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Comparison of Evaluation, Measurement & Verification Processes: Arkansas to Bordering States

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Comparison of Evaluation, Measurement & Verification Processes: Arkansas to Bordering States

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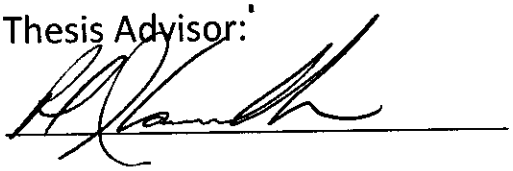

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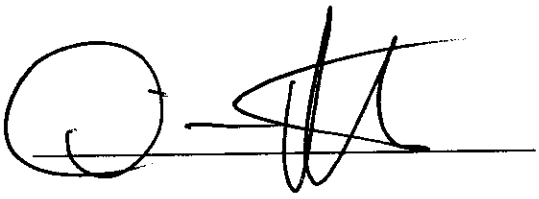

AN UNDERGRADUATE HONORS THESIS
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Comparison of Evaluation, Measurement & Verification Processes

Arkansas to Bordering States

William Carlisle

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The purpose of this paper is to compare Evaluation, Measurement, and Verification (EM&V) standards established by Arkansas and surrounding states. EM&V is the process to quantify the energy savings of an energy management project. This paper details the rules and regulation regarding the EM&V proceedings required by investor-owned utilities in providing energy-saving projects. By comparison of each state's requirement, a clear understanding is found on where Arkansas stands in maturity of its program requirements. The reader will find Arkansas on the forefront of EM&V standardization that represents a model that surrounding states are striving to emulate.

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Background

Energy efficiency programs are growing across the country, driven out of necessity to reduce consumption and the desire to make better use of the resources available. Different programs strive to provide energy users incentives to implement energy saving projects. One program is by utility companies offering rebate programs to customers for implementing energy saving measures. Energy savings projects often do not compare favorably to other projects. By offering monetary incentives for energy efficiency projects, a project's appeal can be increased.

Investor-owned utilities (IOUs) are publically traded utilities and are subject to regulation by governing commissions in the operating states. Many of the governing bodies require the IOUs to implement energy savings programs to incentivize customers to conduct energy savings projects. The typical structure for the utility rebate program is a utility customer implementing a project, and the utility offering a rebate on customer's bill, varying with project scope.

How the utility will quantify the value of the savings is a challenge. The program can provide certain available projects and offer a prescribed savings for that project. This approach limits the availability of industrial projects that may be complex and customized. To account for the savings of such projects, a system must be established to define the value of the savings.

Many utility rebate programs offer incentives for energy efficiency projects, but to determine actual savings to justify the incentive, a measurement and verification process must be established.

Costs

There is a delicate balance between cost and accuracy on the measurement and verification (M&V) selection for individual projects. The measurement and verification adds cost and labor to individual projects, but the savings must be determined. Additional costs can be in the form of equipment, metering, logging, or even interval sampling [14]. More costly M&V selection adds accuracy to the measured savings, yielding a better savings determination for the rebate provider. The less expensive option typically yields less accurate results. When selecting an M&V procedure, it is important to optimize the additional cost and accuracy that different measures provide. In fact, "quantitative uncertainty analysis can be used to determine the proper levels of M&V that are acceptable for each project" [14].

Standards

IPMVP

Industry standards have been established to better unify the procedure for measurement and verification. M&V can be characterized in a number of ways, but the most widely recognized standard for basing M&V procedures derives from International Performance and Measurement Verification Protocol (IPMVP). The first edition was issued in 1996 and was created to "provide an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects" [15]. The protocol was initially named North American Energy M&V Protocol when it was first published in 1996. Now there have been two revisions to the issue, the most current one issued in 2002. The effort to create such a standard was led by the US Department of Energy in conjunction with various international organizations. IPMVP offers four distinct approaches to measurement and verification. The following table, from the protocol, describes the options in further detail:

Overview of M&V Options		
M&V Option	How Savings Are Calculated	Typical Applications
A. Partially Measured Retrofit Isolation Savings are determined by partial field measurement of the energy use of the system(s) to which an ECM was applied, separate from the energy use of the rest of the facility. Measurements may be either short-term or continuous. Partial measurement means that some but not all parameter(s) may be stipulated, if the total impact of possible stipulation error(s) is not significant to the resultant savings. Careful review of ECM design and installation will ensure that stipulated values fairly represent the probable actual value. Stipulations should be shown in the M&V Plan along with analysis of the significance of the error they may introduce.	Engineering calculations using short term or continuous post-retrofit measurements and stipulations.	Lighting retrofit where power draw is measured periodically. Operating hours of the lights are assumed to be one half hour per day longer than store open hours.
B. Retrofit Isolation Savings are determined by field measurement of the energy use of the systems to which the ECM was applied, separate from the energy use of the rest	Engineering calculations using short term or continuous measurements	Application of controls to vary the load on a constant speed pump using a variable speed drive. Electricity use is measured by a kWh meter installed on the electrical

of the facility. Short-term or continuous measurements are taken throughout the post-retrofit period.		supply to the pump motor. In the baseyear this meter is in place for a week to verify constant loading. The meter is in place throughout the post-retrofit period to track variations in energy use.
C. Whole Facility Savings are determined by measuring energy use at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period.	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.	Multifaceted energy management program affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a twelve month baseyear period and throughout the post-retrofit period.
D. Calibrated Simulation Savings are determined through simulation of the energy use of components or the whole facility. Simulation routines must be demonstrated to adequately model actual energy performance measured in the facility. This option usually requires considerable skill in calibrated simulation.	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-use metering.	Multifaceted energy management program affecting many systems in a building but where no baseyear data are available. Post-retrofit period energy use is measured by the gas and electric utility meters. Baseyear energy use is determined by simulation using a model calibrated by the post-retrofit period utility data

Table 1. Overview of M&V Options from IPMVP Ref. [15]

Option A: Partially Measured Retrofit Isolation

Option A requires only certain measures to be taken to quantify the energy savings. Other parameters may be stipulated, given such error in stipulation will not result in significant change to the savings. This option is common with residential application and common industrial projects where several key parameters are already assumed. In fact, some programs use a prescribed savings approach where certain projects are set to a certain monetary value of savings. An example of Option A includes a lighting retrofit where the power consumption is measured periodically and hours of operation can be estimated (e.g., 30 minutes longer than daily operating hours) [15].

