The Missouri Technical Reference Manual

Volume 1: Overview and User Guide

Final

March 31, 2017

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The Missouri Division of Energy (DE) led the development of a statewide TRM, funded by a US Department of Energy (DOE) grant, facilitated through contract with Vermont Energy Investment Corporation (VEIC) and supported by 14 formal, cost share partners, including Ameren Missouri, Kansas City Power & Light, Laclede Gas Company, Empire District Electric, Summit Natural Gas, Missouri American Water Company, Missouri Public Utilities Alliance, Missouri Energy Initiative, Renew Missouri, Sierra Club, NRDC, DNR, OPC, and PSC staff. Although consensus could not be reached on all issues, the active support of these 14 partners led to significant agreement on many aspects of the TRM and is a testament to the potential value and benefit the cost share partners see in adoption and use of a statewide TRM. The statewide TRM was developed for Commission review for use by investor-owned utilities and as an available resource for other independent utilities, program administrators and evaluators. Due to the regulatory and legal roles of the Public Service Commission and the Office of Public Counsel, those two partners, while they actively monitored TRM development, did not take a position on the actual content of the MO TRM-2017.

1. Missouri TRM 2017 Development

1.1 Oversight Committee and Technical Advisory Committee Guidance and Input

The Missouri TRM Oversight Committee oversaw and managed the project, provided information to VEIC, commented on its work products, and worked to ensure that the MO-TRM 2017 will meet the needs of the Missouri stakeholders. The Oversight Committee had the opportunity to participate in every aspect of the development of the MO-TRM 2017. Oversight Committee members were also designated or identified additional technical and subject matter experts to the Technical Advisory Committee (TAC) – these individuals provided data and technical input, reviewed draft savings calculations, and attended teleconferences to review, comment, and participate in the development of the MO-TRM 2017.

The MO-TRM 2017 development is guided by a spirit of collaboration and shared goals, as indicated by grant partner letters of commitment and support. The group solicited input from and considered the advice of VEIC, TAC members, appropriate consultants, and other credible resources. Parties were expected to share relevant information and resources; be prepared to identify and explain the basis for positions; and to strive for consensus on decision-making items. Periodic Oversight Committee and TAC meetings were used to maximize the level of collaboration and visibility into the measure characterization process. The Oversight Committee made final decisions based on recommendations provided by the TAC.

In the event of any disagreement, VEIC noted the issue, documented the grounds for disagreement, and sought feedback on whether additional research or follow-up was warranted, within the scope of the grant.

If, after a reasonable opportunity for discussion and research, consensus cannot be reached, an agreement may be proposed to move the process forward. Oversight Committee members may accept or register disagreement with the proposed resolution. In keeping with the goal of transparency, the final MO-TRM 2017 document will include all proposed resolutions, and also note all areas of and grounds for continuing disagreement in the Appendix section of Volume 1.

The final draft of the MO-TRM 2017 will be submitted to the Missouri Public Service Commission.

1.2 MO-TRM 2017 Development Approach

1.2.1 Guiding Principles

A statewide TRM will only effectively serve utilities and stakeholders and their needs if it is thorough, accurate, transparent, and easy to use. However, there is also a need to balance features, function, and cost and the trade-offs inherent in improvements in each of these key features. To achieve this balance while maximizing value, this MO-TRM 2017 was developed with the following goals in mind.

- **Best data**. Available, Missouri-specific information was used whenever possible as a starting point for developing the MO-TRM 2017. This approach is not only efficient but also takes advantage of the utilities' and stakeholders' insights, program knowledge, and internal expertise. This unified statewide TRM was started with the common elements of a TRM alongside savings estimates from the utilities and was updated with the most current information and Missouri-specific inputs available at the time.
- **Best practices**. The approach of using local data as a framework and then benchmarking and supplementing with relevant information, data, and lessons from other jurisdictions leads to measure characterizations that are as accurate as possible and most relevant to Missouri's programs. The MO-TRM 2017 is built on best-practice approaches to TRM development, including the US Department of Energy's Uniform Methods Project protocols, when relevant, and includes enhancements informed by experience in other jurisdictions when appropriate.

- **Prioritization**. Not all measures or savings assumptions are equally important. The development objective for the MO-TRM 2017 was intentionally focused on establishing highly reliable results for those measures, assumptions, and protocols that are likely to have the greatest impact on energy, savings, and cost-effectiveness for Missouri's programs. Shared information and experience, along with a focus on the most significant assumptions, provides the guidance for the development of the remaining measures. Continuing to prioritize new and evolving measures through cycles of future characterization development is an effective way to balance considerations of usefulness and cost.
- **Stakeholder involvement**. The most transparent and useful TRMs not only include data from utilities and stakeholders but also reflect their input and buy-in for the process and the final decisions made. The development of the MO-TRM 2017 provided extensive and inclusive opportunities for utility and stakeholder involvement through the Oversight Committee and TAC that provided forums for input and discussion. Regular Oversight Committee and TAC meetings were used to maximize the level of collaboration and visibility into the measure characterization process. TAC members met more than 20 times (including supplemental calls) during the MO-TRM 2017 development and measure characterization process where as Oversight Committee members met a total of 13 times during this same period. The intent of this TRM development process was to achieve and represent a broad consensus among the stakeholders. Where consensus did not emerge on specific measures or issues, items of disagreement were noted and have been catalogued in the Appendix of Volume 1 of the MO-TRM 2017.

2 MO-TRM 2017 Organizational Structure

2.1 Overall Organization

For ease of use and update, the MO-TRM 2017 is published in three volumes:

Missouri TRM - Origin, Product and Vision (Missouri Division of Energy Supplemental)

Volume 1: Overview and User Guide

Volume 2: Commercial and Industrial Measures

Volume 3: Residential Measures

Information within Volumes 2 and 3 of the MO-TRM 2017 is organized in a way to help facilitate its access and use. The structure within these technical documents follows a two-level format, each of which becomes a major heading in the Table of Contents. These levels are designed to define and clarify what the measure is and where it is applied.

Level 1: End-use Category

- This level of organization represents most of the major end-use categories for which an efficient alternative exists. The following table gives examples of the end-use categories likely to be found in the MO-TRM 2017.

End-Use Categories in the MO-TRM 2017

Commercial and Industrial Market Sector	Residential Market Sector
Agricultural	Appliances
Appliances	Consumer Electronics
Compressed Air	Hot Water
Consumer Electronics	HVAC
Food Service	Lighting
Hot Water	Miscellaneous
HVAC	Motors
Lighting	Shell
Miscellaneous	
Motors	
Refrigeration	
Shell	

Level 2: Measure and Technology

- This level of organization represents the individual efficient measures, such as CFL lighting and LED lighting, both of which are individual technologies within the Lighting end-use category.

Within a particular market, end use, and measure (e.g., LED Lighting), the MO-TRM 2017 is not further divided by implementation or delivery methodology. For example, the characterization of a CFL installed through any residential pathway – upstream lighting, direct install, efficiency kits, hard-to-reach populations, etc. – is provided in one residential measure document, with lookup tables for the appropriate distinctions in program delivery.

Intended to help answer the question "What technology defines the measure?" this organizational approach seeks to captures the common information about a measure regardless of implementation or delivery mechanism, and then provides within the measure those additional assumptions relevant to such program options. In addition, characterizations are also designed to be agnostic on which fuel the measure is designed to save – electricity or natural gas. By organizing the MO-TRM 2017 this way, measures that save on both fuels are captured in one place and defined with formulas and variables that allow visibility into the various fuel savings values. As a result the intent is to create a categorization process for the MO-TRM 2017 that is easier to use and to maintain.

Further, information presented for each measure is standardized and may reflect either default/deemed or customer-specific values. Many of the measures may require the user to select the appropriate input value from a list of inputs for a given parameter in the savings algorithm. Where the MO-TRM 2017 asks the user to select the input, look-up tables of allowable values are provided. For example, a set of input parameters may depend on building type; while a range of values may be given for each parameter, only one value is appropriate for any specific building type. If no table of alternative inputs is provided for a particular parameter, then the single deemed value will be used, unless the measure has a custom allowable input. Section 2.3 below provides further information on measure characterization content.

2.2 Measure Code Specification

Developing measure codes helps to uniquely identify each measure in the MO-TRM 2017. Codes are designed in a way that reflects the organization of the MO-TRM 2017 and the needs of the MO-TRM 2017 users. Abbreviations for each MO-TRM 2017 section are combined with abbreviations for other relevant components of measure identification to make up a descriptive code name:

Code Structure = Market + End-use Category + Measure + Measure Version # + Effective Date

For the purposes of the MO-TRM 2017(v.1.) the "effective date" is defined as the first publishing date of a TRM, March 31st 2017—not the official approval date of a measure or its input values. With abbreviations delineated by a dash ('-'), this approach results in a unique, 18-character alphanumeric code that can then be used for tracking measures and their associated savings estimates. Measure codes appear at the end of each measure.

For example, a commercial boiler measure is coded: "CI-HVC-BOIL-V01-170331".

