7.2.3 System Planning[22]

Ameren Missouri assesses system capacity, efficiency and losses through seasonal distribution system planning studies.

Annual Load Analysis and System Planning Process

Ameren Missouri records summer and winter peak load conditions (power, power factor, phase balance and voltage levels) at bulk and distribution substations. Distribution loads are temperature-corrected to represent 1-in-10 year maximum values using multipliers derived from statistical analyses of historic load data for several types of area load characteristics. Temperature adjustments for bulk substations are derived from historical temperature vs. loading profile curves for each particular bulk substation.

Engineers also calculate bulk substation loads using a power flow computer model that simulates the electric power delivery system. Using temperature-corrected distribution substation loads and current equipment ratings as inputs, the software calculates bulk substation loads. These are compared to temperature-corrected values and used to evaluate what, if any, diversity factors apply at each bulk substation.

After verifying the validity of the system model, engineers conduct seasonal planning studies of winter and summer peak conditions, evaluating worst case single-contingency failure scenarios for all bulk substations, 34,500 V and 69,000 V circuits, distribution substations, and distribution circuits. These studies pinpoint system limitations and enable engineers to identify upgrades required to maintain adequate system capacity. The evaluation of distribution system losses and maintenance of adequate system voltage levels are included in these analyses.

Planning system upgrades to withstand single-contingency outage conditions ensures that load levels will remain within circuit capabilities for such events. Under normal conditions (the majority of the time) individual circuit elements operate at lower load levels with correspondingly lower losses.

An integral part of the entire load analysis process is the establishment of equipment ratings and/or loading limits. Ameren Missouri evaluates transformer and conductor losses as part of the methodology used to establish distribution equipment ratings.

Distribution System Engineering Analyses

The Transformer Load Management (TLM) System relates customers to the distribution transformers serving them, allowing Ameren Missouri to predict transformer peak demand and apparent power from the customers' total monthly energy usages. Ameren Missouri uses this information to analyze distribution circuits and to reduce distribution

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[22] 4 CSR 240-22.045(1)(A)

losses through the more efficient loading of transformers. Additionally, customer meters are automatically read during peak load periods to confirm the transformer peak demands calculated with the TLM system.

EPRI's Distribution Engineering Workstation (DEW) software and Siemens PTI PSS/E software are used to analyze distribution circuits, ensuring reliable, safe, and efficient operation of the distribution system. DEW or PSS/E is used for: load estimation, power flow analysis, protective device coordination, fault current calculation, voltage flicker, phase balancing, and capacitor placement. Both software systems allow engineers to analyze existing, alternate, or proposed configurations for over/under voltages/currents, line losses, appropriate conductor sizing, and optimal capacitor placement.

SCADA (Supervisory Control and Data Acquisition) is used to remotely monitor and control the electric distribution system. Engineers use SCADA data to ensure that system models properly reflect real distribution system conditions, therefore enabling better planning of future system development.

Capital Project Evaluation[23]

Ameren Missouri assesses the feasibility and cost effectiveness of potential system expansion and modernization projects on an ongoing basis. Both conventional and advanced technologies are regularly considered. Due to recent trends in load growth, the majority of approved projects in recent years have focused on system reliability improvement and modernization, as opposed to capacity increase. Potential capital projects are identified by various operating, engineering and planning personnel. All bulk substation, subtransmission feeder and distribution substation projects are reviewed by Distribution System Planning prior to consideration for funding. Distribution feeder and customer service projects are reviewed by Service Division and Distribution Operations staff prior to consideration for funding.

Capital projects are considered to be mandatory if they are required by PSC or government regulations, result from court cases, are necessary to meet minimum obligations to serve, or address imminent public or employee safety concerns. Funding priorities for projects which are not mandatory are based on cost/benefit and risk assessments. Key to this evaluation is a reliability based prioritization metric called the Service Availability Cost Factor (SACF) - a calculated index that facilitates ranking projects on a common cost/benefit basis. In its simplest form, SACF represents the cost per unit risk where risk is measured as customer load in kVA multiplied by hours of outage. By giving preference to projects with the best cost/benefit ratios (lowest SACF

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[23] 4 CSR 240-22.045(4)(C); 4 CSR 240-22.045(4)(D); 4 CSR 240-22.045(4)(D)1; 4 CSR 240-22.045(4)(D)2; 4 CSR 240-22.045(4)(E); 4 CSR 240-22.045(4)(E)1

scores), Ameren Missouri ensures that system capacity and reliability will be enhanced as fully as possible through proper prioritization of capital investments.

Cost/benefit evaluations for three common types of projects are outlined below:

1. Substation Overload
   A single-unit substation serves load that peaks above the unit's normal rating. Considering the shape of the load curve, the unit serves 400,000 kVA-hrs above its rating, on an annual basis. Load served above a unit's rating is considered to be at risk of experiencing rotating service interruptions. The cost of replacing the transformer with a larger unit is estimated to be $1M. The cost/benefit ratio for this project would be $1M / 400,000 kVA-hrs = $2.50 / kVA-hr.

2. Redundant Supply Circuit
   A single-unit substation is loaded to 12 MVA under summer peak conditions. The substation is served by an overhead circuit with an average forced outage rate of 6 hrs/yr. Ameren applies forced outage weighting factors which increase with higher load and/or longer duration. The weighting factor for this example is 2.0. Assuming an outage occurs during summer peak, a weighted total of 144,000 kVA-hrs are considered to be at risk of forced outage, due to the supply circuit. A second 34.5 kV supply can be built from an independent source for a total cost of $1,250,000, thereby reducing outage time to that required for automated switching at the substation. The cost/benefit ratio for this project would be $1,250,000 / 144,000 kVA-hrs = $8.68 / kVA-hr

3. Smart Grid Feeder Automation
   Two independent 12.47 kV feeders serve adjacent areas. Both feeders serve peak loads of 8 MVA (distributed evenly along their lengths), with average forced outage rates of 8 hrs/yr. The forced outage weighting factor for this example is 1.5. Two (normally closed) reclosers can be installed at the mid-points of the feeders and a third (normally open) recloser can be installed as a tie between the ends of the feeders, for a total cost of $225,000. Advanced technology reclosers will be employed and programmed to work as an automatic transfer system, such that a fault in any one section of a feeder can be isolated and service can be automatically restored to the remainder of the feeder. This project will alleviate a weighted total of 96,000 kVA-hrs at risk. The cost/benefit ratio for this project would be $225,000 / 96,000 kVA-hrs = $2.35 / kVA-hr.

7.2.4 Peak Demand Reduction via Voltage Control[24]

For over 20 years, Ameren Missouri has had the ability to reduce demand at selected distribution substations by reducing load tap changer (LTC) voltage setpoints at the time of peak system demand. The actual load reduction achieved in this manner depends upon the magnitude and voltage sensitivity of the affected electrical loads. Peak demand shaving through voltage reduction has been limited to short durations during emergency situations and can sometimes play a role in deferring electrical system capacity enhancement projects.

Estimating demand reduction due to voltage control begins with identifying substations with appropriate LTC equipment. Ameren Missouri has identified 260 substations capable of implementing voltage control. The magnitude of potential demand reduction has been estimated based on substation demand data gathered from July 2008 through June 2009, a test year used to support weather normalization modeling.

It is estimated that 70% of the summer distribution system peak demand, or approximately 5,400 MW, is served by substations with voltage control capability. Although higher levels of voltage reduction are possible, this study assumed voltage reduction would be limited to 2.5%. Based on Ameren Missouri experience, load decreases by approximately 0.84% for every 1% reduction in voltage. Furthermore, experience indicates not all LTC equipment responds when signaled to reduce voltage. It is assumed that 90% of the equipment will respond properly. On this basis, Ameren Missouri can achieve approximately 100MW of demand reduction via voltage control at the time of system peak. However, Ameren Missouri has determined that voltage reduction should not be included in its capacity position since there are no provisions in MISO tariff for a load serving entity to include voltage reduction to modify its coincident peak demand or to register it as a demand response resource.

7.2.5 System Efficiency[25]

Ameren Missouri regularly pursues opportunities to improve distribution system efficiency through ongoing activities and projects, including those listed below:

Periodic System Loss Study

Ameren Missouri evaluates the efficiency of its overall electric delivery system on a periodic basis by performing a comprehensive loss study. Losses in each portion of the system are calculated under peak load conditions using the computer software noted previously. Loss data from these evaluations are used in ongoing system planning activities and as supporting information for Rate Case Filings.

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[24] 4 CSR 240-22.045(1)(A); 4 CSR 240-22.045(1)(D)

[25] 4 CSR 240-22.045(1)(A); 4 CSR 240-22.045(1)(D)

System Upgrade and Expansion Projects

By their nature, many types of energy delivery upgrade and expansion projects improve system efficiency by reducing load current, I^2R losses, or both. Examples of such projects include:

- Constructing new circuits or rebuilding existing circuits that make use of higher operating voltages, as in the conversion of power lines from 4 kV to 12 kV or the migration toward 138kV-fed distribution substations
- Constructing new circuits or rebuilding existing circuits with larger conductors
- Reconnecting single phase loads on three phase circuits to achieve balanced system phase currents
- Upgrading existing substations or strategically placing new substations to serve areas with increasing load density; and
- Reconfiguring distribution feeders as appropriate when connecting new customers

Reactive Power (VAR) Optimization

Customer loads consume real power (measured in watts), however AC power systems also require reactive power (measured in volt-amperes-reactive, or VARs) to deliver energy. Delivering VARs consumes distribution circuit capacity and can create undesirable levels of voltage drop. Ameren Missouri installs capacitor banks to maintain overall power factor near unity, thereby releasing as much system capacity as practical. Maintaining a power factor near unity reduces the current flows through the system that are necessary to satisfy its real power requirements. This in turn lowers line losses (I^2R losses) and reduces conductor heating, ultimately helping to prolong equipment life.

Because the amount of reactive power that customers need varies with load, a controlled but variable source of VARs enables optimal system performance. Ameren Missouri employs automatic and remotely controlled capacitor banks to stabilize system voltage as loads are cycled on and off. As recommended in the 2009 Ameren Missouri End-to-End Efficiency Study, performed with assistance from EPRI, Ameren Missouri has increased its focus on optimizing reactive power flow within the distribution system. To replace obsolete equipment and improve capacitor bank control capabilities, the company has budgeted to install a fleet of 2300 new capacitor bank controllers. This change-out will be completed in phases, with removed controllers providing spare parts for remaining obsolete equipment. Installation of new controllers began in 2011 and approximately 700 were installed by the end of 2013. The remaining units are scheduled for installation over the next 5–10 years. These new controls replace aging equipment and improve system performance, power factor and distribution system efficiency.

Volt/VAR Optimization Supporting Conservation Voltage Reduction

As discussed in Section 7.2.4, demand can be reduced by lowering the distribution system voltage level; however, the shape of the load duration curve may be elongated. Customer equipment, such as motors, transformers and lighting ballasts, play a significant role in this issue, due to the energy consumed by their magnetic cores. Magnetic core losses are typically reduced by lowering the utilization voltage, but it may take longer to complete a customer load process because the rate of energy transfer is reduced. Even so, it is typically possible to reduce energy consumption and related fuel utilization if voltage is held at a reduced level for the long-term. Long-term voltage reduction cannot be achieved by simply reducing LTC setpoints, since voltage regulation in distribution circuits will often result in low supply voltage at some customer locations. To reduce energy consumption without exceeding allowable voltage limits, feeder voltage profiles must typically be flattened before they are lowered. These issues are addressed by the electric utility industry under the topics of Volt/VAR Optimization (V/VO) and Conservation Voltage Reduction (CVR).

As noted in the 2009 Ameren Missouri End-to-End Efficiency Study conducted by EPRI, the results of industry Conservation Voltage Reduction studies indicate that for every 1% reduction in delivered utility voltage, customer energy consumption may drop as much as 0.6 - 1.0%. Recognizing that CVR should be limited by what can be tolerated operationally by customers and by the minimum acceptable voltage level allowed by Missouri PSC standards, Ameren Missouri is interested in evaluating CVR as an energy and demand conservation measure on its distribution system.

Ameren Missouri has initiated a Voltage Control Pilot Project (VCPP) to evaluate V/VO operational effectiveness and evaluate CVR on selected distribution power lines. Most circuits to be studied are part of a distribution automation project in St. Louis County; others are located in a more rural setting northwest of the metropolitan area. VCPP design and construction were completed during 2011. Communication and control systems associated with the new equipment have been implemented in conjunction with a new Advanced Distribution Management System (ADMS). Distributed control programming and V/VO & CVR operational testing are expected to be completed during 2014-2015. The objective of this pilot project is to evaluate potential distribution energy savings, and the costs to achieve them, associated with employing VCPP and CVR on typical Ameren Missouri distribution circuits.

Loss-Evaluated Distribution Transformer Purchasing

Ameren Corporation currently purchases transformers based on Total Cost of Ownership (TCO), including acquisition cost plus the evaluated cost of no-load and load losses, capitalized over a 30-year life. By purchasing high-efficiency distribution transformers that meet the US Department of Energy efficiency requirements, Ameren will gradually reduce total circuit losses in a cost-effective manner. Ameren Missouri conservatively projects an annual demand savings of 0.11 MW and an annual energy savings of 817 MWh's from replacing ~8,500 transformers, yearly.

Ameren evaluates the option to purchase high-efficiency, amorphous core transformers as they become available in volumes required. Although amorphous core transformers presently carry an additional purchase premium, the corresponding reduction of no-load losses can lead to a favorable TCO and an improvement in system efficiency to the long-term advantage of rate payers.

7.2.6 Distributed Generation

Ameren Missouri does have an interest in distributed generation (DG) as a means of deferring distribution system expansion projects. One example is the Ameren owned and operated Maryland Heights Energy Center, a landfill gas project in St. Louis County. This project includes 3 x 5 MW combustion turbine-generator sets, operating on landfill gas. The project feeds into the local 34.5 kV distribution system and is capable of producing maximum output of 15 MW.

Potential projects are analyzed on a case-by-case basis; however, the scope of candidates tends to be small. At this time, Ameren Missouri is evaluating the potential installation of photovoltaic generating capacity at a number of locations. Factors that influence the evaluation of potential DG installations include noise and/or emissions ordinances, operational complexities associated with fuel availability, equipment maintenance, and the fact that traditional system expansion projects usually provide secondary benefits like improving reliability which offset the benefits of installing DG.

Ameren generally cannot dispatch customer-owned DG, so this type of resource is not included when performing load analysis and system improvement evaluations. Chapter 8 explores distributed generation as a demand-side resource.

7.2.7 Advanced Distribution System Technologies[26]

Ameren Missouri has adopted a Smart Grid Strategy to transform our electric grid to create a secure, reliable and more efficient infrastructure enabling customers' use of "energy smart" technologies. The company intends to implement plans that are consistent with a corporate goal of serving 75% of appropriate Ameren customers with a multi-layered penetration of smart technologies.

There have been many technological, operational and societal benefits identified in association with the US Department of Energy's vision for the Smart Grid. Ameren

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[26] 4 CSR 240-22.045(1)(A); 4 CSR 240-22.045(1)(D); 4 CSR 240-22.070(1)(B)

Missouri's Smart Grid vision focuses on the continued pursuit of service reliability, operating efficiency and asset optimization, and on building a secure, robust energy delivery infrastructure as a means of enabling other Smart Grid elements. Among these elements are emerging technologies owned and operated by customers who are motivated by the prospect of becoming more active participants in energy-related decisions.

Ameren Missouri views the Smart Grid as the infusion of technology – communications technology, automation technology, and end-device intelligence – into the otherwise passive system of poles, wires, cables, transformers, switches and meters comprising the electric infrastructure. From a practical standpoint, capabilities like communicating with end devices, controlling them remotely, configuring them to operate automatically, receiving reports back on what they did, and the central control and back office systems necessary to integrate and support these functions, all represent features of an intelligent grid.

Ameren Missouri considers the Smart Grid to be more of a direction than a destination. Given the digital nature of the technology being referenced by the term and the frequency with which it turns over relative to the more robust hardware it attempts to automate, the Smart Grid will never represent a discrete state of existence that, once arrived at, signals the end of the effort. Simply put – in the same way that few people will ever have their "last" cell phone or their "last" personal computer, the electric grid will likely never achieve what can be considered a "final state" of automation or intelligence.

Ameren Missouri's current activities in electric infrastructure technology are driven by deliberate and intended benefits associated with its adoption of the Smart Grid. These intended outcomes are summarized below:

Reliability Improvement – Deploy smart technologies across the energy delivery infrastructure in order to improve electric service reliability for Missouri customers.

Efficiency, Optimization and Integration – Improve the operating efficiency and asset optimization of the energy delivery infrastructure and further integrate Ameren's existing Smart Grid applications, allowing for the flexibility, scalability, and extensibility of these and future applications.

Customer Enablement and Use of Technology – Provide the necessary resources to both prepare the electric grid for emerging customer technologies and enable motivated electric customers in Missouri to make use of those technologies and become more active participants in energy decisions.

Ameren Missouri sees its communication role as one of leading its employees, customers, regulators, and other stakeholders to a greater understanding of Smart Grid concepts, applications, and potential benefits, as well as Ameren Missouri's specific plans for the future. Internally, Ameren Missouri fosters an environment of continuous learning for leaders and subject matter experts around Smart Grid topics through its participation in pilot installations and research projects, its participation with other utilities and industry groups on the development of Smart Grid concepts and standards, and the engagement of external consultants and industry experts. Additionally, there will be opportunities to partner with property developers and large customers in active demonstrations that showcase Ameren Missouri's Smart Grid applications.

7.2.8 Ameren Missouri's Smart Grid Plan[27]

Various aspects of Ameren Missouri's Smart Grid Plan are discussed below, but enabling all is the availability of enhanced digital control and communication capabilities. The basic function of power delivery systems is not changing; we still need generators, transformers, overhead and underground circuits, switches, circuit breakers, fuses, etc. New is the ability to better sense system conditions, evaluate the health of system equipment, and employ either local or remote control schemes via high-speed 2-way digital communications technology. Advanced equipment, offering this type of control and communication capability, is replacing older types of less advanced equipment. Some replacements are programmatic on a set schedule, while others are implemented as equipment is replaced due to age or failure. Several types of conventional equipment and their advanced technology replacements are outlined below. This list is representative of present options, but certainly does not include every advanced technology item available today or in the future.

Conventional Equipment	Advanced Technology Equipment
Solid Blade Manual Switch	Remote Control Switch with SCADA communication and current/voltage monitors or Electronic Recloser
Oil Type Recloser	Electronic Recloser with SCADA communication and current/voltage monitors and fault location capability
Faulted Circuit Indicator	Faulted Circuit Indicator with SCADA communication
Capacitor Control (Time / Temp / 1-way comm.)	Local/Remote Capacitor Control with 2-way comm. and current, voltage, kVA and status monitors
Underground Manual Switch	Padmount Switch with SCADA communication and current/voltage monitors and fault location capability

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[27] 4 CSR 240-22.045(1)(D); 4 CSR 240-22.045(4)(B); 4 CSR 240-22.045(4)(E)1

Network Protector	Advanced Network Protectors with SCADA comm. and current/voltage/load and equipment condition monitoring capability
Electromechanical Relays	Microprocessor Based Relays with SCADA comm. and current/voltage/load/fault impedance/equipment condition monitoring/etc. capability
Transformer Bushing Tests	Online Bushing Power Factor Monitoring
Transformer Oil Tests	Online Transformer Oil Monitoring
Circuit Breaker Timing Tests	Online Breaker Timing and Contact Wear Monitoring

Automated Switching Applications

Ameren Missouri's design strategy for the (34.5 & 69 kV) subtransmission system includes providing redundant service to distribution substations with load in excess of 10 MVA. Substations with loads below 10 MVA typically employ radial configurations with single supplies. When load exceeds 10 MVA, a second supply with automatic high-side transfer equipment is typically installed. As load approaches 15 MVA, a second (larger) substation transformer and automatic low side transfer capability usually is added. As load approaches 20 MVA, the first transformer is normally replaced with a unit equal in rating to the second transformer and the transfer scheme is upgraded to an automatic high/low selective scheme. In densely populated areas, redundant subtransmission circuits are typically available at each substation; but, redundant circuits are not always available at all substations in less populated areas. In such locations, redundant subtransmission supplies are typically provided via automated switching devices in nearby circuits and a radial supply circuit is extended to the substation in question. Ameren focuses on minimizing the length and exposure associated with such radial supply circuits until further development achieves full redundancy at the substation.

Whether a line switch or part of a substation, Ameren Missouri employs modern, SCADA-controlled, automatic smart switching devices in order to limit the time and effort required to execute switching actions. Substation transfer schemes are always designed for automatic operation, while line switches may be designed for automatic or remote control operation, depending upon the circumstances involved. Conventional manual switches are only employed in less critical locations, where they are not involved in automated service restoration. In recent years, several existing manual switches have been upgraded to remote control capability or replaced by new SCADA-controlled equipment. Up to 200 automated line switches could be required in addition to the 220 already in service to fully deploy on this strategy over the next 10-15 years.

Ameren Missouri's strategy for automating 12kV distribution circuits is to install SCADA-equipped smart switching devices (at least one bisecting the feeder backbone and at least one tying the downstream section to a different feeder) to limit the load dropped due to a single line contingency to roughly half the feeder's peak load. Although this is a general design objective, it can only be implemented in those cases where the existing circuit topology supports the restoration of unfaulted line sections to a different feeder. Up to 1,600 automated switches could be required in addition to the 160 already in service to fully deploy on this strategy over the next 20-25 years.

Ameren Missouri plans to deploy 12kV smart switching strategies annually by circuit, substation, or group of adjacent substations as appropriate, according to the greatest combined customer density and potential reliability improvement for the cost. Substation and circuit candidates for switching solutions are identified through the standard annual contingency analysis studies conducted, as well as through periodic reliability reports of worst-performing feeders, worst performing high customer-density substations, etc.