Option B: Retrofit Isolation

Option B requires that all parameters affecting the project be measured on a short-term or continual basis. This approach is inherently difficult due to the challenge of identifying all parameters. A multitude of inputs are possible in determining the energy usage of a process, and to quantify all parameters can add significant cost to the project, especially if error on the parameter does not, by large, change the energy savings. Therefore, it is oftentimes more cost-effective to use Option A. An example of Option B

includes an *application of controls to vary the load on a constant speed pump using a variable speed drive. Electricity use is measured by a kWh meter installed in the electrical supply to the pump motor. In the baseyear this meter is in place for a week to verify constant loading. The meter is in place throughout the post-retrofit period to track variations in energy use* [15].

Option C: Whole Facility

Option C requires measuring the energy impact on the entire facility level. This method is prevalent when savings are greater than 10% of the base year energy use (IPMVP 28). This is also effective when multiple projects are being evaluated and entire facility monitoring is feasible. Likewise, when certain parameters cannot be sub-metered, Option C is deemed the best approach. An application of this method is the Department of Energy's EnPI tool. This tool compares energy saving performance to a baseline year. Inputs include production and energy usage (electric and natural gas). Variables include heating degree days (HDD), cooling degree days (CDD), dew point temperature, product output, moisture content of the product, shift schedule adjustments. The tool regressions the data in comparison to the baseline and outputs [2]:

- Total Baseline Primary Energy Consumed (MMBtu/year)
- Total Current Year Primary Energy Consumed (MMBtu/year)
- Adjustment for Baseline Primary Energy use (MMBtu/year)
- Adjusted Baseline of Primary Energy (MMBtu/year)
- New Energy Savings for Current Year (MMBtu/year)
- Total Energy Savings since Baseline Year (MMBtu/year)
- Annual Improvement in Energy Intensity for Current Year (%)
- Total Improvement in Energy Intensity for Baseline Year (%)

EnPI is a highly effective tool in determining facility energy performance changes by normalizing the effects that variables have on the consumption of a facility. A specific example of Option C includes a *multifaceted energy management program affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a twelve month baseyear period and throughout the post-retrofit period* [15].

Option D: Calibrated Simulation

Option D requires the simulation of energy consumption in a facility. This approach is often used when no baseline energy data is available, such as new building construction. There exist numerous energy

simulation softwares such as EnergyPlus and eQuest. The calibrated simulation is often expensive and difficult to accurately model the actual performance and is, therefore, not used unless necessary. An example of Option D includes a *multifaceted energy management program affecting many systems in a building where no baseyear data are available. Post-retrofit period energy use is measured by the gas and electric utility meters. Baseyear energy use is determined by simulation using a model calibrated by the post-retrofit period utility data* [15].

International Organization for Standardization

In December of 2014, the International Organization for Standardization issued the first edition of ISO 50015:2014. This standard is labeled Energy management systems-- Measurement and verification of energy performance of organizations--General principles and guidelines. ISO 50015 was developed to work in conjunction (or independently) with other standards such as ISO 50001:2012--Energy management system. ISO 50001 outlines the model of improving efforts for quality and environment standards. The new issue, ISO 50015, outlines the framework for measurement and verification of these energy management systems.

The protocol "does not specify calculation methods; rather it established a common understanding of M&V and how M&V could be applied to different calculation methods" [16]. Largely, it defines the principles and considerations required to conduct appropriate M&V plans.

The manual defines the six fundamental steps in the M&V process which include [16]

1. Establish and document an M&V plan
2. Data gathering
3. Verify the implementation
4. Conduct M&V analysis
5. Report M&V results and issue documentation
6. Review the need to repeat the process

Like IPMVP, specific measures are defined within the outline established with the ISO50015.

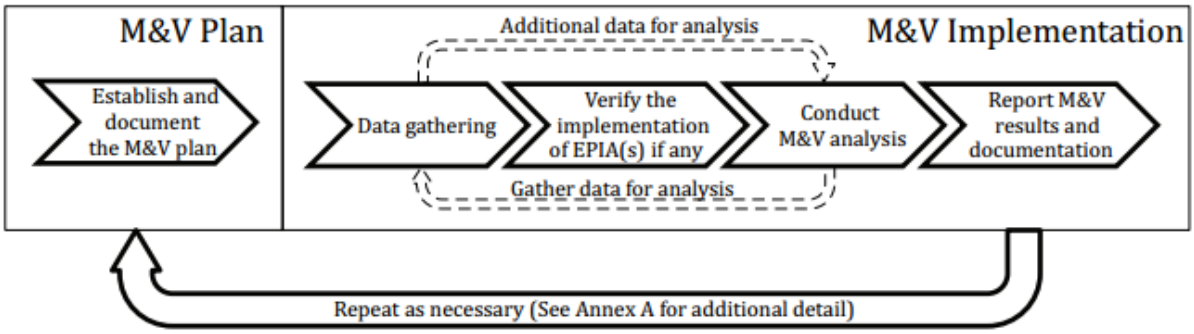

Figure 1. Fundamentals of M&V Process Ref. [16]

California Standard Practice Manual

The California Standard Practice Manual was initially published in 1983 to establish standard procedures for cost-effectiveness evaluations for utility sponsored energy savings programs in California [8]. Since its inception, it has been widely regarded as the industry standard for cost effectiveness for such programs in the United States. The manual has been revised several times until it reached its current state issued in 2001.

This manual recognizes five perspectives to compare for demand-side management (DSM) program cost effectiveness. The five measures include Participant (PCT), Ratepayer Impact Measure (RIM), Total Resource Cost (TRC), Social Cost (SCT), and Utility/Program Administrator (UCT). Social cost is considered a variation of TRC, but the American Council for Energy Efficiency Economy (ACEEE) recognizes as an independent measure when evaluating state utility programs. The following excerpts come from the California Standard Practice Manual describing each measure [8].

