



Memorandum

To: Erin Daughton, Vince Gutierrez; ComEd
CC: Jennifer Morris; ICC Staff, Jeff Erickson, Randy Gunn; Guidehouse
From: Jan Harris and Karen Maoz; Guidehouse
Date: December 18, 2020
Re: ComEd EUL Research CY2020 Commercial Behavioral and Operations and Maintenance Measures EUL Values Delphi Panel Final Outcomes

This memo provides the results of the Delphi panel held to quantify a set of effective useful life (EUL) values for commercial behavioral and operations and maintenance (O&M) type measures.¹ In the scope of work for this research,² Guidehouse recommended developing default EULs per measure category, controllability and accessibility (remote or manual),³ and building type, rather than per program or per measure. Guidehouse further suggested using a Delphi panel methodology⁴ to determine these values. Following ComEd approval of this approach, Guidehouse implemented the research as outlined in the scope. The resulting EUL values apply to behavior and operations-based measures outside of Retrocommissioning (RCx) and Monitoring Based Commissioning (MBCx) in programs such as Business Energy Analyzer (BEA), the Smart Building Operations (SBO) Pilot,⁵ and Facility Assessments. Guidehouse has made a separate recommendation for the EUL of the RCx program Virtual Commissioning (VCx) path as discussed in the next section. The team's EUL recommendations are presented in Table 1 below.

¹ These behavioral and O&M measures differ from other measure types in that a person must perform an action and this action must be checked periodically to ensure compliance. The savings of these measures depend on ongoing human interventions that may or may not continue to occur over time.

² See memo titled *ComEd EUL Research CY2020 SOW Virtual Delphi Panel* sent to ComEd on July 1st, 2020.

³ Manual changes involve localized manipulation of controls requiring periodic or recurring adjustments due to their accessibility, reversibility, and/or lack of permanence. Manual changes encompass both behavioral changes (that must be constantly repeated to save energy, like turning off lights) and easily reversible programming (like an accessible programmable thermostat). While the Guidehouse team acknowledges that these are two separate classes of changes, they were not distinguished between during the Delphi panel and thus are not distinguished in our results. Future research could be done to further distinguish between these different types of manual measures. Remote changes typically require a key or combination or password to access and change. Remote changes usually cannot be overridden or manipulated by just any building occupant and will remain in place unless overridden or altered by individuals with necessary skills and access to the protected system.

⁴ Please also refer to the memo dated May 4th, 2020, titled *ComEd EUL Research CY 2020 Commercial Behavioral Measures* for additional background and reasoning for pursuing a Delphi panel approach versus other methodologies to determine these default EUL values.

⁵ This program was a pilot in CY2018 that was not extended. However, it may be representative of future similar program types.

Table 1. Final Findings

Measure Group	EUL
Remote HVAC Control Changes	6
Manual HVAC Control Changes	2
Remote Lighting Control Change	6
Manual Lighting Control Change	2
Unknown*	4
VCx	7.3

Source: Guidehouse

* For programs where measures are unknown (for example, Business Energy Analyzer), the average of 4 can be used until program-specific research is available. However, if any information about the prevalence of various types of measures is known that information should be taken into account to create a weighted average EUL.

It was determined unanimously by the panel that persistence of these commercial EE behavior-based measures does not vary by building type. Thus, there is one EUL value per measure group. EUL values for the two *remote* measure groups were found by the panel to be the same, and EUL values for the two *manual* measure groups were also found to be the same. Final values were confined to whole numbers.

Defining the Measures

This research targets measures that are non-widget based and are not part of RCx or MBCx.⁶ The behavior and operations-based measures targeted in this research are employed in the following ComEd programs:

- BEA
- SBO Pilot⁷
- VCx
- Facility Assessments

These programs promote similar actions but use differing tactics. It is understood that some tactics may engage customers over a period of time and this ongoing engagement may influence savings persistence. Currently programs employing these measures use the RCx program EUL value. However, these programs are inherently different and implement different sets of measures and there is little available data to support or reject the use the RCx EUL value as an appropriate proxy.⁸ Therefore, Guidehouse recommended developing more defensible EUL values for these behavioral and O&M measures.

Guidehouse recognizes that ComEd and the program implementer for VCx have argued that this program is extremely similar to MBCx and should be similarly excluded from this memo. However, the evaluation

⁶ MBCx was included in the May and July 2020 memos. However, this program is more aligned with the RCx program model. The significant differences between the RCx and MBCx measures and the measures shown in Appendix A are the controllability and ongoing monitoring. The RCx and MBCx programs provide enhanced delivery that requires additional hardware and software solutions as well as training, the presence of a commissioning champion, and change management. Whereas, the specific measures addressed in this memo and described in the appendix do not require such an engagement and changes onsite.