Example Measure Code Specification Key

Market (@@)	End-use (@@@)	Specific Measure (@@@@)	Measure Version (V##)	Effective Date
CI (Commercial and Industrial)	AGE (Agricultural Equipment)	BOIL	V01	YYMMDD
RS (Residential)	APL (Appliances)	T5HO	V02	YYMMDD
	CEL (Consumer Electronics)	HPT8	V03	YYMMDD
	FSE (Food Service Equipment)	…	…	…
	HVC (HVAC)			
	HWE (Hot Water)			
	LTG (Lighting)			
	MSC (Miscellaneous)			
	RFG (Refrigeration)			
	SHL (Shell)			

2.3 Components of MO-TRM 2017 Measure Characterizations

Each measure characterization uses a standardized format that includes at least the following components. Measures that have a higher level of complexity may have additional components, but also follow the same format, flow and function.

DESCRIPTION

Brief description of measure stating how it saves energy, the markets it serves and any limitations to its applicability.

DEFINITION OF EFFICIENT EQUIPMENT

Clear definition of the criteria for the efficient equipment used to determine delta savings. Including any standards or ratings if appropriate.

DEFINITION OF BASELINE EQUIPMENT

Clear definition of the efficiency level of the baseline equipment used to determine delta savings including any standards or ratings if appropriate. If there is more than one definition of baseline equipment required for an individual measure – such as a measure that can be offered through "time of sale" or "early replacement" the measure will clearly identify this and state the criteria to be used to determine the delta savings in each case.

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

The expected duration in years (or hours) of the savings. If an early replacement measure, the assumed life of the existing unit is also provided.

DEEMED MEASURE COST

For time of sale measures, incremental cost from baseline to efficient is provided. Installation costs should only be included if there is a difference between each efficiency level. For Early Replacement the full equipment and install cost of the efficient installation is provided in addition to the full deferred hypothetical baseline replacement cost.

LOADSHAPE

The appropriate loadshape to apply to electric savings is provided. The MO-TRM 2017 does not define loadshapes for gas-saving measures.

COINCIDENCE FACTOR

Definition of coincidence factor being used.

CALCULATION OF ENERGY SAVINGS

Algorithms are provided followed by list of assumptions with their definition.

If there are no input variables, there will be a finite number of output values. These will be identified and listed in a table.

Algorithms in measure characterization include:

ELECTRIC ENERGY SAVINGS

SUMMER COINCIDENT PEAK DEMAND SAVINGS

NATURAL GAS SAVINGS

WATER IMPACT DESCRIPTIONS AND CALCULATION

DEEMED O&M COST ADJUSTMENT CALCULATION

Only required if the operation and maintenance (O&M) cost for the efficient case is different to the baseline.

MEASURE CODE

2.4 Program Delivery

The measure characterizations in the MO-TRM 2017 are not grouped by program delivery type. As a result, the measure characterizations provided include information and assumptions to support savings calculations for the range of program delivery options commonly used for the measure. The organizational significance of this approach is that multiple baselines, incremental costs, O&M costs, measure lives, and in-service rates are included in the characterizations for measures that are delivered under two or more different program designs. Values appropriate for each given program delivery type are clearly specified in the algorithms or in look-up tables within the characterization.

Care has been taken to clearly define in the measure's description the types of program delivery that the measure characterization is designed to support. However, there are no universally accepted definitions for a particular program type, and the description of the program type(s) may differ by measure. Nevertheless, program delivery types can be generally defined according to the following table. These are the abbreviations and definitions used in the measure descriptions in MO-TRM 2017 Volumes 2 and 3. When necessary, individual measure descriptions may further refine and clarify these definitions of program delivery type.

2.4.1 Program Delivery Types

Program	Attributes
TOS Time of Sale	**Definition:** A program in which the customer is incented to purchase or install higher efficiency equipment than if the program had not existed. This may include retail rebate (coupon) programs, upstream buy-down programs, online store programs, or contractor based programs as examples **Baseline** = Federal Standard, code or other (explained) baseline equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** LED lamp rebate
NC New Construction	**Definition:** A program that intervenes during building design to support the use of more-efficient equipment and construction practices **Baseline** = Building code, Federal Standard or Baseline Study **Efficient Case** = The program's level of building specification **Example:** Building shell and mechanical measures

Program	Attributes
RF Retrofit	**Definition:** A program that upgrades existing equipment before the end of its useful life **Baseline** = Existing equipment or the existing condition of the building or equipment. A single baseline applies over the measure's life **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Air sealing and insulation
EREP Early Replacement	**Definition:** A program that replaces existing equipment before the end of its expected life **Baseline** = Dual; it begins as the existing equipment and shifts to new baseline equipment after the expected life of the existing equipment is over **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Refrigerators, freezers
ERET Early Retirement	**Definition:** A program that retires duplicative equipment before its expected life is over **Baseline** = The existing equipment, which is retired and not replaced **Efficient Case** = Zero because the unit is retired **Example:** Appliance recycling
DI Direct Install	**Definition:** A program where measures are installed during a site visit **Baseline** = Existing equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Lighting and low-flow hot water measures
KITS Efficiency Kits	**Definition:** A program where measures are provided free of charge to a customer in an Efficiency Kit **Baseline** = Existing equipment **Efficient Case** = New, premium efficiency equipment above federal and state codes and standard industry practice **Example:** Lighting and low-flow hot water measures

3 General Assumptions

The information contained in this MO-TRM 2017 contains VEIC's recommendations for the content of the Missouri MO-TRM 2017. Sources that are cited within the MO-TRM 2017 have been chosen based on two priorities, geography and age. Whenever possible and appropriate, VEIC has incorporated Missouri-specific information into each measure characterization. The Business Programs TRM documents from Ameren, KCP&L, and Empire District Electric were reviewed, as well as program and measure specific data from evaluations, efficiency plans, and working documents.

The assumptions for these characterizations rest on VEIC's understanding of the information available. In each case, the available Missouri and Midwest-specific information was reviewed, including evaluations and support material provided by the Missouri utilities and project cost share partners.

When Missouri or region-specific evaluations or data were not available, best practice research and data from other jurisdictions was used, often from west and east-coast states that have allocated large amounts of funding to evaluation work and to refining their measure characterization parameters. As a result, much of the most-defensible information originates from these regions. In every case, the most recent, well-designed, and best-supported studies have been used to support the MO-TRM 2017 and only if appropriate have conclusions been generalized for practical application to the Missouri programs.

General Savings Assumptions

The MO-TRM 2017 savings estimates are expected to serve as average, representative values, or ways to calculate savings based on program-specific information. All information is presented on a per-measure basis. In using the measure-specific information in the MO-TRM 2017, it is helpful to keep the following notes in mind.

- All estimates of energy (kWh or therms) and peak (kW) savings are for first-year savings, not lifetime savings.
- Unless otherwise noted, measure life is defined to be the life of an energy consuming measure, including its equipment life and measure persistence.
- Where deemed values for savings are provided, they represent the average energy (kWh or therms) or peak (kW) savings that could be expected from the average of all measures that might be installed in Missouri in the program year.
- In general, the baselines included in the MO-TRM 2017 are intended to represent average conditions in Missouri. Some are based on data from the state, such as household consumption characteristics provided by the Energy Information Administration. Some are extrapolated from other areas, when Missouri data are not available.

3.1 Algorithms and Variables

Many of the measures in the MO-TRM 2017 require the user to select the appropriate input value from a list of inputs for a given parameter in the savings algorithm. Where the MO-TRM 2017 asks the user to select the input, look-up tables of allowable values are provided. For example, a set of input parameters may depend on building type; while a range of values may be given for each parameter, only one value is appropriate for any specific building type. If no table of alternative inputs is provided for a particular parameter, then the single deemed value will be used, unless the measure has a custom allowable input.

3.1.1 Custom Value Use in Measure Implementation

This section defines the requirements for capturing Custom variables that can be used in place of defaults for select assumptions within the prescriptive measures defined in this statewide TRM. This approach is to be used when a variable in a measure formula can be replaced by a verifiable and documented value that is not presented in the MO-TRM 2017. This approach assumes that the algorithms presented in the measure are used as stated and only allows changes to certain variable values and is not a replacement algorithm for the measure. A custom variable is when customer input is provided to define the number or the value is measured at the site. Custom values can also be supplied from product data of the measure installed. In certain cases the custom data can be provided from a documented study or report that is applicable to the measure. Custom variables and potential sources are clearly defined in the specific measures where "Actual" or "Custom" is noted.

3.1.2 Footnotes and Documentation of Sources

Each new and updated measure characterization is supported by excel work documents, references and other analysis, of which all non-confidential material is made available on the Missouri Division of Energy's web site (https://energy.mo.gov/). In addition, the characterizations themselves use footnotes to document the references that have been used to characterize the technology. These reference documents are too numerous to include in an Appendix to the MO-TRM 2017 and are instead posted to the Missouri Division of Energy TRM's website. Similarly all supporting non-confidential reference materials and files can be found on the Missouri Division of Energy TRM website.

3.2 Savings Outputs

In using the measure-specific information in the MO-TRM 2017 it is important to note that savings outputs do not include a net to gross (NTG) calculations.

For energy efficiency programs throughout the U.S., evaluators differentiate between savings at a "gross" and "net" level to better account for the impact of free ridership, secondary market impacts, spill over and other factors.

Given the multiplicity of program design, budget and delivery specifics across Missouri it is not the intent of the MO-TRM 2017 to assume how each utility energy efficiency program will determine their NTG, rather that each utility uses methodologies consistent with the best available information including most recent utility-specific EM&V.