Participant Test (PCT)

Participant (PCT) quantifies the benefits to the customer for participating in the rebate program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer. The PCT serves as an indicator to the desirability of the program to customers.

Ratepayer Impact Measure (RIM)

The Ratepayer Impact Measure (RIM) test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely,

rates or bills will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels.

Total Resource Cost (TRC)

The Total Resource Cost Test measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. The test is applicable to conservation, load management, and fuel substitution programs. For fuel substitution programs, the test measures the net effect of the impacts from the fuel not chosen versus the impacts from the fuel that is chosen as a result of the program. TRC test results for fuel substitution programs should be viewed as a measure of the economic efficiency implications of the total energy supply system (gas and electric).

Social Cost (SCT)

A variant on the TRC test is the Societal Test. The Societal Test differs from the TRC test in that it includes the effects of externalities (e.g. environmental, national security), excludes tax credit benefits, and uses a different (societal) discount rate. It goes beyond the TRC test in that it attempts to quantify the change in the total resource costs to society as a whole rather than to only the service territory (the utility and its ratepayers). In taking society's perspective, the Societal Test utilizes essentially the same input variables as the TRC Test, but they are defined with a broader societal point of view.

More specifically, the Societal Test differs from the TRC Test in at least one of five ways. First, the Societal Test may use higher marginal costs than the TRC test if a utility faces marginal costs that are lower than other utilities in the state or than its out-of-state suppliers. Marginal costs used in the Societal Test would reflect the cost to society of the more expensive alternative resources. Second, tax credits are treated as a transfer payment in the Societal Test, and thus are left out. Third, in the case of capital expenditures, interest payments are considered a transfer payment since society actually expends the resources in the first year. Therefore, capital costs enter the calculations in the year in which they occur. Fourth, a societal discount rate should be used. Finally, Marginal costs used in the Societal Test would also contain externality costs of power generation not captured by the market system.

Utility/ Program Administrator (UCT)

The Program Administrator Cost Test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. Costs are defined more narrowly.

There are differnet methods to express each measure. For a matter of consistancy, the manual outlines the primary and secondary approaches to expressing the cost-effectiveness tests.

Cost Effectiveness Tests	
Participant	
Primary	Secondary
Net Present Value (all participants)	• Discounted Payback (years) • Benefit-cost Ratio • Net Present Value (average participant)
Ratepayer Impact Measure	
Lifecycle revenue impact per Unit of energy (kWh or therm) or demand customer (kW) Net present value	• Lifecycle revenue impact per unit • Annual revenue impact (by year, per kWh, kW, therm, or customer) • First-year revenue impact (per kWh, kW, therm, or customer) • Benefit-cost ratio
Total Resource Cost	
Net present value (NPV)	• Benefit-cost ratio (BCR) • Levelized cost (cents or dollars per unit of energy or demand) • Societal (NPV, BCR)
Program Administrator Cost	
Net present value (NPV)	• Benefit-cost ratio • Levelized cost (cents or dollars per unit of energy or demand)

Table 2. Cost Effectiveness Test Expressions Ref. [8]

Scope

There exists a missing platform for standardizing specific EM&V plans. IMPVP and ISO 50015:2014 provide the basic framework for M&V practices, but fail to establish a specific M&V courses of action. Additionally the California Standard Practice Manual structures the method of how a program should evaluate the cost-effectiveness of projects, but it is up to the state to dictate which measures are to be used.

This paper's intent is to compare the EM&V practices established by Arkansas to the surrounding states. Each state has a governing board that regulates the investor owned utilities, and is responsible for establishing EM&V procedures for the energy savings programs, in accordance to IPMVP. States included in this analysis are: Arkansas, Texas, Oklahoma, Missouri, Tennessee, Louisiana, and Mississippi. Each state's M&V program will be outlined and described in further detail.

Arkansas

In 2003 the Arkansas General Assembly recognized that "enormous amounts of energy are wasted by consumers of all classes and economic levels due to inadequate insulation of buildings and other inefficiencies in the use of energy" [26]. In January 2007, the Arkansas Public Service Commission (APSC) passed the Rules for Conservation and Energy Efficiency Programs (C&EE) [29]. The provision made the Arkansas Public Service Commission responsible for enabling energy conservation programs throughout the state and granted authority to require utilities under its jurisdiction to implement such projects. This also granted the utilities ability to recover the costs introduced by the program by increasing rates. Thereby, the commission required the investor-owned utility providers (electric and natural gas) to offer energy savings programs, known as Demand Side Management (DSM) [3]. To build on this program, the Public Service commission adopted an energy efficiency resource standard (EERS) in 2010. This standard, applying to electric and natural gas IOUs, establishes guidelines for efficiency program cost recovery, shareholder performance incentive, and utility resource planning [29].

In establishing the state Conservation and Energy Efficiency Program, Section 12 outlines the framework for the measurement and verification [26]:

> *All EM&V activities undertaken as part of a utility-sponsored program, including, but not limited to, estimation of energy efficiency savings and process evaluations, shall be conducted consistent with the Arkansas Technical Reference Manual (TRM) and with national best program evaluation practices as established by the National Action Plan for Energy Efficiency ("NAPEE"), the State & Local Energy Efficiency Action ("SEE Action") Network, the International Performance Measurement and Verification Protocol ("IPMVP"), or other similar nationally or internationally accepted EM&V standards. The TRM shall set forth Protocols for EM&V activities. An organization selected by a program administrator to conduct EM&V activities shall be independent of the organization or organizations involved in the particular EE program design, management, and implementation, such that the verification professionals conducting or reviewing evaluations have no financial stake, beyond the evaluation contract itself, in the program or program components being evaluated.*