⁷ This program was a pilot in CY2018 that was not extended. However, it may be representative of future similar program types.

⁸ In particular, RCx provides enhanced delivery that requires additional hardware and software solutions as well as training, the presence of a commissioning champion, and change management. Whereas, the specific measures addressed here and described in the appendix do not require such an engagement and changes onsite. Note that VCx which has some of these features is described separately below.

team does not believe VCx is sufficiently similar to RCx to use it as a sole EUL proxy. The RCx program offerings require onsite investigation, which happens in both the traditional RCx and MBCx channels, but not in VCx. The RCx approach identifies and troubleshoots why equipment and algorithms are not operating as designed. This approach allows for direct corrections and additions of sensors and functions for optimization. These are fundamental building operation changes that are not just tied to a setpoint or schedule. Based on communications from Power TakeOff, the VCx program aligns with RCx except for certain adjustments and controllability that an RCx program provides. For example, the RCx program does not allow measures implemented through a programmable thermostat whereas the VCx program does.

Given the information available, Guidehouse cannot provide a definitive EUL for the VCx program at this time. The VCx program as implemented by Power TakeOff differs in important respects from RCx and MBCx in terms of its program logic and delivery, as described above. Therefore, Guidehouse cannot recommend the RCx EUL as a sole proxy for VCx. Primary research must be undertaken in order to determine an appropriate EUL for the VCx program; such research is being planned for CY2021.

Without empirical or other relevant and defensible evidence to support a given EUL value, the IL TRM attachment A evaluation protocol⁹ calls for use of a proxy or proxies and conservative estimation of EUL. The nearest proxies we have are RCx (EUL 8.6 years), Strategic Energy Management (SEM) (EUL 5 years)¹⁰ and the manual and remote control measures covered in the Delphi panel described by this memo which found EULs of 6 years and 2 years respectively. ComEd has provided information that 70% of VCx measures are implemented through a BAS system (similar to the RCx program) while the other 30% are implemented through other means which may be more easily reversible by the program occupants or reflect the measures addressed in the Delphi panel. Guidehouse and ComEd have agreed to use a weighted average of the proxies. Guidehouse calculations used the following:

- RCx EUL of 8.6 years (weighted at 70% reflecting the BAS implemented measures)
- Non-BAS implemented measures use a proxy averaging the following values to 4.3 years (weighted at 30%):
 - SEM EUL of 5 years
 - Remote changes of 6 years
 - Manual changes of 2 years

This weighted average calculates to an EUL of 7.3 years. Until primary research has been undertaken, Guidehouse recommends an EUL value of 7.3 years for the VCx program.

Given this information about VCx, the EULs identified in Table 1 would apply to Facility Assessments and other programs in the vein of BEA or the SBO pilot. For similar programs where manual and remote measures cannot be distinguished, Guidehouse recommends 4 years which is an average of the remote and manual EULS above.

Appendix A lists the measure types that fall into the behavioral or the O&M categories and they include:

- Control settings
 - Thermostat programming, lighting controls (occupancy sensors, daylight sensors), set point and schedule adjustments, and resets
- Preventative or scheduled maintenance
 - Including consumable parts (e.g., lamps, filters, refrigerant), coil cleaning, and minor repair (e.g., freeing stuck dampers or valves, economizer repairs)
- Shutdown procedures

⁹ Additional protocols include the Uniform Methods Project, Chapter 13: Assessing Persistence and Other Evaluation Issues, <https://www.nrel.gov/docs/fy17osti/68569.pdf>

¹⁰ SEM is a program that establishes interventions for customers to adopt no and low-cost measures to save energy. The SEM program also continues the engagement after implementation (like VCx and MBCx). This program's defined EUL, based on primary program research, of 5 years is different than the RCx program even with similar features.

These behavioral and O&M measures differ from other measure types in that a person must perform an action and this action must be checked periodically to ensure compliance. The ongoing savings of these measures depend on ongoing human interventions that may or may not continue to occur after year one.

Selecting Delphi Panel as a Method

Guidehouse considered other approaches before recommending the Delphi panel approach. Engineering based approaches to assess savings persistence over time typically employ either:

1. Onsite data collection, using sub-meters for end use metering of specific measures and creation of a pre installation baseline
2. Whole building energy use simulation modelling using whole building consumption data from pre and post measure installation

While these methods may be employed for evaluation purposes to determine year one savings, they would need to be repeated periodically for several years to determine if the measures were still in place and still generating savings. Being dependent on ongoing human intervention means that there will be wide variation in savings duration even within one program type as each person who implements and maintains these measures will do so differently. Also, given the disparity of facility types where these measures get installed, energy use intensities, control types and savings persistence may vary considerably across different building types. For this reason, we do not recommend these engineering-based approaches for estimating EULs for these types of measures.

