Exhibit No.:	
Issues:	Ameren Technical Reference Manual
Witness:	Robert Fratto
Sponsoring Party:	Missouri Department of Natural Resources – Division of Energy
Type of Exhibit:	Rebuttal Testimony
Case No.:	EO-2012-0142

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

Case No. EO-2012-0142

Ameren Missouri MEEIA Filing

REBUTTAL TESTIMONY

OF

ROBERT FRATTO

GDS ASSOCIATES, INC.

On behalf of the

Missouri Department of Natural Resources

APRIL 20, 2012

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Ameren Missouri's filing under the Missouri Energy Efficiency Investment Act (MEEIA)	)))	Case No. EO-2012-0142

AFFIDAVIT OF ROBERT FRATTO

STATE OF NORTH CAROLINA	)	
	)	**SS**
CITY OF RALEIGH	)	

Robert Fratto, of lawful age, being duly sworn on his oath, deposes and states:

1. My name is Robert Fratto. I work in the City of Raleigh, North Carolina, and I am employed by GDS Associates as a Managing Director.
2. Attached hereto and made a part hereof for all purposes is my Rebuttal Testimony on behalf of the Missouri Department of Natural Resources' Division of Energy, consisting of 5 pages of testimony, 1 attachment and 1 schedule, all of which have been prepared in written form for introduction into evidence in the above-referenced docket.
3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct to the best of my knowledge.

Robert Fratto

Subscribed and sworn to before me this 20th day of April, 2012.

Notary Public

My commission expires: November 9, 2016

DARLINE O. STALEY NOTARY PUBLIC GRANVILLE COUNTY, NC

I. INTRODUCTION

Q. Please state your name, position and business address.

A. My name is Robert Fratto and I am a Managing Director at GDS Associates, Inc. (GDS), an energy, engineering and management consulting firm with headquarters in Marietta Georgia. My business address is 2113 Hopeton Avenue, Raleigh North Carolina, 27614

Q. Please describe GDS Associates.

A. GDS Associates Inc. is a multi-service consulting and engineering firm formed in 1986 that now employs a staff of over 170 in five locations across the U.S. Our consultants are recognized leaders in their respective fields, dedicated to their clients and innovative in their approach to meeting unique challenges. Our broad range of expertise focuses on clients associated with, or affected by, electric, gas, water and wastewater utilities. The services that GDS offers include:

- energy efficiency, renewable energy and demand response planning, program design, implementation and evaluation;
- integrated resource planning;
- electric transmission and distribution system planning;
- wholesale and retail rate studies;
- and other planning and implementation projects for the electric and natural gas industries.

In addition, we offer information technology, market research, and statistical services to a diverse client base.

Q. Can you please summarize your work experience and educational background?

A. I am currently a Managing Director at GDS Associates, where I am responsible for managing and conducting projects in the areas of energy efficiency planning, implementation and evaluation. Overall, I have more than thirty years' experience in the energy industry that includes extensive work in the areas of energy efficiency services and demand-side planning. I joined GDS in July 2004 after working as an independent energy consultant and holding various management and analytical positions with Progress Energy, The Cadmus Group and Commonwealth Electric Company (now NSTAR).

My education includes a Master's Degree in Business Administration from Suffolk University and a Bachelor of Science Degree in Industrial Engineering from Northeastern University. I am also a Certified Energy Manager.

Additional detail can be found in my resume, which is provided in Attachment A to this testimony.

Q. On whose behalf are you appearing in this proceeding?

A. I am appearing on behalf of the Missouri Department of Natural Resources ("MDNR").

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my testimony is to sponsor the GDS report, *Review of Energy Savings Equations in Ameren Missouri's Technical Resource Manual* (Ameren TRM Review Report), which was prepared on behalf of MDNR by me with the assistance of other GDS staff under my direct supervision. The report is attached as Schedule RLF-1

Q. **What is a Technical Resource Manual?**

A. A Technical Resource Manual (TRM) is a document and/or a database that contains common assumptions for energy efficiency measures. Typically these include measure

energy savings, savings algorithms, useful measure life and in some cases, measure costs. Where appropriate, some TRMs also include other measure related resource savings such as water savings. TRMs serve a wide range of users including utilities, regulators and third party program evaluators. They provide a consistent, readily available source of energy efficiency measure data that all stakeholders can agree to use for cost-effectiveness screening, program planning, tracking and reporting and evaluation of program performance relative to statutory goals.

A TRM is intended to be a flexible and living document that is periodically updated to capture the addition of new measures, the removal of some measures when they are no longer relevant and modifications to characterizations of existing measures.

Q. **What was the scope of your review of the Ameren Missouri TRM?**

A. The Missouri Department of Natural Resource (MDNR) contracted with GDS Associates (GDS) to conduct an engineering and technical review of energy savings equations and estimated annual energy savings values presented in Ameren Missouri's Technical Resource Manual (TRM) as filed in Case No. EO-2012-0142. The primary purpose of our review of Ameren Missouri's energy savings equations was to determine if they properly capture all of the factors needed to calculate kWh savings in accordance with commonly applied engineering principles and practices. In conducting its review of measure savings estimates, GDS compared savings estimates from Ameren Missouri's TRM to savings estimates from other TRMs. The purpose of this comparison was to identify measure savings values in the Ameren Missouri TRM that warrant further review because they fall outside the range of savings estimates from other TRM.

Q. **Please describe your review of energy savings equations in the Ameren Missouri TRM?**

A. GDS reviewed each measure specific energy savings equation presented in the Ameren Missouri TRM to determine if they properly capture all of the factors needed to calculate kWh savings in accordance with commonly applied engineering principles and practices. Where appropriate, revised or alternative equation formulations were recommended.

Q. **What is the purpose of the energy savings equations in the Ameren Missouri TRM?**

A. After each equation, the TRM states the following: If the appropriate field data required to complete this equation cannot be obtained, the deemed savings values (in the following table) are to be used for each measure.

Q. **Please describe your review of energy savings values presented in the Ameren Missouri TRM?**

A. The GDS analysis consisted of a comparison of energy savings values for each non-weather sensitive measure in the Ameren Missouri TRM to savings values for the same measure in other TRMs. The other TRMs that were used for comparison purpose are the Ohio, Pennsylvania, Massachusetts, Mid-Atlantic, New York, Texas and Vermont TRMs. Energy savings comparisons were not conducted for weather sensitive measures. Savings values for weather sensitive measures and savings values based on actual program year 2 (October 2009 - September 2010) evaluation (EMV) reports were not included in the GDS analysis.

Q. **Why are weather sensitive measures excluded from your comparison?**

A. For all weather sensitive measures not included in program year 2 EMV reports, building simulation modeling was conducted by Morgan Marketing Partners to determine measures savings estimates in the Ameren Missouri TRM. GDS agrees with Ameren Missouri that the building simulation approach is far more accurate for quantifying measure level energy savings values for weather sensitive measures.[1] Conducting additional building simulation analysis or detailed review of the building simulations conducted by Morgan marketing partners was beyond the scope of the analysis conducted by GDS.

Q. Why are measure savings values based on program year 2 (PY2) EMV reports excluded from your comparison?

A. Measures savings values in the Ameren Missouri TRM that are based on actual PY2 EMV results represent best estimates of measure savings for Ameren programs and were therefore presumed to be more accurate than savings values that might be found in TRMs from other states.

Q. **Has the Ameren TRM Review Report been provided to Ameren Missouri and other parties in this case?**

A. It has been distributed to all parties to the case and was discussed at a technical conference on March 30, 2012.

Q. Will you be discussing the findings and recommendations included in the Ameren TRM Review Report?

A. No, those will also be addressed by the rebuttal testimony of Mr. Adam Bickford.

Q. Does this conclude your rebuttal testimony?

A. Yes.

[1] Appendix A, Ameren Missouri Technical Resource Manual, 2012 Energy Efficiency Filing, p. 2.

