EUL RESEARCH

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PROJECT CHALLENGE

- EE measure EULs are now more important given the recent FEJA legislation and the goals set out for attaining “cumulative persisting annual savings” (CPAS).
- Research on persistence of savings can be costly and time-consuming (e.g., multi-year studies), particularly if field research is needed.
- The challenge is to design a research agenda for savings persistence that is cost-effective and takes into account the risks of conducting potentially expensive research that produces little value in terms of improved information.
- One approach is to use R&D planning tools and concepts:
  - The **expected value of information** (EVI) is the increase in expected value due to obtaining more information about an uncertain quantity – in this case, better information on EULs to produce better CPAS estimates.
  - Basic approach involves assessing how much uncertainty there is around current EUL estimates, and the value of reducing these uncertainties.
  - Builds on and leverages current EUL values and information.

EUL RESEARCH PRINCIPLES

This approach applies the following research principles:

1. Develop the best available estimates of Equivalent Useful Lifetimes (EULs) for use in the Cumulative Persisting Annual Savings (CPAS) calculations for each year.

2. Develop a “learning process” that builds on and improves the existing EUL estimates.

3. Leverage existing information and the initial estimates of EULs.

4. Consider the value of EUL studies relative to the costs of the research, i.e., use a value of information (VOI) structure.

5. Develop a structure that at the end of each year, there is a foundation for the next year’s research.

SIX STEP RESEARCH PROCESS – COMPLETED STEPS

Step 1: Assess the knowledge base for current EUL estimates and collect data from other EUL/Persistence studies.

Step 2: Develop current best estimates for all relevant EULs for CPAS calculations based upon the lit review and stakeholder input.

Step 3: Assess the uncertainty in current estimates of measure persistence to see where evaluation and verification dollars should be invested.

- Conduct short surveys of experts to bracket the current best estimate.
- Used to assess how likely an EUL estimate is likely to be modified based on in-field research.
  - If there is a consensus that the current EUL estimate for a measure is unlikely to change; then, the value of additional research is likely to be low.
  - This approach has been used in projects for NEEA, Iowa, Ontario, and in other program evaluations. So, it is not a new process
- This is a "learning" approach to evaluation for the unique challenges of addressing persistence leveraging the initial EUL estimates.

SIX STEP RESEARCH PROCESS – TO BE COMPLETED

Step 4: Build a structural model of persistence for prioritized measures that incorporates key factors.

- The structural model will look at intervals of time (e.g., every 2 or 4 years), and examine high and low brackets on the EUL impacts of different factors to assess potential magnitude of impacts of specific factors.
- This level of analysis is needed to assess when to field studies and what should be addressed – e.g., what can you learn in year 5 of a measure with an 8 year EUL.

Step 5: Perform small sample verifications where only visit or survey 10 to 20 customers/sites to assess persistence.

- Testing the likelihood observed data consistent with the assumed EUL.
- Tiering or staging the research in this manner would help ensure we are addressing estimation/validation of EULs in a cost-effective manner.

Step 6: Develop larger field scale evaluations for measures where additional, more detailed research should be undertaken; where the small sample data shows that field data are inconsistent with the current EUL estimate.

STEPS 1 & 2 - TRM V7 UPDATES

- Navigant's justification for selecting an EUL value
  - Public report and spreadsheet of all ComEd and TRM measures' EUL selection and literature review
- Recommendation for further research – high impact measure with poor quality source or high potential for persistence impacts on EUL

Energy Management System (EMS) example:

Data sources and Estimation Approaches	EUL decision making process when multiple sources were available
15 - DEER 2008 (also referenced in DEER 2014) 14 – 2004 Retention Study of Pacific Gas and Electric Company's Commercial Energy Efficiency Programs-1994-1995 Commercial Lighting and HVAC Ninth Year Retention 11-25 – ASHRAE database 20 - SDGE 1994 & 1995 Commercial Energy Efficiency Incentives - Ninth Year Retention Evaluation 15 – 2007 GDS Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures 10 - GDS Measure Life (Retrofit) 10 - Anecdotal reference from two EMS industry articles	EUL is based on DEER 2014, which is based on research of primary literature and meta-analysis. However, the DEER studies are more than 10 years old. Technology has changed and communication protocols, programming language, etc. quickly become obsolete and lose provider support. Additionally, the 2009 Focus on Energy measure life study indicate that the measure life is dependent on system operator behavior. Per the ASHRAE database, which is from actual buildings, the range is broad. However, in consideration of technology changes and behavior influences, Navigant recommends performing primary research.

