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CC: Jennifer Morris, ICC; Jeff Erickson, Randy Gunn, and Carly Olig, Navigant
From: Karen Maoz, Paul Higgins, Sharon Mullen, and Rob Neumann, Navigant
Date: September 17, 2019
Re: Effective Useful Life for Retro-commissioning and Behavior Programs

INTRODUCTION

Upon request, Navigant reviewed commercial programs that provide retro-commissioning and behavioral interventions for operational and maintenance changes. The review was to assess the appropriate effective useful life (EUL) based on the literature and Navigant's assessment. The programs included in this assessment and the resulting EUL are provided in Table 1 and details provided in the EUL Comparison section.

Table 1. Program Level EUL Assessment

Program Name	EUL
Retro-Commissioning (RCx)	8.6
Monitoring-Based Commissioning (MBCx)[1]	8.6
RCxpress	8.6
RCx Building Tune-Up	7.5
Business Energy Analyzer	1
Operational Efficiency Offering (OEO)	4
Smart Building Operations	8.6
Virtual Commissioning (VCx)	8.6
Strategic Energy Management	5
Home Energy Reports	*

Source: Navigant analysis

With the exception of HER, a residential program included for comparison, most of these programs have little to no information on the persistence of the energy savings. Seventhwave conducted a persistence study of RCx for ComEd.[2] This study summarized secondary research and limited primary data to a California study that identified only measure persistence, not savings persistence. The Seventhwave study also quantified savings persistence based on primary research of ComEd RCx projects from PY3 and PY6. As a result of this study, Navigant calculated a 8.6-year EUL for RCx.

[1] From Seventhwave study recommendations: "Some type of "Monitoring-based Cx (MBCx) Lite" approach seems appropriate to attempt. **The current MBCx program is likely to have much better persistence than RCx** because measures are tracked over time. However, many buildings are not able to follow MBCx due to BAS compatibility, IT or data security concerns in integration, or simply cost. Those sites that cannot be connected via MBCx could still be tracked in a simpler fashion. Many projects have significant enough savings to track via utility bills or main-meter readings (where chilled or hot water, or steam are metered, for example). This type of MBCx Lite would require some high-level analysis of future energy-efficiency measures that get installed at the building." There are some differences where MBCx tracks usage at the end use level.

[2] Persistence of Savings from Retro-Commissioning Measures - A field study of past ComEd Retro-Commissioning Projects. http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/ComEd_Retrocommissioning_Persistence_Study_Seventhwave_Oct_2018.pdf

Similar programs from other sectors can provide insight to the commercial sector. It is important to note that these are not exact matches, but the overarching theory and research approach may be applicable. Strategic Energy Management (SEM) is primarily delivered to the industrial market, but Navigant sees parallels in the way the program provides guidance and training for change at the facility level. The HER Program for the residential sector provides participants ongoing reports on their energy use and feedback on what they can do to reduce their usage. For both of these programs, Navigant completed persistence evaluations with recorded findings and learnings to leverage here.[3]

LIMITATIONS AND RESEARCH QUESTIONS

Under the Illinois framework promulgated by FEJA[4], ComEd must calculate the cumulative persisting annual savings (CPAS) of measures installed through an energy efficiency program in the year they are implemented. For many behavioral or operations and maintenance types programs, the EULs of measure savings are not well understood. In such cases, establishing an EUL for CPAS calculations early in the program roll out or prior to data collection in future years should be based on known examples or established programs.

This memo presents the following research questions:

- Is there an appropriate EUL value to apply to the program?
  - Why is the value justified?
  - If justified, is there still a need to study further?
  - If not, what kind of data is needed?
- Does the program need a new EUL assessment methodology, not previously established?

PROGRAM DESCRIPTIONS

The following provides the description of each program.

Retro-Commissioning Program

The Retro-Commissioning Program includes four distinct paths: traditional Retro-Commissioning (RCx), Monitoring-Based Commissioning (MBCx), RCxpress, and Building Tune-Up. Each of the four paths recommends and implements measures similar to those offered through RCx, as shown in Table 1.[5] Navigant performed a high-level review to classify these measure categories. The top savings categories are optimization, scheduling, and repair.