EDUCATION:

Executive Management Development Program, Northeastern University, 1986
Masters of Business Administration, Suffolk University, 1979
BS Industrial Engineering, Northeastern University, 1973

SUMMARY:

Mr. Fratto is a Managing Director with GDS Associates, an energy and engineering consulting firm. His thirty plus years of experience in the energy industry includes extensive work in the area of energy efficiency planning and evaluation. Mr. Fratto has also designed, implemented efficiency program for various utilities and energy efficiency organizations. Bob joined GDS in July 2004 after working as an independent energy consultant and holding various management positions with Progress Energy and Commonwealth Electric Company (now NSTAR). He is currently based in Raleigh, NC, where he is providing energy efficiency consulting services to clients such as the Missouri Department of Natural Resources, the Maryland Energy Administration and Efficiency Maine

Mr. Fratto has also provided energy efficiency consulting services to various other clients including the Maryland Department of Housing and Community Development, Austin Energy, Pennsylvania Public Utilities Commission, Oglethorpe Power Corporation, U.S. Environmental Protection Agency, Bonneville Power Administration, GasNetworks, KeySpan Energy (now National Grid), Vermont Department of Public Service, New Hampshire Public Utilities Commission, Connecticut Energy Advisory Board and Springfield Massachusetts Housing Authority. At Commonwealth Electric Company, Mr. Fratto held various management positions including, Manager Market Planning & Research, Manager Demand Program Administration and Manager Load Forecasting. At Progress Energy Mr. Fratto directed DSM planning activities and designed and delivered various energy efficiency services.

Mr. Fratto earned his Master's Degree in Business Administration from Suffolk University and has a Bachelor of Science Degree in Industrial Engineering from Northeastern University. Mr. Fratto is also a Certified Energy Manager.

EXPERIENCE and ACCOMPLISHMENTS:

GDS Associates, Inc. – Marietta, GA

Managing Director – 5/03 to Present

Manage energy efficiency projects and staff, and provide energy efficiency consulting services, including energy efficiency program planning and program evaluation to GDS clients. Current and past projects include:

- Assisting the Missouri Department of Natural Resources with review of utility Integrated Resource Plans, including DSM programs and DSM cost recovery mechanisms.
- Managing an energy efficiency potential study for the Efficiency Maine Trust.

- Conducted cost-benefit analysis and provided testimony in support of the Maryland Department of Housing and Community Development's proposed state weatherization assistance program.
- Conducted process evaluations of Austin Energy's Weatherization Assistance and Home Performance with Energy Star Programs.
- Reviewed energy efficiency program plans submitted by the Connecticut electric utilities and provided analysis and recommendations to the Connecticut Energy Advisory Board regarding alternative financing mechanisms and program design features that can reduce program costs.
- Managed an energy efficiency and demand response potential study for transmission need areas in Central Maine Power Company's service territory.
- Conducted an analysis of commercial sector energy efficiency potential for South Mississippi Electric Power Association.
- Reviewed a proposed Energy Efficiency Utility Order of Appointment for The Vermont Department of Public Service and provided findings and recommendations regarding the length of the appointment and compensation mechanism.
- Conducted a natural gas energy efficiency potential study for GasNetworks, a collaborative of local natural gas companies serving customers throughout New England.
- Developed commercial energy efficiency measure characteristics and baseline data in support of an all fuels energy efficiency potential study conducted for the New Hampshire Public Utilities Commission.
- Managed a process evaluation of Bonneville Power Administration's Non-Wires Solution Initiative.
- Assisted a Public Housing Authority with preparation of a performance contracting RFP and selection of an Energy Services Company.
- Conducted primary marketing research to identify customer preferences for various energy efficiency incentives.
- Prepared a research report on the use of energy efficient electrical equipment in the small business market.
- Managed a study of the lighting, HVAC and motor equipment supplier market in the State of Maine.

Progress Energy – Raleigh, NC

Senior Fundamental Market Analyst – 4/01 to 2/03

Conducted market analysis in support of wholesale power business development. This included identification of market opportunities and trends, competitor tracking, and customer targeting.

- Managed the design and implementation of a market intelligence and deal tracking information system.
- Developed a customer-targeting tool that allows business development managers to identify and rank potential customers

- Improved business planning through implementation of better data mining tools and use of market segmentation analysis.

Regulatory Project Analyst – 8/99 to 4/01

Managed regulatory compliance activities, tracked and analyzed industry marketplace changes and recommended positioning strategies for operating companies.

- Prepared project plans and monitored progress for a company wide effort to secure government approvals of a major merger.
- Created position proposals on important industry deregulation issues.
- Developed a strategic plan for the company's renewable energy activities.

The Cadmus Group, Durham, NC

Account Manager/Consultant – 12/98 to 6/99

Assisted local governments and educational institutions with planning and implementing energy efficiency projects in conjunction with the EPA's Energy Star Buildings and Green Lights Partnerships.

Carolina Power & Light Company, Raleigh, NC

Product Developer/Manager – 4/96 to 12/98

Developed and screened new product ideas, conducted market and financial analysis, prepared business plans and identified partnering strategies. Marketed, delivered and had P&L responsibility for products and services.

Demand Planning Director – 8/93 to 4/96

Directed demand-side planning activities, including assessment of market potential, analysis of program costs/benefits and preparation of demand reduction forecasts.

Commonwealth Electric Company, Wareham, MA

Senior Project Engineer – 6/92 to 4/93

Provided project management support for the engineering and planning departments.

Manager Program Administration – 6/91 to 6/92

Administered the delivery of energy efficiency services, including lighting, HVAC and building shell programs to both consumer and business markets.

Manager Market Planning & Research – 6/80 to 6/91

Managed a group that developed marketing plans for demand-side management programs, prepared demand forecasts, and provided regulatory support.

Senior Resource Planner – 8/74 to 6/80

Developed plans for power purchases and plant additions to meet customer demand.

PROFESSIONAL MEMBERSHIP:

Association of Energy Engineers

Association of Energy Services Professionals

ADDITIONAL TRAINING & CERTIFICATIONS:

- Certified Energy Manager
- Certified Demand-Side Management Professional
- Building Operator Certification
- Compressed Air Challenge – "Fundamentals of Compressed Air Systems"
- Ballast Technology
- Energy Options, Futures and Derivatives
- Utility Demand-Side Management
- Cost-of-Service & Retail Rate Design
- Marginal Cost in Electric Utility Ratemaking
- Fundamentals of Load Research
- Load Forecasting and Econometrics
- Project Management
- Public Speaking & Presentation Skills
- Supervisory Skills
- Professional Selling Skills

TESTIMONY:

Have provided expert witness testimony in various cases on DSM planning, evaluation and implementation issues before the following state commissions:

- Maryland Public Service Commission
- Missouri Public Service Commission
- Maine Public Utilities Commission
- Vermont Public Service Board
- Massachusetts Department of Public Utilities

GDS Associates, Inc.
Engineers and Consultants

FINAL REPORT

Missouri Department of Natural Resources

Review of Energy Savings Equations in Ameren Missouri's Technical Resource Manual

Ameren Missouri's Filing to Implement Regulatory Changes in Furtherance of Energy Efficiency as allowed by MEEIA.2012 Energy Efficiency Filing

(SCHEDULE RLF-1, Case No. EO-2012-0142)

March 19, 2012

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TABLE OF CONTENTS

1.0 INTRODUCTION

The Missouri Department of Natural Resource (MDNR) contracted with GDS Associates (GDS) to conduct an engineering and technical review of energy savings equations and estimated annual energy savings values presented in Ameren Missouri's Technical Resource Manual (TRM)[1] as filed in Case No. EO-2012-0142. This report presents the results of that review.

