PROVING ENERGY SAVINGS OF NEW EE/EWR PRODUCTS:

EVALUATION GUIDELINES FOR INVENTORS & MANUFACTURERS

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Developed by TRC Companies on behalf of Consumers Energy

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ENERGY EFFICIENCY SAVINGS INTRODUCTION

- Energy efficient (EE) technologies and practices have the potential to:
  - Help customers save billions of dollars on energy bills.
  - Provide an economic and environmentally beneficial resource for utilities to meet their customers' needs.

- To provide these benefits, the energy industry needs technologies and solutions with proven energy savings.

- However, the process for proving energy savings is complex. This is why new products are often developed in collaboration with utilities and energy efficiency evaluation professionals specializing in energy savings measurement.

ENERGY EFFICIENCY SAVINGS INTRODUCTION

- **Objective:** This presentation is meant to provide an overview of how utilities calculate the energy savings of their energy efficiency programs, with the purpose of helping manufacturers and inventors understand the steps needed to demonstrate the savings of their product.

  This presentation is intended to give an overview of how to prove energy savings. However, this is a complex, nuanced topic that is not fully detailed in this presentation.

- **Structure:** To do so, this presentation first introduces utility program energy efficiency savings, then explains why it is important for utilities to have certainty around what energy savings are. The presentation then gets into the details of how savings are defined and proven.

ENERGY EFFICIENCY SAVINGS INTRODUCTION

- Typically, new technologies have compelling energy savings proven through engineering analyses or energy consumption data analyses. For example:

  - Technologies like light bulbs have very clear energy saving that come from replacing older, inefficient bulbs with more efficient options.

    The difference between an LED and incandescent bulb is significant.

  - Technologies like lighting controls provide savings by helping customers use their existing light bulbs more efficiently.

    Controls that turn lights off when no one is present can cut lighting usage considerably.

- For both types of technologies described above, utilities look for established savings that are proven by testing.

ENERGY EFFICIENCY SAVINGS INTRODUCTION

- There are evaluation industry standards and key steps required for establishing credible, defensible savings estimates for energy efficient technologies, activities, or interventions (collectively known as energy efficiency "measures").

- While we provide an overview of how energy savings methodology may apply to a manufacturer or inventor in this document, this is a a complex and technical topic.
    - There is an industry of energy efficiency evaluation professionals specializing in defining and proving energy savings.
    - Consumer Energy recommends that you partner with an established evaluation firm with expertise to study product savings.

WHY IT MATTERS?

- Utilities must prove to the Michigan Public Service Commission (MPSC) that they have achieved energy savings targets in a way that passes stringent cost-effectiveness tests.
- To comply with MPSC regulations, Consumers Energy hires independent third-party evaluation firms to rigorously vet energy savings.
- Utilities submit detailed accounting of evaluated energy savings and program costs for approval to the Michigan Public Service Commission (MPSC).

WHY IT MATTERS?

- The accuracy of energy savings poses significant risk for utilities.

- If energy efficiency measures save less than expected:
  - The utility can be at risk of not achieving the statutory energy savings target as defined by Michigan law and incurring financial penalties.
  - Utility may not have enough energy supply to meet customers' needs.

- Because of this risk, utilities are looking for confidence in the savings of the measures they include in their EE programs.

ESTABLISHING ENERGY EFFICIENCY ENERGY SAVINGS

This document will discuss the following issues:

- Defining program logic
- Developing energy savings estimates
- Measuring realized energy savings
- Ensuring savings are cost-effective
- The Michigan Energy Measures Database (MEMD)
- Next steps

DEFINING PROGRAM LOGIC

When utilities develop energy efficiency programs and activities, the first step is to define a theory of how that intervention will lead to energy savings.

This includes spelling out a program logic model that demonstrates how planned program activities will help:

- Reduce barriers to energy efficiency
- Produce the desired outcomes, such as energy savings

The program theory then provides the basis for defining how much energy a given program or intervention will save.

DEFINING PROGRAM LOGIC

For example, providing in-store discounts will help motivate and enable customers to purchase highly-efficient LED light bulbs.

Barriers to energy efficiency

- LEDs are more expensive than less efficient bulbs
- Customers unaware of benefits of LEDs

Program activities

- Provide instant in-store discounts on LEDs
- Develop signage at stores explaining benefits of LEDs

Program Outputs

- Customers purchase and install LEDs at a higher rate than would have otherwise

Program Outcomes

- Customers save energy on lighting their homes
- Consumers Energy achieves savings goals

DEFINING ENERGY SAVINGS

Energy savings for utility energy efficiency programs are equal to the difference between (a) energy consumption after an energy efficient technology or activity is in place, and (b) what energy consumption would have been **without** the measure (or "baseline" consumption).