For the reasons outlined above in which disparity of savings persistence is dynamic across applications, we recommended developing default EULs per measure category, control location (remote or onsite), and building type, rather than per program or per measure. This variability in persistence (also described in the Seventhwave persistence study on RCx¹¹) may be due to factors such as employee turnover, building owner changes, employee training, and more. Therefore, the typical persistence across program types should take into consideration this variability resulting in an EUL that focuses on the measure category instead of the program and should be considered an average across the program models.

Panelist Selection

Participating expert panelists are shown in Table 2 below. The recruitment list included energy efficiency industry experts whose experience ranged from researchers to evaluators to program implementers to commissioning professionals (bios available upon request). In order to achieve an unbiased panel, panelists should not include persons or organizations that stand to gain or lose materially from the outcome. However, our panel included multiple implementation contractors and the sponsoring utility as they have intimate knowledge of these programs and measures.

¹¹ "Persistence of Savings from Retro-Commissioning Measures A field study of past ComEd Retro-commissioning projects" June 13, 2018. Seventhwave

Table 2. Expert Panelists

Organization	Individual
ComEd	Thomas Johansen
InCA	Roger Hill
SBW	Jeff Romberger
Michaels Energy	Ryan Kroll
KW Engineering	Sean Harleman
Nexant	Clay Schroeder
DNV GL	Julia Vetromile
Power Takeoff	Peter Widmer
Guidehouse	Dustin Bailey

Delphi Panel Approach

Guidehouse followed the nine-step methodology laid out in the July 2020 memo, and shown again here:

1. Assemble a list of industry experts on lighting, HVAC, equipment maintenance, operation and shut down procedures, process controls, and possibly others
2. Recruit industry experts and secure an agreement for their participation in the Delphi process
3. Generate a list of the measures and measure categories
4. Create a table that has all the measures, but no values for the EUL (see Table 3 below) so as not to influence the experts on starting EUL values
5. Circulate the table to the Delphi panel participants and ask them to populate the table with what they consider to be reasonable EUL values and return it to Guidehouse
6. Consolidate the table with EUL values based on expert input
7. Circulate the populated table to all members of the expert panel (see Appendix B for summary of responses) for their review and consideration prior to discussion
8. Hold a virtual meeting to discuss EUL values, the reasoning behind the participants' suggested values as well as potential changes or revisions to these EUL values based on feedback and discussion from the group
9. Facilitate this meeting and iterate until consensus on values is reached

ComEd approved this approach which Guidehouse followed. As outlined above, there are other ways to approach this research, including variations in the Delphi approach. The target for Illinois EUL research has been to improve the existing assumptions using cost-efficient data collection and analysis options. The unpopulated table circulated to all panelists is shown as Table 3. As part of the email requesting panelist input, a description of each measure group was also provided (see Appendix A).

Table 3. Unpopulated Table sent to Panelists

Building Type → Measure Group ↓	Education	Office	Hospitality	Healthcare	Retail	Restaurant
Remote HVAC Control Changes						
Manual HVAC Control Changes						
Remote Lighting Control Change						
Manual Lighting Control Change						

The meeting started with introductions and a review of the proposed activities. We began by asking if the persistence of these commercial EE behavior-based measures varies by building type. Each building type was discussed, and then an online vote was taken using pollev.com. The voting options were “yes”, we need different values for each building type, or “no”, use one value for all building types (entire row has same value). Each measure group was reviewed, and the values discussed and voted on. All panelists participated in an in-depth discussion of the relevant issues. For all measure groups, the vote was in favor of one EUL value for all the building types. EUL values for each measure group were discussed and changes made to the input values as desired by panelists. An online vote was taken. The voting options were “yes” accept the average EUL value that came out of the discussion, or “No” we need to keep working until consensus is reached. EUL values for the remote measure groups were found to be the same, and EUL values for the manual measure groups were also found to be the same. Final values were confined to whole numbers. Summary findings are shown in Table 4 below; these Delphi panel findings were expanded into Guidehouse’s recommendations in Table 1.

Table 4. Final Findings of Delphi Panel

Measure Group	EUL
Remote HVAC Control Changes	6
Manual HVAC Control Changes	2
Remote Lighting Control Change	6
Manual Lighting Control Change	2

Source: Guidehouse

At the conclusion of the process, each panelist was asked to review the final values and confirm that they were comfortable with the consensus. Panelists confirmed they were satisfied with these values although one panelist expressed concern that the approach was independent of program delivery (which was part of the initial research design).¹² All panelists were asked again if there were any questions, problems or discomfort with the outcome. Again, all agreed to these values and the call was concluded. The values shown in Table 4 above are the recommended EUL values for the respective measure groups.