Funding for automated switching applications is approved for specific projects and programmatic efforts on an annual basis. Although such investments are very important, they are not considered to be mandatory and do compete with other non-mandatory projects for capital funding. As noted in section 7.2.3, capital funding for non-mandatory electric distribution projects is allocated based on cost/benefit and risk assessments for each competing project. This approach provides the greatest benefit to customers for the available capital funding in each budget year.

Smart Substation Technologies

For many years Ameren Missouri has been building substations that are considered "smart" by today's standards. As a means of ushering in the next generation of substation intelligence in the industry, Ameren Missouri has adopted Smart Substation Design Guidelines to incorporate combinations of the following features into the standard design of capital projects:

- transformer bushing power factor monitoring
- water and dissolved gas content monitoring
- fault detection and location monitoring
- switchgear circuit breaker timing and contact wear monitoring
- circuit breaker trip coil failure monitoring
- multi-function temperature sensing

These projects include the construction or re-build of entire substations as well as the installation or replacement of substation transformers. Additionally, mobile substation transformer and switchgear purchases going forward will feature a combination of these types of sensors.

Industry data indicates that over the long term, the capture and trending of substation transformer diagnostic sensor data can reduce substation outage events due to unforeseen transformer failures and extend the average operating lives of these large assets. The premium for the sensing technology involved is less than 5% over all construction scenarios. Ameren Missouri plans to install this sensor technology on substation transformers over time as an integral part of its capital substation projects going forward, including those undertaken for reasons of load growth, reliability upgrade, or condition-based maintenance.

Multi-Layered Network Architecture

Currently several isolated and overlapping networks are operating today in support of AMR meters, radio-controlled line capacitors, substation SCADA and automated switching, none of which is sufficient for the long-term expansion and widespread use of intelligent end devices. It's anticipated that more capacity will be required for ultimate end device populations in the tens of thousands, and more speed could be required to support large file transfers from remote diagnostic sensors in substations.

In response to this Ameren Missouri has developed and is deploying a multi-layered network architecture intended to support existing smart applications and enable future applications – a Wide Area Network (WAN) backbone for backhauling large amounts of field application data, Local Area Networks (LANs) for aggregating intelligent end device data (typically at substation locations), and Field Area Networks (FANs) for supporting communication with field end-devices beyond and downstream from the substation.

Ameren Missouri is developing a WAN that leverages various industry-proven transport systems such as fiber, digital microwave, and common carrier leased services, and likely features a mix of private and non-shared public infrastructure of either a wired or wireless nature. WAN infrastructure additions over time will focus on the connection of substations and other key network entry points, the delivery of information to the control center(s), and the application of necessary security layers throughout the network architecture.

Ameren Missouri is deploying LAN technology over time at substations as their specific locations are identified as effective aggregation points for planned feeder deployments of intelligent end devices like automated line switches, capacitors and regulators. Since these devices are being deployed on the distribution system by circuit or substation, the already owned or leased substation site becomes the preferred choice for this aggregation. Targeting these deployments at "smart" substation sites also allows for communications consolidation and maximizing the impact of the LAN infrastructure investment.

In some areas of the Ameren Missouri service territory the FAN will feature a radio frequency (RF) mesh network that is both self-organizing and self-optimizing, dynamically routing data communications amongst a diverse set of paths that wirelessly interconnect multiple end devices. In other areas, the FAN will feature a more traditional point-to-multipoint RF network or a cellular-based alternative, depending on the application and its inherent reliability and latency requirements. Ameren Missouri plans to adopt the use of intelligent end devices with open architectures as endorsed by National Institute of Science and Technology (NIST) standards, regardless of the smart applications involved and the other technology choices made.

Advanced Distribution Management System (ADMS)

Ameren Missouri is implementing an Advanced Distribution Management System (ADMS) as a means of providing an integrated suite of software applications with which to manage the electric distribution system. It is a highly integrated system of applications that provides distribution system operators a common user interface with which to monitor and control the distribution system on a daily basis. It not only replaces existing applications like outage management, switching orders, and Supervisory Control and Data Acquisition (SCADA), it features new applications such as dynamic circuit modeling, switching and restoration simulations, and a distribution system dashboard.

ADMS is foundational to future Ameren Missouri Smart Grid planning since it enables advanced applications that rely on the integration of functions formerly separate and distinct. In addition, ADMS allows for growth and scalability that is not feasible on the current platforms in use and provides the flexibility to add and integrate future applications. Current Ameren Missouri plans call for the ADMS platform to be implemented by the end of 2014.

Supervisory Control and Data Acquisition (SCADA)

Ameren Missouri's strategy for substation supervisory control and data acquisition is to programmatically introduce remote load monitoring at existing substations lacking such capability, for purposes of improving daily operations and facilitating the long-term planning of substation assets. Remote outage detection and supervisory control features will be introduced at existing substations lacking such capability on an opportunistic basis in association with other capital projects.

Ameren Missouri's 30+ years of experience in this area has shown that continuously updated load information on substation components can defer or eliminate previously justified capital projects, quickly identifies unforeseen overloads, releases capacity by allowing for daily operation closer to margin, and greatly enhances outage restoration activities. Remote metering also enables automatic transfer capability in smart switching applications and enables feeder level optimization via phase balancing and the operation of line capacitors. Supervisory control of switching devices further enhances operations by allowing for real-time outage notification and immediate intervention by dispatchers in restoration scenarios.

Of Ameren Missouri's 660 distribution substations, there are approximately 190 without remote metering capability. Ameren Missouri's plan is to upgrade a prescribed number of these substations annually on a programmed basis according to the preferences of operating and circuit planning entities, and align these upgrades as appropriate with smart switching and smart capacitor deployments that are planned on associated feeders.

There are approximately 250 Ameren Missouri distribution substations without outage detection and supervisory control capability. Ameren Missouri's plan is to convert these substations opportunistically over time as other capital projects are undertaken to replace their switching devices. Ameren is also funding the programmatic addition of metering and SCADA capabilities at some of these substations, which are not scheduled for other upgrade projects in the foreseeable future.

Capacitor Control and Volt-VAR Optimization

Smart line capacitor operation has helped Ameren Missouri maintain a consistent 98% distribution system power factor over the last twenty years. However, the capacitor control technology available today allows for feeder level efficiencies and degrees of optimization that were never before possible. The use of Volt-VAR Optimization as an advanced distribution system application not only helps achieve these levels of efficiency and optimization, but also more effectively controls customer end-use voltages, and more reliably supports the reactive requirements of the transmission system. Ameren Missouri's intent is to leverage new ADMS system capabilities to integrate substation load monitoring with "smart" line capacitor operation for the first time in order to achieve these goals.

Ameren Missouri's first step as part of this automation strategy is the deployment of the next generation of "smart capacitor" technology on the distribution and subtransmission systems. Ameren Missouri will leverage the need to replace the existing 25-year old line capacitor control system in operation today in the St. Louis metro area for this deployment. To this end, 2,300 capacitor controls will be upgraded over the next 5–10 years due to the unavailability of legacy controls and the fact that no other hardware replacements are necessary as part of these upgrades.

Additionally, Ameren Missouri will be installing "smart" capacitors in place of the remaining 1,100 non-fixed units in the service territory. This deployment will take place over time by circuit, substation, or group of adjacent substations, coincident with the deployment of automated switches in order to maximize the benefits associated with the communications investment.

After ADMS is implemented, Ameren Missouri will begin controlled experimentation with Conservation Voltage Reduction (CVR) as a means to enhance energy conservation and demand reduction. This will take place on a substation (or substation unit) basis as its distribution feeders are outfitted with "smart" capacitors and as degrees of voltage flattening and power factor optimization are confirmed. As Ameren Missouri validates the CVR application over time, consideration will be given to expanding it over wider areas of the service territory and over different times of day and seasons of the year. As this application is enabled with the ADMS platform and matures, more programmatic approaches can be adopted.

AMR (Automated Meter Reading) vs. AMI (Advanced Meter Infrastructure)

Ameren Missouri currently reads 1.2 million electric and 130 thousand gas meters with a one way AMR RF system. The system delivers daily meter information (daily usage. meter flags and outage detection). It is also capable of delivering demand, TOU and interval information for a small proportion of the meters. The system was installed between 1995 and 2000. The AMR modules in the meters are projected to have a 15-20 year life. In addition parts and components of the RF network equipment are becoming difficult and expensive to obtain due to the age of the equipment. Due to these issues Ameren Missouri is currently developing an AMI Business Plan to replace the AMR system in Missouri.

The plan will determine the time frame, functionality and the capital/O&M costs of the replacement system. The plan will evaluate the benefits to Ameren Missouri customers of such things as demand response, dynamic pricing, remote disconnect/reconnect, customer prepay and other benefits that would improve customer choice and would be enabled if a modern AMI system replaced the existing Ameren Missouri AMR system. The plan will quantify the benefits of improvements in field work efficiency and customer outage duration through improved detection of meter problems, improved theft detection, improved outage detection and improved customer voltage information that would be obtained through using a modern AMI system using current communication technology.

Emerging Customer Technologies

Ameren Missouri continually follows the advancements and industry trends associated with emerging customer-owned products and technologies, especially as they influence the planning around their eventual penetration on Ameren's distribution system – these include electric vehicles, small-scale distributed generation and energy storage, smart appliances and Home Area Networks.

Ameren Missouri has taken a particular interest in the emergence of electric vehicles and is currently investigating opportunities for contributing to the region's overall preparedness. Ameren Missouri is studying the potential penetration of electric vehicles in the service territory and the resultant impact of vehicle charging on the distribution system. We are identifying the various business models possible in association with electric vehicles, including the utility interface, ownership of charging stations, and possible rate structures associated with charging of these vehicles at home, at work, and in public places.

Ameren Missouri is also participating as a corporate member of the St. Louis Regional Clean Cities Plug-In Readiness Task Force as a means of following the initial discussions around being plug-in ready and identifying possible community partnering opportunities for technology promotion. Internally, Ameren Missouri has taken delivery of six PHEV bucket trucks (associated with an EPRI Demonstration Project) and five PHEV sedan model vehicles. These activities are being pursued as a means of self-education and preparation for the energy advisor role Ameren Missouri is expecting to assume in this area with inquiring customers. Ameren Missouri proactively installed charging stations at its corporate headquarters and several operating centers to support its growing electric fleet and early-adopting employees.

7.2.9 Advanced Technology Investment Strategy[28]

As discussed in Section 7.2.3, Ameren Missouri assesses the feasibility and cost effectiveness of potential system expansion and modernization capital projects on an ongoing basis. Both conventional and advanced technologies are regularly considered, with advanced technologies applied where they offer significant reliability or operational advantages. Conventional technologies are applied where there is no appreciable advantage offered by employing more expensive advanced technology. Most projects include a mix of conventional and advanced technology equipment.

Ameren Missouri updates its 5-year capital budget plan on an annual basis. Individual capital projects are submitted for consideration and are approved or deferred, based on cost/benefit and critical risk assessments. Through this annual budget development process, Ameren ensures that system capacity and reliability will be enhanced as fully and cost effectively as possible through proper prioritization of capital investments.

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[28] 4 CSR 240-22.045(4)(B); 4 CSR 240-22.045(4)(C); 4 CSR 240-22.045(4)(D)

In addition to individual capital projects, Ameren Missouri implements several types of advanced technology equipment on programmatic bases. Specific examples are discussed below:

- **Substation Equipment Monitors** - Ameren Missouri has adopted Smart Substation Design Guidelines to incorporate transformer bushing power factor monitors, water & dissolved gas content monitors, fault detection & location monitors, switchgear circuit breaker timing & contact wear monitors, circuit breaker trip coil failure monitors and multi-function temperature sensing monitors into the standard design of substation capital projects. Of Ameren Missouri's 600 distribution substations, approximately 190 are without remote metering capability. Approximately 250 distribution substations are without outage detection and supervisory control capability. Ameren Missouri plans to upgrade these facilities opportunistically over time as substation capital projects are undertaken. This is an on-going investment strategy whose costs are incorporated into individual capital projects.

- **Reduced Loss Transformers** - Ameren Missouri purchases substation and distribution line transformers on a Total Cost of Ownership basis, optimizing the combined purchase + evaluated loss cost. By purchasing high-efficiency distribution line transformers that meet the US Department of Energy efficiency requirements, Ameren will gradually reduce total circuit losses in a cost-effective manner. Ameren Missouri conservatively projects an annual demand savings of 0.11 MW and an annual energy savings of 817 MWh's from replacing approximately 8500 distribution line transformers yearly. Replacement of distribution line transformers is an on-going investment strategy which is budgeted annually, based on anticipated transformer usage.

- **Faulted Circuit Indicators (FCI)** – Ameren Missouri installs conventional FCI equipment at key locations in distribution circuits to reduce customer interruption durations by assisting in the identification of fault locations. Self-powered, SCADA-equipped FCI modules are installed at key locations in subtransmission circuits to provide similar benefits on a larger scale. Ameren plans to install between 100 and 150 sets of smart FCI's per year over the next 5–10 years. Specific locations are identified on an annual basis to address distribution system operational concerns. This is an on-going investment strategy which is budgeted annually, based on business needs and priorities.

- **Automated Subtransmission Switching Equipment** – Ameren Missouri employs SCADA-equipped smart switching devices at substations and key locations on subtransmission circuits to reduce the time and effort required to execute switching actions. Approximately 220 smart switches are presently in-service and another 200 are expected to be installed over the next 10-15 years. Specific locations are identified on an annual basis to address distribution system operational concerns. This is an on-going investment strategy which is budgeted annually, based on business needs and priorities.

- **Automated Distribution Switching Equipment** – Ameren Missouri employs SCADA-equipped smart switching devices to sectionalize 12kV distribution feeders and tie unfaulted sections to neighboring feeders to facilitate emergency outage recovery. Approximately 160 switching devices have been installed to date and another 1600 devices are expected to be installed over the next 20-25 years. Specific locations are identified on an annual basis to address distribution system operational concerns. This is an on-going investment strategy which is budgeted annually, based on business needs and priorities.
- **Capacitor Control Equipment** - Ameren Missouri has begun to deploy a new "smart capacitor" control scheme on its distribution and subtransmission systems. This upgrade is driven by the obsolescence of existing control equipment, but will enable the company to maintain a consistent 98% power factor while facilitating feeder level control optimization that was never before possible. To this end, 2300 voltage or load controlled capacitors will be upgraded over the next 5–10 years and an additional 1100 seasonally switched banks will be upgraded beyond that date. Specific capacitor bank upgrades are scheduled on an annual basis to replace failed equipment and address distribution system operational concerns. This is an on-going investment strategy which is budgeted annually, based on business needs and priorities.

7.3 Compliance References

8. Demand-Side Resources

Highlights

- *Ameren Missouri completed its most comprehensive Demand Side Management (DSM) Potential Study and Market Assessment in 2013. Key components were:*
    - *Energy efficiency potential for the planning period 2016-2034*
    - *Demand response potential*
    - *Distributed generation potential*
    - *Combined heat and power potential*
    - *Demand-side rate potential*
- *Although Demand Response (DR) programs are not cost effective for 2016-2018, Ameren Missouri is considering an innovative pilot DR program to better understand the tolerance customers have for various frequencies and durations of DR events.*
- *Ameren Missouri plans to spend $148 million from 2016-2018 to achieve 426 GWH of energy savings and 114 MW of peak demand savings*

Ameren Missouri continues to build on its DSM planning, implementation and evaluation performance leadership from MEEIA Cycle 2013 - 2015. Examples of performance leadership include:

- The addition of formal project management processes and procedures
- The addition of a state-of-the art DSM data collection and tracking system
- The addition of a Marketing Manager
- The development of market segmentation strategies to tailor specific DSM messages to specific market segments[1]
- The addition of a state-of-the art web-based Technical Reference Manual
- The execution of national best practice EM&V processes and procedures

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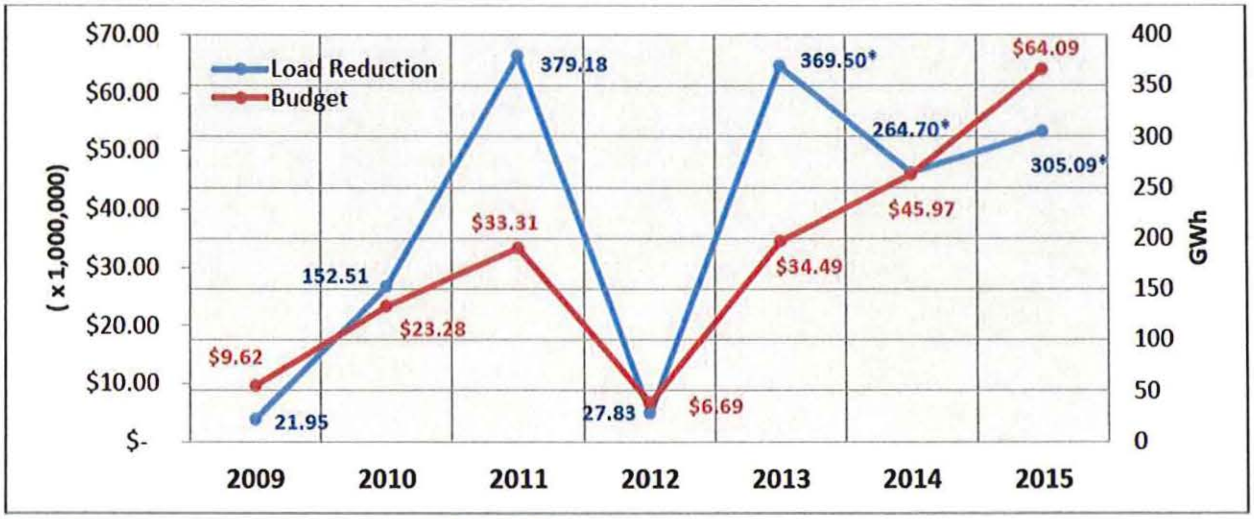
[1] 4 CSR 240-22.050(1)(A)1 through 3; 4 CSR 240-22.050(3)(B) The market segmentation is discussed further on page 2-4 thru 2-7 in Volume 3 of the Potential Study

8.1 Implementation Plan Summary

8.1.1 Introduction

Since the inception of its large scale DSM programs beginning in 2009, Ameren Missouri has achieved impressive improvements in energy efficiency. Figure 8.1 charts the changes in annual load reductions and associated energy efficiency budgets from 2009 through 2013 and projected for 2014 and 2015.

Figure 8.1: Ameren Missouri DSM Annual Load Reductions and Budgets

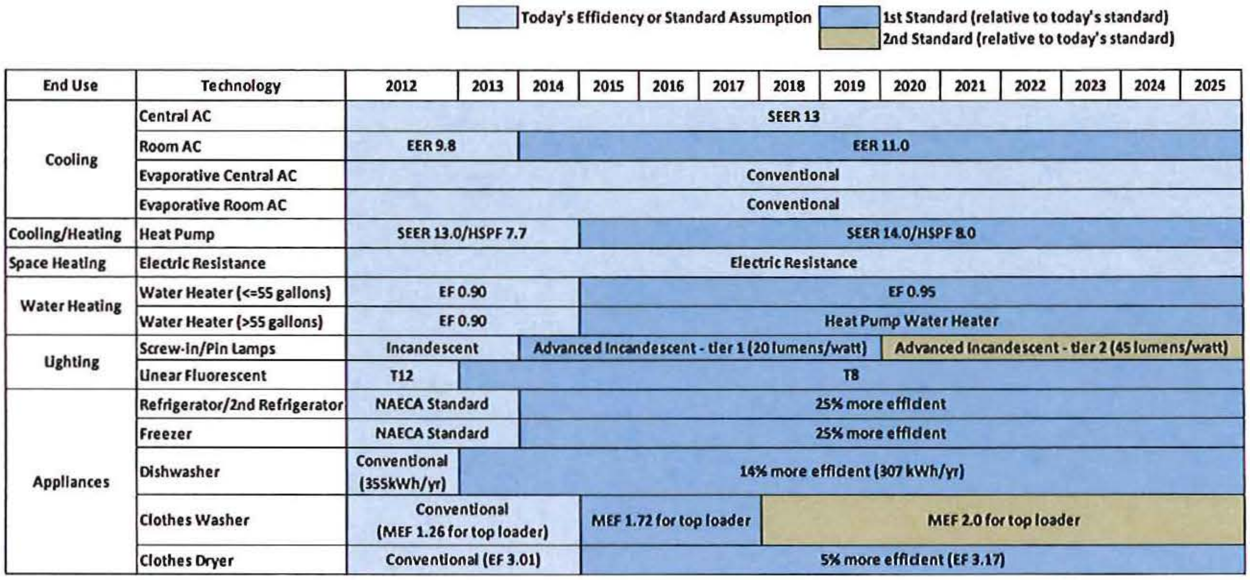


*Per draft settlement position, September 2014

However, in addition to the Ameren Missouri initiatives to encourage customers to become more energy efficient, there are other non-Ameren Missouri initiatives that impact the availability of customer energy efficiency opportunities for Ameren Missouri to pursue going forward. Those initiatives, including the enactment of new building codes and appliance efficiency standards, are diminishing some of the proverbial "low hanging fruit" or low-cost but high-yield energy efficiency opportunities, such as residential lighting.

Table 8.1 illustrates the multitude of residential appliance efficiency standards that will go into effect over the 20-year planning horizon.