Table 2. Retro-Commissioning (RCx) Program Measure Categories

Measure Category	% of Total
Optimization	**54.20%**
Temperature Reset	9.80%
OA damper/Econ	8.60%
Pressure Control	7.10%
Fan optimization	5.50%

[3] Home Energy Report Opower Program Decay Rate and Persistence Study. http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY7_Evaluation_Reports/ComEd_HER_Opower_Persistence_and_Decay_Study_2016-01-29_Final.pdf and Navigant evaluation for AEP Ohio Continuous Energy Improvement Program in 2016. Volume 3 of the 2016 PUCO Filing of Evaluation Compliance Report.
[4] Future Energy Jobs Act of 2016 (Public Act 099-0906), http://www.ilga.gov/legislation/publicacts/99/PDF/099-0906.pdf.
[5] The separate program paths exist mainly to permit different delivery methods to accommodate differences among segments.

Measure Category	% of Total
Air Flow Control	4.80%
Optimization	4.40%
Pressure Reset	3.70%
Reduce Simultaneous Heat and Cool	2.70%
Pump Optimization	2.60%
Temperature Control	1.60%
Heating controls	1.60%
Refrigeration	1.00%
Sequencing	0.50%
Freeze Control	0.30%
Scheduling	**37.60%**
Scheduling	22.80%
Night and Temp Setback	11.30%
Lighting Schedule	1.70%
Start Up	1.00%
Compressed air	0.80%
Repair	**1.50%**
Maintenance	0.60%
Data Center	0.60%
Economizer	0.20%
Exhaust	0.10%
Other	5.90%
Filter	0.80%
Turn off	0.00%

Source: Navigant analysis of retro-commissioning program data.

Unfortunately, in reviewing the Seventhwave study, there was insufficient data to assess an EUL by measure category. However, the categories that seemed to have the highest persistence are air flow adjustment, filters, plant control optimization, and system schedule. Scheduling, the largest contributor to savings, includes not just setting on and off times, but also optimizing scheduling with other equipment, programmed shutdown, sequence of operations, and adding new controls.

Traditional Retro-Commissioning

The RCx path, which targets buildings over 500,000 square feet, pays for 100% of a detailed study (up to $100,000), contingent on a participant's commitment to spend a minimum of $25,000 of their own money implementing a bundle of study recommendations having an average simple payback of 18 months or less. RCx service providers (RSPs) are on-site for several days – in some cases person-weeks – over a 12-15 month project. Many of those hours are escorted, and ideas shared and discussed with the site

representative and RSP. Reports are presented to building management and operators at each phase.[6] Additionally, the customer must participate in the building operator certification training.

To qualify for RCx, the participant must have a building automation system (BAS) in place that can handle complex schedules, setbacks, and reset based on specified datapoints. Measures must be automated to operate without intervention. Measure settings must be observable and verifiable from BAS screens. BAS access must be limited by multi-authority passwords and location.

Monitoring-Based Commissioning

The MBCx path, which also targets buildings over 500,000 square feet but accepts sites as small as 150,000 square feet, provides similar auditing service as traditional RCx that identifies, analyzes, implements and verifies measures for at least 12 months with the RSP monitoring BAS data periodically to ensure on-going savings.

MBCx projects are fully funded by the program and require no customer commitment. The funding covers the study, monitoring software, and engineering services. However, RSP compensation is primarily performance-based. The implementer therefore has an incentive to work with the customer to ensure that savings are realized, and to recruit only highly motivated customers for participation.

RCxpress

The RCxpress path, which targets buildings of between 150,000 and 500,000 square feet, pays for 100% of a detailed study (up to $60,000), contingent upon a participant's commitment to spend $5,000 or $10,000, based on project size, of their own money implementing a bundle of study recommendations with a combined simple payback of 18 months or less. As with RCx, the customer must also participate in the building operator certification training.