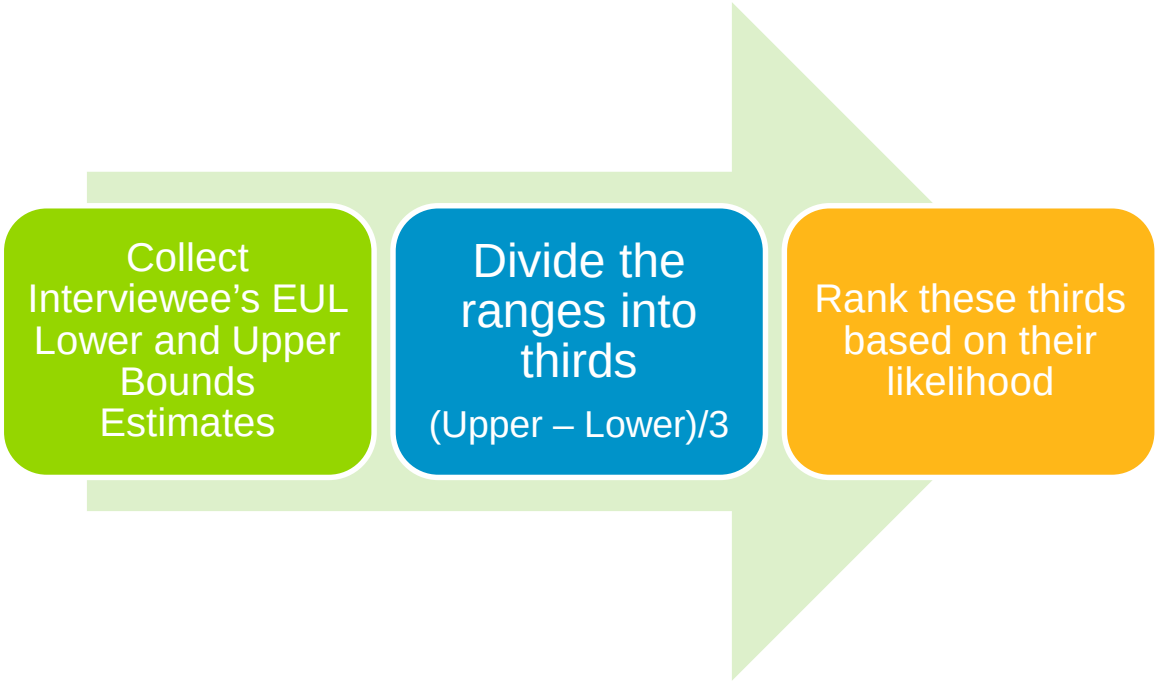
STEP 3 - EUL RESEARCH TASKS

STEP 3 - Task	Rationale
Measures Identified	Based on previous research, categorize measures for this phase
Expert interviews	Better understand the likely EUL ranges and the potential impacts from persistence factors
Value of Information Modeling	Evaluate the risk that the current TRM EUL value may differ significantly from the experts' estimates
Recommend Measures for Field Research	Provide recommendations for field research

STEP 3 - INTERVIEW GUIDE

- Provide project background – definition of EUL
- Discuss the interviewee's background with specific measures
- Discuss the EUL range
  1. Ask what the likely lower EUL bound observed in the field might be. Repeat for upper bound
  2. Likelihood estimate - split the EUL range into thirds and ask the interviewee to rank these three EUL ranges based on their likelihood
- Persistence characteristics
  - Ask which persistence characteristic likely affect the measure persistence and to what degree
    - 0 – little to no impact
    - 1 – some impact
    - 2 – significant impact