3.3 Baseline Assumptions

The concept and definition of the baseline is a key element of every measure characterization and is directly related to the program delivery type. Without a clear definition of the baseline, the savings algorithms cannot be adequately specified and subsequent evaluation efforts would be hampered. As a result, each measure has a detailed description (and in many cases, specification) of the specific baseline that should be used to calculate savings. Baselines in the MO-TRM 2017 fall into one of the following categories, and are organized within each measure characterization by the program delivery type to which it applies.

1. Building Code: As defined by the minimum specifications required under applicable local codes or applicable federal standards.
2. Existing Equipment: As determined by the most representative (or average) example of equipment that is in the existing stock. Existing equipment baselines apply over the equipment's remaining useful life.
3. New Equipment: As determined by the equipment that represents standard practice in the current market environment or what has been specified for individual measure use. New equipment baselines apply over the effective useful life of the measure.

3.3.1 Measure Specific Baseline Assumptions

Lighting Baseline Assumptions – it has been agreed by the stakeholder group for the purposes of the MO-TRM 2017 that CFL and LED lamp baselines are assumed to be an EISA qualified lamp.

Furnace Baseline Assumptions – it has been agreed by the stakeholder group for the purposes of the MO-TRM 2017 that the baseline for new furnace equipment is assumed to meet the federal minimum efficiency standard for individual equipment specifications.

3.3.2 Shifting Baseline Assumptions

The MO-TRM 2017 anticipates the effects of changes in efficiency codes and standards on certain measures. When these changes occur, a shift in the baseline is usually required. This complicates the measure savings estimation somewhat, and will be handled in future versions of the MO-TRM by describing the choice of and reasoning behind a baseline change. In this initial version of the MO-TRM, a shifting baseline assumption may apply to early replacement measures as well as several lighting end-use measures.

3.4 Electrical Loadshapes (kWh)

Loadshapes are an integral part of the measure characterization and are used to divide energy savings into appropriate periods for the purpose of estimating cost effectiveness.

For the purposes of assigning energy savings (kWh) periods, the MO-TRM 2017 has compiled 13 individual Residential Loadshapes alongside 106 individual Commercial and Industrial Loadshapes (see Appendix) that can be used alongside Ameren Missouri's 22 End-use Loadshapes as provided in their utility TRM.

This approach to electric loadshape use in the MO-TRM 2017 has been developed by the stakeholder group in recognition of existing utility agreements and policies regarding loadshape use as well as the undeniable differences amongst some measures in the same end-use category and the differences across the portfolio of measures offered by various utilities across Missouri. This approach was discussed and agreed to by the TAC to allow TRM-users to select the loadshape that suites their need and efficiency program offering.

3.5 Summer Peak Period Definition (kW)

To estimate the impact that an efficiency measure has on a utility's system peak, the peak itself needs to be defined. Missouri is in a unique position with two RTOs (SPP and MISO) as well as Associated Electric Cooperative, Inc. (which is not a member of any RTO), operating in Missouri. As a result, there is some disparity in the peak definition across the state.

Because Missouri is a summer peaking state, only the summer peak period is defined for the purpose of the MO-TRM 2017. Summer peak coincidence factors can be found within each measure characterization. The source is provided and is based upon evaluation results, analysis of load shape data, or through a calculation using stated assumptions.

For measures that are not weather-sensitive, the summer peak coincidence factor is estimated whenever possible as the average of savings within the peak period defined.

3.6 Weather Data for Weather-sensitive Measures

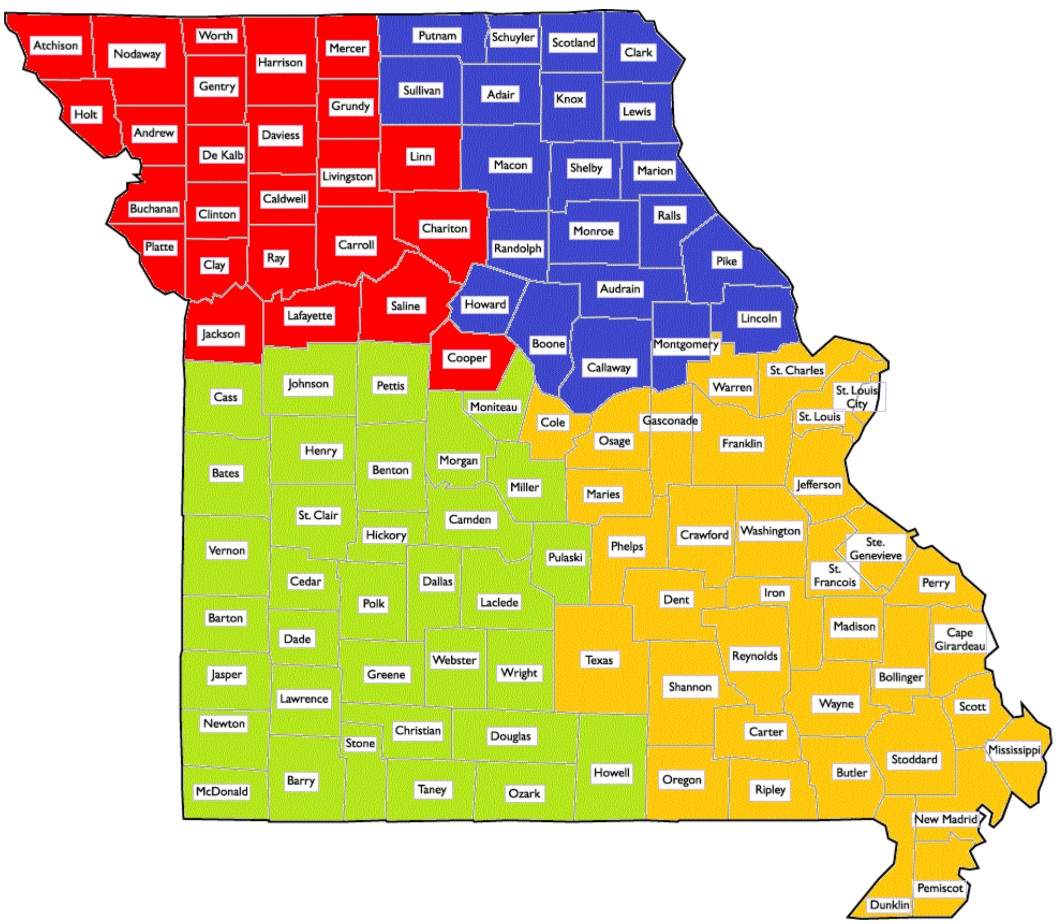
Many measures are weather sensitive. Because there is a range of climactic conditions across the state, VEIC engaged TAC participants to provide input on which airports and cities represent the best proxies for determining appropriate weather data across Missouri. The result of this engagement with stakeholders is illustrated in the table below. This table assigns each of the proxy cities to one of four climate zones and provides a fifth statewide average for when a location is "unknown" as well as two individual categories for the "heat-island affect" of both St. Louis and Kansas City.

Default Weather Sites and Climate Zones specified in the MO-TRM 2017:

State	City	Station/Description	Climate Zone
IA	Fort Madison	Fort-Madison	NE
NE	Lincoln	Lincoln-Muni-AP	NW
MO	Cape Girardeau	Cape-Girardeau-Muni-AP	SE
MO	Kaiser	Kaiser-Mem(AWOS)	SW
MO	Knob Noster	Whiteman-AFB	Average/Unknown
MO	St Louis	St-Louis-Lambert-IAP	City
MO	Kansas City	Kansas-City-IAP	City

The following graphic of Missouri State color-codes the counties by the four "climate zones" identified in the table above (NE/NW, SE/SW). Although, the State's average "unknown" value and individual city zones are not highlighted on this map given each zone has an associated heating and cooling degree-day, the result is that there are a total of 14 climate zones identified for use in the MO-TRM 2017.

Default County Weather Zone Assignment:



3.7 Use of O&M Costs

Some measures specify an operations and maintenance (O&M) parameter that describes the incremental

O&M cost savings that can be expected over the measure's lifetime. When estimating the cost effectiveness of these measures, it is necessary to calculate the net present value (NPV) of O&M costs over the life of the measure, which requires an appropriate discount rate. The utility's weighted average cost of capital (WACC) is the most commonly used discount rate that is used in this context.

Each utility has a unique WACC that will vary over time. As a result, the MO-TRM 2017 does not specify the NPV of the O&M costs. Instead, the necessary cost and time line information required to calculate the NPV is included. An example is provided below to demonstrate how to calculate the NPV of O&M costs.

EXAMPLE

Baseline Case: O&M costs equal $150 every two years.

Efficient Case: O&M costs equal $50 every five years.

Given this information, the incremental O&M costs can be determined by discounting these cash flows in the Baseline Case and the Efficient Case separately using the applicable WACC. Then the NPV of the incremental O&M costs is calculated by subtracting one NPV from the other. This value is used in each utility's cost-effectiveness screening process.

Effect of O&M costs for those measures that include baseline shifts that result in multiple component costs and lifetimes cannot be calculated by this standard method. In only these cases, the O&M costs are presented as Annual Levelized equivalent cost (i.e., the annual payment that results in an equivalent NPV to the actual stream of O&M costs) and utilities should apply their own real discount rate to determine NPVs.

