# Estimating Savings Persistence – Value of Information and Continuous Learning Approaches

*Presenter:* *Daniel M. Violette Ph.D.*
*Lumina Decision Systems, Inc.*

*Co-authors:* Karen Maoz, Lucas Schroyer, and Scott Robinson
*Navigant Consulting*


# Estimating Persistence of Energy Savings: Challenges

- Persistence is one of the more uncertain factors in assessing cost effectiveness of DSM investments;
- And, studies to verifying persistence can be expensive.
- Field studies to verify measure EULs with an estimated life of 8 years can require field data from both before and after the 8-year expected life to produce direct estimates of the EUL median value.
- Bottom Line: The high cost of in-field EUL research along with the complexities of multi-year experimental designs makes identifying cost-effective research approaches important for the industry.

# Value of Information (VOI) Analyses

- Value of information analysis is defined in the literature as:

  *"a means of valuing the expected gain from reducing uncertainty through some form of data collection exercise."*

- In this case, the additional data collection involves potentially high-cost field data for assessing and improving the accuracy of EUL estimates.

- In healthcare, for example, the additional research might involve drug trials or epidemiological studies.

- In general, R&D portfolios are designed by assessing the value of improved information than can be obtained through staged research.

# Cost-effective Research Design

- There is an increasing emphasis on savings persistence as more states emphasize long-lasting savings.
- For example, Illinois now has targets expressed as “cumulative persisting annual savings” (CPAS) with the passage of the Illinois Future Energy Jobs Act (FEJA).
- Given the high cost of persistence research, it is important to appropriately design studies such that the overall research effort is cost-effective.
  - Design efficiency focuses on providing information that will have the greatest impact on cumulative savings.
  - The expected benefits of the research should outweigh the costs prior to making those substantive investments.

# Tiered Research Design for Cost Effectiveness

## Phase I Efforts – VOI Analysis:

**Step 1**: Develop the best initial estimates of EULs for each EE measure.

**Step 2**: Assess the uncertainty around each initial EUL estimate and the persistence factors that contribute to the uncertainty

**Step 3**: Determine the impact of EE EUL uncertainty on CPAS targets to set field research priorities.

## Phase II Efforts – Tiered Field Research Consistent with VOI:

**Step 4**: Plan the field research using the persistence factors identified in step 2 to develop testable hypotheses.

**Step 5**: Small sample field research to determine whether field results are aligned with the initial EUL estimate.

**Step 6**: Expand the field research for EE measures where the small samples demonstrate the need for additional information to improve EUL estimates.

# Translate into Actionable Tasks

## PHASE 1 – VOI Analysis Tasks:

| | |
|---|---|
| **Task 1: Prioritize Measures** | Research priorities are defined and measure groups are identified and prioritized to allow for cost-effective additional research. |
| **Task 2: Assess EUL Uncertainty through expert interviews** | Evaluate current EUL uncertainty through a range and likelihood methodology. Define EUL upper and lower estimates then determine where within the range the EUL value is likely to fall. |
| **Task 3: VOI Assessments** | Perform a Value-of-information (VOI) assessment to determine where more expensive in-field research is necessary and estimate the benefits from a more refined EUL. |



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# Actionable Tasks (cont.)

## PHASE 2 – Tiered Field Research Tasks:

| | |
|---|---|
| **Task 4: Measure Level Research Plan** | Develop a structural model that examines how key persistence factors impact measure EULs to inform and develop hypotheses for the field research. |
| **Task 5: Small Sample Verifications** | Perform small sample verifications where only visit or survey 10 to 20 customers/sites to assess persistence. |
| **Task 6: Large Scale Field Research** | Develop larger field scale evaluations for measures where additional, more detailed research should be undertaken; i.e., where the small sample data shows that field data are inconsistent with the current EUL estimate. |

# Priority Measures for Evaluation

| 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 Controls |
| | | | LED Fixtures |
| | | | LED Lamps |
| **3. C&I Thermostat/HVAC controls** | Commercial | HVAC | Thermostat Adjustment |
| | | | Programmable Thermostat |
| | | | HVAC Controls |
| **4. Energy Management Systems** | 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 |

# Assessing EUL Uncertainty – Two Approaches

- Literature review used to gain insights into the reasonable ranges for measure EUL estimates:
  - The range of estimates from the literature turned out to not be necessarily representative of EUL uncertainty.
  - EULs in literature reviews often turn out to be relatively close to each other resulting in tight ranges.
  - ISSUE: EUL estimates found used in different jurisdictions may all be based on the same few studies.
- SME interviews are valuable in moving beyond this limitation and provide better assessments of measure EUL uncertainties:
  - Goal: develop range and likelihood values, i.e., a high-value/low-value range and some likelihood of where within this range the actual EUL might fall.
  - Use SME expertise to also gain insights into the factors that impact EUL uncertainties.

