Expected Value Prescriptive Savings Method

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For most energy savings measures or measure packages, determining the savings is not as straightforward as a typical run for each building type and climate. Multiple parameters impact the savings, and each parameter may interact with others. A discrete savings impact for a particular building type will be an estimate at best and may not reflect the actual weighted impact of multiple parameters. Using expected value analysis, it is possible to make an expert projection of what the likely states for parameters might be with a reasonable estimation of their probability.

The approach taken for a sample "Premium Ventilation Package" of measures[1] is to use Decision Programming Language (DPL)[2] in conjunction with eQUEST (DOE 2) results. DPL has been used to analyze a wide variety of decision problems including branding and marketing decisions, market entry strategies, capital investment decisions, capital allocation decisions, environmental restoration decisions and multi-attribute decision applications. Here the "decision" is whether or not to implement the measure package, and the thrust of the analysis is to determine an **expected value of savings**. The advantage of a probability based expected value analysis is that it is very forgiving regarding accuracy of any particular parameter value or probability. This is unlike a custom analysis, where a single incorrect input can result in a very inaccurate savings projection for a particular site.

Relevant Parameters

The first step in the method is to identify relevant parameters and determine which parameters should be analyzed. Relevant parameters are those which impact the same end uses that the measure will impact. Multiple parameters that were expected to have an impact on measure savings are listed below. These are grouped as meta-parameters, influencing parameters (those that have the greatest impact on energy use/savings) and other parameters.

Meta-Parameters

Meta-parameters typically require a separate analysis and separate treatment in savings allocation.

- Heating system type
- Major climate zone
- Major building type

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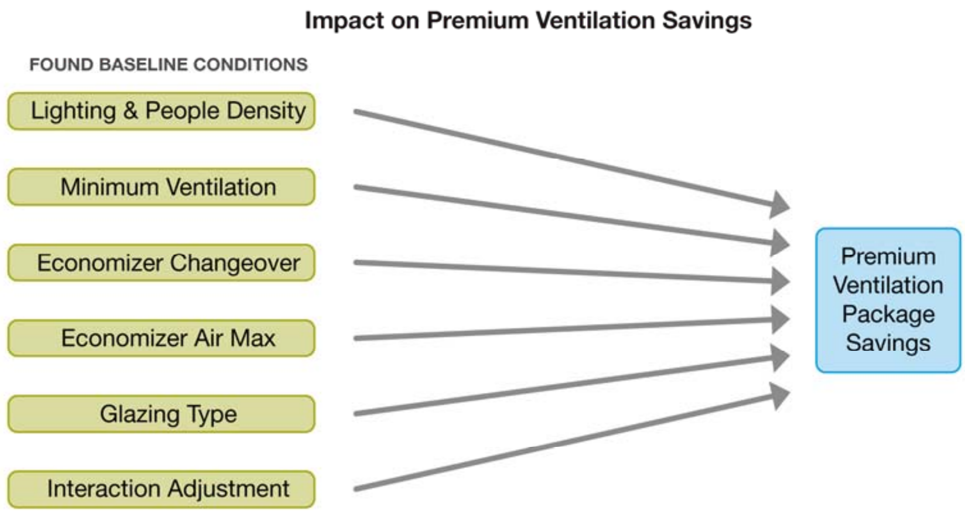
[1] Reid Hart, "Premium Ventilation Package Testing: Short-Term Monitoring Report – Task 7" (Portland Energy Conservation, Inc. (PECI) for Bonneville Power Administration (BPA), October 2009), www.peci.org/resources/commercial-retail.html.

[2] While DPL was used for this analysis, there are reasonably priced shareware spreadsheet add-in calculators to determine expected value from a decision tree using a similar methodology.

Influencing Parameters

An influence diagram for this package of measures is shown in Figure 1. The value of each of the analyzed parameters is expected to influence the expected value of savings for the measure package on a program-wide basis. The interaction adjustment provides a simple method to deal with parameter interaction while reducing the number of simulation runs required.

Figure 1: Influence Diagram for Electric Savings



Other Relevant Parameters

The following parameters are thought to be relevant to the investigation. They were not included in the initial analysis[3] due to budget considerations, but should be included in a final review of this measure package.