Table 8.1: Residential Appliance Efficiency Standards[2]



▭ Today's Efficiency or Standard Assumption
■ 1st Standard (relative to today's standard)
▨ 2nd Standard (relative to today's standard)

End Use	Technology	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13													
	Room AC	EER 9.8		EER 11.0											
	Evaporative Central AC	Conventional													
	Evaporative Room AC	Conventional													
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7			SEER 14.0/HSPF 8.0										
Space Heating	Electric Resistance	Electric Resistance													
Water Heating	Water Heater (<=55 gallons)	EF 0.90			EF 0.95										
	Water Heater (>55 gallons)	EF 0.90			Heat Pump Water Heater										
Lighting	Screw-In/Pin Lamps	Incandescent		Advanced Incandescent - tier 1 (20 lumens/watt)						Advanced Incandescent - tier 2 (45 lumens/watt)					
	Linear Fluorescent	T12	T8												
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard		25% more efficient											
	Freezer	NAECA Standard		25% more efficient											
	Dishwasher	Conventional (355kWh/yr)	14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)			MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)			5% more efficient (EF 3.17)										

Another significant initiative was "The American Recovery and Reinvestment Act of 2009 (ARRA)" which provided approximately $235 million in funding for energy efficiency projects in Missouri through 2012. This very large state investment in energy efficiency further diminished the potential for energy efficiency for utility sponsored programs from the levels estimated in the Ameren Missouri 2009 DSM Potential Study.

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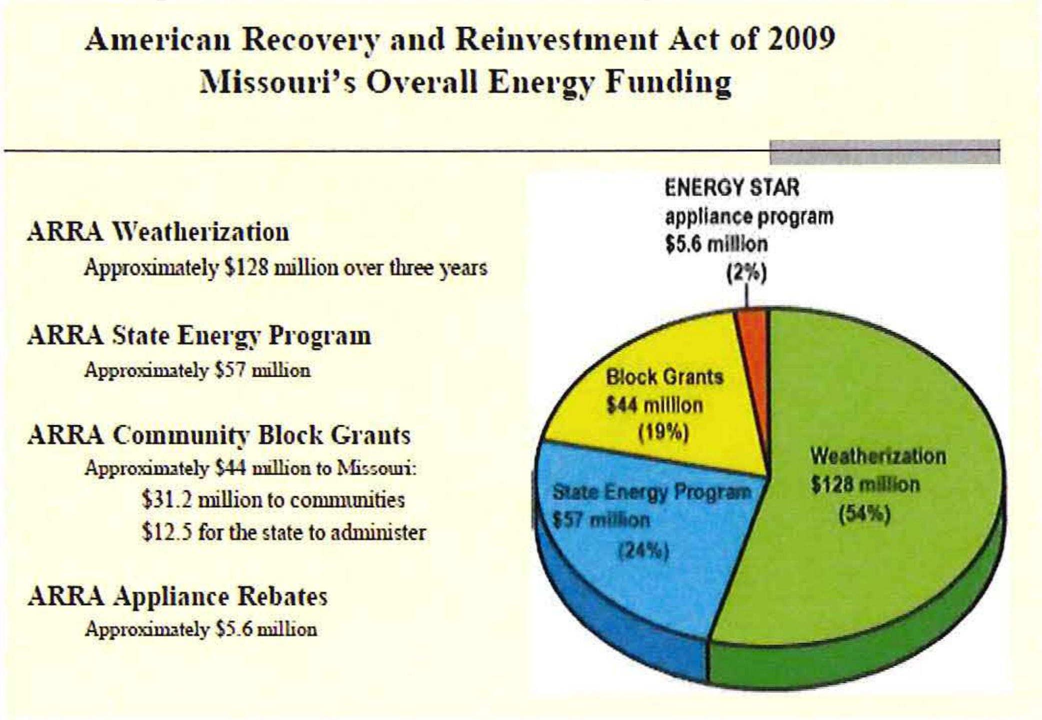
[2] Volume 3 of the Ameren Missouri DSM Potential Study

The Missouri distribution of ARRA funds for energy efficiency related projects is shown in Figure 8.2.

Figure 8.2: Missouri ARRA Funding Source and Uses



American Recovery and Reinvestment Act of 2009
Missouri's Overall Energy Funding

ARRA Weatherization
Approximately $128 million over three years

ARRA State Energy Program
Approximately $57 million

ARRA Community Block Grants
Approximately $44 million to Missouri:
$31.2 million to communities
$12.5 for the state to administer

ARRA Appliance Rebates
Approximately $5.6 million

Finally, the Ameren Missouri assumptions for market prices for both energy and capacity have decreased from levels used in the MEEIA Cycle 2013 - 2015 program analysis work, which were based on the 2011 IRP filing. The benefits associated with energy efficiency measures are a function of the level of avoided energy and capacity costs. The lower avoided costs yield lower benefits which increase the likelihood that marginally cost effective measures from the 2011 IRP filing are no longer cost effective. If not cost effective, the measure is excluded from the DSM Potential Study and annual load reduction estimates are reduced accordingly.

The decrease in avoided costs is attributable to the drop in the price of natural gas as well as the overall state of the economy where electric load growth has flattened. Figure 8.3 illustrates the dramatic differences between the Ameren Missouri avoided energy and capacity costs assumed for both the MEEIA Cycle 2013 - 2015 and MEEIA Cycle 2016 – 2018 filings.

Figure 8.3: Avoided Energy and Capacity Comparison, MEEIA Cycle 2013 - 2015 vs. MEEIA Cycle 2016 – 2018 - **NP**

[redacted]

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8.2 DSM Potential Study[3]

8.2.1 2013 Ameren Missouri DSM Potential Study

8.2.1.1 Overview

Ameren Missouri worked together with stakeholders to develop a scope of work, select contractor(s), review plans, analyze data, and report results for the 2013 Ameren Missouri DSM Potential Study. The contractor selected to perform the actual Study was EnerNOC Utility Solutions Consulting.

The 2013 DSM Potential Study was the most comprehensive customer market assessment analysis for either an IRP filing, or MEEIA filing, ever made by Ameren Missouri.[4] For example, in addition to estimating the technical, economic, and achievable levels of energy efficiency and demand response potential, the 2013 study also assessed the potential for:

- Customer distributed generation/combined heat and power application over the 2016-2033 planning horizon
- The implementation of demand-side rates to impact DSM potential[5]

8.2.1.2 Stakeholder Interactions during DSM Potential Study – 2014 IRP

There was significant communication with Stakeholders regarding the development of the Ameren Missouri Demand Side Market Potential Study. Ameren engaged, informed, requested, responded, presented and updated Stakeholders via numerous communication channels. Ameren involved Stakeholders with the Potential Study from the beginning, requesting Stakeholder review and comments of the Bidders List and RFP feedback, until the end, requesting review and comments of the Potential Study report. Stakeholder interactions regarding the 2013 Potential Study commenced June 2012 and continued through 2014. Stakeholder comments were considered and where applicable used in the development of the Ameren Missouri DSM Portfolios that are analyzed within the IRP. Notable Stakeholder feedback regarding adjustments to Potential Study included adjustments to the bidding process, measure lists, and project scope/budget to include provisions for focus groups.

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[3] EO-2012-0142 13; EO-2012-0142 14

[4] 4 CSR 240-22.050(2) A comprehensive description of the market research and customer surveys performed can be found in Volume 2 of the DSM Potential Study

[5] 4 CSR 240-22.050(1)(C) A more detailed description of demand-side rates can be found in Volume 6 of the DSM Potential Study

The itemized listing of Stakeholder communications can be found in Chapter 8-Appendix A.

8.2.1.3 Overall Conclusions

- The enactment of new building codes and appliance efficiency standards are diminishing some of the proverbial "low hanging fruit" or low-cost but high-yield energy efficiency opportunities, such as residential lighting.

- For the 2016-2018 DSM Implementation Planning period, 60% of the program-level energy-efficiency potential is expected to come from business customers and the remaining 40% from residential customers.

- MISO capacity markets indicate that demand response opportunities have little market capacity value for the immediate future. Since Ameren Missouri is not projecting a need for demand response for reliability purposes, the business case for demand response for Ameren Missouri customers is dependent on the MISO capacity market.[6]

- Since 2010, new program evaluation impact reports in non-Ameren jurisdictions about certain types of demand response programs that in the 2010 study were thought to have no "losers" are now available in the public domain. Specifically, in 2010 the peak time rebate (PTR) program, where customers are paid if they respond to calls to reduce peak demand but are not penalized if they do not respond to such calls, was thought to have only winners. The evaluation reports based on new empirical data show conclusively that there are both winners and losers in this program.

- Opportunities for cost-effective combined heat and power applications for Ameren Missouri industrial customers are relatively small due in part to industrial customers who have elected to opt out of participation in Ameren Missouri energy efficiency programs.

- The analysis of demand-side rates in the study indicate that inclining block rates (IBR) and time-of-use (TOU) rates have the potential to reduce customers' energy consumption. If offered as a customer opt-out option, demand-side rates have significant customer energy usage reduction potential. However, if they are offered as a customer opt-in option, the potential diminishes to relatively modest levels.

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[6] 4 CSR 240-22.050(4)(F)

The complete 2013 Ameren Missouri DSM Potential Study can be found within Chapter 8-Appendix B. The supporting documentation for the 2013 Ameren Missouri DSM Potential Study can be found within the work papers.

8.2.1.4 Energy Efficiency Potential[7]

Key findings related to measure-level electric potentials are summarized as follows:[8]

- **Technical potential** reflects the adoption of all energy-efficiency measures regardless of cost-effectiveness, is a theoretical upper bound on savings. First-year net savings are 1,242 GWh, or 4.1% of the baseline projection. Cumulative net savings in 2018 are 2,728 GWh, or 8.9% of the baseline. By 2030, cumulative savings reach 9,858 GWh, or 29.2% of the baseline projection.
- **Economic potential** reflects the savings when the most efficient cost-effective measures are utilized by all customers. The first-year savings in 2016 are 858 GWh, or 2.8% of the baseline projection. By 2018, cumulative net savings reach 1,923 GWh, or 6.3% of the baseline. By 2030, cumulative savings reach 7,718 GWh, or 22.9% of the baseline projection.
- **Maximum achievable potential (MAP)** establishes a maximum target for the savings a utility can hope to achieve through its programs. MAP involves incentives that represent up to 100% of the incremental cost of energy efficient measures above baseline measures, combined with high administrative and marketing costs. It also considers a maximum participation rate by customers. In 2016, savings for this case are 510 GWh, or 1.7% of the baseline and by 2018 cumulative net savings reach 1,179 GWh, or 3.8% of the baseline projection. By 2030, cumulative MAP savings reach 5,377 GWh, or 15.9% of the baseline projection.
- **Realistic achievable potential (RAP)** represents a forecast of likely customer behavior under realistic program design and implementation. It takes into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. For example, it considers more realistic incentives (i.e., less than 100% of incremental cost), defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The RAP also takes into account recent utility experience and reported savings. In

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[7] 4 CSR 240-22.050(4)(C); Volume 3 of the Potential study addresses how the study included the EIA technology forecast updates on page 2-14

[8] 4 CSR 240-22.050(2)

2016, net realistic achievable savings are 105 GWh, or 0.3% of the baseline projection. By 2018, RAP reaches 426 GWh, or 1.4% of the baseline. By 2030, RAP reaches 3,958 GWh, or 11.7% of the baseline projection.

There is an important distinction to make when describing energy efficiency potential. There are two types of potential estimates – measure level and program level. Measure level potential does not include two significant costs – program administration and portfolio administration. When these two costs are included, it is not unusual to remove marginally cost effective energy efficiency measures from a program in order to make the program cost effective. For this reason, program potential is usually less than measure level potential.

Table 8.2 reflects the EnerNOC measure and proposed program potential both in terms of annual GWh and in terms of % of sales for the 2016-2033 planning period. Figure 8.4 shows the distribution of measure level potential by residential, commercial and industrial customer segments. Ameren Missouri subsequently updated program potential estimates to reflect 2013 EM&V data and updated program field implementation direction.

Table 8.2: Summary of Cumulative Measure and Program Energy Efficiency Potential (Energy Savings in GWh) – Pre 2013 EM&V[9]

	2016	2017	2018		2025	2030
Baseline Projection (GWh)	30,249	30,449	30,694		32,228	33,721
Cumulative Savings (GWh)						
Program RAP	174	346	539		1,629	2,133
Program MAP	251	495	768		2,235	2,890
RAP (Measure-Level)	339	561	806		2,697	3,958
MAP (Measure-Level)	510	833	1,178		3,753	5,376
Cumulative Savings (% of Baseline)						
Program RAP	0.6%	1.1%	1.8%		5.1%	6.3%
Program MAP	0.8%	1.6%	2.5%		6.9%	8.6%
RAP (Measure-Level)	1.1%	1.8%	2.6%		8.4%	11.7%
MAP (Measure-Level)	1.7%	2.7%	3.8%		11.6%	15.9%

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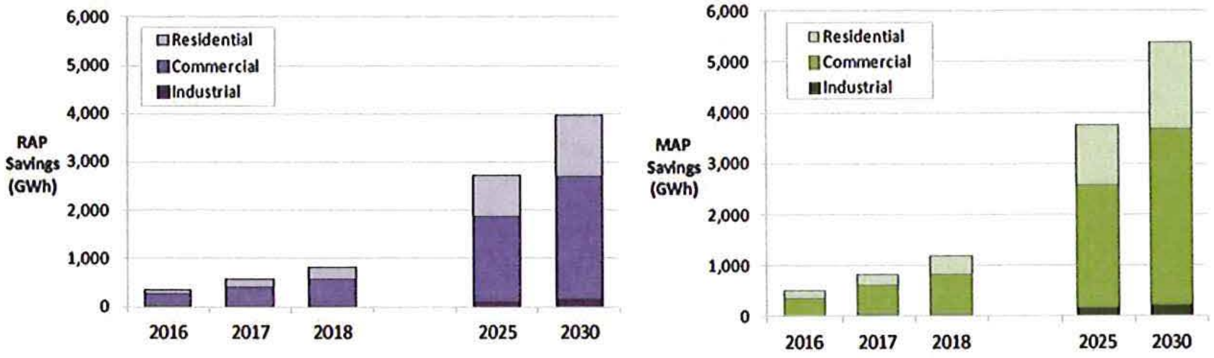
[9] Table from Volume 3 of the DSM Potential Study

Figure 8.4: Source of Annual Load Reductions 2016-2030[10]



Cumulative Realistic Achievable Potential

Cumulative Maximum Achievable Potential

To summarize Figure 8.4, results from the 2013 DSM Potential Study for the 2016-2018 DSM Implementation Planning period, show that approximately 70% of the measure-level energy-efficiency potential is expected to come from business customers and the remaining 30% from residential customers.

It is important to note that the 2013 Ameren Missouri DSM Potential Study used the MEEIA Cycle 2013 - 2015 Technical Reference Manual (TRM) as the source of energy efficiency measure incremental energy savings estimates. On February 15, 2014, approximately two months after the completion of the 2013 DSM Potential Study, the Ameren Missouri Evaluation, Measurement, and Verification (EM&V) contractors published the first draft of the 2013 program individual measure EM&V impacts and distributed it to Ameren Missouri and all stakeholders simultaneously. As expected, the EM&V individual measure impacts differed from the deemed measure savings listed in the MEEIA Cycle 2013 - 2015 TRM. Depending on the individual energy efficiency measure, some of the 2013 EM&V impact assessments were higher than what was in the MEEIA Cycle 2013 - 2015 TRM and some were lower. For both residential and business energy efficiency potential, the overall impact of the 2013 EM&V impact estimates was to lower annual energy efficiency potential from what was stated in the DSM Potential Study.

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[10] Volume 3 of the Ameren Missouri DSM Potential Study

8.2.1.5 Reassessment of Annual Load Reductions in DSM Potential Study

As new Ameren Missouri customer specific EM&V data becomes available, the TRM should be revised to reflect current Ameren Missouri specific individual measure impact analyses. In an ideal setting, the TRM would be updated prior to the start of a new DSM Potential Study. However, since the 2013 DSM program EM&V impacts were not known until February 15, 2014, that was not possible. In fact, if any stakeholder chooses to contest the 2013 EM&V impact reports, there is a schedule for resolution of EM&V disputes in the MEEIA Cycle 2013 - 2015 Stipulation and Agreement that could extend the finalization of 2013 EM&V impacts until September 2014.

Ameren Missouri, however, took the draft February 15, 2014 individual measure and program EM&V impact assessments and made adjustments to the individual measure level savings in the 2013 DSM Potential Study in order to have a more accurate assessment of DSM potential for the MEEIA Cycle 2016 – 2018 plan as well as the 20-year planning horizon for the 2014 Ameren Missouri IRP filing.

The results of updating the 2013 DSM Potential Study to reflect 2013 EM&V individual measure impacts are shown in Table 8.3:

Table 8.3: Measure Level Potential Inclusive of 2013 EM&V Impact Assessments

	2016	2017	2018		2025	2030
Baseline Projection (GWh)	30,249	30,449	30,694		32,228	33,721
Cumulative Savings (GWh)						
RAP (Measure-Level)	314	527	758		2,409	3,481
Cumulative Savings (% of Baseline)						
RAP (Measure-Level)	1.04%	1.73%	2.47%		7.47%	10.32%

Ameren Missouri did not update the EnerNOC program potential, at least as EnerNOC designed programs for the Potential Study, to reflect 2013 EM&V results. Rather, Ameren Missouri proceeded independently with its own program design parameters, using post 2013 EM&V results, to design the DSM programs for the 2014 IRP and MEEIA Cycle 2016 – 2018 filings. The Ameren Missouri program design process, specifically the mapping process from EnerNOC DSM potential to Ameren Missouri DSM program potential, is described in detail in Section 8.6 Planning Process.

Key components in the Ameren Missouri program design process that differed from EnerNOC DSM Potential Study program designs included the following:[11]

1. Update program cost effectiveness to reflect 2013 EM&V measure savings
2. Re-visit EnerNOC proposed programs, such as residential consumer electronics, for which EnerNOC relied on secondary data sources for measure incremental savings and costs if there was no TRM measure level data to use
3. Work with Ameren Missouri implementation team, including contractors, to develop better estimates of future program administration and incentive costs
4. Consider and remove, if not cost effective, programs proposed by EnerNOC

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[11] 4 CSR 240-22.050(1)(D)

8.3 Portfolio Programs

8.3.1 Proposed Portfolio Programs[12]

Table 8.4 presents a high level summary of the proposed programs.

Table 8.4: Realistic Achievable Potential (RAP) Portfolio Programs

Residential - Lighting	Incentives are provided to retail partners to increase sales and awareness of ENERGY STAR® qualified lighting products whereby the end-user receives a discount on the price of ENERGY STAR qualified or other high efficiency lighting products in stores or online.
Residential - Efficient Products	Incentives are provided to customers to raise awareness of the benefits of "high-efficiency" products whereby the end-user receives a discount on the price of qualified products via mail-in rebate or from program allies and contractors.
Residential - HVAC	Incentives are provided to customers for improving the efficiency of new and existing HVAC systems, heat pumps, and air conditioners by achieving electric energy savings.
Residential - Appliance Recycling	An incentive and free pickup is provided to a customer for the retirement and recycling of an inefficient refrigerator or freezer in working condition. A turnkey appliance recycling company will verify customer eligibility, schedule pick-up appointments, pick up appliances, recycle and dispose units, and perform incentive processing.
Residential – Low Income	Delivers energy savings to low income qualified customers by directly installing measures and educating the customer regarding energy efficiency.
Residential – Energy Efficiency Kits	Kits provided to raise customer awareness of the benefits of "high-efficiency" products and educate residential customers about energy use in their homes and to offer information, products, and services to residential customers to save energy cost-effectively.
Business – Standard Incentive	Incents customers to purchase energy efficient measures with predetermined savings values and fixed incentive levels.
Business – Custom Incentive	Applies to energy efficient measures that do not fall into the Standard Incentive program. These projects are often complex and unique, requiring separate incentive applications and calculations of estimated energy savings.
Business - Retro-Commissioning	This program has a special focus on complex control systems and provides options and incentives for businesses to improve operations and maintenance practices for buildings, systems, and processes, achieving electric energy savings.
Business - New Construction	Provides incentives to overcome cost barriers to incorporating energy efficient building design and construction to achieve electric energy savings.
Residential Demand Response	Ameren Missouri is considering a pilot program in 2016-2018 to test customers' tolerance for the frequency and duration of DR events
C&I Demand Response	Ameren Missouri is considering a pilot program in 2016-2018 to test customers' tolerance for the frequency and duration of DR events.

The detailed program templates can be found in Chapter 8-Appendix C.

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[12] 4 CSR 240-22.050(1)(B); 4 CSR 240-22.050(1)(D); 4 CSR 240-22.050(3)(G)3 An in depth look into the design of each potential demand-side program can be seen in the work papers.