STEP 3 – EUL DATA COLLECTED FOR MODEL INPUTS



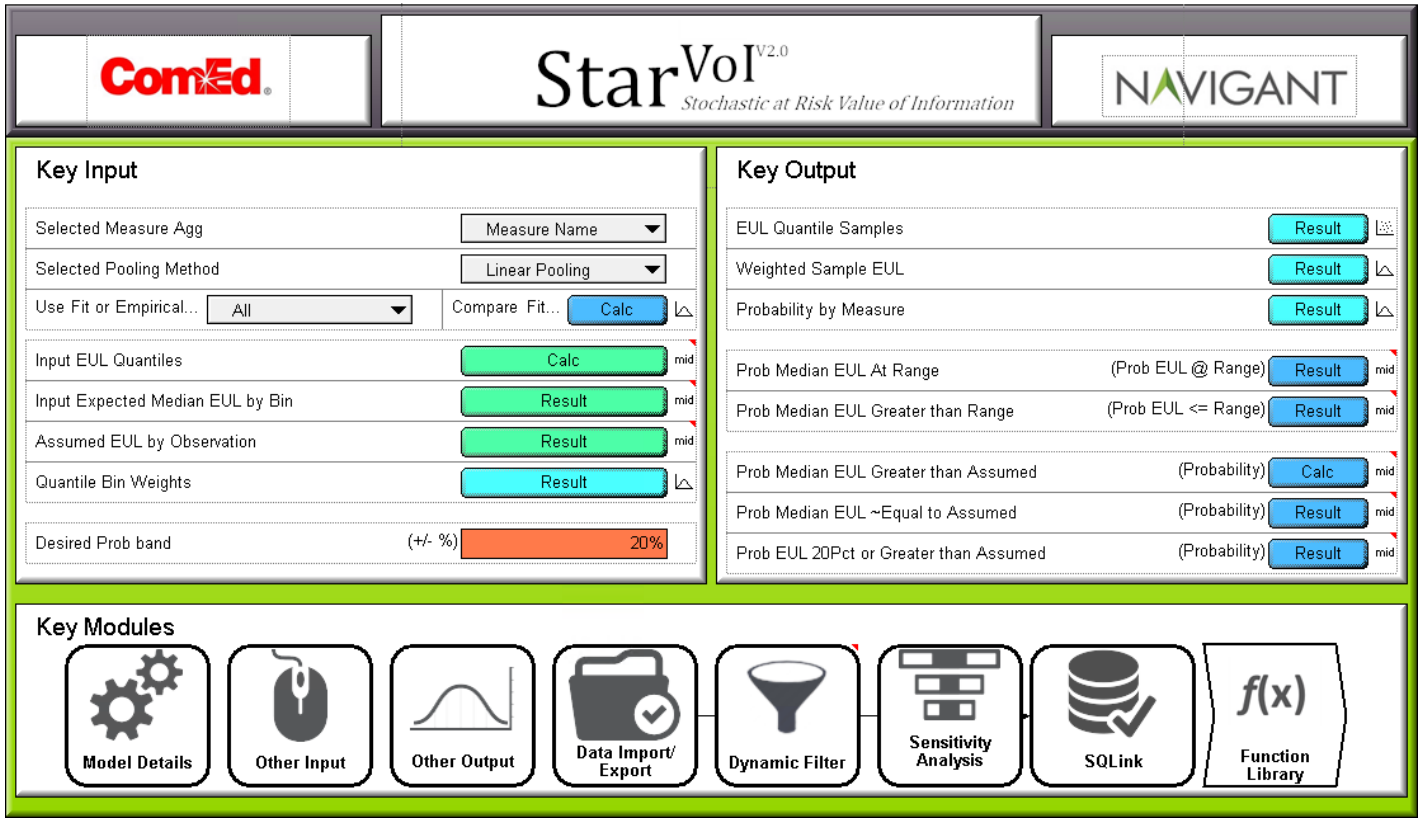
Example Measure	Lower Bound Estimate	Upper Bound Estimate	Ranges	Ranked EUL Ranges	Takeaway
AC Tune-up	1 year	4 years	A. 1-2 years B. 2-3 years C. 3-4 years	Most likely. Group B Middle likely. Group A Least likely. Group C	The EUL for a AC Tune-up measure is likely around 2-2.5 years