The Technical Reference Manual provides the best approaches to measurement and verification of DSM portfolio projects. It covers the framework for "conducting cost-effective DSM Program evaluations. Primary interests that are described in detail are the types of information needed, the frequency of data

collection, and metrics that must be reported [3]. The manual cannot cover all M&V scenarios, but the implement or is expected to execute measures that are consistent with the provisions provided in the TRM. The investor owned utilities in Arkansas include:

Electric	Natural Gas
AEP-SWEPCO	Arkansas Oklahoma Gas (AOG)
Empire District	CenterPoint Energy
Entergy	Entergy
OG&E	SourceGas

Table 3. Arkansas Investor-Owned Utilities

The utility companies in Arkansas adhere to the requirements as enacted by the APSC. The natural gas utility providers have very similar rebate programs that reflect their joint partnership in creating the programs. The TRM as the primary resource reflects the state wide use of IPMVP option A. The manual provides consistency for the statewide projects that could not have otherwise been offered. The manual reflects that of Option A because of its intent to "describe the types of information that must be collected to conduct a comprehensive examination of a program's overall effectiveness, the recommended frequency for conducting these program evaluations, and the key metrics that must be reported during these evaluation activities" [3]. Although this resource does not reflect that of all M&V cases, it is the standard as to which the utilities are to uphold. Therefore, different approaches to measurement and verification may be necessary and are to be determined by the independent contractor. The TRM is updated annually to better align with industry practices.

The Arkansas PSC requires that all utilities source an independent M&V contractor for all projects to properly align the interests involved in energy efficiency projects. In conjunction with the contractor, the utilities are required to jointly fund an EM&V monitor [29] (which is currently Cadmus Group from St. Louis).

Arkansas adheres to the methods in the California Standard Practice Manual for the evaluation of energy savings projects. The state recognizes four of the five tests identified including: TRC, UCT, PCT, and RIM. Although all four are recognized, the Commission identifies the TRC as the primary cost effectiveness test and is required for all levels of screening.

Texas

In 1999, Texas legislature enacted Senate Bill 7 in which the provisions required that "at least 10% of an investor-owned utility's annual growth in electricity demand be met through energy efficiency programs each year" [9]. This established the nation's first energy efficiency resource standard (EERS), which ACEEE defines as "specific, long-term targets for energy savings that utilities or non-utility program administrators must meet through customer energy efficiency programs" [10]. Public Utilities Commission of Texas (PUCT) is the governing body for investor-owned utilities in the state. The success of the EERS program has enabled PUCT to increase annual goals to 20% in 2010, 25% in 2012, and finally 30% in 2013 [35]. Following, Texas legislation passed the House Bill 1125 that required all EERS goals to be met as a percentage of total peak loads versus growth in demand [9].

It is important to note that since 1999 Texas is the only state discussed in this paper with deregulated electricity [38]. This means that there exists a free market for the utility services.
Instead of regulated monopolies that provide all electricity service, separate companies provide the power generation, transmission and distribution, and retail sales [9]. Transmission and Distribution Utilities (TDUs) are the providers of electricity and are under the regulation of PUCT. The TDUs are the companies that provide the energy efficiency programs to meet the mandates. The electric investor – owned TDUs organized together to form EUMMOT (Electric Utility Marketing Managers of Texas), to facilitate coordination among the energy savings programs [9].

The investor owned utilities in Texas include:

Electric	Natural Gas
AEP Texas	Atmos Energy
El Paso Electric Company	CenterPoint Energy
Texas New Mexico Power	Texas Gas Service
Xcel Energy	
CenterPoint Energy	
Entergy	
Oncor	
Sharyland Utilities	

Table 4. Texas Investor-Owned Utilities

The Public Utility Commission of Texas adopted the Substantive Rule 25.181 – The Energy Efficiency Rule in 2011. Under this legislation, IOUs are required to offer energy efficiency programs to meet the EERS goals. The programs are administered by the utility and implemented by the retail electric provider of energy efficiency service provider [35]. PUCT is responsible for reviewing and approving all plans. To recover the costs of offering the program, the utilities include an Energy Efficiency Cost Recovery Factor (EECRF) through tariffs on the billing rate.

For-profit customers that receive electric service on the transmission level are not eligible for the energy savings programs and are therefore not responsible for paying the incremental charges that fund the programs. The customers are responsible for conducting their own energy efficiency measures and therefore no M&V is required for the program. The customer may work with energy efficiency service providers to implement such programs, but not through the utility service.

The state legislature addressed the EM&V framework necessary for the energy efficiency programs in Rule 25.181. The following excerpt for Senate Bill 1125 established the means by which the EM&V standards are to be established [6]:

> *(3) The commission shall select an entity to act as the commission's EM&V contractor and conduct evaluation activities. The EM&V contractor shall operate under the commission's supervision and oversight, and the EM&V contractor shall offer independent analysis to the commission in order to assist in making decisions in the public interest.*
>
> *(4)Evaluation activities will be conducted by the EM&V contractor, starting with activities associated with program year 2012, to meet the evaluation objectives defined in this section. Activities shall include, but are not limited to:*
>
> > *(A) Providing appropriate planning documents.*
> >
> > *(B) Impact evaluations to determine and document appropriate metrics for each utility's individual evaluated programs and portfolio of all programs, annual portfolio evaluation reports, and additional reports and services as defined by commission staff to meet the EM&V objectives.*
> >
> > *(C) Preparation of a statewide technical reference manual (TRM), including updates to such manual as defined in this subsection.*

(6)The following apply to the development of a statewide TRM by the EM&V contractor.

(A) The EM&V contractor shall use existing Texas, or other state, deemed savings manual(s), protocols, and the work papers used to develop the values in the manual(s), as a foundation for developing the TRM. The TRM shall include applicability requirements for each deemed savings value or deemed savings calculation. The TRM may also include standardized EM&V protocols for determining and/or verifying energy and demand savings for particular measures or programs. Utilities may apply TRM deemed savings values or deemed savings calculations to a measure or program if the applicability criteria are met.