RCx Building Tune-Up

This path, which targets buildings less than 150,000 square feet, pays for a limited study (up to $35,000) and pays a customer incentive of $0.04 per verified kWh saved, capped at total implementation cost. RCx Building Tune-up is focused on the most common RCx measures in smaller commercial buildings and results in a briefer deliverable on a faster timeline.

Business Energy Analyzer

Business Energy Analyzer is a web-based behavioral and operational tool, accessible to all ComEd non-residential customers, that provides users with ongoing, easy-to-understand information on their energy usage over time, and recommendations for practical ways to reduce their energy consumption (called "solutions") which are customized for each user and include behavioral, operational, and capital solutions, as well as suggested ComEd energy efficiency programs for which the participant may qualify, tailored to their specific business type, size, and equipment inventory. A sample of BEA recommendations follows.

- Behavioral recommendations:
  - Turn off lighting when natural daylight is sufficient
  - Set your thermostat back 15 degrees during closed hours

[6] The long timeline reflects the complexity of building automation systems, seasonal programming needs, and the learning curve for all parties. A lot of equipment is involved for RCx projects, particularly for a very large building. Adjustments require careful design to avoid engineering liability, expensive damage to the building, and risk to occupants due to air quality issues. It takes time to figure out what the options are, choose which options, implement the changes, and then test the new systems for errors.

    - Power down your computer and office machines
- Operational recommendations that may involve a cost to the participant but are not incentivized by ComEd:
    - Make doors and windows air-tight. Caulk or weather-strip doors and windows and put gaskets behind outlet covers
    - Check, clean or change your air filters
    - Improve efficiency with equipment upgrades and tune-ups
- Capital improvements incentivized by ComEd

The recommendations above are similar to those of the residential Home Energy Reports (HER) Program. Both HER and BEA show participants their recent energy usage patterns pulled from their AMI meters, and compare them to a) their own usage in the same period the previous year and b) those of other, similar ComEd customers. Both programs provide tips and recommendations for saving energy. BEA[7] however can provide more individually tailored recommendations than HER because enrollees are asked to provide specific information on their business, premise size, and complement of lighting fixtures, appliances, and other equipment. HER is more generic. Both HER and BEA channel customers to other ComEd Energy Efficiency programs. They have also both been verified, through billing analysis, to yield consistent savings in the 1-3% range.

Similar to the HER Program, BEA participants receive a monthly nudge in the form of an emailed Business Energy Report. The monthly e-mail sent to BEA users is opt-out. The participation is at the customer's own discretion and there is only voluntary tracking of what actions are complete, in progress, and not interested.[8]

Operational Efficiency Offering (OEO)

The OEO identifies non-incentivized energy efficiency opportunities discovered through ComEd's Facility Assessment Program, which comprise a mix of custom and Illinois Technical Reference Manual (IL TRM) measures. The Facility Assessment Program identifies energy efficiency opportunities and the associated energy savings, cost savings, project cost, potential incentives, and simple payback. These energy efficiency opportunities may include incentivized measures that are offered through other existing ComEd program offerings, such as lighting or HVAC, but may also include low-cost, no-cost, and operational measures outside of other programs.

The low-cost, no-cost and operational measures take advantage of equipment already installed at the site or apply maintenance or operational best practices to realize energy savings for little or no investment by the customer.

During a Facility Assessment, OEO measures are identified and entered as prospective projects in the OEO tracking system. Implementation may or may not occur at the time of the assessment. If it does not occur during the assessment, program outreach staff follow up with the customer to see if the OEO measures were implemented.

Several of the measures in this offer are behavioral in nature, and those identified as "manual" in Table 2 must be repeated consistently by facility staff to be effective. OEO recommends these measures, and program staff may follow up three months following delivery of the recommendations, but there is no monitoring otherwise available to ensure that the recommended measures are consistently adopted. Without any existing study, most of these were assigned three to five year EUL values. It is not clear that these values are appropriate due to the manual nature of the actions.