The primary purpose of our review of Ameren Missouri's energy savings equations was to determine if they properly capture all of the factors needed to calculate kWh savings in accordance with commonly applied engineering principles and practices. In conducting its review of measure savings estimates, GDS compared savings estimates from Ameren Missouri's TRM to savings estimates from other TRMs. The purpose of this comparison was to identify measure savings values in the Ameren Missouri TRM that warrant further review because they fall outside the range of savings estimates from other TRM. The budget for this project did not allow for any building simulation modeling for the purpose of verifying weather sensitive savings estimates, or a review of building simulations conducted by Ameren Missouri.

Section 2 of this report presents results of the GDS review for each energy savings equation in the Ameren Missouri TRM. In Section 3 GDS summarizes its findings regarding the Ameren Missouri TRM savings equations, presents summary savings estimate comparison tables and provides its recommendation regarding whether the Ameren Missouri TRM should be: (1) accepted in its current form, (2) rejected as inadequate, or (3) accepted with conditions.

In addition to this report GDS also provided MDNR Excel spreadsheets containing all of the energy savings data collected from other TRMs and all of the comparative analysis.

[1] Appendix A, Technical Resource Manual, 2012 Energy Efficiency Filing

2.0 REVIEW OF ENERGY SAVINGS EQUATIONS

This section of the report presents findings with regard to the energy savings equations presented in Ameren Missouri's TRM. Each equation was reviewed by GDS to determine if it properly captures all of the factors needed to calculate kWh savings in accordance with commonly applied engineering principles and practices. Where appropriate, revised or alternative equation formulations are recommended.

2.1 Residential Lighting

The residential lighting savings equation on page 5 of the Ameren Missouri TRM does not account for additional cooling savings associated with reduced lighting wattage or in service rate. An "in-service" rate is used to reflect the fact that not all lighting products purchased are actually installed. A more appropriate form of this equation is:

EF = Average heating system efficiency

2.2 Residential HVAC

The energy savings equation show on page 7 of the Ameren Missouri TRM for early replacement HVAC applications is just a statement of fact that the savings = base use less efficient use. Instead the TRM should include the equation form shown on page 10 of the March 2011 Check Me program evaluation.[4] For use in an early replacement application, that equation would be as follows:

Adjustment Factor = Factor considering appliances not plugged in year-round (also known as partuse)

Otherwise an additional in situ adjustment factor should be applied. The in situ adjustment captures the impact on consumption of factors such as household size, location of the unit or climate, if the average consumption estimate is from a different climate region. Ohio uses a single in situ adjustment factor in their TRM that includes climate differences, while Vermont uses two adjustment factors, one for in situ usage and the other for temperature of the appliance location. Both also use an adjustment factor to capture the impact of partial appliance use.

Energy Star Refrigerator

The equation on page 30 of the Ameren Missouri TRM that is identified as the change in use equation for Energy Star refrigerators is an equation that is typically included in TRMs.

$$\Delta kWh = Base\ UEC - Efficient\ UEC$$

Where:

UEC = Average unit energy consumption

It is noted in the Ameren Missouri TRM that *"If the appropriate field data required to complete this equation cannot be obtained, the deemed savings values in the table are to be used for each measure."*

It is unlikely that base consumption and energy efficient refrigerator assumption can be reliably acquired in the field without metering, therefore this equation is simply statement of fact that kWh savings is equal to the difference between consumption of the determined base unit and energy efficient unit. Therefore it is critical that the deemed savings values that will be used are from a recent Ameren Missouri EMV report. This is the case, according to Ameren Missouri, as the estimated savings credit for Energy Star refrigerators of 1,126 kWh is taken from an Ameren Missouri PY2 EMV Report. However, it should be noted that the estimated savings credit is from an impact evaluation of Ameren Missouri's 2010 Multi-Family Income Qualified Program (MFIQ) and therefore may not be an appropriate estimate to apply to other programs that target single family homes or are not income limited.[6] Factors that can affect refrigerator energy use that may be correlated with income include family size, number of meals eaten out of the home, refrigerator age, size and features.

Smart Strip Plug Outlet

The following equation for a smart strip plug outlet from page 31 of the Ameren Missouri TRM is correctly stated:

[6] Multifamily Income-Qualified Program Evaluation Program Year 2, 2010, Final Report, Prepared by the Cadmus Group for Ameren Missouri, April 2011, p. 3.

The following equation for a **two speed high efficiency pool pump** from page 32 of the Ameren Missouri TRM is also incorrectly correctly stated for the same reasons discussed above.

required if the motor was running at full speed. It is unclear how this is captured through the Control Factor.

2.4 Residential Building Shell

There are no savings equations identified in Ameren Missouri's TRM for residential building shell measures, Instead, it states on page 33 that the savings values for residential building shell measures (referring to Single Family Window Replacement, Multi Family Window Replacement and Multi Family Window Film) were developed using building simulations. The energy savings values in the data tables for each of these measures also reference footnote "1" as a source, but no there is no corresponding footnote. It also is not clear how a single savings value for each building shell measure was developed. The Building Simulation Protocols section of the TRM states on page 91 that Ameren Missouri has a database that allows it to apply population weights for climate zone, building type and vintage to compile weighted savings values. However, there is no description of the specific weighting algorithm that was used to develop the deemed saving values for residential building shell measures or key assumptions such as heating and cooling degrees days and/or full load heating/cooling hours. Also, the estimated savings credits for residential building shell measures contain no detail on whether they include heating as well as cooling savings or other related ancillary HVAC system savings associated with pumps, fans and motors.

2.5 Residential Water Heating

Water Heater

On page 34 of the Ameren Missouri TRM the residential water heating energy savings formula is listed as:

$$\Delta kWh = \frac{\left\{\left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed}}\right) \times \left(HW \times 365 \times 8.3 \frac{lb}{gal} \times (T_{hot} - T_{cold})\right)\right.}{3413 \frac{Btu}{kWh}}$$

EFbase = Energy Factor of baseline water heater

EFproposed = Energy Factor of proposed efficient water heater

T_{hot} = Temperature of hot water

T_{cold} = Temperature of cold water supply

When this formula is used with the given Ameren water heater input assumptions, the estimated 157 kWh savings credit shown on page 35 of the Ameren Missouri TRM can be verified. For this calculation GDS assumed 64.3 GPD, which appears to be incorrectly identified in the Ameren Missouri as an Energy Factor.[9]

Water Heater Blanket

The water heater blanket savings equation on page 35 of the Ameren Missouri TRM is not theoretically correct. It assumes a thermal efficiency of the electric heater element of 100%. There should be a thermal efficiency coefficient in the denominator. In the Pennslyvania TRM, the thermal efficiency of an electric heater element is assumed to be 97%[10]. The revised equation would read as follows:

Missouri's Multi-Family Income Qualified Program (MFIQ).[11] No estimate of heat loss per linear foot is provided for non-income qualified multi-family dwellings or single family dwellings. However an annual savings estimate of 257 kWh per 10 linear feet is provided for single family dwellings. The cited source for this estimate is the Morgan Measure Libraries.

