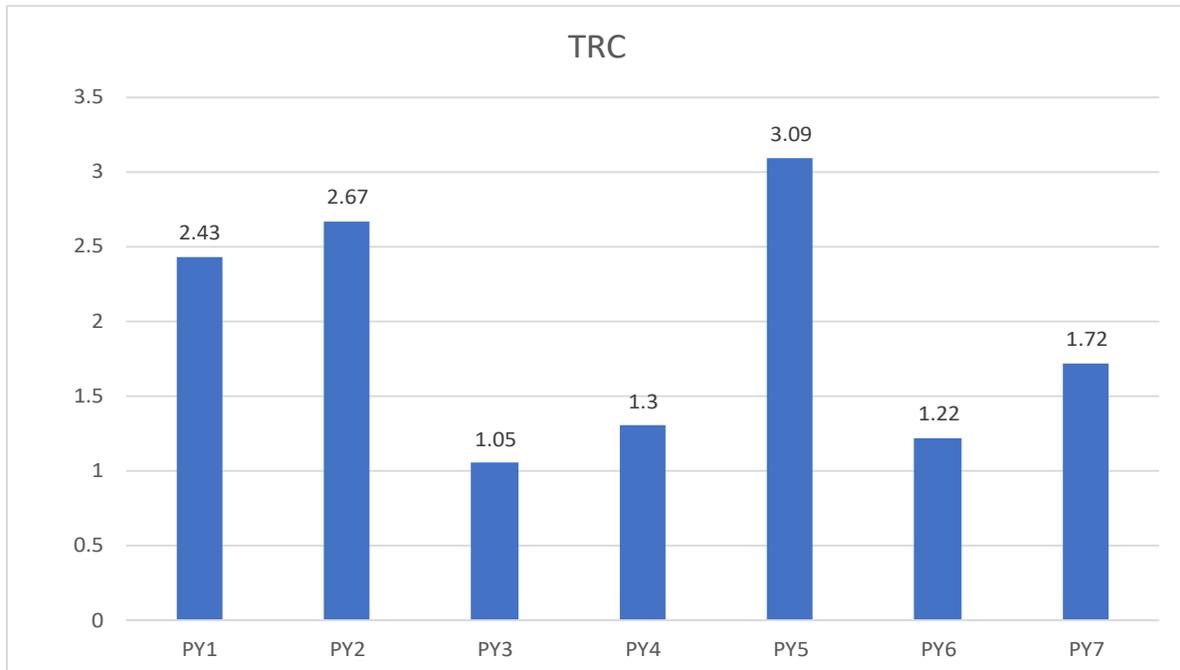
Cost Effectiveness

Cost effectiveness of the program is assessed to determine whether the energy efficiency improvement lighting and non-lighting measures satisfy the Illinois total resource cost (TRC)⁵ test (benefit-cost ratio) over the life of the installed measures, considering other quantifiable societal benefits. The Illinois TRC results for the program does not disaggregate results by lighting versus non-lighting, as such, limited information can be presented in this paper about the actual cost effectiveness of the non-lighting component of the program. From Figure 7, the TRC

⁵ The Illinois TRC test is defined in the Illinois Compiled Statutes (ILCS) Section 8-104b as follows: "Cost-effective" means that the measures satisfy the total resource cost test which, for purposes of this Section, means a standard that is met if, for an investment in energy efficiency, the benefit to cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the measures to the net present value of the total costs as calculated over the lifetime of the measures.

test remains above the 1.00 threshold⁶, indicating the program is generally cost effective, although values have been historically higher in the initial years, when lighting dominated the program savings.

Figure 6. Illinois TRC test for programmatic impact



Source: Illinois Stakeholder Working Group. TRC Reports for ComEd Business Standard Program (formerly C&I Prescriptive). http://www.ilsag.info/trc_reports.html. PY7 TRC value is still draft at the time of submitting this draft paper.

Future program TRC analysis is expected by stakeholders to produce results at the measure or end-use level and made publicly available for better assessment of the cost effectiveness of non-lighting measures, as their increasing participation, incremental cost, and share of savings become crucial for program success.

Trade Ally Recruitment and Training

Trade allies are a key part of the Standard Program marketing and outreach. Several opportunities are provided by the program to actively get the trade allies and service providers to engage with non-lighting customers. These have included being registered trade allies and being listed on ComEd website, group training, access application status, sales coaching, discount on technical training, eligibility for trade ally bonus. These efforts have seen increasing number of non-lighting trade allies in the program, which historically has been dominated by lighting trade allies (current ratio is about 4 to 1 lighting to non-lighting trade allies and contractors in the program).

⁶ The PY5 TRC value of 3.09 is exceptional, resulting from high levels of demand savings, which meant the TRC benefit/cost ratio benefited from an assumption of high value of avoided transmission and distribution (T&D). The program and evaluation team revised this assumption in subsequent years.

The program experienced oversubscription in late PY7 and early PY8, which were marked as success from the program's strong network of trade allies and contractors, and coincided with the increasing share of the non-lighting program participation (see Figure 1). The strong demand urged ComEd to place applications by trade allies and contractors onto a wait list system, and granted funding on a first-come, first-serve basis as funds became available.⁷

Awareness and satisfaction among trade allies and contractor participants in the wait list process and program overall have been higher, and partly due to effective program communication through several marketing channels, including monthly marketing newsletter ("The Wire"), hosting special webinars, providing tips to trade allies about customer engagements, and hosting bimonthly paperwork sessions.

For the program to continue to increase non-lighting trade ally share will require providing comprehensive bonus incentives on high impact and long life non-lighting technologies (include providing lighting trade allies incentives to install non-lighting technologies), improve information dissemination to customers on the status of their projects especially during a wait list regime.