8.3.2 Portfolio Overview

The RAP portfolio is the set of Energy Efficiency Programs that:

- **Is cost-effective** at the measure, program, and portfolio level – albeit marginally cost effective for some proposed programs. The overall portfolio benefit-cost ratio using the Total Resource Cost test is 2.01 for energy efficiency programs.
- **Aligns with best practice**. The program designs selected for this portfolio have been based on a review of program experience across the country as well as by the June 2013 ACEEE Review of Exemplary Programs.
- **Is flexible and mitigates risk**. By selecting this portfolio, Ameren Missouri is committing to its overarching elements: namely the energy savings goals and the budgets to achieve them within the proposed program design and implementation flexibility requirements discussed in detail in Section 8.11.3 of this report. Specific program designs are still conceptual. Incentive levels are still broadly and formulaically developed for some programs and developed via latest 2013 market information from implementation contractors for other programs. Detailed program design and implementation planning typically occur after the Commission reviews the Company's IRP planning process and corresponding MEEIA 2016 – 2018 filing. Once the review process is complete, the Company works with implementation contractors (or subcontractors) to develop more detailed plans that include specific incentive levels,[13] participation levels, and implementation plans. This will allow the Company to bring a third party implementation contractor's expertise (or in-house management expertise) into the process before the program design is complete. The RAP portfolio plan is based on a formal assessment of the risks associated with each program and is designed to manage those risks, but strict adherence to this plan is neither intended nor probable. A key element of the risk management strategy is the flexibility to shift resources within the portfolio – to modify portfolio composition and risk as the market responds to our programs.
- **Represents a diverse cross-section of opportunities** for customers of all rate classes to participate in the programs.
- To the extent possible, **coordinates with other existing energy efficiency efforts**. Ameren Missouri continuously works to coordinate with the natural gas energy efficiency programs offered by Ameren Missouri. The Company is also

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[13] 4 CSR 240-22.050(3)(G)5B; The levels of incentives paid by the utility are discussed further in Volume 2 of the Potential study; 4 CSR 240-22.050(3)(G)5C; Incentives paid by entities other than the utility are discussed in Volume 5 of the Potential Study

working with Laclede Gas to improve coordination between natural gas/electric energy efficiency programs that address opportunities to improve the heat gain/loss characteristics of buildings.[14]

The MEEIA Cycle 2016 – 2018 portfolio proposed for 2016-2018 includes many enhancements, improvements, and evolutions relative to the MEEIA Cycle 2013 - 2015 portfolio. The key changes for MEEIA Cycle 2016 - 2018 include:

- Degree of portfolio flexibility requested is greater for MEEIA Cycle 2016 – 2018 than for MEEIA Cycle 2013 - 2015 for reasons described in Section 8.11.3.
- The MEEIA Cycle 2016 - 2018 DSM programs included in the plan were designed in 2013 for reasons related to the schedule requirements needed for Ameren Missouri to be in a position to implement programs in January 2016. Yet, the market for DSM products and services continues to evolve quickly. It is important that this filing include regulatory mechanisms that enable Ameren Missouri to make appropriate changes to the proposed 2016-2018 DSM implementation plans between the time of this filing and January 2016 to reflect changes in the DSM marketplace.
- Avoided costs, on which benefits are calculated for energy efficiency programs, are approximately half of what they were for the MEEIA Cycle 2013 - 2015 filing.
- CFLs, the most prominent energy efficiency measure in MEEIA Cycle 2013 - 2015, are no longer cost effective in MEEIA Cycle 2016 - 2018 due to federal legislation requiring higher levels of lighting efficiency beginning in 2020.
- More than 60% of annual load reductions are projected to come from business DSM programs in MEEIA Cycle 2016 - 2018. This is the inverse of MEEIA Cycle 2013 – 2015 filing where residential programs provided approximately 70% of total portfolio load reductions.

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[14] 4 CSR 240-22.050(3)(F)

Table 8.5 summarizes annual incremental portfolio energy savings, demand savings, and program costs for the 3-year implementation planning period 2016-2018.

Table 8.5: Estimated Incremental Annual Net Savings at Meter and Costs for the Implementation Period - RAP Portfolio[15]

	2016	2017	2018	Total
Residential EE Programs net energy savings (MWh)	58,505	45,691	61,472	165,668
Business EE Programs net energy savings (MWh)	46,252	91,927	122,536	260,715
Total estimated net energy savings (MWh) at meter	**104,757**	**137,617**	**184,008**	**426,382**
Residential EE Programs net demand reduction (MW)	14	9	13	36
Business EE Programs net demand reduction (MW)	13	28	37	78
Estimated net demand reduction (MW) at meter	**27**	**37**	**50**	**114**
Residential EE Programs annual costs ($ millions)	$21.81	$18.61	$22.96	$63.38
Business EE Programs annual costs ($ millions)	$14.60	$30.23	$39.36	$84.19
Estimated costs (Program costs in millions)*	**$36.41**	**$48.84**	**$62.32**	**$147.57**

*Note: The Company may choose to equalize expenditures for each year after finalizing implementation plans with its implementation contractors.

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[15] 4 CSR 240-22.050(3)(H); More comprehensive tables can be found in the work papers including participants, utility costs, and program participant costs for each year of the planning horizon

The breakdown of the portfolio energy saving and budget metrics by individual program is shown in Table 8.6 below:

Table 8.6: Ameren Missouri Portfolio Summary for Implementation Cycle 2016-2018[16]

Realistic Achievable Potential	Net Incremental Energy Savings (GWh) at Meter			Net Incremental Demand Reductions (MW) at Meter			Annual Budget ($M)		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Lighting	20.2	18.3	22.9	0.01	0.01	0.01	$5.70	$5.50	$6.72
Efficient Products	5.7	1.9	6.7	2.09	0.71	2.24	$2.44	$1.30	$2.50
HVAC	19.9	13.9	17.2	8.94	6.24	7.74	$8.30	$6.87	$7.78
Appliance Recycling	3.0	2.7	4.1	0.74	0.66	1.02	$1.22	$1.11	$1.67
Low Income	3.5	2.7	4.3	0.84	0.61	0.92	$2.35	$1.99	$2.49
EE Kits	6.2	6.2	6.2	1.03	1.03	1.03	$1.81	$1.84	$1.81
EE Residential Total	**58.5**	**45.7**	**61.5**	**13.66**	**9.25**	**12.95**	**$21.81**	**$18.61**	**$22.96**
Standard	18.6	20.9	35.0	3.32	3.72	6.24	$5.89	$6.59	$10.96
Custom	27.6	53.5	72.0	10.05	19.47	26.18	$8.71	$16.82	$22.54
RCx	0.0	10.0	8.9	0.00	3.21	2.84	$0.00	$3.92	$3.38
New Construction	0.0	7.5	6.7	0.00	1.80	1.60	$0.00	$2.91	$2.48
EE Business Total	**46.3**	**91.9**	**122.5**	**13.37**	**28.19**	**36.86**	**$14.60**	**$30.23**	**$39.36**
EE PORTFOLIO TOTAL	**104.8**	**137.6**	**184.0**	**27.03**	**37.45**	**49.81**	**$36.41**	**$48.84**	**$62.32**

	Total System Energy (GWh)			Total System Peak (MW)		
	2016	2017	2018	2016	2017	2018
Ameren Missouri Baseline Forecasts	30,249	30,449	30,694	8,226	8,239	8,273
DSM as %	0.35%	0.45%	0.60%	0.33%	0.45%	0.60%

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[16] 4 CSR 240-22.050(3)(G)4; 4 CSR 240-22.050(3)(G)5 A through F A more detailed look including cumulative savings, measure specific cost, incentives can be found in the work papers

The breakdown of cost effectiveness by individual program is shown in Table 8.7 below:

Table 8.7: Cost Effectiveness Tests for Implementation Cycle 2016-2018[17]

REALISTIC ACHIEVABLE POTENTIAL (RAP) Portfolio

	TRC	UCT	PCT	RIM	RIM (Net Fuel)	SOC
ENERGY EFFICIENCY						
RES-Lighting	1.05	1.06	∞	0.32	0.37	1.61
RES-Efficient Products	1.29	1.98	2.66	0.65	0.74	2.17
RES-HVAC	1.34	1.99	3.51	0.54	0.61	2.00
RES-Appliance Recycling	1.08	1.08	∞	0.36	0.41	1.38
RES-Low Income	0.79	0.81	5.82	0.35	0.39	1.07
RES-EE Kits	1.53	1.53	15.43	0.38	0.44	2.05
RES-TOTAL	**1.22**	**1.50**	**5.59**	**0.45**	**0.51**	**1.81**
BUS-Standard	1.49	1.93	3.66	0.54	0.64	2.07
BUS-Custom	1.67	2.43	3.42	0.62	0.75	2.37
BUS-RCx	1.59	1.59	7.10	0.50	0.61	2.20
BUS-New Construction	1.46	2.40	2.80	0.64	0.77	2.14
BUS-TOTAL	**1.61**	**2.22**	**3.54**	**0.59**	**0.72**	**2.26**
EE PORTFOLIO TOTAL	**1.45**	**1.91**	**4.17**	**0.53**	**0.63**	**2.08**

Ameren Missouri's portfolio for MEEIA Cycle 2016 - 2018 contains a substantial list of improvements to the planning process from methods previously employed for MEEIA Cycle 2013 - 2015. For example, the knowledge gained from the actual program implementation and evaluation experience of MEEIA Cycle 2013 - 2015 as well as program years prior to MEEIA Cycle 2013 - 2015 allows Ameren Missouri to incorporate actual field experience into the program design process. Deployment of industry leading project management practices in MEEIA Cycle 2013 - 2015 and the addition of a full-time DSM project manager is a significant improvement in integrating DSM program design with portfolio and program implementation and evaluation. Continuous updating of primary market research on customer demographics, psychographics and appliance saturations is an aid to developing more efficient programs and program delivery mechanisms. Ameren Missouri's active participation in the Electric Power Research Institute's (EPRI) Industrial Center of Excellence (ICOE) has been invaluable in designing new business programs or adjuncts to existing programs that include options for business customers to achieve Energy Star For Industry certification.

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[17] 4 CSR 240-22.050(5)(E); 4 CSR 240-22.050(5)(F);4 CSR 240-22.050(5)(G) A more detailed look at the cost-benefit test can be found in the work papers

8.3.3 DSM Portfolios Considered

8.3.3.1 Portfolio Descriptions

Ameren Missouri examined a number of possible DSM portfolios within alternative resource plans in the integration process. The DSM portfolios considered are shown below, along with a brief description of portfolio features. Further details surrounding individual program metrics within each portfolio are available in the Electronic Work Papers in the "Portfolio Screens" folder.

RAP Portfolio

The realistic achievable potential (RAP) portfolio represents a level of DSM programs that are based on the RAP measure level savings which were identified within the Ameren Missouri Potential Study and subsequently updated with the latest information and assumptions from Ameren Missouri program implementation experience, EM&V assessments of program implementations, and the IRP process. The RAP Portfolio of programs represents estimates of Energy Efficiency and Demand Response program potential based on realistic program implementation assumptions, such as: industry-standard incentive levels, customer acceptance barriers, etc. RAP corresponds to best practices, proven delivery methods, and known program experience from around the country, with emphasis on program experience obtain from Ameren Missouri program implementations. The Ameren Missouri RAP EE programs are expansions and evolutions of the best practice programs that Ameren Missouri currently has in the field that form a more comprehensive and innovative path forward. The Ameren Missouri DR programs are limited to direct load control programs, which are currently the only type of DR programs that the MISO capacity markets accept as capable of providing market capacity value.[18]

MAP Portfolio

The maximum achievable potential (MAP) portfolio represents the most aggressive level of DSM programs that could be delivered by Ameren Missouri and are based on the MAP measure level savings which were identified within the Ameren Missouri Potential Study and subsequently updated, as with the RAP portfolio of programs, with the latest information and assumptions from Ameren Missouri program implementation experience, EM&V assessments of program implementations, and the IRP process. MAP represents estimates of Energy Efficiency and Demand Response potential that are based on the most optimistic program implementation assumptions, such as: boosted utility budgets, higher incentive levels, high customer acceptance, cutting edge delivery methods, etc. The Ameren Missouri MAP EE programs are an enhanced mix of the programs that Ameren Missouri currently has in the field that form a more

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[18] 4 CSR 240-22.050(6)(A)

comprehensive and innovative path forward with the goal of maximizing the amount of EE program savings that can be achieved. The Ameren Missouri DR programs maximize the capacity saving potential that can be achieved by assuming favorable conditions, such as the need for reliability resources in a capacity constrained world and the easing of MISO capacity market acceptance criteria to allow the inclusion of DR pricing programs, which enhances the potential for capacity deliveries from both direct load control and pricing DR programs.

Mid Portfolio

This aggressive portfolio, in the most simplistic of terms, is basically a mathematical construct that is designed to be a set of programs that will deliver a level of savings that are half-way between those of the RAP portfolio and the MAP portfolio. This portfolio was developed to determine the potential merit, if any, of delivering DSM programs at a level that is between RAP and MAP.

8.3.3.2 Portfolio Impacts and Costs

Each of the Portfolios that were developed achieves various levels of savings (energy and demand) in each year of the planning horizon at projected annual costs. Below are plots illustrating the costs and savings of the portfolios that were investigated.

Figure 8.5: Portfolio Energy Efficiency Spending

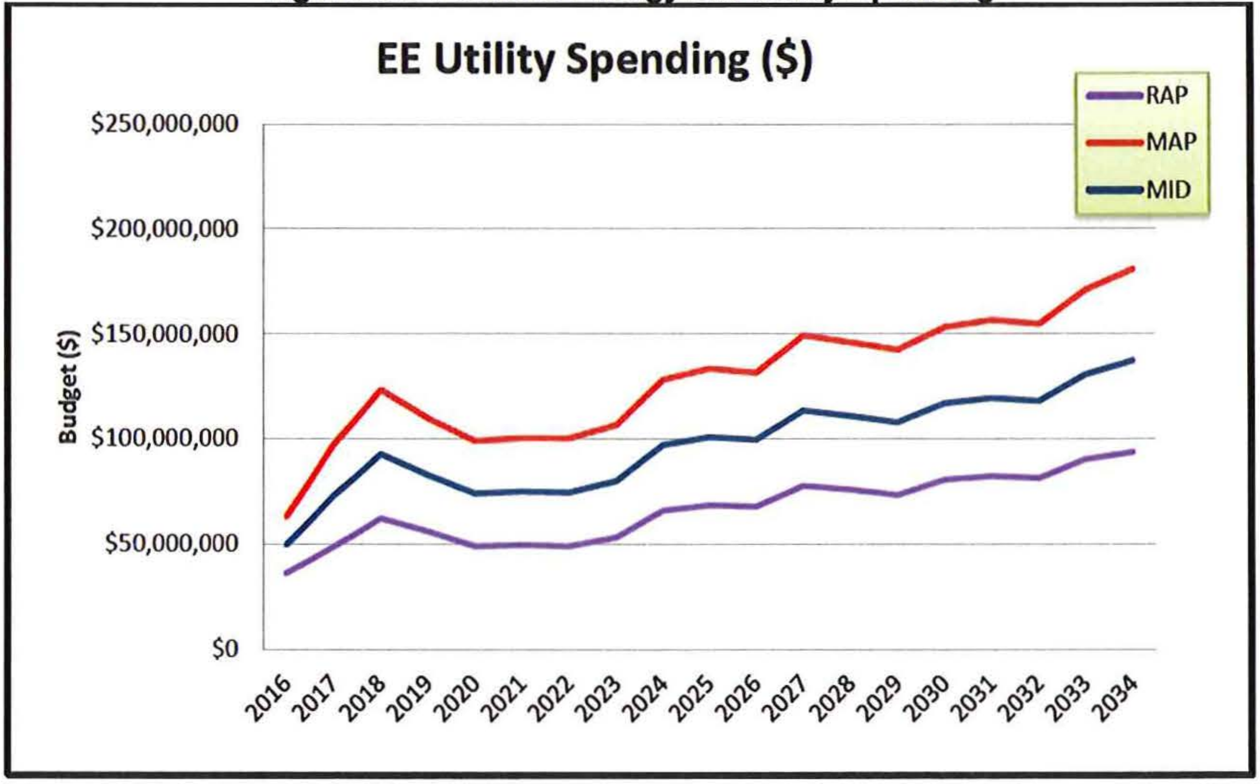


Figure 8.6 shows the projected annual budget for each of the Demand Response portfolios that were developed. Note that the MAP portfolio budget is lower than the RAP portfolio budget for 2025 through 2032 due to the introduction of DR pricing programs within the MAP portfolio. The cost to deliver DR pricing programs is less than the price of direct load control programs.

Figure 8.6: Portfolio Demand Response Spending

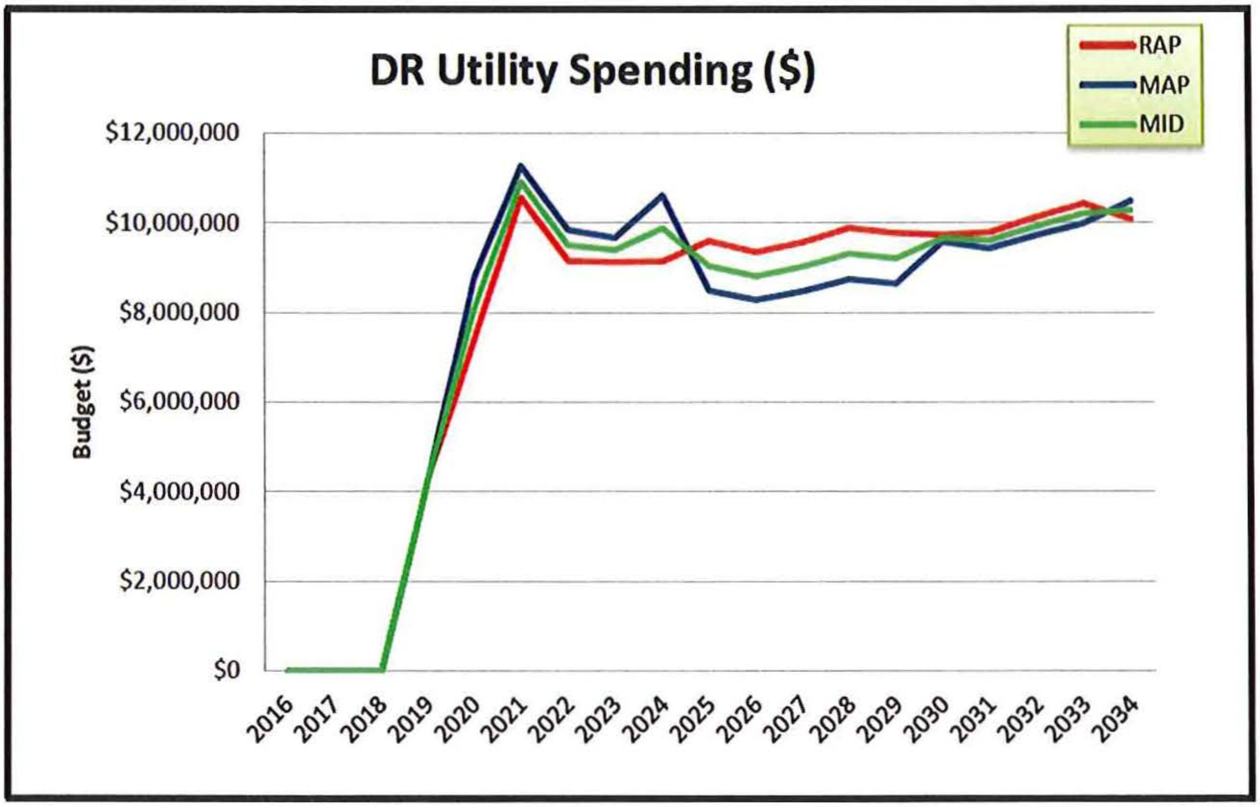
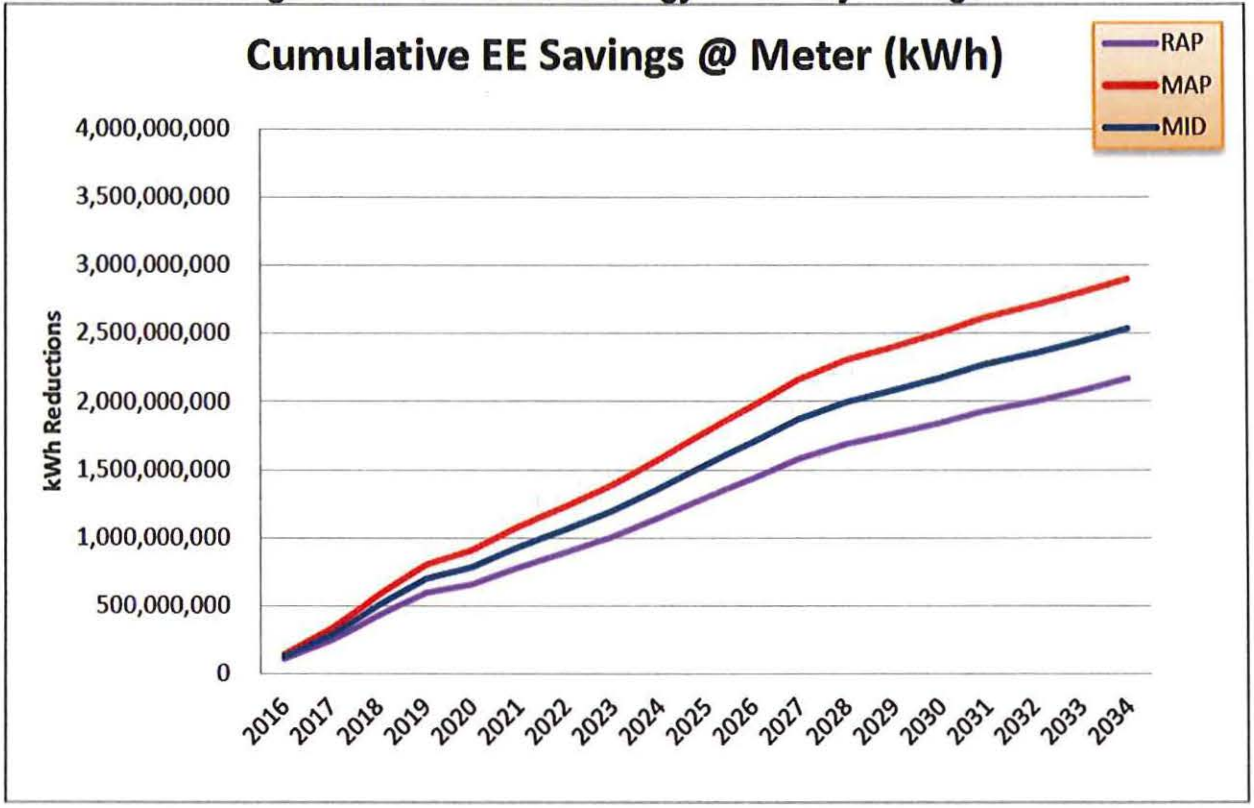


Figure 8.7 shows the projected annual cumulative energy savings (annual energy savings realized by new measures as well as annual energy savings from existing measures that are still actively saving energy) for each of the Energy Efficiency portfolios that were developed:

Figure 8.7: Cumulative Energy Efficiency Savings[19]



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[19] 4 CSR 240-22.050(6)(B)

Figure 8.8 shows the projected annual cumulative demand savings (annual demand savings being realized by new measures as well as annual demand savings from existing measures that are still active) for each of the Energy Efficiency portfolios that were developed:

Figure 8.8: Cumulative Energy Efficiency Peak Load Reductions

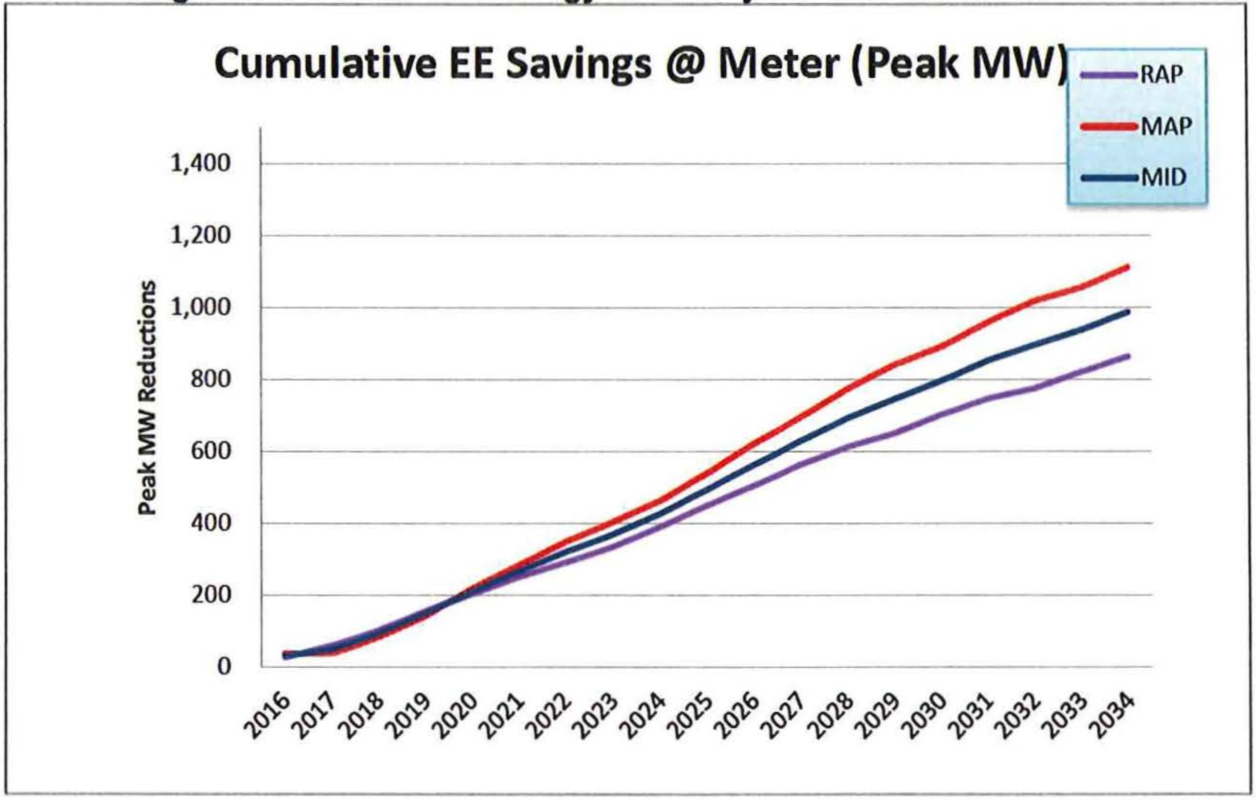

Figure 8.9 shows the projected annual cumulative demand savings for each of the Demand Response portfolios that were developed:

Figure 8.9: Cumulative Demand Response Peak Load Reductions

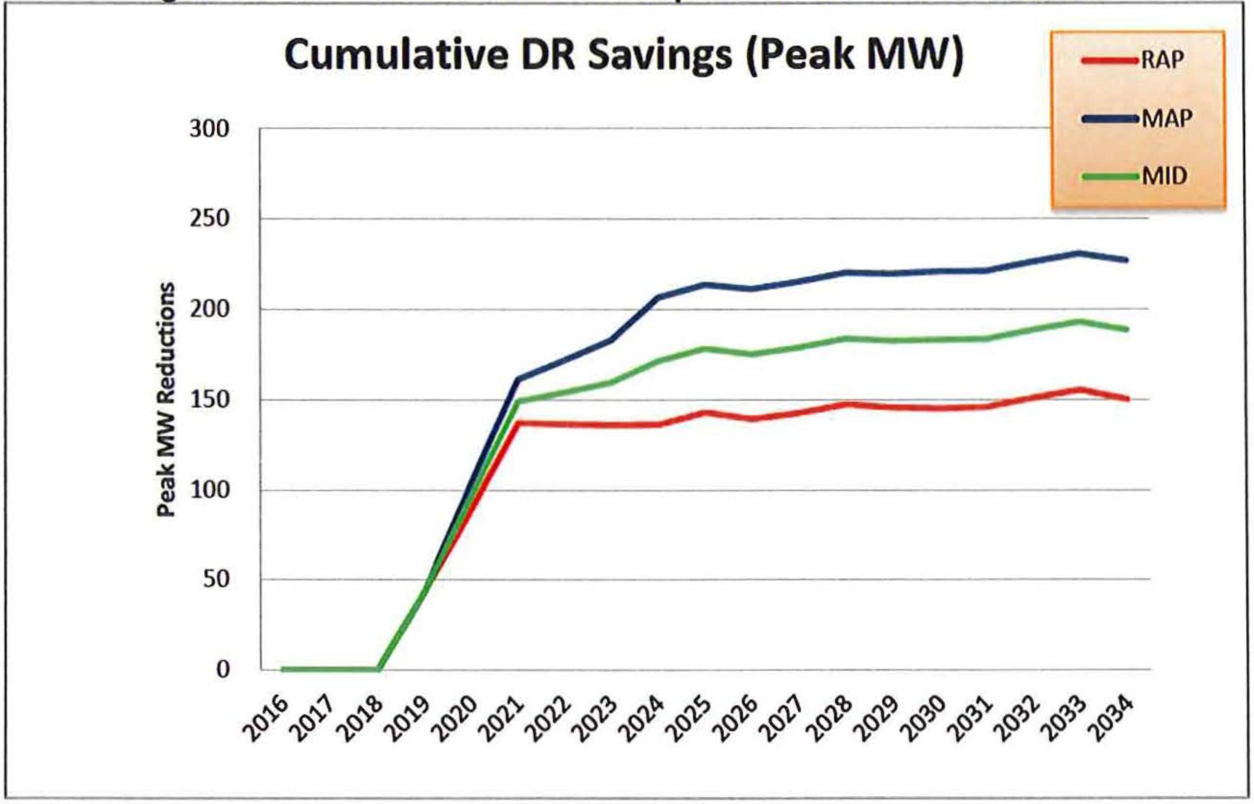

Table 8.8 summarizes the cost-effectiveness of each portfolio. Further details can be found in the work papers in the folder entitled "Portfolio Screens". The cost-effectiveness tests below do not incorporate any demand response and are specific to energy efficiency only.

Table 8.8: Portfolio Cost-Effectiveness Tests (2016-2034)

	Cost-Effectiveness Test Results					
Portfolio	Utility Test	TRC Test	RIM Test	RIM (Net Fuel)	Societal Test	Participant Test
RAP	2.72	2.01	0.66	0.82	2.96	4.31
MAP	1.89	1.69	0.60	0.72	2.52	4.45
MID	2.18	1.81	0.63	0.76	2.69	4.39

The following tables summarize each portfolio's program level cost-effectiveness tests.

Table 8.9: RAP Cost-Effectiveness Tests (2016-2034)

Program Cost-Effectiveness Test Results

RAP	Utility Test	TRC Test	RIM Test	RIM (Net Fuel)	Societal Test	Participant Test
RES-Lighting	0.96	0.96	0.33	0.39	1.49	∞
RES-Efficient Products	3.17	1.71	0.65	0.78	2.77	3.22
RES-HVAC	2.70	1.72	0.63	0.73	2.46	3.65
RES-Appliance Recycling	1.27	1.27	0.39	0.45	1.64	∞
RES-Low Income	1.01	1.00	0.40	0.45	1.35	6.87
RES-EE Kits	1.57	1.57	0.38	0.45	2.11	15.59
RES-TOTAL	**2.19**	**1.54**	**0.56**	**0.65**	**2.30**	**4.26**
BUS-Standard	3.32	2.75	0.85	1.09	4.11	4.46
BUS-Custom	2.84	2.13	0.65	0.82	3.04	4.42
BUS-RCx	3.21	2.36	0.64	0.83	3.33	5.08
BUS-New Construction	3.82	2.42	0.90	1.17	3.63	3.36
BUS-TOTAL	**3.11**	**2.37**	**0.73**	**0.93**	**3.47**	**4.36**
PORTFOLIO TOTAL	**2.72**	**2.01**	**0.66**	**0.82**	**2.96**	**4.31**

Table 8.10: MAP Cost-Effectiveness Tests (2016-2034)

Program Cost-Effectiveness Test Results

MAP	Utility Test	TRC Test	RIM Test	RIM (Net Fuel)	Societal Test	Participant Test
RES-Lighting	0.96	0.96	0.33	0.39	1.49	∞
RES-Efficient Products	2.07	1.44	0.58	0.69	2.39	3.34
RES-HVAC	1.73	1.29	0.56	0.63	1.82	3.65
RES-Appliance Recycling	1.02	1.02	0.36	0.41	1.31	∞
RES-Low Income	0.95	0.93	0.39	0.44	1.26	6.84
RES-EE Kits	1.11	1.10	0.35	0.40	1.48	15.55
RES-TOTAL	**1.63**	**1.27**	**0.52**	**0.60**	**1.91**	**4.14**
BUS-Standard	2.20	2.32	0.75	0.93	3.49	4.82
BUS-Custom	1.90	1.83	0.58	0.71	2.63	4.72
BUS-RCx	2.02	1.97	0.57	0.72	2.78	5.45
BUS-New Construction	2.47	2.10	0.79	1.00	3.17	3.62
BUS-TOTAL	**2.05**	**2.02**	**0.65**	**0.81**	**2.97**	**4.68**
PORTFOLIO TOTAL	**1.89**	**1.69**	**0.60**	**0.72**	**2.52**	**4.45**

Table 8.11: MID Cost-Effectiveness Tests (2016-2034)

Program Cost-Effectiveness Test Results						
MID	**Utility Test**	**TRC Test**	**RIM Test**	**RIM (Net Fuel)**	**Societal Test**	**Participant Test**
RES-Lighting	0.96	0.96	0.33	0.39	1.49	∞
RES-Efficient Products	2.43	1.54	0.61	0.73	2.54	3.29
RES-HVAC	2.05	1.44	0.58	0.67	2.05	3.65
RES-Appliance Recycling	1.13	1.13	0.37	0.43	1.45	∞
RES-Low Income	0.97	0.96	0.39	0.45	1.30	6.85
RES-EE Kits	1.27	1.26	0.36	0.42	1.70	15.57
RES-TOTAL	**1.84**	**1.38**	**0.53**	**0.62**	**2.06**	**4.19**
BUS-Standard	2.56	2.49	0.79	1.00	3.73	4.67
BUS-Custom	2.20	1.94	0.61	0.75	2.79	4.59
BUS-RCx	2.39	2.12	0.60	0.76	2.99	5.29
BUS-New Construction	2.91	2.22	0.83	1.06	3.35	3.51
BUS-TOTAL	**2.40**	**2.16**	**0.68**	**0.86**	**3.17**	**4.54**
PORTFOLIO TOTAL	**2.18**	**1.81**	**0.63**	**0.76**	**2.69**	**4.39**

8.4 Evaluation Measurement and Verification (EM&V)

8.4.1 Existing EM&V Model

Separate evaluators are currently under contract for the Residential and Business portfolios. The consultants provide an annual independent review of the gross and net program impacts. They also provide process evaluations including reviews of databases and marketing materials, conduct implementer interviews, and measure customer satisfaction with programs.

The Commission has hired a State Auditor to audit and report on work of Ameren Missouri's independent EM&V contractors. The Auditor a) monitors EM&V planning, implementation, and analysis of the EM&V contractors, (b) provides on-going feedback to the Energy Efficiency Regulatory Stakeholder Advisory Team (EERSAT) on EM&V issues and (c) provides EERSAT with a copy of their final report in a timely manner.[20]

The evaluators submit their draft annual process and impact evaluation reports to EERSAT and the State Auditor for review and comment 45 days after the completion of each program year and their final annual process and impact evaluation reports 135 days after the completion of each program year.[21]

8.4.2 Proposed EM&V Model

8.4.2.1 Evaluation Contractor Role

For the MEEIA 2016 – 2018 Cycle, a competitive procurement process will take place to ensure that the most qualified evaluation contractor(s) is hired prior to the start of the programs in order to understand the program details and ensure adequate data requirements are implemented. Ameren Missouri has allocated 5% of portfolio resources to EM&V to ensure a balanced approach is utilized to estimate net savings.

An independent process evaluation provides recommendations for program improvements while impact evaluation accurately accounts for energy impacts.

Evaluation Contractors enhance implementation efforts in several ways. For example, evaluators provide valuable training for Ameren Missouri staff, implementers, and regulatory stakeholders on NTG calculation methodologies, deemed savings approaches, and share experiences from other utility service areas. Evaluators contribute meaningfully to operational efforts, having done so in the past for program design roundtable discussions, design of customer forms and materials, data tracking system setup, and program delivery modifications.

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[20] Case No. EO-2012-0142 Unanimous Stipulation and Agreement Resolving Ameren Missouri's MEEIA Filing 11.c, EO-2012-0142 14

[21] Case No. EO-2012-0142 Unanimous Stipulation and Agreement Resolving Ameren Missouri's MEEIA Filing 11.c

The development of a statewide TRM is an effort that may occur in MEEIA Cycle 2016 - 2018. IOU EM&V contractors could make meaningful contributions to the collaborative development of the specific protocols, algorithms, and inputs for each measure included in the statewide TRM. If Missouri develops a statewide TRM, an additional $1 million should be added to the EM&V (3)-year budget for this Cycle to cover the evaluator's incremental efforts to support the development of the statewide TRM.

8.4.2.2 Evaluation Plan

The Evaluation Plans are detailed work plans that fulfill the evaluation objectives and identify the activities that will be undertaken in each program year.

The EPA has proposed GHG rules, Section 111(d) of the Clean Air Act. This may impact MEEIA Cycle 2016 – 2018 EM&V. The EM&V plan will lay the foundation for how these new rules impact the EM&V results. EPA should provide guidance to states, as soon as practicable, but no later than June 2015, setting forth a non-exhaustive list of approvable approaches/provisions that may be included in state compliance plans. Missouri should have the option to adopt those and other policies and programs in their compliance plans.

Translating electricity energy efficiency savings into avoided emissions has not been part of previous EM&V plans. However quantifying CO_2 savings from energy efficiency savings may be a change to the EM&V plan in MEEIA Cycle 2016 – 2018 and beyond. Ameren Missouri will need to begin to understand the magnitude of CO_2 savings as well as kWh savings for individual measures. The significant value of energy efficiency programs may well come from CO_2 savings going forward. Consequently, the measure mix of the program may change to emphasize measures with the most CO_2 savings

The EM&V plans described within this section should be considered a preliminary planning document and subject to change based upon program design changes incorporated by the implementation team in 2015. The evaluation plans for each DSM program will be developed the first quarter of 2016. Each evaluation plan will be composed of three – one year work plans which support the overall three year program cycle. As programs and markets evolve each year, the evaluation methods may need to change to ensure the evaluation method(s) being used continue to be appropriate. Findings from process evaluations and market assessments can help identify when to reassess impact evaluation methods. This will give the evaluation team the same type flexibility as the implementation teams to make appropriate modifications to respond to program and market condition changes. The EERSAT will be engaged with the development and review of the overall three year EM&V plans prior to its implementation and be informed as modifications are made throughout the program cycle.

8.4.2.3 Impact Evaluations[22]

One of the most important aspects of evaluation is the measurement of savings achieved, or impact evaluation results. Ameren Missouri has developed, in coordination with the evaluation contractor, the necessary methods to estimate load impacts of the EE programs offered by the Company.[23] The impact evaluation estimates of gross program savings may include engineering analysis and formulas, building simulation models, meter data, statistical models and billing analysis.

In its MEEIA 2016 - 2018 filing, Ameren Missouri will propose all program NTG values be deemed. In addition, Ameren Missouri will propose an alternative methodology to adjust deemed NTG values over the course of the 3-year implementation plan. However, should Ameren Missouri's NTG proposal not be accepted, Ameren Missouri will continue to require evaluators to use a balanced approach when calculating NTG by using the following formula and measure each component of the equation:

> NTG = 1 – Free Ridership + Participant Spillover + Nonparticipant Spillover + Market Effects

For the low income program, the evaluation will also include an analysis of how the program affects bill payments, arrearages, and disconnections.

8.4.2.4 Process Evaluations[24]

Ameren Missouri has collaborated with its evaluators to identify appropriate process evaluation goals, procedures, and practices.[25] These evaluations focus more on program design and delivery, market segments, and other societal factors that affect the program's performance.

Process evaluations use program implementer/contractor interviews, retailer surveys and review of program materials to inform the process evaluation. Stakeholder and retailer interviews provide details on program design, database review, staffing levels, training, implementation, marketing to retailers and trade allies, retailer and trade ally satisfaction, marketing to consumers, products, payments and invoicing, communications, tracking and market feedback. Program data reviews provide further information on program design and implementation processes.

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[22] 4 CSR 240-22.070(8)(B)
[23] 4 CSR 240-22.050(7)
[24] 4 CSR 240-22.070(8)(A)
[25] 4 CSR 240-22.050(7)

8.4.2.5 Data Collection[26]

Thus far, Ameren Missouri has been engaged with the EM&V contractors to develop and implement the necessary protocols, methodologies, and technology to gather the appropriate data necessary to facilitate effective evaluation.[27] As programs mature and the market begins to transform, it is important for Ameren Missouri to continue to have open lines of communication with both the evaluation teams and the implementation teams. A centralized data tracking system will be utilized by the implementation contractors to track program metrics for use by the evaluators in the EM&V process.

8.4.2.6 Internal Verification and Quality Control

The evaluation contractor has responsibility for installation verification and estimation of energy savings for purposes of independent evaluation. Besides coordinating independent EM&V, Ameren Missouri requires implementation contractors to develop and implement internal Quality Assurance and Quality Control (QA/QC), inspection, and due diligence procedures. These procedures will vary by program and are necessary to assure customer eligibility, completion of installations, and the reasonableness and accuracy of savings upon which incentives have been based. Evaluators will review these QA/QC procedures.

8.4.2.7 Annual EM&V Reporting

The evaluation contractors will prepare annual draft and final impact and process evaluation reports. The reports will include ex-ante gross, ex-post gross and ex-post net energy savings and demand reduction for each of the programs and residential and non-residential portfolios. The reports will also include a summary of the process evaluation and will identify specific detail regarding the impact methodologies and results as well as key findings, conclusions and recommendations. Based on the annual report results, Ameren Missouri will complete the cost effectiveness analysis at the program and portfolio level.

8.4.3 Stakeholder Considerations[28]

Ameren Missouri will continue to work with the evaluation contractors and make the necessary plans to incorporate EERSAT and the State Auditor into the planning/evaluation process. It would be beneficial to have all parties participate early in the process by reviewing evaluation plans prior to finalizing.

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[26] 4 CSR 240-22.070(8)(C)

[27] 4 CSR 240-22.050(7)

[28] EO-2012-0142 14

8.5 Outreach, Marketing and Communications[29]

Developing and executing a comprehensive marketing communications plan is essential to reaching the residential and business energy efficiency goals. Executing a mix of marketing simultaneously with a consistent message creates repetitive exposure which drives recognition and as a result drives participation. In addition, a multi-media plan enables Ameren Missouri to reach their diverse customer base. All marketing execution is approved and managed by Ameren Missouri, however all implementation contractors and Ameren Missouri's communication Agency of Record will contribute to the marketing efforts.

The most opportunistic means to market the business energy efficiency programs is through Trade Allies, Program Business Development staff and key customer facing employees such as Key Account Executives and Customer Service Advisors. Trade Allies are experts in energy efficient technology, understanding market conditions, and are whom customers go-to when seeking energy efficient products and services. They are the primary channel for marketing and outreach. The marketing efforts for the business portfolio are also a combination of internal and external activities.