A more detailed form of the above equation that does not require a valid heat loss per linear foot estimate is as follows:[12]

$$\Delta kWh = ((1/Rexist - 1/Rnew) \times (Length * Circumference) \times \Delta T \times 8{,}760) / \eta DHW / 3413$$

Where:

Rexist = Assumed R-value of existing uninsulated piping = 1.0[13]

Rnew = R-value of existing pipe plus installed insulation

Length = Length of piping insulated

Circumference = Circumference of piping (0.5" pipe = 0.13ft, 0.75" pipe = 0.196ft)

ΔT = Temperature difference between water in pipe and ambient air

8,760 = Hours per year

ηDHW = DHW Recovery efficiency (ηDHW) = 0.98

3413 = Conversion from Btu to kWh

Low Flow Showerhead

The energy savings equation for low flow showerhead on page 37 of the Ameren Missouri TRM was taken from Ameren Missouri's Multifamily PY2 Report.[14]

ΔGPM	= Difference in gallons per minute for the base showerhead and the new showerhead
ΔTemp	= Difference in temperatures of the shower water and the water main
EF	= Energy factor of the water heater
Number of Units	= Number of showerheads in home
409.7	= A constant derived from 3,413/8.33

This is an appropriate equation for estimating electric water heater kWh savings associated with installation of a low flow showerheads. However, the assumed number of units is not provided in the TRM or the Multifamily PY2 Report.

Low Flow Faucet Aerators

The energy savings equation for low flow faucet aerators on page 38 of the Ameren Missouri TRM was taken from Ameren Missouri's Multifamily PY2 Report.[15]

Number of Units = number of faucets in home

• 409.7 = a constant derived from 3,413/8.33

• CF =Coincident Factor= 0.70 *(Coincidence Factor is not used in this equation)*

2.6 Commercial Lighting

Lamps & Fixtures

The following commercial lighting savings formula shown on pages 40-49 of Ameren Missouri's TRM, is appropriate.

Interior Lighting Operating Hours by Building Type		
Building Type	Annual Hours	Building Mix Weighting**
Assembly	5,397	4.2%
Big Box Retail	6,439	4.0%
Fast Food Restaurant	6,492	2.4%
Full Service Restaurant	4,850	1.2%
Grocery	6,702	6.2%
Hospital	3,758	5.9%
Hotel	8,760*	1.7%
Large Office	5,571	11.3%
Light Industrial	5,594	43.0%
Primary School	3,149	7.2%
Small Office	4,342	5.6%
Small Retail	4,883	2.0%
Warehouse	5,063	5.3%
Weighted Average	5,202	100%

Source: From Ameren Missouri PY 2 EMV report conducted by ADM Associates, Inc. 2011
*Non-Guest Room
** Weights taken from Morgan Measure Database

The above table shows a weighted average operating hours of 5,202 which is different than assumed annual operating hours used for some of the lighting measures such as the 4,160 hours shown on page 40 and 3680 hours shown on page 47 of the TRM. There is no source cited in the TRM for these operating hours.

Lighting Controls

The following commercial lighting controls savings formula shown on pages 50 of Ameren Missouri's TRM, is appropriate if the SF term in the equation is defined as square feet of controlled lighting space instead of square feet in a room.

2.7 Commercial Cooking Equipment

Energy Star Steam Cooker

The Energy Star Steam Cooker savings formula on page 51 of Ameren Missouri's TRM is not correct. It is missing two key parameters: "Operating days per year" and "Percent of Time in Manual Mode. "

Operating days per year = The number of days in the year that the equipment operates

Percent Time in Manual Mode = The average amount of time per day the steamer is operated in manual (constant steam) mode, without the use of a cooking timer that switches the steamer into standby mode. Expressed as a percentage of total hours operated per day (%).

The correct equations are as follows:

The above equation will replicate the results from the Electric Steam Cooker Savings Calculators that can be found on the Food Service Technology Center and Energy Star Websites.[18]

Energy Star Hot Food Holding Cabinet

The following Energy Star Hot Food Holding Cabinet energy savings formula on page 51 of the Ameren Missouri TRM is correct

kWbase = Connected load kW for typical reach-in refrigerator or freezer door and frame with a heater.

Beverage Vending Machine Controls

The energy savings formula for Beverage Machine Controls in the Ameren Missouri TRM is an appropriate formula, but savings, based on actual field data could be more precisely calculated using an alternative approach that takes into consideration nameplate information and assumptions regarding the duty cycle of the equipment.

The formula as stated on page 57 of the Ameren Missouri is as follows:

Efficient Refrigeration Condenser

The energy savings formula for an Efficient Refrigeration Condenser on page 58 of the Ameren Missouri TRM is correct. However, GDS was unable to precisely replicate the deemed savings value of 120 kWh /ton based on the key assumptions provided in the TRM. This may be due to rounding of the average load percentages shown in the TRM.

- Cost estimates include installation.
- 77°F temperature difference from makeup water to hot water supply (Standard US DOE Test Procedure)
- Diversity Factor (DF): 0.65
- Heaters are generally located in unconditioned spaces
- 360 days per year
- Et Base: Thermal efficiency of existing unit

Pre-Rinse Spray Valves

The following formula for Pre-Rinse Spray Valves on page 60 of the Ameren Missouri TRM produces results that a very similar to those that GDS derived from the Food Service Technology Center's Pre-Rinse Spray Valve Calculator. Those differences are likely due to rounding of inputs.

2.10 Commercial Motors and Drives

Commercial Pumps for Process

GDS is unable to determine the validity of the following energy savings formula for Commercial Pumps for Process on page 61 of the Ameren Missouri TRM. It is not clear how the fixed energy savings factor (ESF) of 15% was derived and no values are provided for pump efficiency. Using the assumption provided in the TRM, we could replicate any of the savings values shown on page 62 of the TRM.

$$\Delta kWh = (HPmotor \times LF \times 0.746/\eta motor) \times HOURS \times (ESF/\eta pump)$$

Key Assumptions:

- 3680 hours of operation
- Load Factor = LF = 76%.
- $\eta motor$ = Motor efficiency = 90%
- $\eta pump$ = pump efficiency
- ESF = Energy Savings Factor = 15%

It is not clear why Ameren Missouri did not use a more classical approach for estimating pump savings, when the "before" and "after" pump system efficiencies are known. That equation would be as follows:

Annual Energy Savings (kWh) = kW x t x (1 – η1/ η2)

Where:

kW = Input kW for pump drive motor under original operating conditions

t = Annual pump operating hours (Note: kW x t is the baseline pumping system energy use)

η1 = Efficiency of the original pumping system, %

η2 = Efficiency of the improved pumping system, %

Commercial Variable Frequency Drives for Process Pumping

The following energy savings equation for Commercial Variable Frequency Drives for Process Pumping on page 63 of the Ameren Missouri TRM is missing a .746 conversion factor unless BHP is stated in kW. Also, there are no input values provided in the TRM for the Energy Savings Factor (ESF).

$$\Delta kWh = (BHP/\eta motor) \times HOURS \times ESF$$

Key Assumptions:

- Hours of operation = see chart below
- The average loading of the pumps analyzed was 86% pump capacity.
- Coincidence Factor (CF) = 0.78
- BHP = Brake horsepower of motor, should be collected with application.
- 11motor = efficiency of motor being driven by VFD = 59%

2.11 Commercial HVAC Applications

Chillers

The following commercial chillers savings formula is applied to chiller measures on pages 65 - 67 of Ameren Missouri's TRM.

Key Assumptions:

BtuH = Cooling capacity in Btu/Hour

EERb = Efficiency rating of the baseline unit.

EERq = Efficiency rating of the High Efficiency unit.

EFLH =Equivalent Full Load Hours- This represents a measure of energy use by season during the on-peak and off peak periods. This value will be determined by existing measured data of kWh during the period divided by kW at design conditions

The above equation is appropriate for calculating energy savings for unitary HVAC units. However for heat pumps a more common approach would be to use the above equation for calculating cooling savings and use the Heating Seasonal Performance Factor (HSPF), as a replacement for EER in the above equation, to calculate heating savings. This is mentioned in the under Key Assumptions for each of the Heat Pump measures, but then a single EER value is provided. So it is not clear if this equation and the Key Assumptions as written will correctly quantify heat pump savings.