STEP 3 - INTERVIEWS COMPLETED

Measure	Number of SME Interviews Completed	Lowest EUL Value	Current EUL Value	Highest EUL Value
AC Tune-up	4	<1 year	3	10
Advanced Lighting Control Systems	3	5	8	20
Compressed Air Leak Repair	3	1	3	10
Energy Management System	2	1	15	20
HVAC Controls	3	5	15	30
Lighting Controls	3	1	8	22
Smart Thermostat	4	1	11	15
Thermostat Adjustment	3	<1 year	2	8
Programmable Thermostat (Com)	3	1	10	20
Programmable Thermostat (Res)	3	1	8	20
LED Fixtures (Com)	4	2	15	25
LED Lamps (Com)	4	<1 year	15	25
LED Fixtures (Res)	4	3	15	20
LED Lamps (Res)	4	1	10	>30 years

STEP 3 - VALUE OF INFORMATION (VOI)

What is the likelihood that our current TRM values are “wrong”



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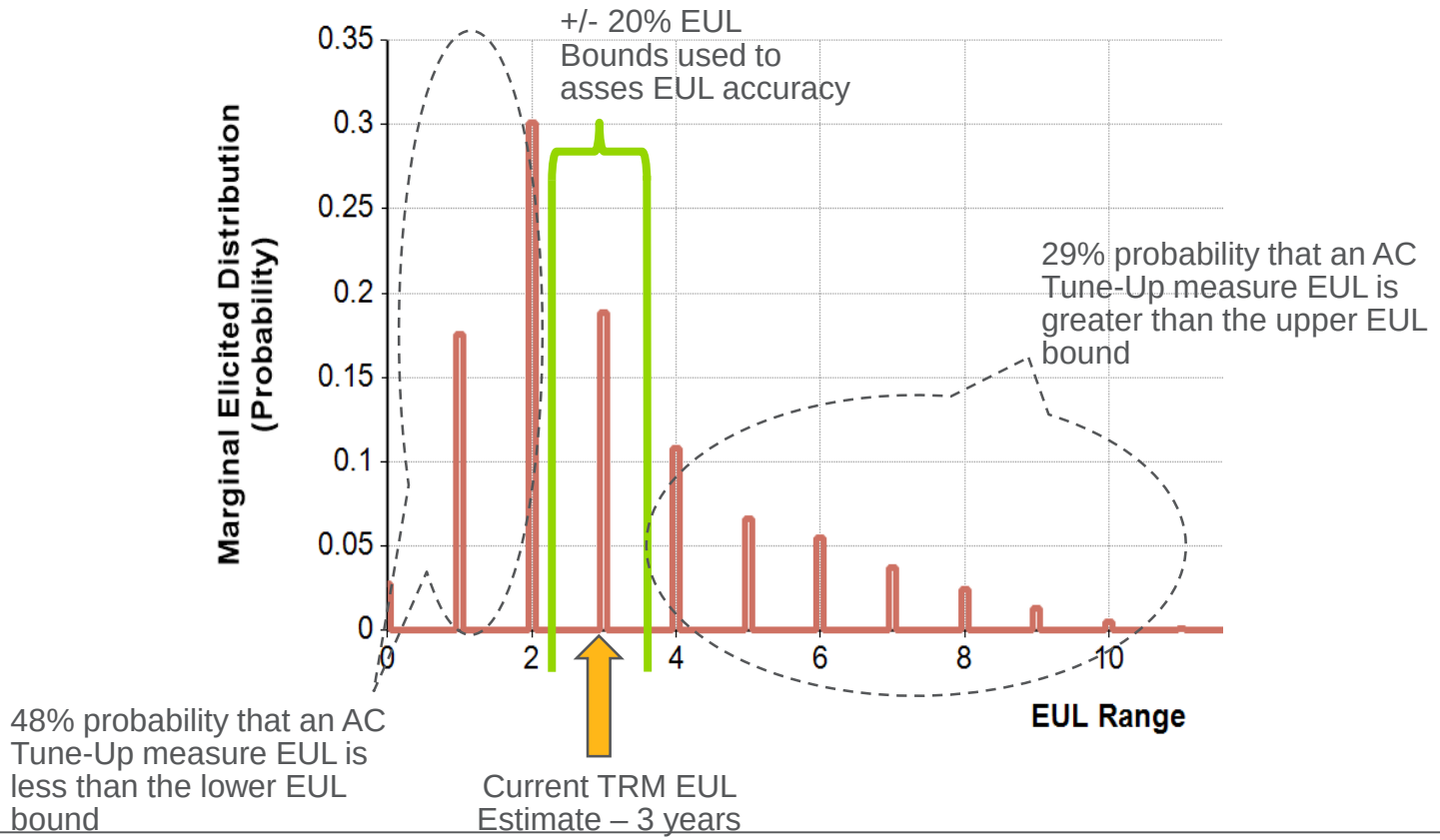
STEP 3 – RESULTS. EUL UNCERTAINTY TEST (AC TUNE-UP EXAMPLE)