(B) The TRM shall be reviewed by the EM&V contractor at least annually, pursuant to a schedule determined by commission staff, with the intention of preparing an updated TRM, if needed. In addition, any utility or other stakeholder may request additions to or modifications to the TRM at any time with the provision of documentation for the basis of such an addition or modification. At the discretion of commission staff, the EM&V contractor may review such documentation to prepare a recommendation with respect to the addition or modification.

In 2011, Texas legislature required the Public Utility Commission of Texas (PUCT) "to develop an EM&V framework that promotes effective program design" [12]. To develop an "independent evaluation if utility energy efficiency and load management programs," PUCT select Tetra Tech to conduct the independent EM&V of utility's energy savings programs. Tetra Tech consists of multiple subcontractors including [12]:

- Texas A&M Center for Applied Technology
- Texas Energy Engineering Services, Inc. (TEESI)
- The Cadmus Group
- Itron
- Johnson Consulting Group

Tetra Tech is responsible for developing appropriate M&V procedures for energy savings contracts. Tetra Tech and associated companies work with PUCT as the independent EM&V team to develop and maintain the Texas Technical Reference Manual (TRM). TRM provides the measures that have been

approved for use in Texas for deemed savings. The reference guide serves as a "centralized source of deemed savings values, where appropriate, Measurement & Verification methods by measure category" [35].

Like the Arkansas TRM, the Texas TRM represents IPMVP Option A: Partially Retrofit Isolation Measurement. This method encompasses the majority of M&V requirements. There are four types of deemed savings identified in the TRM[35]:

- *Point estimates that provide a single deemed savings value that correspond to a single measure or type of technology.*
- *Deemed saving tables that provide energy and peak savings as a function of size, capacity; building type, efficiency level, or other inputs.*
- *Savings algorithms that require user defined inputs that must be gathered on site and the identification of default inputs where primary data could not be collected. In many cases, these algorithms are provided as references to deemed savings tables, point estimates, or calculator explanations.*
- *Calculators are used by different utilities and implementers to calculate energy savings for different measures. In many cases, there are several different calculators available for a single measure. Sometimes their background calculators are similar, and in other cases, estimates can vary greatly between each calculator.*

For evaluation standardization, Texas recognizes the Utility/Program Administrator Cost Test (UCT) as the single effectiveness test. Rule 25.181 states, "An energy efficiency program is deemed to be cost-effective if the cost of the program to the utility is less than or equal to the benefits of the program," which is consistent with the UCT formed by the California Standard Practice Manual.

Oklahoma

Oklahoma also offers energy efficiency programs through utilities regulated by the states. The IOUs' governing body is the Oklahoma Corporation Commission (OCC). In 2008, the OCC required electric and natural gas utilities to provide energy efficiency programs [33]. The purpose of this order was to "set specific savings goals for each utility to reduce the rate of growth of peak demand, energy usage, and capacity addition without adversely affecting customer comfort or state economic activity, based on market potential studies, integrated resource plans, or other evidence" [20]. In Oklahoma Office of Administrative Tile 165, Chapter 35, the demand portfolio submission required "all electric utilities under rate regulation of the Commission shall propose, at least once every three years, and be responsible for the administration and implementation of a demand portfolio of energy efficiency and demand response programs within their service territories" [21]. This same standard is established for natural gas utilities in OAC Chapter 45 [24]. These rules established the energy-savings programs in Oklahoma. The investor-owned utilities affected by this mandate include:

Electric	Natural Gas
Oklahoma Gas & Electric	Arkansas-Oklahoma Gas Corporation
Public Service Company of Oklahoma (PSO)	CenterPoint Energy Company
Empire District Company	Ft. Cobb Fuel Authority
	LeAnn Gas Company
	Oklahoma Natural Gas
	Panhandle Natural Gas Incorporated
	West Texas Gas Company

Table 5. Oklahoma Investor-Owned Utilities

Since the rule's inception, all electric and natural gas IOUs have submitted their 3 year plan and many have filed for an additional plan following the initial term. The companies may recover the cost associated with the program through increase utility rates. These programs have largely affected residential and commercial customers, where large industrial users have and exercised the right to opt out [33]. Oklahoma does not currently have and Energy Efficiency Resource Standard.

The EM&V method is much more rudimentary than those previously described. There is not a technical reference manual issued by the commission. In fact, individual utilities are responsible for the EM&V process, third party contractor required. The excerpt from Chapter 35 outlines the basis of the EM&V structure [23]:

165:35-41-6. Evaluation, measurement, and verification

a. Utilities are responsible for timely evaluation, measurement, and verification of their energy efficiency and demand response programs.

b. The intent of the evaluation, measurement, and verification process is:

1. To provide a reliable calculation of the net savings produced by energy efficiency and demand response programs;

2. To assess the effects of programs on the market for energy efficient products and services and products and services that support demand response programs; and

3. To assess the effectiveness of the administration and implementation of energy efficiency and demand response programs.

c. Utilities shall prepare and maintain a program-tracking database.

d. Each evaluation, measurement, and verification plan for a program will explain the methods that will be applied with an explanation of how those methods will meet the requirements of this rule.

e. Deemed savings, customer bill analysis, on-site metering, and statistical sampling will be permitted in appropriate applications.

f. Assumptions with any supporting research about the ratio between gross savings in energy consumption by utility customers and net savings attributable to energy efficiency and demand response programs will be included in the evaluation, measurement, and verification plan.

g. The evaluation, measurement, and verification process shall produce reports that are fully documented, auditable, and transparent.

While the EM&V structure outlined by the state remains basic, the utility companies remain responsible for establishing the framework. Most utilities provide prescribed rebate offerings for specific projects. From publically available resources, no M&V framework is available.

For evaluation standards, Oklahoma recognized all five metrics from the California Standard Practice Manual. The tests are intended to be used together to deem a program viable. The commission identifies the total resource cost (TRC) to be the primary metric, but also requires “Results of the Rate Impact Measure Test contained in the California Standard Practice Manual shall also include an estimate of the impact on average customer bills” [22]. The OCC reviews and audits all programs.