Guest Room Energy Management System

The following equation for calculating savings associated with Guest Room Energy Management Systems is provided on page 73 of the Ameren Missouri TRM. It appears that this equation is appropriately capturing all of the factors in a form that is necessary to calculate HVAC energy savings. However In some applications where lighting is also controlled, these additional savings should be included. Also, a source should be provided for the assumed 30% Energy Savings Factor (ESF), the cooling/heating correction factors should be defined, and a purpose and description of the (12/9.7) term is needed.

$$\Delta kWh = \frac{\left[\frac{BTU * (1 - OPC)}{Cooling\ design\ temp - room\ setpoint\ temp} * CDD * 24 * CCF\right]}{12000} * \left(\frac{12}{9.7}\right) + \left[\frac{BTU * (1 - OPH)}{room\ setpoint\ temp - heating\ design\ temp} * HDD * 24 * HCF * ESF\right.$$

Key Assumptions:

Assumes 30% energy savings over baseline.

CCF = cooling correction factor= 1

HCF = heating correction factor = 0. 75

ESF =energy savings factor= 30%

BTU= BTU per ton= 12,000 *size of unit (tons)

Example: 1 ton unit= 12,000 BTU* 1 ton= 12,000

OPC = oversized percentage cooling = 15%

OPH = oversized percentage heating = 15%

CDD = annual cooling degree days = 1295

HDD = annual heating degree days = 5329

Cooling Design Temp= 91 F

Heating Design Temp= 7F

Room Setpoint Temp= 71 F

2.12 Commercial Miscellaneous

Tractor Heater Timers

The following energy savings equation for Tractor Heater Timers can be found on page 74 of the Ameren Missouri TRM. This equation is appropriate for calculating energy savings for this measure.

3.0 SUMMARY OF FINDINGS AND RECOMMENDATION

This section of the report summarizes the findings of our review of energy savings equations and energy savings estimates presented in Ameren Missouri's TRM.

3.1 Review of Energy Savings Equations

A summary of the GDS analysis of energy savings equations is presented in Tables 3.1.1 and 3.1.2 for the Residential and Commercial & Industrial sectors, respectively. Issues found with the energy savings equations have been grouped into the following categories in the summary tables:

Equation Summary Tables - Definitions

(1) **Incorrect Equation:** The equation as presented in the TRM will not correctly calculate measure savings

(2) **Interactive Effects Not Included:** The impact of installing the measure on energy consumption by other end-uses is not included in the equation. For example, lighting measures also impact cooling and heating energy consumption.

(3) **In-Service Rate Not Included:** In service rate, or the percentage of units rebated that actually get used, is not included in the equation..

(4) **Non Calculative:** The equation represents a simple statement of fact (such as savings equals base use minus efficient use) instead of an engineering equation that will actually calculate base and efficient use based on key inputs such as equipment wattage, horsepower, operating hours, and efficiency ratings.

(5) **In-Situ Adjustment Factor Not Included:** An in situ adjustment factor which captures the impact on consumption of factors such as household size, location of the unit or climate is not included in the equation.

(6) **Key Assumptions Incorrectly Stated/Not Defined/Missing:** Key equation assumptions listed in the TRM are incorrectly stated, not defined or missing.

(7) **Key Assumption Source Missing:** The source for a key equation assumption such as an energy savings rate is not provided.

(8) **Alternative Equation Would Improve Precision:** The precision of savings estimates will be improved by using an alternative equation.

(9) **Other:** Other issues that do not fit into any of the above categories were found. Notes in the tables summarize these other issues.

Table 3.1.1
Summary of Energy Savings Equation Findings
Residential Sector

Measure	Incorrect Equation	Interactive Effects Not Included	In-Service Rate Not Included	Non Calculative	In-Situ Adjustment Factor Not Included	Key Assumptions Incorrectly Stated/Not Defined/Missing	Other
Lighting		**X**	**X**				
HVAC				**X**			
Appliance Recycling					**X**		
Energy Star Refrigerator				**X**			**X (Note 1)**
Pool Pump and Motor	**X**						
VFD on Pool Pump						**X**	
Water Heater	**X**						
Water Heater Blanket	**X**						
Pipe Wrap							**X (Note 2)**
Low Flow Showerhead						**X**	
Low Flow Faucet Aerators						**X**	

Table Notes:

(1) Non-calculative equation is typical for refrigerators in TRMs. However, estimated savings credit is from Multi-Family Income Qualified Program impact evaluation report which may not be applicable for homes that are not income limited or single family homes.(See Section 2.3, p. 5 for additional detail)

(2) The equation requires an estimate of heat loss per linear foot of water heater pipe, which according to the TRM is taken from the Multi-Family Income Qualified Program impact evaluation report. This may not be appropriate for homes that are not income limited or single family homes. See Section 2.5, p. 10 for an alternative approach for calculating pipe wrap savings that does not require a priori knowledge of heat loss per linear foot of water heater pipe.

Table 3.1.2
Summary of Energy Savings Equation Findings
Commercial & Industrial Sector

Measure	Incorrect Equation	Interactive Effects Not Included	Key Assumption Source Missing	Key Assumptions Incorrectly Stated/Not Defined/Missing	Alternative Equation Would Improve Precision	Other
Lamps & Fixtures		X (Note 1)				X (Note 2)
Lighting Controls				X (Note 3)		
Energy Star Steam Cooker	X					
Energy Star Ice Machine				X		
Anti-Sweat Heater Controls				X		
Beverage Vending Machine Controls					X	
Efficient Refrigeration Condenser						X (Note 4)
Heat Pump Water Heaters	X (Note 5)			X		
Low Flow Faucet Aerators			X			
Commercial Pumps for Process			X	X	X	
Commercial VFDs for Process Pumping	X			X		
Chillers	X (Note 6)					
Unitary & Heat Pump Systems	X (Note 7)					
Guest Room Energy Management System			X	X		X (Note 8)

Table Notes:

(1) An interactive factor is included in the equation, but the value is set to 1.0 for the first 3 year implementation program. (See Section 2.6, p.12)

(2) Operating hours provided in the table on p. 39 of the TRM could not be found in the referenced source, and not all of the weighted operating hours provided in the TRM for each measure match those shown in the table on p. 39. (See Section 2.6, pp. 12 – 13)

(3) Alternative equation form is also recommended. (See Section 2.6, p. 13)

(4) GDS was unable to precisely replicate the estimated savings credit for this measure using the stated equation and assumptions provided in the TRM.

(5) Undefined parameter in the equation may need to be removed.

(6) This could also be a problem with an incorrectly defined key assumption. (See Section 2.11, p. 20)

(7) Problem is with Heat Pump equation

(8) Does not included potential for lighting savings.

3.2 Review of Deemed Energy Savings Values

A summary of the GDS analysis of deemed energy savings values is presented in the following tables. This analysis consisted of a comparison of energy savings values for each non-weather sensitive measure in the Ameren Missouri TRM to savings values for the same measure in other TRMs. In addition to the other TRMs referenced in the Ameren Missouri TRM (Ohio and Pennsylvania), GDS also reviewed and compiled energy savings values from the Massachusetts, Mid-Atlantic, New York, Texas and Vermont TRM.

Energy savings comparisons were not conducted for weather sensitive measures. These included the following measures as identified on page 2 of the Ameren Missouri TRM.