# EUL Uncertainty -- Approach

- Each measure was evaluated in terms of the likelihood that the currently assumed TRM EUL is either overestimated or underestimated.
  - Examined the likelihood that additional field research on a measure's EUL would provide a new, revised estimate that would be at least +/- 20% different than the current TRM EUL.
  - If the VOI assessment shows there is a high probability that new researched EUL value would fall within this +/- 20% range, there is a limited need for further research, i.e., the research priority would be low.

# Benchmarking Bounds on Current EUL Estimates

| Measure Name | Current TRM Estimated EUL (years) | EUL Bounds used for assessment | |
|---|---|---|---|
| | | Lower Bound (-20%) | Upper Bound (+20%) |
| AC Tune-up | 3 | 2.4 | 3.6 |
| Advanced Lighting Control Systems | 8 | 6.4 | 9.6 |
| Custom HVAC Controls | 15 | 12 | 18 |
| Energy Management System | 15 | 12 | 18 |
| LED Lamps (Com) | 15 | 12 | 18 |
| LED Lamps (Res) | 10 | 8 | 12 |
| Smart Thermostats | 11 | 8.8 | 13.2 |



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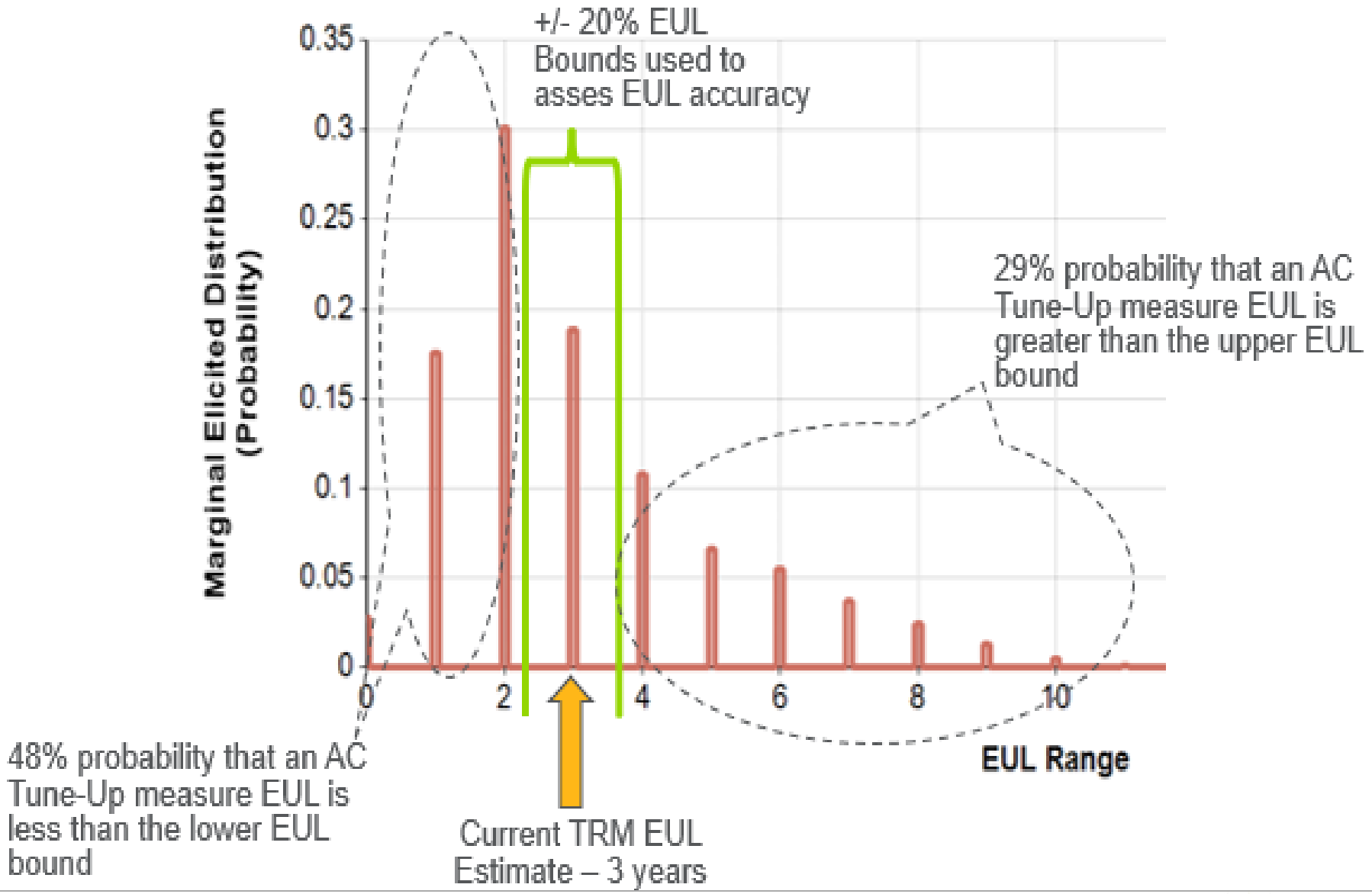
# Example Uncertainty Assessment – AC Tune-Up