Energy savings	=	Baseline energy consumption	-	Energy consumption with EE measure
Reduction in energy consumption caused by EE measure		*Energy consumption expected had EE measure not been implemented*		*Energy consumption after EE measure implemented*

DEFINING ENERGY SAVINGS

For example, replacing an inefficient 60-watt incandescent light bulb with a 10-watt LED decreases energy consumption by 83%.

83%
less energy
used

Annual energy savings of 75 kWh = 60 watts*1500 hours/year - 10 watts*1500 hours/year

Reduction in energy consumption is 75,000 watt-hours, or 75 kWh

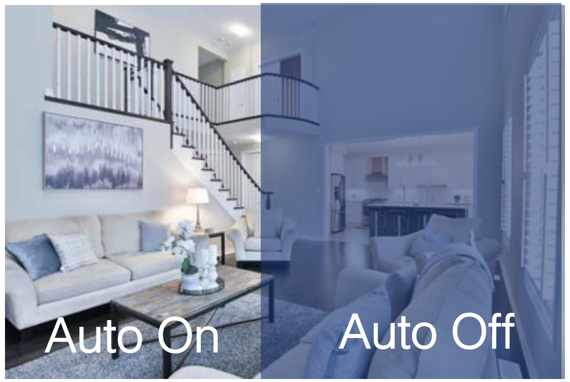
Baseline energy consumption of existing light bulb used 1500 hours a year

Consumption of new efficient light bulb used 1500 hours a year

DEFINING ENERGY SAVINGS

Alternatively, lighting controls or occupancy sensors can help save energy by reducing time that a light is turned on unnecessarily.

46%
less energy used



Annual energy savings of 7 kWh = 10 watts*1500 hours/year - 10 watts*800 hours/year

Reduction in energy consumption is 7,000 watt-hours, or 7 kWh

Baseline energy consumption of light bulb used 1500 hours a year

Consumption of same light bulb only used 800 hours a year

DEFINING ENERGY SAVINGS

To establish energy savings, manufacturers will have to demonstrate:

- Baseline energy consumption (without the EE measure in place)
- Energy consumption after EE measure in place

Energy savings	=	Baseline energy consumption	-	Energy consumption with EE measure
Reduction in energy consumption caused by EE measure		*Energy consumption expected had the EE measure not been installed*		*Energy consumption after EE measure installed*

ESTABLISHING A BASELINE

Establishing baseline energy consumption can be complicated, as it requires determining what would have happened absent the EE intervention. This is not necessarily the same thing as consumption before the EE intervention. For example, in some cases baselines will be driven by policies such as building energy codes and equipment standards.

To establish defensible energy savings estimates, the manufacturer will need to articulate a baseline scenario based on the intended use case and quantify energy consumption of relevant energy-using technologies in the baseline.

A clear articulation of exactly what energy uses the EE measure is intended to affect is a key first step to establishing energy savings.

For more detail on baselines See EPA's "Guidebook for Energy Efficiency Evaluation, Measurement, and Verification," June 2019.

ESTABLISHING A BASELINE

Baseline considerations differ for EE measures that involve (1) installing new equipment, (2) using existing equipment more efficiently, or (3) targeting more efficient behavior.

For new equipment EE measures, potential baseline scenarios include:

- Customer would have used existing equipment indefinitely
- Customer would have installed new equipment that is less energy efficient
- Customer would have installed energy efficient equipment at a later time

For EE measures that are intended to help customers use existing equipment more efficiently, such as equipment controls, the baseline would be defined by how much the relevant energy-consuming equipment consumed before the EE measure was installed.

ESTABLISHING ENERGY CONSUMPTION WITH EE MEASURE

Next, to establish energy savings, a manufacturer will need to quantify energy consumption after the EE measures have been put in place. This includes two key pieces:

1. Measuring how relevant factors/actions changed from the baseline

2. Measuring effect of an EE measure on energy loads in places installed

ESTABLISHING ENERGY CONSUMPTION WITH EE MEASURE

Examples of the types of data needed to estimate energy consumption and savings:

- Efficiency of equipment (i.e., watts of light bulb)
- Hours of equipment usage
- Interactions between types of equipment (i.e., using efficient light bulbs increases the need to heat spaces)

If it is not possible to collect data on the factors that drive energy use, another way to calculate savings is to analyze customers' building-level energy consumption data (their billing data). This billing analysis approach involves developing a regression model that measures the change in consumption after an EE measure has been put in place, controlling for weather and other factors that affect consumption.

MEASURE LIFE

In addition to annual savings, the duration of these savings is key for a utility to understand how cost-effective it is for them to invest in that measure. For example, a utility will get 5 times the energy savings from an efficient light bulb that is expected to last 5 years versus one that lasts 1 year.