Missouri

In 2009, Missouri enacted the Missouri Energy Efficiency Investment Act (MEEIA) under Senate Bill 376. This act was established to "ensure that utility financial incentives are aligned with helping customers use energy more efficiently and in a manner that sustains or enhances utility customers' incentives to use energy more efficiently"[28]. The bill frames the creation of demand-side programs for IOUs under the jurisdiction of Missouri Public Service Commission. The act enabled the cost recovery programs for the utilities and well as evaluation standards. The tabulated companies are under the jurisdiction of Missouri Public Service Commission:

Electric	Natural Gas
Ameren Missouri	Ameren Missouri
Kansas City Power & Light (KCP&L)	Empire District
Empire District Electric Company	Laclede Gas Company
	Liberty Utilities
	Missouri Gas Energy
	Summit gas Energy

Table 6. Missouri Investor-Owned Utilities

With some delay in the implementation of the act's provisions, one of Missouri's largest IOUs submitted the first three year plan in 2012 [32]. The MEEIA marks the beginning of a new era in Missouri, a state that previously had little legislation for energy efficiency programs. The EM&V framework for the DSM programs is outlined in Missouri's Code of State Regulations. The following excerpt from Division 240 Chapter 20 describes the M&V process [5]:

> *(7)Evaluation, Measurement, and Verification (EM&V) of the Process and Impact of Demand-Side Programs. Each electric utility shall hire an independent contractor to perform and report EM&V of each commission approved demand-side program in accordance with 4 CSR 240-20.094 Demand-Side Programs. The commission shall hire an independent contractor to audit and report on the work of each utility's independent EM&V contractor.*
>
> *(A) Each utility's EM&V budget shall not exceed five percent (5%) of the utility's total budget for all approved demand-side program costs.*
>
> *(B) The cost of the commission's EM&V contractor shall—*
>
> *1. Not be a part of the utility's budget for demand-side programs; and*

> *2. Be included in the Missouri Public Service Commission Assessment for each utility.*
>
> *(C) EM&V draft reports from the utility's contractor for each approved demand-side program shall be delivered simultaneously to the utility and to parties of the case in which the demand-side program was approved.*
>
> *(D) EM&V final reports from the utility's contractor of each approved demand-side program shall—*
>
> *1. Be completed by the EM&V contractor on a schedule approved by the commission at the time of demand-side program approval in accordance with 4 CSR 240- 20.094(3); and*
>
> *2. Be filed with the commission and delivered simultaneously to the utility and the parties of the case in which the demand-side program was approved.*
>
> *(E) Electric utility's EM&V contractors shall use, if available, a commission-approved statewide technical resource manual when performing EM&V work.*

Missouri has not developed a statewide M&V standard as seen in Texas and Arkansas. The state relies on the utilities to manage the M&V process through third party contractors. The Missouri PSC has an EM&V auditor that reviews the program applications and approves the M&V procedure. One proponent of a state-issued technical reference manual is Ameren Missouri. Ameren has pushed for the development of a statewide TRM during the entirety of MEEIA legislation [19]. In 2012, Ameren submitted its own TRM jointly with its three year DSM proposal, passed by the Missouri PSC. Ameren is now working with a contractor to develop a web-based TRM for the next three year program cycle [7]. The development of an independent TRM benefits in adding consistency and transparency to the M&V process. Ameren is setting a standard through the implementation of a TRM for the state. It is believed that there is collaboration among electric IOUs to begin an investigation of a statewide TRM [32].

For evaluation standards, Missouri recognizes all five metrics from the California Standard Practice Manual. The commission identifies the total resource cost (TRC) to be the preferred cost effectiveness test [28]. The regulation defined by Chapter 3 marks the impact evaluation requirement for all EM&V reports that include at a "minimum the TRC of each program" [4]. The Missouri PSC reviews and audits all programs.

Tennessee

In 1996, the Tennessee Regulatory Authority (TRA) was established to promote and protect the public interest regarding investor owned utilities. The utilities regulated by the TRA include:

Electric	Natural Gas
Appalachian Power Company	Atmos Energy Corporation
Entergy Arkansas, Inc.	B&W Pipeline, LLC
Kentucky Utilities Company	Chattanooga Gas Company
Kingsport Power Company	Counce Natural Gas
Plains And Eastern Clean Line LLC	ESG Pipeline
	General Gas Pipeline, LLC
	Navitas TN NG, LLC.
	Piedmont Natural Gas Co.
	Renewco-Meadow Branch, LLC

Table 7. Tennessee Investor-Owned Utilities

The problem exists in that the largest electric provider, by far, is the Tennessee Valley Authority (TVA). TVA is a corporation owned by the US government, created in 1933 to address environmental and economic issues in the Tennessee Valley. Today, TVA is that largest publicly owned utility in the country, serving customers in states Tennessee, Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia [1]. Because TVA represents the vast majority of electricity providing in Tennessee, solely focusing on the energy efficiency programs of the IOUs would not adequately depict that of the entire state. In fact, TVA is the primary provider of energy efficiency programs in the state.

As TVA is not regulated by the TRA, the governing body consists of a board of directors. The board of directors has established a robust goal of a 3.5% reduction in sales through energy efficiency programs [34]. Also in 2007, in a House Joint Resolution 472, the "General Assembly hereby urge[ed] the Tennessee Valley Authority to make large-scale efforts to pursue energy efficient means of producing power and to consider such energy efficient means when addressing the growing demand for electricity in the Tennessee River Valley" [18]. TVA has created DSM programs in response to this initiative for residential, commercial, and industrial users.

Under this program, TVA, in collaboration with KEMA, created its own Technical Resource Manual. The original manual created in 2010 now has its 3rd edition, published in 2015. The following excerpt, from the TRM, describes its purpose and objective [37].