# EULs likely to benefit most from additional research

- Assessment of relative accuracy and potential value in updating EUL estimates took into account:
  - Potential bias
  - Overall Uncertainty
- Measures that have either:
  1. An overall uncertainty of over 80%, i.e., combined probability of being outside either bound; or,
  2. Over a 50% probability of being outside one of bounds (i.e., either upper or lower bound)

  These measures were identified as having EUL values that would benefit from additional research.

# EUL Uncertainty Analysis

| EUL Uncertainty Assessment | Measure | Current TRM EUL | EUL +/- 20% Bounds | Probability EUL is Less than Lower Bound | Probability EUL is Greater than Upper Bound |
|---|---|---|---|---|---|
| Accurate (relatively) | 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% |
| May be inaccurate (based on criteria) | Advanced Lighting Control Systems | 8 | 6.4 - 9.6 | 2% | 77% |
| | Custom HVAC Controls | 15 | 12 - 18 | 81% | 1% |
| | LED Lamps (Com) | 15 | 12 - 18 | 87% | 3% |
| | Smart Thermostats | 11 | 8.8 - 13.2 | 62% | 1% |

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# Summary and Conclusions

- The VOI approach provided recommendations for research into EULs where the additional information from in-field EUL studies would likely provide the most value.
- The SME participants in the study were able to provide the information needed and indicated that they understood the process.
- Question: Is this more direct estimation of uncertainty better than just using intuitive approaches? Is it worth the effort?
  - The approach for dimensioning uncertainty in this project was viewed as credible by SME participants.
  - SMEs indicated that they learned by going through the process.
  - Unstructured intuitive or ad approaches may use rules of thumb:
    - May select those measures that simply provide most savings.
    - May not appropriate the value of selecting measures most likely to benefit from that additional data collection.

# Practical Perspectives

- The approach set out in this paper was easy to implement, the SME elicitation process did not take much time, or require many resources.
- One key is to not over design the process.
- The goal is to improve the information not develop perfect information.
- Importantly, the process set out in this effort not only used the SME participants to dimension uncertainty, but also used their expertise to provide value in other ways.
  - An important component of the interviews was to identify factors that contributed to uncertainty in EUL estimates.
  - This contribution was viewed as important by stakeholders and might have justified the interviews with SMEs even if the dimensioning of uncertainty exercise was not undertaken.
- These approaches are widely used in other industries, such as for infrastructure risk assessment, and cyber security.

# Addendum: SME Interview Approach

(if needed)

- Provide background – definition of technology and application.
- Start by bounding the EUL range:
  1. Ask what the likely lower EUL bound might be for the actual or true EUL if a field study were performed. Repeat for upper bound.
  2. Likelihood estimate - split the EUL range into three bins and ask the interviewee to rank these bins based on the likelihood.
- EUL factors -- Ask experts about factors likely affect EULs and to what degree (provide list of factors known to affect EULs).

  0 – little to no impact

  1 – some impact

  2 – significant impact