[7] BEA program also offers users the ability to keep track of which suggestions they've implemented, and which ones remain outstanding.
[8] The BEA program implementer does collect information on frequency and timing of participants accessing the BEA portal.

Table 3. Operational Efficiency Offer Measure Categories (Top 80%)

End Use Type	Measure Category	Percent of Savings
HVAC	HVAC System Controls	19%
Process	Manual On/Off Process Controls	14%
HVAC	Manual HVAC Temp Adjustments	11%
Plug Load	Computer power controls	5%
HVAC	Heater Control	5%
Process	Disable unneeded Equipment	5%
Process	Process VSD	4%
Air Compressor	Reduced compressor pressure	4%
Lighting	Manual Light Controls	4%
Process	Process Equipment Setpoints	3%
HVAC	Server Closest HVAC Setpoint	3%
HVAC	HVAC Economizer	2%
HVAC	Exhaust Fan Hour Reduction	2%

Source: Navigant analysis of ComEd tracking data

Smart Building Operations Pilot Program

This program was a pilot in one facility in 2018. One project implemented the software and monitoring package at a commercial facility in CY2018. The package includes software that analyzes energy usage data from smart meters and sub-meters to inform and encourage energy efficient building operation decisions. The software calculates the facility's forecasted baseline and displays real-time energy usage against it to encourage building operators to look for energy-saving actions when usage trends above that baseline.

The building operators made several energy efficiency improvements after implementing the tool, including: adjusting pump speeds, adjusting HVAC setpoints, installing lighting controls and lighting operations. The building operators had a list of operational activities they could implement to meet their ongoing energy saving goal. Navigant determined this pilot was primarily behavior-based during communications with the implementer. There was one retrofit measure claimed by the pilot. The Smart Building Operations Pilot Program model includes coaching the building operators about energy efficiency opportunities, use of software, an agreement to hardware installation of sub-meters and in-house buy-in.

Strategic Energy Management (SEM) Program

The SEM Program follows a methodology that engages champions[9] at industrial and large commercial facilities.[10] The program facilitates trainings, education, walk-through audits, and peer communication to help the champions encourage a change in culture at the facility. The program achieves energy savings through operational and maintenance (O&M) improvements, incremental increases in capital energy efficiency projects, additional capital projects that would not otherwise have been considered (e.g., process changes, consideration of energy efficiency in all capital efforts), and improved persistence for

[9] Leaders who drive the energy efficiency projects within a company or facility by encouraging those up the organization to approve the projects and downstream to motivate culture change.
[10] Typical customers have more than 10 million kWh of annual energy consumption.

O&M and capital projects. The SEM Program provides training and implementer support to identify O&M improvements. Training is typically broken into group training and site-level training or audits. Sites of similar operation are formed into groups called cohorts, though two current cohorts (Alumni and Mega) have mixed sectors. Cohorts are made up of SEM participants that began in the program at the same time. This training usually lasts for one year and occurs monthly or bi-monthly. Navigant included this program in the comparison since it has had an evaluated persistence analysis[11] and has some similarities in programmatic activities across the programs included here.[12]

Virtual Commissioning (VCx) Program

ComEd provides the VCx program implementer with 30-minute interval usage data on a daily basis for every non-residential ComEd customer with at least a year of AMI meter data available. The implementer screens the data using their data analytics engine to identify potential operational saving opportunities across a wide range of customer accounts. The implementer individually analyzes the flagged accounts to verify the opportunity and develops a custom set of recommendations based on the meter data, weather data, and other associated business data available to the team. The implementer then reaches out to the account through a combination of phone and email messages to discuss their energy usage and business processes, deliver a custom set of operational recommendations to the customer and seek their agreement to implement the agreed-upon measures on a specified date. The participant is responsible for independently implementing the recommended solutions, but the implementer remains actively engaged with the participants, monitoring their energy use on an on-going basis and reaching out to assist virtually, as needed.[13] The implementer confirms that the changes were implemented by monitoring the participant's AMI data and comparing their actual usage to the expected post-change usage levels predicted by their custom model.

Projects implemented to date are mostly setpoint adjustments and scheduling changes, as shown in Table 3.