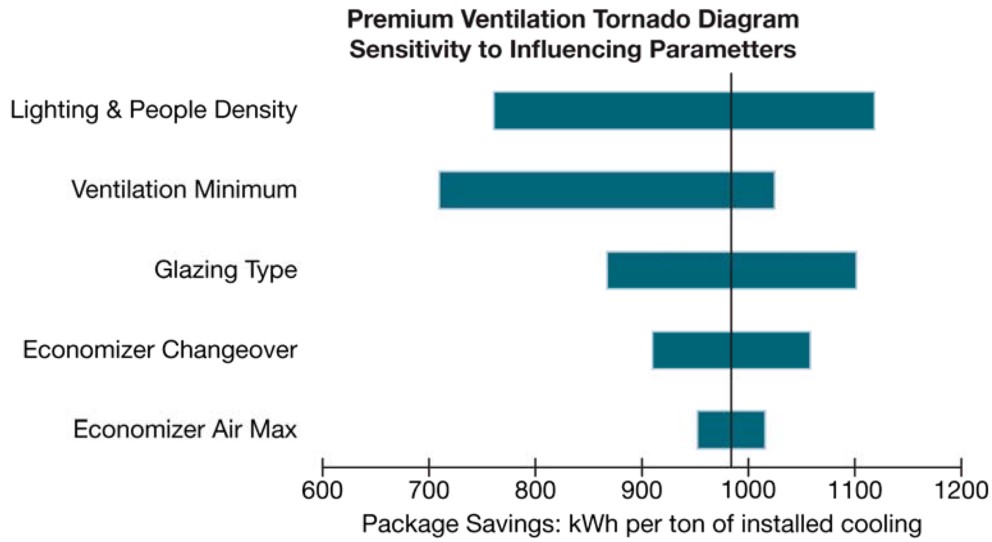
- Hours of operation
- Perimeter to floor area ratio
- Base case measure overlap
- Measure reliability
- Minor climate zones
- Electric demand impacts
- The impact of market transformation effects and delivery improvements over time

Parametric Analysis

The second step in the method is to determine the sensitivity on the savings of each influencing parameter. Parametric analyses were performed with eQUEST version 3.62c for the influencing parameters, using typical, high, and low values for each parameter. The sensitivity of the analyzed parameters on energy savings is shown in Figure 2. Note that for total energy savings impact the lighting (internal load) and ventilation minimum parameters create the most change.

[3] Reid Hart, "Premium Ventilation Package Testing: Decision Framework Matrix Report – Task 5" (Portland Energy Conservation, Inc. (PECI) for Bonneville Power Administration (BPA), October 2008), www.peci.org/resources/commercial-retail.html.

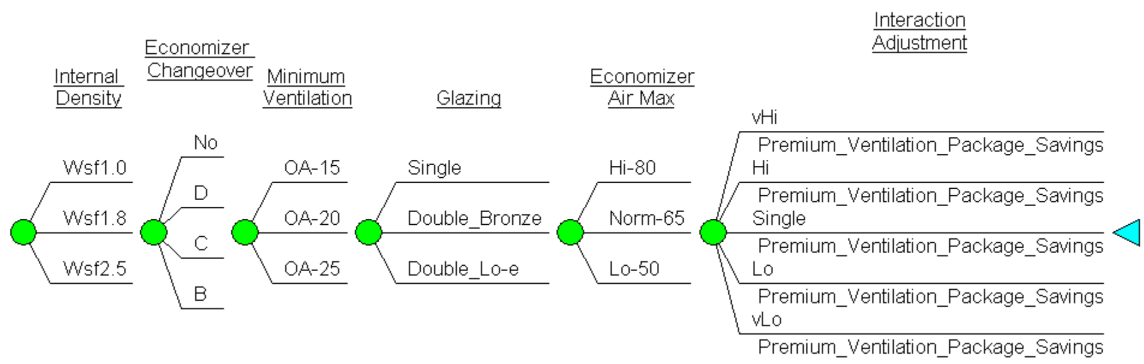
Figure 2: Parameter Sensitivity When Reported as kWh/Ton (Heat Pump)



Probability and Factor Assignments

Next the influence diagram is resolved into a decision tree, as shown in Figure 3. For each of the chance nodes (green circles), state assignments are made for each parameter. Each state is assigned a probability and a value that cascades through to the final result.[4] The probabilities should be based on building characteristic surveys or field investigations and could be enhanced by having a group of experts meet to agree on a set of probabilities for a particular measure or package.