> *The Tennessee Valley Authority (TVA) Technical Resource Manual (referred to as TRM or "manual") documents energy-efficiency program savings and methodologies for specific energy-efficiency measures. The manual supplies unit savings estimates, calculation algorithms, and methods for addressing specific measures. For each measure type, the recommended savings and verification processes are outlined as well as assumptions and resources used to measure and/or calculate the savings impacts. The manual also defines the minimum acceptable documentation for an implementer to provide TVA in order to claim the savings achieved by a local power company.*
>
> *This manual provides a framework for TVA program implementers and program evaluators to document program impacts. Implementers, which include TVA, TVA contractors, and local power companies, are the entity or people that administer a program, review project applications, and process an incentive. Implementers should use this manual to properly document their program savings; the manual is intended to assist implementers to report accurate and consistent savings estimates and to minimize any evaluation risk. Measurement and verification (M&V) evaluators may reference this manual to understand implementer documentation source and methodology. Additionally, evaluators can use this manual as guidance for minimum guidelines for verifying program savings; however, additional effort may be required.*
>
> *This manual provides the methods for customizing or updating the default deemed savings values, as well as providing a framework for custom measure project reviews.*

The M&V framework established by the TRM is consistent with Option A of IPMVP as it is for Arkansas, Texas, and Ameren Missouri. TVA has authority under this process to administer the program, but an independent third party contractor has been engaged to "collect onsite performance data, validate adherence to program guidelines and identify potential process improvement" [34]. Although the TRN has not commissioned a state-wide energy efficiency program for the IOUs, TVA's TRM serves as a framework of which to base the EM&V process.

For evaluations, TVA recognizes three of the five California Standard Practice Manual metrics as described in the TVA Potential Study, issued in 2011. These metrics include TRC, RIM and UCT [34]. The

framework for cost-effectiveness highlights the TRC cost as the primary evaluation metric in stating, “the Total Resource Cost (TRC) test was applied to assess the benefits and costs associated with the [demand response] programs" [13]. Although, TVA is not legally required to abide by these standards, the board of directors treats this program as such.

Louisiana

The governing body for Louisiana IOUs is the Louisiana Public Service Commission (PSC). Currently, most of Louisiana IOUs do not offer energy efficiency programs to customers, as it has not been mandated by LPSC. In a study conducted by ACEEE from a report titled *Louisiana's 2030 Energy Efficiency Roadmap*, the case proved that "Louisiana has large, untapped potential for cost-effective energy efficiency that can save consumers billions in lower energy bills ... [but] sustained leadership and effective implementation will be critical measures of success in tapping into the state's energy efficiency potential" [17].

The LPSC has been attempting to construct a DSM program since 2009, where one was finally approved in 2012, but only to be struck down by the commission in 2013 while under new leadership [30]. The framework is still under review, but in 2014, utilities filed proposals for "quick-start" energy efficiency programs [30]. The rules under consideration would lay the framework for such a quick-start program for the electric and natural gas IOUs. Therefore, there is no EM&V protocol established by the LPSC. The investor owned utilities in Louisiana include:

Electric	Natural Gas
SWEPCO	Atmos Energy
Entergy New Orleans	CenterPoint Energy Resources Corp.
CLECO	Entergy Gulf States Louisiana, L.L.C.
Entergy Louisiana	Evangeline Gas Company, Inc.
Entergy Gulf States Louisiana	JPC Energy, LLC
	Livingston Gas & Utility Company
	Magnolia Natural Gas, LLC
	Pierre Part Natural Gas Company, Inc.
	South Coast Gas Company, Inc.
	St. Amant Gas Company
	The Nezpique Gas System, Inc.

Table 8. Louisiana Investor-Owned Utilities

However, Entergy New Orleans (ENO) is the sole IOU offering an energy efficiency program. Entergy New Orleans offers an Energy Smart program that was established by the New Orleans City Council. The program offers incentives for audits and upgrades for residential, commercial, and industrial customers

[11]. ENO contracts CLEAResult to implement the energy efficiency measures. As CLEAResult has much experience in EM&V throughout the nation, they make use of typical EM&V measures as seen in the Texas and Arkansas Technical Reference Manuals. No M&V information is available by public resources. IFC International issued a report on Achievable Demand Side Potential Study for Entergy New Orleans. The study includes the impact a DSM program would have on Entergy NO, but does not specify the EM&V framework [39].

Mississippi

The Mississippi Public Service Commission governs the state's IOUs. In 2013, the commission passed a rule outlying the framework for IOUs to implement energy efficient programs. The program identified is the "Quick Start" energy efficiency program for electric and natural gas IOUs which defines the program criteria including benefit tests, cost recovery, and EM&V [31]. The utilities under the governance of this program include:

Electric	Natural Gas
Entergy Mississippi, Inc.	Atmos Energy Corporation
Mississippi Power Company	CenterPoint Energy
	Willmut Gas & Oil Company
	Mississippi Natural, Inc.
	Southeast Utilities, LLC
	Burnsville/Counce Gas Corporation, Inc.
	Mississippi Gas Corporation
	Mississippi River Gas, LLC

Table 9. Mississippi Investor-Owned Utilities

The Mississippi PSC passed Rule 29 in 2013, amended to the Public Utilities Rules of Practice and Procedure as the Quick Start program. Under Rule 29, the program is intended to "encourage the early implementation of energy efficiency programs and to provide experience on which Mississippi's service providers and the Commission can build Comprehensive Portfolios — long-term energy efficiency programs" [25]. The EM&V program is to be included in the Quick Start Plan. The following excerpt from Chapter 29 outlines the basis for EM&V [25]:

> *The identification of the specific EM&V procedures that will be implemented to determine whether the program has achieved its stated objectives. The EM&V plan should appropriately balance the need to assess and improve program performance with EM&V costs. EM&V approaches should be guided by Best Practices. Portfolio EM&V cost targets should be no more than five percent of total portfolio costs although EM&V costs for some individual programs may be higher;*

Although specific M&V plans have not been established by the state, utilities are to contract third party contractors to implement the M&V procedures, but there are plans to further develop a state wide

practice for M&V plans as the state develops its EERS [31]. The Best Practices referenced in the EM&V outline are "identified by the National Action Plan for Energy Efficiency (NAPEE), by similar national organizations, and by utilities with significant long-term energy efficiency experience" [25].