- Using the EUL probability distributions generated in Navigant's Star VOI TM model, if there was a >50% chance that a measure's EUL is outside the bounds (+/-20% of the TRM EUL) then research might be needed



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STEP 3 – RESULTS. NO FURTHER RESEARCH RECOMMENDED

Measure Name	TRM EUL	EUL +/- 20% Bounds	Probability EUL is Less than Lower Bound	Probability EUL is Greater than Upper Bound
AC Tune-up	3	2.4 - 3.6	48%	29%
Energy Management System	15	12 - 18	45%	22%
LED Lamps (Res)	10	8 - 12	43%	28%
Lighting Controls	8	6.4 - 9.6	40%	32%
Programmable Thermostats (Res)	8	6.4 - 9.6	29%	32%

STEP 3 – RESULTS. EUL IS LIKELY INACCURATE BUT NO RESEARCH RECOMMENDED

Measure Name	TRM EUL	EUL +/- 20% Bounds	Probability EUL is Less than Lower Bound	Probability EUL is Greater than Upper Bound	EUL Uncertainty Assessment findings
Advanced Lighting Control Systems	8	6.4 - 9.6	2%	77%	Future research; nascent technology*
Programmable Thermostats (Com)	10	8 - 12	63%	20%	Is this measure transitioning to Smart Tstat or HVAC controller?
Smart Thermostats (Res)	11	8.8 - 13.2	62%	1%	Future research; nascent technology, not installed long enough*
Thermostat Adjustment (Com)	2	1.6 - 2.4	20%	62%	Is this measure transitioning to Smart Tstat?

*May consider initial research year over year to develop a survival curve analysis that will feed into a final assessed value. Technologies may not be in the market long enough for meaningful findings.

STEP 3 – RESULTS. EUL ESTIMATES LIKELY TO BE IMPROVED BY ADDITIONAL RESEARCH – RESEARCH RECOMMENDED

Measure Name	TRM EUL	EUL +/- 20% Bounds	Probability EUL is Less than Lower Bound	Probability EUL is Greater than Upper Bound	EUL Uncertainty Assessment findings
Compressed air - Leak Repair	3	2.4 - 3.6	17%	60%	Propose research.
Custom HVAC Controls	15	12 - 18	81%	1%	Propose research. EULs are likely too high because the HVAC controls performance and continued operation can be impacted by the RUL of controlled equipment.
LED Fixtures (Com)	15	12 - 18	77%	4%	Propose research BUT first check planned research in other jurisdictions; consider tabling lamps due to pending EISA standard change.
LED Fixtures (Res)	15	12 - 18	73%	3%	
LED Lamps (Com)	15	12 - 18	87%	3%	