3.8 Treatment of Interactive Effects in the MO-TRM 2017

The MO-TRM 2017 presents engineering equations for most measures. This approach is desirable because it conveys information clearly and transparently, and is widely accepted in the industry. Unlike simulation model results, engineering equations also provide flexibility and the opportunity for users to substitute local, specific information for specific input values. Furthermore, the parameters can be changed in TRM updates to be applied in future years as better information becomes available.

One limitation is that some interactive effects between measures are not automatically captured. Because we cannot know what measures will be implemented at the same time with the same customer, we cannot always capture the interactions between multiple measures within individual measure characterizations. However, interactive effects with different end-uses are included in individual measure characterizations whenever possible. For instance, waste heat factors are included in the lighting characterizations to capture the interaction between more-efficient lighting measures and the amount of heating and/or cooling that is subsequently needed in the building.

By contrast, no effort is made to account for interactive effects between an efficient air conditioning measure and an efficient lighting measure, because it is impossible to know the specifics of the other measure in advance of its installation. For custom measures and projects where a bundle of measures is being implemented at the same time, these kinds of interactive effects should be estimated.

4 Glossary

Baseline Efficiency: The assumed standard efficiency of equipment, absent an efficiency program.

Building Types: Sixteen C&I building prototypes were modeled using DOE/EnergyPlus for the MO-TRM 2017. The building types are based on the DOE Commercial Reference Buildings developed by DOE, NREL, PNNL, and LBNL. Detailed descriptions and variable calculations for each building prototype can be found on the Missouri Division of Energy TRM's website. Note for C&I modeling efforts, TYM3 weather data is used as it is a designed input of energy modeling.

The following list provides a high level definition for each C&I building type offered in the MO-TRM 2017 and follows DOE reference building documentation. For additional information about the prototype models and the associated inputs please refer to https://energy.gov/eere/buildings/commercial-reference-buildings.

Building Type Name	Floor Area (ft2)	Number of Floors	CBECS #	Weighting
Large Office	498,588	12	1,251	0.5%
Medium Office	53,628	3	12,394	5.3%
Small Office	5,500	1	62,691	26.9%
Warehouse	52,045	1	70,785	30.4%
Stand-alone Retail	24,962	1	27,814	11.9%
Strip Mall	22,500	1	2,538	1.1%
Primary School	73,960	1	8,820	3.8%
Secondary School	210,887	2	7,070	3.0%
Supermarket	45,000	1	3,110	1.3%
Quick Service Restaurant	2,500	1	5,385	2.3%
Full Service Restaurant	5,500	1	12,080	5.2%
Hospital	241,351	5	747	0.3%
Outpatient Health Care	40,946	3	9,892	4.2%
Small Hotel	43,200	4	8,051	3.5%
Large Hotel	122,120	6	404	0.2%
Midrise Apartment*	33,740	4		0.0%

Note: To help determine the appropriate building type to use as a reference to a specific project, the user should take into consideration the predominant use type, size of the building/project, and the HVAC systems that serve the project. Where a project is defined by multiple uses or systems it may be appropriate to utilize floor area weighted averages of model outputs (e.g., EFLH) based on the distribution of those use types in the project under consideration. For example, if the user is defining EFLHs for a system or measure that impacts both retail and office spaces within a 75,000 ft^2, 5-story building then they may consider an area-weighted average EFLH from Medium Office and Stand Alone Retail.

Coincidence Factor (CF): Coincidence factors represent the fraction of connected load expected to be coincident with a particular system peak period, on a diversified basis. Coincidence factors are provided for summer peak periods.

Commercial & Industrial: The market sector that includes measures that apply to any of the building types defined in the MO-TRM 2017, which includes multifamily common areas and public housing[1].

Connected Load: The maximum wattage of the equipment, under normal operating conditions.

Deemed Value: A value that has been assumed to be representative of the average condition of an input parameter.

Default Value: When a measure indicates that an input to a prescriptive saving algorithm may take on a range of values, an average value is also provided in many cases. This value is considered the default input to the algorithm, and should be used when the other alternatives listed in the measure are not applicable.

End-use Category: A general term used to describe the categories of equipment that provide a service to an individual or building. See Section 2, Level 1: End-use Category Table for a list of the end use categories that are incorporated in the MO-TRM 2017.

Energy Efficiency: "Energy efficiency" means measures that reduce the amount of electricity or natural gas required to achieve a given end use. "Energy efficiency" also includes measures that reduce the total Btus of electricity and natural gas needed to meet the end use or uses. For purposes of this Section, "energy efficiency" means measures that reduce the amount of energy required to achieve a given end use. "Energy efficiency" also includes measures that reduce the total Btus of electricity and natural gas needed to meet the end use or uses.

Equivalent Full Load Hours (EFLH): The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW) or therms.

Evaluation: (synonym EM&V) in the energy efficiency arena, impact evaluation is an investigation process to determine energy or demand impacts achieved through the program activities, including but not limited to savings verification, measure research and program research.

High Efficiency: General term for technologies and processes that require less energy, water, or other inputs to operate.

Incremental Costs: This is a calculated difference in equipment or technology cost between a base equipment model and the more efficient model. Incremental costs can be as little as $0, indicating that there is no expected cost difference between baseline and efficient technologies. Cost of labor or other installation related costs is not considered in incremental costs.

Interested Stakeholders: Any party with technical knowledge of Energy Efficiency Program implementation savings calculations.

Lifetime: The number of years (or hours) that the new high efficiency equipment is expected to function. These are generally based on engineering lives, but sometimes adjusted based on expectations about frequency of removal, remodeling or demolition. Two important distinctions fall under this definition; Effective Useful Life (EUL) and Remaining Useful Life (RUL).

> **EUL** – EUL is based on the manufacturers rating of the effective useful life; how long the equipment will last. It is an estimate of the median number of years that the measures installed under a program are still in place and operable.
>
> **RUL** – Applies to retrofit or replacement measures. For example, if an existing working refrigerator is replaced with a high efficiency unit, the RUL is an assumption of how many more years the existing unit would have lasted. As a general rule the RUL is usually assumed to be 1/3 of the EUL.

[1] Measures that apply to the multifamily and public housing building types describe how to handle tenant versus master metered buildings.

Load Factor (LF): The fraction of full load (wattage) for which the equipment is typically run.

Measure Cost: The incremental (for time of sale measures) or full cost (both capital and labor for retrofit measures) of implementing the High Efficiency equipment.

Measure Description: A detailed description of the technology and the criteria it must meet to be eligible as an energy efficient measure.

Measure: An efficient technology or procedure that results in energy savings as compared to the baseline efficiency. There are three main measure types:

1) **Prescriptive Measures** - measures or technologies are offered through a standard (in contrast to custom) program, for which partially or fully deemed input values are applicable:

    i. **Fully deemed measures -** measures whose energy savings are expressed on a per unit basis in the MO-TRM 2017 and are not subject to change or choice by the program administrator.

    ii. **Partially deemed measures -** measures whose energy savings algorithms are deemed in the MO-TRM 2017, with input values that may be selected to some degree by the program administrator, typically based on a customer-specific input.

2) **Custom Measures –** these are measures or technologies that due to the complexity in the design and configuration of the particular measure in the energy efficiency project, a more comprehensive custom engineering algorithm and financial analysis may be used that more accurately characterize the energy efficiency savings within a project. *Note: the MO-TRM 2017 does not contain any custom measures.*

3) **Comparison group EM&V measures** – these are measures that determine program savings based on the differences in electricity consumption patterns between a comparison group the program participants, not a deemed savings value. Comparison group approaches include randomized control trials (RCTs) and quasi-experimental methods using nonparticipants, and may involve simple differences or regression methods. Because the effects of implemented measures is reflected in the observed participant-comparison differences, separate verification is not required. These methods are generally used for planning purposes to estimate program-level savings, not facility- or project-level savings, and are therefore considered an evaluation method. *Note: The reference to and inclusion of Residential Peer Comparison Behavior Programs in the MO-TRM 2017 is an example of where comparison group EM&V values should be used to support program considerations, rather than deemed, alongside robust reference documentation for the sources of those values and the appropriate use of SEEAction[2] and UMP guidelines[3] as required for program evaluation/savings calculation*.

Measure research: an evaluation process focused on providing better/more granular data to facilitate updating measure-specific MO-TRM 2017 input values or algorithms.

Residential: The market sector that includes measures that apply only to detached, residential buildings, duplexes and applicable multifamily units.

Operation and Maintenance (O&M) Cost Adjustments: The dollar impact resulting from differences between baseline and efficient case Operation and Maintenance costs.

Operating Hours (HOURS): The annual hours that equipment is expected to operate.

Program: The mode of delivering a particular measure or set of measures to customers. See Section 2.4.1 for a list of program descriptions that are presently operating in Missouri.

Program research: an evaluation process that takes an alternative look into achieved program level savings

2 Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations; SEEAction (State and Local Energy Efficiency Action Network- EPA/DOE), 2012

3 The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Residential Behavior Protocol, NREL/ DOE, 2015.

across multiple measures. May or may not be specific enough to inform future MO-TRM updates. Ex. Program billing analysis.

Savings verification: an evaluation process that independently verifies program savings achieved through prescriptive measures.