Areas for Improving Non-lighting Share

Several non-lighting end-use technologies are promoted by the program. As stated above, the program adaption to federal and legislative changes requires that measure offerings and strategies are developed to promote high impact non-lighting measures with long life and persistence. Reviewing program performance is necessary to optimizing the performance of the all measures, especially the harder to reach non-lighting measures. The following section details the findings from this effort in the ComEd Standard Program.

Holistic Approach to Improvement

Energy management systems have historically been a significant contributor of energy savings to the ComEd Standard Program, accounting for an average of six percent of the overall program savings since PY5. Working against the success of the EMS measure is the volatile realization rates that have accompanied this measure (See Figure 5). Facilitated by monthly meetings, the program staff, implementer, and evaluator have worked together to identify opportunities to improve the predictability and realization rate of this measure. Several options have been proposed which address the different elements of the measure, including sampling, deeming savings, reviewing savings methodology and application criteria. Efforts are currently in progress to further develop some of these approaches for use in the following program year.

Lessons learned from this effort have shown that improving regular communication between program staff and implementation and evaluation teams allow for program inefficiencies to be addressed, and improve trust and understanding to reduce surprises during every cycle of evaluation, particularly for non-lighting technologies.

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http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY8_Evaluation_Reports_Final/ComEd_Standard_Program_PY8_Evaluation_Report_2017-01-15_Final.pdf

Investigation of Past Failures

Variable speed drives are the largest non-lighting source of energy savings. As such, it is important to minimize reductions to the realization rate of VSD projects. In PY9, several large VSD projects were adjusted negatively during evaluation due to disqualification of measures from individual projects for not meeting program eligibility requirements as mentioned above.

This finding has led to a review of pre-application review procedures to identify these instances and correct or account for them prior to the measures implementation. In addition to updated internal review processes, a “parallel path” review process has been implemented to allow evaluation input prior to the final program evaluation. It is not yet known why the customers are installing the VSDs in these fashions, but the program’s awareness of this issue has led to process improvements that should reduce their occurrence. Additional research is being considered to determine whether a fixed speed VSD measure is appropriate for the program.

The concept of investigating poor realization rates applies to programs broadly. They are areas where improvement could lead to significant increase in verified energy savings, the results of which would increase the non-lighting savings in future program years.

Evaluation of Measure Performance

Eighty-nine percent of compressed air savings come from VSD compressors, with the remaining 11 percent from other measures including desiccant dryer, filters, flow controller, no-loss drains, and refrigerated cycling dryers. This disparity was investigated to determine whether it is reasonable, while also attempting to identify opportunities to improve non-compressor measure participation. For reference, the 2017 Focus on Energy Business Incentive Program generated 22 percent of their compressed air savings from non-compressor measures.⁸ The investigation of the ComEd Standard program compressed air measure performance resulted in several findings, indicating the value of this exercise to generate savings from non-compressor measures.

1. The compressed air incentive worksheet is difficult to find on the program website, relative to other incentive worksheets.
2. Eligible equipment such as cycling refrigerated dryers and no-loss condensate drains, when integrated in new VSD compressors were not being applied for. In a review of the last three programs years, evaluation found about 25 percent of compressed air projects contained a “missed opportunity.”
3. ComEd offered 12 compressed air measures, though only three had significant participation: VSD air compressors, cycling refrigerated dryers, and no-loss condensate drains. This indicated that either certain measures had barriers to adoption, which would require further research to identify.
4. Of the 12 offered measures, only one measure involved the demand-side of compressed air systems (the uses of compressed air). This indicated a possible area of opportunity, relative to other similar programs.^{9, 10}

⁸ Focus on Energy Online Reporting Data. <http://evaluations.focusonenergy.com/#!/data>

⁹ DTE Energy offers a comprehensive list of demand-side compressed air measures. 2018 Measures and Specifications Catalog, DTE Energy.

¹⁰ Focus on Energy offers a few demand-side measures. 2018 Business Programs: Process Systems Catalog, Focus on Energy.

While the results of this review may help improve the contributions of the compressed air end-use, the concepts are applicable to all end-uses. Review of non-performing end-use should seek to investigate the questions: what measures receive little participation? And why?

Review Program Documentation

Building on the review of compressed air measures, a review of the refrigeration measures found very low participation in the floating head pressure control measure. The Standard Program had not received more than two projects in a year, despite being advertised as having a payback of less than one year.¹¹ After reviewing the program documentation, the measure criteria were found to exclude participation of the program's target market: grocery stores. This measure will need to be revised to encourage eligible participation from the target market. This finding applies to programs broadly. Measure criteria, and program documentation, should be reviewed regularly to ensure that they are not unnecessarily restrictive or barriers to legitimate participation.

Conclusions

The ComEd Standard Program has great potential to increase its share of non-lighting participation and savings at a time when federal and state regulations drive opportunities for non-lighting participation and savings. In the near-term, lighting will continue to be the simpler, more cost-effective source of energy savings. However, there is gradual decrease in returns from this end-use that requires non-lighting measures to make up the difference. Since non-lighting end-uses do not share the synergies (e.g., cost-effective, simple, impacts aesthetics) of lighting, more attention and effort from programs will need to be applied to produce successes. This will require undertaking strategic initiatives to revamp the marketing of non-performing, low free ridership, cost effective and long lasting non-lighting technologies. This will involve all program stakeholders including program staff, implementers, and evaluators, in addition to establishing mechanisms for evaluation early feedback and continuous improvement processes to market the non-lighting technologies.

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