STEP 3 – RESULTS. RECOMMENDED RESEARCH SUMMARY

EUL Uncertainty Assessment	Measure Name	TRM EUL	EUL +/- 20% Bounds	Probability EUL is Less than Lower Bound	Probability EUL is Greater than Upper Bound	Energy Savings Impact Level
Accurate	AC Tune-up	3	2.4 - 3.6	48%	29%	3
	Energy Management System	15	12 - 18	45%	22%	2
	LED Lamps (Res)	10	8 - 12	43%	28%	1
	Lighting Controls	8	6.4 - 9.6	40%	32%	2
	Programmable Thermostats (Res)	8	6.4 - 9.6	29%	32%	3
No Research Recommended	Advanced Lighting Control Systems	8	6.4 - 9.6	2%	77%	3
	Programmable Thermostats (Com)	10	8 - 12	63%	20%	2
	Smart Thermostats	11	8.8 - 13.2	62%	1%	3
	Thermostat Adjustment	2	1.6 - 2.4	20%	62%	2
Research Recommended	Compressed air - Leak Repair	3	2.4 - 3.6	17%	60%	2
	Custom HVAC Controls	15	12 - 18	81%	1%	3
	LED Fixtures (Com)	15	12 - 18	77%	4%	1
	LED Fixtures (Res)	15	12 - 18	73%	3%	1
	LED Lamps (Com)	15	12 - 18	87%	3%	1

The Energy Savings Impact Level illustrates which measures make up either a large, medium, or small amount of the PY2017 portfolio savings, an indicator of historical significance which may reflect forward looking savings. A rank of 3 indicates a measure that contribute less than 1% of the total kWh savings by customer class. A rank of 2 is for measures that make up less than 5% and a rank of 1 is for measures that contribute a large portion (>5%) of the PY 2017 kWh portfolio savings.

STEP 4 – FIELD RESEARCH PLANNING (ONGOING)

- Build off findings from the initial screen to develop necessary research steps to inform the field research in terms of persistence topics and target measure years
  - For example
    - Should we collect data for a lighting measure in year 5 or year 10?
    - Should we look at installation practices and remodeling? Other topics of interest?
- It is important to gather data from program implementation tracking systems, i.e., building types for commercial measures and types of participants for residential measures.

Field work and surveys will assess the impact that persistence factors have on measure EUL at critical measure years

STEPS 5 & 6. FIELD RESEARCH (FUTURE)

STEP 5. Small Sample Verification

- Visit or survey 10 – 20 customers/sites to assess persistence impacts to determine if a large scale field evaluation is needed to update a measure's EUL
- Staging the research in this manner will help ensure EUL research is conducted in a cost-effective manner

STEP 6. Large Scale Field Evaluations

- Where the small sample data shows that field data are inconsistent with the current TRM EUL estimates
- Field Research may include
  - Onsite data collection
  - Metering
  - AMI
  - Web Surveys
  - Phone Surveys