The “effective useful life (EUL)” or “measure life” is the duration of time an EE measure is expected to save energy. In other words, the measure life is not solely determined by how long the EE measure would last before breaking; rather, measure life reflects how long customers continue to use it.

MEASURING ENERGY SAVINGS

The above slides have outlined how to define *expected energy savings*. In addition to defining how a technology saves energy, it is very important to have rigorous plans for measuring *actual energy savings*.

Utilities conduct on-going measurement to understand the energy saved through their programs. All utility energy efficiency savings are vetted by an independent third-party evaluation contractor before being submitted to the MPSC.

MEASURING ENERGY SAVINGS

Because of the risk posed if actual savings are lower than expected savings, utilities are looking for evidence of energy savings *before* pursuing a technology. Thus, it is important for manufacturers to understand how savings will be evaluated and provide strong evidence and measurements supporting their savings expectations.

The exact methods used to evaluate savings will depend on how the measure is expected to save energy. Thus, we have laid out some examples of how energy savings are measured. An independent evaluation contractor could help manufacturers better understand how to measure energy savings.

MEASURING ENERGY SAVINGS

Independent third-party evaluation contractors measure how much energy utility programs have saved using a statistically-representative mix of:

- On-site equipment inspections *(to check how equipment is operating)*
- Equipment energy-use metering *(to measure specific equipment's energy use*)
- Customer surveys *(to ask key questions about how customers use equipment)*
- Customer diary studies *(to have customers document when/how they use equipment)*
- Billing data analyses *(to measure building-level changes in energy use)*

When conducing evaluations, evaluators are careful to measure savings over a range of customers and weather conditions to make sure they are measuring savings that represent a utility's customer base during typical weather conditions.

MEASURING ENERGY SAVINGS

For example, proving energy savings for LED light bulbs that replace incandescent light bulbs may include:

Energy savings =  - 

Baseline energy consumption

Energy consumption with EE measure

- Installing meters on customers' lamps to measure number of hours bulbs are used
- Conducting surveys to understand what types/efficiency bulbs customers replace
- Conducting in-store visits to ask customers what they will do with bulb at time of purchase

- Conducting inspections to ensure that customers have installed program bulbs
- Analyzing federal energy codes to understand differences in efficiencies across types of bulbs

MEASURING ENERGY SAVINGS

Similarly, proving energy savings for lighting controls may include:

Energy savings =

Baseline energy consumption

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Energy consumption with EE measure

- Installing meters on customers' lighting before controls are installed to measure baseline lighting usage

- Installing meters on customers' lighting after controls are installed to measure lighting usage with controls
- Compare energy billing data to measure change in consumption after lighting controls installed

COST EFFECTIVENESS

In addition to proving that programs and measures save energy, utilities are also required to show that their investments in energy efficiency are cost-effective. In other words, the value of the energy savings from their programs is higher than the costs of creating those savings.

Benefits	>	Costs
• Value of energy supply that Consumers Energy does not need to build or purchase • Value of reducing load on the grid		• Costs of administering programs • Cost of equipment or incentives provided to customers to help them adopt efficient measures

COST EFFECTIVENESS

To ensure that programs are cost-effective, Consumers Energy must carefully balance energy savings from a measure against the cost of helping customers adopt the measure. When savings are small, Consumers Energy can only invest a small amount in promoting the measure.

For example, highly efficient windows can help customers save on their heating and cooling needs.

However, given how much energy they save over standard windows, Consumers Energy can only pay customers $15 per efficient window—which cost at least $150 each—to keep the savings cost-effective.

MEMD MEASURE REQUIREMENTS

The Michigan Energy Measures Database (MEMD) is Michigan's statewide official source of savings that utilities can claim for a well-established measure. Using savings values from the MEMD reduces Consumers Energy's risk, since MEMD savings have been vetted and approved by the Michigan Public Service Commission.

The MEMD is developed and maintained by the Michigan Energy Waste Reduction (EWR) Collaborative, a group of representatives from utilities, program implementers, evaluation professionals, manufacturers, contractors, customer and environmental stakeholders, etc.

MEMD MEASURE REQUIREMENTS

The MEMD Overview & Maintenance Process Manual outlines requirements for adding measures to the MEMD. All parties proposing new MEMD measures must submit their application for a new measure to the EWR Collaborative, which provides annual recommendations to the MEMD Developer on new measures to include. More details on the process for adding new measures are included in the MEMD Overview & Maintenance Process Manual.

Source: Michigan Energy Waste Reduction Collaborative, "MEMD Overview & Maintenance Process Manual. March 2018.

MEMD MEASURE REQUIREMENTS

The EWR Collaborative uses the following criteria to assess new MEMD measure additions:

- Complete Draft Workpaper
- Reasonable Savings Estimates
- Representative Baseline
- Michigan Specific Parameters
- Measure Interactions Considered
- Reasonable Data Timeframe
- Final Data Utilized

The following slides provide more details on these criteria.