- HVAC measures (heat pumps, air conditioners, furnaces, chillers, etc.);
- Building shell (insulation, air sealing, duct sealing, windows, etc.);
- Thermostats;
- Energy Management Systems;
- Condensers;
- Other measures whose savings depend on weather

For all weather sensitive measures not included in program year 2 (October 2009 - September 2010) EMV reports, building simulation modeling was conducted by Morgan Marketing Partners to determine measures savings estimates. GDS agrees with Ameren Missouri that the building simulation approach is far more accurate for quantifying measure level energy savings values for weather sensitive measures.[22] Conducting additional building simulation analysis or detailed review of the building simulations conducted by Morgan marketing partners was beyond the scope of this project. GDS considered comparing Ameren Missouri's weather sensitive savings estimates to weather sensitive savings estimates from other TRMs, adjusted for weather differences. However such estimates were generally not available. The other non-building simulation option would require calculation of weather sensitive estimates for other states using TRM equations, which for HVAC measures requires knowledge of equivalent full load cooling hours. In many TRMs, estimates of equivalent full load cooling hours vary by weather zone and building type. Determining an average savings value would therefore require multiple calculations with appropriate weighting factors applied, for example, to determine average commercial sector savings for an HVAC measure. This was also beyond the scope of this project and would not be as accurate as reviewing the existing building simulations upon which the savings estimates are based and conducting new simulations, if necessary.

Also not included in our comparison of TRM savings values were the following measures in the Ameren Missouri TRM with savings values based on actual PY2 EMV Reports.

The measures in Tables 3.2.1 to 3.2.4 are:

- CFL PRE-EISA 13 Watt
- CFL - Fixture 391 Watt

[22] Appendix A, Ameren Missouri Technical Resource Manual, 2012 Energy Efficiency Filing, p. 2.

- CFL PRE-EISA for Multifamily 13.5 Watt
- Freezer - Recycling
- Refrigerator - Recycling
- Energy Star Refrigerator
- Energy Star Freezer
- Electric Water Heater Wrap Multi Family
- Electric Water Heater Pipe Wrap Multi Family
- Low Flow Showerhead Multi Family
- Low Flow Faucet Aerator Multi Family
- Commercial Lighting 4-Lamp T5 Fluorescent Lighting Fixture Replacing 400 watt Metal Halide
- Commercial Lighting 6-Lamp T5 Fluorescent Lighting Fixture Replacing 400 watt Metal Halide
- Commercial Lighting 8-Lamp T8 Fluorescent Lighting Fixture Replacing 400 watt HID
- Commercial LED Exit Signs Replacing Incandescent Exit Sign
- GU-24 pin-based CFL
- Interior CF 1 L 26W Quad
- Interior CF 1 L 32W Triple
- New pin-based CFL Fixture (>45W)
- Passive Infrared or Ultrasonic
- Dual Technology Sensors
- Interior Wall Sensors
- Anti-Sweat Heat Controls
- Strip Curtains for Walk-in Coolers
- Beverage Vending Machine Controls
- Energy Star Vending Machine
- Lighted Snack Dispensing Vending Machine

The following tables present the final results of our analysis of energy savings values in the Ameren Missouri TRM.

- **Table 3.2.1:** Non-weather sensitive energy savings values in the Ameren Missouri TRM that fall within a range of energy savings values from other TRMs.
- **Table 3.2.2:** Energy savings values in the Ameren Missouri TRM that fall outside of the a range of energy savings values from other TRMs
- **Table 3.2.3:** Comparison of energy savings values in the Ameren Missouri TRM to other TRMs, where only one comparative energy savings value could be found.
- **Table 3.2.4:** Measures from the Ameren Missouri TRM for which no comparative values could be found in other TRMs

Table 3.2.1
Summary of TRM Measure Savings Comparisons
Measures That Fall Within Range

Ameren Missouri TRM				Other TRMS - Savings Estimates						
Measure Type	Measure Name	Annual kWh Savings	Savings Source	Low	Average	High	Does Ameren Estimate Fall in Range?	Percent Difference of Ameren Savings from Other TRMs Average	Is Ameren Savings within +/- 10% of Other TRMS Average?	Comparison TRMs
Res Lighting	CFL POST-EISA 13 Watt	31.5	MML (1)	26.0	30.5	38.1	Yes	3%	Yes	OH, PA, Mid-Atlantic
Res Lighting	CFL POST-EISA 18 Watt	37.4	MML	27.2	36.8	52.7	Yes	2%	Yes	OH, PA, VT, Mid-Atlantic
Res Lighting	CFL- Torchiere Floor Lamps 55 Watt	164.0	MML	105.2	158.2	292.7	Yes	4%	Yes	MA, OH, PA, VT,
Res Lighting	LED Downlight E26 Light Bulb 10.5 Watt	54.5	Ameren TRM Formula	48.0	59.3	74.3	Yes	-8%	Yes	MA, VT, Mid-Atlantic
Res Appliances	Dehumidifier - Recycling	139.0	MML	66.0	114.9	182.8	Yes	21%	No	MA, NY, VT
Res Appliances	Room AC - Recycling	113.0	MML	16.6	118.7	256.0	Yes	-5%	Yes	MA, OH, NY, PA, VT, Mid-Atlantic
Res Appliances	Smart Strip Plug Outlet	184.0	MML	58.7	95.4	184.0	Yes	93%	No	MA, OH, PA, VT, Mid-Atlantic
Res Appliances	Variable Frequency Drive on Swimming Pool Pump	1,543.0	MML	400.0	960.0	1,676.0	Yes	61%	No	MA, OH, PA, Mid-Atlantic
Res Water Heating	Heat Pump Water Heater COP > 2.0	1,802.0	MML	1,162.0	1,457.7	1,914.0	Yes	24%	No	MA, OH, PA
Res Water Heating	Electric Water Heater Wrap Single Family	180.0	MML	79.0	142.4	200.0	Yes	26%	No	OH, NY, PA, VT, Mid-Atlantic
Res Water Heating	Water Heater Thermostat Set-Back 120 Degrees	163.0	MML	146.0	217.0	288.0	Yes	-25%	No	MA, VT
Res Water Heating	Electric Water Heater Pipe Wrap Single Family	257.0	MML	33.0	166.7	266.9	Yes	54%	No	OH, TX, VT, Mid-Atlantic
Res Water Heating	Low Flow Showerhead Single Family	361.0	MML	168.0	290.9	461.0	Yes	24%	No	OH, PA, TX, VT, Mid-Atlantic
Res Water Heating	Low Flow Faucet Aerator Single Family	57.0	MML	24.5	57.9	139.8	Yes	-2%	Yes	OH, PA, TX, VT, Mid-Atlantic
Com Lighting	Commercial Lighting 3-Lamp T5 Fluorescent Lighting Fixture Replacing 250 watt HID	449.0	MML	212.2	425.1	507.7	Yes	6%	Yes	MA, ME, OH, PA, Mid-Atlantic
Com Lighting	Commercial Lighting Double 6-Lamp T5 Fluorescent Lighting Fixture Replacing 1000 watt HID	1,456.0	MML	837.4	1,623.1	2,545.9	Yes	-10%	No	MA, ME, OH, NY, PA, Mid-Atlantic
Com Lighting	Commercial Lighting 4-Lamp TB Fluorescent Lighting Fixture Replacing 250 watt HID	616.0	MML	337.0	585.8	724.0	Yes	5%	Yes	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Lighting	Commercial Lighting 6-Lamp TB Fluorescent Lighting Fixture Replacing 400 watt HID	961.0	MML	578.2	950.0	1,161.4	Yes	1%	Yes	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Lighting	Commercial Lighting Double 8-Lamp T8 Fluorescent Lighting Fixture Replacing 1,000 watt HID	2,005.0	MML	1,611.6	2,108.0	2,423.4	Yes	-5%	Yes	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Lighting	Commercial Pulse Start Metal Halide	1,090.0	MML	1,089.9	1,173.5	1,220.7	Yes	-7%	Yes	MA, NY, PA, Mid-Atlantic