8.6 The Planning Process

8.6.1 Cost-Effectiveness Defined

Ameren Missouri calculated the cost effectiveness of its DSM measures, programs, and portfolios using the total resource cost (TRC) test, the utility cost test (UCT), the participant cost test (PCT), the societal cost test (SCT) and the ratepayer impact measure (RIM) test.[30] In each year of the planning horizon, the benefits of each demand-side program are calculated as the cumulative energy and demand impact multiplied by all applicable avoided costs, and then summed into net present values for the timeframe considered.[31] The definitions of the tests, drawing upon the California Standard Practice protocol for DSM economic assessment, are outlined below:

The Total Resource Cost (TRC) test measures benefits and costs from the perspective of the utility and society as a whole. The benefits are the net present value of the energy and capacity saved by the measures. The costs are the net present value of all costs to implement those measures. These costs include program administrative

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[29] 4 CSR 240-22.050(3)(E)

[30] 4 CSR 240-22.050(5)(E); 4 CSR 240-22.050(5)(F); 4 CSR 240-22.050(5)(G)

[31] 4 CSR 240-22.050(5)(A); the cost effectiveness of each demand-side program can be found in the workpapers

costs and full incremental costs (both utility and participant contributions), but no incentive payments that offset incremental costs to customers and no lost revenues.[32] The full incremental costs include single upfront costs and operational & maintenance costs where applicable.[33] Programs passing the TRC test (that is, having a B/C ratio greater than 1.0) result in a decrease in the total cost of energy services to all electric ratepayers.[34]

The Utility Cost Test (UCT) measures the costs and benefits from the perspective of the utility administering the program.[35] As such, this test is characterized as the revenue requirement test. Benefits are the net present value of the avoided energy and capacity costs resulting from the implementation of the measures. Costs are the administrative, marketing and evaluation costs resulting from program implementation along with the costs of incentives but do not include lost revenues.[36] Programs passing the Utility Cost test result in overall net benefits to the utility, thus making the program worthwhile from a utility cost accounting perspective.[37]

The Participant Cost Test (PCT) measures the benefits and costs from the perspective of program participants, or customers, as a whole. Benefits are the net present value savings that participating customers receive on their electric bills as a result of the implementation of the energy efficiency and demand response measures plus incentives received by the customer. Costs are the customer's up-front net capital costs to install the measures. If the customer receives some form of a rebate incentive, then those costs are considered as a credit to the customer and are added to the customer's total benefits.[38]

The Societal Cost Test (SCT) is a variation of the TRC that includes "externalities" and uses a social discount rate. Since there has been no protocol to establish inputs to the SCT in Missouri, Ameren Missouri calculated the SCT for each of its DSM programs using "placeholder" values. Benefits were increased by 10% across the board and a lower discount rate was used to estimate SCT values for each program.[39]

The Ratepayer Impact Measure (RIM) test measures the difference between the change in total revenues paid to a utility and the change in total costs to a utility resulting from the energy efficiency and demand response programs. If a change in the

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[32] 4 CSR 240-22.050(5)(B)3
[33] 4 CSR 240-22.050(5)(B)1
[34] 4 CSR 240-22.050(5)(D)
[35] 4 CSR 240-22.050(5)(C)
[36] 4 CSR 240-22.050(5)(C)1; 4 CSR 240-22.050(5)(C)2&3
[37] 4 CSR 240-22.050(5)(D)
[38] 4 CSR 240-22.050(5)(F)
[39] 4 CSR 240-22.050(5)(F)

revenues is larger or smaller than the change in total costs (revenue requirements), then the rate levels may have to change as a result of the program.[40]

8.6.1.1Avoided Costs[41]

The avoided cost curve that was provided for use in the 2014 EE Potential Study was derived from the results of a simulation model used to reflect an expectation of market prices. These forward price forecasts were developed using modeling software provided by Ventyx and commonly referred to as "Strategic Planning" or "MIDAS". This detailed simulation modeling software provides a production cost projection and that process has been outlined in Chapter 2 (Planning Environment) in much greater detail. The results of this production cost model provided 15 unique forward power price forecasts that would include probable environmental costs by adjusting the following input variables;

1. Natural gas
2. Load growth
3. Coal plant retirements
4. Cost of carbon[42]

Each of these power price forecasts was given a weighting based on the combined probabilities of the inputs. This probability and weighting process is further discussed in chapter 2 (Planning Environment). To present a single forecast for use in the study, the final procedure was to use each price forecast and weight it appropriately to derive a single probability weighted average that would represent a power price forecast representative of the range of possibilities that were used for analysis in the 2014 IRP.

Finally, to better reflect the expected prices in the Ameren Missouri area, a basis adjustment was applied to adjust the Indy Hub prices to Ameren Missouri prices.

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[40] 4 CSR 240-22.050(5)(F)

[41] 4 CSR 240-22.050(5)(A)1 through 3; 4 CSR 240-22.050(6)(C)2; Volume 3 of the Potential Study discusses the sensitivity analysis performed around avoided cost

[42] 4 CSR 240-22.050(6); 4 CSR 240-22.050(5)(A)3

Table 8.12 shows the avoided costs used for the valuation of Ameren Missouri's DSM efforts in the IRP analysis.

Table 8.12: Avoided Costs – **NP**

Year	Energy ($/MWH)	Capacity ($/kW-Year)	Distribution ($/kW-Year)	Transmission ($kW-Year)
2016	$27	**[redacted]**	$17	$6
2017	$29	**[redacted]**	$18	$6
2018	$32	**[redacted]**	$18	$6
2019	$34	**[redacted]**	$18	$6
2020	$36	**[redacted]**	$19	$6
2021	$39	**[redacted]**	$19	$6
2022	$42	**[redacted]**	$19	$7
2023	$45	**[redacted]**	$20	$7
2024	$48	**[redacted]**	$20	$7
2025	$53	**[redacted]**	$21	$7
2026	$56	**[redacted]**	$21	$7
2027	$58	**[redacted]**	$21	$7
2028	$61	**[redacted]**	$22	$7
2029	$64	**[redacted]**	$22	$7
2030	$67	**[redacted]**	$23	$8
2031	$70	**[redacted]**	$23	$8
2032	$74	**[redacted]**	$24	$8
2033	$77	**[redacted]**	$24	$8
2034	$82	**[redacted]**	$25	$8

8.6.2 New Web-Based Technical Reference Manual (TRM)[43]

The most significant improvement to the planning process, however, may very well be Ameren Missouri's acquisition of new, state-of-the art software to both develop and periodically update a secure, online Technical Reference Manual (TRM) database capable of capturing, organizing, and tracking the comprehensive set of Ameren Missouri's energy efficiency measures, their corresponding data elements and values, along with accompanying documentation. The TRM software will also support Ameren Missouri in the calculation of its 2013-2015 ex-post actual annual kWh. Ameren

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[43] EO-2012-0142 14

Missouri, the Commission, stakeholders and ultimately customers will realize the following benefits of the system:

- **Total transparency**: Consolidation and organization of efficiency measures, measure attributes, and supporting data, including all savings values, costs, assumptions, equations, savings estimation protocols and source documentation. An easy-to-use, web-based interface to facilitate access to measure parameters, savings calculation algorithms, effective useful life, and incremental measure costs.

- **Automated version control**, including logging, retention, and archiving of all measure versions, including interim measure updates. Greater transparency into measure assumptions due to the fact that source documentation can be directly linked to a measure and the relevant attributes and parameters.

- **Reporting:** Ability to create customized measure specific reports and/or export files in various file formats; this can be used to develop batch upload files for Ameren Missouri's program tracking systems.

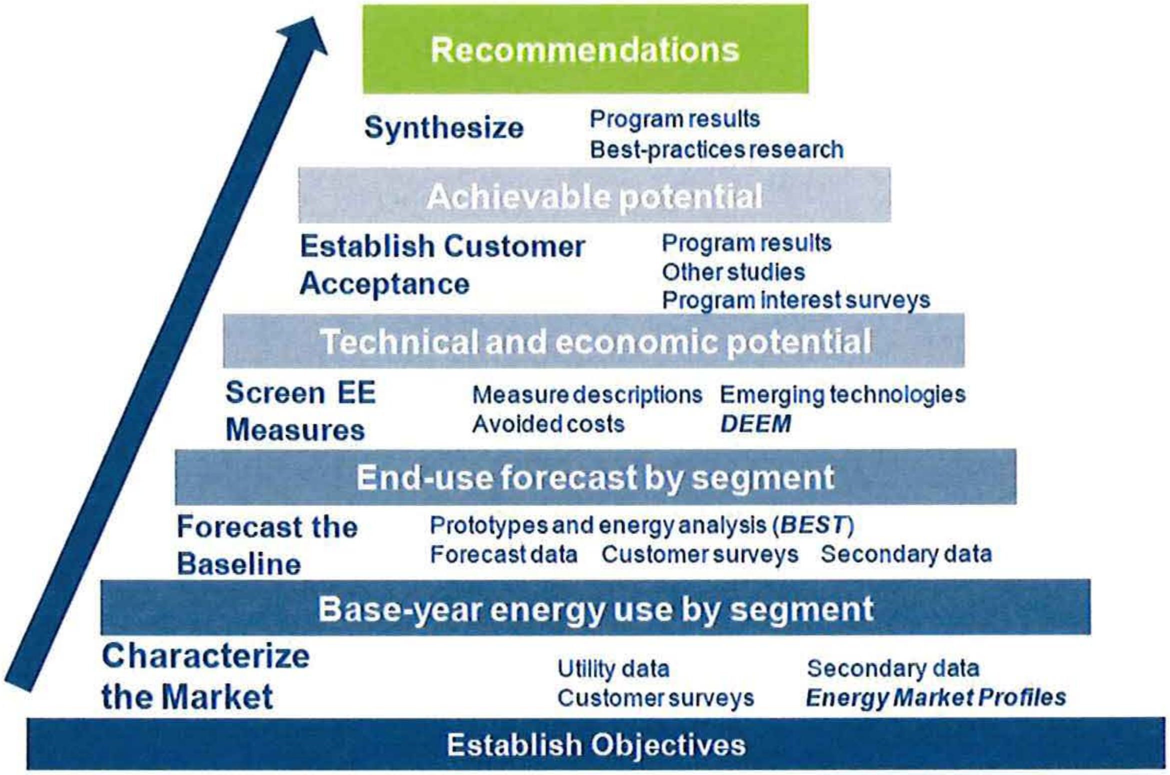
- **Maintenance of accurate records** of TRM savings based on versions for tracking and reporting using the online TRM tool.

Significant improvements are evident when comparing the web-based TRM to the previous hard copy version of the TRM. The first version of the TRM was a WORD document supported by voluminous work papers in multiple formats and file locations. Ameren Missouri leveraged previous evaluation reports from its programs implemented between 2009 and 2011, Ameren Missouri specific data from its DSM Potential Study, its internal database of measures, and other states' TRMs where applicable to develop the first Ameren Missouri TRM. In MEEIA Cycle 2016 - 2018, Ameren Missouri is adopting a transparent, online TRM tool to identify measure level savings values and algorithms based on Ameren Missouri specific EM&V measure impact savings from 2013 program evaluations measured directly from Ameren Missouri customers to develop energy efficiency measure savings estimates. All documentation and workpapers supporting individual measure savings estimates will be included in the online tool. As was true in MEEIA Cycle 2013 - 2015, it is critical that individual measure savings estimates be agreed upon at the beginning of the program implementation and applied prospectively. The automated, online TRM will be used by Ameren Missouri to provide the transparency and the ability to maintain and update, if required, the measure energy and demand savings throughout the implementation period.

8.6.3 Program Design Process[44]

The flow of the overall planning process is illustrated in Figure 8.10.

Figure 8.10: Overview of DSM Planning Process



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[44] 4 CSR 240-22.050(3)(G); 4 CSR 240-22.050(3)(I) Additional documentation for the assessments and sources can be found in the work papers

The results of the 2013 Potential Study generated measure level energy efficiency savings potential for different tiers including Realistic Achievable Potential (RAP) and Maximum Achievable Potential (MAP). The measure level potentials were developed by EnerNOC using measure level data from the MEEIA Cycle 2013 - 2015 TRM.[45] LoadMAP, EnerNOC's modeling tool, displays the results of inputs and outputs used to derive the measure level energy savings of each measure assessed in the 2013 Potential Study.

EnerNOC Utility Solutions developed The Load Management Analysis and Planning (LoadMAP^{TM}) tool in 2007 and has used it for the EPRI National Potential Study and more than two dozen end-use forecasting and potential studies. LoadMAP can provide energy savings in a variety of ways. The LoadMAP model provides forecasts of baseline energy use by sector, segment, end use, and technology for existing and new buildings. Ameren Missouri forecasting personnel and EnerNOC worked together closely to ensure that the baseline forecast for the Potential Study and Ameren Missouri's own load forecast were similar in assumptions and results. LoadMAP also provides forecasts of total energy use and savings associated with various levels of energy-efficiency (or DSM or conservation) potential — technical, economic, RAP, and MAP. Figure 8.10 depicts the bottom-up analysis approach of the LoadMAP process.

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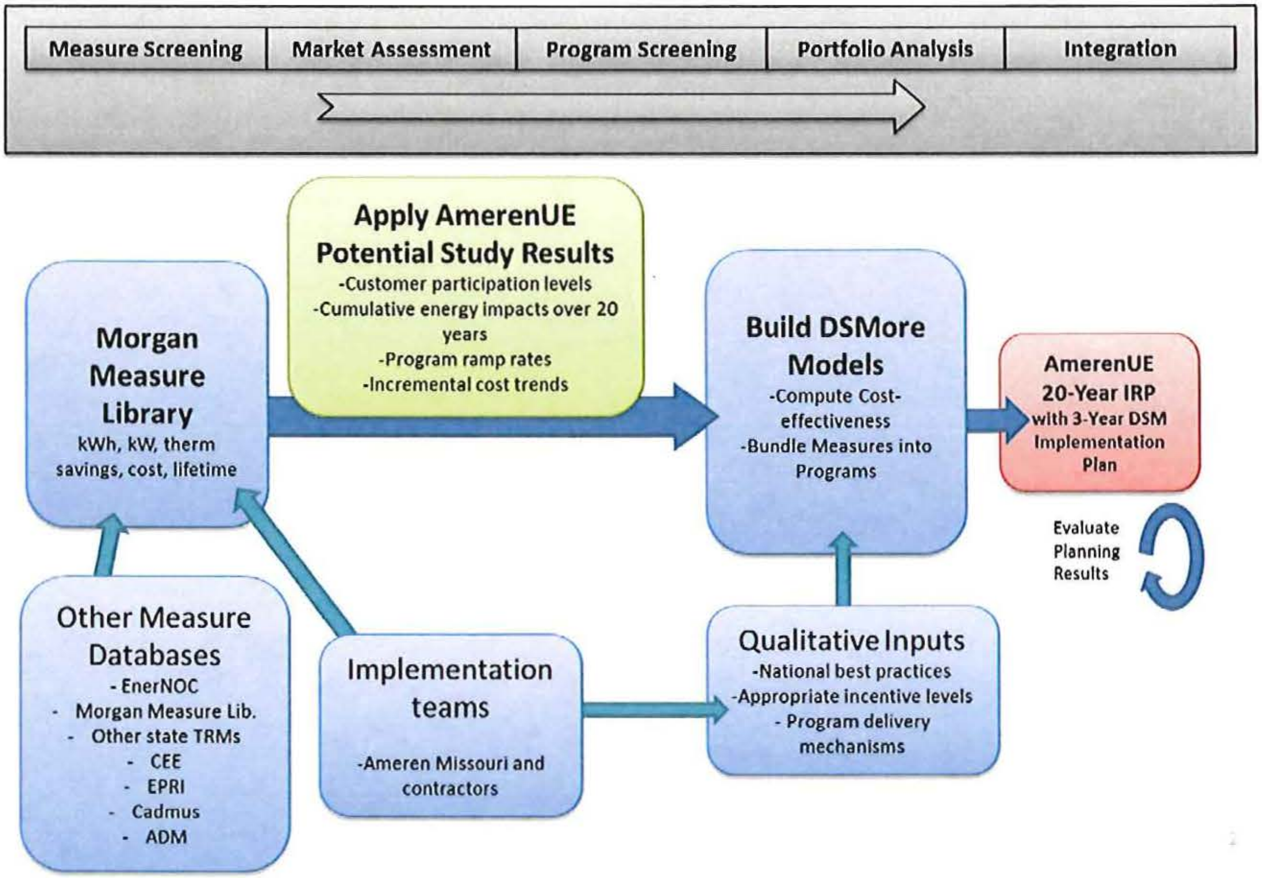
[45] 4 CSR 240-22.050(3)(C) The comprehensive list of end-use measures and demand side programs can be found in the work papers

Figure 8.11 elaborates on the Ameren Missouri DSM program design process from what was done for purposes of the DSM Potential Study in the achievable potential segment in Figure 8.10.

Figure 8.11: Overview of Ameren Missouri DSM Program Design Process



Within the LoadMAP taxonomy, measures can be categorized into types, equipment measures and non-equipment measures. Equipment measures, or efficient energy-consuming equipment, save energy by providing the same service with a lower energy requirement. An example is the replacement of a standard efficiency refrigerator with an ENERGY STAR model. For equipment measures, many efficiency levels are available for a specific technology that range from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. Non-equipment measures save energy by reducing the need for delivered energy but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). Examples include building shell measures such as insulation, equipment controls, equipment maintenance, and whole building design. Non-equipment measures can apply to more than one end use. For example, insulation levels will affect the energy use of cooling and space heating. In addition certain measures within LoadMAP take into account the interaction of building systems and how they affect the savings of other measures.[46]

The deliverables of the 2013 Potential Study included 3 types of Microsoft Excel LoadMAP files generated for three class sectors – residential, commercial, and industrial:[47]

1. LoadMAP.xlsx – performs the baseline forecast and analyzes equipment measures
2. LoadMAP Measures.xlsx – analyzes non-equipment measures
3. LoadMAP Final Results.xls – collects results from the two other files and includes pre-defined figures and tables for summarizing analysis results.

Flexibility to update the measure level and program level potentials is fundamental to Ameren Missouri's ability to manage risk and uncertainty due to:

1. Program design based on the 2013 DSM Potential Study which relies on older data
2. Changing customer interest
3. Changing baselines
4. Market transformation

EM&V results of Ameren Missouri's 2013 DSM programs became available after the completion of the 2013 Potential Study. Ameren Missouri updated the DSM Potential Study to reflect the 2013 individual measure impacts based on Ameren Missouri customer specific data. 2013 EM&V results were applied to the Potential Study results by updating Potential Study deliverable files. EnerNOC provided LoadMAP files as described above but also provided Program Expansion files to provide program level energy savings by tier. Ameren analyzed the Program Expansion files to generate energy savings for measure level and program level as indicated by EnerNOC. The measures included in the Program Expansion files were screened via EnerNOC's benefit/cost tests. Ameren Missouri updated the Program Expansion file for measure level savings to include EM&V results. Specifically, the EM&V realization rates were applied to EnerNOC's Program Expansion file for both the residential and commercial data. Measures in the Program Expansion File that did not correspond to an EM&V assessment remained the same and were not adjusted. This allowed for an update to measure level potentials based on the 2013 Potential Study. Next, all measures were screened by Ameren via the DSMore software. Measures that were not cost-effective

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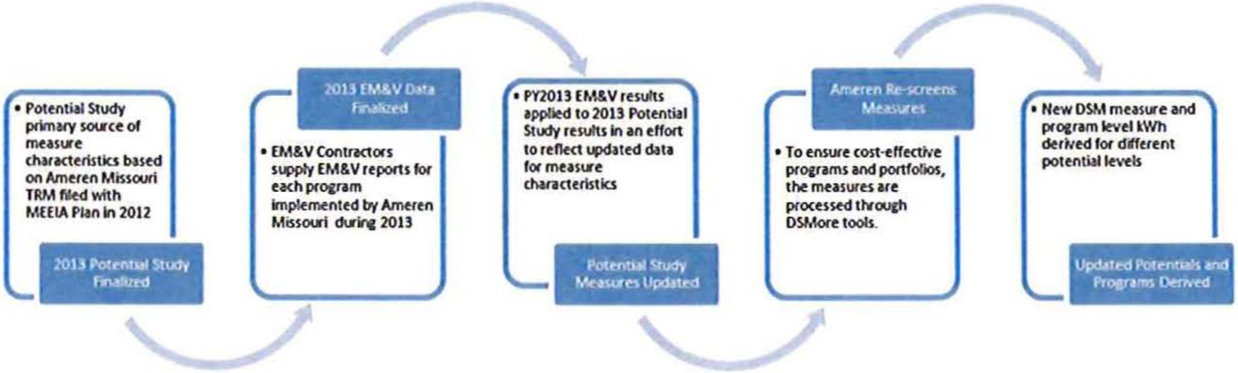
[46] 4 CSR 240-22.050(3)(G)2 A further description of these measures is found on page C-11 of Volume 3 of the DSM Potential Study

[47] 4 CSR 240-22.050(3)(G)1 The analysis of each stand-alone end-use measure can be found in the work papers

after the application of the EM&V realization rates were removed from the potential and portfolio. Subsequently, the program level potential was generated using updated EM&V results.

Figure 8.12 below depicts the process of updating the Potential Study with 2013 EM&V data. The same methodology will apply for 2014 and 2015 EM&V data when it becomes available.

Figure 8.12: Overview of DSM Potential Study Update Process



- Potential Study primary source of measure characteristics based on Ameren Missouri TRM filed with MEEIA Plan in 2012
- EM&V Contractors supply EM&V reports for each program implemented by Ameren Missouri during 2013
- PY2013 EM&V results applied to 2013 Potential Study results in an effort to reflect updated data for measure characteristics
- To ensure cost-effective programs and portfolios, the measures are processed through DSMore tools.
- New DSM measure and program level kWh derived for different potential levels

8.6.4 Interactive Effects[48]

Interactive effects were assessed by Ameren Missouri's contractors for the Ameren Missouri DSM Potential Study. Capturing the interactive effects of all applicable measures required examining many instances where multiple measures affect a single end use both positively and negatively. To avoid overestimation of total savings, the assessment of cumulative impacts accounts for the interaction among the various end uses.

This was accomplished by establishing a base level model that incorporated many non-related measures and identifying the savings achieved by stacking the incremental measure within an additional modeling run, with a comparison of the base and modified runs to arrive at the implemented measure impact on energy consumption.

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[48] 4 CSR 240-22.050(3)(G)2

8.7 Demand Response Potential[49]

8.7.1 Definition(s) of Demand Response

The Federal Energy Regulatory Commission (FERC) defines demand response as changes in electric use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. FERC's definition of demand response conforms to the North American Reliability Corporation (NERC) definition developed by a consortium of utilities and end users – of which Ameren Missouri had a leadership role.

The Midcontinent Independent System Operator (MISO) describes demand response as the ability of a Market Participant (MP) to reduce its electric consumption in response to an instruction received from MISO. MPs can provide such demand response either with discretely interruptible or continuously controllable loads (Demand Resources) or with behind-the-meter generation (BTMG).

The Missouri Integrated Resource Planning (IRP) rules define demand response in the context of the definition of an energy management measure. The Missouri IRP rules define energy management as any device, technology, or operating procedure that makes it possible to alter the time pattern of electricity usage so as to require less generating capacity or to allow the electric power to be supplied from more fuel efficient generating units. Energy management measures are sometimes referred to as demand response measures.