[11] Navigant evaluation for AEP Ohio Continuous Energy Improvement Program in 2016. Volume 3 of the 2016 PUCO Filing of Evaluation Compliance Report.

[12] http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_CY2018_Evaluation_Reports_Final/SEM_CY2018_Process_Eval_Memo_ComEd-Nicor-Gas_2019-07-31_Final.pdf

[13] The implementer works with the customer to understand their energy usage and identify savings opportunities, enroll them in the VCx Program, and monitor their progress throughout the program. All energy savings actions taken by each participant are documented. The documentation includes a detailed log of each contact with the customer, the actions each participant agrees to take, and the date each action was undertaken. Post-change monitoring continues as long as ComEd maintains its contract with the IC.

Table 4. Virtual Commissioning Program Measures

Program Year	Measure	Count	Description
CY2018	Lighting - Schedule	17	Change to lighting schedule
CY2018	Lighting - Occupancy	2	Change to lighting occupancy setting
CY2018	HVAC - Schedule	4	Change to HVAC schedule
CY2018	HVAC - Setpoint	4	Change to HVAC setpoint settings
PY9	Lighting - Schedule	18	Change to lighting schedule
PY9	Lighting - LED	3	LED install
PY9	HVAC - Schedule	21	Change to HVAC schedule
PY9	HVAC - Setpoint	24	Change to HVAC setpoint settings
PY9	HVAC - other	7	Other HVAC optimization. Equipment tuning, fan settings, etc.
PY9	Other - Schedule	2	Change to schedule for non-lighting or HVAC appliances or equipment

Source: Power Take Off data

If a participant's energy use unexpectedly increases, the implementer reaches out to them to determine whether the change is due to a temporary non-routine event (e.g., work performed by a contractor) or a temporary or permanent change to their normal operation (e.g., a change in business hours, an additional shift). In such cases, the implementer asks the participant for details, including the purpose of the event and its starting and (if relevant) ending dates and times, to facilitate the inclusion of one or more binary flags in their ongoing monitoring model so that their savings calculations are not biased.

In cases where the participant's energy usage does not respond as anticipated by the usage model, or begins to revert back to pre-engagement levels, the implementer continues working with them to bring their energy use back to the conditions post-initial intervention.

The implementer continues engagement with a participant until:

- The participant becomes non-responsive when the implementer contacts them when energy use increases
- The participant maintains the reduced energy consumption
- The contract with ComEd ends
- If, after 12 full months of engagement, a participant is unable to achieve significant savings through VCx, the implementer removes them from their roster and refers them to another appropriate ComEd EE program (e.g., Facility Assessments)

The targeted buildings are facilities that have at least one year of 30-minute interval AMI data available and those that have multiple facilities such as national accounts. The activity requires no financial commitment of the customer, but the customer is responsible for implementing the recommendations.

Currently, there is not an assessment of the persisting savings from the combination of the participants maintaining savings, adjusting usage upon program intervention, and those that become non-responsive after initial intervention.

Home Energy Reports (HER) Program

The HER Program provides mailed or emailed personalized comparative analysis of a residential customer's usage compared to peers. Information includes opportunities for reducing energy usage. Customers may opt out of receiving the mailers. The program targets residential customers. This program

is provided in this comparison to provide a benchmark for BEA. One big difference between the two programs is that BEA is an opt-in and HER is an opt-out program.

EUL COMPARISON

Navigant proposes the values provided in Table 4 until data gathering and analysis is completed for the above business programs. (The only exceptions are those with existing EUL evaluation data: traditional RCx and Strategic Energy Management.) Per the Illinois TRM[14], Navigant's recommended EULs for the remaining programs are based on our review and understanding of these programs, based on leverage existing source documentation for other similar measures, projects, or programs.