It is also important to point out that Tennessee Valley Authority operates in Mississippi, but not as an investor owned IOU. TVA operates its own comprehensive energy efficiency program that is further detailed in the *Tennessee* section. TVA conducts its M&V framework under a TRM that is unique to the company.

Mississippi PSC recognizes all five of the cost-effectiveness metrics defined in the California Standard Practice Manual as described in Rule 29. The measures included are: TRC (and SCT), UCT, PCS, and RIM. Although these measures are recognized as the standard practices, Rule 29 states, “Quick Start programs are exempt from the requirement to provide cost-effectiveness showings under the cost-benefit tests of Section 105" [25]. Therefore, under the Quick Start program, such cost-effectiveness measures are not necessary.

Summary & Conclusion

Each state has a unique approach to demand side management programs. As some states provide comprehensive energy efficiency programs to customers, others are entering the developmental stages of implementing these programs. Texas and Arkansas represent states with mature programs, as Tennessee would also be considered due to TVA's energy efficiency programs. Louisiana and Mississippi are two states that have much potential in growing such programs, with progress currently being made. Oklahoma and Missouri have DSM programs in place, but more collaboration can be made to better its offerings. The following table summarizes the results of this study. The M&V column describes the M&V of each state where TRM represents technical reference manual, IND represents an individual utility offering a TRM, and N/A indicates the state does not specify a specific M&V procedure. The remaining columns are the California Standard Practice Manual, where the check boxes represent which metrics are recognized by the states (red check indicates it as the primary metric).

States	M&V	TRC	UCT	PCT	RIM	SCT
AR	TRM	☑	☑	☑	☑	
TX	TRM		☑			
OK	N/A	☑	☑	☑	☑	☑
MO	IND	☑	☑	☑	☑	☑
TN	IND	☑	☑		☑	
LA	N/A					
MS	N/A	☑	☑	☑	☑	☑

Table 10. EM&V Summary Chart

The M&V process of each state is also unique. Arkansas and Texas both offer a statewide Technical Reference Manual that companies use to base the M&V process. These manuals provide specific measures and practices to utilize for specific projects, which add clarity to the standards set by IPMVP and ISO 50015. The TRMs strongly rely on IPMVP Option A, which does not necessarily reflect that of all cases. Largely, independent contractors are hired to conduct the M&V proceedings, and will perform the process in compliance with the TRM but also from experience. The technical reference manuals provide a strong basis for the utility providers to offer savings programs.

Tennessee and Missouri are unique in that there is not a statewide TRM, but for each state, a utility provider has developed its own TRM to be used with its energy efficiency program. This represents a great opportunity for the states to adapt the manuals for statewide use. Missouri IOUs have expressed interest in the collaboration of developing a standard TRM, which could be derived from the TRM already created by Ameren Missouri. Tennessee is different in that the utility offering the TRM is a federally-owned entity (TVA). The governing commission for IOUs in Tennessee has not made efforts to initiate a statewide TRM, but a great opportunity exists in making use of the one developed by TVA.

Louisiana, Mississippi, and Oklahoma have no state-approved M&V standards. As each state is in a different stage of developing DSM programs, no standardization has been met. Oklahoma and Mississippi both have created rules and regulation regarding the M&V framework, but leave the specific measures to the utility providers. The process then often derives from desk review or that of third party consulting. EM&V auditors from the commissions audit the programs to ensure consistency with the expectations. Louisiana, on the other hand, has made no effort to create an M&V process, as the state has not approved a DSM program. The only company offering energy efficiency programs is Entergy New Orleans which was initiated by the New Orleans City Council. These states have little progress in standardizing the M&V process, but there is potential to use the framework established by the other states' TRMs.

All states under consideration of this study (besides Louisiana) recognize the evaluation metrics established by the California Standard Practice Manual. Oklahoma and Mississippi deem all five metrics acceptable measures. Arkansas recognizes four of the five (TRC, UCT, PCT, and RIM); TVA recognizes three of the five (TRC, RIM and UCT), and Texas recognizes one of the five metrics (UCT). Arkansas, Oklahoma, Missouri, and Tennessee deem total resource cost (TRC) as the primary metric in project evaluation.

In all, Arkansas has a robust M&V process compared to bordering states. Offering a statewide technical reference manual creates a clear basis for M&V implementers to standardize practices. The TRM paints a clear understanding of the methods of quantifying the savings for energy efficiency projects. Arkansas is on the forefront of recognizing the need for such standardization as it was the first state in the region to adapt the TRM in 2011. Texas followed in suit in 2012. Arkansas has established itself as a model for surrounding states to base their EM&V proceedings.

Acronyms

ACEEE- American Council for Energy Efficiency Economy

AEP-SWEPCO- American Electric Power/ Southwestern Electric Power Company

APSC -Arkansas Public Service Commission

CDD-Cooling Degree Days

CSPM-California Standard Practice Manual

DSM- Demand Side Management

EECRF - Energy Efficiency Cost Recovery Factor

EERS- Efficiency Resource Standard

HDD-Heating Degree Days

IOU- Investor-Owned Utility

IPMVP- International Performance Measurement and Verification Protocol

IRP - Integrated Resource Plan

ISO-International Organization for Standardization

LPSC - Louisiana Public Service Commission

MEEIA - Missouri Energy Efficiency Investment Act

MPSC- Mississippi Public Service Commission

MPSC- Missouri Public Service Commission

NEMVP- North American Energy M&V Protocol

OCC - Oklahoma Corporation Commission

OG&E-Oklahoma Gas and Electric

PCT -Participant

PSC Public Service Commission

PSO - AEP Public Service of Oklahoma

PUCT- Public Utilities Commission of Texas

RIM -Ratepayer Impact Measure

SCT -Social Cost

SFV - Straight-Fixed Variable

TDU- Transmission and Distribution Utility

TEESI -Texas Energy Engineering Services, Inc.

TRA - Tennessee Regulatory Authority

TRC- Total Resource Cost

TRM-Technical Reference Manual

TVA - Tennessee Valley Authority

UCT -Utility/Program Administrator Cost Test

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