Figure 3: Decision Tree for Combined Saving Analysis

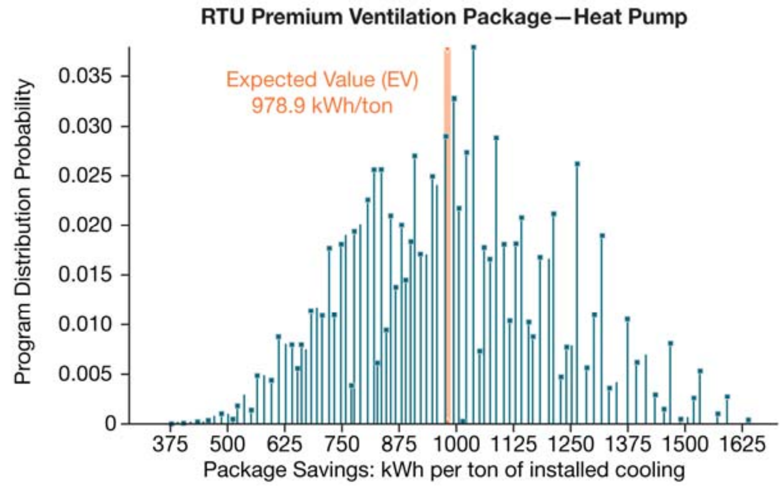


Program or Regional Expected Value of Savings

When all the possible combinations of parameter states are explored, a resulting savings for each combination is determined. The probability of occurrence of various savings results can be seen in the histogram in Figure 4.

[4] The assigned factors and probabilities can be viewed in the full report: Ibid.

Figure 4: Histogram of Probability of Various Saving Levels

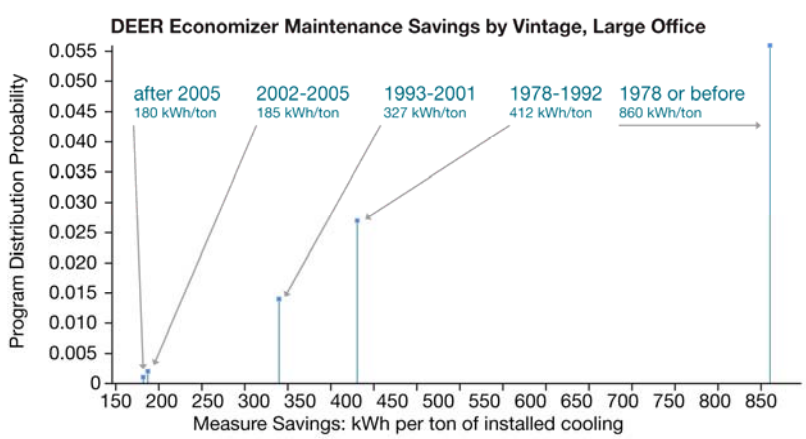


The expected value (EV) is the product of each combination result and its probability (the product of all node probabilities down the tree for that case) is shown as a vertical line in Figure 4. Expected value analysis shows the range of results that can occur in individual cases as well as the expected value for the program, population, or region as a whole.

Drawbacks of Building Type or Vintage as Primary Parameters

Note that building type and building vintage are not among the parameters analyzed. While this is a common approach, such as in the DEER[5] database, there are flaws. Buildings with similar occupancies, vintage, and types get lumped together despite having widely different energy use.
Some small retail shops have short hours, low occupancy and very low internal loads. Others have very high internal loading and refrigeration use, such as a convenience store. Figure 5 shows the impact of this lumpiness on the probability of savings. Using this approach could result in significantly over or under-stated savings estimates depending on the individual buildings' actual energy use.

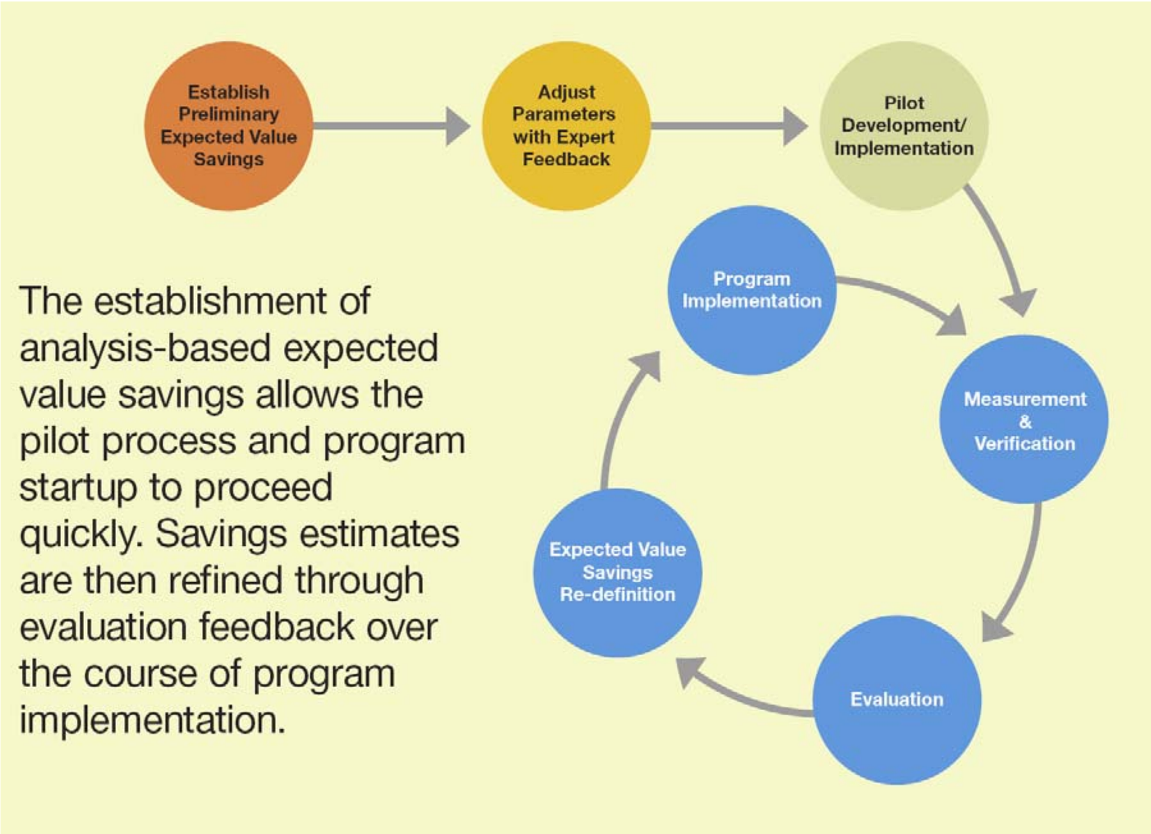
Figure 5: Histogram of Probability of Various Saving Levels using a Building Vintage Approach