Appendix A – High Impact Measures from MO-TRM 2017

Market Sector	Measure Name	End Use Category
Commercial & Industrial	Combination Oven	Food Service
Commercial & Industrial	Commercial Steam Cooker	Food Service
Commercial & Industrial	Conveyor Oven	Food Service
Commercial & Industrial	Fryer	Food Service
Commercial & Industrial	Convection Oven	Food Service
Commercial & Industrial	Griddle	Food Service
Commercial & Industrial	Infrared Charbroiler	Food Service
Commercial & Industrial	Infrared Rotisserie Oven	Food Service
Commercial & Industrial	Kitchen Demand Ventilation Controls	Food Service
Commercial & Industrial	Rack Oven	Food Service
Commercial & Industrial	Infrared Salamander Broiler	Food Service
Commercial & Industrial	Water Heater	Hot Water
Commercial & Industrial	Boiler	HVAC
Commercial & Industrial	Boiler Averaging Controls	HVAC
Commercial & Industrial	Boiler Lockout/Reset Controls	HVAC
Commercial & Industrial	High Temperature Heating & Ventilating (HTHV) Direct-Fired Gas Heaters	HVAC
Commercial & Industrial	High Turndown Burner for Space Heating Boilers	HVAC
Commercial & Industrial	Infrared Heaters	HVAC
Commercial & Industrial	Programmable Thermostat	HVAC
Commercial & Industrial	Steam Trap Replacement or Repair	HVAC
Commercial & Industrial	Demand Controlled Ventilation	HVAC
Commercial & Industrial	Furnace	HVAC
Commercial & Industrial	Compact Fluorescent Lamp	Lighting
Commercial & Industrial	Fluorescent Delamping	Lighting
Commercial & Industrial	High Performance and Reduced Wattage T8 Fixtures and Lamps	Lighting
Commercial & Industrial	LED Bulbs and Fixtures	Lighting
Commercial & Industrial	LED Screw Based Omnidirectional Bulb	Lighting
Commercial & Industrial	T5 Fixtures and Lamps	Lighting
Commercial & Industrial	Commercial Solid and Glass Door Refrigerators & Freezers	Refrigeration
Commercial & Industrial	Refrigerated Beverage Vending Machine	Refrigeration
Residential	Refrigerator and Freezer Recycling	Appliances
Residential	Low Flow Faucet Aerator	Hot Water
Residential	Low Flow Showerhead	Hot Water
Residential	Water Heater	Hot Water
Residential	Advanced Thermostat	HVAC
Residential	Air Source Heat Pump	HVAC
Residential	Boiler	HVAC
Residential	Duct Sealing	HVAC
Residential	Ductless Air Source Heat Pump	HVAC
Residential	Furnace	HVAC
Residential	Programmable Thermostat	HVAC

Market Sector	Measure Name	End Use Category
Residential	Compact Fluorescent Lamp	Lighting
Residential	LED Screw Based Omnidirectional Bulb	Lighting
Residential	Air Sealing	Shell
Residential	Ceiling Insulation	Shell

Note: Volume 2&3 include a table of contents that provides a comprehensive listing of all the measures that have been characterized in the MO-TRM 2017 in addition to these High Impact.

Appendix B – Residential Loadshapes in MO-TRM 2017

Residential												
Electric Loadshape Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Residential Freezer	7.9579%	7.2518%	8.1080%	7.9918%	8.4083%	8.5730%	9.6095%	9.6095%	8.4277%	8.2582%	7.8465%	7.9579%
Residential Refrigerator	7.7053%	7.2169%	8.0272%	7.8752%	8.5646%	8.9112%	9.4239%	9.4212%	8.4971%	8.5653%	7.8717%	7.9204%
Residential Clothes Washer	8.4732%	7.6579%	8.4818%	8.2112%	8.4883%	8.2176%	8.4942%	8.4977%	8.2265%	8.5045%	8.2341%	8.5129%
Residential Clothes Dryer	8.4736%	7.6583%	8.4749%	8.2139%	8.4831%	8.2211%	8.4984%	8.4963%	8.2287%	8.5031%	8.2360%	8.5128%
Residential DWH	10.3527%	9.0720%	9.5543%	8.4799%	8.3600%	7.7065%	6.7712%	6.3688%	6.9373%	7.9644%	8.4752%	9.9577%
Residential Indoor Lighting	10.1182%	8.8441%	9.2879%	8.4645%	7.9393%	6.8508%	6.7864%	7.0565%	7.3792%	8.4539%	8.9880%	9.8312%
Residential Outdoor Lighting	10.6265%	8.2162%	7.0887%	6.8146%	8.1853%	6.7163%	8.6752%	6.9401%	8.2908%	10.0507%	8.7252%	9.6704%
Residential Cooling	0.1200%	0.1100%	0.3130%	1.5047%	6.5410%	21.0823%	28.4780%	27.0766%	12.6605%	1.8472%	0.1444%	0.1222%
Residential Space Heat	23.0652%	15.9357%	13.1370%	6.3607%	2.0772%	0.1584%	0.0218%	0.0000%	1.1456%	5.5202%	12.2775%	20.3008%
Residential Heating and Cooling	10.7824%	9.1052%	7.1135%	4.1179%	4.4424%	10.6128%	14.2881%	13.3494%	5.7810%	3.8018%	6.2104%	10.3950%
Residential Dehumidifier	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	8.8235%	45.5882%	45.5882%	0.0000%	0.0000%	0.0000%	0.0000%
Residential Miscellaneous	8.4893%	7.7366%	8.4863%	8.2144%	8.4847%	8.2122%	8.4883%	8.4840%	8.2136%	8.4869%	8.2122%	8.4915%
Flat	8.4932%	7.6712%	8.4932%	8.2192%	8.4932%	8.2192%	8.4932%	8.4932%	8.2192%	8.4932%	8.2192%	8.4932%

Appendix C – Commercial and Industrial Loadshapes in MO-TRM 2017

Commercial and Industrial												
Electric Loadshape Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Commercial Cooking	8.5765%	7.7435%	8.5667%	8.2952%	8.5638%	8.0084%	8.2805%	8.2822%	8.0363%	8.6118%	8.3637%	8.6716%
Commercial Office Equipment	8.5595%	7.7309%	8.5532%	8.2828%	8.5532%	8.0338%	8.3073%	8.3099%	8.0616%	8.6011%	8.3509%	8.6560%
Commercial Miscellaneous	8.5109%	7.7715%	8.6136%	7.9796%	8.5335%	8.1995%	8.4099%	8.4199%	8.2512%	8.5277%	8.2589%	8.5238%
Commercial Exterior Lighting	10.6265%	8.2162%	7.0887%	6.8146%	8.1853%	6.7163%	8.6752%	6.9401%	8.2908%	10.0507%	8.7252%	9.6704%
Commercial Refrigeration	8.3486%	7.6158%	8.3346%	8.0783%	8.5133%	8.4295%	8.7457%	8.7230%	8.3319%	8.4563%	8.1112%	8.3119%
Commercial Compressed Air	8.5109%	7.7715%	8.6136%	7.9796%	8.5335%	8.1995%	8.4099%	8.4199%	8.2512%	8.5277%	8.2589%	8.5238%
Commercial Process	8.5109%	7.7715%	8.6136%	7.9796%	8.5335%	8.1995%	8.4099%	8.4199%	8.2512%	8.5277%	8.2589%	8.5238%
VFD Supply Fan	8.5189%	7.7184%	8.4616%	8.1639%	8.4471%	8.2376%	8.5678%	8.4759%	8.2987%	8.4140%	8.2041%	8.4921%
VFD Chilled Water Pump	8.5854%	7.6914%	8.4181%	8.1166%	8.5594%	8.2373%	8.6393%	8.6259%	8.1236%	8.2758%	8.2332%	8.4939%
VFD How Water Pump	7.3492%	6.6437%	7.3116%	7.2253%	8.2376%	10.1517%	10.6330%	10.6594%	9.8397%	7.5777%	7.0486%	7.3226%
Pool Heating – With Cover	0.0000%	0.0000%	0.0000%	0.0000%	25.2163%	7.0258%	0.0000%	3.5082%	20.4011%	43.8485%	0.0000%	0.0000%
Pool Heating – No Cover	0.0000%	0.0000%	0.0000%	0.0000%	7.2413%	0.0000%	0.0000%	0.0000%	9.9656%	82.7931%	0.0000%	0.0000%
Full Service Restaurant Indoor Lighting	7.7564%	7.1553%	7.9943%	7.8641%	8.7478%	9.1915%	9.5437%	9.4568%	8.5349%	8.3191%	7.5659%	7.8701%
Hospital Indoor Lighting	8.9058%	7.6905%	8.9991%	7.9435%	8.2769%	8.4133%	8.2713%	8.7015%	7.9015%	8.0989%	8.4615%	8.3360%
Large Hotel – Building Indoor	7.8189%	7.0410%	7.8954%	7.8710%	8.6478%	9.2590%	9.6437%	9.6318%	8.6314%	8.1365%	7.6073%	7.8161%