Source: Michigan Energy Waste Reduction Collaborative, "MEMD Overview & Maintenance Process Manual. March 2018.

MEMD MEASURE REQUIREMENTS

The EWR Collaborative uses the following criteria to assess new MEMD measure additions:

- Reasonable Savings Estimates:
  - "A reasonable savings estimate is one that relies on the best practical and reliable data collection and estimation methods.
  - Savings estimates must be supported by sound evaluation results and/or engineering estimates.
  - For measures that rely on primary research to develop key parameter assumptions, savings can be considered reasonable if the errors associated with sampling meet or exceed 10% precision at a 90% confidence level.
  - For measures that rely on engineering analysis or simulation modeling, savings can be considered reasonable if the analysis and/or modeling approach follows industry best practices and passes the review of the MEMD Technical Subcommittee."

Source: Michigan Energy Waste Reduction Collaborative, "MEMD Overview & Maintenance Process Manual. March 2018.

MEMD MEASURE REQUIREMENTS

The EWR Collaborative uses the following criteria to assess new MEMD measure additions:

- Michigan Specific Parameters: "Savings estimates must rely on parameters specific to the Michigan region and its climate zones, and be applicable to measures implemented in Michigan"

- Reasonable Data Timeframe: "When applicable, savings values should rely on a reasonable and sufficient timeframe for data collection to produce repeatable and consistent results"

Source: Michigan Energy Waste Reduction Collaborative, "MEMD Overview & Maintenance Process Manual. March 2018.

WHERE TO GO FROM HERE

To develop estimated savings values, a manufacturer first needs to develop a theory of how a utility program could produce energy savings, as well as a clear baseline scenario, as described above.

Next, the manufacturer would want to quantify savings in one of the following ways:

- A formula that calculates the change in energy consumption with an EE measure by quantifying the most important factors that will affect energy consumption *(like the light bulb example).*
- An engineering simulation model that uses building science computer models to predict how energy use will change.
- Calculating changes in actual building energy consumption after the EE measure is installed, controlling for weather and other relevant factors through a regression model.

EVALUATORS THAT WORK IN MICHIGAN

These are technical issues that we have covered at a high-level in this presentation. Given the complexity and importance of demonstrating energy savings, Consumers Energy recommends that you work with an experienced energy efficiency evaluator or program implementer to help you define a program theory and prove energy savings.

Here are some of the nationally-recognized energy efficiency evaluation firms that currently work in Michigan:

- TRC Companies
- The Cadmus Group
- Apex Analytics
- Guidehouse
- Evergreen Economics
- Michaels Energy
- ILLUME
- DNV
- Driftless Energy

QUESTIONS?

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APPENDIX

GLOSSARY

- Baseline condition: "The efficiency level and operating conditions that would have occurred without the EE activity."
- Baseline consumption: "The electricity use that would have occurred at the baseline efficiency level and operating efficiency."
- Energy Efficiency Measure (EE Measure): "A single technology, energy-use practice, or behavior that, once installed or operational, results in a reduction in the electricity use required to provide the same or greater level of service at an end-use facility, premise, or equipment connected to the delivery side of the electricity grid."
- Expected useful life (EUL): "The duration of time an EE activity is anticipated to remain in effect with the potential to save electricity."
- Logic model: A plausible model of how a program will function under certain conditions. A logic model typically outlines the program resources, activities, and outputs, as well as short, intermediate and long-term outcomes.

GLOSSARY

- **Michigan Energy Measures Database (MEMD):** “The MEMD is a collection of spreadsheets and supporting documentation that presents approved electric, natural gas energy, and electric peak demand savings values for Energy Waste Reduction (EWR) measures in the state of Michigan.”
- **Metering:** “The collection of energy-use data over time. These data may be collected at the end use, a circuit, a piece of equipment, or a whole building (or facility).”
- **Verification (of EE project or EE measure installation):** “An assessment by an independent entity to ensure that the EE activities have been installed correctly and can generate the predicted savings. Verification may include assessing baseline conditions and confirming that they EE activities are operating according to how they were designed to operate. Site inspections, phone and mail surveys, and desk review of program documentation are typical verification activities.”

For additional definitions and detail, see:

- U.S. Environmental Protection Agency. “Guidebook for Energy Efficiency Evaluation, Measurement, and Verification.” June 2019. Retrieved from https://www.epa.gov/sites/production/files/2019-06/documents/guidebook_for_energy_efficiency_evaluation_measurement_verification.pdf
- Michigan Energy Waste Reduction Collaborative, “MEMD Overview & Maintenance Process Manual. March 2018.