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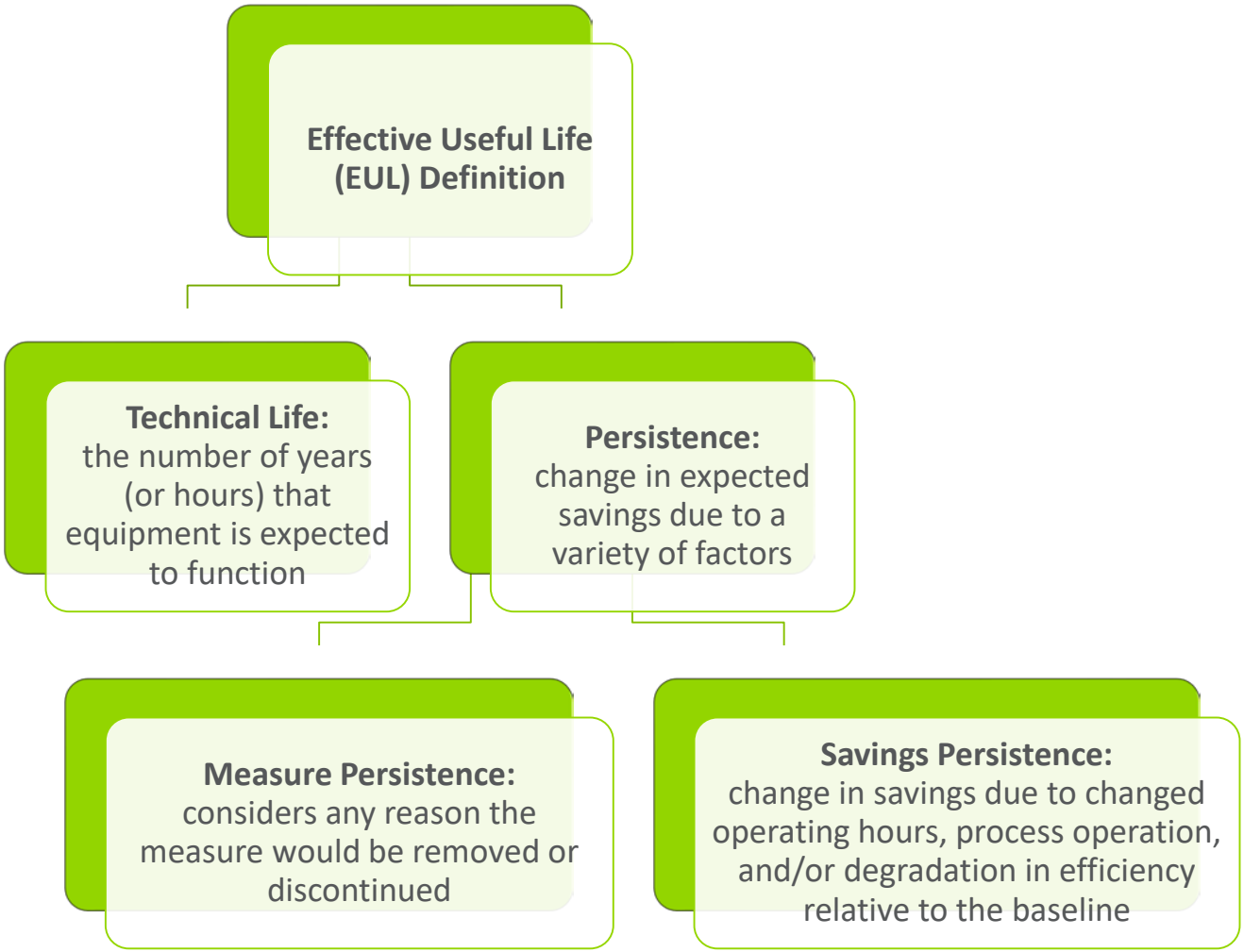
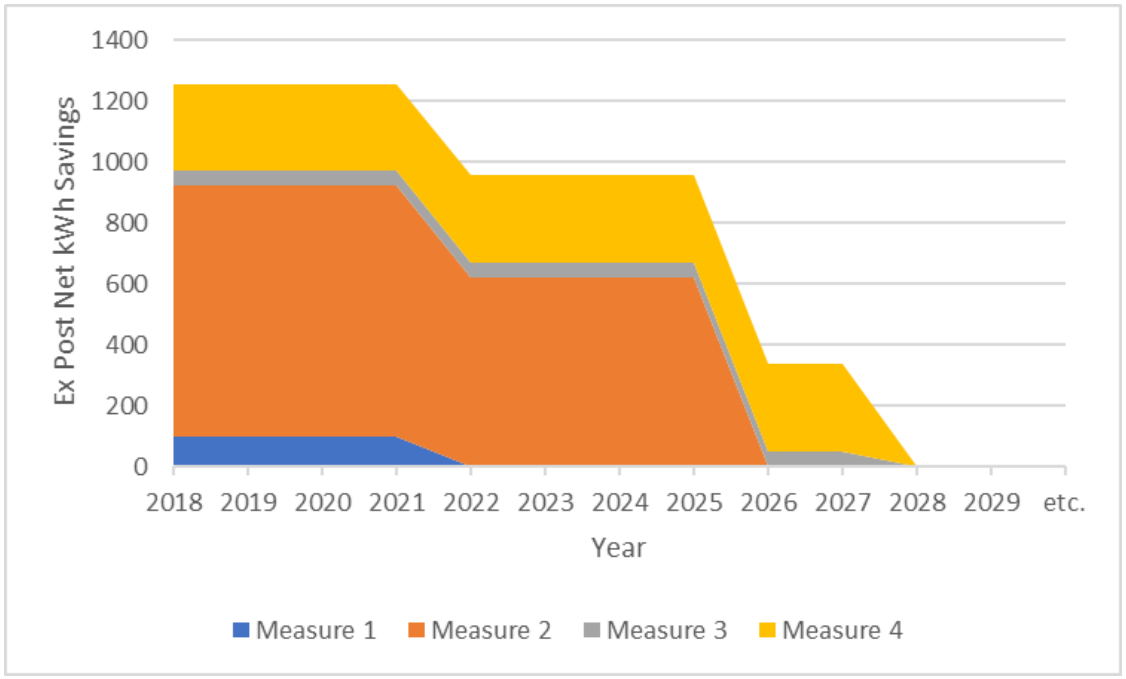
APPENDIX