[5] The **Database for Energy Efficient Resources** (DEER) is a California Energy Commission and California Public Utilities Commission sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life.

Program Development Cycle

In general, accountability for expected savings is one of the largest obstacles to overcome whenever new programs begin to take shape. Therefore it is important not only to take the time at the beginning of program development to establish realistic savings estimates, but also to revisit these estimates over the course of the implementation cycle to ensure that results are tracking well with expected savings. By instituting an expected value savings methodology from the beginning, savings variability can be diminished and implementation protocols can be refined through evaluation to allow programs to continue to operate with confidence in savings estimates.



Establishing Preliminary Savings

Establishing a list of baseline parameters that likely influence savings estimates is a critical first step in determining a preliminary savings value. These expected baseline parameters are run through multiple simulations to determine the sensitivity of total savings from each parameter, and a preliminary savings estimate is then proposed. Taking this first step allows programs to determine if further development is warranted given the likelihood of expected savings.

Adjust Parameters with Expert Feedback

Refining the savings estimate through the use of expert feedback is also essential to ensure that possible baseline parameters with potentially large savings sensitivities have not been overlooked. In many cases, review through an expert feedback session results in adjustments to the savings estimate which bolsters confidence in the final established savings value.

Pilot / Implementation Phase

Initiating a pilot phase will test the program implementation approach and provide meaningful information before engaging in a larger roll-out effort. Because of confidence found in the expected savings value through early review, the pilot program is often allowed to begin quickly with implementation focusing on areas that were found to have large sensitivities to savings.

Ongoing Program Refinement

Once the pilot program has been allowed to run for a designated period of time, the refinement cycle begins which helps improve savings estimates through evaluation and verification efforts.

Measurement and Verification

Establishment and execution of a Measurement and Verification (M&V) plan before the end of the pilot phase is essential to validate the preliminary expected savings value. M&V plans should target parameters that were initially found to have large savings impacts.

Evaluation

Performing an evaluation of the M&V results allows realized savings to be compared to expected savings. This evaluation is not only a significant part of the program development cycle and ongoing accountability procedure, but it also allows for the opportunity to discover additional baseline parameters that may not have been included in the preliminary savings estimate.

Expected Value Savings Re-definition

The expected savings value is re-defined to ensure that any adjustments to the parameter influence weighting or changes in parameter impact found during the evaluation are incorporated into a new savings estimate.

Program Implementation

Provided that realized savings track well with expected savings, or that revised savings still prove cost-effective, the program is allowed to continue through this M&V and evaluation cycle.

A Faster Path Forward for the Energy Efficiency Industry

There have been delays in identifying acceptable deemed savings for HVAC measures in the commercial sector. Unlike lighting, HVAC measures have highly variable baseline conditions and interaction with multiple parameters. Consequently, many approaches for HVAC savings in the commercial sector have relied on custom analysis or very simplified deemed savings.

It is important to develop a reasonable method that provides a good projection of program-wide savings combined with an easier program implementation path. Investigation into packaged unit HVAC savings shows that baseline conditions have more impact on individual building savings than most measure parameters. A uniform “building type and vintage” approach does not capture the complex texture of building stock. Contractor implemented programs make analyzing individual building savings impractical. The expected value method uses parametric simulation efficiently and provides a good representation of program-wide energy savings.

Acknowledgements

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