Commercial and Industrial												
Electric Loadshape Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lighting												
Small Hotel – Building Indoor Lighting	7.1308%	6.9878%	7.5044%	8.3325%	9.1226%	9.1709%	9.5926%	9.4555%	8.8722%	8.8924%	7.2079%	7.7304%
Midrise Apartment – Building Indoor Lighting	7.2596%	6.6109%	7.5445%	7.6068%	9.1500%	9.9149%	10.3313%	10.1961%	8.8340%	8.1670%	7.0274%	7.3574%
Small Office Indoor Lighting	7.5800%	6.9813%	8.3773%	7.8693%	9.0924%	9.4916%	8.9497%	9.8525%	8.4261%	8.3636%	7.5149%	7.5013%
Large Office Indoor Lighting	8.0180%	7.1775%	8.5050%	7.6592%	8.9242%	9.4346%	8.8494%	9.6071%	8.2716%	8.1321%	7.8607%	7.5605%
Medium Office Indoor Lighting	7.3667%	6.9573%	8.2159%	8.0283%	9.0974%	9.5438%	9.1246%	9.9020%	8.4629%	8.5276%	7.3111%	7.4623%
Outpatient Health Care Indoor Lighting	8.0396%	7.3925%	8.6443%	8.3430%	8.7813%	8.6725%	8.6354%	9.2067%	7.8000%	8.5991%	7.9866%	7.8990%
Primary School Indoor Lighting	8.3017%	7.5870%	8.9363%	8.3699%	9.8054%	10.7438%	5.9776%	6.0725%	8.9480%	8.9651%	8.1469%	8.1458%
Quick Service Restaurant Indoor Lighting	7.9093%	7.2020%	8.0155%	7.8951%	8.6833%	9.1159%	9.4679%	9.3449%	8.4605%	8.3128%	7.6305%	7.9623%
Stand-Alone Retail Indoor Lighting	7.7451%	7.1281%	8.1764%	8.0042%	8.8654%	9.1252%	9.1812%	9.4636%	8.3539%	8.4993%	7.6334%	7.8243%
Secondary School Indoor Lighting	7.7576%	7.1253%	8.5556%	8.2649%	10.0252%	11.0503%	6.8209%	6.8109%	9.1215%	9.0366%	7.6808%	7.7502%
Strip Mall Indoor Lighting	7.7311%	7.1219%	8.1689%	8.0135%	8.8706%	9.1248%	9.1816%	9.4707%	8.3592%	8.5299%	7.6114%	7.8163%
Supermarket Indoor Lighting	7.9196%	7.2064%	8.2446%	7.9157%	8.6830%	9.1668%	9.2273%	9.4399%	8.4521%	8.2302%	7.6068%	7.9076%
Warehouse Indoor Lighting	8.0610%	7.3050%	8.6001%	7.7903%	8.6070%	9.1071%	8.8526%	9.5404%	8.1573%	8.1922%	7.9647%	7.8223%
Full Service	8.9634%	7.9680%	8.8351%	8.0955%	8.2506%	7.9844%	8.2506%	8.2506%	7.9844%	8.2564%	8.3998%	8.7612%

Commercial and Industrial												
Electric Loadshape Name	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Restaurant Ventilation												
Hospital Ventilation	8.3366%	7.5475%	8.3766%	8.1292%	8.4998%	8.4509%	8.7197%	8.7483%	8.2915%	8.4451%	8.0905%	8.3643%
Large Hotel – Building Ventilation	7.4991%	6.9831%	7.7234%	7.9512%	8.7969%	9.2947%	10.0687%	9.4437%	8.5561%	8.5058%	7.4040%	7.7733%
Small Hotel – Building Ventilation	3.8658%	4.4678%	4.4946%	4.7621%	9.9262%	15.4599%	17.4582%	15.5880%	10.2465%	6.9822%	2.7900%	3.9586%
Midrise Apartment – Building Ventilation	12.8563%	9.9654%	10.5140%	4.4376%	4.4891%	9.2458%	11.2307%	8.7973%	4.9031%	3.4844%	10.2473%	9.8290%
Small Office Ventilation	10.3964%	8.4345%	9.8331%	7.7784%	7.3144%	7.4576%	7.5079%	7.7035%	7.0550%	7.3294%	9.6172%	9.5726%
Large Office Ventilation	9.8040%	7.8899%	9.2755%	6.7936%	7.7388%	8.7850%	9.0970%	8.8955%	7.3066%	7.2327%	8.3891%	8.7923%
Medium Office Ventilation	9.6315%	7.8646%	9.4106%	7.3273%	7.7826%	8.4480%	8.7922%	8.5973%	7.5514%	7.3681%	8.5081%	8.7182%
Outpatient Health Care Ventilation	8.4401%	7.6200%	8.5317%	8.1622%	8.4659%	8.3769%	8.5679%	8.6283%	8.1116%	8.4552%	8.2070%	8.4332%
Primary School Ventilation	9.6306%	7.5263%	9.0064%	6.5511%	8.0667%	11.2230%	8.3606%	8.1051%	7.7194%	7.1264%	8.2390%	8.4454%
Quick Service Restaurant Ventilation	9.0289%	7.9527%	8.8846%	8.0818%	8.2320%	7.9664%	8.2320%	8.2320%	7.9664%	8.2320%	8.4239%	8.7671%
Stand-Alone Retail Ventilation	8.7593%	7.9930%	8.7993%	8.1154%	8.3019%	8.1105%	8.2214%	8.3692%	7.9719%	8.3202%	8.3436%	8.6943%
Secondary School Ventilation	9.2192%	7.4705%	8.9360%	6.5582%	7.8214%	9.7471%	10.3246%	9.0844%	7.2774%	7.0404%	8.2397%	8.2810%
Strip Mall	8.7901%	8.0126%	8.8187%	8.1099%	8.2832%	8.0937%	8.2043%	8.3518%	7.9563%	8.3054%	8.3625%	8.7115%

Commercial and Industrial												
Electric Loadshape Name	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Ventilation												
Supermarket Ventilation	9.7811%	8.4300%	9.3610%	8.0916%	7.7747%	7.4474%	7.6956%	7.6956%	7.5130%	7.8880%	9.0564%	9.2656%
Warehouse Ventilation	10.9198%	9.3978%	10.3561%	7.6955%	7.0422%	6.9957%	7.0058%	7.4465%	6.7092%	7.0478%	9.3455%	10.0381%
Full Service Restaurant Cooling	0.0111%	0.2712%	0.9483%	2.6236%	8.8898%	22.8231%	27.7819%	22.2692%	10.1789%	3.8517%	0.0366%	0.3145%
Hospital Cooling	5.0599%	4.6960%	6.0686%	6.9860%	9.5387%	12.6560%	13.3272%	12.7691%	9.6499%	7.7950%	5.6907%	5.7628%
Large Hotel – Building Cooling	1.2103%	2.1667%	2.4393%	4.6341%	9.9001%	18.7221%	21.3569%	18.3771%	10.4961%	6.4682%	1.7116%	2.5174%
Small Hotel – Building Cooling	0.9850%	1.8599%	2.4553%	4.7397%	10.8156%	18.0036%	20.7134%	18.1856%	11.4088%	7.3067%	1.2898%	2.2366%
Midrise Apartment – Building Cooling	0.0014%	0.0519%	0.5949%	1.4066%	8.6035%	23.7339%	30.3403%	22.7165%	9.4411%	2.9824%	0.0097%	0.1178%
Small Office Cooling	0.0886%	0.4296%	1.3307%	3.3665%	10.3645%	21.8947%	24.8794%	21.1595%	10.4165%	4.9256%	0.2793%	0.8651%
Large Office Cooling	3.0775%	3.0092%	4.0240%	4.5882%	9.2232%	17.7939%	18.7331%	17.0315%	9.6624%	5.8861%	3.0812%	3.8897%
Medium Office Cooling	0.3801%	1.0749%	1.9412%	4.7735%	11.1480%	19.8344%	22.0246%	19.3187%	10.4701%	6.6687%	0.7621%	1.6037%
Outpatient Health Care Cooling	3.1276%	3.5566%	4.4833%	6.4543%	10.3678%	14.7948%	15.9587%	14.9992%	10.2992%	7.9153%	3.7428%	4.3002%
Primary School Cooling	1.6318%	1.2503%	2.4362%	4.1897%	10.6384%	22.8111%	19.7623%	17.3012%	10.5184%	6.0738%	1.3620%	2.0249%
Quick Service Restaurant Cooling	0.0042%	0.2519%	0.8020%	2.3713%	8.3837%	23.0225%	28.9268%	22.4431%	9.9084%	3.5567%	0.0230%	0.3064%
Stand-Alone	0.0029%	0.3209%	0.9316%	2.5663%	9.2347%	22.2346%	26.9875%	22.0084%	10.7385%	4.4947%	0.0482%	0.4316%