EFFECTIVE USEFUL LIFE DEFINITION



CUMULATIVE PERSISTING ANNUAL SAVINGS (CPAS)

- Signed in 2016, CPAS is a new legislative accounting requirement for reporting program savings starting in 2018.
- Adoption of CPAS led ComEd to re-evaluate existing EUL data for their prescriptive and custom measures to ensure they are using the most accurate and up-to-date EUL estimates when reporting program savings.



Navigant Consulting's Illinois FEJA
CPAS Savings Example

Factors Affecting EUL

- Delivery Method
- Installation Practices
- Sizing and rating
- Maintenance
- Climate Zone
- Operating Hours
- Operations / Practices
- Occupancy changes
- Remodeling

Source: NW Council's RTF definitions

FACTORS AFFECTING MEASURE EUL

The following table provides the NW Council's RTF definitions for the factors that may have a substantial impact of measure lifetime used in this EUL research.

RTF Persistence Factor	Description
Program delivery method	Measures directly installed may last longer than measures delivered via mail for self-install, because self-installers may be less skilled and may not install according to manufacturer expectations, such as appropriate placement.
Installation practices	Does the installation adhere to equipment manufacturer requirements for the class of equipment and comply with the product warranties? Adjustments may be needed to lifetimes originally estimated if they assumed practices not consistent with likely installation practices.
Sizing and rating	Is the equipment sized and rated for the likely operating schedules and duty cycles, and are these consistent with the manufacturer's recommendations and warranty? Over and under sizing the equipment can change the lifetime of the measure.
Maintenance	Is maintenance performed in a fashion that is consistent with the manufacturer requirements or best practices for the equipment and its associated controls or measure components? Is maintenance likely to be performed over the life of the measure? Deferred maintenance can decrease the lifetime.
Region or climate zone	Region or climate may affect measure lifetime in many ways. For example, differences in climate zones may lead to changes in loading on the affected equipment.
Operating hours	Operating hours, determined by installation location, business type, or climate, might affect lifetime of certain measures, such as changes to lighting, HVAC equipment. This may not be a factor for other measures such as insulation.
Operating conditions and practices	Adjustment to lifetime might be needed if operating conditions are "dirtier" than manufacturer recommendations or on/off switching occurs frequently.
Occupancy changes	Changes in occupancy, such as those caused by business turnover, may change lifetime. For example, measure lifetime estimated for all commercial applications may not be appropriate if the measure applies only to one sector, such as restaurants, where ownership and occupancy changes frequently.
Remodeling practices	The lifetime should account for removal of the measure due to remodeling prior to its expected physical failure.

PRELIMINARY EUL ASSESSMENT FOR HIGH PRIORITY MEASURES

Research Grouping	Sector	End Use	Measure Name
1. AC Tune-up	Commercial	HVAC	AC Tune-up
2. C&I Lighting	Commercial	Lighting	Lighting Controls
			Advanced Lighting Control Systems
			LED Fixtures
			LED Lamps
3. C&I Thermostat/HVAC Controls	Commercial	HVAC	Thermostat Adjustment
			Programmable Thermostat
			HVAC Controls
4. Energy Management System	Commercial	Whole Building	Energy Management System
5. Compressed Air	Industrial	Compressed Air	Compressed Air – Leak Repair
6.Res Thermostat	Residential	HVAC	Programmable Thermostats
			Smart Thermostat
7.Residential Lighting	Residential	Lighting	LED Fixtures
			LED Lamps
8. Street Lighting	Other	Lighting	Streetlighting

This was added after the initial list was set. Navigant has not been able to incorporate this measure into the results of Phase I.