(1) Morgan Measure Libraries

Table 3.2.1 (Continued)
Summary of TRM Measure Savings Comparisons
Measures That Fall Within Range

Ameren Missouri TRM				Other TRMS - Savings Estimates						
Measure Type	Measure Name	Annual kWh Savings	Savings Source	Low	Average	High	Does Ameren Estimate Fall in Range?	Percent Difference of Ameren Savings from Other TRMs Average	Is Ameren Savings within +/- 10% of Other TRMS Average?	Comparison TRMs
Com Lighting	Commercial Ceramic Metal Halide (20- 100 watt)	445.0	MML (1)	148.0	398.8	503.2	Yes	12%	No	MA, OH, NY, PA, Mid-Atlantic
Com Lighting	Commercial LED/Induction Garage Light Replacing HID Exterior Light	1,614.0	MML	1,594.3	1,727.2	1,801.6	Yes	-7%	Yes	MA, NY, PA, Mid-Atlantic
Com Lighting	Compact fluorescent lamp >= 30 W and <= 115	497.0	MML	496.8	531.9	561.4	Yes	-7%	Yes	MA, NY, PA, VT, Mid-Atlantic
Com Lighting	Compact fluorescent lamps with reflectors	202.0	MML	144.6	202.3	228.7	Yes	0%	Yes	MA, ME, NY, PA, VT, Mid-Atlantic
Com Lighting	LED lamp	177.0	MML	176.6	189.1	199.6	Yes	-6%	Yes	MA, NY, PA, VT, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Freezers 30 to 50 ft3	3,869.0	MML	3,869.0	3,869.0	3,869.0	Yes	0%	Yes	OH, NY, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Refrigerators less than 15 ft3	722.0	MML	720.1	720.8	722.0	Yes	0%	Yes	OH, NY, VT
Com Refrig	Energy Star Commercial Solid Door Freezers 15 to 30 ft3	869.0	MML	563.0	747.6	869.0	Yes	16%	No	ME, OH, NY, VT, Mid-Atlantic
Com Refrig	Energy Star Commercial Solid Door Freezers more than 50 ft3	3,757.0	MML	2,608.7	2,999.5	4,171.0	Yes	25%	No	OH, NY, VT, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 3 HP	3,246.2	MML	2,636.1	4,388.5	7,014.2	Yes	-26%	No	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 5 HP	5,356.7	MML	4,393.5	7,287.8	11,573.8	Yes	-26%	No	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 7.5 HP	8,116.2	MML	6,590.2	10,971.2	17,535.4	Yes	-26%	No	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 10 HP	10,713.4	MML	8,787.0	14,575.6	23,147.6	Yes	-26%	No	MA, ME, OH, NY, PA, VT, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 15 HP	16,232.3	MML	13,180.4	21,234.4	35,070.9	Yes	-24%	No	MA, ME, OH, NY, PA, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 20 HP	21,643.1	MML	17,573.9	28,312.5	46,761.1	Yes	-24%	No	MA, ME, OH, NY, PA, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 25 HP	27,053.9	MML	21,967.4	33,738.7	58,451.4	Yes	-20%	No	MA, OH, NY, PA, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 30 HP	32,464.6	MML	26,360.9	40,486.5	70,141.7	Yes	-20%	No	MA, OH, NY, PA, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 40 HP	43,286.2	MML	35,147.9	53,982.0	93,522.3	Yes	-20%	No	MA, OH, NY, PA, Mid-Atlantic
Com Motors	VFDs for Process Pumping - 50 HP	54,108.4	MML	43,934.8	67,477.5	116,902.9	Yes	-20%	No	MA, OH, NY, PA, Mid-Atlantic

(1) Morgan Measure Libraries

Table 3.2.2
Summary of TRM Measure Savings Comparisons
Measures That Fall Outside of Range

Ameren Missouri TRM				Other TRMS - Savings Estimates						
Measure Type	Measure Name	Annual kWh Savings	Savings Source	Low	Average	High	Does Ameren Estimate Fall in Range?	Percent Difference of Ameren Savings from Other TRMs Average	Is Ameren Savings within +/- 10% of Other TRMS Average?	Comparison TRMs
Res Lighting	CFL POST-EISA 23 Watt	51.2	MML (1)	42.7	44.7	46.2	No	15%	No	OH, PA, Mid-Atlantic
Res Lighting	CFL - High Watt 65 Watt	113.0	MML	123.8	159.9	192.1	No	-29%	No	MA, OH, NY, PA, VT,
Res Lighting	CFL - Specialtly 26.5 Watt	44.1	MML	48.3	59.2	75.8	No	-25%	No	MA, OH, NY, PA, TX, VT, Mid-Atlantic
Res Lighting	CFL POST -EISA for Multifamily 13 Watt	31.5	MML	24.0	25.8	27.6	No	22%	No	OH, PA
Res Appliances	Two Speed High Efficiency Pool Pump	1,081.0	MML	400.0	491.0	594.0	No	120%	No	MA, OH, PA, Mid-Atlantic
Res Water Heating	Efficient Electric Tank Storage Water Heater 0.93 EF	157.0	MML	77.0	120.3	150.0	No	30%	No	MA, TX, VT
Com Lighting	Compact fluorescent lamp less than 30W	202.0	MML	202.4	216.7	228.7	No	-7%	Yes	MA, NY, PA, VT, Mid-Atlantic
Com Lighting	Occupancy Sensors under 500 W	397.0	MML	428.7	454.7	480.7	No	-13%	No	OH, PA
Com Cooking	Energy Star Steam Cooker - 3 Pan	11,188.0	MML	2,813.0	4,143.4	5,473.8	No	170%	No	OH, PA
Com Cooking	Energy Star Steam Cooker - 4 Pan	12,159.0	MML	3,902.0	4,997.9	6,093.9	No	143%	No	OH, PA
Com Cooking	Energy Star Steam Cooker - 5 Pan	13,139.0	MML	5,134.0	5,968.2	6,802.5	No	120%	No	OH, PA
Com Cooking	Energy Star Steam Cooker - 6 Pan	15,170.0	MML	6,311.0	6,911.0	7,511.1	No	120%	No	OH, PA
Com Refrig	Energy Star Commercial Solid Door Freezers less than 15 ft3	595.0	MML	458.1	478.1	538.0	No	24%	No	OH, NY, VT, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Freezers 15 to 30 ft3	2,004.0	MML	2,001.1	2,001.4	2,002.0	No	0%	Yes	OH, NY, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Freezers less than 15 ft3	722.0	MML	1,562.0	1,568.4	1,581.2	No	-54%	No	OH, NY, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Freezers more than 50 ft3	7,118.0	MML	5,694.0	5,694.0	5,694.0	No	25%	No	OH, NY, Mid-Atlantic
Com Refrig	Energy Star Commercial Glass Door Refrigerators 15 to 30 ft3	1,434.0	MML	671.6	677.7	690.0	No	112%	No	OH, NY, VT
Com Refrig	Energy Star Commercial Solid Door Freezers 30 to 50 ft3	1,728.0	MML	1,728.3	1,838.5	2,169.0	No	-6%	Yes	OH, NY, VT, Mid-Atlantic
Com Motors	VFDs for Air Compressors	5.8	MML	404.5	602.3	800.2	No	-99%	No	OH, PA

(1) Morgan Measure Libraries

Table 3.2.3
Summary of TRM Measure Savings Comparisons
Only One Other TRM Comparison