Table 5. EUL Assignments and Justification

Program Name	EUL	Justification	Compared to RCx
Retro-Commissioning (RCx)	8.6	Based on a study conducted by Seventhwave	Not Applicable
Monitoring-Based Commissioning (MBCx)[15]	8.6	Assumes to be the same as RCx based on the level of investment, actions taken, and internal commitment. Similar type of participants, too. (Should study what happens after monitoring contract ends.)	Engagement continues to include both "new" savings after year one and "fixing" savings claimed year one.
RCxpress	8.6	Similar to RCx, just not as comprehensive	Limited implementation and may be a different measure mix altogether.
RCx Building Tune-Up	7.5	Similar to RCx, except different rigor of analysis; recommendations are more standard and quick hits; mostly scheduling; kept the EUL at the original EUL and not increased based on new analysis	Unclear on the persistence of scheduling measures compared to other RCx measures and ongoing engagement.
Business Energy Analyzer	1	Unclear what actions are happening and any capital improvements attributed to another program rebate are removed from BEA savings Legacy customers (like HER) are re-measured each year.	Different than other programs in that it is unclear what is implemented.
Operational Efficiency	4	Midpoint of the assigned values per measure category implemented. Unclear on the stickiness of the manual actions.	Unclear on the persistence of manual adjustments.

[14] See IL TRM v. 7.0, Attachment B of Vol. 4 ("Effective Useful Life for Custom Measure Guidelines," Figure 1. The TRM recommends that for non-TRM measures, similar measures with high-quality source EULs should be researched. If those exist, then a 1:1 comparison can be made. If no high-quality source documenting the targeted measures exist (e.g., in the case of MBCx and VCx, operational adjustments such as HVAC scheduling and lighting), the EUL should be the default value from the custom EUL recommendations table. After a review of the TRM, the Seventhwave report (see footnote 1) is the highest-quality source available.
[15] From Seventhwave study recommendations: "Some type of "Monitoring-based Cx (MBCx) Lite" approach seems appropriate to attempt. **The current MBCx program is likely to have much better persistence than RCx** because measures are tracked over time. However, many buildings are not able to follow MBCx due to BAS compatibility, IT or data security concerns in integration, or simply cost. Those sites that cannot be connected via MBCx could still be tracked in a simpler fashion. Many projects have significant enough savings to track via utility bills or main-meter readings (where chilled or hot water, or steam are metered, for example). This type of MBCx Lite would require some high-level analysis of future energy-efficiency measures that get installed at the building." There are some differences where MBCx tracks usage at the end use level.

Program Name	EUL	Justification	Compared to RCx
Smart Building Operations	8.6	Similar to RCx with on-site training and coordination. Unsure what happens when software contract ends, however, end use meters exist that provide valuable input data. Additionally, some activities mirror the RCx approach of onsite engagement and coaching. May be an aggressive value for EUL.	Highly dependent on specific application of software, but may leverage similar measure implementation as RCx.
Virtual Commissioning (VCx)	8.6	The main area of concern is that there is no information as to what happens when relationship ends or does not end.	There are a few differences: (1) RCx is not predominantly scheduling, whereas the VCx is mostly scheduling; (2) VCx is heavy on lighting scheduling, whereas RCx is not; (3) The Seventhwave study is based on traditional RCx, which includes new programming, new controls and sensors, and tuning of systems, whereas, VCx is mostly remote.
Strategic Energy Management	5	Based on evaluation studies of persistence of savings post program intervention. The EUL begins when the initial actions are taken.	Not applicable
Home Energy Reports	*	Deemed persistence calculation based on evaluation studies and number of years of treatment. 50% of first year savings by year 3.	Not applicable

**The EUL is based on an annual persistence value.*

RECOMMENDATIONS

Navigant recommends ComEd undertake program-specific studies for more accurate EUL for the non-RCx programs, since the applicability of the Seventhwave research findings across these programs is unclear. However, the Seventhwave study did provide the foundation for a research approach. Navigant recommends a similar measure level analysis for each program model at least three and six years post measure implementation. The analysis would require following duplicative methods used for the implementation and evaluation of the measures for the first-year analysis. For ongoing persistence analysis, Navigant believes a different methodology must be established to address each engagement intervention as either a unique new savings or a fix of the original measure.