APPENDIX A– MEASURE DESCRIPTION WITH DELPHI PANEL EDITS

Below are the measure groups and the underlying measures that this study addresses. These behavioral and O&M measures differ from other measure types in that the savings depends on ongoing human

¹² Future research can be undertaken to focus on program specific EULs as desired.

interventions that may or may not continue to occur after year one. All measures and groups were reviewed by the panelists and were adjusted as indicated by the highlighted text:

1. **Remote HVAC Control Changes:** which includes the following measures and energy efficiency (EE) actions:
 - a. Reprogram thermostat (run time reduction) **Consider move to manual** (voted No)
 - b. Equipment scheduling (schedule for occupied times)
 - c. Occupancy sensors
 - d. Boiler controls (hot water reset)
 - e. Night setback
 - f. Occupancy setback (hotels, CO2 sensors)
 - g. Static pressure reset
 - h. Ventilation controls
2. **Manual HVAC Control Changes:** which includes the following measures and EE actions:
 - a. Use of checklists
 - ~~b. Combustion Controls~~ (might overlap with remote control) **voted to remove**
 - c. Run time reduction
3. **Remote Lighting Control Change:** which includes the following measures and EE actions:
 - a. Incorporate lighting into centralized (remote) building control
 - b. EMS and digital controls
 - c. Occ sensors (high bay)
 - d. Occ sensors
 - e. Daylight sensors (inside)
 - f. Outdoor photo sensors
4. **Manual Lighting Control Changes:** which includes the following measures and EE actions:
 - a. ~~Scheduled~~ checklist lighting shut down (**voted to remove the word scheduled**)
 - b. Time of day on/off
 - c. Lighting operation policy (checklist)

APPENDIX B– DELPHI PANELISTS FINAL EUL RECOMMENDATIONS

The following four sets of tables are the adjusted estimates provided by industry experts.

Table 5. EUL Recommendations

Measure Group	Education	Office	Hospitality	Healthcare	Retail	Restaurant	
Remote HVAC Control Changes	4	4	4	4	3	3	
	8	8	8	8	8	8	
	7	7	7	7	7	7	
	5	5	5	5	3	2	
	7	7	7	7	7	7	
	3	3	3	3	3	3	
	9	9	9	9	9	9	
	7	10		10	7		
Min	3	3	3	3	3	2	
Max	9	10	9	10	9	9	
Range	6	7	6	7	6	7	
Mode	7	7	7	7	3	3	
Median	7	7	7	7	7	7	Final Value
Mean	6.25	6.63	6.14	6.63	5.88	5.57	6

Measure Group	Education	Office	Hospitality	Healthcare	Retail	Restaurant	
Manual HVAC Control Changes	2	2	2	2	2	2	
	2	2	2	2	2	2	
	2	2	2	2	2	2	
	3	4	2	4	2	2	
	2	2	2	2	2	2	
	1	1	1	1	1	1	
	2	2	2	2	2	2	
	4	4		4	4	4	
Min	1	1	1	1	1	1	
Max	4	4	2	4	4	4	
Range	3	3	1	3	3	3	
Mode	2	2	2	2	2	2	
Median	2	2	2	2	2	2	Final Value
Mean	2.25	2.38	1.86	2.38	2.13	2.13	2

Measure Group	Education	Office	Hospitality	Healthcare	Retail	Restaurant	
Remote Lighting Control Changes	4	4	4	4	3	3	
	6	6	6	6	6	6	
	7	7	7	7	7	7	
	5	5	5	5	5	5	
	8	8	8	8	8	8	
	4	4	4	4	4	4	
	8	8	8	8	8	8	
	7	10		10	7	0	
Min	3.5	3.5	3.5	3.5	3	0	
Max	8	10	8	10	8	8	
Range	4.5	6.5	4.5	6.5	5	8	
Mode	7	8	8	8	7	8	
Median	6.5	6.5	6	6.5	6.5	5.5	Final Value
Mean	6.06	6.44	5.93	6.44	5.94	5.06	6

Measure Group	Education	Office	Hospitality	Healthcare	Retail	Restaurant	
Manual Lighting Control Changes	2	2	2	2	2	2	
	2	2	2	2	2	2	
	2	2	2	2	2	2	
	2	2	1	4	2	2	
	3	3	3	3	3	3	
	1	1	1	1	1	1	
	2	2	2	2	2	2	
	4	4		4	4	4	
Min	1	1	1	1	1	1	
Max	4	4	3	4	4	4	
Range	3	3	2	3	3	3	
Mode	2	2	2	2	2	2	
Median	2	2	2	2	2	2	Final Value
Mean	2.25	2.25	1.86	2.50	2.25	2.25	2