While the definitions have commonalities, the FERC definition of demand response is clear that the purpose of demand response is to either (1) induce lower electricity use at time of high wholesale market prices or (2) provide relief when system reliability is jeopardized. It is important in any analysis of Ameren Missouri's demand response potential to keep both of these purposes in mind when examining the value proposition to all of Ameren Missouri's end-use customers.

An aspect to note in the Missouri IRP rule's definition of demand response is the inclusion of the term "demand response measures" which includes both energy efficiency and demand response. Energy efficiency refers to using less energy to provide the same level of service to the energy consumer in an economically efficient way. Energy efficiency is about replacing an inefficient measure, such as an incandescent light bulb, with an efficient measure such as a compact fluorescent light bulb. Demand response, in contrast, is a program based on a change in customer

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behavior changing their normal electricity consumption patterns. There are no industry standard baseline expectations for such changes in behavior as there are for energy efficiency (where one can simply calculate the change in energy consumption from installing a new light bulb for example). Since demand response is a customer behavior change program and not a specific measure, there simply are no effective useful life standards to be applied in the cost effectiveness analyses of demand response programs.

The National Action Plan For Energy Efficiency (NAPEE) paper entitled "Coordination of Energy Efficiency and Demand Response" published in January 2010 echoes these facts (that energy efficiency is about the implementation of measures and demand response is about programs). Here are two extracts from the NAPEE paper:

Page 2-1:

"The definition of energy efficiency makes three key assumptions: (1) existing consumer devices are replaced with devices that use less energy, assuming no change in operating practice; (2) new energy-using devices should perform their functions using less energy; and (3) actual kilowatt-hour usage is reduced, irrespective of when that reduction occurs (i.e., it is not time-sensitive)."

Page 2-7:

"When customers participate in demand response, there are three possible ways in which they can change their use of electricity (DOE, 2006):

- *Customers can forego or reduce some uses of electricity. Raising thermostat settings, reducing the run time of air conditioners, dimming or reducing lighting levels, or taking some elevators out of service are common customer load curtailment strategies.*
- *Customers can shift electricity consumption to a time period outside the demand response event or when the price of electricity is lower. For example, an industrial facility might employ storage technologies to take advantage of lower cost off-peak energy, reschedule or defer some production operations to an overnight shift, or in some cases, shift production to companion plants in other service areas. Similarly, with enough notice, commercial or residential customers could pre-cool their facilities and shift load from a higher to lower cost time period. Residential and commercial customers could also choose to delay running certain appliances until prices are lower. Most successful demand response programs have a customer override capability that allows the customer to choose not to adjust its energy use when a specific demand response event is called."*

8.7.2 Ameren Missouri History of Implementation of Customer Demand Response Programs

- Ameren Missouri offered an interruptible rate to large industrial customers from 1983 through 2000. Five (5) participating Ameren Missouri customers provided a total contractual commitment of 54 MW of interruptible load. The interruptible tariff was structured with a 50% demand charge credit which averaged approximately $5/kw-month at the time. Interruptible events were limited to system reliability emergencies. Few interruptible events were called each year. As stated above, the interruptible rate tariff was discontinued in 2000.

- In 1994, Ameren Missouri also offered a subsequent pilot interruptible rate referred to as Rider G for smaller industrial customers with smaller demand charge credits. Four (4) participating Ameren Missouri customers provided a total contractual commitment of 17 MW of interruptible load. Each of these 4 customers experienced a need for increased firm power due to growth of operations and, subsequently, each eventually opted out of participating on the rate. Rider G was discontinued in 2003.

- The Company offered commercial and industrial customers a voluntary curtailment rate option or a peak power rebate (PPR) program referred to as Rider L beginning in 1999. The Company opted to offer a non-penalty based price-responsive DR on the premise that customers may be more likely to sign-up for non-penalty based programs and that penalty based and non-penalty based programs have similar response characteristics. The PPR program structure allows customers to remain on the standard rate for all non-event hours and switch to an incentive rate for a pre-determined number (in this case 60) of critical-peak event hours during a program year.

  There was a total of twenty (20) customers representing a total potential load of 67 MW enrolled in Rider L of the Company's retail electric service tariff. The last Rider L curtailment event was called in 2009. A total of 4 Rider L customers participated in the 2009 curtailment events and all 4 customers combined offered a range of approximately 6 to 9 MW peak demand reduction per event. The Company removed Rider L from its tariffs in 2013.

- The Company also offered a commercial and industrial customer interruptible program with a slight difference from the Rider L program structure. The Company implemented Rider M in 2000, and it remains available to qualifying customers. Rider M is also voluntary and pays participating customers a monthly curtailment option fee plus a price per (KWH). These fees and kWh prices provided for under Rider M were agreed upon in advance by the Company and the customer, based upon various customer selected curtailment options contracted for with the Company, and are applicable during the summer billing months of June – September.

- In Case No ER-2007-0002 Ameren Missouri proposed a tariff to implement a new industrial demand response pilot program known as Rider IDR. The pilot program was designed to assess whether industrial process customers would/could respond to load curtailments to interrupt their use of power when they are directed to do so by the Company. The tariff defined the occasions when a customer could be asked to interrupt, but the decision to interrupt would be at the discretion of Ameren Missouri. Rider IDR limited the hours available for interruption to 200 hours per year. The customer could choose the amount of curtailable load to be included in the program. The availability of the program was to be limited to no more than five customers with a total demand response aggregated load of 100 MW and would last for three years. Customers who agreed to participate in the program would be paid a demand credit of $2.00 per kW per month with an additional credit of 8 cents per kWh when interrupted. Rider IDR was never implemented due primarily to the inability to align the provisions in the Rider with the MISO requirements for qualification of a program for resource adequacy purposes necessary to qualify the program for participation the MISO market.

- In 2004 and 2005 the Ameren Missouri conducted a Residential Time-Of-Use (RTOU) Pilot study. The RTOU Pilot study encompassed two innovative rate offerings that provided financial incentives for customers to modify their consumption patterns during higher priced "critical peak periods" (i.e., CPP). Originally, the rate offerings were organized into three treatment groups for the Pilot study and included:

  Treatment Group #1 – These customers received a three-tier time-of-use rate[50] with high differentials;

  Treatment Group #2 - These customers received the same time-of-use rate as the first treatment group but were also subject to a critical peak pricing (CPP) element; and

  Treatment Group #3 - These customers received the same treatment, i.e., TOU rate and CPP, as treatment group number two but had enabling technology, i.e., a "smart" thermostat, installed by Ameren Missouri. The enabling technology automatically increased the customer's thermostat setting during critical peak pricing events.

  For 2005, the first treatment group, i.e., the time-of-use rate only, was dropped from the Pilot Study. The principal reason for dropping the time-of-use only group was that this group failed to display a significant shift in load from the on-peak to the mid-peak or off-peak periods. Therefore, the second year pilot focused on the critical peak pricing element and those customers with "smart" thermostats. Fifteen-minute interval load monitoring equipment was available on the total premises load for a statistically representative sample of customers in each treatment group. In addition to the treatment groups, the Company constructed control groups for use in the analysis. Once again, fifteen-minute interval load monitoring equipment was available on a statistically representative sample of control group customers.

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[50] The TOU rates differ by season (i.e., summer versus winter).

Table 8.13 presents findings for the eight critical peak pricing periods in 2005. The table presents the average demand for the control and RTOU treatment groups. An additional 0.52 kW on average was achieved by the group with the enabling technology of a programmable controllable thermostat.

Table 8.13: Peak Pricing Periods 2005[51]

Three Tier TOU with CPP (CPP)

CPP Event			Control Group (kW)	RTOU Pilot Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)			
	Hour Ending								
Date	Start	End					T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5 35	4 85	0 50	9 3%	2 63	0 0088	Reject
21-Jul-05	3:00 PM	6:59 PM	5 71	4 91	0 80	14 1%	3 75	0 0002	Reject
22-Jul-05	3:00 PM	6:59 PM	5 84	5 05	0 79	13 5%	3 54	0 0005	Reject
26-Jul-05	3:00 PM	6:59 PM	5 98	4 91	1 06	17 8%	5 28	0 0000	Reject
2-Aug-05	3:00 PM	6:59 PM	5 38	4 73	0 65	12 1%	3 24	0 0013	Reject
9-Aug-05	3:00 PM	6:59 PM	5 64	4 74	0 90	16 0%	4 33	0 0000	Reject
10-Aug-05	3:00 PM	6:59 PM	5 01	4 24	0 76	15 2%	4 00	0 0000	Reject
19-Aug-05	3:00 PM	6:59 PM	5 61	4 88	0 74	13 1%	3 54	0 0004	Reject
Average			5 56	4 84	0 72	13 0%	3 90	0 0001	Reject

Three Tier TOU with CPP and Thermostat (CPP-THERM)

CPP Event			Control Group (kW)	RTOU Group (kW)	Difference Control-RTOU (kW)	Percent Difference (%)			
	Hour Ending								
Date	Start	End					T-Test	Pr>|t|	Ho: Control=RTOU
30-Jun-05	3:00 PM	6:59 PM	5 02	4 30	0 72	14 4%	2 93	0 0036	Reject
21-Jul-05	3:00 PM	6:59 PM	5 37	4 09	1 27	23 7%	5 22	0 0001	Reject
22-Jul-05	3:00 PM	6:59 PM	5 38	4 18	1 20	22 4%	5 39	0 0001	Reject
26-Jul-05	3:00 PM	6:59 PM	5 56	4 38	1 18	21 2%	4 93	0 0001	Reject
2-Aug-05	3:00 PM	6:59 PM	5 23	3 66	1 57	30 0%	6 30	0 0001	Reject
9-Aug-05	3:00 PM	6:59 PM	5 47	4 01	1 46	26 7%	5 76	0 0001	Reject
10-Aug-05	3:00 PM	6:59 PM	4 95	3 82	1 13	22 8%	4 95	0 0001	Reject
19-Aug-05	3:00 PM	6:59 PM	5 38	3 97	1 41	26 1%	5 49	0 0001	Reject
Average			5 29	4 05	1 24	23 5%	6 05	0 0001	Reject

- From 1993 to 1998 Ameren Missouri implemented a residential central air conditioner direct load control program called "No Sweat". The Company invested a total of $1.9 million implementing the program during that time. The program paid customers an annual incentive payment of $40 for the option to interrupt their air conditioners a finite number of times. Customers participating in the program also received free HVAC diagnostic services from HVAC contractors hired by Ameren Missouri. Communication to switches that cycled customer air conditioners off and on was handled by the existing 154 MHz radio infrastructure at Ameren Missouri. Dead zones and poor reception reduced the cycling benefits, while the manual policing of the radio system added to the program cost.

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[51] Volume 4 of the Ameren Missouri DSM Potential Study

- In 2009, Ameren Missouri conducted a Personal Energy Manager (PEM) Rebate Pilot Program that had the dual purpose of assessing the effectiveness of potential residential price response programs and testing the associated technology. Part of the technology test was to determine whether new vendor (Tendril) hardware was compatible with Ameren Missouri's automated meter reading (AMR) system and how well it would interface with the AMR meters.

  This pilot program provided bill credits to residential customers who, at Ameren Missouri's request, voluntarily reduced their electricity consumption during Price Response Events designated by Ameren Missouri. To minimize any potential customer inconveniences, participants were recruited from Ameren Missouri employees who volunteered to take part. The program provided technology that enabled interactive energy monitoring and remote thermostat control in the home, allowing Ameren Missouri to test the technology. (The technology also assisted the customer in managing their electricity consumption during non-events.) The pilot program was implemented with installation of varying configurations of the new Tendril equipment in the homes of 374 Ameren Missouri employees during June and July of 2009.

  The industry name for demand response programs with voluntary participation and no penalties for non-participation when load curtailment events are called is Peak Time Rebates (PTR). A key finding from the 2009 Ameren Missouri PEM pilot in the independent third party evaluation of the program conducted by the team of Cadmus and PA Consulting was the difficulty in estimating an accurate baseline against which to assess load reductions by program participants. Cadmus and PA noted that customers who had taken no load reduction actions were often given an incentive payment and customers who had taken load reduction actions were often not compensated for their efforts. This may have been the first documentation that questioned the premise that PTR programs had no "losers." Subsequent evaluation, measurement and verification of large scale PTR programs in other jurisdictions, most notably California, have shown that voluntary PTR is not a "no losers" program when payment for non-performance due to measurement error is considered.

8.7.2.1 Summary of Ameren Missouri Demand Response Program History

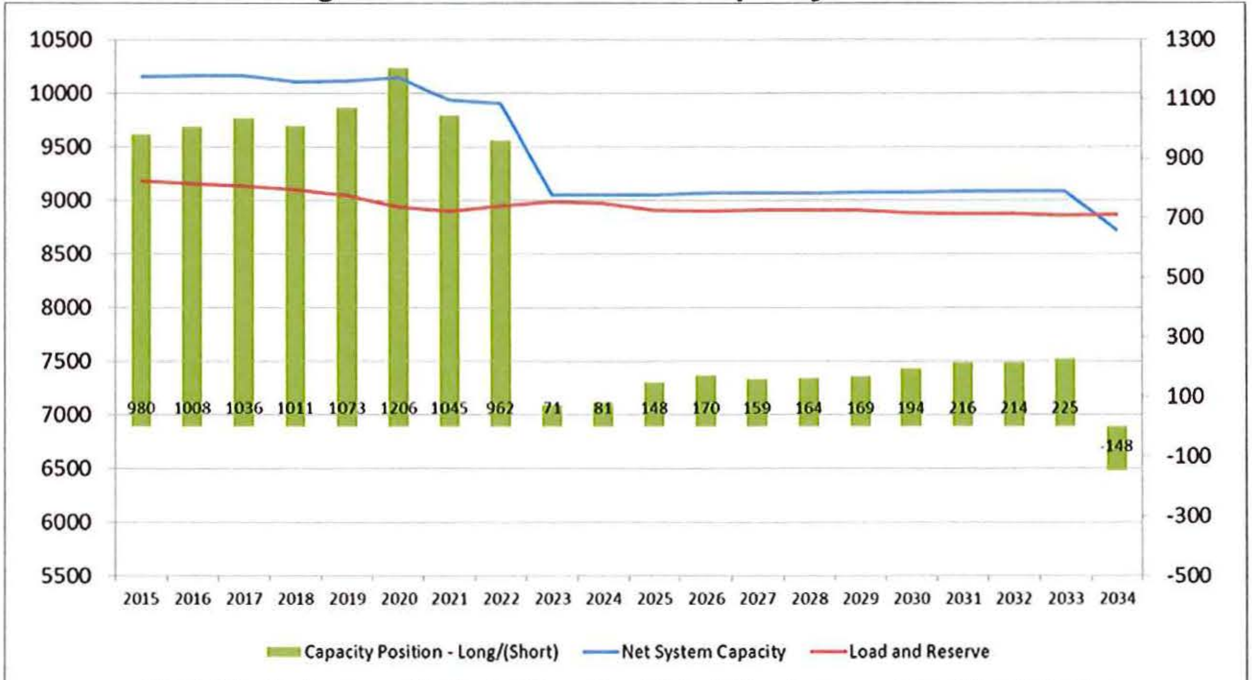
Each of the eight Ameren Missouri demand response programs had a finite effective useful life. Some programs were terminated because the value received was not commensurate with the value paid. Some programs were terminated because they were pilot programs and fulfilled their pilot program testing objectives. Some programs were terminated because they were determined through evaluation not to be cost effective. Some programs were terminated simply because customers were not interested in participating.

8.7.3 Ameren Missouri Capacity Position

Referring back to the definitions of demand response, recall that the purpose of demand response is to either (1) induce lower electricity use at times of high wholesale market prices or (2) provide relief when system reliability is jeopardized. The purpose or objective(s) for implementing demand response programs for Ameren Missouri customers is essential in the development of the realistic achievable potential for cost effective demand response.

Figure 8.13 depicts the Ameren Missouri's baseline capacity position through 2030 at the time of this analysis.

Figure 8.13: 2013 Baseline Capacity Position



Note: Left-hand scale corresponds to Load and Generation; right-hand side scale corresponds to net Capacity Position

The graph in Figure 8.13 indicates that Ameren Missouri expected to be long on capacity through 2030. Consequently, Ameren Missouri would not need, at least under circumstances at the time of this analysis, demand response capability to provide capacity for system reliability through 2030. Granted, there may be circumstances under which the Ameren Missouri capacity position may change, as evidenced by the analysis of alternative resource plans discussed in Chapter 9. Examples of such circumstances include the retirement of one or more existing coal plants and an increase in the electric sales forecast.

The discussion of the Ameren Missouri current capacity position shows (1) that Ameren Missouri has sufficient resources to meet its own resource adequacy requirements under the MISO tariff in the near term planning horizon of 2016-2018 as well as in the long term through 2030. Ameren Missouri continuously re-evaluates its capacity position as conditions change – conditions including plant retirement studies and load forecast sensitivities. However, acquiring additional resources (whether demand response or other resources) in the near term will only increase the current surplus position for the Company in that time period.

8.7.4 Market Prices for Capacity

Referring back to the definitions of demand response, recall that one of the purposes of demand response is to induce lower electricity use at times of high wholesale market prices.

Given that Ameren Missouri does not currently require demand response to meet its own reliability needs, the primary benefit of utilizing such a resource in the 2016-2018 implementation planning period would be in the form of providing an incremental resource to the marketplace – primarily in the form of additional capacity. It is critical in this discussion to recognize that Ameren Missouri is a participant in the MISO markets. As such, its generation is dispatched into the market whenever its incremental production cost is less than the Locational Marginal Price (LMP) established for that generators' pricing zone. What this means is that as long a generator is "in the money" it will run. Adding additional energy resources does not directly result in a reduction in Ameren Missouri's generation, unless a specific generator is the marginal unit in the MISO market.

It is impossible in today's current market to structure a "cost based" tariff for DR programs where the compensation amount is pre-specified ($ amount, not formula) without ending up with significant deviations to actuals (and thus other customers either subsidizing or being enriched by participants).[52] The most effective means of ensuring

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[52] 4 CSR 240-22.050(4)(F)

that customers are not over (or under) paid would be to structure the tariffs to provide for the pass through to demand response customers of actual revenues (and charges) received from the applicable MISO market (less a reasonable admin fee). The exception to this rule would be for a program which was designed specifically to avoid construction of capacity – and even then, if the customer is not obligated to participate for the period of time in which the capacity deficiency is expected to occur, then they are simply being overpaid in the interim.

The reality is that most DR service providers require compensation somewhere in the vicinity of the effective annualized cost of a new combustion turbine generation (CTG) for each MW of load reduced to make the business case for providing demand response services. Among other costs, significant investments for DR service providers include network operations centers, telecommunications systems, IT infrastructure, marketing expertise, risk management frameworks and the provision of financial incentives to customers to participate in DR programs. A DR business model that would allow the compensation received for DR customer load reduction services to vary and to fall to almost zero as the MISO market experienced for capacity in 2013 would not be a viable business model for DR service providers.

MISO demand response market participation rules are established in its FERC approved Tariff and further detailed in its Business Practice Manual (BPM) No. 026. The MISO demand response market participation rules will be discussed in more detail later in the description of how Ameren Missouri defines Realistic Achievable and Maximum Achievable demand response potential.

It is important to put context around the current value of capacity in the MISO market. MISO capacity market results for the 2013/2014 year cleared at $1.05/MW-day. MISO cleared with 8,100 MW of excess capacity not clearing and 96% of bids offered as price takers at a price of zero. UBS Investment Research, in a discussion of the MISO capacity markets on April 18, 2013 stated, "Given substantial oversupply and the current market construct, we would expect prices to continue to clear at low prices going forward."

The PJM 2016/2017 Base Residual Auction (BRA) experienced declines from prior auctions in the market value of capacity as shown in the Table 8.14 from PJM:

Table 8.14: PJM Market Value of Capacity

	RTO									
Auction Results	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012[1]	2012/2013	2013/2014[2]	2014/2015[3]	2015/2016[4]	2016/2017[5]
Resource Clearing Price	$40.80	$111.92	$102.04	$174.29	$110.00	$16.46	$27.73	$125.99	$136.00	$59.37
Cleared UCAP (MW)	129,409.2	129,597.6	132,231.8	132,190.4	132,221.5	136,143.5	152,743.3	149,974.7	164,561.2	169,159.7
Reserve Margin	19.2%	17.5%	17.8%	16.5%	18.1%	20.9%	20.2%	19.6%	20.2%	21.1%

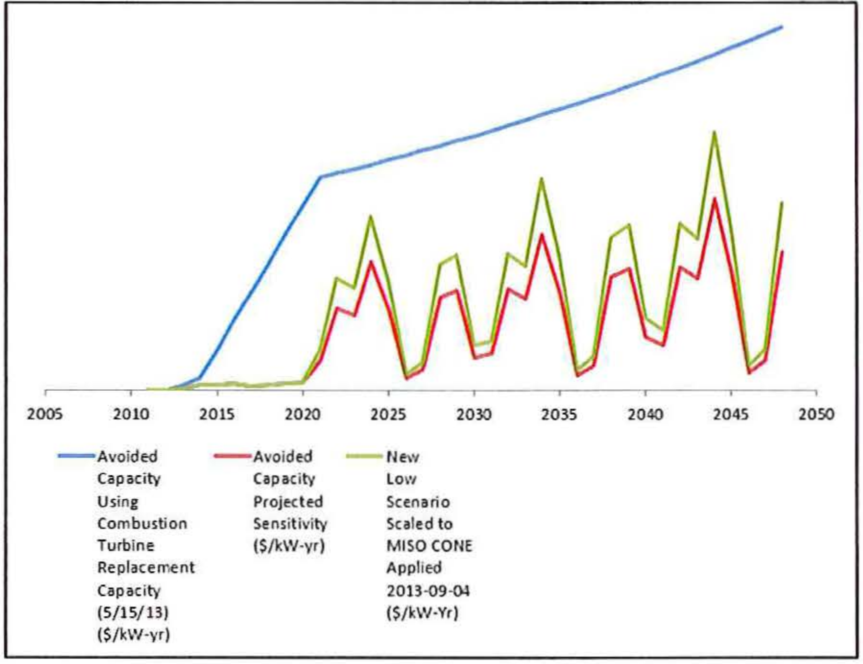
1) 2011/2012 BRA was conducted without Duquesne zone load.
2) 2013/2014 BRA includes ATSI zone
3) 2014/2015 BRA includes Duke zone
4) 2015/2016 BRA includes a significant portion of AEP and DEOK zone load previously under the FRR Alternative
5) 2016/2017 BRA includes EKPC zone

While the PJM 2016/2017 BRA capacity price of $59.37/MW-day is significantly higher than the 2013/2014 MISO capacity price of $1.05/MW-day, $59.37/MW-day is equivalent to approximately $22/kw-year, far below the levelized cost of a CTG or the typical cost of a DR program.