Ameren Missouri TRM				Other TRMS - Savings Estimates			
Measure Type	Measure Name	Annual kWh Savings	Savings Source	Average	Percent Difference of Ameren Savings from Other TRM	Is Ameren Savings within +/- 10% of Other TRM?	Comparison TRM
Res Lighting	LED Dimmable Light Bulb 12 Watt	48.0	Ameren TRM Formula	54.2	-11%	No	MA
Res Lighting	LED Flood PAR30 Bulb POST-EISA 15 Watt	35.0	Ameren TRM Formula	51.1	-32%	No	MA
Res Lighting	LED Flood PAR38 Bulb POST - EISA 18 Watt	32.0	Ameren TRM Formula	48.0	-33%	No	MA
Res Lighting	LED Globe G25 Bulb 8 Watt	32.0	Ameren TRM Formula	58.3	-45%	No	MA
Res Lighting	Metal Halide Outdoor Lighting 35 Watt	189.8	MML (1)	156.0	22%	No	MA
Res Lighting	Occupancy Sensor	217.0	MML	99.0	119%	No	MA
Com Hot Water	Commercial Heat Pump Water Heater - 10K-50K BTU/h >= 3.0 COP	21,156.0	MML	21,449.8	-1%	Yes	NY
Com Hot Water	Commercial Heat Pump Water Heater - 50k-100k BTU/h >= 3.0 COP	52,890.0	MML	53,624.6	-1%	Yes	NY
Com Hot Water	Commercial Heat Pump Water Heater - 300k-500k BTU/h >= 3.0 COP	282,081.0	MML	285,998.8	-1%	Yes	NY
Com Hot Water	Commercial Heat Pump Water Heater > 500k BTU/h >= 3.0 COP	423,122.0	MML	428,998.7	-1%	Yes	NY
Com Hot Water	Pre-Rinse Spray Valves <= 0.64 gpm	5,626.0	MML	650.2	765%	No	NY
Com Hot Water	Low Flow Faucet Aerators <= 1.5 gpm	174.0	MML	108.5	60%	No	NY
Com Misc	Tractor Heater Timers	576.0	Focus on Energy Evaluation Business Programs: Deemed Savings Manual v1.0	664.0	-13%	No	NY
Res Appliances	Single Speed High Efficiency Pool Pump	694.0	MML	409.0	70%	No	OH
Com Cooking	Energy Star Hot Food Holding Cabinets - Full Size > 15 ft3	5,278.0	MML	5,256.0	0%	Yes	OH
Com Cooking	Energy Star Hot Food Holding Cabinets - Three-Quarter Size 10- 15 ft3	2,832.0	MML	2,847.0	-1%	Yes	OH
Com Cooking	Energy Star Hot Food Holding Cabinets - Half Size < 10 ft3	1,788.0	MML	1,862.0	-4%	Yes	OH

(1) Morgan Measure Libraries

Table 3.2.4
Summary of TRM Measure Savings Comparisons
No Other TRM Comparisons Found

Ameren Missouri TRM			
Measure Type	**Measure Name**	**Annual kWh Savings**	**Savings Source**
Res Water Heating	Geothermal Heat Pump Desuperheater	1,540.0	MML (1)
Com Lighting	Commercial LED Case Lighting	429.0	MML
Com Lighting	Occupancy Sensors over 500 W	994.0	MML
Com Lighting	Central Lighting Control	11,500.0	MML
Com Lighting	Switching Controls for Multilevel lighting	8,000.0	MML
Com Lighting	Daylight Sensor controls	14,800.0	MML
Com Lighting	Retro-Commissioning Lighting	5,311.4	MML
Com Refrig	Energy Star Ice Machine > 1000 lbs/24 hours	6,048.0	MML
Com Hot Water	Commercial Heat Pump Water Heater - 100k-300k BTU/h >= 3.0 COP	141,041.0	MML
Com Misc	Window Repalcement	30,575.0	MML
Com Opt	Optimized Process Cooling	16,325.0	MML
Com Opt	Optimized Process Heating	7,053.0	MML
Com Opt	Compressed Air Optimization	200.0	MML
Res Lighting	CFL - Reflector 20 Watt	44.1	MML
Res Lighting	HID Outdoor Bulb 505 Watt	603.0	MML
Res Lighting	Airtight Can Bulb for Multifamily N/A Watt	85.0	MML
Com Refrig	Energy Star Ice Machine < 500 lbs/24 hours	1,652.0	MML
Com Refrig	Energy Star Ice Machine 500 - 1000 lbs/24 hours	2,695.0	MML
Com Motors	Commercial Pumps for Process - 1.5 HP 5.66% Improvement	1,991.0	MML
Com Motors	Commercial Pumps for Process - 2 HP 7.48% Improvement	513.0	MML
Com Motors	Commercial Pumps for Process - 3 HP 7.19% Improvement	573.0	MML
Com Motors	Commercial Pumps for Process - 5 HP 2.86% Improvement	664.0	MML
Com Motors	Commercial Pumps for Process - 5 HP 21.3% Improvement	9,232.0	MML
Com Motors	Commercial Pumps for Process - 5 HP 12.9% Improvement	4,405.0	MML
Com Motors	Commercial Pumps for Process - 5 HP 13.75% Improvement	1,569.0	MML
Com Motors	Commercial Pumps for Process - 5 HP 24.54% Improvement	4,254.0	MML
Com Motors	Commercial Pumps for Process - 7.5 HP 7.48% Improvement	1,840.0	MML
Com Motors	Commercial Pumps for Process - 7.5 HP 6.05% Improvement	1,720.0	MML
Com Motors	Commercial Pumps for Process - 10 HP 2.96% Improvement	1,026.0	MML
Com Motors	Commercial Pumps for Process - 10 HP 4.6% Improvement	1,629.0	MML
Com Motors	Commercial Pumps for Process - 10 HP 12.25% Improvement	4,043.0	MML
Com Motors	Commercial Pumps for Process - 15 HP 16.09% Improvement	7,332.0	MML
Com Motors	Commercial Pumps for Process - 20 HP 2.45% Improvement	1,267.0	MML
Com Motors	Commercial Pumps for Process - 20 HP 9.24% Improvement	5,340.0	MML
Com Motors	Commercial Pumps for Process - 20 HP 4% Improvement	3,409.0	MML

3.3 Recommendations

GDS recommends that the Ameren Missouri TRM be accepted with the following revisions:

(1) All equations identified as incorrect should be revised.

(2) All key assumptions that are identified as missing, incorrectly stated, not defined or not sourced should be added or corrected.

(3) Equations identified as non-calculative should be revised such that they will actually calculate base and efficient use based on key inputs such as equipment wattage, horsepower, operating hours, and efficiency ratings.

(4) Interactive factors, in-service rates and in situ adjustment factors should be added to equations where they have been identified as missing. It is important to identify these factors in all energy savings equations, whenever it is appropriate, even if the factor values are set to 1.0.

(5) Alternative equations suggested by GDS to improve the precision of the energy savings estimates should be either adopted by Ameren Missouri or an explanation should be provided explaining why the current equation is preferred.

(6) Other issues with equations that have been identified by GDS should be reviewed by Ameren Missouri and any necessary TRM changes should be made or a response should be provided.

(7) In the absence of new evaluation data addressing measures with questionable savings estimates, additional research should be conducted on those measures in Table 3.2.2 above that have been identified as having savings estimates that are outside the range of estimates from other TRMs and also differ by more than ± 10% from the average "other TRMs" energy savings. The purpose of this additional research would be to determine if the differences identified by GDS are valid and if not, to make any necessary changes to energy savings values.

(8) In the absence of additional evaluation data addressing measures for which only one or no comparative values from other TRMs could be found, Ameren Missouri should conduct additional research to assess the reasonableness of energy savings estimates for such measures.