Commercial and Industrial												
Electric Loadshape Name	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Retail Cooling												
Secondary School Cooling	0.0271%	0.2430%	1.2842%	3.8593%	11.4625%	26.4290%	21.5603%	17.6332%	11.1178%	5.5375%	0.0897%	0.7564%
Strip Mall Cooling	0.0057%	0.2911%	0.9480%	2.6034%	9.2497%	22.1019%	26.8523%	22.0352%	10.8609%	4.6730%	0.0209%	0.3579%
Supermarket Cooling	0.0815%	0.3146%	0.6625%	2.1297%	7.7012%	22.9687%	29.5970%	22.7527%	9.9727%	3.3117%	0.1167%	0.3908%
Warehouse Cooling	0.0000%	0.0000%	0.0000%	0.1291%	2.2174%	18.9907%	40.7158%	30.1139%	7.1559%	0.6772%	0.0000%	0.0000%
Full Service Restaurant Electric Heating	21.0607%	17.2036%	16.9498%	6.0036%	1.3240%	0.0468%	0.0458%	0.1177%	1.5201%	3.2957%	16.3277%	16.1045%
Hospital Electric Heating	11.9972%	10.5855%	10.7707%	8.0515%	6.6307%	5.1232%	5.0836%	5.5850%	6.7939%	7.8317%	10.6086%	10.9384%
Large Hotel – Building Electric Heating	21.9286%	16.1525%	17.3090%	5.8225%	1.1435%	0.0280%	0.0243%	0.0947%	1.6312%	3.0921%	17.3221%	15.4516%
Small Hotel – Building Electric Heating	25.7145%	23.0431%	19.1629%	1.5883%	0.0491%	0.0000%	0.0000%	0.0000%	0.2002%	0.1563%	13.8548%	16.2307%
Midrise Apartment – Building Electric Heating	21.4431%	16.8713%	16.9150%	5.8359%	1.1911%	0.0219%	0.0292%	0.0792%	1.6099%	3.1485%	16.7090%	16.1458%
Small Office Electric Heating	23.2781%	18.4404%	17.3926%	4.2408%	0.6872%	0.0134%	0.0081%	0.0234%	0.8304%	1.9604%	15.7798%	17.3454%
Large Office Electric Heating	22.0520%	16.3664%	16.7841%	5.1972%	1.4878%	0.2173%	0.1917%	0.4442%	2.3426%	3.6601%	15.7356%	15.5211%
Medium Office Electric Heating	25.8829%	19.8461%	18.2458%	2.2543%	0.3094%	0.0016%	0.0019%	0.0059%	0.4660%	0.7521%	16.0775%	16.1566%
Outpatient Health Care Electric Heating	12.5456%	10.2118%	11.2459%	8.2180%	6.5460%	4.9957%	4.7851%	5.2956%	6.3620%	7.5791%	11.1246%	11.0906%
Primary School Electric Heating	22.7225%	18.2224%	18.0280%	4.4314%	1.2867%	0.0867%	0.1113%	0.2210%	1.2951%	2.3371%	16.4040%	14.8539%

Commercial and Industrial												
Electric Loadshape Name	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Quick Service Restaurant Electric Heating	21.6882%	24.1222%	16.8672%	3.9774%	0.5690%	0.0326%	0.0427%	0.0363%	0.4983%	1.3685%	12.9032%	17.8943%
Stand-Alone Retail Electric Heating	21.7910%	17.7770%	17.2192%	5.6444%	1.1993%	0.0279%	0.0324%	0.0882%	1.1211%	2.8581%	15.9447%	16.2966%
Secondary School Electric Heating	22.1378%	18.3408%	18.3693%	4.6761%	1.4544%	0.0502%	0.0423%	0.0878%	1.4968%	2.5502%	16.9799%	13.8144%
Strip Mall Electric Heating	21.7558%	17.5267%	17.2519%	5.7789%	1.2776%	0.0348%	0.0458%	0.1111%	1.2238%	2.9623%	15.9380%	16.0932%
Supermarket Electric Heating	20.4450%	16.6407%	16.2010%	6.8443%	1.8196%	0.0918%	0.0937%	0.1718%	1.6065%	4.0035%	16.0020%	16.0801%
Warehouse Electric Heating	23.5466%	21.3193%	17.2239%	4.7200%	0.7637%	0.0056%	0.0018%	0.0023%	0.4608%	1.7040%	12.8748%	17.3772%
Full Service Restaurant Heat Pump	14.9995%	13.7487%	11.1019%	4.3341%	4.1560%	6.9754%	8.2804%	6.9315%	4.4571%	3.6460%	9.6368%	11.7326%
Hospital Heat Pump	8.3041%	7.7130%	7.5192%	6.2943%	7.9259%	10.4930%	11.5003%	10.7478%	8.1238%	6.7742%	6.7655%	7.8389%
Large Hotel – Building Heat Pump	6.2612%	6.1059%	5.8862%	5.5819%	8.2455%	13.2475%	15.0272%	13.1944%	8.5685%	6.4623%	5.3342%	6.0852%
Small Hotel – Building Heat Pump	8.5656%	9.0037%	7.4416%	5.1337%	7.4555%	11.0816%	12.8033%	11.2818%	7.7591%	5.8527%	6.0434%	7.5781%
Midrise Apartment – Building Heat Pump	16.0192%	14.2929%	11.6847%	4.2954%	3.8542%	5.9006%	7.1963%	5.8745%	4.1170%	3.8336%	10.4825%	12.4490%
Small Office Heat Pump	13.9965%	12.8113%	10.3851%	4.0757%	4.8296%	8.0159%	9.0106%	7.8168%	4.8155%	3.6839%	8.9570%	11.6022%
Large Office Heat Pump	11.8315%	10.1383%	9.4622%	5.2978%	6.1769%	8.8579%	9.7209%	8.8195%	6.2723%	5.3731%	8.4861%	9.5636%
Medium Office	10.3916%	9.5841%	8.3463%	4.4802%	6.6586%	10.9876%	12.3828%	10.7187%	6.5216%	4.8535%	6.9043%	8.1707%

Commercial and Industrial												
Electric Loadshape Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump												
Outpatient Health Care Heat Pump	8.5685%	7.4088%	7.7353%	6.3763%	8.0147%	10.4015%	11.1634%	10.6019%	7.9976%	6.8711%	7.0444%	7.8166%
Primary School Heat Pump	14.5915%	12.6409%	10.4009%	4.3206%	5.2085%	8.9406%	8.3740%	7.3724%	5.1790%	4.2308%	8.9894%	9.7516%
Quick Service Restaurant Heat Pump	16.4496%	15.1661%	11.8960%	3.7484%	3.4642%	6.2441%	7.5626%	6.1505%	3.7932%	2.8903%	10.0458%	12.5892%
Stand-Alone Retail Heat Pump	15.3327%	14.1592%	11.2920%	4.0451%	4.0103%	6.8966%	8.1706%	6.9091%	4.2802%	3.4355%	9.5561%	11.9126%
Secondary School Heat Pump	14.3245%	12.5532%	10.2142%	4.0786%	5.4247%	9.8329%	9.3598%	7.3351%	5.2711%	4.0924%	8.9528%	8.5607%
Strip Mall Heat Pump	15.6003%	14.1092%	11.4149%	4.0087%	3.9561%	6.8250%	8.1062%	6.8733%	4.2822%	3.3613%	9.6331%	11.8296%
Supermarket Heat Pump	17.1474%	15.4968%	12.3805%	4.9509%	3.4144%	4.4558%	5.3992%	4.5111%	3.5318%	3.8125%	11.2137%	13.6859%
Warehouse Heat Pump	21.8890%	21.8471%	15.0158%	4.1077%	1.2711%	1.2028%	2.0577%	1.6256%	1.0922%	2.0885%	10.9961%	16.8065%
Full Service Restaurant Electric DWH	9.8931%	9.0617%	9.8416%	8.8503%	8.3707%	7.3928%	7.0423%	6.9930%	6.9970%	7.8360%	8.3526%	9.3689%
Hospital Electric DWH	9.9330%	9.0925%	9.9005%	8.8318%	8.3842%	7.3836%	6.9818%	6.9735%	6.9410%	7.8291%	8.3957%	9.3535%
Large Hotel – Building Electric DWH	10.2337%	9.3750%	10.0555%	8.9857%	8.3245%	7.1657%	6.7643%	6.6168%	6.7326%	7.7237%	8.4183%	9.6043%
Small Hotel – Building Electric DWH	9.9631%	9.1132%	9.8077%	8.8717%	8.3513%	7.3246%	7.0333%	6.9068%	6.9592%	7.8473%	8.3875%	9.4344%
Midrise Apartment – Building	10.2321%	9.3728%	10.0396%	8.9880%	8.3208%	7.1615%	6.7755%	6.6141%	6.7396%	7.7282%	8.4166%	9.6110%

Commercial and Industrial												
Electric Loadshape Name	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Electric DWH												
Small Office Electric DWH	8.8552%	8.0349%	8.9659%	8.3696%	8.4955%	8.0376%	8.0390%	8.1220%	7.8578%	8.2881%	8.2590%	8.6754%
Large Office Electric DWH	10.0612%	9.2701%	10.4954%	8.8651%	8.4726%	7.4445%	6.5371%	6.9315%	6.6689%	7.6234%	8.3842%	9.2461%
Medium Office Electric DWH	9.7091%	8.9127%	10.0474%	8.7233%	8.4828%	7.6140%	6.9656%	7.2804%	7.0190%	7.8175%	8.3497%	9.0786%
Outpatient Health Care Electric DWH	9.7390%	8.9378%	10.0256%	8.9430%	8.5141%	7.5036%	6.9328%	7.2917%	6.6424%	8.0108%	8.4401%	9.0191%
Primary School Electric DWH	10.7209%	9.8161%	11.3408%	9.4037%	9.3078%	8.3212%	3.1936%	3.3698%	7.1510%	8.3984%	9.2253%	9.7514%
Quick Service Restaurant Electric DWH	9.7865%	8.9565%	9.7375%	8.8039%	8.3777%	7.4575%	7.1529%	7.1066%	7.0897%	7.8861%	8.3429%	9.3022%
Secondary School Electric DWH	11.3274%	10.4280%	12.0169%	9.9685%	9.6936%	7.2228%	2.1710%	2.3227%	6.2246%	8.7010%	9.6094%	10.3140%
Supermarket Electric DWH	9.3714%	8.5890%	9.4060%	8.6549%	8.4196%	7.7031%	7.5198%	7.5371%	7.4263%	8.0562%	8.2568%	9.0598%
Flat	8.4932%	7.6712%	8.4932%	8.2192%	8.4932%	8.2192%	8.4932%	8.4932%	8.2192%	8.4932%	8.2192%	8.4932%

Appendix D: Non-Consensus Documentation for MO-TRM 2017

Consensus Decision-Making Approach

The best TRMs are not only accurate and rigorous but are also useful, transparent, and equitable. The Missouri statewide TRM development is guided by this spirit of collaboration and shared goals, as outlined by grant partner letters of commitment and support and in detail in Section 1.1 of the MO-TRM 2017. To ensure broad consensus amongst stakeholders, monthly Oversight Committee (OC) and Technical Advisory Committee (TAC) meetings were used to maximize the level of collaboration and visibility into the measure characterization process and, where differences lay, to work towards reaching consensus on TRM content.