The discussion of the acquisition of demand response resources from Ameren Missouri customers for purposes of bidding into the MISO capacity market shows that there is market price volatility and prices are far below that of the typical cost of a DR program.

With the preceding background, the following graph shows the Ameren avoided capacity assumptions at the time of the completion of the 2013 DSM Potential Study versus a projection of avoided capacity costs based on a multi-dimensional analysis of MISO's projected capacity position over time as well as an analysis of the market price of capacity in other more mature RTO capacity markets:

Figure 8.14: Avoided Cost Sensitivity Curves



Ameren Missouri assumptions for the market price for capacity are based on the assumption that load and generation come into equilibrium at some future point. When equilibrium is reached and there is no excess generating capacity, new resources will be required to meet resource adequacy requirements, and these resources will have a cost comparable to MISO's assumed Cost of New Entry (CONE). Ameren Missouri's assumption is that capacity price remains at CONE to the end of the planning horizon.

The alternative or market sensitivity capacity view is indicative of a more dynamic market with the balance between load and generation ebbing and flowing such that capacity prices approaching those of new CTGs may seldom, if ever, be reached. The alternative view is based on an analysis of actual historical capacity transactions.

The graph of the RTO historical view for capacity versus the assumption that the market price for capacity will eventually approach those of the cost to build a new CTG illustrates high risk and wide bands of uncertainty associated with considering Ameren Missouri customer demand response programs for which customers derive value if the opportunity to reduce customer revenue requirements as the result of a supply and demand imbalance situation in MISO should arise.

It is important to note again that Ameren Missouri revised assumptions for MISO market capacity prices shortly after the completion of the 2013 DSM Potential Study. Repeating Figure 8.15 illustrates the revised assumptions for capacity price relative to the assumptions used for the DSM Potential Study:

Figure 8.15: Avoided Energy and Capacity Comparison, MEEIA Cycle 2013 - 2015 vs. MEEIA Cycle 2016 - 2018 (2010 vs 2013 Potential Comparison) - **NP**

[redacted]

**

The dashed purple line denotes the current Ameren Missouri assumptions for avoided capacity. It approximates the lower alternative view of capacity prices referenced in the 2013 Ameren Missouri DSM Potential Study.

8.7.5 Demand Side Management Program Qualification to Participate in MISO Markets and Resource Adequacy Construct

Provisions exist in the MidContinent ISO (MISO) for demand side management programs to participate in markets for energy, capacity and ancillary services, depending on the capabilities of the resource and the manner in which the program owner has chosen to register the resource with MISO. Of particular importance is the requirement that only those programs with mandatory curtailment provisions requiring the resource to be available for use in the event of an emergency declared by the MISO, pursuant to their emergency operating procedures, qualify for capacity purposes or as an Emergency Demand Resource. Programs which make curtailment an economic option for the participant do not qualify for those purposes.

In addition to participating in the capacity markets, qualified and properly registered DSM programs may also participate in the MISO energy and ancillary services markets. Programs which are not qualified to be properly registered in the MISO market may still be able to indirectly participate in the energy markets by reducing output in a given hour thereby reducing Ameren Missouri's load clearing requirement in the MISO for that hour.

As such, the valuation of a given DSM program necessarily requires an understanding of whether the program will qualify for registration in the MISO Markets, and for which specific products. A program which does not contain mandatory curtailment provisions during MISO emergency events cannot properly be assigned a value for capacity (the current assumption being that this provides the primary value to DSM programs), but may be assigned a value for energy.

8.7.6 Determination of Realistic Achievable and Maximum Achievable Demand Response Potential

The definitions of Realistic Achievable Potential (RAP) and Maximum Achievable Potential (MAP) necessarily are different for energy efficiency and demand response for Ameren Missouri. The reason is the current MISO demand response market construct within which Ameren Missouri would bid its demand response capacity resources. Ameren Missouri does not have similar MISO constructs for its customer energy efficiency programs.

For energy efficiency, RAP represents a forecast of likely customer behavior under realistic program design and implementation. It takes into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. For example, it considers more realistic incentives (i.e., less than 100% of incremental cost), defined marketing campaigns, and internal budget constraints. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. The RAP also takes into account recent utility experience and reported savings.

For energy efficiency, MAP establishes a hypothetical upper limit for the savings a utility can hope to achieve through its programs. MAP involves incentives that represent up to 100% of the incremental cost of energy efficiency measures above baseline measures combined with high administrative and marketing costs.

Demand response RAP and MAP definitions are much different than for energy efficiency due to the fact that demand response is a totally different product offered in a totally different market – the MISO capacity market. The analysis approach for estimating demand response potential is, by necessity, different from the approach used for energy efficiency. Energy efficiency can occur outside of utility programs to the extent that it is naturally occurring or technology driven; but can be enhanced and enabled by utility programs. Demand response, however, does not exist without a utility program in the Ameren Missouri service territory. Therefore, a program-by-program analysis is at the core of a demand-response Potential Study. The basic steps to perform this assessment are as follows:

- **Characterize the market.** The first step is to segment the market into the relevant customer segments. The first level of segmentation is by sector: residential and C&I customers. Within residential customers, the population is segmented further by describing housing types and presence of end uses (such as single family homes with central air conditioning and electric water heating). For C&I customers, the next level of segmentation is based on the maximum demand values, typically following utility rate schedules. Segmentation may also be by building type or industry
- **Identify the baseline forecast.** The second step is to identify what the peak demand forecast will be absent any DR programs for the relevant peak season, typically summer.
- **Define relevant DR options.** The next step is to identify applicable DR options for each customer segment.
- **Outline DR program participation hierarchy.** For each customer segment that has more than one DR option, the next step is to define the participation hierarchy. This accounts for program overlaps and ensures that cross-participation in DR events and double counting does not take place.

Ameren Missouri defines RAP for the case in which Ameren Missouri might acquire customer demand response resources for the sole purpose of bidding into the MISO capacity market as:

> A forecast of likely customer behavior under realistic program design and implementation within the current MISO capacity market construct. It takes into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through demand response programs in other RTO jurisdictions.

Ameren Missouri defines MAP to be the case in which Ameren Missouri might acquire customer demand response resources for system reliability under revised

MISO demand response business practices where voluntary customer curtailment programs would be eligible to participate in the MISO capacity market.

8.7.7 Capacity Equivalence

Capacity Equivalence is the true capacity value of a program (DSM, DR, wind, hydro, etc.).

$$1 \text{ MW of DSM} \neq 1 \text{ MW of Gas} \neq 1 \text{ MW of Coal Generation}$$

The calculation of the amount of reserve MW at time of system peak may not provide an indication of the capacity, or load relief that will be available throughout the ***entire year*** to meet customer requirements. Capacity equivalence is determined at system level with adjustments for reserve margin and distribution losses. It varies according to the pattern of load relief afforded by the potential program.

Examples of typical capacity equivalence factors include:

Table 8.15: Typical Capacity Equivalence Factors

Programs	CE	comments
Water Heating & Lighting Measures	1.286	Informational
Central AC and Heat Pump Cycling	0.553	50% cycling using radio receiver
Water Heater Cycling	0.605	
Refrigerator Removal	1.016	prevent primary refrigerators from becoming secondary refrigerators
Freezer Removal	0.947	
Central A/C and Heat Pump Shading	0.929	Informational

Capacity equivalence is factored into the capacity benefit of demand response programs in the following manner:

$$\text{Avoided Capacity Benefit} = \text{Avoided Capacity Cost} \times \text{Peak Demand Reduction} \times \text{Capacity Equivalence}$$

Although Ameren Missouri has conducted rigorous capacity equivalence analyses on potential new intermittent type resources in the past when system reliability was an issue, Ameren Missouri did not calculate capacity equivalence for potential demand side resources because demand response programs are not required in the planning horizon for system reliability.

8.7.8 Demand Response Program Effective Useful Lives

Demand response is a customer behavior change program. It is not like an energy efficiency measure which is equipment related and may have an effective useful life of 18 years such as a central air conditioning unit or 25+ years for an LED light bulb.

Demand response is modular. It can be installed in discrete chunks, i.e., 50 MW blocks and it can be removed in discrete chucks. The history of the eight Ameren Missouri demand response programs illustrates the modularity of customer demand response programs. A non-Ameren Missouri example of the modularity of demand response programs is the 2013 decision by the Idaho Public Utilities Commission (IPUC) to ramp down two existing customer demand response programs at Idaho Power Company due to Idaho Power having sufficient generation capacity to meet 100% of its load obligations. The IPUC subsequently reinstated demand response after mandating two critical assumptions which resulted in the programs being found to be cost effective. These assumptions were: (1) the effective useful life is 20 years, and (2) the avoided capacity cost against which to evaluate the benefits of demand response is a new 170 MW combustion turbine generator. Another example is the ramp down of demand response resources bid into the 2016/2017 PJM capacity auction due to PJM's acquisition of new natural gas power supply sources and increased capacity import capabilities. There are no "best practice" guidelines as to what the effective useful lives of demand response programs should be because demand response is modular by design.

The development of an effective useful life assumption is critical to the cost effectiveness calculation of any demand response resource. Ameren Missouri has chosen to assume a three year useful life for all demand response resources in the estimation of demand response potential. The three year useful life is assumed to coincide with each of Ameren Missouri's three year Missouri Energy Efficiency Investment Act (MEEIA) implementation plans.

Ameren Missouri has chosen to assume a three year effective useful life in large part to mitigate MISO capacity market price risk and uncertainty. This is due to the fact that the primary value proposition of demand response to Ameren Missouri customers in the current planning horizon is to sell capacity into the MISO market for the purpose of reducing revenue requirements. The 2013/2014 MISO capacity auction yielded capacity prices of $1.05/MW-day or essentially $0 per kw-year.

8.7.9 Peak Time Rebate (PTR) Programs

The 2010 Ameren Missouri DSM Potential Study, used in the development of the Ameren Missouri MEEIA Cycle 2013 - 2015 DSM implementation plan, selected a customer opt-out Peak Time Rebates (PTR) construct to represent the potential for mass market demand response. PTR was selected because it is a credit only program and customer opt-in rates are better for credit only programs than other penalty and dynamic pricing programs such as critical peak pricing (CPP). Since 2010 there has been significant activity in the evaluation of PTR programs. The results have refuted the heretofore held belief that PTR programs had no "losers" and only "winners."

In 2012, San Diego Gas & Electric Company (SDG&E) enrolled approximately 1.2 million residential customers in a PTR program, branded as "Reduce Your Use Rewards." PTR is a pay for performance program that pays customers to reduce electricity use during the peak period on selected days (referred to as event days) that are not known until the day before they occur. The incentive is paid based on the difference between the metered load during the peak period on event days and an estimate of what the customer would have used during the same period if the PTR event had not occurred. This estimate is referred to as the baseline load. The accuracy and magnitude of incentive payments are dependent on the accuracy of the baseline estimate. Given the normal fluctuation in any given residential customer's usage across days, it is very difficult to accurately estimate baselines for individual customers on individual event days. The evaluation of the SDG&E PTR pilot showed conclusively that baseline and payment errors resulted in payments being made to customers who do not reduce demand. These payment errors must be recovered from all customers.

Consequently, for the 2013 Ameren Missouri DSM Potential Study, Ameren Missouri selected CPP rather than PTR to represent residential dynamic pricing demand response potential.

8.7.10 FERC National Assessment of DSM Potential – 2009

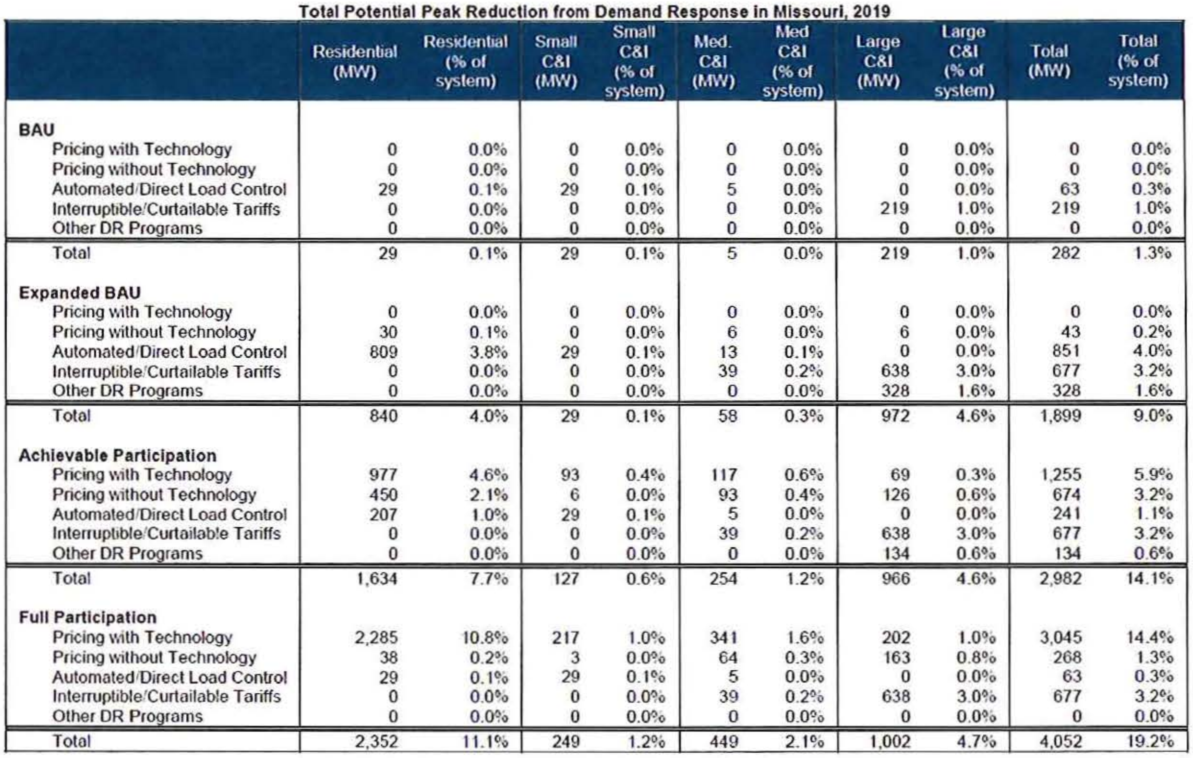
Many DR Potential studies attempt to benchmark to the June 2009 FERC National Assessment of DSM Potential. In fact, the 2010 Ameren Missouri DR Potential Study was benchmarked to the FERC study.

The 2013 Ameren Missouri DR Potential Study does not attempt to benchmark to the 2009 FERC study for a variety of reasons including:

- The age of the report. The industry has advanced its knowledge of DR potential considerably since 2009. One example is the analysis of empirical data on the true costs and benefits of a PTR program, as described in the previous section.

  - The study does not address the situation where an IOU is long on capacity as is the RTO in which it operates.
  - The applicability of secondary data sources for DR impacts should be supplanted by Ameren Missouri primary data sources for DR impacts in any instance.
- Assumptions around dynamic pricing rates, dynamic pricing customer participation estimates and dynamic pricing load reduction impacts are not representative of Ameren Missouri. For example, the 2009 FERC study shows the following amounts of DR potential for Missouri in 2019:

Table 8.16: Total Potential Peak Reduction from DR in MO, 2019



Total Potential Peak Reduction from Demand Response in Missouri, 2019

	Residential (MW)	Residential (% of system)	Small C&I (MW)	Small C&I (% of system)	Med. C&I (MW)	Med C&I (% of system)	Large C&I (MW)	Large C&I (% of system)	Total (MW)	Total (% of system)
BAU										
Pricing with Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pricing without Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Automated/Direct Load Control	29	0.1%	29	0.1%	5	0.0%	0	0.0%	63	0.3%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	0	0.0%	219	1.0%	219	1.0%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	29	0.1%	29	0.1%	5	0.0%	219	1.0%	282	1.3%
Expanded BAU										
Pricing with Technology	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pricing without Technology	30	0.1%	0	0.0%	6	0.0%	6	0.0%	43	0.2%
Automated/Direct Load Control	809	3.8%	29	0.1%	13	0.1%	0	0.0%	851	4.0%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	39	0.2%	638	3.0%	677	3.2%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	328	1.6%	328	1.6%
Total	840	4.0%	29	0.1%	58	0.3%	972	4.6%	1,899	9.0%
Achievable Participation										
Pricing with Technology	977	4.6%	93	0.4%	117	0.6%	69	0.3%	1,255	5.9%
Pricing without Technology	450	2.1%	6	0.0%	93	0.4%	126	0.6%	674	3.2%
Automated/Direct Load Control	207	1.0%	29	0.1%	5	0.0%	0	0.0%	241	1.1%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	39	0.2%	638	3.0%	677	3.2%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	134	0.6%	134	0.6%
Total	1,634	7.7%	127	0.6%	254	1.2%	966	4.6%	2,982	14.1%
Full Participation										
Pricing with Technology	2,285	10.8%	217	1.0%	341	1.6%	202	1.0%	3,045	14.4%
Pricing without Technology	38	0.2%	3	0.0%	64	0.3%	163	0.8%	268	1.3%
Automated/Direct Load Control	29	0.1%	29	0.1%	5	0.0%	0	0.0%	63	0.3%
Interruptible/Curtailable Tariffs	0	0.0%	0	0.0%	39	0.2%	638	3.0%	677	3.2%
Other DR Programs	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total	2,352	11.1%	249	1.2%	449	2.1%	1,002	4.7%	4,052	19.2%

It is apparent that residential pricing accompanied by DR enabling technology accounts for the majority of DR potential in 2019.[53]

Compare and contrast the FERC 2009 National Demand Response study for Missouri with the 2013 Ameren Missouri Demand-Side Rates Potential Study. It should be noted that the Brattle Group conducted both studies.

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[53] 4 CSR 240-22.050(3)(D)

Table 8.17: 2013 Ameren Missouri Demand-Side Rates Potential Study[54]

Combination	Participation Scenario	Residential Rate	SGS Rate	LGS Rate	Peak Reduction (MW)	Peak Reduction (% of System Peak)
1	Opt-In	TOU	TOU	CPP	69	0.82%
2	Opt-In	IBR	TOU	CPP	78	0.93%
3	Opt-Out	TOU	TOU	CPP	259	3.07%
4	Opt-Out	IBR	TOU	CPP	294	3.48%

- One size does not fit all. For example, most of Ameren Missouri residential air conditioning load has a peak demand below 5 kW. This impacts the peak load reduction per home which, in turn, impacts the cost effectiveness of RES demand response programs.

The FERC study has a "Full Participation" scenario which is similar to technical potential which has little value for an Ameren Missouri DSM Potential Study.

8.7.11 2013 DR Potential Study Results

There are three sets of avoided capacity costs used to assess demand response potential over the 2016-2034 planning horizon. The first is the Ameren Missouri avoided capacity cost curve at the time the 2013 DSM Potential Study began. The second is the MISO market based sensitivity capacity cost curve developed to emulate actual capacity prices in MISO and other RTOs. The third is the most recent Ameren Missouri avoided capacity cost curve that was approved in February 2014, approximately two months after the completion of the 2013 DSM Potential Study.

Knowing the history and chronology of the Ameren Missouri avoided capacity cost curves, Table 8.18 below is an extract from the 2013 DR Potential Study using the avoided capacity curves set forth at the outset of the study.

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[54] Volume 6 of Ameren Missouri DSM Potential Study

Table 8.18: Ameren Missouri Peak Demand Savings Potential[55]

	2016	2017	2018		2025	2030
System Peak Forecast (MW)	7,328	7,368	7,420		7,901	8,241
Peak Demand Savings (MW)						
RAP Program Potential		16	60		234	238
MAP Program Potential		16	60		286	303
Savings (% of System Peak)						
Realistic Achievable Potential	0.0%	0.2%	0.8%		3.0%	2.9%
Maximum Achievable Potential	0.0%	0.2%	0.8%		3.6%	3.7%

Table 8.19 below is also an extract from the 2013 DR Potential Study. This table shows the results of the sensitivities around the results in Table 8.18. The row named "Market-based Avoided Costs" reflects the results using market-based avoided capacity costs.

Table 8.19: Peak Demand Savings Sensitivities

	2016	2017	2018	2025	2030
RAP DR Potential (MW)					
Base Case	-	16	60	234	238
Market-based Avoided Costs	-	-	-	-	-
Longer Program Life	55	126	238	434	446
RAP DR Potential (% of the system peak)					
Base Case	-	0.22%	0.80%	2.96%	2.89%
Market-based Avoided Costs	-	-	-	-	-
Longer Program Life	0.75%	1.71%	3.21%	5.49%	5.41%
MAP DR Potential (MW)					
Base Case	-	16	60	286	303
Lower Avoided Costs	-	-	-	52	53
Longer Program Life	55	126	238	540	563
MAP DR Potential (% of the system peak)					
Base Case	-	0.22%	0.80%	3.62%	3.68%
Lower Avoided Costs	-	-	-	0.66%	0.64%
Longer Program Life	0.75%	1.71%	3.21%	6.83%	6.83%

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[55] Volume 4 of Ameren Missouri DSM Potential Study