During the development of the MO-TRM 2017, neither the TAC nor OC made use of formal voting procedures, instead consensus decision-making was the nature of settlement discussions as outlined below.

- In the event of a disagreement or where there is lack of clarity on an issue within the TAC, VEIC noted the issue, documented the grounds for disagreement, and sought feedback on whether additional research or follow-up was warranted, within the scope of the grant.
- If after a reasonable opportunity for additional discussion and research, consensus was still not reached, it is the role of the OC to review all non-consensus decisions by considering the varying positions of the TAC members alongside other credible resources/supporting documentation, and to discuss possible solutions.
- It is the role of the OC to review the information and to comment on (if presented) a proposed agreement. Oversight Committee members may accept or register continued disagreement with the proposed resolution. For the purposes of the OC, consensus may be determined through one of two ways:
    1. **In-Person or Teleconference.** Consensus may be determined if no objections are voiced in an OC meeting to an issue. The meeting may be in-person or over the phone. Determining consensus through lack of objection at a meeting will be used sparingly as it is preferable for parties to see written proposals and have ample time to consider the proposal.
    2. **Review of Written Proposal**. Generally, consensus should be determined through review of a written proposal so parties know what they are agreeing to with written affirmative consent so that it is clear which parties are indicating consent. Consensus will be determined on a particular written proposal based on receiving no objections from any party on that written proposal by a date specified reasonably in advance by the OC.
- Notwithstanding, while it is the hope that consensus can be reached by the OC, if there is no final resolution, language will be included in the introductory language (Volume 1) of the TRM document to outline the non-consensus issue and positions.
- In keeping with the goal of transparency, this non-consensus document will be developed to capture all areas of and grounds for continuing disagreement accompanied by TAC-and OC-supported recommendations that identify the issue, different opinions and the basis for those opinions. For consensus decision-making, stakeholders should provide one position on a particular issue, per company or organization.

MO-TRM 2017 HDD baseline decision and non-consensus documentation

Background:

Many of the residential measure savings algorithms (HVAC and Shell) make use of heating degree days assumptions to capture weather dependency of measures. For the draft measures, VEIC proposed referencing a base temperature of 60 degrees with the belief that this would better align TRM savings estimates with actual realized savings. This recommendation was based on VEIC's own experience with program evaluation, current practice of neighboring states (both Iowa and Illinois have adopted HDD60), and guidance from forward-thinking members of the industry.

In much of VEIC's experience, using base temperature of 65 degrees without any other correction or calibration factor typically overestimates a residential building's heating requirements. Ultimately, a heating load is influenced by much more than outdoor temperature - things like occupancy, behavior or physical building characteristics all interplay with outdoor air temperature to reach the cumulative effect. A lower base temperature of 60 is intended to better reflect how the heating system is expected to operate, considering all of these other factors.

After several discussions during which stakeholders sought additional feedback, the TAC was unable to reach consensus on the most appropriate base temperature to use for heating degree day specification and the subject was moved to the OC for consideration.

After significant review of the TAC positions and supporting materials presented to the OC in favor of and against the use of HDD 65 vs HDD 60 the OC continued to register disagreement but concurred with the documentation of this non-consensus issue and varying positions as well as how the TRM can best identify and treat those measures impacted by this HDD non-consensus input in MO-TRM V1.0. In addition the OC agreed that this baseline discussion be recommended for review in future revisions of the TRM utilizing new information available at that time.

The following summarizes those positions presented by TAC and OC members on the HDD 60 vs. 65 non-consensus issue including supporting reference documentation and studies. Additional positions and/or supporting material can be found on the Missouri Division of Energy website (https://energy.mo.gov/) and should be referenced.

Given the non-consensus nature of this issue it is strongly recommended that any future discussion or consideration of heating degree value should be informed by metering or evaluation results specific to participating utilities' programs and customer bases.

Case for using HDD 60:

The HDD is the temperature which is deemed for when people turn on their heat at home. The HDD baseline affects many measures which are weather dependent. Using a less accurate value may lead to over-or under-estimating the energy savings, especially given the uncertainty around how reliably program evaluation can be expected to inform a robust net savings estimate. Supporting arguments, documentation and references for this recommendation include:

- Neighboring states of Iowa and Illinois have adopted HDD60 and have affirmed its use based on EM&V data[4].
- In much of VEIC's experience, using base temperature of 65 degrees without any other correction or calibration factor typically overestimates a residential building's heating requirements. Ultimately, a heating load is influenced by much more than outdoor temperature - things like occupancy, behavior or physical building characteristics all interplay with outdoor air temperature

[4] http://www.ilsag.info/ and http://www.iowautility.org/

to reach the cumulative effect. A lower base temperature of 60 is intended to better reflect how the heating system is expected to operate, considering all of these other factors[5].

- The MO-TRM 2017 should be developed based upon the recommended HDD60 baseline until there is further clarity around the ability of a future evaluation to inform net savings realized from the affected measures[6].
- HDD baselines should be reviewed in future revisions of the TRM utilizing new information available at that time and additional consideration should also be taken at this time to revise the CDD base temperature from 70 to 65.

Case for HDD 65:

Using HDD 60 instead of HDD 65 would be a deviation from current Missouri utility practices and away from industry norm. ASHRAE 90.1 standard for commercial construction uses a heating baseline of 65 degrees and the NOAA Engineering Weather Database, EnergyStar ® and CEE also standardized heating degree-days using a baseline of 65 degrees. Over the years, HDD65 seems to have been adopted as the de facto baseline and shifting away from using HDD65 represents a significant change in how savings are currently calculated and could result in artificially low savings calculations. If the concern is about the general accuracy of determining space heating and cooling savings, shifting to a completely different baseline requires a more comprehensive review and discussion than what can be achieved during the MO-TRM 2017 development rather than making one global adjustment for this document that may or may not be a more accurate representation of reality. Supporting arguments, documentation and references for this recommendation include:

- On an extremely rare basis lower base temperatures have been used for commercial buildings, but not residential. Commercial buildings tend to have a larger number of internal sources for heat gains, and also tend to have proportionally less infiltration. Conversely, residential structures tend to be leakier, which offset the smaller internal heat gains. The main point here is that the tightness of the structure makes a big difference in which base temperature is most accurate.
- Older homes and low income homes tend to be leakier, and HDD65 is probably more representative. Newer homes tend to be less leaky, but the internal heat generation argument is very weak. For example, the HPwES analysis for Ameren in all likelihood included a high percentage of homes with programmable thermostats. These will also offset a lot of energy usage, but aren't tied to the base temperature.
- The optimal base temperature depends on the building and that generally means HDD65 given the housing stock in Missouri. You can never determine it perfectly (degree-day-based calculations can never be that accurate), but using degree days with a base temperature that's approximately right for your building can significantly improve the accuracy of your calculations. According to *http://eyeonhousing.org/2014/02/the-age-of-the-housing-stock-by-state/* the average age of housing stock in the state of Missouri is nearly 40 years. In addition, urban and suburban areas in and around STL and KC tend to have housing stock older than the average. These homes are more

[5] Belzer and Cort (2004) "Statistical Analysis of Historical State-Level Residential Energy Consumption Trends", Pacific Northwest National Laboratory, and MA Residential Retrofit/Low-Income (RRLI) Home Energy Services 2011 Impact Evaluation Report. Both documents can be found within supporting document on this non-consensus issue on the Missouri Division of Energy TRM website.

[6] Opinion Dynamic's June 3rd 2016 memo to Ameren regarding the 2015 Home Performance with Energy Star program supports using a lower temperature to calculate savings related to residential weather sealing and insulation components.

likely leakier and less insulated. As more screw in CFL's and LED lamps replace incandescent there is even less internal heat gain in homes[7].

- Current Missouri utility practice uses HDD 65 for planning, financial reporting, pricing and forecasting of utility rates, and resource planning and reporting[8]. The planning and reporting is used on regional and national levels in the calculation for forecasting peak demand for the electric and natural gas industries.
- The MO-TRM 2017 should develop weather dependent measures using the HDD65 baseline until new information is available to support deviation from this.

[7] http://www.greenbuildingadvisor.com/blogs/dept/building-science/choosing-base-temperature-degree-days

[8] This includes the use of HDD 65 for regression analyses to normalize for weather where individual utilities do not use HDD/CDD in engineering algorithms for calculating savings.